NFPA®

350

Guide for Safe Confined Space Entry and Work

2019

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NFPA® 350

Guide for

Safe Confined Space Entry and Work

2019 Edition

This edition of NFPA 350, *Guide for Safe Confined Space Entry and Work*, was prepared by the Technical Committee on Confined Space Safe Work Practices. It was issued by the Standards Council on November 5, 2018, with an effective date of November 25, 2018, and supersedes all previous editions.

This edition of NFPA 350 was approved as an American National Standard on November 25, 2018.

Origin and Development of NFPA 350

This first edition of NFPA 350, *Guide for Safe Confined Space Entry and Work*, established best practices and "how tos" for confined space entry and work, translating what is required in regulations into practical approaches to implement those requirements. Whereas existing regulatory standards provide minimum requirements, NFPA 350 strives to establish work practices that achieve a higher level of safety.

NFPA maintains a long history governing the safe entry and work practices for the maritime sector through NFPA 306, *Standard for the Control of Gas Hazards on Vessels*. The success of the maritime confined space entry program, in particular the competencies and qualifications of marine chemists whose certification NFPA manages, led to the incorporation of those practices and procedures into both OSHA shipyard regulations and the regulations of the U.S. Coast Guard. Similarities in construction and usage prompted the development of NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*, a standard for entry and work in aboveground and underground tanks and containers. NFPA's protection for emergency responders extends to confined spaces as well, with NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents*, and NFPA 1006, *Standard for Technical Rescue Personnel Professional Qualifications*. With that long history of established standards of practice for confined space entry and work, NFPA proposed a new project related to confined spaces.

The Technical Committee on Confined Space Safe Work Practices began its work on a preliminary draft in September 2012 and worked in earnest to provide a preliminary draft to the NFPA Standards Council for the August 2013 meeting, at which it was approved and placed in the Fall 2015 revision cycle.

Background documents considered by the Standards Council as part of the project request highlighted gaps in the existing regulations and standards that applied to general industry confined space entry and work. OSHA's permit-required confined space standard had been in place for 20 years when the work of the committee began. Initially, the committee identified those gaps and discussed how to simplify some of the terminology used in confined space documents. Among the gaps identified were issues related to basic confined space hazard identification, evaluation, and control. Of particular concern was the lack of informative guidance on how to perform some of the key requirements in the OSHA standard, such as air monitoring and ventilation. In further support of the initial findings of the committee, the Chemical Safety Board (CSB) addressed the committee at its first meeting and noted additional disparities in confined space safe practices related to the hazards of adjacent spaces and hot work. The committee, with its range of experts, targeted those gaps and missing information as areas that could be incorporated into NFPA 350.

Perhaps the most significant discussion topic in the committee centered on terminology such as permit-required confined spaces and nonpermit spaces. While the committee did not want to conflict with existing standards, in particular the OSHA standards, the committee recognized that the differences in terminology continued to create confusion. The committee ultimately decided to simply use the term "confined space" to describe any space that meets the OSHA 1910.146 definition.

Another simplification provided by NFPA 350 is the default recommendation to perform air monitoring of all confined spaces prior to entry. Such monitoring eliminates the possibility of misjudging a space that is not expected to have an atmospheric hazard. The committee believes that the few minutes it takes to perform air monitoring of a space — confirming the presence or absence of specific atmospheric hazards — will be time well spent.

NFPA 350 identifies three types of hazards that should be recognized, evaluated, and controlled: inherent hazards, introduced hazards, and adjacent hazards. Identifying those three distinct sources of potential hazards helps Entry Supervisors and workers to think broadly about the number of hazards that could occur in and around confined spaces and to evaluate and control the hazards.

While other standards indicate what needs to be done, NFPA 350 describes how to perform those tasks. For example, NFPA 350 provides information on the selection, calibration, and use of gas monitors as well as information about the types and installation of ventilation devices for different types of confined space configurations and hazards.

The committee noted that there was a lack of qualifications and competencies for those involved in confined space entries beyond the Attendant, the Entrant, and the Entry Supervisor. To complement those individuals and their defined roles and competencies, NFPA 350 identifies other roles that also are important in confined space entries, such as a Gas Tester, Ventilation Specialist, and Standby Worker.

For confined space rescue, NFPA 350 provides a tiered approach to response and includes the organizational elements of emergency preparedness that normally are in place in a fire department but not necessarily in a facility rescue program. The document aligns with NFPA 1670 and NFPA 1006 in providing the technical aspects of rescue and qualifications for Rescuers.

It is well recognized that changes that occur during confined space work can negatively affect confined space entry and work safety. NFPA 350 outlines the types of changes that can occur during confined space work and provides a method for reporting and managing those changes through a management-of-change system.

Since elimination of a hazard is the apex of the traditional hierarchy of controls, NFPA 350 notes that the best way to eliminate confined space hazards is to eliminate the confined space entirely or to redesign it to eliminate or minimize hazards by incorporating safety features such as better lighting and ventilation. That can be done during design or through redesign using the principles of Prevention through Design (PtD). Years of potential worker exposures to confined space hazards could be eliminated through design or redesign.

The 2019 edition of the guide contains editorial changes to clarify the recommended practices for safe work within confined spaces. Additionally, the guide is revised to include information specific to construction activities as addressed in OSHA's 29 CFR 1926 Subpart AA, "Confined Spaces in Construction."

Definitions for *engulfment* and *purging* are added to the guide. Information pertaining to photoionization detectors (PID) is included because these devices are now widely available and used in combination with other atmosphere testing devices for assessing atmosphere hazards within confined spaces.

The committee clarified the recommendations for entry and work in confined spaces that are inerted (oxygen deficient). The committee also added recommendations for rescue in confined spaces that do not have a hazardous atmosphere but are so configured that rescue operations could be difficult. The recommended practice for selection, evaluation, and approval of a qualified rescue service is revised.

A table illustrating the gas hazards that can exist in confined spaces specific to various industries is added to Annex A.

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

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: Scope: This committee shall have primary responsibility for documents on safeguarding against fire, explosion, and health hazards associated with entry and work in confined and enclosed spaces. The committee shall also have primary responsibility for developing safe work practices based upon hazard recognition, evaluation, and control for those occupancies with confined or enclosed spaces. The safe work practices shall also address exit procedures from the spaces.

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2019 Edition

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 extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex E. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. 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 E.

Chapter 1 Administration

1.1 Scope.

1.1.1 This guide provides information to protect workers from confined space hazards.

1.1.2 This guide supplements existing confined space regulations, standards, and work practices by providing additional guidance for safe confined space entry and work. References are provided throughout the guide and annexes to direct the reader to other regulations and standards or other content that might be applicable.

1.1.3 This guide provides information to identify, evaluate, assess, and then eliminate, mitigate, or control hazards that are present or that may occur during entry into or work in and around confined spaces.

1.1.4 This guide provides information on how to understand confined space safety and safeguard personnel from fire, explosion, and other health hazards that are uniquely associated with confined spaces.

1.1.5 This guide provides information regarding training, qualifications, and competencies required for personnel responsible for confined space hazard identification, hazard evaluation, and hazard control for personnel who work in and around confined spaces.

1.1.6 This guide provides information on confined space rescue best practices.

1.1.7 This guide provides information concerning confined space hazards and safety practices that are applicable to all types of confined spaces.

1.1.8 This guide provides information regarding hazards adjacent to confined spaces that might affect the safe conditions necessary for entry and work in a confined space.

1.1.9 This guide provides criteria for eliminating, mitigating, or controlling hazards in the confined space design phase.

1.2 Purpose. The purpose of this guide is to provide safe work practices for persons working in and around confined spaces. This guide goes beyond the minimum requirements that have been established by regulations and standards. This guide strives to achieve a higher level of safety with best practices for identifying, evaluating, and then eliminating, mitigating, or controlling hazards to manage the risks associated with confined space activities. This guide is also intended to address confined space–related work practices and procedures not fully covered or explained in existing regulations and standards related to confined space entry and work.

1.3* Application. This guide is intended to provide guidance for safe entry into confined spaces and associated work.

1.3.1 This guide is not intended to supersede or replace any requirements in existing or future codes, standards, and regulations applicable to confined space activities.

1.4 Equivalency. Nothing in this guide 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 guide.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this guide and should be considered part of the recommendations of this document.

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

NFPA 10, *Standard for Portable Fire Extinguishers,* 2017 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 2019 edition.

NFPA 70®, National Electrical Code®, 2017 edition.

NFPA 70E®, Standard for Electrical Safety in the Workplace®, 2018 edition.

NFPA 306, *Standard for the Control of Gas Hazards on Vessels,* 2019 edition.

NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair,* 2015 edition.

NFPA 652, *Standard on the Fundamentals of Combustible Dust,* 2019 edition.

NFPA 1006, *Standard for Technical Rescue Personnel Professional Qualifications,* 2017 edition.

NFPA 1561, *Standard on Emergency Services Incident Management System and Command Safety,* 2014 edition.

NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents,* 2017 edition.

NFPA 1855, *Standard on Selection, Care, and Maintenance of Protective Ensembles for Technical Rescue Incidents,* 2018 edition.

NFPA 1951, *Standard on Protective Ensembles for Technical Rescue Incidents,* 2013 edition.

NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services,* 2018 edition.

NFPA 1983, *Standard on Life Safety Rope and Equipment for Emergency Services,* 2017 edition.

NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies,* 2016 edition.

NFPA 1992, *Standard on Liquid Splash–Protective Ensembles and Clothing for Hazardous Materials Emergencies,* 2018 edition.

2.3 Other Publications.

N **2.3.1 AIChE Publications.** American Institute of Chemical Engineers, 120 Wall Street, FL 23, New York, NY 10005-4020.

Guidelines for Engineering Design for Process Safety, Center for Chemical Process Safety, April 2012. https://www.aiche.org/ccps/resources/publications/books/guidelines-engineering-design-process-safety-2nd-edition.

Inherently Safer Chemical Processes: A Life Cycle Approach, Center for Chemical Process Safety, December 2008. https://www.aiche.org/ccps/publications/books/inherently-safer-chemical-processes-life-cycle-approach-2nd-edition.

2.3.2 AIHA Publications. American Industrial Hygiene Association, 3141 Fairview Park Drive, Suite 777, Falls Church, VA 22042.

"Prevention through Design: Eliminating Confined Spaces and Minimizing Hazards." AIHA Confined Spaces Committee, May 2014. https://www.aiha.org/government-affairs/Position-Statements/PtD%20Conf%20Space%20AIHA%20-%20BOD%20Approved.pdf.

2.3.3 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI/AIHA/ASSE Z10, *Occupational Health and Safety Management Systems*, 2012.

ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, 2012.

Δ **2.3.4 API Publications.** American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005-4070.

API STD 653, *Tank Inspection, Repair, Alteration, and Reconstruction,* 2014.

API RP 2009, *Safe Welding, Cutting, and Hot Work Practices in the Petroleum and Petrochemical Industries,* 2002, reaffirmed 2007.

API STD 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks,* 2014.

API RP 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks,* 2001, reaffirmed 2006.

API RP 2027, *Ignition Hazards and Safe Work Practices for Abrasive Blasting of Atmospheric Storage Tanks in Hydrocarbon Service,* 2002, reaffirmed 2012.

API RP 2201, *Safe Hot Tapping Practices in the Petroleum and Petrochemical Industries,* 2003, reaffirmed 2010.

API PUBL 2202, *Dismantling and Disposing of Steel from Aboveground Leaded Gasoline Storage Tanks,* 1991.

API RP 2207, *Preparing Tank Bottoms for Hot Work,* 2007, reaffirmed 2012.

API STD 2217A, *Guidelines for Safe Work in Inert Confined Spaces in the Petroleum and Petrochemical Industries,* 2016.

N **2.3.5 ASABE Publications.** American Society of Agricultural and Biological Engineers, 2950 Niles Road, St. Joseph, MI 49085.

ANSI/ASABE S607, *Ventilating Manure Storages to Reduce Entry Risk*, 2010, reaffirmed 2014. https://elibrary.asabe.org/abstract.asp?aid=36208&t=2&redir=&redirType=

2.3.6 ASSE Publications. American Society of Safety Engineers, 520 N. Northwest Highway, Park Ridge, IL 60068.

ANSI/ASSE Z117.1, *Safety Requirements for Entering Confined Spaces*, 2016.

ANSI/ASSE Z244.1, *Control of Hazardous Energy — Lockout/Tagout and Alternative Methods*, 2003, reaffirmed 2014.

ANSI/ASSE Z590.3, *Prevention Through Design: Guidelines for Addressing Occupation Hazards and Risks in the Design and Redesign Processes,* 2011, reaffirmed 2016.

N **2.3.7 AWS Publications.** American Welding Society, 550 NW LeJeune Road, Miami, FL 33126.

Safety and Health Fact Sheet Bundle for Chemical Industry Welding:

Fact Sheet No. 4: "Chromium and Nickel in Welding Fume," October 2003.

Fact Sheet No. 11: "Hot Work in Confined Spaces," September 2009.

Fact Sheet No. 24: "Fluxes for Arc Welding and Brazing: Safe Handling and Use," January 2002.

Fact Sheet No. 27: "Thoriated Tungsten Electrodes," October 2003.

Fact Sheet No. 36: "Ventilation for Welding and Cutting," September 2009.

2.3.8 CDC Publications. Center for Disease Control and Prevention, 1600 Clifton Road, Atlanta, GA 30333.

DHHS (NIOSH) Publication No. 2011-121, *Prevention through Design: Plan for the National Initiative,* Department of Health and Human Services and National Institute for Occupational Safety and Health, November 2010.

2.3.9 CGA Publications. Compressed Gas Association, George Carter Way, Suite 103, Chantilly, VA 20151-1788.

CGA G-7.1, *Commodity Specification for Air*, October 2011.

Δ **2.3.10 ICS Publications.** International Chamber of Shipping, 38 St. Mary Axe, London, United Kingdom, EC3A 8BH.

International Safety Guide for Oil Tankers and Terminals (ISGOTT), 2006.

2.3.11 U.S. Government Publications. U.S. Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001.

Emergency Response Guidebook, U.S. Department of Transportation (DOT), 2012. http://phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/Hazmat/ERG2012.pdf

Title 29, Code of Federal Regulations, Part 1910, "Occupational Safety and Health Standards."

Title 29, Code of Federal Regulations, Part 1915, "Occupational Safety and Health Standards for Shipyard Employment."

Title 29, Code of Federal Regulations, Part 1926, "Safety and Health Regulations for Construction."

2.3.12 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Advisory Sections.

NFPA 77, *Recommended Practice on Static Electricity,* 2019 edition.

NFPA 99, *Health Care Facilities Code,* 2018 edition.

NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft,* 2015 edition.

NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair,* 2015 edition.

NFPA 1006, *Standard for Technical Rescue Professional Qualifications,* 2017 edition.

NFPA 1026, *Standard for Incident Management Personnel Professional Qualifications,* 2018 edition.

NFPA 1451, *Standard for a Fire and Emergency Service Vehicle Operations Training Program,* 2018 edition.

NFPA 1521, *Standard for Fire Department Safety Officer Professional Qualifications,* 2015 edition.

NFPA 1561, *Standard on Emergency Services Incident Management System and Command Safety,* 2014 edition.

NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents,* 2017 edition.

Chapter 3 Definitions

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

3.2 NFPA Official Definitions.

3.2.1 Guide. A document that is advisory or informative in nature and that contains only nonmandatory provisions. A guide may contain mandatory statements such as when a guide can be used, but the document as a whole is not suitable for adoption into law.

3.3 General Definitions.

3.3.1* Acceptable Entry Conditions. Conditions that meet all entry requirements specified in the confined space program and all entry conditions listed on the entry permit.

3.3.2 Accident. An unplanned occurrence, which results in a loss such as unintended injury, illness, death, property damage, or damage to the environment. [**1521,** 2015]

3.3.3 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. [**326,** 2015]

3.3.4 Administrative Controls (Work Practice Controls). Work procedures such as written safety policies, rules, supervision, schedules, and training with the goal of reducing the duration, frequency, and severity of exposure to hazardous situations.

3.3.5 Air Changes per Hour (ACH). An amount of air equal to the gross volume of the air passing through a confined space in an hour.

3.3.6 Air-Moving Devices. Term that includes venturi-type devices that exhaust only (eductors) and fan or blower systems.

Δ **3.3.6.1** ***Axial-Flow Fans.*** A category of three fan types — propeller, tube-axial, and vane-axial — where the air flow through the impeller is parallel to the shaft on which the impeller is mounted.

3.3.6.2 ***Centrifugal-Flow Fans.*** A fan that includes a wheel or rotor mounted on a shaft that rotates within a scroll-shaped housing, which allows air to enter the center of the rotor and move with centrifugal force at right angles through the rotor blades and into the housing.

Δ **3.3.6.3*** ***Venturi-Type (Eductors).*** Devices commonly powered by air or steam that operate on the venturi principle, where air moving through the horn increases in velocity as it passes through the smaller cross-sectional area and exits the horn.

Δ **3.3.7 Atmospheric Monitoring.** The act of using a portable or fixed monitor to sample the atmosphere in or around a confined space to determine the concentration of air contaminants and oxygen.

3.3.8 Attendant. A person who is qualified to be stationed outside confined spaces, who monitors authorized Entrants, and who performs specified attendant duties.

3.3.9 Bonding. For the purpose of controlling static electric hazards, the process of connecting two or more conductive objects together by means of a conductor so that they are at the same electrical potential, but not necessarily at the same potential as the earth. [**77,** 2019]

3.3.10 Breathing Air. Uncontaminated air with an oxygen content between 19.5 and 22 percent; sources may include ambient air or Compressed Gas Association (CGA) Grade D breathing air from a compressor or cylinder.

3.3.11 Bump Testing. A qualitative function check where a challenge gas is passed over the sensor(s), at a concentration and exposure time sufficient to activate all alarm indicators, to present at least their lower alarm setting.

3.3.12 Cold Work. Any construction, alteration, repair, or task that does not involve heat, fire, or spark-producing operations.

3.3.13* Confined Space. A space that (1) is large enough and so configured that a person can bodily enter and perform assigned work, (2) has limited or restricted means for entry or exit, and (3) is not designed for continuous occupancy.

3.3.14 Confined Space Entry. Includes ensuing work activities in a confined space and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space. [**1006,** 2017]

3.3.15 Confined Space Rescue Service. The confined space rescue team designated by the Owner/Operator or Entrant Employer to rescue victims from within confined spaces, including operational and technical levels of industrial, municipal, and external service providers.

3.3.16 Confined Space Rescue Team. A combination of individuals trained, equipped, and available to respond to confined space emergencies.

3.3.17* Contractor. Employers who perform work under contract to Owners/Operators at the Owner's/Operator's confined space work site.

3.3.17.1 ***Subcontractor.*** Employers who perform work under contract to the primary contractor.

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

Δ **3.3.19 Engineering Controls.** A method of reducing exposure to a hazard through elimination, design, redesign, isolation, or substitution.

N **3.3.20 Engulfment.** The surrounding and effective capture of a person by a fluid (e.g., liquid, finely divided particulate) substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing. [**1670,** 2017]

3.3.21 Entrant. Person authorized to enter a confined space.

3.3.22* Entrant Employer. The person(s) or organization responsible for personnel under their employ who make entry into a confined space.

3.3.23 Entry. See 3.3.14, Confined Space Entry.

3.3.24 Entry Supervisor. The person(s) responsible for overseeing entry operations for a given confined space.

3.3.25 Entry-Type Rescue (Entry Rescue). Removal of Entrant(s) for rescue requiring entry into a confined space.

Δ **3.3.26* Explosionproof.** Referring to apparatus enclosed in a case that is capable of withstanding an explosion of a specified gas or vapor that might occur within it and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within and that operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby.

3.3.27 Fall Arrest. A system intended to arrest a worker's fall before the worker hits the surface or object below.

3.3.28 Fall Restrain. A personal fall protection system to prevent a worker from traveling to an edge from which the worker could fall.

3.3.29 Gas Monitor. A direct-reading, portable instrument designed to detect hazardous gases and vapors, including, but not limited to, oxygen, combustible gas, and a variety of toxic gas components or volatile organic compounds (VOCs).

3.3.30 Gas Tester. Qualified person(s) responsible for operating a gas monitor and able to interpret results for atmospheric monitoring.

3.3.31 Grounding. The process of directing electrical current to earth in order to minimize the buildup of an electrical charge resulting in an ignitable spark.

3.3.32 Hazard. Biological, chemical, mechanical, electrical, atmospheric, environmental, or physical agent that has or may have the potential to result in injury, illness, property damage, or interruption of a process or an activity in the absence of a control measure.

3.3.32.1 ***Adjacent Hazards.*** Hazards that may exist in the area(s) surrounding the space.

3.3.32.2 ***Inherent Hazards.*** Hazards that may exist as a permanent or intermittent essential characteristic or attribute of the space.

3.3.32.3 ***Introduced Hazards.*** Hazards not normally associated with the space's purpose or processes but are brought into the space or adjoining area(s) deliberately or inadvertently.

3.3.33 Hazard Evaluation. The process of identifying hazards or potential hazards and then determining the risk or potential risk of each hazard identified.

3.3.34 Hazard Identification. The determination of present and potential physical, chemical, atmospheric, mechanical, electrical, environmental, and biological hazards in and around a confined space as well as hazards elsewhere in the facility or vicinity that may impact confined space operations.

3.3.35 Hazardous Atmosphere. Any atmosphere that is oxygen enriched or oxygen deficient, contains a toxic or contaminant, is potentially flammable or explosive, or is immediately dangerous to life and health.

3.3.36 High Angle. Refers to an environment in which the load is predominantly supported by the rope rescue system. [**1670,** 2017]

3.3.37 Hot Work. Any activity that creates a source of ignition, including, but not limited to, welding, cutting, open flames, frictional heat or sparks, smoking, and operation of internal combustion engines.

3.3.38 IDLH. Immediately dangerous to life or health.

3.3.39 Incident Management System (IMS). A system that defines the roles and responsibilities to be assumed by responders and the standard operating procedures to be used in the management and direction of emergency incidents and other functions. [**1561,** 2014]

Δ **3.3.40 Inert Gas.** A nonreactive, nonflammable, noncorrosive gas such as argon or nitrogen.

3.3.41 Inerting. The displacement of gas or vapors and oxygen (air) using an inert gas to eliminate the possibility of a potentially flammable atmosphere in a confined space.

3.3.42 Intrinsically Safe. As applied to equipment and wiring, equipment and wiring that are incapable of releasing sufficient electrical energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture. [**99,** 2018]

3.3.43 Isolation Specialist. Person responsible for protecting the confined space from the unwanted release of energy (electrical, mechanical, and/or hydraulic), as well as liquids, gases, chemicals, and other materials impacting upon the space.

3.3.44* Job Hazard Analysis (JHA). A safety management risk assessment (RA) technique that is used to define and control the actual or potential hazards associated with any process, job, or procedure.

3.3.45 Lockout. A method for isolating equipment and machinery from being energized or relieving stored energy. *(See also 3.3.82, Tagout.)*

3.3.46 Lower Explosive Limit (LEL). The lowest volume concentration of a combustible gas or vapor that when mixed with air will ignite, creating a fire or explosion (also known as lower flammable limit or LFL).

3.3.47 Maintenance. The routine recurring work required to keep a facility (e.g., plant, building, structure, ground facility, utility system, or other real property) or equipment in such condition that it can be continuously utilized, at its original or designed capacity and efficiency, for its intended purpose.

3.3.48 Management of Change (MOC). A system used to evaluate and address the impacts of changes.

N **3.3.49 Mitigation.** Activities taken to reduce the impacts from hazards.

3.3.50 Non-entry Rescue (Retrieval). Removal of Entrant(s) for rescue not requiring entry into a confined space.

Δ **3.3.51* Occupational Exposure Limit (OEL).** The maximum amount of a hazardous material that a worker should be exposed to for a given period of time, also known as permissible exposure limit (PEL) per OSHA, recommended exposure limit (REL) per NIOSH, and threshold limit value (TLV) per ACGIH. OELs can be established by the government (OSHA), organizations (ACGIH), trade organizations, and manufacturers.

3.3.52* Owner/Operator. The person(s) or organization responsible for all confined spaces within a given facility.

3.3.53 Patient Packaging. The process of securing a subject in a transfer device, with regard to existing and potential injuries/illness, so as to avoid further harm during movement.

3.3.54 Peak Value. The highest measured concentration of combustible or toxic gas components and the lowest measured level of oxygen as detected by a gas monitor.

3.3.55 Periodic. Occurring or recurring at regular predetermined or specified intervals.

3.3.56* Permit-Required Confined Space (Permit Space). A confined space that has one or more of the following characteristics: (1) contains or has the potential to contain a hazardous atmosphere, (2) contains a material that has the potential for engulfing an Entrant, (3) has an internal configuration such that an Entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross-section, or (4) contains any other recognized serious safety or health hazard.

3.3.57 Personal Protective Equipment (PPE). All clothing and other devices worn by a worker to protect against workplace hazards.

3.3.58 PPM. Parts per million.

3.3.59 Pre-Incident Rescue Action Plan. Rescue preplan for potential confined space emergencies.

3.3.60 Prevention through Design (PtD). A concept that studies the safety impacts during the initial design phase and seeks to eliminate hazards and reduce risks rather than relying on reactive hazard isolation and control approaches.

N **3.3.61 Purging.** The replacement of a flammable, indeterminate, or high-oxygen-bearing atmosphere with another gas that, when complete, results in a nonflammable final state.

3.3.62 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 related to the subject matter, the work, or the project. [**1451,** 2018]

3.3.63 Rescue Attendant. A person who is qualified to be stationed outside a confined space to monitor Rescue Entrants, summon assistance, and perform non-entry rescues.

3.3.64 Rescue Entrant. A person entering a confined space for the specific purpose of rescue.

3.3.65 Rescue Plan. See 3.3.59, Pre-Incident Rescue Action Plan.

N **3.3.66 Rescue Service.** The rescue team designated for confined space rescue.

3.3.67 Rescue Supervisors. The person(s) in charge of managing the actions of a team performing a rescue.

3.3.68 Rescuer. A person that performs confined space rescue.

3.3.69 Retrieval. See 3.3.50, Non-entry Rescue.

3.3.70 Retrieval Equipment. Life safety components that can include, but are not limited to, harnesses, ropes, pulleys, cable winches, and portable anchors that can be assembled to create a retrieval system.

3.3.71 Retrieval Lines. See 3.3.72, Retrieval System.

3.3.72 Retrieval System. Combinations of rescue equipment used for non-entry (external) rescue of persons from confined spaces. [**1670,** 2017]

3.3.73 Risk. The probability that a substance or situation will produce harm under specified conditions, determined by a combination of two factors: (1) the probability that an adverse event will occur, and (2) the severity of the consequences of the adverse event.

3.3.74 Risk Assessment. A process for systematically evaluating risk that considers the severity of consequences and the likelihood that the adverse event will occur.

3.3.75 Rope Rescue. The use of systems comprised of rope rescue equipment, which can include life safety rope, life safety harnesses, and auxiliary equipment, and an appropriate anchor system to remove a person from an untenable position.

3.3.76 Safety Officer. A member of the command staff responsible for monitoring and assessing safety hazards or unsafe situations and for developing measures for ensuring personnel safety. [**1026,** 2018]

3.3.77 Self-Contained Breathing Apparatus (SCBA). A respirator worn by the user that supplies a respirable atmosphere that is either carried in or generated by the apparatus, and that is independent of the ambient environment.

3.3.78 Span Calibration. The adjustment of the gas monitor's sensor response to match the desired value compared to a known traceable concentration of test gas.

3.3.79 Standard Operating Procedures (SOP). A written organizational directive that establishes or prescribes specific operational or administrative methods to be followed routinely for the performance of designated operations or actions.

3.3.80 Standby Worker. Person assigned to perform work in support of confined space operations.

3.3.81* Supplied Air Respirator (SAR). A respirator worn by the user that supplies a respirable atmosphere that is generated by a remote source and connected via a hose line.

Δ **3.3.82 Tagout.** A method of tagging, labeling, or otherwise marking an isolation device during hazard abatement operations to prevent accidental removal of the device. *(See also 3.3.45, Lockout.)* [**1670,** 2017]

3.3.83 Vapor and Gas Freeing. The removal of flammable or toxic vapors and gases from a tank by displacement or the reduction of the percentage of vapors and gases in the tank to a safe level by dilution with fresh air.

3.3.84 Ventilation. The changing of air within a compartment by natural or powered means. [**302,** 2015]

3.3.85 Ventilation Specialist. Person responsible for determining ventilation needs to comply with permit requirements.

3.3.86 Volatile Organic Compound (VOC). Organic chemicals that have a high vapor pressure at ordinary room temperature as a result of low boiling points, which cause large numbers of molecules to evaporate or sublimate from the liquid or solid form of the compound and enter the surrounding air.

3.3.87 Zeroing. The act of setting the baseline response of the gas monitor's sensors in clean air to 20.9 percent for oxygen and 0.0 percent for all other measured gas components.

Chapter 4 Identification of Confined Spaces Within a Workplace

4.1* Identification and Documentation of Confined Spaces. The Owner/Operator is responsible for evaluating and documenting confined spaces in the entire facility, including, but not limited to, detached buildings, structures, sewers and drainage, trenches, tanks, vessels, containers, tunnels, vaults, manholes, and property grounds to determine if there are confined spaces present that are configured so they could be entered by employees, contractors, the public, or visitors to the facility.

4.2 Identification of Confined Spaces During Construction. All construction activity should be evaluated to determine if confined spaces may be present or created at any time during various construction phases. If confined spaces are identified, these evaluations should be documented and managed in accordance with a confined space program.

Δ **4.3 Determination of Confined Spaces.** Spaces that should be evaluated to determine if they could be confined spaces include those that have all three of the following characteristics:

(1) They are large enough and so configured that a person can bodily enter and perform assigned work.
(2)* They have limited or restricted means for entry and exit. Any space that requires a ladder to access or requires a worker to crawl or contort his or her body to enter or exit could be considered a confined space. Nonstandard staircases such as spiral stairs or ships' ladders could also be considered to have limited access or restricted means of egress. Often, these spaces are located below grade or require descent into a space. There are also confined spaces, such as water tanks, HVAC systems, and wind turbines, that are typically located aboveground. Other spaces, by virtue of the distance a worker would have to travel to exit the space in an emergency, may be considered to have limited means of exit.
(3) They are not designed for continuous human occupancy. These are spaces where employees would not normally be assigned for work. They are spaces where a desk, computer, or phone would not be placed but that might need to be entered for nonroutine inspection, maintenance, or repair work. Utility vaults, crawl spaces, tanks, and belowgrade structures are examples of spaces that typically are not designed for continuous human occupancy.

Δ **4.4 Signs.** Confined spaces should have posted signs, tags, or labels denoting them as confined spaces and prohibiting unauthorized entry. In facilities with similar, recognizable, or multiple confined spaces (such as storage tank facilities or workplaces with multiple manholes), the Owner/Operator may choose to identify such spaces with facility signage and/or identify the spaces in their written confined space programs in lieu of individual signs or labels. Signs, tags, or labels should have wording similar to the following:

DANGER — CONFINED SPACE

DO NOT ENTER WITHOUT AUTHORIZATION

4.5 Securing Confined Spaces. All confined spaces should be locked up, guarded, protected, or barricaded to guard against unauthorized entry.

4.6 Identification of Spaces for Nonfacility Personnel.

4.6.1 Owners/Operators should inform all individuals working in or around confined spaces of the potentially hazardous nature of confined spaces on their property, regardless of whether or not they are employees.

4.6.2* Employers sending employees to a location where it is reasonably anticipated that they may work in or around confined spaces should make sure those employees know how to identify confined spaces and are aware of the hazards associated with them.

Chapter 5 General

5.1* General Requirements. The terms *confined space*, *non-permit-required confined space*, and *permit-required confined space* may cause confusion among employers and workers. To minimize such confusion, this guide uses only the term *confined space* and makes provisions for identifying and evaluating the hazards of all confined spaces, requiring permits for entry if hazards are identified.

Δ **5.1.1** All confined spaces have the potential to be an OSHA-defined permit-required confined space, depending on the work to be performed and the inherent or introduced hazards in the space at the time of entry. While the procedures required to safely enter a confined space vary widely, the same basic evaluation of the hazards within those spaces should be performed prior to and during entry. All confined spaces should be evaluated in accordance with the guidelines in Chapters 6 and 7, and all hazards found should be eliminated, mitigated, or controlled in accordance with the guidelines in Chapters 8 and 9.

Δ **5.1.2*** Table 5.1.2 shows the terminology used in commonly referenced confined space entry documents, such as 29 CFR 1910.146, "Permit-Required Confined Spaces"; Subpart AA of 29 CFR 1926, "Safety and Health Regulations for Construction"; ANSI/ASSE Z117.1, *Safety Requirements for Entering Confined Spaces*; API STD2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*; and API RP 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*, and how the terms relate to those given in this guide. Other jurisdictions and countries may have different definitions and requirements in addition to those provided in the table.

5.2 Confined Space Program. A written confined space program should be developed by Owners/Operators for every facility that has one or more confined spaces and by employers and Contractors/Subcontractors engaged in confined space operations. Guidance on developing written programs is provided in Chapter 12.

5.3 Confined Space Evaluation.

5.3.1 Pre-Entry Evaluation. All confined spaces should be evaluated prior to entry. Chapters 6, 7, and 13 provide additional information.

5.3.2 Permit. A permit should be issued by the Entry Supervisor for all confined spaces with hazards identified in accordance with Chapter 13.

Δ **5.4 Entry Conditions.** Entry into confined spaces by assigned qualified Entrants should be permitted by the Entry Supervisor only after a pre-entry evaluation has been performed and, if necessary, an entry permit has been issued *(see Sections 5.5 and 5.6)*.

Δ **5.5 Basic Requirements and Considerations.** Prior to entering a confined space, the following should be performed:

(1) All inherent, introduced, and adjacent hazards of the confined space should be anticipated, identified, and evaluated in accordance with a written confined space entry program and the guidance provided in Chapters 6 and 7.
(2) All hazards should be eliminated, mitigated, or controlled in accordance with Chapters 8 and 9.
(3) An authorized Entry Supervisor qualified in accordance with Chapter 11 should be assigned to oversee the work.
(4) Only authorized Entrants qualified in accordance with Chapter 11 should be assigned to enter the space.
(5) An Attendant qualified in accordance with Chapter 11 should be assigned for permit entries.
(6) If atmospheric monitoring is required, a Gas Tester qualified in accordance with Chapter 11 should be assigned.
(7) If ventilation is required, a Ventilation Specialist qualified in accordance with Chapter 11 should be assigned.
(8) If energy sources are required to be isolated or controlled, an Isolation Specialist qualified in accordance with Chapter 11 should be assigned.
(9) If required, qualified Rescuers and/or Rescue Services as well as appropriate rescue equipment should be available in accordance with Chapter 10.
(10) Any other required permits, including, but not limited to, hot work, should be issued.
(11) A pre-entry evaluation and/or confined space entry permit should be issued and signed by the Entry Supervisor in accordance with Chapter 13.
(12) A pre-entry meeting should be held with all personnel entering or working in or adjacent to the space to discuss the work to be performed; job requirements and assignments; actual and potential hazards; methods of eliminating, mitigating, or controlling the hazards as listed in the conditions on the permit; and conditions that require immediate evacuation.
(13) Communication between the Entrant and the Attendant and the Attendant and Rescuer, if required, should be established in accordance with Chapter 8.
(14) Permit entry should not occur until all conditions for entry established on the permit have been met. If conditions change, the permit should be cancelled, operations should be ceased, and the Entrant should immediately vacate the space.

5.6* Roles and Responsibilities. Every workplace that has one or more confined spaces that can be entered, as identified in Chapter 4, should have personnel assigned to perform the responsibilities of the following roles listed in 5.6(1) through 5.6(10), as applicable. It is acceptable for one person to hold more than one of the following positions as long as they are trained, qualified, and authorized to fulfill that role and it will not adversely affect the safety of the entry:

(1) Owner/Operator and/or Entrant Employer
(2) Entrant
(3) Attendant
(4) Entry Supervisor
(5) Gas Tester
(6) Ventilation Specialist
(7) Rescuer (could be Attendant for non-entry rescue)
(8) Rescue team or Rescue Service
(9) Standby Worker
(10) Isolation Specialist

Δ Table 5.1.2 Terminology for Confined Space Entry in Various Standards and Documents

Standard or Document	Term Used	Term Used in NFPA 350	Comments
29 CFR 1910.146 and Subpart AA of 29 CFR 1926	Confined space	Confined space	NFPA 350 uses the same definition as OSHA for a confined space.
29 CFR 1910.146 and Subpart AA of 29 CFR 1926	Permit-required confined space	Confined space	NFPA 350 does not distinguish between permit-required confined spaces and confined spaces. All confined spaces with hazards need permits for entry.
ANSI/ASSE Z117.1	Non-permit-confined space	Confined space	All confined spaces need pre-entry evaluation prior to entry. If no hazards are identified and no hazards will be introduced, then no confined space entry permit will be required.
29 CFR 1910.146 and Subpart AA of 29 CFR 1926	Reclassification (downgraded) entry	Confined space entry	This is not defined in NFPA 350. A confined space with hazards that have been eliminated, mitigated, or controlled after the pre-entry evaluation will not require a confined space entry permit.
29 CFR 1910.146 and Subpart AA of 29 CFR 1926	Alternate procedures entry	Confined space entry	This is not defined in NFPA 350. A confined space where all hazards have been evaluated and the only hazard is a potentially hazardous atmosphere that is being eliminated, mitigated or controlled with effective ventilation would be issued a confined space entry permit that contains restrictions requiring ventilation and continuous monitoring.
API STD 2015 and API RP 2016	Nonconfined space (a confined space that is no longer a confined space due to reconfiguration)	None	If a space does not meet all the specifications for a confined space, then it is not a confined space and NFPA 350 does not apply.
NFPA 326	Nonconfined space (for purposes of tank entry, cleaning, or repair to 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)	None	If a space does not meet all the specifications for a confined space, then it is not a confined space and NFPA 350 does not apply.

5.7 Training Guidelines.

5.7.1 Both Owners/Operators and Entrant Employers should ensure that their employees and Contractor/Subcontractor employees who work in and around confined spaces have the necessary awareness, understanding, knowledge, and skills to safely perform their duties in accordance with Chapter 11.

5.7.2 Owners/Operators and Entrant Employers should ensure that all employees engaged in confined space operations have been educated, trained, and/or qualified as follows:

(1) Before beginning initial work and/or duty assignments
(2) Before assignment to a different type of work or duty other than initially assigned
(3) Whenever a change occurs in operations, equipment, equipment configuration, materials, procedures, guidelines, work assignment, or duties that creates or has the potential to create a hazard for which the employee has not been previously trained, educated, or qualified
(4) Whenever an Owner/Operator and Entrant Employer has reason to believe an employee requires retraining or additional education due to inadequacies in the employee's performance or skill or because the employee deviates from the confined space program permit requirements or procedures

5.8* Training Verification. Both Owners/Operators and Entrant Employers should verify, in writing, that their employees and Contractor/Subcontractor employees who work in and around confined spaces have been trained, educated, or qualified as required. The verification should contain the names of the employees; the means used to determine that the employees understand the specific requirements of the training or work to be performed; the signature, name, or initials of the trainer(s), educator(s), or qualifier(s); the specific subjects and content; and the date(s) the training, education, or qualification was completed, in accordance with Chapter 11.

Chapter 6 Identification and Evaluation of Hazards In and Around Confined Spaces

6.1 General. The purpose of this chapter is to provide information on how to anticipate, identify, evaluate, and prioritize the hazards for working in and around confined spaces.

Δ **6.1.1** Work in and around confined spaces is generally hazardous, and conditions may change significantly with little or no warning. Research, knowledge, and preplanning are necessary to ensure that confined spaces are correctly identified and that chemical, physical, atmospheric, toxic, and other potential hazards are identified and evaluated. Once hazards are evaluated, measures to eliminate, mitigate, or control risks should be developed and implemented. Identification and evaluation should continue throughout the work period.

6.1.2 Workers may become quite familiar with the space(s) in which they operate. Likewise, work may be routine and repetitive, and complacency may ensue with continual uneventful entries. While knowledge of the space and equipment can be helpful when preplanning work, it does not lessen the vigilance needed to enter, work in, and exit a confined space safely. Each entry should be considered an individual and unrelated event. The space's history and prior use should be considered in anticipation of hazards.

6.1.3 Identifying hazards in around a confined space is a three-stage process as follows:

(1) The anticipation or preplan stage starts with recognizing and understanding actual and potential hazards and identifying resources that might be needed to work in and around confined spaces.
(2) The hazard identification stage confirms anticipated hazards and recognizes additional potential hazards.
(3) The hazard evaluation stage determines the risk of each hazard identified and the recommended elimination, mitigation, and/or control measures.

6.1.4 After all hazards have been identified and all risks have been assessed, the appropriate means to eliminate, mitigate, or control hazards should be implemented in accordance with Chapter 8.

6.2 Hazard Anticipation/Preplan. Many hazards can be anticipated through the preplanning process before work begins. The preplanning process consists of a thorough analysis of the space, its construction, its purpose and condition, the systems contained within it, and the scope of work necessitating the entry. Preplanning should identify potential hazards and resources that might be needed to work in and around confined spaces and to prevent adverse consequences related to the work. There are two primary components to the preplanning stage: intelligence gathering and resource identification.

6.2.1 Intelligence Gathering. Hazard preplanning starts with the collection of information that could be useful prior to determining actual and potential hazards when planning for confined space operations. This intelligence gathering includes, but is not limited to, review of any previous permits concerning that space or adjacent spaces, using previously prepared hazard surveys, preplans, schematics, blueprints, work orders, equipment guides, safety data sheets (SDS), manuals, control measures, and prior experience from previous entries and knowledge from workers familiar with the space. Identification and determination of probable hazards and an understanding of the operations and processes associated with the space may also be helpful.

6.2.2 Resource Identification. Once the preplanning process is complete, resources and controls needed to conduct confined space operations should be identified. Controls include, but are not limited to, those listed in 6.2.2.1 through 6.2.2.3.

