NFPA®

56

Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems

2020

NFPA®

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NFPA® 56

Standard for

Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems

2020 Edition

This edition of NFPA 56, *Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems,* was prepared by the Technical Committee on Gas Process Safety. It was issued by the Standards Council on November 4, 2019, with an effective date of November 24, 2019, and supersedes all previous editions.

This edition of NFPA 56 was approved as an American National Standard on November 24, 2019.

Origin and Development of NFPA 56

In February 2010, an explosion occurred at a power plant