6.2.2.1 Elimination, Substitution, and Engineering Controls. Some common elimination, substitution, and engineering controls include, but are not limited to, the following:

(1) Eliminating chemicals, materials, or processes that have the potential to generate a hazard in or around a confined space
(2) Substituting hazardous chemicals with nonhazardous chemicals used in or around the confined space
(3) Substituting hazardous processes with nonhazardous processes in or around the confined space
(4) Using general and local exhaust ventilation, inerting, or purging equipment, including vapor recovery equipment, if needed
(5) Installing isolation devices
(6) Installing permanent barricades

6.2.2.2 Administrative and Work Practice Controls. Some common administrative and work practice controls include, but are not limited to, the following:

(1) Assigning qualified personnel for all identified tasks
(2) Developing confined space, respiratory protection, isolation, hot/cold work, and other applicable programs
(3) Following regulations and industry standards
(4) Performing a job hazard analysis (JHA) prior to starting work and reassessing as needed
(5) Limiting exposures and exposure times to hazardous and toxic chemicals
(6) Providing decontamination stations and eye wash stations and showers
(7) Providing hazardous material and waste collection, disposal, and/or containment equipment
(8) Identifying and providing rescue personnel and/or services
(9) Developing entry and hot work permits with restrictions and limitations identified
(10) Following regulatory permit requirements
(11) Providing outside services needed (e.g., cranes)
(12) Providing and using appropriate ladders, tripods, and rescue equipment, including harnesses and lifelines
(13) Designating areas for specific equipment, work, breaks, and nonrelated activities
(14) Providing adequate and appropriate lighting equipment
(15) Using temporary barricades and road blocks
(16) Using any special equipment [e.g., ground fault circuit interrupter (GFCI), emergency generators, non-sparking tools, and test equipment]
(17) Utilizing lockout/tagout equipment (e.g., tags, locks, and lock boxes)

6.2.2.3 Personal Protective Equipment. Some common personal protective equipment (PPE) includes, but is not limited to, the following:

(1) Hazard-specific area and personal atmospheric testing and monitoring equipment
(2) PPE (e.g., thermal stress or impervious clothing, safety glasses, protective gloves, safety hard hat, safety footwear) as determined by a JHA
(3) Respiratory protective equipment (e.g., air-purifying and atmosphere-supplying respirators)

6.3 Hazard Identification.

6.3.1 General. Hazard identification performed at the site of the confined space, can help verify hazards identified in the preplan and identify new hazards that were not anticipated. Hazard identification is accomplished by conducting a review of the space's documentation (e.g., SDS for material the space held) and atmospheric monitor testing. A visual inspection should also be conducted around the exterior of the space and then, following confined space entry protocol, in all areas within the space. The person(s) conducting the inspection should comply with all posted warning signs and permits and follow confined space program requirements for potential exposure to any materials or conditions that could pose a hazard, such as toxic or hazardous chemical residue or a change in the atmospheric conditions. Atmospheric monitoring *(see Chapter 7)* should be conducted to determine the atmospheric conditions inside and adjacent to the space prior to, during, and following entry for inspection purposes.

6.3.2 Hazard Sources. Hazard sources can be directly or indirectly associated with working in and around confined spaces. Direct and indirect hazards include, but are not limited to, the following:

(1) Those directly associated with confined spaces and those that are integral to or in and around the space that affect it
(2) Those resulting from product(s) stored in or around the space
(3) Those resulting from operations, work activities, and processes taking place within or near the space

6.3.3 Hazard Types. Hazards may be atmospheric, physical, mechanical, electrical, chemical, biological, environmental, or psychological. Equal consideration should be given to potential hazards directly and indirectly associated with the space.

6.3.4 Location of Hazards. Hazards that directly or indirectly affect the space can be inherent, introduced, or adjacent.

6.3.4.1 Inherent Hazards.

6.3.4.1.1 Inherent hazards are those hazards that exist as a permanent, essential characteristic or attribute of the space. Hazard identification should include whether the location and configuration, including restricted access, obstructions, or remoteness, could inhibit or interfere with movement, work operations, ventilation, escape, rescue, or firefighting.

6.3.4.1.2 Inherent hazards to be identified include, but are not limited to, the following:

(1) *Limited access into the space.* Spaces for which ladders or scaffolding are needed to reach the portal, to enter and exit the space, or to perform work therein are considered to have limited access. Elevated spaces require different considerations for entry and rescue than those that are at ground level, including fall protection.
(2) *Size and shape of the portal.* The restrictive nature of some portals makes access with certain types of PPE difficult or impossible or requires Entrants to contort their bodies while entering or exiting. An elevated, open, unprotected edge or portal may create a fall hazard.
(3) *Size and shape of the space/vessel.* Inwardly converging walls or a funnel-shaped discharge can entrap an Entrant; congested or dark spaces can inhibit mobility or create slip, trip, and fall hazards.
(4) *Products or processes in the space.* Chemicals, thermal stress, noise, steam, pressurization, mechanical equipment, operations, and other activities associated with the use of the space can create hazards. Disturbing product residue during entry or work can release a contaminant that produces a hazard not detected during pre-entry testing.
(5) *Fixed equipment within the space.* Piping systems, conduits, ducts, machinery, pressurized lines, and fire suppression systems should be evaluated for potential hazards and locked out/tagged out, tested, gas-freed, liquid-freed, steam-freed, vapor-freed, and/or inerted if needed to reduce the risk.
(6) *Structures.* Structural integrity should be evaluated prior to use. Items that are susceptible to degradation and physical damage include, but are not limited to, fixed ladders, floors, pipes, anchor points, and supports.

6.3.4.2 Introduced Hazards.

6.3.4.2.1 Introduced hazards are those not normally associated with the space's purpose or processes but are brought into the space or adjoining area(s) deliberately or inadvertently. As part of the hazard evaluation and risk assessment, the proposed actions of Entrants and the materials, products, and techniques used to gain access, enter, inspect, clean, and/or repair a confined space should be carefully considered to ensure they do not introduce hazards. This also includes an evaluation of work being performed in the area(s) immediately surrounding the space.

Δ **6.3.4.2.2** Examples of introduced hazards include, but are not limited to, the following:

(1) *Atmospheric hazards.* Ventilating a space may introduce contaminants from the following:
   (a) Sources outside the space via an ill-placed supply-air duct
   (b) Contaminated air drawn from internal combustion engine exhaust
   (c) Oxygen-deficient air drawn from another space or source or from an inert atmosphere
   (d) Product off-gassing captured by forced ventilation and contaminated adjacent areas
(2) *Chemical hazards.* Products used in cleaning, abating, painting, or coating need to be checked for reactivity with other chemicals that might be present. Chemicals may produce hazardous vapors or gases and/or displace or consume oxygen due to the nature of the confined space.
(3) *Application and drying of paints, chemical cleaners, and coatings.* These can cause an explosive atmosphere.
(4) *Compressed gas hazards.* Compressed gases used for welding, cutting, inerting, hot work, or fire suppression systems pose a hazard due to their contents (e.g., toxic or flammable gases), their ability to displace or enrich the atmospheric oxygen content (e.g., carbon dioxide fire extinguishing systems), and their potential to become a projectile if damaged. Compressed gas cylinders, hoses, valves, and regulators should be thoroughly inspected, evaluated, and leak-checked prior to being brought into a confined space. Due to the inherent risks, compressed gas cylinders other than breathing air cylinders should not normally be introduced into confined spaces.
(5) *Hot work.* Hot work such as welding, cutting, grinding, drilling, burning, and/or intentional heating of materials can produce hazardous atmospheres and flammable conditions. Hazards can include welding fumes, the release of gases, the depletion or enrichment of the space's oxygen content, or the production of ignition sources.
(6) *Electrical hazards.* Electrical hazards include, but are not limited to, shock, ignition, and static discharge. Lighting, power tools, and extension cords are examples of equipment that may generate these hazards when brought into a confined space. Additional consideration should be given to unexpected sources of electrical energy/ignition sources such as static electric discharge that may be generated by the use of air/pressure lines or even exhaust fans. Ground fault circuit interrupters (GFCIs) should be considered when using AC power.
(7) *Slip, trip, fall, and/or entanglement hazards.* The following are examples of slip, trip, fall, and/or entanglement hazards that can occur in or around the space:
   (a) Ladders or scaffolding used to reach portals, gain entry, or gain access inside the space
   (b) Equipment, electrical cords, cables, hoses, tools, ventilation ducts, and other items brought into the space

6.3.4.3 Adjacent Hazards.

6.3.4.3.1 Adjacent hazards are hazards or other conditions that may exist in the area(s) surrounding the space. Adjacent hazards may also involve other spaces that are in proximity to the entry site and may pose significant hazards that need to be evaluated separately prior to entry.

Δ **6.3.4.3.2** Examples of adjacent hazards include the following:

(1) *Adjacent spaces.* Spaces, containers, and vessels that share a common wall; contact each other in any way; or share a surrounding, cover, or use need to be assessed for possible hazards or operation that may affect the subject space or vice versa (e.g., hot work, compressed gases, machinery). This includes evaluating areas in all directions from the subject space — those that share a common point/wall, contact, corner, diagonal, decks/floor, tank top, and/or bulkhead/wall. Raceways and vaults that parallel or that interconnect spaces containing power or other wires and piping are examples of adjacent spaces.
(2) *Adjacent work activities.* Operations and work that are being performed in nearby spaces should be analyzed for effects or dangers posed to the subject entry.
(3) *External hazards.* Areas surrounding the subject space should be assessed for other possible dangers that may affect entry. Pedestrian and vehicle traffic, equipment, smoke and exhaust, contaminate-producing activities, sparking, heating or cooling, or transfer of product may produce hazards.

6.3.5 Types of Hazards. A pre-entry evaluation should be conducted for all confined spaces to determine if hazards are present. It should be assumed that a confined space is not safe for entry until the hazards (present or potential) are identified, evaluated, and then eliminated, mitigated, or controlled. Hazards include, but are not limited to, mechanical, electrical, physical, chemical, atmospheric, biological, and psychological.

6.3.5.1 Mechanical Hazards. Mechanical hazards are created by equipment with stored energy (mechanical, robotic, electrical, pneumatic, or hydraulic) or equipment that is/was energized in and around the subject space. Mechanical hazards have the potential to crush, burn, cut, shear, stab, or otherwise strike or wound workers and include rotating or other moving equipment. This equipment can be associated with either mechanical processes that take place in the space or other machinery in the vicinity.

6.3.5.2 Electrical Hazards. Electrical hazards are created by an electrical current, charge, or field capable of causing injury. All electrical sources should be treated as a potential hazard, including low-voltage sources. Low voltage does not mean low hazard. If electrical hazards are present, they should be evaluated by a qualified person as to the potential risk and controls in accordance with *NFPA 70E*. Voltage alone does not determine the severity of electrical shock. The three factors that determine the severity of electrical shock are as follows:

(1) The actual quantity of current (amperes) flowing through the body
(2) The path of current through the body
(3) The time the current flows through the body

6.3.5.2.1* As electricity travels from its source and returns to that source, either through a wire, conductive material, or the ground, it makes a complete circuit. If anything, such as a human body, comes in contact with the current-carrying wires and is grounded, electrocution is possible. Electricity follows all conductive paths to ground, not only the path of least resistance.

6.3.5.3 Physical Hazards.

N **6.3.5.3.1** These hazards include hazards other than mechanical or chemical that would cause harm to the body, including, but not limited to, noise, engulfment, falls, wet/slick surfaces, slip/trip hazards, lighting, radiation, vibration, and extremes of temperature and pressure. Entrapment hazards are where the shape or configuration of the vessel itself can exert enough force on the body to cause death by strangulation, constriction, or crushing and may include narrow cross sections, sloping floors, funneling configurations, or other internal configurations.

N **6.3.5.3.2** Physical hazards include explosion and fire hazards created by various chemical agents, such as flammable liquids, vapors, mists, and gases, as well as combustible settled dust in excess of $\frac{1}{32}$ in. (0.79 mm), and airborne concentrations that impair visibility to less than 5 ft (1.5 m) are indicators of potential explosive conditions. Concentrations of explosive/flammable vapors that have reached their lower explosive limit (LEL) and have not exceeded their upper explosive limit (UEL) are capable of explosion. There is no effective PPE for an explosive environment; elimination, mitigation, or control is recommended. Generally, atmospheres that have reached 10 percent of their LEL are considered hazardous and should require additional precautions and actions prior to entering a space. LEL is the lowest concentration of gas or vapor in air in which burning will take place.

6.3.5.4 Chemical Hazards. These hazards may arise from exposure to concentrations of gases, vapors, mists, fumes, liquids, or dusts. Routes of exposure are through inhalation, absorption through skin or mucous membrane (e.g., nose, throat, eyes), ingestion, or injection. All four routes of entry should be considered in the evaluation of confined space hazards as follows:

(1) Inhalation is the most common way for a toxic chemical to enter the body. Inhaled materials are in the form of a fume, dust, gas, mist, or vapor.
(2) Skin absorption occurs when a chemical, such as a solvent, passes through the skin and enters the blood stream. Some dusts and mists, like pesticides, may dissolve on moist skin and then be absorbed.
(3) Ingestion occurs when workers do not wash their hands before eating or where they drink beverages or smoke in an area when hazardous chemicals are used.
(4) Injection occurs when a chemical enters the body through a break in the skin, typically by a sharp object.

6.3.5.4.1 Chemical hazards and oxygen levels may be measured using atmospheric monitoring devices, such as multi-gas meters, single gas monitors, and colorimetric tubes. The following are types of chemical hazards:

(1) Systemic poisons are materials that damage human organs or systems, such as the kidneys, liver, or central nervous system. Common poisons and toxic chemicals found in or around confined spaces include carbon monoxide from incomplete combustion (e.g., engines or fires), hydrogen sulfide from decaying biological material (e.g., rotting fish, seaweed, grains), cleaning operations (e.g., toxic volatile organic compounds, solvents), and welding fumes (e.g., heavy metals).
(2) Corrosives are chemicals that cause visible destruction of living tissue at the site of contact. Some examples are muriatic acid, sulfuric acid, and lye.
(3) Irritants are chemicals that are not corrosive but may cause a reversible inflammatory effect on living tissues. Irritants are similar to corrosives, but they are weaker in their effects. Their sites of action are the skin, eyes, and lungs.

Δ **6.3.5.5* Atmospheric Hazards.** Statistics indicate that atmospheric hazards are the most common cause of death in confined spaces. Oxygen deficiency and enrichment atmospheres are also hazardous. The normal amount of oxygen is 20.8 percent to 20.9 percent in the air. Where oxygen is lower than 20.8 percent, there may be a chemical or process consuming or displacing oxygen; where it is higher, there may be a source of oxygen being introduced to the space. Oxygen deficiency may lead to atmospheres that cannot sustain life and that may become immediately dangerous to life and health. Oxygen-enriched atmospheres greater than 22 percent oxygen may increase the risk of a fire or explosion hazard by altering the properties of flammable or combustible substances. Common atmospheric hazards include but are not limited to, the following:

(1) Oxygen deficiency (less than 20.8 percent), which may be caused by the following:
   (a) Oxygen displacement by other gases and vapors, such as inert gases or by evaporating liquids
   (b) Oxygen consumption through rusting metals (oxidation), combustion, respiratory consumption by workers, or organic decay of aqueous molasses or drying of paints
   (c) Oxygen absorption or adsorption, where molecules adhere to the surface of a solid body such as damp carbon
(2)* Flammable/explosive atmospheres, which may be caused by the following:
   (a) Vaporization of flammable liquids
   (b) Byproducts of chemical reactions
   (c) Flammable gases
   (d) Elevated airborne concentrations of combustible dust
   (e) Gases from decomposition
(3) Toxic atmospheres containing substances that are poisonous and may cause injury or death independent of oxygen concentration in which the effect of contamination may be immediate (acute) or cumulative (chronic)
(4) Hypobaric and hyperbaric conditions, which may be present in high and low altitudes and pressurized spaces and may also affect atmospheric monitoring devices *(see also A.6.3.5.5)*

6.3.5.6 Biological Hazards. Biological hazards are created by viruses, bacteria, fungi, parasites, or other living organisms that may cause disease in humans. Common sources of biological hazards include bodily fluids and waste, insect bites or stings, rats, snakes, and microbial pathogens. Some biological materials, such as bacteria and molds, can be sampled and then analyzed at a microbial laboratory. Although the results may take time, the data may assist in determining and documenting potential exposures.

Δ **6.3.5.7 Psychological Hazards.** Confined spaces, restricted movement, excessive noise, and PPE restriction may create psychological hazards. Some Entrants may easily become claustrophobic or stressed, which may cause them to hyperventilate and/or may alter their ability to reason and make sound decisions. Entrants exhibiting physiological or other signs of stress should be denied entry or removed immediately.

6.4 Hazard Evaluation.

6.4.1 Following hazard identification, the Entry Supervisor should conduct an assessment to determine the actual and potential risks to Entrants and other confined space workers. Risk assessment is a process in which the expected severity of illness, injury, or property damage that an identified hazard may cause is coupled with the probability of that level of hazard occurring. Risk assessment enables prioritization of resources and indicates whether or not a hazard needs to be eliminated to establish acceptable entry parameters. If the level of risk is greater than what is acceptable (as described in the Owner's/Operator's or Entrant Employer's confined space program), control measures should be determined by the Entry Supervisor to eliminate, mitigate, or control the risk to an acceptable level.

Δ **6.4.2** The general steps needed to provide acceptable entry conditions include, but are not limited to, the following:

(1) *Investigate thoroughly.* Using information in this guide, Entry Supervisors should conduct a thorough investigation of existing or potential hazards that could pose a danger to Entrants and confined space workers. Entry Supervisors should then ensure entry requirements are documented on permits and that Entrants and workers know what the hazards are, where and when they may be located or expected, and what control measures are appropriate for each hazard.

(2) *Conduct a hazard evaluation to determine the risks.* Entry Supervisors should develop hazard scenarios that describe the environment, the possible exposures, actions, or events that could precipitate a hazard, and the outcome should the hazard occur. Hazard scenarios should determine what can go wrong, how the event may occur, what the consequences may be, and how likely the event is to happen. Consideration should also be given to the Entry Supervisors and Entrants themselves because their level of training, experience, and use of PPE can contribute to or create hazards in and around confined spaces. For example, wearing chemical protective clothing to prevent skin contact for an extended period of time in a hot environment may create heat stress hazards.

(3)* *Assess and evaluate risks.* Entry Supervisors should conduct a risk assessment to evaluate the hazards. This assessment should be based on the needs of the situation and the identified hazards. Examples include performing atmospheric monitoring in the space (e.g., for oxygen levels, flammability, and toxic chemicals) and performing a visual inspection to determine if there are physical hazards. There are numerous methods for conducting risk assessments; one such method is outlined in ANSI/AIHA/ASSE Z10, *Occupational Health and Safety Management Systems.*

(4) *Prioritize the risks.* The Entry Supervisor should prioritize and note which of the hazards pose the highest risk and focus on eliminating, mitigating, or controlling them first.

(5) *Determine control measures.* Entry Supervisors should know it is always best to eliminate hazards or to substitute with a less hazardous material or process wherever possible, regardless of the probability or severity of the hazard. If that is not feasible, the next best strategy is to determine which of the following control measures may reduce exposures, starting with engineering controls, followed by administrative controls and the use of PPE:

  (a) *Engineering controls.* Engineering controls include, but are not limited to, the following:

    (i) Local exhaust ventilation to remove contaminants

    (ii) General dilution ventilation to supply fresh air to the space

  (b) *Administrative controls.* Administrative controls include, but are not limited to, the following:

    (i) Rotating employees

    (ii) Restricting time to control toxic chemical, noise, or heat exposures

    (iii) Posting warning signs and ensuring that personnel are trained how to identify, evaluate, and control hazards

    (iv) Developing and implementing appropriate confined space, isolation, hot work, and other safety programs

  (c) *Personal protective equipment.* PPE should be used when engineering and administrative controls are not sufficient to reduce or eliminate, mitigate, or control the hazards, as PPE does not reduce or remove the hazard. *(See also Chapter 8.)*

(6) *Verify control measures.* Entry Supervisors should ensure that the control measures chosen do not introduce additional hazards that have a higher level of risk or change the existing risk(s). For example, if ventilation ducts block the exit for Entrants, it may be determined that the risk of not having the ventilation outweighs the risk posed by the blocked exit.

(7) *Determine if the level of risk is acceptable.* Entry Supervisors should determine if the risk has been reduced to an acceptable level, as determined by the organization or the supervisor, with the control measures chosen. For example, the risk assessment might conclude that a complicated, redundant ventilation system is required for entry. A facility in-house confined space entry team might conclude they are uncomfortable and unfamiliar with implementing such a system and determine that they will not complete the entry; instead, they conclude the risk is too great and decide to not conduct entry operations, choosing instead to hire a professional contractor.

(8) *Implement and train.* After the controls are implemented, Entry Supervisors should ensure that personnel involved in the entry operations are informed of the hazards, risk assessment determinations, and specific control measures and whether those control measures may pose a hazard.

(9) *Institute ongoing assessment.* Entry Supervisors should ensure that the identification and evaluation of hazards is an ongoing process as conditions often change in a confined space due to inherent, introduced, and adjacent hazards. Entry Supervisors should conduct regular visual and atmospheric monitoring of the space to ensure conditions do not change. Personnel should be aware

that changing conditions may indicate the need to evacuate the space and re-evaluate it.

6.5 Communications. A vital, reiterative part of reducing hazards is communication. The Entry Supervisor is responsible for communicating the identified hazards, risks, and selected controls to all persons involved with the entry into or working around a confined space.

Δ **6.5.1** Communications may be verbal or written through the use of permits, applicable programs, safe work practices, signs and placards, or a job hazard analysis (JHA) form. All verbal notification of hazards should be documented in writing.

6.5.2 The authorization for entry procedure and permit should outline how communication during the entry, work, and exit stages will be conducted, ensuring that authorized Entrants and Attendants can maintain contact during entry and throughout the work shift. Where the potential exists for voice communications to be hampered by noise, PPE, distance, space configuration, or other blockage, two forms of communication should be used.

6.5.3 The risks and potential exposures of the entry as well as the signs and symptoms of exposure need to be communicated to the Entrant and the Attendant. The Entry Supervisor should ensure that they are familiar with the equipment assigned, such as PPE, atmospheric testing equipment, and the rescue equipment available, as well as alarms and means of communication.

6.5.4 Entrants and Attendants should have the ability to witness and review any testing results conducted; if that is not done, then the results need to be communicated to them.

6.5.5 The means of rescue or recovery as well as the means of egress should be communicated to all Entrants and Attendants.

6.5.6 The Entry Supervisor needs to ensure that the Attendant(s) has the means to notify the designated rescue team, the notification method is operable, and the rescue team is aware of the entry.

6.5.7 All personnel involved need to be informed of other key information, given the circumstances of the particular confined space, to ensure employee safety. This information includes, but is not limited to, additional permits (e.g., hot work, electrical work, lockout/tagout), other work being performed in the vicinity of the confined space, forecasted atmospheric conditions, and past concerns or issues with the space.

Δ **6.6 Resources.** The resources contained in 6.6.1 through 6.6.4 are intended to provide guidance in identification of hazards associated with confined spaces.

6.6.1 Safety Data Sheets (SDS). Safety data sheets (SDS) should be available and reviewed for substances that were previously or are currently stored or used in a confined space being entered, have been used to purge a confined space being entered, or are being brought into the space being entered.

6.6.1.1 SDS should be reviewed or evaluated to determine, at a minimum, the flammability, combustibility, toxicity, asphyxiation hazard, and reactivity of materials.

6.6.1.2 All hazards identified during the SDS evaluation should be recorded on the confined space permit in accordance with Chapter 13 and evaluated and controlled in accordance with Chapters 7, 8, and 9.

Δ **6.6.2 Blueprints and Schematics.** Blueprints and schematics may provide information about the construction, dimensions, and distances of the space. They may familiarize the Entrant with equipment locations, size, power sources, and safety features.

Δ **6.6.3 Placards and Markings.** Placards and markings can provide Entrants with warnings for specific hazards.

Δ **6.6.4 Department of Transportation Emergency Response Guide.** This guide, which provides information on many hazardous substances, is available online at http://phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/Hazmat/ERG2012.pdf.

Chapter 7 Atmospheric Monitoring

7.1 General. The purpose of this chapter is to outline the steps necessary for testing and evaluating confined space atmospheres for gaseous hazards and to help determine the equipment necessary for this task. This chapter does not cover evaluating or testing for nongaseous hazards such as dusts, particulates, or other potential atmospheric hazards. If potential for other nongaseous atmospheric hazards does exist, a qualified person should be consulted regarding safe work practices in these environments.

7.2 Procedures for Atmospheric Monitoring. Atmospheric monitoring should be performed using the procedures described in this chapter prior to any confined space entry to determine if the atmosphere within the space is safe for entry. Atmospheric monitoring may not be necessary if the documented initial hazard evaluation, as described in Chapter 6, has determined that there is no potential for atmospheric hazards to exist in the space. Atmospheric monitoring is performed for the following two distinct purposes:

(1) Pre-entry testing
(2)* Continuous monitoring of the atmosphere within the space *(see Section 7.14)*

7.3 Pre-Entry Testing. The atmosphere of a confined space should be tested for all potential hazardous atmospheric contaminants as identified in the initial hazard evaluation *(see Chapter 6)* before each entry by a Gas Tester. The appropriate testing equipment should be used to determine that the atmospheric concentrations at the time of entry are within the range of acceptable entry conditions required by the entry permit *(see also 7.14)*. The results of the testing (e.g., actual gas concentrations) should be recorded, along with the stipulated acceptable entry conditions, according to the permit recommendations in Chapter 13. All gas monitors should be equipped with the proper sensors to detect the potential atmospheric hazards being tested and certified for use in the environment where they are being used. Refer to the gas monitor manufacturer's specifications and hazardous location and intrinsic safety certifications according to the electrical code.

7.3.1 All portable gas monitors used for confined space atmospheric monitoring should be turned on and zeroed by the Gas Tester according to Section 7.9.

7.3.2 All portable gas monitoring equipment used for confined space atmospheric monitoring should be bump tested and calibrated according to Sections 7.8 and 7.10.

7.3.3 If atmospheric monitoring is done from outside the confined space, initial testing should be performed with all ventilation controls turned off to ensure testing of a static atmosphere and to determine the background gas concentration levels in the event that ventilation fails during entry. However, after initial testing is completed, the atmosphere should be continuously monitored with the ventilation controls turned on if ventilation is necessary as a means to mitigate the hazard.

7.3.4* Tests for atmospheric hazards should be conducted by the Gas Tester simultaneously or in the following order:

(1) *Oxygen deficiency and/or oxygen enrichment.* An oxygen-deficient atmosphere represents the most common atmospheric hazard in confined spaces. Most combustible gas sensors are oxygen dependent and might not provide reliable readings in oxygen-deficient atmospheres. Therefore, oxygen concentrations should be the first hazard tested and the concentration recorded to ensure that sufficient oxygen is present for proper sensor operation according to the equipment manufacturer's recommendations.
(2) *Combustible or flammable mixtures.* Combustible gases and vapors present an immediate threat for fire and explosion and are a common atmospheric hazard found in confined spaces.
(3) *Toxic gases and vapors.* Testing should be done as necessary as determined by hazard identification *(see Chapter 6)*.

7.3.5 The Gas Tester performing atmospheric monitoring should be trained and knowledgeable according to Section 7.10 and Chapter 11 with regard to the potential atmospheric hazards and the specific monitor being used to test the confined space.

7.3.5.1 The Gas Tester performing atmospheric monitoring should verify that the monitor is functioning properly *(see Sections 7.8 and 7.9)*, has the appropriate accessories (e.g., filters, tubing, and probes) and is equipped with the proper sensors for the identified and potential atmospheric hazards related to the confined space. In addition, the Gas Tester should have an understanding of the equipment specifications, including, but not limited to, response time, measurement range, and operating temperature *(see Section 7.4)*.

Δ **7.3.6** If the confined space has not been opened or the atmosphere is not immediately accessible for testing, the Entry Supervisor should open the confined space just enough to allow insertion of a probe for testing. Any potential hazard including, but not limited to, pressure and electric shock should be eliminated, mitigated, or controlled prior to opening the space. Some manhole covers may have a small opening or an existing fitting or connection to allow the insertion of a sampling hose.

7.3.6.1 If the entrance to the confined space can be affected by wind or ambient air flow, the Gas Tester should remain on the upwind side of the entrance.

7.3.6.2 The purpose of testing before completely opening the confined space is to prevent the creation of an immediately hazardous atmosphere either inside or outside the confined space, or to prevent dilution of the atmosphere inside the space with outside air, and to protect the personnel outside the space.

7.3.7 As much of the confined space's horizontal and/or vertical area as possible should be tested by use of a pump and remote probe or sample hose from the outside before the space is entered for further testing.

7.3.8 Testing should include all irregular areas of the confined space where atmospheric hazards could be present or could accumulate. *(See Section 7.13.)*

Δ **7.3.9*** If entry into the confined space is required to test the entire area, the Gas Tester, equipped with all appropriate PPE (e.g., breathing air, harness, lifeline), can enter the space to complete the test, which would include irregular areas where pockets of gas could become trapped. An entry permit and an Attendant are required for this operation. Once the space has been completely tested, it should be ventilated according to Chapter 9 in order to ensure that any hazards identified in the testing are properly controlled. The Gas Tester must be trained and qualified as an Entrant in order to conduct internal testing.

7.3.10 Where testing for entries involving a vertical descent, the atmosphere should be tested using a gas monitor with a remote sampling pump and hose according to Section 7.7. The atmosphere should be tested at 4 ft (1.2 m) intervals starting at the opening of the space and working towards the bottom of the space.

7.3.11 If the confined space requires a horizontal entry, the atmosphere should be tested using a gas monitor with a sampling pump and rigid sampling probe according to Section 7.7. The atmosphere should be tested at 4 ft (1.2 m) intervals working inward from the opening of the space.

7.3.12 The Gas Tester performing atmospheric monitoring should document their initial results, including all gas readings, and sign the entry permit, which should indicate the date and time of the gas test and the serial number of the gas monitor used to perform the test.

7.3.13 Whereas the pre-entry test determines the initial air quality before the confined space is entered, it is important to continuously monitor for changes in the atmosphere during work operations inside the space to ensure that a safe atmosphere is maintained. *(See Section 7.13.)*

7.3.14 If hazardous atmospheric conditions as described in Section 7.14 are detected during pre-entry testing, entry should be prohibited until corrective actions are taken and retesting verifies acceptable atmospheric conditions in accordance with the applicable confined space program and entry permit. Entry into the space using appropriate respiratory protection may be considered acceptable corrective action provided the atmosphere does not contain flammable or combustible vapors in excess of the acceptable entry conditions.

7.3.14.1 Although the acceptable entry conditions in Section 7.14 are set as trigger points for limiting entry into a space, any atmospheric conditions found to be outside the normally expected readings should be evaluated the Gas Tester and Entry Supervisor to determine if a potential hazard exists. For example, an oxygen reading of 20.5 percent should be investigated to determine if an unidentified hazard has caused oxygen depletion from the normal concentration or if the oxygen reading has been influenced by relative humidity or atmospheric pressure in the space.

7.3.15 Any change in atmospheric measurements that occur during entry operations should be reported immediately to the Entry Supervisor. The new test results should be recorded to document the change in concentration and the time the change occurred.

7.3.15.1 If any results from atmospheric monitoring exceed the acceptable limits for entry required by the entry or hot work permit *(see Section 7.14)*, all work within the confined space should cease and the space should be evacuated immediately.

7.4 Selection and Types of Monitors.

7.4.1 General. A gas monitor should be selected based on the potential hazards identified during the initial hazard evaluation of the confined space. The potential atmospheric hazards should be defined in accordance with Chapter 6. Once the atmospheric hazards prior to entry and in or around the space are determined, the proper monitor can be selected.

7.4.2 Selection of Monitor. Confined space monitors should be calibrated, direct-reading, continuous-monitoring gas monitors. The monitor should detect for oxygen (O_2) content, flammable gases and vapors (LEL), and potential toxic gases, all of which are minimum requirements. The hazard evaluation will determine if it is necessary to monitor for specific gases, including, but not limited to, carbon monoxide (CO), hydrogen sulfide (H_2S), ammonia (NH_3), or VOCs such as benzene. Each of these hazardous gases can require unique sensor technology to be detected properly. In addition, real-time and integrated monitoring of other potential atmospheric hazards, such as welding fumes and particulates, might be necessary per the hazard identification and hazard evaluation.

7.4.3 Portable vs. Fixed Monitors. Portable gas monitors should be used for confined space entry atmospheric monitoring. In confined spaces where fixed gas detectors are installed, portable gas monitors should be used for pre-entry testing and either carried into or worn by the Entrant in the space.

7.4.4 Monitor Accuracy.

7.4.4.1 Direct-reading gas monitors used to evaluate or verify confined space atmospheres should provide a reading accuracy of ±20 percent or better of the actual gas concentration in all use conditions that are covered within the monitors' operating specifications.

Δ **7.4.4.2** The Gas Tester should verify that gas monitors using correlation or response factors to determine the level of a gas or vapor concentration different from that for which the sensor or gas monitors is calibrated have an accuracy of ±30 percent or better with the correlation factor applied. For example, a monitor equipped with a Photoionization Detector (PID) calibrated to isobutylene can be used to detect the level of trichloroethylene in a confined space. The monitor reading should be multiplied by a correlation or response factor, specified by the manufacturer, to determine the relative concentration of trichloroethylene in the space. The accuracy of the value after the reading has been multiplied by the correlation factor should be better than ±30 percent. The gas monitor manufacturer should be consulted for information related to response factors and gas monitor performance.

7.4.4.3 In addition to the accuracy stated in 7.4.4.1 and 7.4.4.2, the Gas Tester should be aware of the specific gas monitor's capabilities as discussed in 7.4.5 through 7.4.9.

7.4.5 Limits of Detection. The minimum detection limit (MDL), which is the smallest level of a gas that can be detected within the specified accuracy or repeatability of the monitor, should be less than 2 percent for oxygen, 2 percent LEL for combustible gases, and at least one order of magnitude lower than the published occupational exposure limit (OEL) or threshold limit value (TLV), whichever is lower, for toxic gases. The levels can be determined from manufacturers' specifications. For example, the current OSHA OEL for chlorine (Cl_2) is a ceiling limit of 1.0 ppm. The MDL for a chlorine monitor should be less than or equal to 10 percent of 1.0 ppm, or 0.1 ppm. Lower MDLs provide for greater reading stability and confidence around gas concentration action points and reduce or eliminate false or nuisance alarms due to detector or sensor instability.

7.4.6 Measuring Range. The gas monitor measuring range for detecting targeted gas hazards should be known and verified to properly evaluate all potential hazards. Gas monitor and sensor measuring ranges should be a minimum of 0 percent to 25 percent for oxygen, 0 percent to 100 percent LEL for combustible gases, and a minimum of zero to a value greater than or equal to the IDLH level for toxic gas hazards when possible. These levels can be determined from manufacturers' specifications. It is preferable to use gas monitors with broader measuring ranges so that atmospheres with contaminants that are outside normal limit values can be properly evaluated, proper mitigation procedures can be established and followed, and proper PPE can be issued and used.

7.4.7 Interferences.

7.4.7.1 The Gas Tester should be aware of gases, other than the targeted sensor gas, that can interfere with the gas monitor and cause erroneous sensor readings. For example, typical carbon monoxide sensors will produce an erroneous response when exposed to hydrogen. It is important that the Gas Tester understand all known potential atmospheric contaminants in the space, whether or not they present a hazard to the Entrant, and the effect the particular contaminant might have on the gas monitor. The gas monitor's performance with regard to interfering gases should be verified by the Gas Tester with the gas monitor or sensor manufacturer.

7.4.7.2 The Gas Tester should be aware that certain compounds can positively interfere with gas monitor or sensor readings in such a way that readings appear greater than actual target gas concentrations. Unless the presence and concentration of a positively interfering gas can be definitively identified and confirmed, appropriate action should be taken by the Entry Supervisor to address the situation and determine the true contents and concentration of hazards in the atmosphere being tested.

7.4.7.3 The Gas Tester should be aware that certain compounds can negatively interfere with gas monitor or sensor readings in such a way that readings appear lower than actual target gas concentrations. In the event that a known negatively interfering gas is believed to be present, the resulting reading from the concentration of that interfering gas should be added to the gas monitor reading for the target gas by the Gas Tester and the sum of the two values accepted as the actual concentration of the target gas present. The Entry Supervisor should then determine the proper actions and procedures to be followed as a result.

7.4.7.4 Alternative or additional test methods as determined by the Entry Supervisor and Gas Tester, including, but not limited to, colorimetric tubes and grab bag sampling, should be used in conjunction with a gas monitor to identify other contaminants in the space and verify the actual concentration of the targeted hazards. *(See Section 7.5.)*

7.4.7.5 Commonly known reasons for sensor interference should be listed in the gas monitor user's manual or otherwise provided by the gas monitor's manufacturer.

7.4.7.6 Gas monitor or sensor readings can be affected by radio frequency interference (RFI) or other electromagnetic interference (EMI).

7.4.7.6.1 Gas monitors used to evaluate or verify confined space atmospheres should be certified by the manufacturer to test and perform in accordance with relevant guidelines for RFI and EMI.

7.4.7.6.2 Care should be taken to keep gas monitors isolated from potential sources of RFI and EMI as much as possible during use. As a rule, portable electronic gas monitors should not be used within 18 in. (0.47 m) of the antenna of a transmitting mobile or handheld radio.

7.4.8 Environmental Factors. Portable gas monitors can be affected by environmental factors, including, but not limited to, temperature, relative humidity, and atmospheric pressure.

7.4.8.1 All gas monitors or sensors used for evaluation or verification should compensate for the effects of temperature on the readings throughout the full measuring range of the sensor and the full operating temperature range of the gas monitor.

7.4.8.2 The effects of temperature as well as the effects of changes in relative humidity and atmospheric pressure on gas monitor readings should be identified and understood in accordance with the manufacturer's product recommendations.

7.4.9 Alarm Indications.

7.4.9.1 Gas monitors should have simultaneous, multiple alarm indicators, including audible, visible, or vibrating alarms to indicate the conditions in 7.4.9.2 through 7.4.9.6.

7.4.9.2 Portable gas monitors should have not only preset alarm values but also manual alarm values that allow the user to set alarms at specific levels. It is critical that a qualified health and safety professional be consulted to determine the level at which gas monitor or sensor alarms should be set for specific applications.

7.4.9.3 Portable gas monitors should have at least two levels of instantaneous alarms for all sensors, including oxygen, LEL, and toxics.

7.4.9.4 Portable gas monitors should have alarms to indicate that the short-term exposure limit (STEL) for toxic gases has been exceeded.

7.4.9.5 Portable gas monitors should have time weighted average (TWA) alarms for toxic gases — typically an 8-hour average.

7.4.9.6 Gas monitors should have alarms to alert the Gas Tester to other conditions, including, but not limited to, the following:

(1) Low battery
(2) Low flow — for gas monitors that have remote sampling pumps
(3) Calibration failure/past due
(4) Bump test past due

7.5 Other Monitor Types. If the confined space could potentially have atmospheric hazards that current gas-monitoring technology cannot detect, other types of detection equipment should be utilized to assess the atmosphere. Such potential air contaminants could include uncommon chemicals, particulates, and, in some cases, unknown air contaminants. Colorimetric detector tubes and industrial hygiene sampling are two methods that can be utilized to determine the level of hazards that currently available electronic monitors cannot detect. Also, real-time particulate monitors may be used to determine the levels of inhalable and respirable particulates in the space. In other cases, integrated air sampling may be required for activities such as welding, sanding, and grinding.

N **7.5.1 Photoionization Detectors (PIDs).** Broadband sensors are able to respond to more than one toxic chemical in real time. Photoionization detectors (PIDs) are a common example of this technology. They provide a single cumulative reading for all chemicals that they detect, and are unable to isolate the constituents of an atmosphere containing a mixture of gases or to determine the identity of an otherwise unidentified chemical. However, they can alert the gas tester to the presence of some chemicals and many VOCs that would otherwise go undetected by a standard multi-gas monitor.

7.5.2 Colorimetric Detector Tubes. Colorimetric detector tubes that are selected for particular chemicals can sometimes be used for screening purposes. These tubes, which are usually made of glass, change color according to the concentration level of the measured contaminant. Air is drawn through the tube with a bellow or manual aspiration pump.

7.5.2.1 Detector tubes, when used, should be used by the Gas Tester according to the manufacturers' specifications and instructions. Most detector tube manufacturers require that only their brand of pump be used in conjunction with the detector tube to obtain accurate measurements.

7.5.2.2 Prior to use, detector tube pumps should be leak-checked by the Gas Tester. This is typically done by compressing the bellows fully, then inserting an unbroken tube and releasing the bellows to see if they expand. If there are no leaks, the bellows will remain fully compressed.

7.5.2.3 If remote measurements to a confined space are made from outside the space, the detector tube should be attached to the end of the sampling hose and not near the pump. Otherwise, the air in the tubing will be measured rather than air in the confined space, resulting in erroneous measurements.

7.5.2.4* Most colorimetric test methods are best used for screening purposes because they are typically only accurate to within ± 25 percent. To ensure safety, 25 percent should be added to the reading to determine the level of toxic gas in the confined space.

7.5.3* Industrial Hygiene Monitoring. If direct-reading gas monitors or colorimetric tubes are not available to assess the potential hazard, laboratory-based industrial hygiene monitoring with intrinsically safe battery-operated pumps and various air-contaminant collection filters, tubes, impingers, or other devices, such as vacuum canisters, should be used. They might be the only means available to measure air contaminants.

• **7.6 Intrinsic Safety.** The Gas Tester should ensure that all monitors used to test for atmospheric hazards within a confined space should be certified by a nationally recognized testing laboratory (NRTL) as intrinsically safe for use in the space according to the classification of hazardous atmospheres in *NFPA 70*. *(See Chapter 8.)*

7.7 Personal Monitoring Versus Remote Sampling. Direct-reading gas monitors can be used in different configurations. Diffusion or passive (personal) monitors work based on unassisted exposure of the gas sensors to the ambient environment. The sensors sense the immediate ambient environment surrounding the gas monitor. Remote sampling or a sample draw mode utilizes either a manual or an automatic pump. The pump, attached or internal to the gas monitor, draws air through a probe and tubing into the gas monitor and directly onto the sensors, which allows the gas monitor to sense the environment away from where the gas monitor is located.

7.7.1* In all cases, remote sampling should be done prior to entering a confined space. The gas monitor and its display should be in direct sight of the Gas Tester at all times during testing. The Gas Tester should remain outside the confined space with the gas monitor connected to a pump, a defined length of tubing, and a probe. The Gas Tester should insert the probe and tubing into the confined space to the point farthest from the entry.

7.7.1.1* Tubing Length and Response Times. The Gas Tester should ensure that adequate time is allowed to completely purge the sample tubing of all residual air and ensure that a full reading is obtained during remote sampling operations. Most automatic pumps draw at approximately 2 sec/ft (7 sec/m) of sample tubing. Therefore, the Gas Tester should allow 2 sec for every foot (7 sec for every meter) of sample probe and tubing used, plus the normal gas monitor response time for the air from the sampling area to be tested by the sensors. The gas monitor manufacturer should be consulted for instructions on remote sampling and gas monitor response time.

7.7.1.2 The Gas Tester should consult the gas monitor manufacturer's instructions to determine the proper type of sample tubing or probe to be used to detect specific hazards because some gases can be absorbed into specific types of tubing, which would produce erroneous readings.

7.7.2 Gas monitors used by confined space personnel for personal monitoring may be used in either diffusion or aspirated mode.

7.7.2.1 Confined space Entrants should wear a gas monitor at all times during entry. It is critical that the monitor or sample input does not get covered by clothing or PPE to ensure that the atmosphere is measured properly.

7.7.2.2 A direct-reading gas monitor should either be worn by the confined space Attendant or placed in the area outside the confined space. This would allow the Attendant to monitor the environment outside the confined space to make sure it is not changing. If ventilation is exhausting toxic materials outside the space, it could affect the area immediately outside the space, including the Attendant, even if the confined space itself is not showing elevated readings. Likewise, if a toxic or combustible atmosphere develops outside the confined space, it could affect the environment in the confined space. The sooner the Attendant can be made aware of changes, the sooner a decision can be made whether or not to stop operations and vacate the space.

7.8 Monitor Calibration

7.8.1 A calibrated, direct-reading gas monitor should be used for entry into a confined space. A calibrated gas monitor is one that has completed a span calibration function before it is put into service. Executing a span calibration is the best way to ensure the unit is reading concentrations as designed and is conducted by exposing a direct-reading gas monitor (or sensors) to a defined concentration of calibration gas. Prior to starting a span calibration, the direct-reading gas monitor should have a zero calibration performed in a clean-air environment, preferably outdoors and upwind from any sources of air contaminants.

7.8.1.1 The gas monitor should be programmed to detect a set concentration of specific gases aligned to the configuration of the gas monitor for calibration purposes. For example, the gas monitor might be programmed to read 20.9 percent oxygen (O_2), 32 percent methane (LEL), 25 ppm hydrogen sulfide (H_2S), and 50 ppm carbon monoxide (CO) during the calibration process. The gas monitor is then exposed to a blend of the same calibration gases with identically defined concentrations. The gas monitor then "calibrates" what it is programmed to see against what it is being exposed to. This is a span calibration. Through this process, the gas monitor will either pass or fail the span calibration. If the calibration or the gas monitor fails, the unit should be removed from service and tagged for maintenance. If the gas monitor passes, it is ready for confined space monitoring.

Δ **7.8.1.2** The gas monitor instruction manual or manufacturer should be consulted to determine the proper gases and concentrations to be used for monitor calibration. Calibration gas can vary depending on its manufacturer. There are different types of combustible gases used in calibration gas blends (e.g., pentane, propane, and methane). Each gas monitor differs on which type of combustible gas should be used to most accurately calibrate its combustible sensors. The manufacturer's recommendations should always be followed. If a gas monitor manufacturer provides its own calibration gas for the monitor, that gas should be used. This ensures that the calibration gas cylinders have gone through a quality assurance program in alignment with the gas monitor.

Δ **7.8.2** Calibration results should be documented. Some direct-reading gas monitors have a data-logging feature that documents the calibration process, which can be downloaded from the gas monitor and stored electronically. Otherwise, the following monitor calibration data should be documented manually:

(1) Date of test
(2) Serial number of gas monitor and sensors tested
(3) Serial number of any docking/calibration station used to perform the test or name of individual conducting a manual test
(4) Type and concentration of each gas used to conduct the test
(5) The result of the test for each sensor in the gas monitor tested

7.8.3 The qualified person performing calibration should ensure that the gas monitor is programmed to sense the gas concentrations listed on the cylinder label.

7.8.4 The qualified person performing the calibration should ensure that the calibration gas cylinder has not expired. Gas cylinders typically have a shelf life of 2 years or less — depending on the type of gas in the cylinder. The qualified person should understand that calibrating with expired gas may result in inaccurate calibration and is not acceptable.

7.8.5 When a manual span calibration is conducted, the qualified person performing the calibration should ensure that the regulator and tubing meet the gas monitor manufacturer's recommendations for the gases being calibrated. Regulators can come in a variety of materials and flow rates. If the manufacturer specifies a 0.5 liters per minute (LPM) flow rate, a regulator with that flow rate should be used. If the manufacturer of the gas monitor supplies regulators, a regulator from that manufacturer should be used. A manufacturer that runs the quality assurance programs for all of its components helps ensure a more accurate calibration process and results in fewer troubleshooting questions.

7.8.6 The qualified person can perform gas monitor span calibration utilizing an automated docking or calibration station. The qualified person should be aware that a docking station made by one manufacturer should not be used to calibrate another manufacturer's gas monitor. The qualified person should either ensure that the calibration is documented by the docking station automatically or manually document the calibration.

7.9 Zeroing. Prior to conducting any atmospheric monitoring, the Gas Tester should zero the gas monitor in a known clean-air environment according to the manufacturer's recommendations and instructions.

7.10 Bump Testing.

7.10.1 Gas monitors used for atmospheric monitoring of confined spaces should be bump tested by the Gas Tester prior to each day's use. A bump test is a brief exposure of the gas monitor/sensors to specified target gas(es) to verify sensor and alarm functionality. It is not intended to measure the accuracy of the gas monitor/sensors. The only way to ensure that a portable gas monitor will respond to the targeted gas is to test it with a known concentration of that gas or an acceptable surrogate gas (i.e., a gas different from the explicit target gas for the sensor). A typical bump test takes 30 to 45 seconds and is a critical step to ensuring the gas monitor is functioning since it was last used or calibrated.

7.10.2 A gas monitor bump test should be performed by the Gas Tester prior to daily use using an automated docking or bump test/calibration station or by manual application of gas to the sensors.

7.10.3 The Gas Tester should perform the test by applying a known concentration of each of the target gases to the gas monitor/sensors individually or in combination and verifying that each sensor responds in a positive manner and that all gas monitor alarms are activated accordingly. The Gas Tester should refer to the manufacturer's instructions and recommendations for performing a bump test.

7.10.4 The concentration of gas used to conduct a gas monitor bump test should be greater than the lowest alarm set point for each sensor.

Δ **7.10.5** The Gas Tester may use surrogate gases (gases different from the explicit target gas for the sensor) to conduct a bump test of the sensor provided that the concentration of gas used produces a response equivalent to or greater than the concentration of the target gas required to exceed the lowest alarm set point for each sensor. This should be done in accordance with the manufacturer's instructions and recommendations.

7.10.6 Any gas monitor that fails to respond properly during a functional bump test should be successfully recalibrated by the Gas Tester prior to further use.

7.10.7 Bump test results should be documented by the Gas Tester and include the following data:

(1) Date of test
(2) Serial number of gas monitor and sensors tested
(3) Serial number of the docking/bump station used to perform the test or the name of individual conducting a manual test
(4) Type and concentration of each gas used to conduct the test
(5) The result of the test (pass/fail) for each sensor in the gas monitor tested

7.11 Clearing Peak Values. Prior to any atmospheric monitoring, the gas monitor's stored peak reading values should be reset by the Gas Tester according to the manufacturer's recommendations and specifications.

7.12 Training and Competency. All Gas Testers should be trained in the proper use of the assigned gas monitor according to the manufacturer's recommendations and in accordance with the requirements of Chapter 11.

7.13 Continuous Atmospheric Monitoring.

Δ **7.13.1** The atmosphere in and around a confined space should remain safe during entry operations. Atmospheric conditions can change quickly or gradually over time; without continuous atmospheric monitoring, air contaminants may increase or the oxygen percentage may decrease or increase, creating dangerous confined space atmospheric conditions. Entrants, Attendants, and other personnel may be unaware of changing conditions if the air quality was only initially monitored and determined to be acceptable. The atmosphere within and outside the confined space should be monitored continuously to ensure continued safe working conditions.

7.13.2 Entry Supervisors, Gas Testers, Attendants, and Entrants should be aware that there are many reasons why air quality may deteriorate in and around confined spaces, including, but not limited to, air contaminants generated by activities inside or outside the space, increased temperatures causing additional chemical vaporization, and existing or new hazards that have not been adequately eliminated, mitigated, or controlled.

7.13.3 Continuous atmospheric monitoring is the best method to ensure that air quality remains acceptable throughout entry operations.

7.14 Acceptable Atmospheric Limits for Entry. Where levels are outside the following parameters, entry is allowed only after control measures as indicated in Chapter 8 are applied:

(1) Oxygen content is between 19.5 percent and 22.0 percent.
(2) Flammable gases and vapors are below 10 percent of the LEL of the material involved.
(3)* Potential toxic air contaminants are at or below one-half the OEL — typically the action level — as determined by the written confined space program.

7.15 Gas Monitor Maintenance.

Δ **7.15.1** Gas monitors used for atmospheric monitoring of confined spaces need to be maintained by a qualified person according to the manufacturers' specifications to ensure that they operate properly, to maximize their longevity, and to maintain their warranties. All maintenance other than routine inspection for damage, cleaning, proper battery charging, and periodic sensor replacement should be performed by the manufacturer. Gas monitors should be cleaned and maintained according to the manufacturer's recommendations.

7.15.2 Qualified personnel responsible for maintaining gas monitors should be aware that sensors have limited service life, even when the meters are used infrequently. The oxygen sensor typically has the shortest life, usually 2 to 3 years. The majority of gas monitors used for atmospheric monitoring of confined spaces have rechargeable batteries that should provide years of service as long as they are charged according to the manufacturers' procedures.

7.16 Training.

7.16.1 The Owner/Operator or Entry Supervisor should ensure that the Gas Tester has been trained to complete the duties and responsibilities of the role in accordance with Chapter 11.

7.16.2 The Owner/Operator or Entry Supervisor should ensure that the Gas Tester has completed a training program covering use, operation, maintenance, calibration, bump testing, and other aspects of the specific gas monitor to be used for atmospheric monitoring according to the recommendations of the gas monitor manufacturer.

7.16.3 The Owner/Operator or Entry Supervisor should ensure that all personnel designated to perform maintenance (e.g., calibration and sensor replacement) on the portable gas monitor have completed a training program on the maintenance of the specific gas monitor according to the recommendations of the gas monitor manufacturer.

Δ **7.17 Record Retention.** Entrant Employers should maintain records pertaining to gas monitor calibration, bump testing, maintenance, and confined space atmospheric monitoring results for a minimum of 1 year or for an amount of time in accordance with applicable industry standards and regulations.

Chapter 8 Hazard Elimination, Mitigation, or Control

8.1 Purpose. The purpose of this chapter is to provide best practices for eliminating, mitigating, or controlling hazards that either already exist in or around confined spaces or are created during entry into and/or working in or around confined spaces.

8.2 General. Entry Supervisors should ensure that all identified inherent, introduced, and adjacent hazards in and around confined spaces are eliminated, mitigated, or controlled to the extent possible prior to entry and that the corrective actions taken are documented on the confined space permit. Hazards that cannot be eliminated, mitigated, or controlled should be noted on the permit by the Entry Supervisor, who should make sure that required personal protection is used or other appropriate measures are taken to ensure safe entry. Chapter 6 provides hazard identification and risk assessment criteria.

8.3 Controls for Other Identified Hazards. The hazard identification and risk assessment process as specified in Chapter 6 requires that hazards be eliminated, mitigated, or controlled to a safe level. This chapter addresses common confined space hazards. Confined spaces, however, may have unique hazards that are not addressed in this best practices guide. Nonetheless, the hazards need to be either eliminated, mitigated, or controlled using appropriate and effective methods.

8.3.1 Hierarchy of Controls. A hierarchy of controls, which is a system used to minimize or eliminate exposure to hazards, should be used as a means of determining the most effective controls. The controls in 8.3.1.1 through 8.3.1.5 are presented from the most effective to the least effective.

8.3.1.1 Elimination controls seek to remove the hazard before entry is made.

8.3.1.2 Substitution controls seek to replace a hazardous material, equipment, or process for a much less hazardous one.

8.3.1.3 Engineering controls are used to isolate, prevent, contact, or otherwise control a hazard.

8.3.1.4 Administrative controls involve actions such as restricting access to hazardous areas or training employees to work safely with hazardous chemicals, machinery, and other hazards.

8.3.1.5 PPE controls provide a last line of defense to minimize the risk of exposure. It is the least desired control as it does not eliminate or reduce the hazard. PPE requires proper selection, training, and use.

8.4 Chemical and Atmospheric Hazards. Entry Supervisors should ensure that atmospheric hazards identified during atmospheric monitoring have been eliminated, mitigated, or controlled prior to entry. Methods to remove hazardous atmospheres from confined spaces include, but are not limited to, cleaning, displacement or dilution via ventilation or inerting (which could create additional hazards, such as low oxygen), purging, or removal by other approved methods *(see 8.4.1 through 8.4.3)*. Prior to entry, a Gas Tester should perform atmospheric monitoring in accordance with Chapter 7 to confirm the space is safe to enter.

8.4.1 Removal of Hazardous Materials and Vapor Freeing. Prior to entry, Entry Supervisors should ensure that harmful or potentially harmful vapors, gases, toxics, and other residual materials have been removed from the confined space to the greatest extent possible in accordance with the entry permit requirements. This can be accomplished from outside the space without bodily entry by ventilating with fresh air or purging with inert gas, water, or steam. If this is not possible, controls are needed to ensure that removal during entry does not create additional hazards. Caution: The use of steam to purge flammable atmospheres without using proper precautionary measures may result in fire, explosion, or an oxygen-deficient atmosphere.

8.4.1.1* Whenever possible, workers should clean the confined space from outside, without the need for entry.

8.4.1.2* Entry Supervisors should ensure that all vapors and toxic gases are exhausted from the confined space to eliminate hazards prior to issuing a permit for entry. This can be accomplished by Ventilation Specialists using blowers or exhaust eductors in accordance with Chapter 9. Entry Supervisors should make sure that intrinsically safe blowers and eductors are used for flammable, toxic, or combustible gas and vapor removal. Ventilation of flammable, combustible, or toxic gases and vapors should exhaust a minimum height of 12 ft (3.7 m) above ground level to provide for proper dissipation. The Entry Supervisor should confirm there are no sources of ignition or personnel in the path (downwind) of hazardous exhausts.

8.4.1.3 Methods such as purging with an inert gas, water, or steam can be used to remove residual vapors. *(See 8.4.3 and 9.5.9.)*

8.4.1.4 Regulations and Standards for Tank Cleaning.

8.4.1.4.1 Confined space entries of petroleum storage tanks should be in accordance with API STD 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks,* and API RP 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*. Entry into inerted confined spaces should be in accordance with API STD 2217A, *Guidelines for Safe Work in Inert Confined Spaces in the Petroleum and Petrochemical Industries*. These standards provide detailed safety requirements for aboveground petroleum storage tanks.

Δ **8.4.1.4.2** Entry Supervisors should ensure that confined space entry into and work within petroleum storage tanks are conducted in accordance with all applicable Owner/Operator and Contractor programs, industry standards, and regulatory requirements. For detailed safety requirements for confined space entry into and work within aboveground petroleum storage tanks, see API STD 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*; API RP 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*; and API STD 2217A, *Guidelines for Safe Work in Inert Confined Spaces in the Petroleum and Petrochemical Industries*.

8.4.1.4.3 Entry Supervisors should be aware that cleaning and entry of tanks, vessels, and containers other than petroleum tanks should be in accordance with all applicable Owner/Operator and Contractor programs, industry standards, and regulatory requirements. NFPA 326 provides detailed safety requirements for all types of tanks, vessels, and containers.

8.4.1.4.4 Entry Supervisors should be aware that entry and work inside marine vessel confined spaces should be in accordance with all applicable Owner/Operator programs, industry practices, and government regulations. NFPA 306 provides guidance for entry into confined spaces on marine vessels.

8.4.1.5* Chemical Residues. Entry Supervisors, Entrants, and Attendants should be aware that even after cleaning is completed, harmful residues might remain within the confined space. The Entry Supervisor should review the applicable SDS to determine if these residues could be harmful to Entrants through breathing or by absorption through the skin, or if they are corrosive. Entry Supervisors should be familiar with testing methods for harmful residues, including, but not limited to, atmospheric testing, wipe testing, or testing with pH paper, which can help determine if additional cleaning is needed and the type of PPE required. Entry Supervisors should ensure that any required testing is performed by a suitably protected and qualified person prior to issuing an entry permit. The Entry Supervisor may require continuous or periodic testing if additional interior cleaning or work can result in harmful releases.

Δ **8.4.2 Combustible Dusts.** Entry Supervisors should ensure that combustible dust residue is removed using intrinsically safe vacuums, manual cleaning methods, or approved water wash-down methods that do not place dust in suspension in spaces where ignition sources could be present. The Entry Supervisor should confirm that vacuum equipment is grounded and bonded to the space being cleaned. Compressed air should not be used to move or clean combustible dust. In these situations, safety procedures should be followed and equipment shut down in the area to eliminate potential sources of ignition. Additional information on compressed air and water cleaning of combustible dust can be found in NFPA 652.

Δ **8.4.3 Inerting.** Entry Supervisors should be aware that ventilation may not always eliminate all of the atmospheric hazards within a confined space. If hot work is to be conducted within a confined space that contains flammable or combustible vapors or liquids, one method to control the ignition hazard is to displace any oxygen in the atmosphere within the space with an inert gas. Inert gas can also be used to displace oxygen where flammable materials or atmosphere cannot be removed prior to entry. Entry Supervisors should not permit entry into confined spaces with inert atmospheres except in limited circumstances in accordance with the Owner's/Operator's or Entrant Employer's confined space and respiratory protection programs. Persons engaged in inert entry operations, including Entry Supervisors, Entrants, Attendants, Rescuers and others should be trained, experienced, and qualified in this specific activity.

8.4.3.1 Entry Supervisors should require Entrants to use approved supplied air respirators (SARs) with an escape cylinder or SCBAs for entry into inert atmospheres. It is critical that respirators worn in inert environments be securely fastened to the face since even a small breach in a standard facepiece seal will expose the entrant to a fatal environment. There are special respiratory redundant air systems available for this type of environment.

8.4.3.2 A means of rescue should be provided in accordance with Chapter 10.

8.4.3.3 Following the use of inert gas, the Entry Supervisor should have the confined space purged with water or ventilated with fresh air in accordance with Chapter 9 and make sure the entry conditions are in accordance with Section 8.4 before a permit for entry without respiratory protection is issued.

8.4.3.4 Entry Supervisors should be aware that tanks, vessels, containers, and equipment adjacent to a confined space entry and/or a confined space work area are potential sources of flammable, combustible, or toxic vapors, gases, or hazardous materials. If the Entry Supervisor deems such conditions as potentially harmful to the confined space, the hazard should be eliminated, mitigated, or controlled prior to permitting entry and/or any work or hot work in the space or adjacent areas.

8.4.3.5 Whenever inert gases are used to purge a space, the Ventilation Specialist and Entry Supervisor should consider the discharge point for the evacuated atmosphere in relation to personnel and any sources of ignition outside or adjacent to the space. The Entry Supervisor may require atmospheric testing in the adjacent areas and barriers placed at appropriate distances to ensure that exhausted contaminants are within acceptable levels as defined in Section 8.4. The Entry Supervisor can use a hot-, warm-, and cold-zone system to delineate areas and degrees of hazard and controls.

8.4.3.6 Whenever inerting is performed, the atmosphere within 35 ft (10.7 m) outside of the opening should be tested as determined by the Entry Supervisor to be sure it is safe for breathing. In outside environments, the Entry Supervisor should consider humidity, wind direction, and wind speed and extend the testing area, if necessary.

8.4.3.7 The Entry Supervisor should ensure that inerted confined spaces are posted as follows:

DANGER DO NOT ENTER

INERT GAS ENVIRONMENT ATMOSPHERE UNSAFE FOR WORKERS

INSUFFICIENT OXYGEN FOR BREATHING

PERMIT REQUIRED FOR ENTRY

Δ **8.4.3.8*** Entry into inert atmospheres should not occur except in well-controlled situations where no other option for entry is available. If entry into an inert atmosphere is needed, specialized breathing apparatus units that commonly include redundant air supply and facepiece securement systems should be utilized. Standard atmosphere-supplying respirators (SCBAs and SARs) do not provide the level of protection necessary to assure the safety of Entrants. Entry Supervisors, Attendants, and Entrants should be aware that leakage or exhaust of breathing air into an inert (or flammable) atmosphere may create a hazard by reducing the effectiveness of the inert concentration and by possibly increasing the oxygen level (thus affecting the explosive limits of a flammable atmosphere).In confined spaces where oxygen-deficient environments exist that are not associated with the intentional and complete inerting of the environment (e.g., low oxygen due to hot work within the space), a combination full facepiece pressure-demand SAR with auxiliary SCBA escape mechanism or a full facepiece pressure-demand SCBA with a minimum 30-minute cylinder may be sufficient to protect Entrants and should be utilized.

8.4.3.8.1 Where any entry requires supplied breathing air, the Owner/Operator or Entrant Employer should assure that the respiratory breathing-air supplier adheres to practices that eliminate both the potential for insufficient oxygen content in an air supply cylinder and the possibility of cross contamination of the cylinder air with other gases. They should assure that only certified compressor sourced breathing (Grade D or better quality per CGA G-7.1, *Commodity Specification for Air)* is used for SAR-required entries. Air supply cylinders should be dedicated to breathing air service and be secured with sealed valves (and racks) and controlled to prevent cross contamination.

8.4.3.8.2 After cylinders and racks are in place at the job site and prior to each day's (or shift's) use, a qualified person should test each breathing air cylinder (to be used) to assure the proper oxygen content and that there is no contamination.

8.4.3.8.3 The Entry Supervisor should assure that respiratory protective equipment (racks, cylinders, hoses, retrieval gear, helmets, and masks) is designed, supplied, and used to minimize risk and human error during entry work and in emergency situations by checking critical respiratory protection components prior to permitting entry.

Δ **8.4.3.8.4** Owners/Operators and Entrant Employers should develop and implement respiratory protection programs that meet applicable regulatory requirements and include medical evaluation, training, and fit testing before providing Entrants with respiratory equipment.

8.4.3.9 Regulations and Standards for Inerting.

Δ **8.4.3.9.1*** Entry Supervisors in the maritime industry should conduct inerting in accordance with NFPA 306, which includes a section on inerting procedures for marine vessels, and in accordance with the *International Safety Guide for Oil Tankers and Terminals (ISGOTT)*. A Certified Marine Chemist may be required to oversee the inerting operation if hot work will be conducted.

8.4.3.9.2 Entry into inerted confined spaces in the petroleum and petrochemical industries should be in accordance with API 2217A, *Guidelines for Safe Work in Inert Confined Spaces in the Petroleum and Petrochemical Industries.*

8.4.3.9.3 Entry into other inert spaces should be in accordance with NFPA 326 and other applicable standards and regulations.

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8.5 Hot Work.

8.5.1 General. All confined space personnel should be aware that hot work is any work that can produce a source of ignition, including, but not limited to, open flames, sparks, static electrical charges, or heat producing activity and is typically associated with cutting, welding, grinding, drilling, abrasive blasting, burning, heating, and brazing operations as part of repair, maintenance, or construction work. Hot work also includes the use of potential spark-producing equipment, including, but not limited to, nonapproved electrical equipment, internal-combustion-powered equipment, and electric- and/or battery-powered tools and equipment. There is also potential for incidents to occur in areas adjacent to confined spaces that were not considered during the initial or subsequent confined space evaluation.

8.5.2 Cold Work Options. Wherever possible, Entry Supervisors should provide alternatives other than hot work in or around confined spaces during a confined space entry. The Entry Supervisor should consider alternative cold work methods, including, but not limited to, mechanical cutting, cold cutting, scraping, hand grinding, and filing with equipment that minimizes the potential for sparks and heat. For example, cutting can be done with hand saws, hydraulic shears, pneumatic chisels, or pipe cutters. Mechanical joining methods such as nuts and bolts, screwed fittings, or couplings can be used. Hand filing can be done instead of mechanical grinding, and threaded pipe might be used instead of welded or soldered pipe. Personnel should be aware that sparks can be generated by some of these techniques, but the risk is greatly reduced as the sparks are typically not hot enough to cause ignition.

Δ **8.5.3 Hot Work Permit.** When hot work is required in or adjacent to a confined space, the Entry Supervisor should issue a separate hot work permit attached to the confined space permit. Either the Owner/Operator of the location where the hot work is to occur or the Contractor/Subcontractor conducting such work should have a hot work program and hot work permit procedures. The Entry Supervisor should ensure that, in addition to all of the requirements on the entry permit, the hot work permit contains information including, but not limited to, the following:

(1) Conditions under which hot work permit authorization is to start/stop or be cancelled
(2) Requirements for ventilation, inerting, or other atmospheric precautions
(3) Requirements for PPE and respiratory protection in addition to that required by the entry permit
(4) Requirements for continuous atmospheric monitoring within the confined space — unless Entry Employer can demonstrate that equipment for continuous monitoring is not commercially available or that periodic monitoring is sufficient — and, when necessary, outside of the confined space as determined by the Entry Supervisor in accordance with the confined space program and hot work program

8.5.4 Evaluation of Hazards.

N **8.5.4.1** Wherever hot work is performed, the Entry Supervisor should evaluate all locations and adjacent spaces where flammable or combustible liquids, gases, or materials may be present or may occur. If such hazards exist, measures should be taken by the Entry Supervisor to control, remove, or clean them prior to issuing the hot work permit. Entry Supervisors should ensure the following:

(1) Hot work is not conducted in areas adjacent to tanks or lines containing flammable or combustible materials, unless there is no other alternative
(2) Safety measures have been implemented
(3) A hot work permit covering such activity has been approved

N **8.5.4.2** When hot work on tanks, vessels, containers, lines, and equipment containing flammable and combustible liquids or gases is to be performed, Entry Supervisors should refer to API RP 2201, *Safe Hot Tapping Practices in the Petroleum and Petrochemical Industries*, and API RP 2009, *Safe Welding, Cutting, and Hot Work Practices in the Petroleum and Petrochemical Industries*, for guidance.

8.5.4.3 The Entry Supervisor should ensure that tanks containing oxygen (excluding breathing-air cylinders), flammable gas, and inert gas remain outside a confined space, if possible. Entry Supervisors, Attendants, and Entrants should be aware that leaking oxygen lines can create an oxygen-enriched environment and leaking acetylene can create a flammable atmosphere, both of which can lead to increased fire and explosion hazards.

8.5.4.4 Entry Supervisors should ensure that all hoses and torches associated with oxygen and gas cylinders are disconnected and the gas and oxygen supply shut off during unattended or extended breaks and at the end of the work period.

Δ **8.5.5 Controls.** Entry Supervisors should confirm that tanks, vessels, and containers that contained flammable or combustible liquids, gases, or materials are free of vapor, gas, and dust and are cleaned or inerted prior to beginning hot work within the confined space. Precautions should be taken by Entry Supervisors and Ventilation Specialists to ensure that no ignition sources are adjacent to or downwind from the confined space because inerted vapors exiting the space may be flammable or combustible.

8.5.5.1 Where performing hot work above a tank, container equipment, vessel, sewer, pit, pipeline, drainage ditch, or similar areas containing, or having the potential to contain, flammable or combustible materials, or where an entry is being made, Entry Supervisors should make sure that precautions are taken to shield the area below from falling sparks and hot materials (e.g., slag). In addition, precautions should be taken to ensure that vapors from these spaces cannot reach the hot work area.

8.5.5.2 Entry Supervisors should also give consideration to adjacent spaces above and below the hot work being conducted. Where welding takes place on an elevated surface, all surfaces below the elevated platform in the vicinity of the welding are potentially at risk. A wet fire blanket or a welding blanket can be used to protect sewer openings, open confined space manways, ditches, and piping containing flammable or combustible liquids or vapors from sparks and slag.

8.5.5.3 Prior to issuing a hot work permit, Entry Supervisors should ensure that Gas Testers conduct atmospheric monitoring in adjacent open confined spaces within 50 ft (15 m) horizontally of the hot work area to confirm that there are no adjacent hazards that could impact or be impacted by the hot work. Entry Supervisors should ensure that hot work is not authorized or performed unless atmospheric testing indicates that oxygen levels are less than 22 percent by volume and the LEL (if applicable) is less than 10 percent, or where oxygen and flammable levels are permitted to meet other requirements established by the applicable confined space and hot work programs. In such cases, the Entry Supervisor should indicate the specific requirements on the hot work permit and check that appropriate permit precautions are taken.

8.5.5.4 Entry Supervisors should also consider testing and implementing precautionary measures to adjacent spaces that are above and below the hot work area. Entry Supervisors should be aware that where welding takes place at an elevated location, all areas below the vicinity of the welding are potentially at risk from falling sparks and slag.

8.5.5.5 The Entry Supervisor should provide fire protection as required by the hot work permit, including, but not limited to, appropriate portable fire extinguishers *(see NFPA 10)* located within 10 ft (3 m) of the hot work area.

8.5.5.6 Entry Supervisors should ensure that all electrical welding equipment used in flammable and combustible atmospheres is as follows:

(1) Inspected and approved prior to use by a qualified person
(2) Intrinsically safe
(3) Properly grounded
(4) Where necessary, bonded to the tank, vessel, equipment, or confined space

8.5.5.7 Entry Supervisors should ensure that ordinary combustible materials are not located within 35 ft (10.7 m) of the hot work area. If such materials are present and cannot be removed, the Entry Supervisor should indicate appropriate preventive measures on the hot work permit and make sure they are implemented to eliminate, mitigate, or control the potential hazards before work begins.

8.5.6 Regulations and Standards for Hot Work. Entry Supervisors should be aware of welding and hot work, and ensure that it is conducted in accordance with Owner/Operator or Contractor programs and procedures, industry practices, and regulations applicable to the specific industry or operation being performed. Owners/Operators, Contractors, and Entry Supervisors should be aware of the most current regulations, codes, and practices, including, but not limited to, those referenced in 8.5.6.1.1 through 8.5.6.4.9.

8.5.6.1 General Industry.

8.5.6.1.1 General industry workplaces covered by OSHA should follow the requirements in 29 CFR 1910.251–1910.255, as a minimum. 29 CFR 1910 provides both general and specific requirements for oxygen–fuel gas welding and cutting, arc welding and cutting, and resistance welding. In addition to the OSHA general industry requirements, additional industry-specific standards should be considered as applicable. Regulatory requirements for other countries and jurisdictions should also be followed.

8.5.6.1.2 ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes,* provides for safe welding and cutting operations and the setup and use of welding and cutting equipment. ANSI Z49.1 contains specific provisions for oxygen–fuel gas welding and cutting, arc welding and cutting, resistance welding, electron beam welding, laser beam cutting and welding, and brazing and soldering. The standard is generally applicable to other welding processes such as submerged arc welding and allied processes.

8.5.6.1.3 NFPA 51B provides guidance for those who manage, supervise, and perform hot work.

8.5.6.1.4 NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*. This NFPA standard outlines procedures for safeguarding tanks or containers, operating at normal atmospheric pressure, that contain or have contained flammable or combustible liquids or other hazardous substances before entry, cleaning, repair, or other activities can be performed.

N **8.5.6.1.5 API RP 2009, *Safe Welding, Cutting, and Hot Work Practices in the Petroleum and Petrochemical Industries.*** This API recommended practice provides guidance for hot work in the petroleum and petrochemical industries.

N **8.5.6.1.6 AWS *Safety and Health Fact Sheet Bundle for Chemical Industry Welding.*** These American Welding Society fact sheets provide information regarding hot work, including performing hot work within confined spaces.

8.5.6.2 Construction Industry.

8.5.6.2.1 In construction settings, 29 CFR 1926.350 to 1926.354 provides information on gas welding and cutting; arc welding and cutting; fire prevention; ventilation for welding, cutting, and heating; and welding, cutting and heating preservative coatings.

8.5.6.2.2 NFPA 51B provides guidance for those who manage, supervise, and perform hot work in the construction industry.

8.5.6.2.3 NFPA 326 contains minimum procedures that permit repair, hot work, or other operations that could potentially create a fire, an explosion, or other hazard wherever hot work is performed on tanks or containers containing flammable, combustible, or other hazardous substance vapors, liquids, or solid residues.

Δ **8.5.6.3 Shipyard/Maritime.** In shipyard/maritime settings, 29 CFR 1915.11–1915.16, 29 CFR 1915.51–1915.57, and NFPA 306 contain information on hot work performed in the maritime industry. In addition, the *International Safety Guide for Oil Tankers and Terminals (ISGOTT)* provides considerable guidance for confined space and hot work activity in oil tankers and terminals.

Δ **8.5.6.4 Petroleum Industry.** In addition to the applicable OSHA, NFPA, and ANSI regulations listed in 8.5.6.4.1 and 8.5.6.4.2, API standards, including, but not limited to, those listed in 8.5.6.4.1 through 8.5.6.4.9, contain information related to hot work in the petroleum industry.

8.5.6.4.1 API STD 653, *Tank Inspection, Repair, Alteration, and Reconstruction.* This document covers the inspection, repair, alteration, and reconstruction of steel aboveground storage tanks used in the petroleum and chemical industries. It provides the minimum requirements for maintaining the integrity of welded or riveted, nonrefrigerated, atmospheric pressure, aboveground storage tanks after they are placed in service.

Δ **8.5.6.4.2 API RP 2009, *Safe Welding, Cutting, and Hot Work Practices in the Petroleum and Petrochemical Industries.*** This document provides guidelines for safely conducting welding, cutting, or other hot work activities in refineries, gas plants, petrochemical plants, and other facilities in the petroleum and petrochemical industries. It provides specific guidance on evaluating procedures for certain types of work on equipment in service. It does not cover regulation or code compliance, hot tapping, welding techniques, normal "safe work" practices, or entry into or work in inert environments.

8.5.6.4.3 API STD 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks.* This standard contains safety practices for preparing, emptying, isolating, ventilating, testing, cleaning, entering, and hot work and recommissioning activities in, on, and around atmospheric and low-pressure [up to and including gauge pressure of 15 psi (103 kilopascals)] aboveground storage tanks that contained flammable, combustible, or toxic materials. This standard directs users from decommissioning (removal from service) through recommissioning (return to service). This standard applies to stationary tanks used in all sectors of petroleum and petrochemical plants and terminals.

Δ **8.5.6.4.4 API RP 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks.*** This recommended practice supplements the requirements of API 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks.* API 2016 provides guidance and information on the specific aspects of tank cleaning to assist in conducting safe tank cleaning operations in accordance with the requirements of API 2015.

8.5.6.4.5 API RP 2027, *Ignition Hazards and Safe Work Practices for Abrasive Blasting of Atmospheric Storage Tanks in Hydrocarbon Service.* This document identifies the ignition hazards involved in abrasive blasting of the exterior of hydrocarbon storage tanks that contain a flammable mixture or a mixture that can become flammable when mixed with air. It also provides operational guidelines for procedures that significantly reduce ignition risks during abrasive blasting of hydrocarbon tanks that may contain a flammable vapor space.

8.5.6.4.6 API PUBL 2202, *Dismantling and Disposing of Steel from Aboveground Leaded Gasoline Storage Tanks.* This document outlines precautions to protect personnel from hazardous exposure to lead antiknock compounds where dismantling and disposing of tanks that contained leaded gasoline.

8.5.6.4.7 API RP 2207, *Preparing Tank Bottoms for Hot Work.* This publication addresses the safety aspects of hot work on petroleum storage tank bottoms. It discusses safety precautions for preventing fires, explosions, and associated injuries.

Δ **8.5.6.4.8 API RP 2201, *Safe Hot Tapping Practices in the Petroleum and Petrochemical Industries.*** This publication provides information for conducting hot tapping operations on in-service equipment in the petroleum and petrochemical industries. Hot tapping is usually performed where it is not feasible, or is impractical, to take the equipment or piping out of service or to purge or clean it by conventional methods.

N **8.5.6.4.9 API STD 2217A, *Guidelines for Safe Work in Inert Confined Spaces in the Petroleum and Petrochemical Industries.*** This publication provides guidance for safely entering and working within confined spaces that have been intentionally purged with an inert gas until the oxygen level in the space is too low to support combustion.

8.6 Energy Sources. All sources of energy — mechanical, electrical, hydraulic, chemical, or stored energy — in confined spaces that could impact worker safety should be eliminated using the appropriate isolation or lockout/tagout procedures in accordance with regulatory requirements and the Owner's/Operator's or Contractor's/Subcontractor's isolation program prior to issuance of an entry permit.

8.6.1 All workplaces with confined spaces that contain energy sources requiring isolation and/or lockout/tagout should have an energy control program developed and implemented by the Owner/Operator or by the Contractor/Subcontractor responsible for isolation.

Δ **8.6.2*** The Isolation Specialist or Entry Supervisor should verify that all energy sources that could potentially impact operations within and around the confined space have been isolated, locked out/tagged out, or otherwise safeguarded prior to the issuance of an entry permit. If there is a need to enter the space to verify that sources have been de-energized, the entry should be performed by an Isolation Specialist, who also qualifies as an Entrant, following the permit process and entry procedures provided in this guide.

Δ **8.6.3** Pipes and lines containing materials that could enter into the confined space should be disconnected and drained. Pipes and lines should also be double blocked, blanked, bled, flushed, purged, or otherwise isolated by the Isolation Specialist prior to issuing an Entry Permit.

8.6.4 Pipes and lines that run through a confined space that will be worked on from inside the space need to be disconnected and drained. Pipes and lines should also be double blocked, blanked, bled, flushed, purged, or otherwise isolated by the Isolation Specialist prior to issuing an Entry Permit.

8.6.5 Pipes and lines that run through but do not terminate within a confined space do not need to be disconnected or isolated as indicated in 8.6.3 provided that the Entry Supervisor determines that the materials in these lines are not impacted by the work being done in the space and do not create a hazard to workers in the space.

8.6.6* Where it is necessary for equipment to continue to operate (not be isolated) in order to perform work within the space, the Entry Supervisor should ensure that the work is performed using approved alternative methods or that control measures provide effective protection for workers in the space.

8.6.7 Regulations and Standards for Energy Control.

8.6.7.1 In the United States, OSHA standard 29 CFR 1910.147 covers the prevention of accidental startup of equipment and machinery or release of stored energy. 29 CFR 1910.333 contains specific requirements for de-energizing and locking out electrical equipment. OSHA electrical safe work practices requirements were derived from *NFPA 70E*, which provides comprehensive electrical safety information to prevent shock, arc, and other electrical safety hazards.

8.6.7.2 ANSI/ASSE Z244.1, *Control of Hazardous Energy — Lockout/Tagout and Alternative Methods*, also establishes requirements for the control of hazardous energy associated with machines, equipment, or processes that could cause injury to personnel.

8.6.7.3 Entry Supervisors should ensure that hot tapping on tanks, vessels, and lines containing products in the petroleum and petrochemical industries is in accordance with the procedures and safe practices provided in API RP 2201, *Safe Hot Tapping Practices in the Petroleum and Petrochemical Industries.*

8.7 Portable Electrical and Mechanical Equipment Used in and Adjacent to Confined Spaces. Entry Supervisors should ensure that electrical and mechanical equipment used in confined spaces is approved, listed, labeled, and authorized as applicable for its intended use. All approved equipment, including, but not limited to, the following should be inspected by a qualified person prior to use to be sure that it is in safe operating condition:

(1) Lighting (low voltage and/or approved)
(2) Communication equipment, including approved cell phones, pagers, and two-way radios
(3) Battery-operated tools
(4) Ventilation equipment and systems
(5) Portable electric and pneumatic tools
(6) Welding and cutting equipment
(7) Mechanical equipment
(8) Extension cords
(9) Compressors, pumps, and hoses
(10) Lifting equipment, including hoists, pulleys, and ropes
(11) Rescue equipment

8.7.1 Wet and Damp Locations. Entry Supervisors should make sure that all electrical equipment for use in wet or damp locations is equipped with ground-fault circuit interrupters and inspected by a qualified person prior to use to confirm it is in good condition and intrinsically safe.

8.7.2 Hazardous Locations.

8.7.2.1* Entry Supervisors should ensure that all electrical and mechanical equipment for use in flammable or potentially flammable atmospheres is approved and inspected by a qualified person prior to use to confirm that it is in good condition, is intrinsically safe, and will not create a source of ignition.

8.7.2.2* Entry Supervisors should make sure that all electrical and mechanical equipment for use in areas where combustible dusts may be present should be approved and inspected by a qualified person prior to use to confirm it is in good condition, is intrinsically safe, and will not create a source of ignition.

8.7.2.3* Entry Supervisors should ensure that all electrical and mechanical equipment for use in areas where easily ignitable fibers or flyings may be present is approved and inspected by a qualified person prior to use to confirm it is in good condition, is intrinsically safe, and will not create a source of ignition.

8.7.2.4 Entry Supervisors should make sure that equipment brought into confined spaces is approved and inspected by a qualified person to confirm there are no exposed electrical components that could cause harm or be a source of ignition, and that moving parts are appropriately guarded or designed to prevent damage, injury, or death from contact, entanglement, or entrapment.

8.7.3 Regulations and Standards. Owners/Operators and Contractors/Subcontractors should ensure that designated Entry Supervisors are aware of all standards and regulations applicable to classified areas within facilities where work in confined spaces is to be performed.

8.8 Bonding and Grounding for Flammable and Combustible Materials. All confined space personnel should be aware that static electricity can be generated in several ways, most typically when two dissimilar materials, which could be solids, liquids, or gases, rub against one another. The accumulation of a static charge creates a potential safety hazard in that the charge can be quickly dissipated, creating a spark. If the spark is hot enough it can become the source of ignition for a fire or explosion if there are flammable or combustible gases, vapors, or dusts present in the atmosphere within a flammable range. The following are ways to prevent static discharges:

(1) Objects can be grounded, which is a means for static electricity that may have accumulated on one or more insulated objects to safely dissipate to the ground.
(2) Objects can be bonded, which provides for equalization of the static electric charge on two objects so that there is no need for a spark to jump from one to another.
(3) Objects can be both grounded and bonded (e.g., one object is grounded to the earth and then bonded to another object with a conductive material, such as copper wire).

8.8.1* Bonding. Entry Supervisors, Attendants, Entrants, and all workers in and adjacent to confined spaces should be aware that equipment, accessories, and appurtenances used in confined space entry, ventilation, cleaning, and other operations may be capable of generating an electrostatic charge. Entry Supervisors should ensure that such objects are electrically bonded to the confined space to avoid generating static electric sparks.

Δ **8.8.1.1 Requirements.** Before use, the Entry Supervisor should make sure that a qualified person thoroughly inspects all cleaning equipment, nozzles, hoses, couplings, and accessories that could potentially create an electrical static charge to ensure that they are properly bonded and grounded, if necessary. Inspections should include, but not be limited to, the following:

(1) Vapor- and gas-freeing, degassing, flushing, and ventilation equipment and appurtenances, such as blowers and eductors; inert gas piping and connections; water, fuel, oil, and steam piping, hoses, nozzles, and connections; flame and detonation arrestors; and flexible vapor intake and exhaust ducting
(2)* Vacuum trucks used for removing materials and, degassing and exhausting vapors from a confined space (truck suction and discharge hoses should be electrically bonded to both the truck and the space, and grounded)
(3) Hoses and nozzles used to inject product, steam, chemicals, solvents, or water into a tank to dislodge and flush residue and sludge or wet down pyrophoric deposits (hoses and nozzles should be bonded to the space and equipment should be grounded)
(4) Abrasive blasting hoses, nozzles, and equipment (bonded to the space and grounded)
(5) Mechanized portable and robotic cleaning equipment (bonded to the space and grounded)
(6) Welding, cutting, grinding, and hot tapping equipment (bonded to the work and grounded to dissipate stray currents)

8.8.2 Grounding (Earthing). Entry Supervisors should ensure that equipment is properly bonded to the power source and that the power source is properly grounded. Where power is provided by power lines, the electrical ground should be tied in at the breaker box. For portable generator sets, the unit should be bonded to the frame. Portable generator sets can be staked to form an earth grounding system or grounded to a facility ground system. Grounding should be consistent with the equipment manufacturer's instructions and applicable national and local electrical wiring codes.

8.8.3* Regulations and Standards for Bonding and Grounding. Owners/Operators and Contractors/Subcontractors should be aware of all standards and regulatory requirements applicable to grounding and bonding and provide appropriate safe practices in their confined space programs.

Δ **8.9 Ignition Sources.** Entry Supervisors should be aware that flammable or combustible liquids, vapors, and gases or combustible dusts and fibers may be released both in and around a confined space during working, ventilation, inerting, or gas freeing, or when removing, agitating, or cleaning residue inside the space. All confined space personnel should be aware that in addition to hot work *(see Section 8.4)*, ignition sources that should be eliminated, mitigated, or controlled include, but are not limited to, the following:

(1) Internal combustion engines located within an unsafe area, such as less than 50 ft (15.2 m) downwind from, near, or adjacent to the space
(2) Nonexplosionproof electrical equipment and electrical equipment not rated for the location or proposed operation
(3) Nonbonded/nongrounded electrostatic generating equipment, such as welding machines, fans and eductors, vacuum trucks, portable generators, and pumps
(4) Nonapproved lighting equipment
(5) Smoking or open flames
(6) Blast cleaning equipment and blasting operations
(7) Grinding and cutting equipment and operations
(8) Unprotected pyrophoric iron sulfide deposits within the space

(9) Nonapproved heating equipment, such as space heaters and hot plates
(10) Vacuum trucks and vacuum operations
(11) Nonapproved communication devices, including cell phones, two-way radios, and pagers

8.9.1 Entry Supervisors should ensure that ignition sources inside and adjacent to confined spaces are eliminated, removed, or controlled.

8.9.2 Entry Supervisors should identify and evaluate ignition sources regardless of whether or not there is potential for combustible materials or a flammable or combustible atmosphere in or around the space.

8.10 Fall Protection. Fall protection should be maintained for all those working in and around confined spaces where falls greater than 4 ft (1.2 m) could occur. Confined space fall hazards should be managed using the following fall protection hierarchy:

(1) *Elimination.* Removal of the hazard by covering all vertical entry points until entry is required
(2) *Protection.* Use of approved guardrail systems to provide a controlled access zone around all vertical entry points
(3) *Restriction.* Use of positioning or restraint devices to eliminate the possibility of a fall for all personnel outside of the immediate vertical entry point
(4) *Fall arrest.* Use of approved fall arrest/belay devices to limit the maximum arresting forces to below 1800 lb (816 kg) for a fall greater than 4 ft (1.2 m) above the lower level of the vertical entry point for all personnel exposed to a fall hazard during confined space operations

8.10.1 Guarded Openings. Falls into confined spaces can occur when entering, working inside of, or working outside a confined space. Floor and wall openings that lead into or may be within confined spaces should be protected to prevent falls from occurring. There are a number of ways to do this as listed in 8.10.1.1 through 8.10.1.3.

8.10.1.1 Controlled access zones can be used during confined space operations to limit exposure to any open spaces or leading edges where persons can accidentally walk. This can include an Attendant warning of potential fall hazards or erecting a barricade around the space.

8.10.1.2 Restraint systems can be used during confined space operations where a worker needs to work near an opening or leading edge. A properly fitted full-body harness can be attached to a short lanyard and secured to a suitable anchor point able to withstand 5000 lb (2268 kg) of force.

8.10.1.3 Fall arrest systems can be used during confined space operations where the risk of a fall cannot be eliminated via controlled access or restraint systems. A properly fitted full-body harness with a self-retracting device or belay line system can be attached to a suitable anchor point able to withstand 5000 lb (2268 kg) of force or engineered with a 2:1 safety factor.

8.10.2 Access.

8.10.2.1 Where utilizing fixed ladders, Entrants should maintain three points of contact at all times. Ladders extending beyond 20 ft (6.1 m) should be equipped with a ladder climbing system or a secondary form of protection, such as a self-retracting device or a belay line attached to a suitable anchor point able to withstand 5000 lb (2268 kg) of force or engineered with a 2:1 safety factor.

8.10.2.2 Where utilizing portable ladders, three points of contact should be maintained at all times.

8.10.2.3 Where Entrants need to be lowered vertically into a confined space, a secondary form of protection should be used, such as a self-retracting device or a belay line attached to a suitable anchor point able to withstand 5000 lb (2268 kg) of force or engineered with a 2:1 safety factor.

8.10.3 Fall protection for vertical rescue descents should be in accordance with Chapter 10.

8.11 Slip, Trip, Ingress, Egress, and Entanglement Hazards.

8.11.1 Entry Supervisors should ensure that walking surfaces are cleaned and dried to eliminate slip hazards (e.g., deicing, removal of oil). Where this cannot be initially achieved, Entry Supervisors should ensure that Entrants use nonslip footwear.

Δ **8.11.2** Entry Supervisors and Entrants should ensure that trip hazards are clearly identified and/or flagged or marked and that cords, lines, tubing, ducting, and hoses brought into the space are placed and secured to minimize trip hazards in work areas and pathways of travel.

8.11.3 Entry Supervisors should make sure that nonfixed entanglements not required for entry and/or work are removed from the space to minimize hazards where necessary. Fixed entanglements should be recognized and appropriate precautions should be implemented by the Entry Supervisor to control the potential hazard.

8.11.4 Entry Supervisors should ensure that approved in-space lighting used in accordance with Section 8.5 provides enough illumination so that all surfaces and obstructions are clearly visible to those working in the space. Portable lighting should be approved for the location in which it is used in accordance with the applicable confined space program and permit requirements.

8.11.4.1 Pathways into (ingress) and out of (egress) the confined space should be illuminated sufficiently for rescue personnel.

8.11.5 Wherever surfaces remain slippery or wet, Entry Supervisors should consider the use of noncombustible portable floor mats or duck boards to raise the entry base above the level of the liquid surface inside the confined space.

8.12 Lighting. Entry Supervisors can use approved, safe lighting in accordance with the applicable confined space program. The lighting selection should consider any hazards presented by the presence of flammable or combustible liquids, vapors, or gases in accordance with Section 8.7. Additional lighting options include, but are not limited to, approved helmet lights, approved low-voltage portable lighting, approved flashlights, and other approved lighting sources. Entry Supervisors and workers should also be aware that cyalume lights (i.e., glow sticks) can be used as backup lighting should the primary lighting fail and can also be used to mark a means of ingress and egress in poorly lit or extended confined spaces.

8.13* Animals. The confined space should be visually inspected by the entry supervisor prior to entry, and any potentially dangerous animals or insects should be removed or eliminated. If an extermination chemical is used, it might be necessary to have the environment in and around the space reassessed prior to permitting entry. The Gas Tester should include the pesticide hazard when retesting. The Entry Supervisor should determine if the space needs to be ventilated and if respiratory protection and/or protective clothing and gloves should be worn by the Gas Testers and workers to prevent skin exposure to the chemicals.

8.14* Personal Protective Equipment (PPE). Entry Supervisors should ensure that PPE is worn in accordance with the requirements of the entry permit where engineering or administrative controls cannot fully eliminate hazards to workers.

Δ **8.14.1** Entry Supervisors should make sure that all confined space workers wear approved PPE including, but not limited to, eye protection, head protection, foot protection, hand protection, protective clothing, respiratory protection, and hearing protection as required by the entry or hot work permit. Workers should be aware that injuries can be prevented or mitigated by the use of PPE . The Entry Supervisor might consider additional PPE including, but not limited to, knee and elbow pads for crawlspaces and cooling vests for hot environments.

8.14.2 The Entry Supervisor should list all required PPE on the entry permit in accordance with the facility and/or Contractor confined space entry program, industry standards, and regulatory requirements.

8.14.3 The Entry Supervisor should ensure that PPE selection is based on the risk/hazard assessment and that the equipment is used in accordance with the Owner/Operator or Contractor/Subcontractor PPE program, industry standards, and applicable regulations.

8.14.3.1* Owners/Operators and Entrant Employers should consider the general PPE requirements, including, but not limited to, hazard assessments, maintenance, and training, provided in applicable regulations and standards.

8.14.3.2 Entry Supervisors should be aware that wherever skin exposure to chemicals is a concern, appropriate protective clothing should be worn by confined space personnel. When developing and implementing PPE programs, Owners/Operators and Contractors/Subcontractors should be aware that there is no single source of information for chemical protective clothing; however, chemical protective clothing manufacturers can often provide information on the proper protective clothing for specific chemicals. *(See also NFPA 1991 and NFPA 1992.)*

Chapter 9 Ventilation

9.1 General. The purpose of this chapter is to specify the minimum recommended practices for ventilation to protect workers who inspect, test, or work in confined spaces.

Δ **9.1.1*** Ventilation is used to supply adequate breathing quality air to an oxygen-deficient atmosphere or a potential oxygen-deficient atmosphere, remove or control atmospheric contaminants, and control temperature for comfort. However, in most confined space applications, supplying breathing air and controlling atmospheric contaminants are the primary purpose of ventilation. Ventilation is used to establish initial safe conditions (prior to initial entry) and may be necessary to maintain safe conditions during entry where there is a potential for changing atmospheric conditions within a space (e.g., presence of residues or hot work).

9.1.2 Ventilation needs should be determined initially by the Entry Supervisor and Ventilation Specialist via a hazard evaluation and risk assessment conducted in accordance with Chapter 6.

9.1.3* Where considering ventilation, the Entry Supervisor and Ventilation Specialist should understand the differences between *ventilation* and *purging*. These terms are often used interchangeably, but actually apply to different atmospheric hazard control methods. Ventilation provides a means to introduce breathing quality air to enter a space and control contaminants in that space through mixing and dilution. Purging is the use of air, water or another safe liquid, steam, or an inert gas to displace a hazardous atmosphere within the space. *(See Section 9.3.)*

9.2 Ventilation Types. There are two types of ventilation that can be used in confined space applications — natural and mechanical.

9.2.1* Natural Ventilation. Natural ventilation is when breathing quality air outside a confined space is allowed to enter and mix with the atmosphere in a confined space through natural pressure differentials without mechanical assistance.

9.2.1.1 Natural ventilation should only be used when a documented hazard evaluation and risk assessment demonstrates that its use will naturally supply adequate breathing quality air to control atmospheric contaminants to acceptable levels within the confined space.

Δ **9.2.1.2*** Where natural ventilation is used, the Entry Supervisor should ensure the atmosphere is continuously monitored to ensure safe entry is maintained in accordance with the entry conditions specified on the entry permit.

9.2.2 Mechanical Ventilation. Mechanical ventilation is the use of one or more powered air-moving devices (e.g., fan, blower, eductor) to either push air into or pull air out of a confined space to create a slight vacuum that allows breathing quality air to enter and circulate in the space. This process introduces breathing quality air, removes contaminants or mixes, and dilutes contaminated air within a space. There are two types of mechanical ventilation: general (or dilution) and local exhaust.

9.2.2.1* General (Dilution) Ventilation. General ventilation can be achieved via the introduction of breathing air into a confined space or by exhausting air from within the confined space using powered air-moving devices, or a combination of both techniques.

9.2.2.1.1 Supply ventilation uses one or more powered air-moving devices oriented so that outside uncontaminated air is pushed into the confined space. Depending upon the size and configuration of the space and capacity of the air-moving devices, ducting might be necessary to direct the supply air a greater distance into the space to reach areas where Entrants will work.

9.2.2.1.1.1 The Entry Supervisor and Ventilation Specialist should ensure that the source of supply air is from a known contaminant-free location.

9.2.2.1.1.2 Supply ventilation can be less effective for controlling highly toxic contaminants as contaminants could be spread before dilution becomes effective. Where highly toxic contaminants are present in a confined space, the Entry Supervisor and Ventilation Specialist should determine if a different control method (e.g., local exhaust, purging, or inerting) is appropriate to ensure the safety of Entrants.

9.2.2.1.2* Exhaust ventilation uses an air-moving device oriented so that air is pulled from within the confined space to create a vacuum that allows outside air to enter the space.

Δ **9.2.2.1.2.1*** The Entry Supervisor should determine if the area or location where exhaust ventilation is discharged from the confined space should be tested or monitored to ensure contaminants are dissipating to the atmosphere upon discharge and that contaminants do not create a hazard for workers outside the confined space.

9.2.2.1.2.2 The Entry Supervisor and Ventilation Specialist should ensure the area or location where exhaust ventilation is discharged from the confined space is located such that contaminants do not re-enter the space through the ventilation supply air source. *(See Section 9.5.)*

9.2.2.1.2.3 The Entry Supervisor and Ventilation Specialist should ensure the source for the makeup or replacement air is free of contaminants.

9.2.2.1.3 The Entry Supervisor and Ventilation Specialist should consider using supply and exhaust ventilation together wherever sufficient openings into the confined space enable such an arrangement.

9.2.2.1.4* Ventilation equipment can generate and accumulate static electrical charges, so the Ventilation Specialist should ensure that all equipment used in the ventilation system is properly bonded and/or grounded wherever a flammable or combustible contaminant exists within a confined space.

9.2.2.2 Local Exhaust Ventilation.

9.2.2.2.1* The Ventilation Specialist should use local exhaust ventilation to capture and collect point source (localized or locally-created) atmospheric contaminants generated from specific work activities or residues to limit the release of the contaminants to the confined space and prevent further contamination of the entire space.

9.2.2.2.2* Entry Supervisors and Entrants should be aware that local exhaust is effective only when it is located and maintained as close as possible to the source of the contaminants.

9.2.3 Comfort Ventilation. The Entry Supervisor should perform a hazard evaluation and risk assessment to determine if heat or cold stress conditions exist and provide for heated or cooled ventilation as necessary to avoid the effects of prolonged exposure to extreme temperature conditions.

9.3 Selection and Design of Ventilation.

9.3.1 General.

Δ **9.3.1.1** The Entry Supervisor and Ventilation Specialist should consider the following as part of the evaluation for identifying and selecting an appropriate ventilation method for controlling a hazardous atmosphere within a confined space:

(1) Whether to use purging, inerting, or ventilation
(2) The size and configuration of the confined space, including the number and location of openings that can be used for ventilation and Entrant ingress and egress
(3) The capacity requirements for selected ventilation equipment
(4) If the confined space was used to store or contain one or more hazardous materials
(5) The current use of the confined space, which might contribute to the existence of hazards within the space
(6) Whether work processes in or adjacent to the space could introduce atmospheric hazards into the confined space
(7) The type of ventilation equipment available

9.3.1.2* Based upon the volume of the confined space, the capacity of the air-moving device(s), and the nature of the hazardous atmosphere within the space *(see 9.3.2)*, the Ventilation Specialist should determine the required time for a single air change and the number of air changes that are necessary to ensure a stable atmosphere within the confined space. The required time and volume of air should be based upon the ventilation equipment manufacturer's specifications and in accordance with the written confined space entry program and any applicable regulatory requirements or consensus standards.

9.3.2 Contaminant Characterization. When selecting and designing a ventilation system, the Ventilation Specialist should consider the physical and chemical properties of gases, vapors, dusts, and all other contaminants that might be present in a confined space. Considerations should include, but not necessarily be limited to, the following:

(1) Characteristics of air, vapor, gas, and dust movement within the space
(2) Density for gases and vapors
(3) Specific gravity of liquids or residues
(4) Vapor pressure and emission rate
(5) Effect(s) of space temperature on air contaminants
(6) Flammability characteristics, such as flammable range for gases and vapors or MEC for dusts
(7) Flash points
(8) Boiling points
(9) Toxicity of contaminants and any OELs, such as PELs, RELs, and TLVs
(10) Stability characteristics of contaminants

9.3.3 Ventilation Design Considerations.

9.3.3.1 The Ventilation Specialist should use supply ventilation when ventilating a confined space to return atmospheric conditions to normal oxygen levels or to maintain safe atmospheric concentrations within the established acceptable range.

9.3.3.1.1 There are situations when the Ventilation Specialist should use exhaust ventilation instead of supply ventilation. Examples of these types of situations include, but are not limited to, the following:

(1) When controlling highly toxic atmospheric contaminants
(2) When gases or vapors are above the upper explosive limit
(3) When friable asbestos is present in the space

9.3.3.1.2* The Ventilation Specialist should ensure that supply ventilation is only used when a clean source of makeup or return air is available. If compressed air is used in the ventilation system as a power source (e.g., in a pneumatic system) or as a source of supply air, it must meet the requirements for Grade D air.

9.3.3.1.3* The Ventilation Specialist should ensure that supply ventilation is evaluated so that sufficient air flow reaches the most distant point within the confined space where Entrants will be present or working.

9.3.3.2* Exhaust ventilation should be cleaned or collected wherever it might endanger workers outside the confined space and in accordance with applicable environmental regulations.

9.3.3.2.1* Exhaust ventilation should only use air-moving devices approved for use in a hazardous or classified location when controlling flammable atmospheric contaminants.

9.3.3.2.2 The Ventilation Specialist should ensure that exhaust ventilation is only used where a clean source of makeup or return air is available.

9.3.3.2.3 The Ventilation Specialist should ensure that exhaust ventilation is evaluated so that the air-moving device(s) are located as close as possible to the contaminant source so contaminants are effectively captured or are safely exhausted from the confined space as described in 8.4.1.2.

9.3.4* Purging Applications and Design. The purging method and time should be determined by the Ventilation Specialist based on contaminant characteristics, configuration of the confined space, specifications of the ventilation equipment, and the entry or work objective.

9.3.4.1* When purging is required to safely enter a storage tank or other confined space that previously contained a flammable liquid, it is important to reduce the potential for fire or explosion. The Ventilation Specialist should purge the confined space with an inert gas to reduce the oxygen level within the confined space. The entry supervisor should ensure the inert gas valve is secured to prevent tampering with the gas flow during entry operations. A sign warning of the hazards of inert atmospheres should be posted as shown.

DANGER DO NOT ENTER

INERT GAS ENVIRONMENT ATMOSPHERE UNSAFE FOR WORKERS

INSUFFICIENT OXYGEN FOR BREATHING

PERMIT REQUIRED FOR ENTRY

Δ **9.3.4.1.1** When an inert gas purge is used to displace flammable vapors that are within or exceed the flammable range, the inert gas should be introduced by the Ventilation Specialist into the space and maintained until the flammable vapor concentration has been reduced to approximately 20 percent of the LFL value for the gas or vapor present within the space.

9.3.4.1.2 Once the flammable vapor concentration has been lowered to a safe level, the Ventilation Specialist can then introduce fresh air to displace the remaining flammable vapors and to increase the oxygen content within the confined space to ambient fresh-air levels.

9.3.4.1.3* While monitoring atmospheric conditions during the inerting process, the Gas Tester should be aware that the flammable vapor concentrations in the inerted atmosphere cannot be detected by catalytic bead–type sensors, and the testing equipment manufacturer should be consulted to determine any necessary steps to collect accurate measurements.

9.3.4.2 The Ventilation Specialist should provide for the introduction of fresh air into the confined space to displace toxic contaminants or oxygen-deficient air and return the confined space atmosphere to the acceptable atmospheric conditions specified on the entry permit.

9.3.4.3 The Ventilation Specialist should purge the confined space with an inert gas wherever hot work will be performed in or adjacent to a confined space that has not been thoroughly cleaned and freed of flammable gases, vapors, and residues in accordance with the safe work practices specified in NFPA 51B.

9.3.4.4* The Entry Supervisor should warn all workers performing work near confined spaces that have been inerted that the inert gas might displace the oxygen in localized areas near the space and create unsafe levels of oxygen. The warning should take the form of a barricade or similar visual notification that identifies the inerting location and the hazards presented by the operation.

9.4 Ventilation Equipment.

Δ **9.4.1 Air-Moving Devices.** *(See 3.3.6.)*

Δ **9.4.1.1 Axial-Flow Fans.** *(See 3.3.6.1.)*

Δ **9.4.1.2 Centrifugal-Flow Fans.** *(See 3.3.6.2.)*

Δ **9.4.1.3 Venturi-Type (Eductors).** *(See 3.3.6.3.)*

9.4.2 Duct Work. The evaluation conducted by the Entry Supervisor and Ventilation Specialist as part of the selection and ventilation design *(see 9.3.1.1)* should include a determination on whether ventilation ductwork is necessary to achieve a stable atmosphere within the confined space.

9.4.2.1 The Ventilation Specialist should determine if it is necessary to attach flexible ducting to any air-moving device to deliver the air to the designated location within or outside the confined space. Flexible ducting may be used to direct exhaust airflow to a predetermined outside location [such as 12 ft (3.7 m) above the surface level] or to an environmental collection system.

9.4.2.2 It is recommended that the Ventilation Specialist use flexible ducting that includes a means to bond the duct material, the air-moving device, and the space. The entire system should be grounded to control the generation of static electricity and dissipate any accumulated static electric charge.

9.4.2.3* The Ventilation Specialist should determine conditions where collapsible, rolled, plastic tubing can be safely used as ventilation ductwork.

9.4.2.4 For entry into confined spaces with a single entry portal, the Ventilation Specialist should consider using a ductwork and blower adapter (e.g., a saddle) to minimize restrictions to the space opening by the placement of the ductwork.

Δ **9.4.3* Thermal Oxidizers.** Where ventilating tanks, vessels, and other confined spaces with flammable atmospheres, local environmental regulations often restrict ventilation discharge emissions. The Ventilation Specialist should determine if the system requires a gas- or vapor-freeing tank connected to a thermal oxidizer unit or vapor recovery system to safely use exhaust ventilation.

Δ **9.4.4* Bonding/Grounding.** Static electricity is created when supply or exhaust air moves through a fan, blower, or ducting. When ventilation is used to dilute or exhaust flammable gases or vapors, the Ventilation Specialist should control all ignition sources, including static electricity. Regulations and best practices require that all air-moving devices, including attached ducting and appurtenances, be properly bonded to the space and grounded to ensure the dissipation of any accumulated static charge within the ventilation system.

Δ **9.4.5 Other Equipment.** In addition to flexible ducting, the ventilation installation might include other equipment, such as adapters (e.g., a saddle), that attach through the opening of the confined space to the air-moving device and ducting so as not to completely obstruct the opening.

9.5 Ventilation Installation.

9.5.1 The Ventilation Specialist should ensure that ventilation equipment and ductwork is arranged to reach the farthest point within the confined space, to maximize the turbulence in the space, to minimize the creation of dead air pockets, and to stabilize the atmosphere within the entire space.

9.5.1.1* When evaluating the confined space configuration, the Ventilation Specialist should consider obstructions within the space that restrict or limit air movement.

9.5.1.2 The Ventilation Specialist should identify the location, size, and number of portals or openings that can be used for ventilation when designing and installing a ventilation system.

9.5.1.3 The location of openings can limit the ability to efficiently and effectively move air throughout the entire confined space. The Entry Supervisor and Ventilation Specialist should identify any opening restrictions that could prevent the ventilation system from operating as designed.

9.5.1.4* In placing the ventilation equipment during the design of the ventilation system, openings for exhaust and supply air should be separated as much as possible to limit the potential for creating short-circuiting conditions.

9.5.2 The Ventilation Specialist should ensure ductwork is installed so that it does not unnecessarily block access into or out of the confined space.

9.5.3* The Entry Supervisor and Ventilation Specialist should identify and implement any necessary precautions to control or remove all ignition sources from the area when there is a potential for the presence of flammable gases and vapors within the flammable range inside the confined space, at the point of ventilation discharge, or in areas adjacent to the space.

9.5.4* The Entry Supervisor and Ventilation Specialist should evaluate the confined space for stratified atmospheres *(see Chapter 7)* and ensure that ventilation ductwork is positioned to remove or displace contaminants.

9.5.5 The Ventilation Specialist should ensure that all air-moving devices and related equipment are bonded and grounded.

Δ **9.5.6** When flammable gases or vapors are exhausted from within a confined space, the Ventilation Specialist should ensure that the discharge points from all exhaust ventilation processes that are not connected to scrubbing systems or other contaminant control systems are located a minimum of 3.7 m (12 ft) above grade. The selection of the exhaust discharge points and locations of personnel should ensure that exhausted contaminants are directed away from areas that might contain sources of ignition and areas where personnel might be working.

Δ **9.5.7** The Ventilation Specialist should ensure that displacement of the confined space atmosphere with uncontaminated air is accomplished by one of the following methods:

(1) Negative pressure or a vacuum used to pull outside air into the confined space using an educator-type air-moving device or other similar equipment
(2) Positive pressure or a diffused air blower or fan used to push outside air into the confined space
(3) A combination of 9.5.7(1) and 9.5.7(2)

9.5.7.1 Where the Ventilation Specialist uses the method described in 9.5.7(2), the following conditions apply:

(1) The connection between the eductor and the confined space should be airtight.
(2) Air should be drawn through the confined space to allow cross ventilation and removal of vapors.
(3) All equipment should be bonded and grounded.

9.5.7.2 Where the Ventilation Specialist uses the method described in 9.5.7(2), the following conditions apply:

(1) If a fill opening that extends into the confined space is used as an air supply point, the portion of the fill pipe that extends into the space should be removed. If entry is required to remove the fill pipe from a space with a flammable atmosphere, then the space might require inerting prior to entry.
(2) The air should be supplied from an approved compressor or blower that has been checked for delivery of Grade D air that is free of contaminants.
(3) The air-diffusing pipe, if used, should be bonded to the confined space to control the accumulation and discharge of static electricity.

9.5.8 Ventilation for Controlling Hazards of Extreme Heat or Cold.

9.5.8.1 Where entry and work in confined spaces involves potential for exposure to temperature extremes, the Entry Supervisor and Ventilation Specialist should determine if there is a need for comfort ventilation.

9.5.8.2* Based upon the results of a hazard evaluation and risk assessment, the Ventilation Specialist should determine an appropriate method to condition or warm the air within the confined space as appropriate for the environment and work.

9.5.9* Purging. The Ventilation Specialist should determine if purging can be safely implemented based upon the results of a hazard evaluation and risk assessment.

9.5.10 Atmospheric Monitoring.

9.5.10.1 The Gas Tester should conduct atmospheric testing in accordance with Chapter 7 and as directed by the Entry Supervisor.

9.5.10.2 If the hazard evaluation and risk assessment indicates that atmospheric conditions within the confined space can change adversely or without warning, the Entry Supervisor and Ventilation Specialist should ensure continuous forced mechanical ventilation and continuous atmospheric monitoring is maintained during all entry and work.

9.5.10.3* If the hazard evaluation and risk assessment indicate that atmospheric conditions will not be maintained within acceptable levels at all times during entry and work, the Ventilation Specialist should use flow monitoring, alarms, secondary power systems, and similar backup systems to ensure the safety of Entrants and the integrity of the ventilation system and fresh air supply.

9.5.10.4 Where ventilation cannot or does not completely eliminate a recognized atmospheric hazard, other protective measures or methods for controlling air contaminants and protecting Entrants should be determined by the Entry Supervisor prior to entry authorization.

9.6 Consideration in Selection of Ventilation. The Entry Supervisor and Ventilation Specialist should consider the following during the selection of ventilation systems for confined spaces:

(1) Source and quality of supply and makeup air
(2) Use of approved equipment where required (e.g., the electrical area classification and use of pneumatic or steam-operated ventilation systems in flammable atmospheres)
(3) Bonding and grounding of all air-moving devices and any ducting or attachments
(4) Noise levels associated with air-moving devices
(5) Maintaining access and egress needs while ventilating spaces
(6) Time required to achieve initial safe conditions and/or for re-entry into a confined space

Chapter 10 Rescue

10.1 Purpose. The purpose of this chapter is to assist the Owner/Operator and the Entrant Employer in assessing a rescue need within confined spaces, to identify the level of operational capability, and to establish operational criteria.

Δ **10.1.1 General.** Recognition and prevention of existing and potential hazards associated with confined space entry and operations may be the best method to avoid the need for rescue. Conducting a proper hazard evaluation and eliminating, mitigating, or controlling all hazards should reduce or eliminate the chance of harm to Entrants, thereby also reducing the need for potential rescue.

N **10.1.1.1** Owners/Operators and Entrant Employers should train or educate Entrants to understand and protect themselves from potential hazards, including the proper selection and proficient use of PPE. Entrants should be trained that when they recognize a threat they should immediately exit the space on their own power, which is better than waiting until they are incapacitated and require rescue. There are two types of rescue options: non-entry rescue, in which ill or injured Entrants are removed without the Rescuers entering the space, and entry rescue, in which Rescuers enter the space to properly remove ill or injured Entrants.

N **10.1.1.2** The information provided in this guide should be applied by all Owners/Operators who are responsible for the selection or provision of a response capability for rescue emergencies within confined spaces and who are associated with confined space operations. The elements associated with rescue program requirements should be identified in the hazard evaluation and risk assessment conducted by the Owner/Operator or Entrant Employer.

Δ **10.1.2 Non-Entry Rescue — Attendant Capabilities.** In a confined space emergency where existing hazards may affect others who would enter the space to provide rescue, it is best practice to extract the incapacitated Entrant without entering the space. In most cases, approved and appropriate non-entry rescue provisions (retrieval systems) should be utilized to allow this option. However, it should be recognized that conditions may exist or arise that would prohibit the use of non-entry rescue. This section is intended to address non-entry rescue.

10.1.2.1 Attendants' Responsibility to Perform Non-Entry Rescue (Retrieval) Operations. Attendants should be responsible for performing emergency notification and certain non-entry rescue (retrieval) operations. If properly qualified and trained, an Attendant may perform in the capacity of a confined space Rescuer once relieved of Attendant duties by another qualified Attendant.

10.1.2.2 Concept and Purpose of Retrieval Systems for Non-entry Rescue. Retrieval systems are intended primarily to provide a means for removal of incapacitated, ill, or injured Entrants from a confined space. This provides a means for removal without entering the space, which limits the exposure to other persons tasked with providing rescue. Retrieval systems should also be used by Rescue Entrants whenever possible. Although the configurations of retrieval systems may differ significantly, if properly selected and configured, these systems can also double as fall protection in spaces where fall hazards exist.

Δ **10.1.2.2.1 Composition of Retrieval Systems.** Retrieval systems usually comprise a rope- or cable-based system, which is attached to the Entrant in such a way as to provide a profile appropriate to the space's configuration that would allow successful removal from the space. The retrieval systems should, in most cases, provide a means of lifting or otherwise moving Entrants so that they can be removed without significant stress to the operator and without danger of stranding or, in vertical rescue, dropping the Entrant should the system release or fail during retrieval (progress capture).

N **10.1.2.2.1.1** In spaces with a vertical depth greater than 5 ft (1.5 m), a means of retrieval that employs mechanical advantage to reduce the force required, combined with a progress capture mechanism (to prevent drop if the system is released), should be used.

N **10.1.2.2.1.2** In horizontally-oriented spaces, retrieval equipment can be as simple as a rope, webbing, or cable system attached to the Entrant's harness or other appropriate type of body rigging (wristlets, anklets, wheeled or low-friction drag devices, etc.) to allow removal from outside the space without endangering the Entrant. Horizontal rescue systems may not have a need for progress capture or a mechanical means of retrieval if the Entrant is on a horizontal, low-friction surface.

N **10.1.2.2.1.3** In all cases, the retrieval system should be appropriately anchored outside the space to prevent the system from being accidentally pulled into the space during operations, rendering it ineffective.

Δ **10.1.2.2.2 Retrieval Systems for Entry and Fall Protection.** Equipment utilized to create retrieval systems sometimes serves other purposes. In the case of vertically configured spaces where no other means of self-assisted entry exists (e.g., ladders or stairs), retrieval systems having the capability of both lowering and raising personnel can be used as the principal means of entering and exiting the space.

N **10.1.2.2.2.1** Entry Supervisors should ensure that an approved and appropriate redundantly anchored and operated backup system is utilized during nonemergency use of retrieval equipment in the event of failure of the primary system. For instance, a tripod and winch, used to lower Entrants into a space in a purely vertical environment, should also have a backup protective system such as fall protection blocks, self-retracting lifelines, or belay systems. Backup systems should be redundantly anchored completely independent of the primary system so that protection is provided in the event of a failure of the primary system.

10.1.2.2.2.2 Where fall hazards exist within a confined space, the retrieval system can also provide an adequate means of fall protection to keep the Entrants safe from falls while working in the space. For this to be effective, Entrants must be attached to individual retrieval systems anchored outside the space that incorporate devices that will withstand the forces expected from a fall while providing appropriate energy absorption to make the fall tolerable to the Entrant's body. These systems should be capable not only of preventing or arresting a fall but also of removing an Entrant in the event of a fall. Fall protection systems and recommended tolerances are addressed in detail in Chapter 8. Where possible, these systems should limit the ability of Entrants to approach unprotected edges, in effect becoming fall restraint rather than fall arrest systems.

Δ **10.1.2.2.3 Retrieval System Configurations.** Unless the requirement is waived, retrieval systems should maintain independent lines on each Entrant to allow independent retrieval of any Entrant should an incident occur. Retrieval systems should be ready to provide immediate removal of an incapacitated, ill, or injured Entrant. Retrieval systems should be capable of actuation within seconds of recognition that an emergency requiring rescue exists. Unless the entry qualifies for waiver of retrieval systems, they should be attached to Entrants prior to entry and remain attached at all times until Entrants have left the space. A retrieval line should not be disconnected inside a space during normal operations, unless necessary for entry rescue, since that would render the system ineffective in case of an emergency that requires retrieval from outside the space. Rescue Supervisors should be aware that retrieval system configurations used by Rescue Entrants can vary from the typical in certain circumstances.

10.1.2.2.3.1 Retrieval System Configuration Considerations for Typical Entries. In entries where portable anchor devices and manufactured systems are employed with only one Entrant, retrieval system configurations can be very simple. Where the need for multiple Entrants occurs or specific structural restrictions in and around the space exist, configuring the systems can be complicated.

Δ **(A)** Although a simple tripod and winch system is a good option for retrieval in most cases, other approved and appropriate methods must be utilized when overhead or working surfaces restrict the ability to erect a tripod. For example, a winch device or other manufactured system might be an excellent choice in a single-Entrant type of entry in which an adequate overhead anchor exists, but where multiple Entrants must enter the space or the device cannot be positioned above the portal, it becomes more complicated to configure all the retrieval devices so that they can be easily monitored and effectively utilized in the event of an emergency.

(B) Retrieval systems might be required to lift incapacitated, ill, or injured Entrants up and directly over the edge of the portal. In such cases, Rescuers should have significant knowledge of managing human bodies over such edges and the equipment and systems necessary to effect retrieval without further injury to Entrants or themselves.

(C) Appropriate assessment and training of all rescue personnel are vital to ensure proper configuration of these systems based on the circumstances surrounding the entry. It is important that the retrieval system to be used accomplishes the rescue objective effectively and safely within an appropriate time frame.

10.1.2.2.3.2 Retrieval System Configuration Considerations for Rescue Entrants. As previously stated, entry for rescue still requires the need for retrieval. Unless waived, retrieval systems can offer significant assistance to persons who are entering spaces during an emergency. Consider the following question: If it is important to maintain an immediate means of retrieval during normal entries when no emergency exists yet, how much more so is it in a situation where an emergency has already occurred? Even when retrieval is possible, it is recommended that Rescue Entrants have an appropriate number of trained backup Rescuers immediately available for entry rescue should a Rescue Entrant get in trouble. The number of backup Rescuers deemed appropriate depends upon the circumstances of the entry and should provide for efficient removal of the Rescue Entrants. These rescue considerations vary significantly from those of typical confined space entries.

Δ **(A)** Considerations may also vary due to the need for Rescuers to handle emergencies quickly and safely by managing risks and minimizing retrieval systems complications. Although independent retrieval may be typical for most entries, Rescuers should consider other issues. For example, when no fall hazards exist within the space and breathing air systems are not required for Rescue Entrants, they could consider placing several Rescuers on a single retrieval line, spacing them out so each can be independently retrieved one at a time. This makes the rigging of the rescue systems necessary to lift and lower Rescuers more efficient outside the space. However, the Rescuers should recognize that while this may be more manageable outside the space, there is additional rope between Rescuers inside the space that must be managed.

(B) In the case of Rescuers on breathing air systems, independent retrieval systems are recommended so that the first Rescuer in is the first Rescuer out, since fatigue or depletion of air supply typically affects the first Rescuer earlier than subsequent Rescue Entrants.

(C) In cases where fall hazards exist, Rescuers should follow the same guidelines as for typical entries by providing independent attachment to appropriate systems to act as fall protection.

(D) In general, Rescuers need more versatility in their retrieval systems while providing the same degree of effectiveness and safety associated with typical entry retrieval.

10.1.2.2.4 Ensuring Operational Readiness in Retrieval Systems. Retrieval systems should be ready at all times. To ensure operational readiness, the following questions should be asked prior to entry:

(1) Does everyone involved know the plan for retrieval? Without communication of this plan of action, personnel around the scene of the emergency may attempt to try many different options, which can slow retrieval or render it ineffective. Know the plan!
(2) Does everyone involved know his or her part in the retrieval plan? While these systems typically are operated by the Attendant, more advanced systems require more than one person's efforts to effect retrieval. Again, it is important that everyone involved knows who is doing what.
(3) Will the retrieval system work the way it is configured? This may seem like an unreasonable question, but retrieval equipment is frequently set up without regard for whether it will actually work. For instance, slightly offsetting a winch device from the center of a portal in a vertically oriented space could trap ill or injured workers against the underside of the portal during extraction, creating significant potential for severe injury. A friction-reducing device or other edge management method used at the portal could prevent this from happening. In any case, systems should be tested prior to use to ensure that everything works the way it was intended.

10.1.2.3 Limitations and Exceptions for Retrieval. It should be recognized that retrieval is not always prudent or even possible. In the case of spaces that contain internal configurations that could entangle or trap a person against a structure, a line attached to the Entrant might not function at all or, worse yet, actually cause further harm to the Entrant during the retrieval attempt.

10.1.2.3.1 The conditions within a space should be carefully evaluated to ensure that such dangers are mitigated, controlled, or eliminated entirely. All spaces should be treated as though hazards are still present until their absence or control mechanism (including appropriate PPE) can be verified. In most cases where these types of internal hazards exist, the logical choice may be to forgo retrieval systems entirely to prevent further rescue complications. The following questions should be considered when determining whether to use a retrieval system:

(1) Would the retrieval equipment increase the overall risk of entry? (If the answer to this question is yes, then the use of retrieval equipment can be waived.)
(2) Would the retrieval equipment contribute to the rescue of the Entrant? (If the answer to this question is no, the retrieval equipment can be waived.)

10.1.2.3.1.1 In these situations, it is important to ensure that an entry-type rescue is available to respond in a timely manner.

Δ **10.1.2.3.1.2** It should be recognized that it may not be prudent to utilize retrieval systems, regardless of the ability to rig and operate them effectively. For example, a worker who is positioned on built-up scaffolding within a space might fall and strike his head on an object. Simply operating the retrieval system to extract this person without regard for a potential spinal injury could create permanent damage to his spine with significant potential for paralysis. Retrieval operations should take into account the hazard versus the risk to the Entrant to ensure safety.

10.1.2.4 Owners/Operators and Entrant Employers should implement rescue procedures for the following Attendant operations:

(1) Recognizing the need for confined space search and rescue
(2) Initiating contact and establishing communications with victims where possible
(3)* Recognizing and identifying the hazards associated with non-entry confined space emergencies
(4) Advising the responding Rescuers of the situation and potential hazards
(5) Recognizing specific confined spaces, their ingress and egress limitations, and internal configurations
(6)* Identifying the need for and performing a non-entry retrieval, based on the conditions present
(7)* Implementing the emergency response system for confined space emergencies

10.1.3 Entry-Type Rescue. Government or jurisdictional regulations often delineate between confined spaces that contain actual or potential threats (hazards) that may necessitate rescue and those that do not have that potential. Confined spaces that do not contain a threat (or in some cases where the threats have been mitigated, controlled, or eliminated entirely) may have no requirement for a rescue provision.

Δ **10.1.3.1** The confined space rescue chapters of NFPA 1670 and NFPA 1006 consider all spaces to which they respond to possibly contain hazards. These standards make no delineation between confined spaces and permit-required confined spaces since an emergency evoking a response has already occurred. These standards assume that a hazard may have caused this emergency, regardless of whether that is the case.

10.1.3.2 Many elements of a confined space rescue program, such as the need for a rescue provision and the mode of response, should be addressed in the planning phase. The response phase addresses the approach to emergencies when they have occurred. All elements of the rescue operation should be carefully considered in the planning phase.

10.1.3.3 The requirement for a rescue provision should not be based solely on the hazards within and around a space that might create emergencies and make it difficult to self-rescue. Also to be taken under consideration are the characteristics that might make it difficult for an ill or injured worker to be removed when not under his or her own power, even if there are no atmospheric, engulfment, entrapment, or other chemical or physical hazards introduced to cause the emergency. Unless a space can be proved to have no potential for hazards and no potential difficulty associated with removal of ill or injured Entrants, a rescue provision of some degree is required.

10.1.3.4 Rescue Response Modes. The degree and rapidity of response should be driven principally by the anticipated hazards. Those spaces that contain known hazards should receive greater scrutiny and perhaps more rapid or complex response based on the hazards. Consideration should also include those spaces where technical rescue may be required to move an ill or injured Entrant to a stable environment once extracted from the space. Rescue capabilities should be evaluated to ensure they are appropriate to the response. Many emergency response agencies do not have the training or equipment to respond to confined space emergencies and simply summoning them to react to these specialized emergencies without ascertaining that they are capable is unacceptable. It is important that the qualifications of the Rescue Service be assessed and verified in advance of an emergency in accordance with the recommendations provided in Section 10.2. Consideration should be given to three basic modes of rescue response:

(1) Tier 1 — Those that have no recognized hazards but could require technical rescue for extraction should a worker become incapacitated
(2) Tier 2 — Those with non-life-threatening hazards requiring rapid intervention
(3) Tier 3 — Those with life-threatening hazards requiring immediate intervention

Δ **10.1.3.4.1* Tier 1 Response Mode.** A Tier 1 response mode may be indicated if a hazard evaluation has been performed (in accordance with Chapter 6) and the space contains no potential for hazards, but its configuration would prohibit Entrants from being easily removed if they were to become incapacitated due to either medical illness or injury. At minimum, this should be applicable to any vertically oriented space greater than 4 ft (1.2 m) in height, whether or not retrieval equipment is in place. A Tier 1 capability suggests that a fully trained rescue team meeting the requirements of the technician level confined space rescue chapter in NFPA 1670 is available to respond within 5 minutes to the site and is capable of setup and rescue entry within 15 minutes of arrival on site.

10.1.3.4.2* Tier 2 Response Mode. A Tier 2 response mode is indicated if a space contains no IDLH or other potentially immediate life-threatening hazards but does contain other actual or potential hazards that could incapacitate Entrants or prevent them from exiting the space without assistance (self-rescue). A Tier 2 capability suggests that a fully trained rescue team meeting the requirements of the technician level confined space rescue chapter in NFPA 1670 is on site with appropriate capability to make safe entry for rescue. The team should be equipped and mobile and capable of setup and rescue entry within 12 to 15 minutes of incident occurrence.

10.1.3.4.3* Tier 3 Response Mode. A Tier 3 response mode is indicated if work is occurring inside a space that contains an IDLH or other immediately life-threatening hazard, either actual or potential. A Tier 3 capability suggests that a fully trained rescue team meeting the requirements of the technician level confined space rescue chapter in NFPA 1670 is standing by in the immediate area with appropriate capability to make safe entry for rescue. This team should be completely set up and capable of rescue entry within 2 minutes of incident occurrence. The rescue team should be dedicated to this singular entry with no other responsibilities.

Δ **10.1.3.5* Protection of Personnel During Rescue.** In general, if the cause of the incident cannot be proved to be unrelated to the atmosphere, regardless of gas monitor readings, appropriate protection in the form of atmosphere-supplying respirators should be worn by Rescuers and provided to victims. If chemical protective clothing is indicated by conditions, appropriate protection should be provided for Rescue Entrants as well. *(See Figure 10.1.3.5.)*

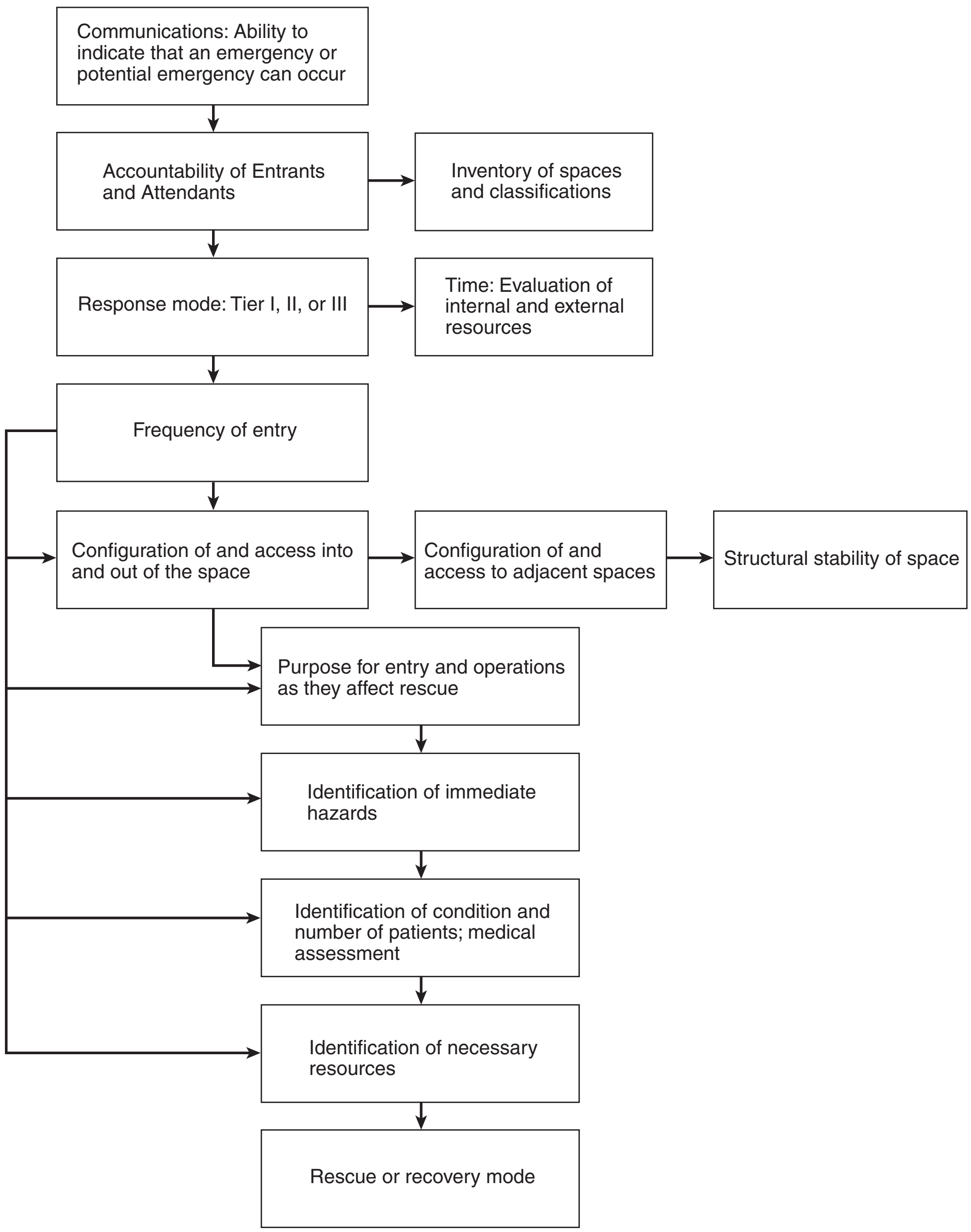
10.1.3.5.1* Rescue Versus Recovery. It should be recognized that rescue is not always possible. Certain conditions may exist that would create unreasonable risks (as opposed to calculated risks) to Rescuers. In such cases, the decision should be made to downgrade the rescue effort, perhaps even to "body recovery." The decision to change the approach to such an incident is generally the responsibility of the person in charge of the Rescue Service and can be loosely based on the following questions. Rescue should not be performed if the answer to any of the following questions is no:

(1) Are there enough rescue team members to perform the rescue safely?
(2) Do Rescuers have the proper equipment to perform the rescue safely?
(3) Do Rescuers have the proper training to perform the rescue safely?

10.1.3.5.2 Communications. Communications equipment and methods are thoroughly outlined in Chapter 8, but it is important to note that the need for communications in rescue operations should be based on the circumstances and the rescue objective, which means the choices made by the rescue team are not only about the type of communications equipment but also about the methods employed.

10.1.3.5.2.1 The principle operational concerns regarding communications for rescue operations involve not only communication from inside the space to the outside, but also communication among Rescuers both inside and outside the space. For example, teams utilizing rope-based or other rescue systems for lowering or raising Rescuers and rescuing Entrants should have communications systems that operate definitively and safely. Communications systems remote from the portal or positioned in high-noise environments might require the use of hand or other visible signals in addition to verbal or radio communication methods. Within the interior of the space, high-noise environments might require the use of equipment such as voice amplifiers, and the use of breathing apparatus can inhibit the ability of Rescuers to speak clearly to one another or to Entrants, even in close proximity.

Δ **10.1.3.5.2.2** Communication methods used between team members outside the confined space and those inside the space should provide backup in the event of a communications system failure. For example, a rescue team utilizing portable radio systems as the primary means of communication between the inside and the outside of the space should have a secondary method of communication readily in place in the event of a radio failure or interference. The backup method should provide an appropriate substitute, which can be as simple as using a predesignated series of hand signals. Hard lines, which use communications cables that allow transmission of voice between two points, could be the simplest means of communication between the outside and the inside of a space. While this may be a very good means of communication, circumstances such as entanglement hazards within the space or breaks in the line could render it ineffective. The selection of the primary and secondary communications system should be determined by the person who is performing the hazard and risk analysis during the pre-incident rescue action planning phase of the operation. Practicing the rescue action prior to actual confined space entry provides the rescue team an opportunity to evaluate the effectiveness of the communication methods to be used.



Δ FIGURE 10.1.3.5 Pre-Incident Action Planning and Assessment Flow Chart.

N **10.1.4 Rescue Provisions in Confined Spaces with No Hazards.** The decision to provide real-time monitoring (e.g., physical direct observation, cameras, monitored wired or wireless "man-down" systems) and/or emergency treatment intervention for confined space entrants should not be based solely on the hazards within and around a space. Medical emergencies can happen at any time, even if all hazards have been eliminated. The characteristics that might make it difficult for an ill or injured worker to be removed and/or appropriately treated when not under his or her own power should also be carefully considered because they may create a situation requiring technical rescue even though the space has no hazards. Such characteristics may include, but are not limited to, space configurations that lend to difficult removal and remote areas where delays in medical treatment response require forms of immediate intervention. Unless a space can be proven to have no potential for hazards and no potential difficulty or delay associated with appropriate treatment of ill or injured Entrants, a means of real-time monitoring and/or treatment intervention is indicated, regardless of whether or not the space contains hazards.

10.2 Rescue Team Qualification. It is the ultimate responsibility of the Owner/Operator to assure that the Rescue Service is qualified and ready to perform rescue from spaces within their jurisdiction. In turn, where the Owner/Operator has assigned this authority to an Entrant Employer and they have agreed to accept the responsibility to provide the Rescue Service, those providing the service should be held accountable to be fully prepared for the task. A Rescue Service should meet all requirements of the technician level confined space rescue chapter in NFPA 1670. The Owner/Operator should assure that qualified Rescue Service candidates are appropriately contacted and informed of the attributes and hazards associated with those spaces for which they will be responsible. After being informed and evaluated, the selected qualified Rescue Service should formally agree to accept this role in order to be considered for the position. A written agreement between the Owner/Operator and Rescue Service is recommended to ensure this consent.

10.2.1* Responsibility. The Entry Supervisor should ensure that the Rescue Service is qualified to act in that capacity. On-site, contracted, or contractor-supplied Rescue Services should meet applicable requirements to ensure that their level of capability is commensurate with the task at hand. Assessment of the Rescue Service's qualifications should consider the training, standard operating procedures (SOPs), equipment, availability, and ability to perform rescue. An evaluation of the rescue team's capabilities should include the overall timeliness of response and a demonstration of the ability to perform safe and effective rescue in those types of spaces to which the team must respond.

Δ **10.2.2 Rescue Program Audits.** The rescue requirements of confined space programs should be audited by a designated person (or team) responsible for Rescue Services selection as defined in 10.2.2.2. Audits should be conducted at least annually and when a management of change (MOC) occurs, affecting the space or operations, and in accordance with the Owner's/Operator's or Entrant Employer's confined space program requirements or applicable government regulations. The Owner/Operator and Entrant Employer should also review the rescue program following each rescue operation and make adjustments if needed.

Δ **10.2.2.1 Content of Audit.** Confined space rescue program audits should be conducted in accordance with 10.2.2.2 to include a full evaluation of the rescue program, regardless of the source of the Rescue Service and its capability. The components of the audit should include, but not be limited to, the following:

(1) Evaluation of the rescue response plan
(2) Review of the Rescue Service's equipment, including the system utilized for inspection, inventory, history of use, and documentation
(3) Review of the Rescue Service's SOPs to ensure they coincide with the needs of the response area
(4) Evaluation of the Rescue Service's availability and timeliness of response to ensure they are appropriate to the response required
(5) Evaluation of the Rescue Service capability by means of a performance evaluation
(6) Review of the Rescue Service's qualifications and training records relative to both rescue and medical provisions
(7) Review of the Rescue Service's pre-incident emergency action plans for each space for which it is responsible
(8) Evaluation of the communication methods used for both Rescue Service notification and operation at an emergency
(9) Additions and corrections to the rescue plan based on audit results

10.2.2.2* Auditor Qualifications. Confined space rescue program audits should be conducted by a designated person or group of persons trained in or familiar with rescue operations and medical provisions at a level commensurate with the recommendations of this guide for rescue team members.

10.2.3 Performance Evaluations. Performance evaluations are a principal means of deciding who is qualified among a group of prospective Rescue Service providers. Performance evaluations should be conducted by the Owner/Operator or Entrant Employer prior to considering a Rescue Service and periodically thereafter to ensure that the provider's performance is still satisfactory. Performance should be evaluated by means of simulated rescue operations in which the Rescue Service removes dummies, mannequins, or persons from actual confined spaces or from representative confined spaces resembling all the spaces to which the Rescue Service could be required to respond in an emergency within their jurisdiction. Representative confined spaces should, with respect to opening size, configuration, and accessibility, simulate the types of confined spaces from which rescue could be performed.

10.2.3.1* Team Composition for Evaluations. Evaluation of Rescue Service performance should include all combinations of personnel expected to participate as members of that team. This may require multiple evaluations to ensure that all team member compositions will provide the appropriate capability for confined space rescue. Ad hoc or one-time rescue teams may need only a qualifying pre-operation evaluation.

10.2.3.2 Frequency of Performance Evaluations. Performance evaluations should be repeated annually.

10.2.3.3 Components of Performance Evaluations. Performance evaluations should include a means of evaluating the team's ability to address patient care (prior to transfer of the patient to the local EMS provider), rescue operations, and safety and confined space operations and safety.

10.2.3.3.1 Patient Care Components. Patient care components should include, but not be limited to, the following:

(1) Assessing and addressing critical immediate life-threatening conditions
(2) Assessing and addressing conditions that are not immediately life threatening
(3) Stabilization and packaging of the patient with regard to injuries so as to prevent further harm if possible
(4) Identification and means of access to appropriate treatment facilities relative to specific confined space–related illness and/or injury, including, but not limited to, toxic exposure, chemical and physical burns, asphyxiation, and physical trauma

10.2.3.3.2 Rescue Operations and Safety Components. Rescue operations and safety components include, but are not limited to, the following:

(1) Rescue system safety
(2) Rescue system efficiency
(3) Team operations (command, control, and communications)

10.3 Hazard Evaluation and Risk Assessments. The Owner/Operator or Entrant Employer should conduct a hazard evaluation and risk assessment of the response area and should determine the feasibility and type of incidents that might require confined space rescue operations.

Δ **10.3.1 Components.** These assessments should include, but not be limited to, the following:

(1) Evaluation of the environmental, physical, social, and cultural factors influencing the scope, frequency, and magnitude of a potential incident
(2) Assessment of the impact that the factors may have on the ability of the Owner/Operator or Entrant Employer to respond to an incident and to continue operating while minimizing threats to Rescuers at an incident site
(3) Identification and maintenance of a list of the type and availability of internal resources needed for technical search and rescue incidents
(4) Identification of the type and availability of external resources needed to augment existing capabilities in confined space rescue incidents
(5) Determination of the potential to respond to rescue incidents that might involve nuclear or biological weapons, chemical agents, or weapons of mass destruction, including those with the potential for secondary devices (Note: If the Owner/Operator or Entrant Employer determines that a hazard evaluation exists for rescue response into a nuclear, biological, explosive, and/or chemical environment, appropriate training and equipment for response personnel should be provided.)

10.3.2 Acquisition of Resources. Where an advanced level of search and rescue capability may be needed in a given confined space, Owners/Operators or Entrant Employers should have a system in place to utilize the most appropriate resource(s) available through the use of local experts, agreements with specialized resources, and mutual aid. The Owner's/Operator's or Entrant Employer's confined space program should establish procedures for the acquisition of the external resources needed for specific emergencies in and associated with confined spaces. A list of the resources should be maintained and updated at least once a year. Additionally, the list should be reviewed and updated by the Owner/Operator or Entrant Employer prior to a planned entry requiring advanced capability.

10.3.3 Documentation. The hazard evaluation and risk assessment should be documented by the persons conducting the work.

10.3.4 Review Process. The hazard identification and risk assessment should be reviewed and updated by the Owner/Operator or Entrant Employer on a scheduled basis and as operational or organizational changes occur.

10.3.5 Surveys. At intervals determined by the applicable confined space program and depending on changes in equipment, operations, or materials, the Owner/Operator or Entrant Employer should conduct surveys in their response area for the purpose of identifying the types of rescue incidents that are most likely to occur in and around confined spaces.

10.4 Standard Operating Procedures (SOPs). The Owner/Operator or Entrant Employer responsible for selection of Rescue Services should establish written SOPs consistent with a level of capability to respond to confined space rescue incidents.

10.4.1* Rescue Procedures. Rescue procedures should include, but not be limited to, identification of hazards, use of equipment, and application of techniques necessary to coordinate, perform, and supervise confined space rescue incidents. The Owner/Operator and the organization responsible for performing confined space rescue should work together to establish operational procedures to ensure that confined space rescue operations are performed in a manner that minimizes threats to Rescuers, Entrants, and others in or around the confined space area.

10.4.2 Evacuation Procedure. The applicable confined space program should include an SOP to evacuate rescue team members and other personnel from an area and to account for their safety when a potential or imminent hazardous condition arises. This procedure should include a method to notify all personnel in the affected area immediately by a designated, effective means, including, but not limited to, audible warning devices, visual signals, and/or radio signals.

10.5 Regulatory Compliance. The Owner/Operator and Entrant Employer should comply with all applicable local, state, and federal laws and regulations and should ensure that rescue personnel adhere to program requirements.

Δ **10.6 Incident Response Planning.** The Owner/Operator or Entrant Employer should train responsible personnel in developing pre-incident emergency action plans to prepare the designated Rescue Service for safe practices associated with rescue from specific and generic confined spaces for which they provide rescue. This process should include determining, reviewing, accessing, and using relevant components of applicable national, state, industry, and local response plans.

10.6.1 Documentation of Response Plan. The procedures for a rescue emergency response in and around confined spaces should be documented in the confined space rescue incident response plan.

10.6.1.1 The plan should be a formal, written document.

10.6.1.2 Where external resources are required to achieve a desired level of operational capability, mutual aid agreements should be developed with other organizations.

10.6.2 Response Plan Distribution. Where required, copies of the confined space rescue incident response plan should be distributed to agencies, departments, Owners/Operators, Entrant Employers, and employees having responsibilities designated in the plan. Copies should also be provided to the Entry Supervisor, Entrants, Attendants, and others involved in the confined space entry or to their authorized representatives.

10.6.2.1 A record should be kept of all holders of the confined space rescue incident response plan, and a system should be implemented for issuing changes and revisions.

10.6.2.2 The confined space rescue incident response plan should be approved by the Owner/Operator, Entrant Employer, and the Rescue Services through a formal, documented approval process and, where required, should be coordinated with participating agencies and organizations.

10.6.3 Type of Response Plan. Confined space response plans are of the two following types:

(1) *Organizational response plan to manage confined space rescue incidents within a specific area or jurisdiction.* This is the overall plan for managing generic emergencies of this type.
(2) *Rescue team pre-incident rescue action plans to address specific or generic approaches to rescue from confined spaces for which they are responsible.* This is the confined space–specific rescue plan that should fit into the organizational response plan.

CONFINED SPACE RESCUE PREPLAN **DATE/STATION:**

This Section to Be Completed with Assistance of Site Representative

Space name and ID:

Space entry configuration:	Portal shape and size:	Access to portal:
❑ Horizontal entry, length: ______ ft ❑ Vertical entry, depth: ______ ft ❑ Horizontal w/ vertical drop: ______ ft ❑ Vertical w/ horizontal extension: ______ ft	❑ Round ______ ❑ Rectangle, H × W: ______ ❑ Oval, H × W: ______ ❑ Other ______	❑ Elevated ❑ Below grade ❑ Grade Internal configuration: ❑ Congested ❑ Clear

HOW WILL WE BE NOTIFIED OF AN EMERGENCY?
❑ Phone ❑ Pager ❑ Radio ❑ Audible signal ❑ Intercom ❑ Other ______

WHO NOTIFIES EMS? ______
WHERE WILL PATIENTS BE TRANSFERRED TO EMS? ______

CAN WE PRE-STAGE EQUIPMENT? ❑ Yes ❑ No If Yes: What can we pre-stage and where? ______
CAN WE PRE-STAGE MANPOWER? ❑ Yes ❑ No If Yes: How many and where? ______
Response time for rest of team? ______

QUESTIONS ABOUT ENTRY AND WORK PERFORMED:
- Is a space permit required? ❑ Yes ❑ No If Yes, why? ______
- Number of Entrants working in space: ______
- Do they all speak English? ❑ Yes ❑ No If No, other language(s)? ______
  Interpreters present? ❑ Yes ❑ No If Yes, how many? ______
- How do workers get into the space? ❑ Crawl in ❑ Rigid ladder ❑ Soft ladder ❑ Scaffolding ❑ Winch/rope system ❑ Other ______
- Is retrieval required? ❑ Yes ❑ No If No, why? ______
  If No, will workers still wear harnesses? ❑ Yes ❑ No
  If Yes, what type of harness: ❑ Cable/harness ❑ Rope/harness ❑ Other: ______
  If Yes, mechanical retrieval used? ❑ Yes ❑ No If Yes, type: ❑ Winch ❑ Rope/Pulley M/A ❑ Other: ______
- Are there any fall hazards inside the space? ❑ Yes ❑ No
  If Yes, what will be used to protect Entrants: ______
- Is respiratory protection required for Entrants? ❑ Yes ❑ No If Yes, why? ______
  Type: ❑ Filter-type respirator ❑ Airpurifying respirator ❑ SCBA ❑ SAR ❑ Other: ______
- Chemical protective clothing required? ❑ Yes ❑ No If Yes, why? ______
  Type: ______
- Can Attendant see the Entrant(s) from the portal? ❑ Yes ❑ No
- Is any hot work being performed? ❑ Yes ❑ No If Yes, what type? ______
- Are any chemicals being brought into the space? ❑ Yes ❑ No If Yes, what type? ______
  ______. Attach MSDS for known contaminants.
- Have all sources of dangerous energy been isolated? ❑ Yes ❑ No If No, why? ______
- Is ventilatioin in place? ❑ Yes ❑ No If No, ventilation equipment and power available? ❑ Yes ❑ No
- How will the atmosphere be monitored? ❑ Once before entry ❑ Periodic: every ______ minutes ❑ Continuous ❑ Other: ______
- Are high-point anchor structures available? ❑ Yes ❑ No If Yes, what? ______
- Is a space diagram available (as builds, etc.)? ❑ Yes ❑ No If No, describe: ______

❑ *Permit located and reviewed*
❑ *SDS located and reviewed*
❑ *Energy isolation sheet located and reviewed*

Δ **FIGURE 10.6.5 Sample Pre-Incident Rescue Action Plan Form.**

10.6.4 Components of Organizational Response Plan. The organizational response plan should include, but not be limited to, the following components:

(1) Command structure
(2) Communications
(3) Internal resources
(4) External resources
(5) Safety and accountability
(6) Regulatory compliance (state, local, and federal)

10.6.5* Components of Pre-Incident Rescue Action Plan. The pre-incident rescue action plan should include, but not be limited to, the following components *(see Figure 10.6.5)*:

(1) Space identification and configuration (adjacent areas)
(2) Notification
(3) Command and control
(4) Communications
(5) Work to be performed
(6) Hazard identification and elimination, mitigation, or control (including adjacent areas)
(7) Environmental concerns
(8) Resource identification (e.g., hazmat, fire, EMS)
(9) Access and egress methods
(10) Retrieval systems
(11) Rescue systems
(12) PPE (including atmosphere supplying respirators)
(13) Action planning
(14) Equipment required (medical and rescue)

10.7 Confined Space Rescue Equipment and Gear.

10.7.1 Operational Rescue Equipment. The Entry Supervisor should ensure that confined space rescue equipment is available and utilized commensurate with recognized standards and the applicable requirements for the rescue operations.

Confined space rescue equipment can include, but is not limited to, the following:

(1) Rescue harnesses (Class III)
(2) Rescue rope
(3) Other rope rescue equipment such as the following:
  (a) Carabiners and snap links
  (b) Rope grab and ascending devices
  (c) Descent-controlled devices
  (d) Portable anchors such as the following:
    i. Beam straps and clamps
    ii. Anchor plates
  (e) Pulleys
  (f) Load straps (end-to-end and multiple configurations)
(4) Mechanical rescue/retrieval devices (vertical and horizontal) such as the following:
  (a) Winches
  (b) Pulley systems (e.g., block and tackle, pre-built)
  (c) Tripods and davit arms
(5) Illumination
(6) Ventilation
(7) Energy control devices
(8) Communication and technology systems such as the following:
  (a) Hardwire
  (b) Mobile communication devices
  (c) Laptops and tablets
(9) Patient packaging and care equipment [basic life support (BLS) and advanced life support (ALS)] such as the following:
  (a) Medical first response kits
  (b) Backboards
  (c) Basket and flexible litters
  (d) Stabilization devices
(10) Grain rescue tube

10.7.1.1 Confined Space Rescue Equipment Standards. The following publications provide information regarding rescue equipment and should be consulted as appropriate:

(1) NFPA 1855, *Standard on Selection, Care, and Maintenance of Protective Ensembles for Technical Rescue Incidents*
(2) NFPA 1951, *Standard on Protective Ensembles for Technical Rescue Incidents*
(3) NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*
(4) NFPA 1983, *Standard on Life Safety Rope and Equipment for Emergency Services*

10.7.1.2 Inspection, Care, and Maintenance of Confined Space Rescue Equipment and Gear. In accordance with manufacturers' requirements/recommendations and reference standards, confined space rescue equipment should be properly inspected and maintained to ensure it will operate as designed. All equipment should be inspected for damage or defect before and after each use as appropriate and removed from service if found defective. Inspections performed according to manufacturers' requirements should be properly documented.

10.7.2* Personal Protective Equipment (PPE). Rescue teams should assess the need for, provide, and train personnel in the utilization of appropriate PPE based on the guidelines listed in Chapter 8. Since some PPE requirements can be satisfied in different ways, it is important that rescue teams not only choose PPE appropriate to the hazards but choose equipment that will most efficiently allow them to meet the rescue objectives.

10.8 Incident Management System.

10.8.1 The Rescue Service should provide for and utilize training on the implementation of an incident management system that meets the requirements of NFPA 1561, with written SOPs applying to all members involved in emergency operations. All members involved in emergency operations should be familiar with the systems.

10.8.2 The Rescue Service should provide for training on the implementation of an incident accountability system that meets the requirements of NFPA 1561.

10.8.3 The incident commander should ensure rotation of personnel to reduce stress and fatigue.

10.8.4 The incident commander should ensure that all personnel are aware of the potential impact of their operations on the safety and welfare of Rescuers and others, as well as on other activities at the incident site.

10.8.5 At all rescue incidents, the organization providing the Rescue Service should provide supervisors who possess skills and knowledge commensurate with the organization's rescue capability.

10.9 Rescue Team Composition.

Δ **10.9.1*** The size and composition of a confined space rescue team and the required rescue equipment should be based on pre-incident planning and practice of the plan to ensure effective operations. The role of a confined space rescue team is intended to include entry into the space to perform a rescue. Therefore, the team should be staffed to provide for the following exclusive functions:

(1)* Entrant/entry team of sufficient size to provide immediate assistance to or rescue of entry team members who become ill or injured and are unable to perform self-rescue
(2)* Backup team of sufficient size to provide immediate assistance to or rescue of entry team members who become ill or injured and are unable to perform self-rescue
(3)* Attendant, whose function is to deny unauthorized persons access and to monitor the conditions in the space and the status of all Entrants
(4) Rescue Supervisor to maintain control of the entire operation and who is knowledgeable in all team functions
(5) Safety officer, whose function is to observe operations in and around the emergency scene, to call attention to any safety hazards, and to halt operations if needed

N **10.9.1.1** The safety officer is qualified and authorized to halt operations when a significant hazard is recognized. Although halting operations ideally should be performed by a single well-trained individual with no other assignments, any rescue team member should be able to halt an operation for safety concerns at any time.

10.10 Entry Rescue — Rescue Service Capabilities.

10.10.1 The organization providing the Rescue Service should be responsible for the development and training of a confined space rescue team that is trained, equipped, and available to respond to emergencies in and around confined spaces of a type and complexity that require anything other than non-entry-type rescues from confined spaces.

10.10.2 The Rescue Service can perform both non-entry- and entry-type rescues from confined spaces.

Δ **10.10.3** Organizations providing the Rescue Service should develop and implement procedures for the following:

(1) Determining and recognizing existing and potential conditions at rescue emergencies
(2) Protecting personnel from hazards in and around the confined space
(3) Ensuring that personnel are capable of managing the physical and psychological challenges that affect Rescuers performing confined space rescues
(4) Identifying the duties of the Rescue Entrant(s)and backup Rescue Entrant(s), the Rescue Attendant, and the rescue team leader, as defined in this guide
(5) Monitoring continuously or at frequent intervals the atmosphere in all parts of the space to be entered for oxygen content, flammability (LEL), and toxicity, in that order
(6) Performing entry-type rescues into confined spaces
(7) Using victim packaging devices that could be employed in confined space rescue
(8) Selecting, constructing, and using rope- or cable-based lowering and raising systems in the high-angle environment commensurate with the needs of the organization
(9) Developing hazard isolation and control requirements
(10) Ensuring that rescue team members take part in a medical surveillance program
(11) Planning response for entry-type confined space rescues in hazardous environments
(12) Implementing the planned response

10.10.4 Where applicable, organizations providing the Rescue Service should have a working understanding of the machinery-related hazards in and around the space as those hazards relate to the rescue, including the ability to recognize and control hazardous energy (lockout/tagout).

Chapter 11 Confined Space Personnel Duties, Responsibilities, Qualifications, and Competencies

11.1* General.

N **11.1.1** All persons engaged in confined space activities and operations should be competent and qualified. There are numerous entities that may be involved, individually or working together, in confined space entry and related activities. These include, but are not limited to, Owners/Operators, Contractors/Subcontractors, facility personnel, Rescue Services, and visitors, as well as other persons and operations both within and outside of the confined space. This chapter covers the duties, responsibilities, qualifications, and competencies of these individuals as related to confined space activities.

N **11.1.2** This chapter lists requirements for all persons and tasks that might be required for entry. It is important to recognize that there are at least three key positions required for a confined space entry that requires permitting: the Entry Supervisor, the Attendant, and the Entrant. In addition to these three positions, rescue should be provided as outlined in Chapter 10. In many applications, one or more of these persons (often the Entry Supervisor) can handle other tasks addressed in this chapter, including, but not limited to, atmospheric testing, issuing permits, conducting ventilation, and providing standby services.

11.2 Entrants.

11.2.1 General.

11.2.1.1 Entrants should be competent, qualified, and authorized to enter and work within confined spaces.

11.2.1.2 As defined in the applicable confined space program, entry occurs when any part of the Entrant's body breaks the plane of a confined space opening.

11.2.2 Entrant Duties and Responsibilities.

11.2.2.1 Entrants should enter the confined space only when designated by their employer, when authorized by the Entry Supervisor, and after a confined space pre-entry evaluation has been performed and a permit issued, if necessary.

Δ **11.2.2.1.1** Each Entrant should verify that his or her name is listed on the entry permit when a permit is required.

11.2.2.1.2 Entrants should be aware of the hazards that might be encountered during entry, including the confined space hazards and controls noted on the permit.

11.2.2.2 Entrants should conduct assigned work following approved procedures that emphasize safety and minimize hazards.

11.2.2.3 Entrants should demonstrate the proper use of approved equipment, materials, tools, and PPE identified in the permit to the Entry Supervisor.

11.2.2.4 Entrants should remain aware of potential atmospheric and non-atmospheric hazards that might be encountered during confined space entry.

11.2.2.4.1 Entrants should exit the confined space when changing conditions result in hazards that cause unacceptable risks or exceed the permit requirements.

11.2.2.4.2 Entrants should immediately exit the space if the entry permit expires or is cancelled.

11.2.2.4.3 Entrants should immediately exit the space when directed by the Attendant or the Entry Supervisor or during any emergency occurring elsewhere in the vicinity that requires evacuation.

11.2.2.5 Entrants should understand and be able to communicate the hazards inside and outside the confined space that may be encountered during entry, including information on the mode, signs or symptoms, and consequences of exposure, and act accordingly depending on the situation.

11.2.2.5.1 Entrants should immediately notify the Attendant of any symptoms of exposure, an emergency, or unacceptable conditions.

11.2.2.5.2 Entrants should exit the confined space immediately if symptoms, warning signs, or unacceptable conditions occur.

11.2.2.6 Entrants should react to emergencies as trained and directed, including, but not limited to, self-rescue or evacuation of the confined space.

11.2.2.7 Entrants may also perform other activities and assigned duties if qualified in accordance with the applicable confined space program, including, but not limited to, self-rescue, atmospheric monitoring, hot and cold work inside the space, and performing non-entry tasks.

11.2.3 Entrant Qualifications.

11.2.3.1 An Entrant should understand and comply with applicable governmental regulations that pertain to the planned confined space entry and work as explained by the Entry Supervisor or included in the entry permit.

11.2.3.2 An Entrant should understand and be able to communicate to the Entry Supervisor the use, limitations, and hazards of materials, substances, and equipment approved for use within the specific confined space (e.g., tools, PPE, energy isolation devices, gas monitors, and chemicals) before entry.

Δ **11.2.3.3** Before entry, an Entrant should understand and be able to communicate to the Entry Supervisor the primary and secondary means of communication to be used while working in the confined space and in the event of emergencies.

11.2.3.4 An Entrant should understand and be able to communicate to the Entry Supervisor before entry how to interpret and respond to gas monitor displays and alarms.

11.2.3.5 An Entrant should understand and be able to communicate to the Entry Supervisor before entry all sections of the confined space entry permit that are applicable to the Entrant's duties.

11.2.3.6 An Entrant should understand and be able to communicate to the Entry Supervisor before entry personal warning signs and overexposure symptoms, including actions that must be taken in the event of exposure.

11.2.3.7 An Entrant should understand and be able to verbally explain to the Entry Supervisor before entry applicable emergency procedures to be taken within or around the confined space.

11.2.4 Entrant Demonstrated Competencies.

11.2.4.1 An Entrant should be able to understand and follow permit requirements.

11.2.4.2 An Entrant should be able to demonstrate the proper use of required assigned equipment, tools, and materials, including, but not limited to PPE, respiratory protection, non-entry rescue devices, instruments, and cleaning and decontamination materials.

11.2.4.3 An Entrant should be able to communicate when evacuation is desired.

11.2.4.4 An Entrant should be able to complete assigned tasks in an approved manner.

11.3 Attendant.

11.3.1 General.

11.3.1.1 Attendants should be competent, qualified, and authorized to oversee the Entrants working inside the confined space and the activities occurring outside the confined space that might affect confined space operations.

11.3.1.2 Attendants should be stationed outside confined spaces but in close proximity to the entry so that continuous communication or visual observation can be maintained with Entrants.

11.3.2 Attendant Duties and Responsibilities.

Δ **11.3.2.1** Attendants should be able to communicate to the Entry Supervisor the hazards inside and outside the specific confined space that might occur during entry, including information on the modes, signs or symptoms, and consequences of exposure to Entrants.

Δ **11.3.2.2** Each Attendant should verify that his or her name is listed on the entry permit. This may require verification by initialing or signature.

11.3.2.3 Attendants should be constantly observing, monitoring, and evaluating the conditions in and around the confined space to ensure that compliance with the requirements of the permit are maintained throughout the entry.

11.3.2.4 Attendants should monitor adjacent areas outside the confined space for changing conditions that might affect safe entry work or activities.

11.3.2.5 Attendants should remain outside the confined space opening during entry operations and should perform their assigned duties until relieved by another assigned Attendant.

11.3.2.5.1 Attendants should inform the replacement Attendant of the status of the Entrant(s) and confined space permit requirements, including any deviations.

11.3.2.5.2 The replacement Attendant's name should be listed on the entry permit and acknowledged by the replacement Attendant's initials or signature, as required by the applicable confined space program.

11.3.2.6 Attendants should monitor Entrants' status and direct Entrant evacuation as needed.

11.3.2.7 Attendants should continuously maintain an accurate count of Entrants in the confined space.

11.3.2.8 Attendants should take the following actions when unauthorized person(s) approach or enter a confined space while entry is underway:

(1) Warn unauthorized personnel not to enter into the confined space
(2) Inform Entrants and Entry Supervisors when unauthorized personnel enter or attempt to enter the confined space
(3) Prevent unauthorized personnel from interfering with Attendant duties

11.3.2.9 Attendants should summon rescue and other emergency services immediately upon recognizing an Entrant's distress inside the confined space.

11.3.2.10* Attendants should perform non-entry rescue as trained and equipped.

11.3.2.11* Attendants may perform other approved assigned duties that do not interfere with the primary duty to monitor and protect the Entrants. Attendants may also perform other assigned duties, if competent and qualified, in accordance with the applicable confined space program, including, but not limited to, performing atmospheric monitoring.

11.3.3 Attendant Qualifications.

11.3.3.1 Attendants should understand and comply with applicable governmental regulations that pertain to the planned confined space entry and work as explained by the Entry Supervisor or as included in the entry permit.

11.3.3.2 Attendants should be competent and qualified to operate and understand the assigned atmospheric monitor and to be capable of recording readings as required.

11.3.3.3 Attendants should know and be able to communicate to the Entry Supervisor the use, limitations, and hazards of materials, substances, and equipment approved for use outside the specific confined space, including, but not limited to, tools, PPE, energy isolation devices, gas monitors, and chemicals.

11.3.3.4 Attendants should know and be able to communicate to the Entry Supervisor the hazards inside and outside the specific confined space that might be encountered during entry operations, including information on the modes, signs or symptoms, and consequences of exposure to Entrants.

11.3.4 Attendant Demonstrated Competencies.

Δ **11.3.4.1** Attendants should be able to read, understand, and communicate permit requirements to the Entry Supervisor.

11.3.4.2 Attendants should be educated or trained in the proper use of required assigned equipment, including, but not limited to, PPE, respiratory protection, and non-entry rescue devices, tools, and communication devices, and be able to demonstrate such competency to the Entry Supervisor.

11.3.4.3 Attendants should be able to communicate with Entrants in order to evacuate the confined space when conditions arise that might endanger the Entrant.

11.3.4.4 Attendants should be able to perform their assigned tasks safely in accordance with the requirements of the applicable confined space program and/or entry permit.

11.3.4.5 Attendants should be able to recognize Entrant signs and symptoms related to hazardous or toxic chemical exposures and oxygen deficiency and take appropriate action required to assist Entrant self-evacuation or rescue operations if properly trained and equipped.

11.4 Entry Supervisor.

11.4.1 General.

Δ **11.4.1.1** Entry Supervisors should be qualified and competent to oversee and direct confined space entry and associated operations in accordance with applicable regulations, entry and work permits, facility operating practices, appropriate confined space program requirements, and other programs and procedures, including, but not limited to, isolation, ventilation and inerting, hot work, and respiratory protection, as applicable to the specific entry.

11.4.1.2* Entry Supervisors can also be designated on the permit(s) as Attendants, Gas Testers, Ventilation Specialists, Isolation Specialists, and Entrants in accordance with the applicable confined space program, provided that they are trained and/or qualified in accordance with the respective requirements provided in this chapter for alternative activities.

11.4.2 Entry Supervisor Duties and Responsibilities.

11.4.2.1 Entry Supervisors should verify that the appropriate information has been recorded on the confined space entry permit, that other specified permits and all tests specified by the permits have been completed, and that all requirements, procedures, and equipment specified by the permit have been satisfied or are in place before issuing the permit to authorize entry.

11.4.2.2 Entry Supervisors should determine the requirements and implement procedures to identify and then eliminate, mitigate, or control hazards.

11.4.2.3 Entry Supervisors should be identified and should sign or initial permits to document acceptance of responsibility, as required by the applicable confined space program or by regulations.

Δ **11.4.2.4** Where required by the applicable confined space program or regulations, the assigned Entry Supervisor should remain at the confined space work site to control operations unless relieved by another competent, qualified, and authorized Entry Supervisor.

N **11.4.2.5** The relieving Entry Supervisor should initial or sign the permit(s) to document the change of responsibility.

11.4.2.6 Entry Supervisors should ensure that personnel involved with the confined space operations are informed when another person assumes the Entry Supervisor role.

11.4.2.7 Entry Supervisors should be trained and qualified as Entrants if duties require entry into confined spaces.

11.4.2.8 Entry Supervisors should be trained and qualified as Gas Testers if duties require maintaining, testing, and operating gas monitors, including interpreting and analyzing test results.

11.4.2.9 Entry Supervisors should be trained and qualified as Ventilation Specialists if duties require ventilation of the space. Entry Supervisors should be knowledgeable of the following:

(1) Requirements for ventilation to ensure that the proper method is used for the hazards present
(2) The confined space configuration
(3) The work to be done

11.4.2.10 Entry Supervisors should conduct a pre-entry safety meeting with all persons involved prior to the start of confined space operations in accordance with the applicable confined space program *(see Section 5.5)*.

11.4.2.11 Entry Supervisors should coordinate activities where multiple Owners/Operators are working on the same job or on nearby jobs that might affect the confined space operations.

11.4.2.12* Entry Supervisors should terminate the entry and cancel the permit if permit requirements are no longer met.

11.4.2.13 Entry Supervisors should cancel the permit and/or take appropriate action in the following situations:

(1) To effect the removal of any unauthorized individuals who enter or attempt to enter a permit space during entry operations
(2) When unauthorized equipment is brought into a space.

11.4.2.14 Entry Supervisors should cancel the permit if conditions arise inside or outside the confined space that were not anticipated on the permit and have the potential to adversely affect operations.

11.4.2.15 Entry Supervisors should cancel and reissue the permit with the new entry and control requirements if the confined space conditions change.

11.4.2.16 Entry Supervisors should identify methods of alerting Rescuers and ensure that Rescuers are available for a timely response, as required by the confined space program.

11.4.2.17 Entry Supervisors should determine that acceptable entry conditions are met and that they remain consistent with requirements of the entry permit, including whenever changes occur inside or outside the confined space. If such changes affect the permit requirements, the Entry Supervisor should cancel the permit, determine new requirements, and reissue the permit once the new requirements are met.

11.4.2.18 Entry Supervisors should ensure that all energy sources, including, but not limited to, electrical, steam, hydraulic, and mechanical, and all tank equipment and appurtenances, including, but not limited to, tank mixers, heaters, sensors, piping or ducting into or from the space, and other instrumentation, have been controlled, disconnected, or isolated before the permit is issued.

11.4.2.19 Entry Supervisors should ensure that the Gas Testers, Entrants, Attendants, and other confined space personnel properly wear and use approved PPE and appropriate respiratory protection as identified on and required by the permit.

11.4.2.20 Entry Supervisors should ensure that access to a confined space is barricaded or prohibited when work is not in progress and an Attendants is not present. Entry should also be prohibited by not issuing a permit or by canceling existing entry permits if required emergency response is not available.

11.4.2.21 Entry Supervisors should ensure that areas are barricaded, cordoned off, or otherwise protected to prevent exposure to hazardous atmospheres where toxic and flammable gases, vapors, or inert gas is vented. Entry Supervisors should ensure that there are no ignition sources present in areas susceptible to flammable or combustible vapors, gases, or combustible dust exhausted from the space.

11.4.2.22* Entry Supervisors should ensure that all ignition sources in the area are eliminated, mitigated, or controlled before permitting work to be conducted that might involve the actual or potential release of flammable or combustible vapor, gas, or dust into the atmosphere around or inside the confined space.

11.4.3 Entry Supervisor Qualifications.

Δ **11.4.3.1*** Entry Supervisors should be certified as confined space entry (safety) supervisors where certification is available and required.

11.4.3.2 Entry Supervisors should know and be able to apply the applicable regulatory and confined space program requirements and be able to explain them to assigned personnel.

11.4.3.3 Entry Supervisors should know the proper use of gas monitors and be able to understand, analyze, and interpret gas monitor readings in order to provide for safe entry and work in confined spaces.

11.4.4 Entry Supervisor Demonstrated Competencies.

11.4.4.1 Entry Supervisors should be able to identify, recognize, and assess hazards associated with the specific confined space and operations and the methods to be used for elimination, mitigation, or control of such hazards in accordance with Chapters 6, 7, and 8.

Δ **11.4.4.2** Entry Supervisors should be able to identify and evaluate the need for required equipment.

11.4.4.3 Entry Supervisors should be able to prepare and issue permits using the requirements for the specific space and work to be performed.

Δ **11.4.4.4** Entry Supervisors should be able to communicate with all personnel, including facility and emergency responders, using available communication methods and equipment.

11.4.4.5 Entry Supervisors should be able to perform their assigned tasks in a competent and approved manner and ensure that personnel for whom they are responsible do the same.

11.5 Rescuer. Rescuers should be competent, trained, and equipped as required by applicable regulations and confined space entry and rescue programs. Rescuers should be designated by the appropriate authority and able to respond to emergencies requiring the rescue of Entrants from outside or from within confined spaces in accordance with the provisions of Chapter 10. A Rescue Service should meet all the requirements of the technician level confined space rescue chapter in NFPA 1670.

11.6 Gas Tester.

Δ **11.6.1 General.** Gas Testers should be qualified in the appropriate selection, inspection, calibration, testing, adjustment, and use of monitoring equipment and applicable monitoring and testing procedures needed to assess and evaluate atmospheres in and around confined spaces in accordance with Chapter 7.

11.6.2 Gas Tester Duties and Responsibilities.

11.6.2.1 Gas Testers should determine proper selection of gas monitors based on the atmospheric hazards that are present or that could be encountered during confined space operations.

11.6.2.2 Gas Testers should inspect, calibrate, bump test, and/or adjust gas monitors prior to use in accordance with manufacturer's instructions.

Δ **11.6.2.3** Prior to entry, Gas Testers should first test, sample, and monitor the atmosphere around the outside of the confined space and then test the atmosphere within the space from the outside (without bodily entry) through an opening using a probe or similar equipment for additional monitoring, if needed.

Δ **11.6.2.4** A Gas Tester should verify that his or her name is listed as such on the entry permit.

11.6.2.5 Gas Testers should be qualified as Entrants and be aware of all confined space hazards, entry requirements, PPE, and other controls prior to entry for testing.

11.6.2.6 Gas Testers should sample, analyze, interpret, and monitor the atmosphere inside the confined space in the following order:

(1) Oxygen levels
(2) Flammable gases and vapors
(3) Toxic/hazardous atmospheric contaminants

Δ **11.6.2.7** Gas Testers should record test results on the permit and verify by signing the permit, indicating the time(s) and the result(s) of the testing.

11.6.2.8 Gas Testers should allow Entry Supervisors, Attendants, Entrants, and workers (or their authorized representatives) to observe the monitoring process and the results.

Δ **11.6.2.9** Gas Testers should re-evaluate conditions by testing, sampling, and monitoring the atmosphere both around and inside the confined space as often as determined by the Entry Supervisor and as indicated on the entry permit.

11.6.3 Gas Tester Qualifications.

11.6.3.1 Gas Testers should be familiar with and be able to apply the confined space program and entry permit requirements and governmental regulations that pertain to the planned confined space work.

11.6.3.2 Gas Testers should be trained and qualified in the appropriate selection, inspection, calibration, adjustment, and use of gas monitors.

11.6.3.3 Gas Testers should understand and be able to communicate to the Entry Supervisor how to assess, interpret, and apply SDS information and limitations pertinent to the hazards associated with the confined space and surrounding area and operations.

11.6.3.4 Gas Testers should understand and be able to communicate to the Entry Supervisor the monitoring of atmospheres in and around confined spaces and should know how to apply the appropriate testing procedures associated with monitoring.

11.6.3.5 Gas Testers should be trained to meet the qualifications for an Entrant in order to test within confined spaces.

Δ **11.6.3.6** Gas Testers should know how to use required and approved PPE based on the hazards associated with the confined space operations in accordance with the confined space permit.

11.6.3.7 Gas Testers should know and be able to communicate to the Entry Supervisor how to monitor, analyze, and interpret results of the atmospheric hazards test readings.

11.6.4 Gas Tester Demonstrated Competencies.

11.6.4.1 Gas Testers should be able to demonstrate the competencies required for a Gas Tester and an Entrant and understand permit requirements for entering confined spaces, conducting monitoring, and recording monitoring results.

11.6.4.2 Gas Testers should be able to select, inspect, adjust, calibrate, bump test, and properly use required gas monitors in accordance with manufacturers' instructions.

11.6.4.3 Gas Testers should be able to conduct monitoring and testing in an approved manner in accordance with the entry permit requirements and applicable regulatory requirements.

11.6.4.4 Gas Testers should be able to compare results with recognized and applicable OELs to assess the risk to entry with and without control measures in place.

11.7 Owner/Operator.

11.7.1 General. Owners/Operators should have control, ownership, or authority over the confined space and should ensure that confined space operations are conducted in accordance with regulatory and industry practices, the Owner's/Operator's confined space program, and Chapter 12.

11.7.2 Owner/Operator Duties and Responsibilities.

Δ **11.7.2.1** Owners/Operators should evaluate and re-evaluate spaces and identify and designate those that should be classified as confined spaces in accordance with Chapter 4. This responsibility may be delegated by the Owner/Operator when the space is under the control of a third party [such as when a building or portion thereof (a space) is leased or contracted to a third party] and the Owner/Operator has no obligation to the building, the space, or the operations therein.

11.7.2.2 Where applicable, Owners/Operators should obtain required jurisdictional permits and authorizations.

11.7.2.3* Owners/Operators should identify and designate those individuals (facility personnel, Contractors, and contract personnel under facility supervision) who are educated, trained, competent, and/or qualified to perform specific confined space–related duties, including, but not limited to, supervising operations, issuing permits, entering into confined spaces, conducting atmospheric monitoring, providing rescue, performing Attendant duties, overseeing ventilation, and conducting hot or cold work operations within or associated with confined spaces. Owners/Operators should designate and identify the individuals and their duties in the written confined space program in accordance with Chapter 12.

11.7.2.4 Owners/Operators should develop and implement a confined space program in accordance with Chapter 12, which should be available for review by the employees and their authorized representatives. The confined space program applicable to the operations may be that of the Owner/Operator, Contractor, and/or Entrant Employer.

11.7.2.5* Prior to entry, Owners/Operators should conduct a confined space entry safety meeting in accordance with Chapter 5 to ensure that assigned Entry Supervisors, Gas Testers, Entrants, Attendants, Ventilation Specialists, Isolation Specialists, Rescuers, and workers are apprised of and understand the hazards associated with the confined space activity.

11.7.2.6 If Owners/Operators arrange for a Contractor to perform work that involves confined space entry, the Owners/Operators should ensure that the Contractor is aware that entry into a confined space requires compliance with an applicable confined space program.

11.7.2.7 Owners/Operators should ensure that any Contractors/Subcontractors are aware of precautions or procedures that the host employer has implemented for the protection of employees in or near the confined space where the Contractor/Subcontractor personnel will be working.

11.7.2.7.1 Owners/Operators should coordinate entry operations with the Contractor when both host employer personnel and Contractor personnel will be working in or near confined spaces.

Δ **11.7.2.7.2** Owners/Operators should debrief Contractors at the conclusion of entry operations regarding the confined space program that was followed and any hazards confronted or created in confined spaces during entry operations. Where the debriefing indicates a need to change program requirements, Owners/Operators and Contractors should revise confined space programs accordingly.

11.7.2.7.3 Owners/Operators should coordinate activities between multiple employers (Owner/Operator, Contractor/

Subcontractor) working on the same job or on other nearby jobs that could affect the confined space operations.

11.7.2.8 Owners/Operators should implement effective measures to prevent unauthorized personnel from entering confined spaces or impeding upon confined space operations.

11.7.2.9 If changes occur in the hazards, use, or configuration of a confined space or in nearby operations that affect the confined space, Owners/Operators should ensure that Entry Supervisors cancel the entry and hot and cold work permits, Entrants leave the space, and operations are discontinued until the confined space is re-evaluated. Owners/Operators should then ensure that Entry Supervisors establish revised entry criteria, if needed, and reissue permits or issue new permits if work is continuing.

11.7.2.10* Owners/Operators should ensure that required equipment appropriate for employee entry and work in and around the confined space is available for use and that it is properly inspected, tested, maintained, and used in accordance with the confined space program and permit requirements.

Δ **11.7.2.11** Owners/Operators should identify, evaluate, and designate Rescue Services or facility rescuers and develop and implement procedures for communicating with and summoning rescue and emergency services.

11.7.2.12 Owners/Operators should develop and implement procedures to review planned confined space operations prior to entry when there is reason to believe that the requirement of the applicable confined space program might not protect employees. The Owner/Operator should revise the program to correct identified deficiencies before entries are authorized.

11.7.2.13* Owners/Operators should review the confined space program annually, or sooner if an MOC occurs that affects the confined space program or if there is a change in the confined space program. The review should use cancelled permits and other information. Based on the review, the program should be revised to ensure continued protection from hazards during entry operations.

11.7.2.14 Owners/Operators should consult with employees and their authorized representatives on the development and implementation of all aspects of the confined space program and make information available to all affected employees and their authorized representatives.

11.7.2.15 Owners/Operators should provide training or education, as needed, regarding existing, new, and revised procedures and work practices so that all employees involved in confined space operations and activities acquire the understanding, knowledge, and proficiency necessary for the safe performance of assigned duties. Training or education should be provided as follows:

(1) Before the employee is first assigned to perform confined space related duties
(2) Whenever there is a change in assigned duties
(3) Whenever there is a change in confined space–related contents, configuration, use, or operations that presents a hazard
(4) Whenever the employer has reason to believe that there are deviations from the confined space entry procedures, operations, or program requirements or that there are inadequacies in the employee's knowledge of those procedures and requirements

11.7.2.16 Owners/Operators should certify that required training or education has been accomplished. The certification should contain the training or education provided, the employee's name, the signatures or initials of the trainers or educators, and the dates of training or education. Owners/Operators should provide for the certification to be available for inspection by employees, employees' authorized representatives, or other authorized entities, including, but not limited to, regulatory inspectors and investigators.

11.7.3 Owner/Operator Qualifications.

11.7.3.1 Owners/Operators should be able to identify and classify confined spaces within their facility.

11.7.3.1.1 Where the Owners/Operators are absent parties, the requirement for identification and classification of spaces may be designated, by contract or agreement, to another responsible entity. Such spaces include, but are not limited to, the following:

(1) Spaces within a portion of a facility owned by, leased to, or controlled by another entity
(2) Spaces within an entire facility leased by or controlled by another entity

11.7.3.2 Owners/Operators should know and understand the regulatory requirements associated with confined space operations and ensure these are identified in the facility confined space program and properly applied by employees working in and around confined spaces.

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11.7.3.3 Owners/Operators should be able to identify, evaluate, and select Contractors, Subcontractors, and Rescue Services.

11.7.4 Owners/Operators Demonstrated Competencies.

11.7.4.1 Owners/Operators should know and be able to communicate permit requirements to Contractors and Entry Supervisors and be able to evaluate permits upon completion of operations to determine if any deficiencies in the facility confined space or permit programs need to be corrected.

11.7.4.2 Owners/Operators should be able to evaluate the need for, identify, and provide equipment required for confined space operations or assure that the Contractors/Subcontractors meet this requirement.

11.7.4.3 Owners/Operators should provide a means of communication and be able to communicate with and coordinate activities among facility personnel, Contractors, and Subcontractors associated with confined space operations and with nearby activities that may affect confined space operations.

Δ **11.7.4.4** Owners/Operators should be able to assign tasks in accordance with the applicable confined space and permit programs, employee qualifications, and operational requirements.

11.7.4.5 Owners/Operators should be able to recognize, evaluate, and classify confined spaces in accordance with the applicable confined space program and regulatory requirements.

11.8 Contractor/Subcontractor.

11.8.1 General. Contractors are employers who perform work under contract to an Owner/Operator at the Owner's/Operator's confined space work site. Contractors may employ

Subcontractors who perform work under contract to the primary Contractors.

11.8.2 Contractor and Subcontractor Duties and Responsibilities.

Δ **11.8.2.1** Contractors should identify and designate those individuals (either Contractor personnel or Subcontractors) who are educated, trained, competent, and/or qualified to perform specific confined space–related duties, including, but not limited to, supervising operations, issuing permits, entering into confined spaces, conducting atmospheric monitoring, providing for rescue, performing Attendant duties, overseeing ventilation, and conducting hot or cold work operations. Contractors/Subcontractors should designate and identify the individuals and their duties in the entry and work permits as required by applicable regulations, standards, and the written confined space program in accordance with Chapter 12.

11.8.2.2 Contractors should participate in a pre-job safety meeting with the Owner/Operator to establish assignments and responsibilities associated with the confined space entry. Subcontractors should attend either this meeting or a separate meeting conducted by the Contractor.

Δ **11.8.2.3** Contractors and Owners/Operators should review the applicable confined space program and determine what is needed to conduct entry and work operations in compliance with program requirements. The applicable confined space program may be that of the Owner/Operator, the Contractor, or both.

Δ **11.8.2.4** If Contractors do not agree to use the Owner's/Operator's confined space program, they should develop and implement their own confined space program in accordance with regulatory requirements, industry standards, applicable safe work practices and procedures, and Chapter 12. The Contractor's confined space program may be used to supplement the Owner's/Operator's confined space program, but may not conflict with it.

11.8.2.5 Contractors should provide for the applicable confined space program to be available for inspection by the Contractor, the Subcontractor, and facility employees and their authorized representatives.

11.8.2.6* During preplan operations, the Contractor should review and evaluate the confined space to be entered, identify actual and potential hazards, and determine appropriate measures to be taken to eliminate, mitigate, or control the hazards.

11.8.2.7* When Contractors/Subcontractors perform work that involves confined space entry, they should be aware that entry into a confined space requires compliance with an applicable confined space program. The same requirements apply between a Contractor and a Subcontractor.

11.8.2.8 Contractors should make sure that they are aware of the hazards associated with the confined space and apprise Subcontractors, as necessary, of such hazards.

11.8.2.9 Contractors/Subcontractors should be aware of any precautions or procedures that the Owner/Operator has implemented for the protection of employees in or near the confined space where the Contractor's/Subcontractor's personnel will be working.

11.8.2.10 Contractors and Subcontractors should coordinate entry operations with each other and with the Owner/Operator when both Owner/Operator personnel and Contractor personnel are working in or near confined spaces.

11.8.2.11 Contractors/Subcontractors should implement effective measures to prevent personnel from entering confined spaces unless they are designated as Entrants.

11.8.2.12 If changes occur in the use of or configuration within a confined space or external to the confined space that affect the hazards, Contractors/Subcontractors should ensure that the entry permit is cancelled, Entrants immediately vacate the space, the confined space is re-evaluated, and new or renewed permits are issued establishing revised entry criteria, as necessary. Contractors/Subcontractors should immediately advise Owners/Operators of changes that affect the confined space or may affect operations.

11.8.2.13* Contractors/Subcontractors should provide the required equipment and ensure that it is properly inspected, tested, maintained, and used in accordance with the confined space program and entry and work permit requirements.

11.8.2.14 If Rescue Services are provided by the Contractors/Subcontractors, Contractors should identify, evaluate, and qualify assigned Rescuers or rescue and emergency services and develop and implement procedures for summoning Rescuers and emergency services.

11.8.2.15 Contractors/Subcontractors should develop and implement procedures to review entry operations when there is reason to believe that the measures taken under the confined space program might not protect employees. Contractors/Subcontractors should revise their program to correct identified deficiencies before subsequent entries are authorized.

11.8.2.16* Contractors should review and evaluate their confined space programs annually, using cancelled permits and other information, and revise the programs to ensure continued protection from hazards during entry operations. Contractors also should provide to Owners/Operators copies of permits they have issued for the Owners'/Operators' review and evaluation.

11.8.2.17* Contractors should consult with and make information available to Contractor employees and their authorized representatives regarding the development and implementation of all aspects of the Contractor's confined space program. Contractors should ensure that the applicable confined space program is also available to Subcontractor employees and their authorized representatives.

11.8.2.18 Contractors/Subcontractors should provide training covering existing, new, and revised procedures and work practices so that all Contractor/Subcontractor employees involved in confined space operations and activities acquire the understanding, knowledge, and proficiency necessary for the safe performance of assigned duties in accordance with confined space program and permit program requirements.

11.8.2.18.1 Contractors/Subcontractors should ensure that their employees are trained, educated, and/or qualified as follows:

(1) Before the employee is first assigned duties associated with confined space operations
(2) Whenever there is a change in assigned duties
(3) Whenever there is a change in permit space classification, hazards, or operations that presents a hazard

(4) Whenever the Contractors/Subcontractors have reason to believe that employees are deviating from the confined space entry procedures, operations, or program requirements or that there are inadequacies in the employees' knowledge and application of procedures and requirements

11.8.2.18.2 Contractors/Subcontractors should certify that employee training, education, and/or qualification has been accomplished. The certification should contain the employee's training, education, and/or qualifications; the employee's name; the signatures or initials of the trainers and/or qualifiers; and the dates of training, education, and/or qualification. The certification should be available for inspection by regulating agencies, Owners/Operators, and Contractor/Subcontractor employees or their authorized representatives, as applicable.

11.8.2.19 After completion of the work, Contractors should meet with Subcontractors and with Owners/Operators to review safety issues that occurred during the confined space operations.

11.8.2.19.1 Contractors/Subcontractors should debrief Owners/Operators at the conclusion of the entry operations regarding the confined space program followed, any hazards discovered or created, or any changes made in the confined space.

11.8.3 Contractor/Subcontractor Qualifications.

11.8.3.1 Contractors/Subcontractors should be able to recognize and understand confined space operations, including, but not limited to, hazard evaluation, entry, and work program and permit requirements.

11.8.3.2 Contractors/Subcontractors should recognize and understand the existing and potential hazards that may be encountered during entry into confined spaces and necessary controls and protective measures to be taken to prevent or mitigate hazards and exposure.

11.8.3.3 Contractors/Subcontractors should know, understand, and comply with applicable regulatory requirements.

11.8.3.4 Contractors/Subcontractors should be able to develop and implement an appropriate confined space program in compliance with the Owner/Operator program.

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11.8.3.5 Contractors/Subcontractors should be able to identify, evaluate, and select qualified Subcontractors and Rescue Services.

11.8.4 Contractor/Subcontractor Demonstrated Competencies.

11.8.4.1 Contractors/Subcontractors should be able to understand and safely conduct confined space entry and work requirements and evaluate or issue permits accordingly.

11.8.4.2 Contractors/Subcontractors should be able to evaluate equipment needs and then identify, select, inspect, maintain, and provide required equipment.

11.8.4.3 Contractors/Subcontractors should provide for a means of communication and be able to coordinate activities associated with confined space operations.

11.8.4.4 Contractors/Subcontractors should be able to assign tasks in accordance with the confined space program and permit requirements applicable to the proposed operations.

11.8.4.5 Contractors/Subcontractors should be able to predict, recognize, and understand hazards associated with the specific space and operations.

Δ **11.8.4.6** Contractors/Subcontractors should be able to evaluate, qualify, and select personnel.

11.9 Ventilation Specialist.

11.9.1* General. Ventilation Specialists should be familiar with, educated, trained, and/or qualified in the various methods and requirements for removing hazardous and/or contaminated atmospheres from confined spaces. Ventilation Specialists might also perform other activities if they are competent or qualified and are assigned in accordance with the applicable confined space program and Chapter 9.

11.9.2 Ventilation Specialist Duties and Responsibilities.

11.9.2.1 Ventilation Specialists should be familiar with acceptable ventilation methods and procedures and ensure that the specific procedures or methods to be used have been reviewed and approved in accordance with Chapter 9.

11.9.2.2 At the confined space planning meeting or prior to permit issuance, Ventilation Specialists should review and understand the potential hazards associated with the use of ventilation methods, including dilution, inerting, and purging, in order to determine the appropriate method to be used to provide a safe atmosphere within the space for entry and work.

11.9.2.3* Ventilation Specialists should be aware of the hazards associated with infrequently used ventilation procedures and the risks of using inert gases, pure oxygen, chemicals, or steam and that such use should be approved by the Entry Supervisor and comply with applicable regulatory requirements and industry practices.

11.9.2.4 Ventilation Specialists should ensure that if the exhausted atmosphere might be combustible or flammable, ignition sources in and around confined spaces have been eliminated, mitigated, or controlled prior to ventilation.

11.9.2.5 Ventilation Specialists should ensure that adequately sized openings are provided for both clean-air intake and contaminated atmosphere exhaust and that the air supply and exhaust points are separated as far apart as possible.

11.9.2.6 Ventilation Specialists should ensure that air introduced into a confined space is from a clean (uncontaminated) source.

11.9.2.7* Ventilation Specialists should ensure that the hazardous atmosphere is properly exhausted and does not enter or accumulate in unapproved areas. Hazardous atmospheres can also be captured and treated where required by the Owner/Operator or applicable regulations. Ventilation Specialists should ensure that ventilation is conducted in accordance with the applicable confined space program, permits, industry standards, and regulatory requirements.

11.9.2.8 Ventilation Specialists should modify ventilation procedures or use appropriate alternatives as necessary to maintain acceptable atmospheric exposure levels in accordance with permit requirements during entry or hot or cold work.

Δ **11.9.2.9** Ventilation Specialists should be familiar with potential atmospheric contaminants, including, but not limited to, liquids, sludge and residue, vapors, gases, welding fumes, and dusts, and familiar with those areas within confined spaces where contaminants may collect, including, but not limited to, sumps, piping, under flooring, between walls, in high or low places (depending on the characteristics of the materials), and less visible or less accessible areas where contaminants are at risk of remaining following cleaning or other routine confined space activities. Where there is a need to enter the confined space to determine the existence of any contaminants, the Ventilation Specialist should have an entry permit and should qualify and meet the same requirements as an Entrant.

11.9.2.10* Ventilation Specialists should ensure that ventilation air streams do not compromise the accuracy of continuous or periodic air test results.

11.9.2.11 Ventilation Specialists should provide ventilation in accordance with the entry permit and for as long as deemed necessary by the Entry Supervisor, Gas Tester, or Entrants.

11.9.2.12 Ventilation Specialists should be able to coordinate and communicate ventilation and atmospheric testing activities with the Gas Tester as directed by the Entry Supervisor.

11.9.3 Ventilation Specialist Qualifications.

11.9.3.1 Ventilation Specialists should be familiar with the confined space program, industry practices, and governmental regulations that pertain to ventilation operations including, but not limited to, oxygen levels, flammable and toxic atmospheric levels, and required air changes per hour (ACH).

11.9.3.2 Ventilation Specialists should be familiar with the use, limitations, and hazards of materials, substances, and equipment approved for use both inside and outside the specific confined space, including, but not limited to, fans, eductors, tubing, hoses, vapor collection equipment, PPE, gas monitors, inert gases, flue gas, steam, water, fuel oil, and chemicals.

11.9.3.3 Ventilation Specialists should know and understand the hazards inside and outside the specific confined space associated with ventilation operations.

11.9.3.4 Ventilation Specialists should know and understand the applicable confined space and permit program, industry practices, and regulatory requirements applicable to ventilation and be able to apply ventilation techniques appropriate to the specific hazards and confined space.

11.9.4 Ventilation Specialist Demonstrated Competencies.

11.9.4.1 Ventilation Specialists should be able to read, understand, and communicate permit requirements to the Entry Supervisor.

11.9.4.2 Ventilation Specialists should be able to appropriately select, inspect, maintain, test, and use required ventilation equipment and PPE.

11.9.4.3 Ventilation Specialists should be able to understand, identify, assess, interpret, and apply information provided by gas monitors in order to provide appropriate ventilation of the space.

11.9.4.4 Ventilation Specialists should be able to communicate and take appropriate action, including, but not limited to, stopping or maintaining ventilation as directed by the Entry Supervisor when evacuation is required.

11.9.4.5 Ventilation Specialists should be able to complete assigned tasks in an approved manner in accordance with the confined space program and permit requirements, the Entry Supervisor's directions, facility and regulatory requirements, and industry practices.

Δ **11.9.4.6** Ventilation Specialists should be able to determine appropriate ventilation flow rates in accordance with the entry permit and regulatory requirements, including the appropriate number of air changes needed per hour, where applicable.

11.10 Isolation Specialist.

11.10.1* General.

N **11.10.1.1** Isolation is the process of removing a confined space from service and completely protecting the space from the unwanted release of energy, liquids, gases, chemicals, and other materials into the space through fixed or temporary connections to the space, as well as disconnecting and de-energizing potentially hazardous machinery and equipment within or attached to the space. Isolation may be permanent or temporary.

N **11.10.1.2** Isolation operations should be performed by Isolation Specialists who should be trained, educated, or qualified and competent to perform required isolation duties.

N **11.10.1.3** Isolation Specialists should be assigned and authorized by the Owner/Operator or Contractors, as appropriate, in accordance with the requirements of the applicable permits, isolation program, or the lockout/tagout program and the confined space program. At the conclusion of confined space operations, Isolation Specialists should be able to restore the space to pre-isolation conditions.

11.10.2 Isolation Specialist Duties and Responsibilities.

11.10.2.1 Isolation Specialists should comply with the applicable lockout/tagout or isolation program and be authorized by the Owners/Operators or Contractors to operate, install, and apply the applicable energy control devices or other isolation equipment, materials, and procedures.

11.10.2.2 Isolation Specialists should inspect and determine that equipment or devices to be used for isolation are approved, in acceptable condition, and appropriate for the task prior to their use.

11.10.2.3 Isolation Specialists should notify authorized personnel, including, but not limited to, Owners/Operators, Contractors, and Entry Supervisors, when the isolation control measures are either applied or removed as required by the applicable isolation program and permits.

11.10.2.4 Isolation Specialists should determine if stored energy is a potential issue and, if so, eliminate, mitigate, or control the hazard.

Δ **11.10.2.5** Isolation Specialists should be able to properly apply and sequence isolation and energy control procedures, both when isolating and when de-isolating the confined space.

11.10.2.6 Isolation Specialists should notify and verify to the Owner/Operator, Contractor, or Entry Supervisor that relevant energy and other hazardous sources have been properly isolated prior to the issuance of permits for work in or around equipment or spaces that need to be isolated.

11.10.2.7 Isolation Specialists should develop an isolation checklist relevant to the confined space and ensure that it is available to Owners/Operators, Contractors, and Entry Supervisors.

11.10.2.8 Isolation Specialists, as well as other authorized individuals, should use methods and procedures approved by the applicable confined space or isolation program when temporarily removing lockout/tagout devices.

11.10.2.9 At the conclusion of the work, Isolation Specialists should take appropriate safeguards, using the isolation checklist for verification purposes, when de-isolating the space in preparation for returning it to service.

11.10.3 Isolation Specialist Qualifications.

11.10.3.1 Isolation Specialists should understand and comply with the requirements of confined space, isolation (lockout/tagout), and permit programs, industry procedures and practices, and governmental regulations that pertain to isolation.

11.10.3.2 Isolation Specialists should know and be able to communicate to Owners/Operators and Contractors the operation, limitations, and hazards associated with the methods and materials, substances, and equipment approved for use for isolating the specific confined space.

11.10.3.3 Isolation Specialists should know and be able to communicate to Owners/Operators, Contractors, and Entry Supervisors the hazards inside and outside the specific confined space associated with isolation operations.

11.10.3.4 Isolation Specialists should know and be able to communicate to Owners/Operators, Contractors, and Entry Supervisors the isolation techniques appropriate to the specific hazards and confined space, including accepted industry practices and procedures and applicable regulatory requirements.

11.10.3.5 Isolation Specialists should understand the application or operation of and be authorized to work with the applicable energy control and other isolation equipment and devices and be able to comply with isolation program procedures and requirements.

11.10.4 Isolation Specialist Demonstrated Competencies.

11.10.4.1 Isolation Specialists should understand all applicable requirements of the confined space entry permits and work permits.

11.10.4.2 Isolation Specialists should be able to identify and evaluate specific isolation needs associated with the confined space entry and proposed work and be able to select approved equipment and methods required to properly isolate the space.

11.10.4.3 Isolation Specialists should be able to communicate with Owners/Operators, Contractors, and Entry Supervisors as required and appropriate. Communication may take place during planning sessions or pre-entry safety meetings and should include reviewing and verifying the isolation checklist.

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11.10.4.4 Isolation Specialists should have the knowledge and experience to understand isolation needs and be able to select and apply appropriate and approved isolation devices, equipment, and methods in accordance with the applicable isolation program and other requirements.

11.11 Standby Worker.

11.11.1* General. Standby Workers are individuals assigned to stay outside the confined space and conduct confined space–related operations, as assigned by the Entry Supervisor, that do not involve duties assigned specifically to Entrants, Gas Testers, Rescuers, Entry Supervisors, Attendants, Isolation Specialists, or Ventilation Specialists. Standby Workers may be assigned other duties, such as relief for Attendants, only if they are appropriately trained and qualified.

11.11.2 Standby Worker Duties and Responsibilities.

11.11.2.1 Standby Workers should work in a safe manner around the confined space area.

11.11.2.2 Standby Workers should be familiar with the hazards in and around the confined space and use appropriate PPE as needed for assigned duties and exposures or as required by a work permit.

11.11.2.3 Standby Workers should follow directions from the confined space Entry Supervisor regarding tasks to be performed.

11.11.2.4 Standby Workers assigned to monitor supplied air systems should not have any other duties that distract from the monitoring and should adhere to the guidelines given in 11.11.2.4.1 through 11.11.2.4.4.

11.11.2.4.1 Standby Workers should maintain air supply cylinders in a secured and upright position, properly switch cylinders as required to provide a constant air supply, and ensure that the cylinders are protected against damage. If cylinders are to be changed and a quick bypass to another cylinder is not available, the Entrant on the air supply will vacate the space until the breathing air cylinder is changed.

11.11.2.4.2 Standby Workers should ensure that breathing air supply lines, hoses, and couplings are maintained in a safe, uninterrupted manner so as to not interfere with air supply and are not used for supplying anything other than breathing air.

Δ **11.11.2.4.3** Standby Workers should ensure that the compressors and/or air pumps (used in lieu of cylinders) are located in an area where the intake air supply is suitable for breathing and free of contaminants. If the intake air becomes or has the potential to become contaminated, Standby Workers should ensure that Attendants are immediately notified to have Entrants vacate the space and that Entry Supervisors are notified so they can cancel the entry permit.

11.11.2.4.4 Standby Workers should immediately notify Attendants and the Entry Supervisor in the event of air supply failure, contamination, or disruption so that Entrants can be directed to switch to emergency bottled air and leave the space. Where Standby Workers also are assigned or acting as Attendants, they should communicate this information to the Entrants.

11.11.2.5 Standby Workers should have an understanding of the emergency response plans established by the Owner/Operator or Contractor and know what to do during an emergency.

Δ **11.11.2.6** Standby Workers conducting cleaning, disposal, or hot and/or cold work operations around the confined space should be able to perform these activities in accordance with the confined space program and issued permit requirements.

Unless it has been determined that the space is not a confined space, Standby Workers conducting hot or cold work operations or other duties inside the space should be trained, qualified, and equipped as Entrants.

11.11.3 Standby Worker Qualifications.

11.11.3.1 Standby Workers should know and comply with the requirements of the specific confined space program; hot work program; applicable permits; Owner/Operator, Contractor, and industry safe work practices; and procedures and governmental regulations that pertain to work assignments.

11.11.3.2 Standby Workers should understand and be able to communicate to the Entry Supervisor the use, limitations, and hazards of materials, substances, and equipment approved for use in assigned duties.

11.11.3.3 Standby Workers should know and be able to communicate to the Entry Supervisor the hazards inside and outside the specific confined space associated with Standby Workers' assigned duties.

11.11.3.4 Standby Workers should know and be able to communicate to the Entry Supervisor the safe work procedures and practices appropriate to the specific internal and external confined space hazards and the Standby Workers' assigned duties.

11.11.4 Standby Worker Demonstrated Competencies.

Δ **11.11.4.1** Standby Workers should be able to understand and comply with the requirements of applicable permits, including, but not limited to, permits covering entry, hot and cold work, and any other activity assigned to Standby Workers.

11.11.4.2 Standby Workers should be able to properly use required PPE and equipment needed to perform their duties.

11.11.4.3 Standby Workers should be able to communicate with all personnel engaged in confined space operations.

11.11.4.4 Standby Workers should be qualified and able to perform assigned tasks.

11.12 Training.

11.12.1 General. All confined space personnel should be trained, educated, and/or qualified as required by the applicable written confined space program and regulatory requirements. Training should include, but not be limited to, the following:

(1) General and specific duties and responsibilities for assigned work
(2) Equipment, tools, PPE, respiratory protection, and monitoring instruments to be used for assigned work
(3) Type and identification of confined space to be entered; configuration; structure; obstruction; means of entry and exit; and materials or substances within, around, or introduced into the space
(4) Atmospheric, physical, and chemical (toxic) hazard awareness, including, but not limited to, the identification, elimination, mitigation, protection, and control measures applicable to the proposed entry, potential exposures, and work
(5) Certification, registration, or licensing where required
(6) The physiological and psychological stresses associated with the specific confined space, the anticipated hazard exposures, and the assigned tasks

11.12.1.1 Sources of training or education include, but are not limited to, the following:

(1) On-the-job (apprentice) training or experience
(2) Company sponsored training or education (internal or external)
(3) Job-required regulatory training or education, including, but not limited to, respiratory protection, hot work, and lockout/tagout, as applicable to duties and assignments
(4) Government, regulatory, private, and labor organization training or education programs, such as NFPA or OSHA online or on-site courses

11.12.2 Retraining.

11.12.2.1 All confined space personnel should be retrained, re-educated, or requalified as required by the confined space program or regulations.

11.12.2.2 All confined space personnel should be retrained, re-educated, or requalified when new duties and responsibilities are assigned.

11.12.2.3 All confined space personnel should be retrained, re-educated, or requalified when new equipment, types of space, or materials are introduced.

11.12.2.4 All confined space personnel should be retrained, re-educated, or requalified when work deficiencies are observed.

11.12.2.5 All confined space personnel should be retrained, re-educated, or requalified when certification requires renewal.

11.12.2.6 All confined space personnel should be retrained, re-educated, or requalified when regulatory requirements change or the confined space program is revised.

Δ **11.12.2.7** All confined space personnel should be retrained, re-educated, or requalified in the proper use of tools and equipment — including, but not limited to, PPE, respiratory protection, and monitoring instruments — in accordance with the manufacturers' instructions and industry practices whenever new tools or equipment are introduced or whenever changes occur in existing tools or equipment.

Chapter 12 Written Confined Space Program

12.1 Purpose. The purpose of the written program is to enable the Owner/Operator, Contractor, or Entrant Employers to establish practices and procedures to provide safe and healthy work environments for their employees where working in confined spaces.

Δ **12.1.1 General.** Before confined space operations begin and workers enter the confined space for any reason, the Owner/Operator, Contractor, or Entrant Employer should develop and implement a written confined space program. The program should be made available to all employees and/or their representatives and should include, but not be limited to, the following:

(1) Program responsibilities
(2) Identification and evaluation of confined spaces
(3) Identification of personnel involved in the confined space entry, including rescue
(4) SOP such as isolation, control of ignition sources, illumination, atmospheric monitoring, and ventilation

(5) Entry permits and other work-related permits and work orders
(6) Other facility safety permits and procedures
(7) Emergency communications and rescue procedures
(8) Training
(9) Resources
(10) Program auditing and change process
(11) Medical qualifications
(12) Regulatory, industry, and other best practices

N **12.1.2 Policy for Contractors.** A contractor-specific written confined space policy should be developed for those worksites where Contractors enter a space. The policy should explain the following:

(a) How the Owner/Operator or employer verifies Contractors are qualified
(b) How hazards within and around the spaces are communicated to Contractors
(c) How relevant safety information is communicated to Contractors
(d) How Contractors are debriefed after entry is completed

12.2 Responsible Person and Responsibilities. There should be one person assigned as the program administrator for the company's or facility's confined space entry program. This person can be the Owner/Operator, Contractor, Entrant Employer, or other qualified individual assigned by the Owner/Operator, Contractor or Entrant Employer. This individual should be identified in the written confined space program. The program should also establish the roles and responsibilities of all individual positions involved in confined space entries. As a minimum, the name of the program administrator should be listed along with a list of authorized Entrants, Attendants, and Entry Supervisors in a separate document, which should be reviewed and updated as needed. Roles such as Gas Tester, Ventilation Specialist, Isolation Specialist, and Standby Worker should be assigned. Responsibilities for applicable programs such as hot/cold work, lockout/tagout, respiratory protection, PPE, and rescue should also be identified in the confined space entry program. Other individuals, if needed, can be assigned by the Entry Supervisor. Chapter 11 provides a list of roles and required training.

Δ **12.2.1 Program Development Responsibility.** A written confined space entry program should be developed and maintained by the Owner/Operator, Contractor, or Entrant Employer for every workplace in which confined space entries will occur. The program should comply with all applicable regulatory requirements and industry standards and practices. Where a conflict may exist between Owner/Operator, Contractor, and Entrant Employer programs, the pre-job evaluation should identify which requirement applies, otherwise the stricter or more restrictive of the requirements would be applicable.

12.2.2 Employee Involvement. Employers should ensure that employees who perform confined space operations, and/or their authorized representatives, are involved in the development and implementation of the written confined space program and the observation of program elements such as atmospheric monitoring.

12.2.3 Written Program Access. Employers should provide all employees and/or their authorized representatives, as well as any contractors performing confined space operations, a copy of or instruction on how to access the facility's written confined space entry program.

12.2.4 Roles and Responsibilities. The written confined space program should establish the roles and responsibilities of all individuals involved in confined space operations. As a minimum, the confined space program administrator should be identified as the person responsible for managing the program. Chapter 11 provides a list of roles and required training.

Δ **12.3 Reporting Unsafe Conditions.** The written confined space program should state that all management and employees should follow all confined space program policies and related safety procedures. The program should also require that anyone involved in confined space entry operations who feels that an unsafe condition exists has the authority to immediately stop work and report their concerns to the Attendant or Entry Supervisor. Entrants should leave and/or not enter the space until the concern is addressed.

12.4 Periodic Review. The written confined space program should be reviewed at least annually by the Owner/Operator, Contractor, or Entrant Employer and the workers involved in the confined space operations to determine if the program is effective in providing safe operations for confined space entries. Additionally, if a change occurs that affects the confined space — such as a change in configuration, contents, or operations — the program should be reviewed and revised prior to the next entry.

12.4.1 If a confined space–related near-miss, injury, accident, or equipment failure occurs, the confined space program should be reviewed and, if necessary, modified to address any deficiencies prior to permitting subsequent entries.

12.4.2 The written confined space program should be approved, signed, and dated by appropriate management as designated in the program.

12.5* Identification of Confined Spaces. Prior to employees entering a confined space(s), Owners/Operators or Entrant Employers should conduct a hazard safety analysis audit of the space(s) in accordance with Chapter 4. The recognized inherent and adjacent hazards should be documented, including the most probable hazards that can be introduced based on work likely to be performed in the space(s).

12.6 Program Procedures. The written confined space program should describe the procedures used to evaluate confined space hazards and identify acceptable entry conditions. Entry Supervisors should use the criteria listed in Chapters 6 and 7 to identify and evaluate hazards and the procedures listed in Chapters 7 and 8 to eliminate, mitigate, or control the hazards.

12.7 Atmospheric Monitoring. The written confined space program should specify the gas monitor(s) and other atmospheric testing instrumentation and procedures to be used for confined space operations, including information addressing inspection, maintenance and repair, calibration, calibration frequency, bump testing, and limitations of atmospheric instrumentation.

Δ **12.7.1*** The written confined space program should specify atmospheric conditions that allow or prohibit entry.

Δ **12.7.2** The written confined space program should specify when and how atmospheric monitoring is conducted.

12.7.3 The written confined space program should specify who is responsible for inspection, maintenance, repair, calibration, daily accuracy test (bump test), selection, and assignment of atmospheric monitoring equipment.

Δ **12.7.4** The written confined space program should specify who is responsible for maintaining atmospheric monitor instructions and manuals, instrument history, and calibration records, as well as where and for how long they are maintained and who has access to them.

Δ **12.8 Ventilation.** The written confined space program should contain information about the selection, use, and maintenance of mechanical ventilation equipment for confined space entry and who is responsible for determining ventilation requirements.

Δ **12.8.1** The written confined space program should specify when and how mechanical ventilation will be used in confined spaces.

12.8.2 The written confined space program should specify if additional or special mechanical ventilation may be required for particular tasks, such as welding or using flammable solvents.

12.9 Rescue. The written confined space program should state that all rescue provisions should be identified prior to entry and during work site analysis in accordance with Chapter 10. The program should also make clear that the Rescue Service is responsible for all rescue operations. It should state that wherever possible, all confined space entries should be done with Entrants wearing a full-body harness attached to either a mechanical retrieval device or to a fixed object outside the space. Personal fall arrest may be necessary depending on the configuration of the confined space relative to entry operations. While self-rescue and non-entry rescue are always a consideration, they might not always be possible. Therefore, a comprehensive emergency rescue response should be developed.

12.9.1 The written confined space program should designate the person(s) responsible for maintaining and inspecting the mechanical retrieval, personal fall arrest, and rescue equipment. The program should state that all equipment must be inspected prior to use, regardless of how frequently it is otherwise inspected.

12.9.2 The Owner/Operator or Entrant Employer should indicate the type of personal fall arrest equipment that will be used during entries.

12.10 Personal Protective Equipment (PPE). The written confined space program should indicate the person(s) responsible for the selection, inspection, and repair and maintenance of PPE and for cross-referencing the program against other PPE policies, such as the respiratory protection program, the facility's PPE policies or procedures, industry standards, practices, and government regulations.

12.11 Isolation Program (Lockout/Tagout). If there is an energy source that can create a hazard in or around the confined space during entry operations, then the written confined space program should identify an Isolation Specialist to address the situation. *(See Chapter 8.)* Additional information can be obtained by cross-referencing the employer's isolation program.

Δ **12.12 Hot/Cold Work.** The written confined space program should reference all facility hot/cold work policies.

12.13 Permits. The written confined space program should include the facility's confined space entry permit. *(See Chapter 13.)*

12.14 Training. The written confined space program should include information on required training and the person(s) responsible for ensuring that all employees receive the proper training required by their job assignment.

12.14.1 Generic training materials can be used for initial training; however, the written confined space program should indicate that all workers should be trained on the worksite's specific confined space hazards, procedures, and equipment before they are authorized to perform any confined space program function.

12.14.2 The written confined space program should indicate the person(s) responsible for maintaining training records.

Δ **12.14.3*** The written confined space program should indicate any and all retraining requirements, which should detail when, under what circumstances, and which workers engaged in confined space operations should comply according to regulatory, industrial, and Owner/Operator or employer policies and following the guidance provided in Chapter 11.

12.15 Recordkeeping. The written confined space program should indicate the person(s) responsible for maintaining confined space program records, including cancelled permits. All permits should be maintained for a period of at least 1 year. *(See Chapter 14.)*

Δ **12.16 Contractors.** The written confined space program should provide a means to inform those working at the worksite of all hazards and potential hazards within and around all confined spaces where they are working. If a joint operation or entry is to be conducted, the applicable permits should detail operations management control responsible for the entry. Employers should ensure that the program details how Contractors/Subcontractors are debriefed after confined space operations and entries, how the debriefing should be documented, and who is responsible for the debriefing. The program should also indicate that if applicable procedures are not followed, the Contractor/Subcontractor can be subject to discipline, including work stoppage and/or removal from the facility.

Δ **12.17 Reporting of Accidents or Near Misses.** The written confined space program should indicate to whom all accidents or near misses, including failures of retrieval systems, ventilation systems, and the activation of atmospheric monitor alarms, should be reported. The facility's incident investigation procedure should be cross-referenced and followed.

Δ **12.18* General Fitness for Duty Evaluation.** The written confined space program should include evaluation criteria for the physical and mental capabilities of personnel assigned to work in confined space operations. The program should consider all actual and potential hazards and operations. The program can reference industry and regulatory medical evaluation procedures, including, but not limited to, respiratory protection capability, exposure determinations, and physiological and psychological stresses that might be present during confined space entries. Physiological and psychological stresses can include climbing ladders, heat stress, and claustrophobia.

Records should be maintained in accordance with applicable regulations and workplace record retention policies.

Chapter 13 Pre-Entry Evaluation and Entry Permit

13.1* General. The Entry Supervisor should perform a pre-entry evaluation immediately prior to all entries into a confined space. If hazards or potential hazards are identified that cannot be eliminated, mitigated, or controlled prior to entry, then the Entry Supervisor should not issue a permit.

13.1.1 The permit should be displayed at the confined space location. Permits should be marked as cancelled after the time allowed on the permit has expired, the work is completed, or a change in conditions requires cancellation and a new or reissued permit.

13.1.2 Cancelled permits should be retained for at least 1 year and should be made available for Entry Supervisors to review prior to entering a confined space.

13.1.3 Permits should be limited to one shift. If work activity exceeds one shift, the permit should be reissued. In addition, permits should be considered cancelled if personnel or conditions change.

Δ **13.2 Pre-Entry Evaluation and Permit Elements.** A pre-entry evaluation and permit should be developed or adopted to meet the needs of the work activities of the Owner/Operator or Entrant Employer. The evaluation and permit can be a single form or two separate forms. Subsections 13.2.1 through 13.2.11 detail elements of each form, how they should be used, and why they are important. Each element can be modified to meet job task requirements and/or the responsible party's confined space and other applicable program management requirements. Each element of the permit has an in-depth section that the Owner/Operator, Entrant Employer, Entry Supervisor, Attendant, and Entrant should be familiar with and should address, as required under the training program. At minimum, the elements listed in 13.2.1 through 13.2.11 should be addressed on the Owner's/Operator's or Entrant Employer's pre-entry evaluation/permit. An example of a combination pre-entry evaluation/permit is provided in Figure B.1.

Δ **13.2.1 Confined Space Identification.** The confined space should be clearly identified on the permit and include the following:

(1) *Location.* The location of the confined space should be as precise as possible and include, if necessary, the address of the location, street or crossroads near the site, building location and/or number, room or space number, assigned facility equipment or confined space identification number, or global positioning system (GPS) coordinates. If there is a space similar to the one on the permit, additional information should be added to the permit to ensure the correct space is identified by all personnel.
(2) *Description.* A detailed description of the space can assist personnel in correctly identifying the confined space. For example, a description might include the type of space (e.g., tank, silo, vault), its function (e.g., fuel oil waste, grain hopper), and/or its physical attributes (e.g., type of material, color, size, shape).

13.2.2 Work Activities. The work activities to be performed in the confined space should be clearly identified on the permit and include the following:

(1) *Time.* The permit should indicate the date(s) and time(s) the permit is valid. Permits are void once the permit date(s)/time(s) have expired.
(2) *Work.* The permit should outline the specific work to be conducted in the space. If there is a change in the scope of work or its location, work should stop until it is evaluated if a new permit needs to be issued. Work not identified on the permit should not be done without the approval of the Entry Supervisor and might require a new permit.

13.2.3 Pre-Entry Evaluation. All confined spaces should have a pre-entry evaluation. The intent of this evaluation is to make sure the confined space is examined before any work activity begins to confirm both existing and potential hazardous conditions do not inherently exist within or adjacent to the confined space and that the potential for hazardous conditions to arise during confined space operations is considered. The Entry Supervisor should sign off on the evaluation. If no hazardous conditions exist, work can proceed. If any hazards do exist, the Entry Supervisor should complete the permit indicating the appropriate elimination, mitigation, and control measures to be implemented to ensure safe entry.

13.2.4 Hazard Identification. The Entry Supervisor should identify all actual and potential hazards on the permit and indicate methods to eliminate, mitigate, or control the hazards to reduce risk to an acceptable level. The Entry Supervisor should ensure personnel are informed about all hazards in and around the space, including inherent hazards, introduced hazards, and adjacent hazards.

13.2.4.1 Inherent Hazards. Inherent hazards include, but are not limited to, the design, structure, configuration, size, and physical condition of the space, as well as any equipment within the space. *(See Chapter 6.)* It might not be possible to eliminate, mitigate, or control these hazards, but measures can be taken to assess their risks and take precautions. For example, where a steep ladder is needed to enter a fuel tank, the ladder's configuration is not changeable — but the way in which supplies are brought into the space can be altered. The worker does not have to carry supplies down the ladder; instead, they can be lowered down.

13.2.4.2 Introduced Hazards. Introduced hazards are typically brought into the space by workers or because of the work process. The introduction of materials, personnel, and work processes should be evaluated carefully to ensure that they do not create a hazardous condition. These are hazards that can be eliminated, mitigated, or controlled, making them a key element in a risk assessment. An example of an introduced hazard is the materials brought into a space to clean, such as solvents used to clean a tank, which can create a hazardous level atmosphere. The condition of the space can be altered by the work process, for example, where workers disturb settled materials, such as fish processing or other biological waste. The disruption of the materials can allow trapped levels of hydrogen sulfide gas to be released, which can create a hazardous atmosphere.

13.2.4.3 Adjacent Hazards. Adjacent hazards are not in the confined space but are in close proximity and can impact operations in the space by entering through openings or other means. Examples of adjacent hazards include, but are not limited to, toxic smoke from a nearby fire or hot work, flammable vapors from a spill or release outside the space, and introduction of a hazard through a common wall with an adjacent space where work is in progress. Entry Supervisors should recognize that adjacent hazards exist, or can potentially exist; should recognize and inspect the surrounding area; and should provide safeguards to eliminate, mitigate, or control all adjacent hazards.

Δ **13.2.4.4 Hazard Control.** The Entry Supervisor should identify all hazards and provide requirements to eliminate, mitigate, or control them on the permit. *(See Chapter 8.)* Where hazards are inherent, they should be recognized and measures should be developed to reduce worker risk. Controls should be clearly outlined on the permit and include such measures as outlined in 13.2.4.4.1 through 13.2.4.4.5.

13.2.4.4.1 Atmospheric Monitoring. The Entry Supervisor should understand and include atmospheric monitoring requirements on the permits for applicable hazardous conditions, which include, but are not limited to, oxygen-deficient, oxygen-enriched, flammable or explosive, toxic, irritant/corrosive, or asphyxiating atmospheres. Atmospheric monitoring might be required intermittently or continuously. The frequency of monitoring depends on the work being performed and other potential introduced or adjacent hazards that could alter the atmospheric conditions in and around the confined space. The permit should detail what atmospheric monitoring should be done, by whom, and at what levels personnel should exit the space.

13.2.4.4.2 Atmospheric Ventilation. The Entry Supervisor should understand ventilation methods and requirements. The Entry Supervisor should verify that ventilating a confined space with fresh air before and during confined space work can reduce or remove atmospheric contaminants. Ventilation, especially during warmer months, can also provide relief from thermal stress. The permit should outline what ventilation should be used prior to and during entry. If ventilation will block access into or out of the space, the permit should outline procedures to ensure worker safety during operations. In situations where ventilation is not a feasible means of making a space safe for entry due to flammability issues, other control methods must be used. Chapters 8 and 9 provide information on hazard control.

Δ **13.2.4.4.3 Personal Protective Equipment (PPE).** The permit should address Entrant and Attendant PPE requirements for specific work, such as entry into inert atmospheres, cleaning, or painting.

13.2.4.4.4 Other Permits. All additional permits needed for work to be performed in and around a confined space should be listed on the entry permit.

13.2.4.4.5 Grounding and Bonding. If the confined space or the ventilation or equipment brought into the space need to be grounded or bonded, then that information should be indicated on the permit as a control.

13.2.5 Communications. The Entry Supervisor should select and indicate on the permit the appropriate methods of communication, and should document how communication will be maintained, as follows:

(1) *Verbal.* Acceptable if line of sight is maintained
(2) *Radio.* Permit to indicate test intervals
(3) *Rescue request.* Permit to indicate how rescue team will be notified

13.2.6* Rescue. Confined space rescue methods should be understood before entry into a confined space. Regardless of whether a confined space has hazards or not, the Owner/Operator or Entrant Employer should ensure rescue is available and appropriate to the space and operations. All confined spaces should have a rescue incident action plan, that describes how rescue will be attempted. The incident action plan should be available to Entry Supervisors, Attendants, and Entrants. The incident action plan should be attached to the entry permit. Where an emergency response team is required by the incident action plan, the team should be notified of applicable confined entries, including their location, hazards, and duration. The following are the four types of rescue:

(1) *Self-rescue.* Rescue before needing assistance. The Entrants(or Attendants) identify a prohibited or dangerous condition and exit under their own power. Self-rescue should not be included in a permit.
(2) *Attendant Rescue.* The Attendant assists the Entrant to vacate the space. The Attendant may activate and use a rescue system (outside the confined space).
(3) *Entry Rescue.* Includes the following:
    (a) *Rescue available.* There is a Rescue Service that has been identified and evaluated, and is able to respond in a timely manner should there be a need.
    (b) *Rescue standby.* A Rescue Service is standing by the confined space, ready and equipped to make immediate entry.

Δ **13.2.7 Entrants.** The Entrant's name should be printed on the entry permit. The Entrant should sign the entry permit, indicating that they have been trained in confined space entry and have reviewed all the hazards associated with the permit-specific entry, including which condition changes would require their immediate evacuation. For multiple Entrants, a sign-in sheet can be attached to the permit.

Δ **13.2.8 Attendant.** The Attendant's name should be printed on the entry permit. The Attendant should sign the entry permit, indicating that they have been trained in confined space entry and have reviewed all the hazards associated with the permit-specific entry. The Attendant must be aware of all potential hazards in the confined space, including possible behavioral effects related to hazard exposure. An Attendant must remain in constant contact with the Entrant until relieved by another Attendant, maintain communication with the Entrant, monitor activities, and order evacuations where needed. The Attendant also performs non-entry rescue or summons a rescue team, if necessary, and cannot perform any other duty that might interfere with the primary duty of ensuring the safety of the Entrant. If the work or hazards change from what is stated on the permit, the Attendant should order Entrants to vacate.

13.2.9 Entry Supervisor. The Entry Supervisor is responsible for all aspects of the entry and issuance of the entry permit. The Entry Supervisor should sign the permit, indicating that they have been trained in confined space entry and have reviewed all the hazards associated with the permit-specific entry. They must be aware of all potential hazards in each space and the SOP and equipment required for each entry. If a space has been evacuated due to a change in conditions, the Entry Supervisor should re-evaluate the space and issue a new permit.

13.2.10 Cancel Permit. Each permit should have an area on the permit to mark the permit as cancelled. A permit can be cancelled at the end of the work activity by the Attendant or

Entrant, or at any time by the Attendant, Entrant, Entry Supervisor, or safety professional because of hazards. The reason the permit was cancelled (e.g., work was completed, conditions changed) should be documented on the permit.

13.2.11 Rescue and Emergency Contact. The entry permit should indicate emergency rescue and contact information.

13.3 Reclassification and Alternate Procedures. A modified permit that includes the alternate procedures and reclassification option is provided in Figure B.2.

Chapter 14 Recordkeeping

14.1 Purpose. The purpose of this chapter is to assist Owners/Operators or Entrant Employers with confined spaces and/or established confined space programs in assessing their record-keeping needs and establishing a records retention program.

14.1.1 General. All records required by or associated with a confined space program — including, but not limited to, pre-entry evaluations, all entry permits, other associated permits, atmospheric monitoring instrument calibration, employee exposure test results, and any additional documents deemed necessary by the confined space program — should be maintained by the Owner/Operator or Entrant Employer for a minimum of 1 year to allow for an annual review of the program. Where required by regulations or employer policy, records shall be maintained for the established period.

14.2 Employer Site Records.

14.2.1 Documented evaluation and classification for each confined space should be maintained for the duration of occupancy or until permanently eliminated.

14.2.2 Owners/Operators or Entrant Employers should conduct annual reviews of programs, permits, and other records associated with confined space activities for continued compliance and effectiveness. Record maintenance and retention requirements should be updated as needed. Corrective action taken as a result of program review should be documented and maintained for a period of 1 year from the date of the review or longer, as required by company policy or regulations.

14.2.3 Owners/Operators or Entrant Employers should inspect, test, and maintain confined space monitoring and calibration equipment, PPE and respiratory protection equipment, breathing air supply and ventilation equipment as required by their respective programs, industry practices, and applicable regulations. Inspection, testing, and maintenance records should be maintained for a minimum of 1 year following the activity, or longer if required by company policy or regulations.

14.3 Employee Records.

14.3.1 Owners/Operators or Entrant Employers should implement programs to retain and maintain employee training, retraining, education, certification, competency, and qualification documentation for the duration of employment or longer, as required by company policy, industry practices, or regulations.

14.3.2 Owners/Operators or Entrant Employers should develop and maintain an up-to-date roster of workers trained, educated, qualified, and authorized to participate in specific confined space operations as part of the confined space program. *(See Section 5.8.)*

14.3.3 Owners/Operators or Entrant Employers should maintain employee confined space medical evaluation–related documents for 30 years past the last employment date of an employee in conjunction with the confined space program, industry practices, or regulations.

Chapter 15 Management of Change (MOC)

15.1 Purpose.

N **15.1.1** This chapter provides information for establishing a management of change (MOC) system for confined space operations. Its purpose is to establish and implement procedures needed to provide for continuous safe operating conditions and work practices whenever change or modifications — other than changes in kind — occur, including, but not limited to, the following:

(1) In confined space classification, configuration, equipment, materials, content, scope of work, operating procedures, processes, or personnel
(2) To Owner/Operator and Contractor confined space programs
(3) To other applicable programs, industry practices, or regulatory requirements

N **15.1.2** Owners/Operators should conduct MOC reviews whenever permanent or temporary changes impact upon confined spaces in their facilities.

15.2 Responsibilities and Communication for Implementing MOC. For an MOC system to function effectively, confined space Owners/Operators or Entrant Employers and their personnel — including, but not limited to, Operations Personnel, Entrants, Attendants, Entry Supervisors, and Rescuers — should be able to recognize confined space–related deviations and changes that are significant enough to trigger an MOC review. Once a deviation or change triggers an MOC review, facility Owners/Operators or Entrant Employers should assign qualified personnel and resources to determine what changes, if any, are needed in the confined space program and hazard control measures. Owners/Operators and Entrant Employers should then implement the changes in their programs and procedures to ensure confined space operations are conducted safely.

15.3 MOC Process and Activation. The MOC process should be developed, implemented, communicated, and documented to ensure that changes and deviations affecting confined spaces have been reviewed and authorized. The MOC process should ensure that changes to equipment, processes, personnel, procedures, or materials affecting confined spaces are properly reviewed against the original confined space hazard assessment and that hazard elimination, mitigation, and control measures applicable to the specific confined space are re-evaluated and changed if needed. The MOC process, if well implemented, can help prevent or minimize confined space incidents and accidents associated with changes or modifications to confined space work.

15.3.1 Owners/Operators and Contractors/Subcontractors should assign qualified persons familiar with the confined space requirements and familiar with the applicable equipment, processes, materials, and operations to review the MOC form. These qualified persons should identify potential MOC issues affecting the worksites' confined spaces, develop preventive and protective measures, and propose changes to the confined space program, as well as other applicable programs, for approval and implementation by the Owners/Operators or Contractors/Subcontractors.

15.3.2 Upon completion of the MOC review, the person(s) conducting the review should originate and submit an MOC form to the Owner/Operator or Contractor/Subcontractor for authorization prior to implementing any change affecting a confined space. The confined space program should be revised to reflect permanent MOCs. An example of an MOC form is shown in Figure D.1.

15.3.3 After changes to the confined space program have been implemented, the MOC form should be reviewed by the Entry Supervisor prior to authorizing entry into confined spaces. The Entry Supervisor should ensure that all confined space program requirements and documentation have been fully addressed and that any changes were consistent with the original or updated confined space classification and hazard assessment documentation prior to providing authorization for confined space entry.

15.4 MOC-Warranted Confined Space Changes.

Δ **15.4.1 Equipment Changes Affecting Confined Space.** Owners/Operators and Contractors/Subcontractors should initiate an MOC process whenever the addition, modification, or removal of equipment might require new or revised processes, procedures, documentation, or training for the confined space work. Examples of changes to confined space equipment include, but are not limited to, changes to the following:

(1) Physical configuration of the space (e.g., external or internal dimensions of space, construction materials, physical condition)
(2) Entry or internal access portals and paths, including the number, size, and configurations that can affect ingress/egress routes)
(3) Internal equipment (e.g., agitators, dampers, piping, obstructions, safety critical equipment, system parts)
(4) Instrumentation and monitoring (e.g., monitors, electrical controls, program/control logic or set/alarm points, calibration, testing, process controls)
(5) Electrical, hydraulic, pneumatic, or mechanical equipment
(6) Electrical classification of equipment
(7) Classification of a space (new classification resulting in a confined space that previously was not, or reclassification resulting in it no longer being a confined space)

15.4.2 Confined Space Process Changes. Owners/Operators and Contractors/Subcontractors should initiate an MOC process whenever there are changes to confined space or adjacent processes, work practices, or procedures that can impact previously established confined space programs and classification and hazard assessment data. Examples of changes to the confined space process include, but are not limited to, the following:

(1) Planned confined space or adjacent work activities (e.g., welding, cleaning, maintenance, repairs, testing, monitoring)
(2) Hazardous atmospheric conditions inside or outside the space (e.g., levels of oxygen, combustible gases, toxic gases)
(3) Physical factors (temperature, humidity, noise, radiation)
(4) Safe upper and lower operating limits (e.g., temperature, pressure, flow, composition)
(5) Changes in ventilation that could affect displacement, dilution, or removal of air contaminants within the space
(6) Additions or changes to preventative maintenance, isolation, or lockout/tagout procedures
(7) Improper application of inspection, testing, preventative maintenance, isolation, or lockout/tagout procedures

15.4.3 Confined Space Content/Chemical Changes. Owners/Operators and Contractors/Subcontractors should institute an MOC process wherever changes in the materials, contents, or chemicals stored or used in confined spaces could impact previously established confined space classification and hazard assessment data. Examples of changes to the confined space content/chemicals include, but are not limited to, the following:

(1) The type, amount, or composition of contents/chemicals stored in a confined space that can affect electrical hazardous area classifications, hazardous atmosphere considerations, air-monitoring provisions, ventilation requirements, PPE requirements for Entrants, or rescue preparedness
(2) The introduction or use of new or changed hazardous chemicals or other materials inside a confined space that might present or produce chemical or physical hazard exposure concerns to Entrants
(3) The use of new or different materials or chemicals whose release outside of the confined space could affect the confined space
(4) Spills or releases of flammable, combustible, or toxic liquids, vapors, gases, or dusts from operations occurring elsewhere within the facility that could affect confined space operations

15.5 MOC Completion and Verification. Owners/Operators and Contractors/Subcontractors should develop and implement an MOC verification process to confirm that the potential safety impacts and consequences from the proposed changes or deviations have been properly addressed. The MOC form should verify that all required MOC action items are complete; the confined space classification/hazard assessments have been updated; and the confined space program, entry procedure, and rescue plan have been revised accordingly. The Entry Supervisor should determine the requirements for safe entry, issue the necessary permits, and ensure compliance to commence confined space operations. An MOC completion and verification process should confirm, but not be limited to, the following items:

(1) Construction and equipment is in accordance with design specifications.
(2) Confined space safety, operating, maintenance, and emergency procedures are in place and are appropriate for the planned activity.
(3) An updated confined space classification and hazard assessment has been performed and recommendations have been implemented before startup.
(4) Requirements and authorizations in the MOC have been met.

(5) Retraining, re-education, or requalification of each affected employee in regard to the changes has been completed and documented.
(6) Assurance has been received that all requirements and authorizations in the MOC have been fulfilled and documented.

Chapter 16 Prevention Through Design (PtD)

16.1 Purpose. The purpose of this chapter is to provide information for establishing a prevention through design (PtD) process for confined spaces to eliminate hazards and reduce risk by studying safety impacts during the initial stages of design rather than relying on reactive hazard isolation and control approaches.

16.2* Background. A PtD concept seeks to initiate a design process to reduce or eliminate inherent risks and hazards associated with the design of facilities, equipment, and products. PtD can minimize retrofitting control costs and the use of labor-intensive administrative hazard control measures. The root PtD concepts and approach have a direct relationship and benefit to hazard and risk reduction efforts associated with confined space entry and rescue operations. Specifically, the application of PtD concepts by Owners/Operators and Contractors/Subcontractors to confined spaces targets two types of interactions — the construction and/or installation of new confined spaces, and the redesign, retrofit, and/or renovation of confined spaces to eliminate, control, or minimize hazards.

Δ **16.3 Responsibilities.** PtD is facilitated when Owners/Operators provide resources and assign safety professionals and engineers to effectively collaborate during the early stages of a capital project process. For a PtD process to function effectively, confined space Owners/Operators must understand the hierarchy of hazard controls and recognize which confined space hazards and risks can be reduced through improved design or redesign. Once an opportunity to reduce risks through a PtD process is identified, facility Owners/Operators should gather the appropriate qualified people and resources to perform a PtD review.

16.4 PtD Process and Activation. PtD has been recognized and formalized by consensus safety organizations, including, but not limited to, OSHA, NIOSH, ANSI, and other consensus safety organizations and industry associations. However, there are no current regulatory requirements or consensus standards that specifically address formal PtD processes specific to confined spaces. Nonmandatory PtD standards and guidelines have been developed, published, and disseminated to the public. Confined space Owners/Operators and Contractors/Subcontractors should consider the following, which can be used to initiate and implement PtD to reduce and eliminate confined space risks and hazards:

(1) Integrating PtD concepts into an MOC process when evaluating potential hazards, risks, and control measures for new confined spaces or when making changes or renovations in existing confined spaces *(see also Chapter 15)*
(2) Using risk assessment and a coinciding hierarchy of controls to attain an acceptable level of risk when performing confined space risk assessments and during development of confined space entry procedures/permits and rescue plans
(3) Investigating confined space incidents and near-misses to evaluate the benefit of PtD concepts to the root cause analysis and corrective action process
(4) Providing training on PtD concepts, practices, and benefits to facility managers, supervisors, engineers, and EHS professionals

16.5 PtD Warranted Confined Space Changes. Subsections 16.5.1 through 16.5.4 provide examples of how PtD concepts can be utilized by Owners/Operators and Contractors/Subcontractors to reduce or eliminate the hazards and risks associated with confined space entry and rescue operations.

16.5.1 PtD to Eliminate Confined Space by Definition. PtD can be used by Owners/Operators and Contractors/Subcontractors to eliminate hazards by designing or redesigning the confined space in such a way that it no longer meets the requirements to be defined as a confined space, including, but not limited to, the following:

(1) Eliminating the need to enter the confined space and perform work by using remotely operated tools, fixed monitoring devices, viewing windows or cameras, or remote grease joints; redesigning the work or maintenance tasks; or relocating critical valves/equipment outside space
(2) Eliminating restricted means of entry and exit by replacing ladders with steps/stairs, enlarging openings/access paths, using standard doorway openings, or adding access points
(3) Designing the space for continuous employee occupancy by improving ventilation, illuminating space, or altering space configuration

16.5.2 PtD to Eliminate Serious Hazards. PtD can be used by Owners/Operators and Contractors/Subcontractors to eliminate hazards by designing or redesigning the confined space in such a way that it no longer has serious hazards, including, but not limited to, the following:

(1) Substituting or eliminating hazardous chemicals that present potential hazardous atmospheres (e.g., using combustible liquids with reduced flash points, using corrosives and toxics that have a lesser exposure concern)
(2) Eliminating serious safety hazards (e.g., installing fixed guards/covers on mechanical and electrical equipment hazards, installing railings and/or fall protection points into the space, installing energy isolation lockout points outside of the space, removing or guarding exposure to sharp/heated/slippery surfaces)
(3) Preventing engulfment or entrapment hazards (e.g., designing pipes, valves, and line breaks to allow for blocking and bleeding of lines outside of the space; designing the space opening to allow for easy emptying of contents; altering configuration of the space to prevent entrapment)

Δ **16.5.3 PtD to Facilitate Rescue of Entrants.** PtD can be used by Owners/Operators and Contractors/Subcontractors to eliminate hazards by designing or redesigning the confined space in such a way that rescue is facilitated, such as, but not limited to, the following:

(1) Designing or redesigning the space to allow for two openings for rescue
(2) Designing or redesigning openings to allow unobstructed access of rescue/retrieval equipment

(3) Permanently mounting a davit arm, receiver, or other fixed anchor point at the space opening
(4) Designing spaces to allow external rescue of Entrants

Δ **16.5.4 PtD Reference Standards and Guidelines.** Several agencies have developed standards and guidelines that reference and discuss the implementation of a PtD process. The following is a summarized list of PtD references, sites, and standards for further reference:

(1) ANSI/ASSE Z590.3, *Prevention Through Design: Guidelines for Addressing Occupation Hazards & Risks in the Design & Redesign Processes*
(2) DHHS (NIOSH) 2011-121, *Prevention through Design: Plan for the National Initiative*
(3) ANSI/AIHA/ASSE Z10, *Occupational Health and Safety Management System* (provides specific reference to use of PtD process)
(4) AIHA's "Prevention through Design: Eliminating Confined Spaces and Minimizing Hazards"
(5) ANSI/ASABE S607, *Ventilating Manure Storages to Reduce Entry Risk*
(6) *Guidelines for Engineering Design for Process Safety* (discusses inherently safer design)
(7) *Inherently Safer Chemical Processes, A Life Cycle Approach* (discusses methods on making development, manufacture, and use of chemicals safer)

Annex A Explanatory Material

Annex A is not a part of the recommendations 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.1.3 For confined space activities within the United States, this guide is intended to incorporate the requirements included in OSHA general industry, construction, agriculture, and maritime standards.

A.3.3.1 Acceptable Entry Conditions. See Section 8.4.

N **A.3.3.6.3 Venturi-Type (Eductors).** When using air as the source of power, these devices work as supply or exhaust. When using steam as the source of power, they should only be used for exhaust ventilation.

These devices are also known as air ejectors, air eductors, or air horns.

A.3.3.13 Confined Space. Tanks, vessels, silos, storage bins, hoppers, vaults, and pits are examples of spaces that often have limited means of entry.

A.3.3.17 Contractor. Contractors may employ subcontractors who perform work under contract to the primary contractor.

N **A.3.3.22 Entrant Employer.** OSHA requirements in Subpart AA of 29 CFR 1926, "Safety and Health Regulations for Construction," define the term "entry employer" which is essentially the same term as "Entrant Employer" in NFPA 350. Therefore, recommendations related to entrant employers in NFPA 350 would also apply to entry employers in OSHA's construction standard.

A.3.3.26 Explosionproof. See *NFPA 70*.

A.3.3.44 Job Hazard Analysis (JHA). For a JHA, the job is first broken into a sequence of steps. Each step should analyze some major task, which will consist of a series of movements. The analyst then looks at each series of movements within that basic task.

Next, all the hazards or potential hazards associated with each step are identified. It is important that the entire environment be considered to determine every conceivable hazard that might exist.

Finally, based on the basic job steps and the potential hazards, it can be determined what actions are necessary to eliminate, mitigate, or control hazards that could lead to accidents, injuries, damage to the environment, or possible occupational illness. Each safe job procedure or action should correspond to the job steps and identified hazards.

A.3.3.51 Occupational Exposure Limit (OEL). OELs include, but are not limited to, those provided by the U.S. Department of Labor Occupational Safety and Health Administration (OSHA), U.S. National Institute for Occupational Safety and Health (NIOSH), American Conference of Governmental Industrial Hygienists (ACGIH), and others. These OEL values can be defined or expressed as a time weighted average (TWA), short-term exposure limit (STEL), or ceiling limit.

A.3.3.52 Owner/Operator. An Operator is a person assigned by the Owner to represent the Owner.

A.3.3.56 Permit-Required Confined Space (Permit Space). The definition in 3.3.56 is based on 29 CFR 1910.146, "Permit-Required Confined Spaces."

A.3.3.81 Supplied Air Respirator (SAR). SAR units for rescue should maintain a separate egress cylinder capable of providing enough air for safe exit should the air hose or air supply malfunction.

A.4.1 The Owner/Operator may outsource this evaluation and documentation to a qualified person.

N **A.4.3(2)** Additional examples include tunnels, tubes, ventilation ducts, and water pipes. The Entry Supervisor should ensure all exit paths are free of hazards and that Entrants can evacuate safely. Alternate evacuation routes should be developed if hazards may impede the main exit path.

A.4.6.2 Examples of this type of job include, but are not limited to, a contractor who is sent to various sites to do contract repair work in confined spaces or a pest control specialist who might enter crawl spaces to apply pesticides. See also 6.3.4.2 on introduced hazards.

A.5.1 Although a pre-entry evaluation should be performed for all confined space entries according to this guide, this is not to imply that all confined spaces will require a permit.

This guide uses the terms *confined space* and *confined space entry* for all spaces that meet the definition of *confined space,* regardless of hazard. The purpose is not to supplant other definitions or regulatory requirements but to clarify and simplify the terminology so that the recommendations contained within this guide can be more readily applied to confined space entries under all conditions and situations.

N **A.5.1.2** Reclassified spaces and spaces that may use alternate procedures remain confined spaces. They may have no recognized hazards (i.e., reclassified spaces) or may have only an atmospheric hazard that can be controlled with ventilation (i.e., necessitates the use of alternate procedures). However, best practice is to include these spaces in the written program *(see 12.1.1)* and develop safe work procedures.

N **A.5.6** The written program should address the circumstances under which one person may be allowed to perform multiple roles during an entry, and procedures should be developed. Not all roles may held by the same person during an entry.

A.5.8 Employees may also be qualified to perform certain tasks based on their experience and by demonstrating competency in performing the task in question to the qualifying person or authority.

A.6.3.5.2.1 Arc flash from energized conductors may produce intense blinding light capable of burning Entrants, explosive high-pressure shock waves, and/or molten metal projectiles.

A.6.3.5.5 In this guide as well as universally, 20.9 percent oxygen is referenced as the ambient oxygen concentration. Although this is true at sea level as well as on the top of Mount Everest [29,035 ft (8850 m)], the amount of oxygen is much less, approximately one-third, on the top of Mount Everest as compared to sea level. This is due to the atmosphere being less dense, so the partial pressure of oxygen, as well as other gases, is much less. Where pressure is less than standard sea level pressure of 760 mm of mercury (Hg) [101.3 kilopascals (kPa)], it is called a hypobaric environment. Where pressure is greater than 760 mm Hg (101.3 kPa), it is called a hyperbaric environment. Some confined spaces could be located at high elevations, therefore having a hypobaric environment in and around the space. Other confined spaces could be purposely pressurized, such as tunnel caissons, or be located in a hyperbaric environment. Both hypobaric and hyperbaric environments create health and safety hazards; for example, hyperbaric environments have an increased fire hazard.

Gas monitors do not take air pressure into consideration, and therefore will provide inaccurate oxygen and air contaminant measurements in hypobaric and hyperbaric environments due to the pressure variations. More sophisticated measurement techniques need to be utilized to obtain accurate measurements in these types of environments.

A.6.3.5.5(2) There is no effective PPE for flammable/combustible atmospheres. Flammable/combustible atmospheres must be eliminated, mitigated, or controlled to provide for safe entry.

A.6.4.2(3) Training, competencies, and PPE are addressed in Chapters 11 and 12; the guidance given there should be used to analyze the hazards and assess the risks.

N **A.7.2(2)** Continuous atmospheric monitoring within the confined space is necessary unless the Entrant Employer can demonstrate that equipment for continuous monitoring is not commercially available (e.g., for gases that can only be detected using colorimetric tubes). In those situations, a periodic monitoring schedule should be established.

N **A.7.3.4** See Figure A.7.3.4 for typical gas hazards in various industries.

A.7.3.9 It is not uncommon for each Entrant to be equipped with a multi-gas monitor in this situation.

A.7.5.2.4 Colorimetric detector tubes visibly change color when chemical reactions occur between the air contaminant and the substance in the detector tube. Because the amount of color change is proportional to the concentration of the air contaminant, a quantitative measurement can be obtained. There are approximately 500 different air contaminants that can be measured with detector tubes. Although gas monitors have replaced detector tubes for common air contaminants, detector tubes provide a means of measuring specific chemicals where alternative direct-reading monitoring do not exist. Examples of these chemicals include, but are not limited to, hydrogen chloride, ozone, and phosgene.

A.7.5.3 The obvious shortcoming of this method is that laboratory analysis of the collected sample needs to be done, which even under the most ideal conditions (i.e., having a qualified laboratory on-site or nearby) can take several hours before the results are known. This type of industrial hygiene monitoring is of value for determining air contaminant concentrations for entries that do not need to take place immediately or to assist in determining the exposure levels that would be expected for a particular type of task.

For example, stainless steel welding creates various safety and health hazards, one of which is generating hexavalent chromium, a known carcinogen and a chemical with an OSHA expanded health standard. Industrial hygiene atmospheric monitoring can determine if the controls utilized, such as local exhaust ventilation, are effective in reducing hexavalent chromium concentrations to below the OSHA action level and OEL, or if the appropriate respiratory protection continues to be needed for future entries.

Δ **A.7.7.1** For example if the confined space is 12 ft (3.7 m) deep and 4 ft × 4 ft (1.2 m × 1.2 m) square and the entry is in the center of the space, the probe should be lowered to within 3–6 in. (7–15 cm) from the bottom of the space to monitor the air at that location for 2 to 3 minutes and the readings should be documented. Then the space at approximately 10 ft (3 m) deep should be monitored for approximately 2 to 3 minutes. This routine should be continued until all levels of the space have been monitored and meet permit requirements before the entry permit confined space is issued.

A.7.7.1.1 If a 12 ft (3.7 m) probe and tube configuration is used, a minimum of 24 seconds should be allowed plus the normal response time of the instrument, typically 2 minutes, before the reading from the sensors is acceptable. For example, the Gas Tester might monitor that environment at 12 ft (3.7 m) for 2 minutes and 30 seconds before moving the probe to the next sampling point.

Most remote sampling pumps have a limit from how far they can draw a sample. Diaphragm or rotary vane pumps used in portable gas detection monitors typically have a limit of up to 100 ft (30 m) total probe and tube length before they are no longer effective.

A.7.14(3) When considering an OEL to determine the acceptable entry limit for a given compound, the lower of the applicable published exposure limits should be considered.

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A.8.4.1.1 Depending on the material to be removed, cleaning devices that utilize water or steam may be preferred. Caution is needed where using steam to avoid burns and/or overheating. Water streams and steam also create static, which could discharge and ignite a flammable atmosphere. Approved cleaning chemicals or combustible (nonflammable) liquids can also be used.

	Combustible gas	Oxygen (O_2)	Carbon monoxide (CO)	Hydrogen sulfide (H_2S)	Sulfur dioxide (SO_2)	Ammonia (NH_3)	Chlorine (Cl_2)	Chlorine dioxide (ClO_2)	Carbon dioxide (CO_2)	Hydrogen (H_2)	Hydrogen cyanide (HCN)	Nitric oxide (NO)	Nitrogen dioxide (NO_2)	Ozone (O_3)	Phosphine (PH_3)	Formaldehyde (CH_2O)	Hydrogen chloride (HCl)	Hydrogen fluoride (HF)	Methyl mercaptan (CH_4S)	Volatile organic compounds (VOCs)
Agriculture	●	●	●	●		●			●			●	●		●				●	
Aircraft maintenance	●	●	●						●											●
Chemical manufacturing	●	●	●	●	●	●				●		●	●				●	●		
Clandestine drug labs	●	●				●									●					●
Construction	●	●	●	●								●	●						●	●
Electrical utilities	●	●	●	●	●									●						
Fire departments	●	●	●	●							●									●
Food/beverage manufacturing	●	●	●	●		●			●		●				●					●
Gas utilities	●	●		●																
Hazmat response	●	●	●	●	●	●	●			●	●				●	●				●
Manufacturing	●	●	●	●					●							●				●
Medical/laboratory	●	●	●											●		●				●
Mining	●	●	●	●							●	●	●							
Oil gas production	●	●	●	●		●														●
Petrochemical and refining	●	●	●	●	●	●	●	●		●										●
Pulp and paper	●	●	●	●	●	●	●	●											●	●
Pharmaceutical	●	●		●		●											●			●
Power plants	●	●	●	●						●										
Public works	●	●	●	●								●		●						
Shipyards	●	●	●	●					●			●								●
Steel mills/foundries	●	●	●	●							●		●				●	●		●
Water/wastewater treatment	●	●	●	●	●	●	●							●					●	●
Welding	●	●	●									●	●	●						

FIGURE A.7.3.4 Typical Gas Hazards by Industry.

A.8.4.1.2 Where flammable vapors or gases might be present, fans, blowers, and eductors are usually air or steam powered. If electrically driven equipment is used, it should be intrinsically safe (explosionproof) and inspected and approved for use by a qualified person.

A.8.4.1.5 Examples of harmful chemical residues include, but are not limited to, corrosive materials such as caustic potash, caustic soda, hydrofluoric acid and hydrochloric acid; pesticides such as chlordane and Aldrin; heavy metals such as lead and arsenic; flammable or explosive materials such as fuel oil or solvents; pyrophoric materials; and biological hazards such as bacteria, viruses, and parasites.

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N **A.8.4.3.8** Inert environments pose particular risks for Entrants since even short exposures may render irreversibly fatal effects.

A.8.4.3.9.1 Additional information concerning fixed inert gas systems and requirements in the marine industry is available in *International Safety Guide for Oil Tankers and Terminals.*

A.8.6.2 Within the United States, 29 CFR 1910.147, "The Control of Hazardous Energy (Lockout/Tagout)," provides requirements for preventing accidental startup of equipment and machinery or the release of stored electrical, mechanical, pneumatic, or other energy. 29 CFR 1910.333, "Selection and Use of Work Practices," has specific requirements for de-energizing and locking out electrical equipment. Within the United States and in other areas, *NFPA 70E* provides comprehensive electrical safety information to prevent shock, arc, and other electrical safety hazards. In addition, API 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*, and API 2217A, *Guidelines for Safe Work in Inert Confined Spaces in the Petroleum and Petrochemical Industries*, provide information for isolating tanks, vessels, and equipment in the petroleum and petrochemical industry for safe entry and work.

A.8.6.6 An example of this is a sweep auger in a grain bin that must be energized to move residual material from the bin. Alternative measures to protect workers could include positioning the worker a safe distance behind the direction of travel, providing a portable guardrail, or installing a kill switch so the worker can stop the auger in an emergency.

A.8.7.2.1 Electrical equipment should be approved for the appropriate electrical classification depending upon its intended use and location (i.e., Zone or Class and Division). Electrical equipment used in Zone 0 and Class 1, Division 1 locations should be intrinsically safe (i.e., explosionproof).

A.8.7.2.2 Electrical equipment should be approved for the appropriate electrical classification depending upon its intended use and location (i.e., Zone 1 or Class 2, Division 1).

A.8.7.2.3 Electrical equipment should be approved for the appropriate electrical classification depending upon its intended use and location (i.e., Class 3, Division 1).

The following documents provide information regarding electrical classification:

(1) NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*
(2) NFPA 499, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*
(3) API 500, *Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 & Division 2*

Δ **A.8.8.1** Additional information on static can be found in NFPA 30; NFPA 77; API RP 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Current*; and the *International Safety Guide for Oil Tankers and Terminals.*

A.8.8.1.1(2) Vapors should be discharged downwind of the truck and away from the confined space and potential sources of ignition. Regulations might require capture removal and treatment of liquids, vapors, and residue.

Δ **A.8.8.3** The following publications contain information regarding bonding and grounding as applicable to confined spaces:

(1) NFPA 77, *Recommended Practice on Static Electricity* (includes detailed information on how to control static electricity)
(2) API 2219, *Safe Operation of Vacuum Trucks in Petroleum Service* (provides requirements for safe use of vacuum trucks in petroleum facilities to remove flammable or combustible liquids, and can also be used as a reference for other facilities where vacuum trucks are used)
(3) API RP 2003, *Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents*
(4) API RP 2027, *Ignition Hazards and Safe Work Practices for Abrasive Blasting of Atmospheric Storage Tanks in Hydrocarbon Service*
(5) NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*

A.8.13 Entry Supervisors and all other confined space personnel should recognize that confined spaces are ideal hideouts for animals and insects. The Owner/Operator or Entrant Employer can arrange for traps to be placed into the space for insects or animals such as skunks or raccoons. If available, a pest control company or local animal control agency should be the first consideration.

A.8.14 OSHA general industry standards have the following specific PPE requirements:

(1) Eye and face protection should be selected and used in accordance with 29 CFR 1910.133, "Eye and Face Protection."
(2) Respiratory protection requirements should be in accordance with 29 CFR 1910.134, "Respiratory Protection."
(3) Head protection should be selected and used in accordance with 29 CFR 1910.135, "Head Protection."
(4) Foot protection should be selected and used in accordance with 29 CFR 1910.136, "Foot Protection."
(5) Hand protection should be selected and used in accordance with 29 CFR 1910.138, "Hand Protection."
(6) Electrical protective clothing should be selected and used in accordance with 29 CFR 1910.137, "Electrical Protective Equipment," and *NFPA 70E*.

A.8.14.3.1 The OSHA standard 29 CFR 1910.132, "General Requirements," which covers general industry in the United States, provides further information and guidance.

Δ **A.9.1.1** NIOSH Fatality Assessment and Control Evaluation (FACE) reports have identified oxygen deficiency as the primary atmospheric hazard that has caused or contributed to worker deaths in confined spaces. Atmospheres changes that may require continuous ventilation during confined space entries may occur for many reasons, including, but not limited to, the presence or disturbance of residues, creation of vapors or fumes during hot work activity, outside contaminants entering the space, and use of chemicals inside the space for cleaning or other maintenance work.

Ventilation specialists should never use pure oxygen or oxygen above normal atmospheric levels to ventilate a confined space for a number of reasons, including, but not limited to, the following:

(1) Oxygen above normal levels will affect the accuracy of the readings on gas monitors.
(2) Oxygen above normal levels will increase the flammable range of combustible and flammable gases, dusts, and vapors, creating a fire or explosion hazard.
(3) Oxygen above normal levels is not safe for Entrants to breathe.

Δ **A.9.1.3** The Entry Supervisor and qualified Ventilation Specialist should understand the differences between ventilation, purging, and inerting. They should be able to select the appropriate hazard control method necessary for removing or controlling a hazardous atmosphere within the confined space. While the terms are frequently used interchangeably, they are distinct hazard control methods. Ventilation generally introduces fresh, uncontaminated air into a space and controls atmospheric contaminants in that the space through mixing and dilution. Inerting is the use of an inert or flue gas to displace or expunge the atmosphere within the space. Purging typically uses water, fuel oil, steam, or nonreactive chemicals to physically displace the atmosphere within the space in order to create a safe or nonexplosive atmosphere by dispersion, mixing, or dilution. *(See Section 9.3 for guidance on appropriate methods of ventilation.)*

A.9.2.1 While natural ventilation is cost effective and does not require specialized equipment, it cannot be relied upon to ensure stable atmospheric conditions necessary for the safety of workers. Space configuration, time constraints, and atmospheric contaminant properties all present challenges to the effective use of natural ventilation in confined spaces; therefore, it is not recommended as a means of hazard control.

Caution is recommended where relying on natural ventilation as the sole means for implementing ventilation of a confined space. Two primary reasons support a cautious approach where considering use of natural ventilation. First, if the space is constructed with internal structure, that structure or other elements of internal configuration can interfere, impede, or divert the air circulation within the space. Second, depending on the physical properties of the air contaminants, such as vapor density, the air circulation from natural ventilation might not effectively reach all points in the space and effective contaminant control would not be accomplished. Incident data illustrate reliance on natural ventilation because it is readily available and requires no additional equipment; however, those data also illustrate that a false sense of security exists because the space has been "ventilated." As a best practice, the only certain means for achieving effective ventilation is with mechanical ventilation equipment that is well-maintained, approved for the applications, installed according to best practices, and supported by frequent atmospheric monitoring to confirm the conditions.

A.9.2.1.2 When relying on natural ventilation as the sole means for implementing ventilation of a confined space, continuous atmospheric monitoring should be used to confirm the conditions within the space remain safe for the duration of the entry operation.

A.9.2.2.1 This ventilation method is often referred to as dilution ventilation because it achieves control of contaminants or low oxygen levels through mixing and dilution of contaminated air by introducing a fresh, uncontaminated supply or makeup air into a confined space.

Δ **A.9.2.2.1.2** An equal amount of makeup air will enter the space to match the amount of air exhausted unless makeup air from a known source is introduced into the space. Unless a source of makeup air is added to the space, it will enter through adjacent spaces such as floor drains, open pipes, or cracks in walls or floors. This method of ventilating a confined space is potentially problematic due to the inability to control the source of the makeup air, allowing potentially contaminated air, such as soil gases, to enter the space.

A.9.2.2.1.2.1 The Entry Supervisor or permit issuer should evaluate and determine safe locations for the dispersing of exhausted atmosphere, depending on the hazard. For example, flammable and combustible vapors that are permitted to be exhausted to the atmosphere should be discharged at least 12 ft (3.7 m) above the surface level so that they can disperse before reaching any sources of ignition at ground level.

A.9.2.2.1.4 Ventilation system bonding and grounding is of particular importance where a contaminant is a flammable vapor, gas, solid, or a combustible dust. *(See Section 9.4 for additional information on bonding and grounding of ventilation equipment.)*

A.9.2.2.2.1 Examples of point source contaminants can include, but are not limited to, fumes from welding or other hot work activities, vapors from solvent cleaning or degreasing, or vapors from painting or coating activities. The Ventilation Specialist should also consider that contaminants can be trapped in hard-to-reach places such as sumps, drains, under flooring, inside open piping, in pontoons on floating roof tanks, and similar locations.

A.9.2.2.2.2 Section 9.3 describes the relationship between supply and exhaust for effectively moving air and indicates that the ratio of supplying or blowing air as compared to exhausting or capturing the air is approximately 30:1. For local exhaust ventilation to be effective, this performance factor means it is important that the local exhaust ventilation application be located as close to the source as possible — typically within one duct diameter. This might require an assistant within the space to be assigned to move the exhaust air–moving device or its attached flexible ducting as the worker moves (e.g., as the welder moves within the space during welding operations, the distance from the ventilation device could increase to greater than the capture distance recommended).

A.9.3.1.2 Air changes per hour (ACH) is a commonly referred-to term that describes air flow in a space and is based upon the volume of the space, the capacity of the ventilation equipment, and the time it takes to move air through a space in one hour. It does not necessarily reflect an effective air exchange and complete mixing of air within the space. Space configuration and obstructions to air flow (including duct work) and the properties of the contaminant (e.g., vapor density, vapor pressure, and specific gravity) will all impact the ventilation time and design of an effective ventilation system.

The number of required air changes should be determined by testing and evaluating the atmosphere within the confined space. It is essential to consistently and reliably maintain an acceptable oxygen level and concentrations of contaminants in the breathing zone of Entrants are at or below the recognized occupational exposure limits(OELs) for the respective contaminant(s). If adequate ventilation cannot be determined or maintained, personnel entering the confined space should be equipped with approved respiratory protective devices.

Acceptable limits are also limits identified in the hazard evaluation conducted in accordance with Chapter 6, the elimination, mitigation, and control methods in Chapter 8, and according to the acceptable entry conditions specified on the entry permit issued in accordance with Chapter 13.

Once the number of air changes and ventilation times are determined and performed, the atmosphere of the confined space should be tested to ensure the atmosphere is stable for safe entry.

The time required for a single air change can be calculated by knowing the volume of the space and the capacity of the air-moving device, as shown by the following equation:

Δ **[A.9.3.1.2]**

$$T = \frac{V}{Q}$$

where:
T = time (min)
V = volume [ft^3 (m^3)]
Q = volumetric flow rate [ft^3/min(m^3/min)]

The estimated ventilation time can also be calculated by applying the purge chart shown in Figure A.9.3.1.2.

Δ **A.9.3.3.1.2** Grade D breathing air is described in CGA G-7.1, *Commodity Specification for Air.*

Δ **A.9.3.3.1.3** Where selecting and designing ventilation, it is important to recognize that the orientation (supply or exhaust) for the mechanical ventilation makes a difference. The effectiveness of both orientations is limited by the ability of the air-moving device to either push the air into the space or to pull the air from within the space. The ratio for supplying versus exhausting is approximately 30:1. Figure A.9.3.3.1.3 illustrates the impact of such limitations for both supply and exhaust ventilation. Where the air-moving device capacity is inadequate to supply air uniformly throughout the space, a condition known as short-circuiting is likely. Short-circuiting is also possible with exhaust ventilation. *(See A.9.5.1.4 for examples.)*

Δ **A.9.3.3.2** Capture methods include, but are not limited to, the use of facility or portable vapor recovery or treatment systems that are used for air quality control. An example of this condition would be an aboveground petroleum or chemical storage tank that previously contained flammable and/or toxic liquids where local environmental regulations control emissions. In this example, exhaust ventilation would be preferred to supply, and the contaminants captured by the exhaust ventilation would need to be controlled during discharge, so that the contaminants were not freely released to the outside air. For a petroleum application, it is common that the discharge would be connected to a thermal oxidizer or similar device to render the flammable vapors nonhazardous.

A.9.3.3.2.1 For example, many axial-flow fan designs include an impeller or propeller that can act as a source for ignition if the impeller gets out of alignment and contacts the fan housing. It is advisable where ventilating flammable vapors to either use supply ventilation or to not use an axial-flow fan design that is not approved for use in a hazardous or classified location.

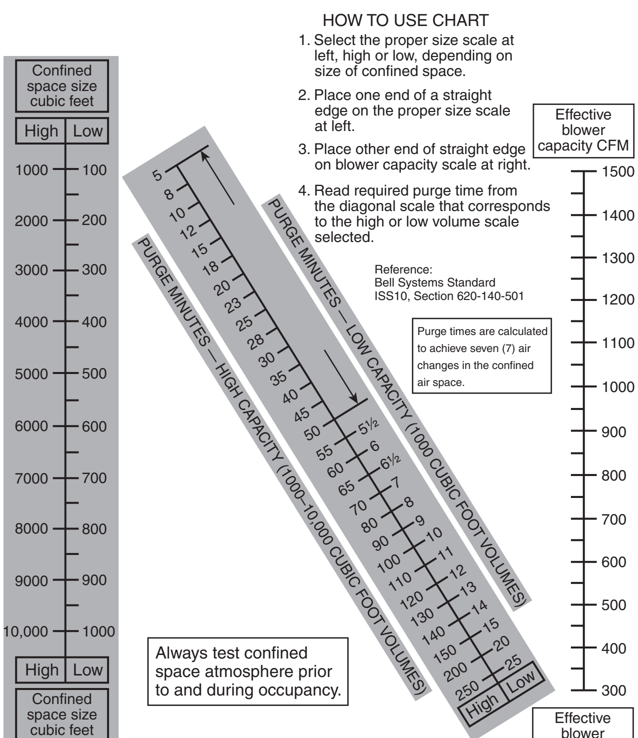
A.9.3.4 As noted in 9.1.3, purging uses air, steam, or an inert gas in the purging process. The most commonly used inert gases are nonflammable gases such as nitrogen, carbon dioxide, or argon.

A.9.3.4.1 For additional guidance on use of inert gases for the gas-freeing of spaces previously containing flammable liquids, see NFPA 306, NFPA 326, or API 2217A, *Guidelines for Safe Work in Inert Confined Spaces in the Petroleum and Petrochemical Industries.*

A.9.3.4.1.3 A minimum oxygen concentration is required due to the operation of the catalytic bead–type sensor, which requires oxygen to be at least approximately 16 percent by volume in air so that the sensor can burn the sample. Low oxygen in the sample, such as would be experienced during inerting, will yield inaccurate results for the flammable vapor concentrations. There are other suitable sensor types that do not require oxygen in the sample where detecting flammable gases or vapors or other methods for detecting flammable vapor concentrations in low oxygen atmospheres. *(See A.9.5.9 for examples of specific inerting conditions for flammable gases or vapors.)*

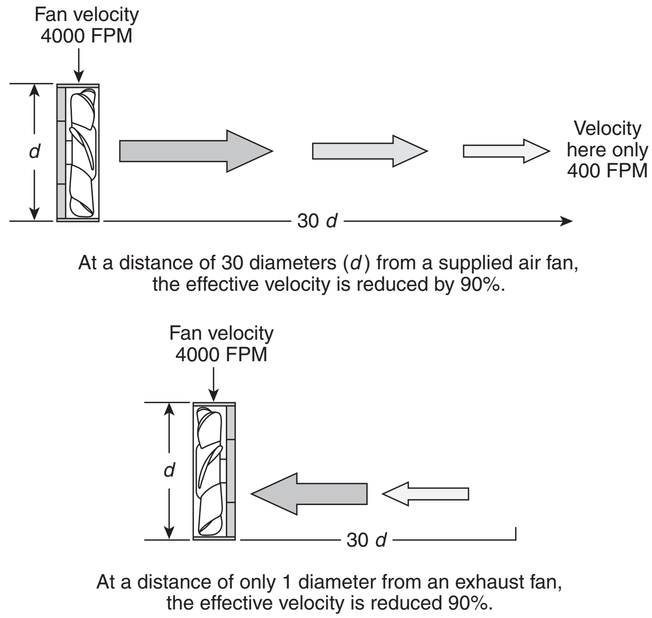
Δ **A.9.3.4.4** Because inert gas typically is lighter than hydrocarbon gases, the hydrocarbon gas and vapors will exit from the lower portion of the space when inert gas is introduced at an upper level. The Ventilation Specialist should be aware that an amount of inert gas equal to several volumes of the space to be inerted is required to replace the atmosphere in the space. The incoming inert gas should have sufficient energy velocity to disperse and penetrate to all areas within the space. It is important to take gas and oxygen measurements at various times, levels, and areas within the space to check the efficiency and continuance of inerting operations.

Entry Supervisors, Ventilation Specialists, and Attendants should be aware that a mixture of inert gas and hydrocarbon gas or vapors can become flammable when vented and mixed with air and should ensure that appropriate measures are in place to eliminate, mitigate, or control any sources of ignition in the discharge area.

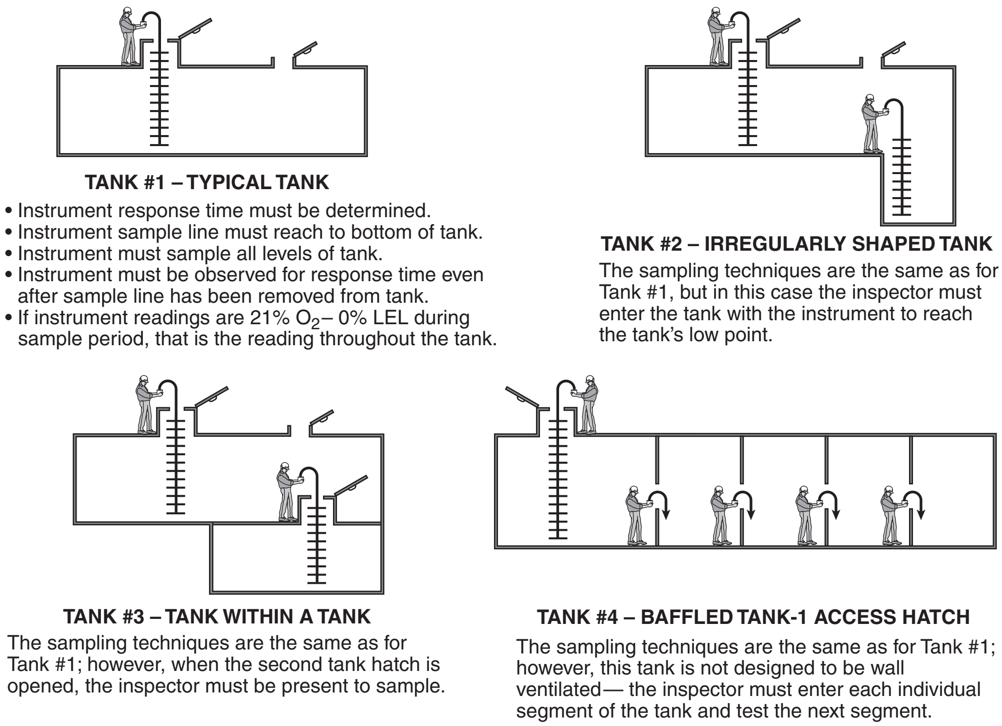


1. Proper ventilation procedures should be followed in accordance with all federal, state, and local laws.
2. Air quality of the confined space should be tested prior to ventilation.
3. Ventilate the confined space for the minimum times recommended above and retest air quality prior to entry.
4. If toxic and/or combustible gases or low oxygen is encountered, increase purge times by 50 percent.
5. If two (2) blowers are used, add the capacities of both and proceed with the "HOW TO USE CHART" directions above.
6. Effective blower capacity is measured with one or two 90° bends in 8 in. diameter, 25 ft blower hose.
7. Maintain continuous ventilation while the confined space is occupied.

Δ **FIGURE A.9.3.1.2 Approximate Purge Times.** ***(Source: Air Systems International, Inc.)***



Δ **FIGURE A.9.3.3.1.3 Supply and Exhaust Ventilation Design Considerations.**



Δ FIGURE A.9.5.1.1 Typical Space Configurations.

In the event that the inert gas system fails to deliver the required amount of inert gas or fails to maintain positive inert pressure in the space, the Entry Supervisor, Ventilation Specialist, and Attendant should take immediate action to vacate the space and repair the inert gas system before re-entry is permitted.

Where the confined space contains pyrophoric iron sulfide deposits, such as may be found in crude oil tanks and process vessels in the petroleum, petrochemical, and marine industries, Owners/Operators and Entrant Employers should immediately repair and restart the inert gas system in order to prevent an ignition within the space. In the event that it is impossible or impractical to resume inerting operations, alternate means of protection should be considered and provided for in the preplanning stage of operations.

A.9.4.2.3 Rolled, plastic tubing cannot be properly bonded or grounded due to the nonconductive construction and is considered less safe than typical rigid, flexible ducting if involved in a fire due to the tendency for the plastic tubing–style ducting to melt. This material is also not effective where used as ducting for exhaust ventilation as it will collapse on itself due to lack of structural integrity. Because of ease of installation and cost, it is quite common in many applications. It can also be flattened during entry so that the entry path is not completely blocked by the ductwork. In spite of these advantages, the hazard evaluation is important where determining whether the plastic tubing can be used for ductwork.

A.9.4.3 Where hot work will be performed on or adjacent to lines, appurtenances, tanks, or vessels in flammable or combustible liquid service, the procedures for hot tapping and welding provided in applicable API recommended practices should be followed. For examples of such installations, refer to API STD 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*, and API RP 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*.

A.9.4.4 For additional guidance on safe practices to control static electricity generation, accumulation, and discharge, refer to NFPA 77 and API RP 2003, *Protection Against Ignitions Arising Out of Static, Lightning and Stray Currents*.

A.9.5.1.1 Obstruction concerns include, but are not limited to, baffles, piping and equipment, grates and screens, internal configuration (e.g., internal structural members), sumps, sloping or uneven surfaces, and similar space characteristics. Examples of typical space configurations are shown in Figure A.9.5.1.1.

A.9.5.1.4 Short-circuiting occurs where inadequate "throw" or projection of the supply air occurs, and the supply air is exhausted before it reaches the desired location within the tank to generate the most turbulence, which promotes the mixing and dilution of the contaminated air. Short-circuiting is also possible where using exhaust ventilation. Both conditions are impacted by the limitations illustrated in A.9.3.3.1.3. Examples of this condition are shown in Figure A.9.5.1.4(a) through Figure A.9.5.1.4(d).

A.9.5.3 For additional guidance on the installation of vent systems for flammable gases and vapors, see NFPA 30.

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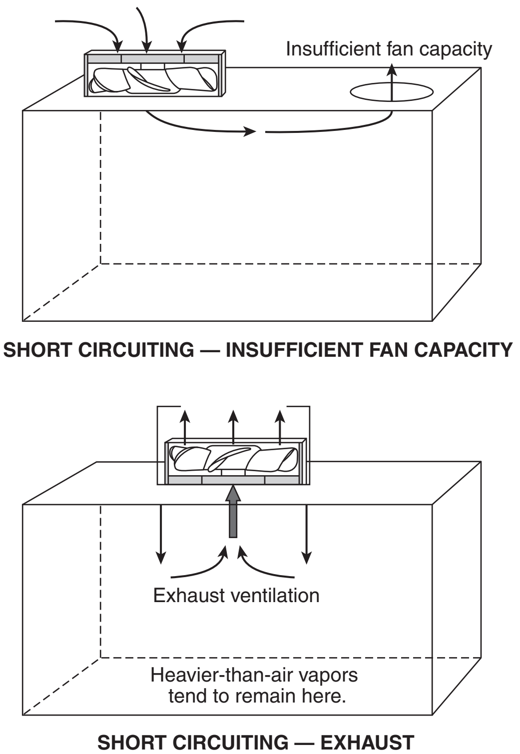


FIGURE A.9.5.1.4(a) Insufficient Fan Capacity.

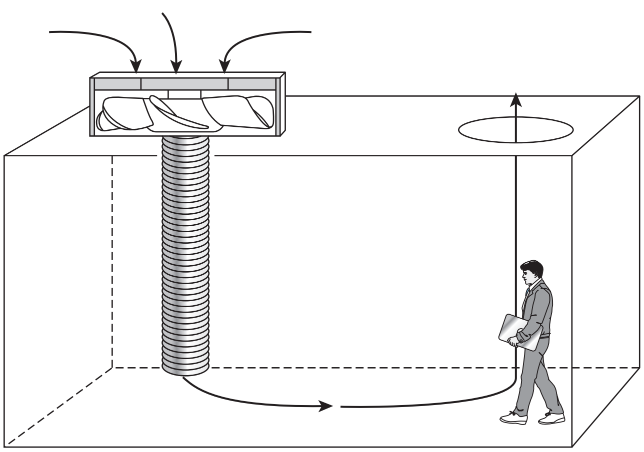
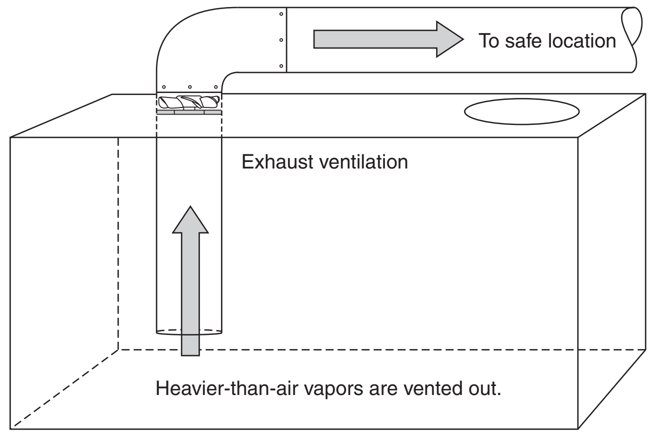


FIGURE A.9.5.1.4(b) Ducting — Supply.



Δ FIGURE A.9.5.1.4(c) Ducting — Exhaust.

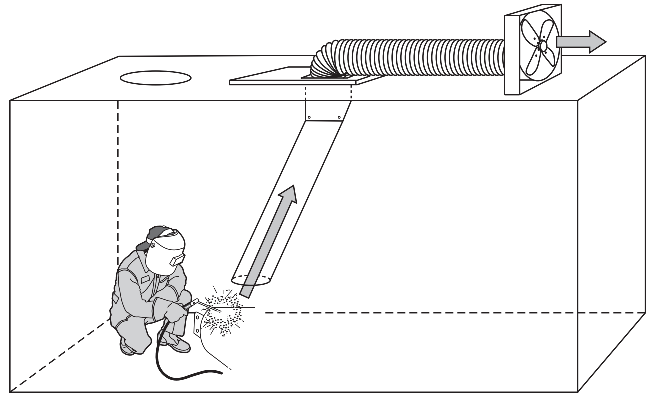


FIGURE A.9.5.1.4(d) Ducting — Local Exhaust.

A.9.5.8.2 Guidance on where ventilation for thermal protection of workers might be necessary can be obtained from the ACGIH publication, *Threshold Limit Values for Chemical Substances and Physical Agents*.

A.9.5.9 Inerting can be used to displace high concentrations of flammable vapors from a space during the cleaning and gas-freeing stage of the process. The objective is to introduce the inert gas so that it displaces the flammable vapors to approximately the LEL for the material before introducing fresh air into the space to bring the oxygen level up to fresh-air levels. Typically, the inert gas is used to displace the flammable vapor concentration to about 1 percent by volume in air. At this point, where air is introduced to remove the remaining vapor concentration and raise the oxygen concentration level, the flammable vapor and air mixture will not be within the flammable range — it will be at a concentration below the LEL — so there will be no danger of a fire or explosion. Typical inert gases used are carbon dioxide, nitrogen, and argon. Proper application for this process requires knowledge of the space configuration and openings and the gas selection. Carbon dioxide and argon are both heavier-than-air gases, while nitrogen is slightly lighter-than-air. Selection of the inert gas might depend on what openings are used for introducing the inert gas and how the flammable vapors are either vented from the space or captured and treated if environmental requirements prohibit emissions. The source of the inert gas can also impact the implementation of the purging process. As also noted in 9.3.4.3, inerting can be used to prepare an area within a confined space (e.g., piping or other hollow structure) or a confined space for hot work where cleaning cannot be effectively accomplished. In this application, the inert gas is used to displace the oxygen concentration to a level below that which will support combustion. It is necessary to reduce the oxygen level to below the limiting oxidant concentration (LOC), which for many petroleum-based materials is approximately 14 to 16 percent by volume. NFPA 306 and NFPA 326 establish a factor of safety below the LOC by requiring that the oxygen concentration be below 8 percent by volume or 50 percent of the LOC, whichever is least.

A.9.5.10.3 Examples of this condition include a decision to conduct entry into an inerted atmosphere and entry into a space during emergency/rescue conditions where ventilation supply air or power source might be compromised and/or unreliable.

A.10.1.2.4(3) This should include fall protection, where applicable, for operations around unprotected edges such as a portal. It is very easy for the Attendant to fall into a vertically oriented space while trying to make contact with an Entrant or attempting Entrant retrieval. The Attendant should take whatever measures are necessary to avoid hazards associated with or created by the emergency.

Δ **A.10.1.2.4(6)** It is important that Attendants be trained to recognize whether they should attempt Entrant retrieval.

Employers should ensure that Attendants understand the implications of attempting retrieval in various situations. For example, say a significant fall takes place due to an interior collapse of scaffolding not related to the atmospheric hazard. If the Entrant is complaining of numbness of the lower extremities, it is not prudent to extract the Entrant with the retrieval system and possibly cause spinal injury. The Attendant should know how to quickly assess each emergency as to whether the hazards and/or the Entrant's condition necessitate rapid removal. Items to be considered by the Attendant in making an assessment include, but are not limited to, the following:

(1) What is the mechanism or cause of injury (e.g., atmospheric, mechanical)?
(2) What is the Entrant's chief complaint? What is the injury or illness?
(3) What is the Entrant's level of consciousness (talking coherently, disoriented, or nonresponsive)?
(4) What are the current hazards (immediately life-threatening, low-hazard, or no hazards related to the emergency)?

These and other questions can be used to perform a rapid risk-versus-benefit matrix to decide whether to attempt to retrieve an entrant from a confined space emergency where retrieval equipment is an option. If the conditions are immediately life threatening and the only choice is to activate the retrieval system or the patient is likely to die, then retrieval is the correct response. If the Entrant's condition and the hazards are not immediately life threatening or if the Entrant's condition could be worsened by retrieval, then entry rescue might be the appropriate option, and the Rescue Service should be notified.

Δ **A.10.1.2.4(7)** Implementing the emergency response system refers to making the appropriate contacts to ensure the rescue team is summoned as well as other appropriate agencies. This can be as simple as utilizing an assigned radio to directly notify the Rescue Service and other appropriate emergency response agencies, or as complex as having two Attendants so that one can physically leave the scene during an emergency to initiate contact with the appropriate agencies. Regardless of the method, it should be planned well in advance so that the response to an emergency can be orchestrated as quickly, safely, and efficiently as possible. Simply calling 9-1-1 does not ensure an appropriate response to confined space emergencies in a timely manner. The Attendant should be ready to summon help in the event of an emergency, regardless of whether non-entry rescue (retrieval) is appropriate.

A.10.1.3.4.1 Tier 1 response usually involves rescues from spaces not addressed by regulatory standards. While responses in such spaces might not require rescue capability of any sort, it should be recognized that medical emergencies occurring within these spaces can create difficult rescues. It is important that Owners/Operators and Entrant Employers conduct an assessment of each planned work activity to determine requirements for a rescue capability. If there is a need for potential rescue, the Owner/Operator or Entrant Employer should assess resources for a qualified rescue capability appropriate to the anticipated emergency. All rescue resources should be available and capable of responding in a timely manner. This should be addressed prior to making entry into spaces requiring Tier 1 response.

Δ **A.10.1.3.4.2** Tier 2 response generally allows a single rescue team to address multiple entries assuming response times are appropriate to the anticipated emergencies. Pre-incident planning should determine whether a rescue team can provide service for multiple spaces. Appropriate communications should exist between various entry/egress points and the Rescue Service to ensure that an emergency in one space will result in the immediate suspension of all entry operations and the exit of Entrants from the other spaces.

A.10.1.3.4.3 With immediate life-threatening hazards, the speed of Rescuer access to the Entrant should be commensurate with the need for life-saving measures associated with cardiac arrest. It is generally considered that, without intervention, cessation of heart function in normal conditions will result in at least some irreversible brain death within 4 to 6 minutes. This is the reasoning behind the recommendations associated with Tier 3 response, especially where non-entry rescue (retrieval) is not possible.

Pre-incident emergency action planning should always establish required response logistics. While Tier 3 response generally suggests a single dedicated rescue team for a single space, conditions may exist that allow a single rescue team to address multiple entries in the same immediate area. The following should be considered when making this determination:

(1) The walking transition time between the most remote two entry/egress points is 1 minute or less.
(2) Either the team is able to divide its forces so that at least one Rescuer is located at each entry/egress point with communications capability to allow immediate notification of other team members in the event of an emergency or, where there are multiple entry sites in close proximity, one Rescuer is able to monitor a number of sites.
(3) All rescue equipment needed to perform entry rescue is set up within a suitable distance at each entry/egress point or multiple points and every team member possesses the appropriate PPE to make immediate entry.
(4) In the event of an emergency at one entry/egress point, operations at the remaining entry/egress points should be terminated immediately and the Entrants should exit the space so the rescue team member attending that entry/egress point can respond by way of another entry/egress point within 1 minute to either begin or assist in rescue operations.

This may not be possible with multiple simultaneous entries monitored by only one team since Tier 3 entries are associated with immediate life-threatening emergencies that require extremely rapid intervention.

A.10.1.3.5 The proper detection of atmospheric hazards depends upon utilization of the correct type and configuration of gas monitors. Gas monitors used for confined space entry typically monitor oxygen, flammable or combustible vapors or gases, and sometimes one or two other toxic exposures. A gas monitor that contains the wrong toxicity sensors relative to the toxins present may fail to detect atmospheric hazards, even though they are present. In general, if an atmosphere is unknown, it should be assumed to be IDLH and appropriate precautions should be taken prior to entry.

If rescue response is required, Rescuers should assume the worst and provide maximum protection for Rescuers based on suspected hazards. Appearances can be deceptive. For example, scale (this can be rust; a hard mineral coating that forms on the inside of boilers, kettles, and other containers in which water is heated; or other encapsulating build-up) can entrap residual products that are in a space. A worker cleaning the interior could, in the process, scrape a scale bubble containing a contaminant that creates a temporary IDLH environment. The worker is incapacitated as a result. Rescue personnel respond and monitor the space to find the atmosphere clear. The decision is made to enter the space without atmosphere-supplying respirators. The first Rescue Entrant steps on a scale bubble and releases the same contaminant that incapacitated the first victim. Rescuers cannot afford to make this type of mistake. *(See Figure A.10.1.3.5.)*

A.10.1.3.5.1 A disregard for Rescuers' safety not only inhibits rescue of the ill or injured persons involved in the incident to which they originally responded but can place other Rescuers at risk by compelling them to retrieve their incapacitated fellow Rescuer. Rescuers should observe this rule: Don't become a victim!

A.10.2.1 The term *Owner/Operator*, in this case, is meant to apply to whoever is responsible for the spaces to which the Rescue Service responds. It generally implies the person, persons, or organization that acquired the Rescue Service to act as response for the entry or entries taking place. This is independent of where the Rescue Service is from since there may be many options, including in-plant teams, outside municipal response services and private contract services.

A.10.2.2.2 The review team can include the confined space Entry Supervisor.

A.10.2.3.1 The performance evaluations should serve as a basis for determining whether the current training has prepared the Rescue Service to function at the established level of capability under abnormal weather conditions, extremely hazardous operational conditions, and other difficult situations.

A.10.4.1 Each rescue response should be based on the circumstances surrounding the incident. SOPs should provide a typical approach while allowing latitude for independent judgment. While the incident manager may be held accountable to justify any divergence, this latitude provides for adjustments to plans to meet changing needs.

Δ **A.10.6.5** Analyzing critical areas related to the incident might be the single most important part of any emergency response preplan. Emergency response agencies generally refer to this process as sizing-up. Having a solid, well thought-out action plan can positively aid in determining if an incident can have a predicted result, minimizing harm to life and damages to property, or expediting the process of rescuing trapped victims. Determining, evaluating, and assessing all the circumstances helps ensure the success of the rescue mission.

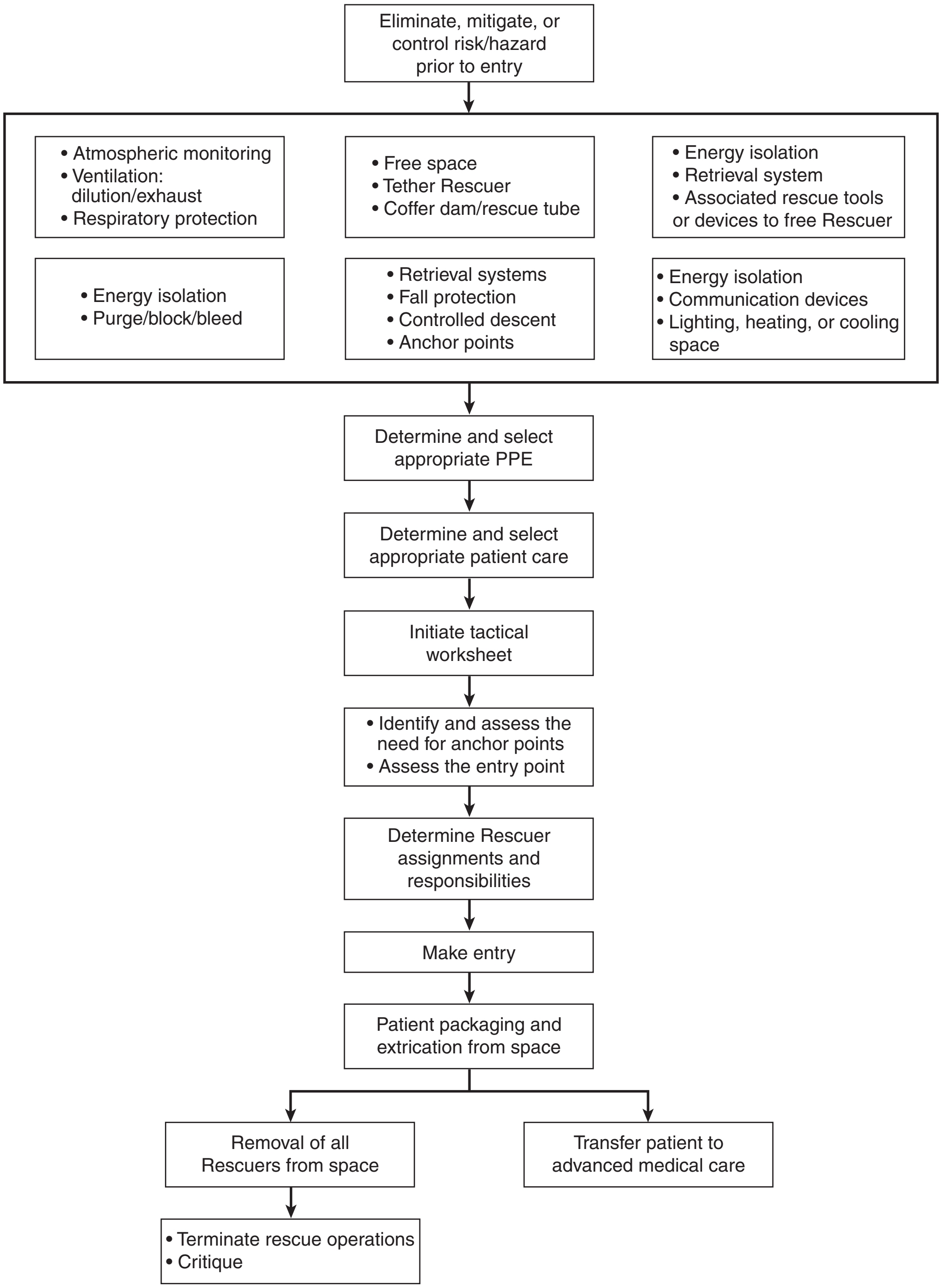
Information Acquisition and Management. Analysis of the potential emergency begins with managing information from the facility about the space prior to any incident. The basics of defining what takes place in the confined space is a logical place to begin this analysis.

Record all findings on a preplan survey or document that is readily available on a moment's notice. Technological equipment makes information readily available and portable to the incident location. The use of tablets, smart phones, and laptop computers aids in facilitating and implementing an action plan. Diagrams, plans, blueprints, and other means of drawings can be created on paper or computer programs, and software can help manage and input ever changing information. Once the information is tabulated, it should be reviewed for accuracy and put on a schedule to be appropriately reviewed so it can be kept current and precise. Users should be aware that technological equipment that is not approved for use in classified areas can present sources of ignition in situations where flammable vapors may be present.

A solid base of written or text type information can be obtained from the facility or Owner/Operator of the space, such as chemical and manufacturing data, SDS, the type of processes for which the space can be used, dates and times the space might be occupied, the size and location of vessels and confined spaces, facility floor plans or site surveys, prior incidents, previous permit entries, the number of workers in and around the space, and the type of work being performed routinely in and around the space.

Hazard and Risk Analysis. Many factors should be taken into consideration during an analysis of a confined space. An in-depth hazard and risk analysis can include, but is not limited to, the following questions: What type of process takes place in the space? What type of work will be done within the space that is not customary to the original process? How does the surrounding environment affect the space, and are there constant changes in the external environment over periods of time that add layers of complexity requiring special attention? What type of work is normally and potentially performed that might require the Entrants to evaluate the internal environment of the space on a timed basis, including temperature exposure and temperature changes, existing or changing atmospheric conditions, or length of work being performed? Will atmospheric monitoring or other hazard evaluation be required? Will specialized breathing apparatus be needed to work within the space? Are there biological or radioactive concerns inside the space?

Will the work being performed in the space change the internal environment? Will it have an effect on the space's immediate external surrounding areas or adjacent processes? Are there concerns with equipment, tools, and machines working in the space either repairing or cleaning? Will equipment being used in the space affect the current atmosphere? What type of ventilation is needed to sustain a nonhazardous atmospheric condition? Will the physical dimensions of the space have an effect on the Entrants, and will the physical or mental health of an Entrant pose a potential hazard to working safely inside the space? These and other considerations are covered more thoroughly in Chapter 6.



Δ FIGURE A.10.1.3.5 Rescue Emergency Action Matrix.

Environmental Considerations. Are low floor level liquids a concern? Are overhead obstructions or utility piping or cables a concern? Will PPE be required to work within the space? Does the space span many levels or floors? Is there a potential for weather to affect the outcome of an incident within the space? Is uncontrollable ambient noise a factor? Is there a potential for vibrations within and adjacent to the space? Does vehicle traffic, heavy equipment, or other processes affect the space? Does the potential for animal and insect interaction pose a concern to Entrants within the space?

Energy Isolation Considerations. Where are the control devices located for power and potential sources of energy for the internal and external areas of the space? How long will it take to verify that these sources are isolated? Can all sources be mechanically controlled, blocked, or blanked, or does the space require personnel to be committed to a location to physically control a device?

Will it take a specialty person or special group of individuals or maintenance workers to secure energy sources? How long will it take to assemble a group to secure energy sources within the facility or location of the space? Do these individuals work on premises or off site? Is there a considerable time factor associated with the specific task of securing energy sources? What is the means of delivering a message that an incident has occurred in a confined space requiring a response?

Communications Considerations. Can Entrants, Attendants, or Rescuers communicate effectively throughout the space, or is there a need for a more complex system requiring radios or communication systems? Will these communication devices work below grade and span the working length and levels of the space?

Work History and Physical Attributes of the Space. How often has the space been entered and is there prior documentation to previous entries? Where are previous entry documents or permit entries located, and are they relevant to potential emergencies? Does the configuration, length, or design of the space put limitations on the use of rescue equipment or require a specific type of equipment? Does the size, location, or height of the entry point pose challenges for Entrants or rescue personnel and rescue equipment?

Capability of Nonrescuers (e.g., Entrants, Attendants, Gas Testers, Entry Supervisors). What is the level of training of the individuals working within the space? How often is an emergency plan reviewed? When was the last time a training session was performed? Is there a safety plan in place for the space?

Rescue Capabilities — On-site and Outside Resources. Are emergency trained professionals on location of the space, or is an outside agency or local fire/rescue department tasked as a resource? What is the time frame for a rescue team of on-site employees to assemble? What is the time frame for an outside resource to arrive on location of the space? What is the level of training of the outside resource? Is the outside resource trained to the ALS medical level? Where is the closest medical facility that can treat a patient who has suffered injury or illness as the result of a potential confined space emergency or hazardous materials exposure?

Does the Owner/Operator of the space have an emergency plan or require notification or contact with specialized agencies such as the FBI, CIA, ATF, military, local and state police, or local security due to restricted areas, processes, or access restrictions?

Does the space require different levels of emergency response depending on the type of process or work being performed in the space? Does the time of day or day of week require different levels of emergency response?

A.10.7.2 Rescuers generally can choose from the following two types of atmosphere-supplying respirators to satisfy Rescuer requirements for respiratory protection in potentially hazardous atmospheres:

(1) Supplied air respirators (SAR) with an egress cylinder of sufficient capacity to allow egress in the event of accidental cessation of air flow from the hose line
(2) Self-contained breathing apparatus (SCBA) with sufficient capacity to perform the rescue operation

When deciding which type of respirator to use, Rescuers should consider the advantages and disadvantages of each relative to the rescue objective.

The limited duration of air supply in extended rescue operations requiring spinal immobilization or difficult extraction might preclude the use of SCBA. However, significant entanglement hazards within a space might make the use of SAR impossible. The portal shape and size might be restrictive and require the use of an SAR instead of an SCBA. The Rescuer should use the apparatus in the manner intended by the manufacturer versus having to remove the bulkier SCBA that otherwise will not fit through the portal, possibly dropping the apparatus or having the face piece pulled off and being exposed to contaminants.

The most effective means of making these and other decisions is through the use of pre-incident rescue action planning and practice of those plans on representative or actual spaces. Only through careful consideration of the circumstances and testing of the plan can PPE choices made by the rescue team be validated.

A.10.9.1 Confined space rescue teams should have enough qualified members to accomplish every function required to achieve the rescue objective. The size and capability of a team will depend on many factors, including, but not limited to, the condition of the Entrant, the size and shape of the space, the size of the access opening, and the hazards present. The positions described in 10.9.1(1) through 10.9.1(5) suggest the number of roles that should be considered to perform an entry-type rescue. Many rescues may require additional functions such as ventilation, rope rescue support, or communication that will require additional trained resources. Pre-incident planning of representative spaces is a key element to determining the size and capabilities of the rescue team. Table A.10.9.1 provides guidance for determining team size depending on the conditions of the space and anticipated rescue methods.

A.10.9.1(1) The size of a rescue entry team will be determined by the size of the space and the difficulty of the rescue operation. Typically, the entry team size should be at least two members. However, some spaces requiring technician-level resources may be only large enough to accommodate a single Rescuer. Some incidents may involve large spaces or complex rescue operations that require several Rescuers to enter the space.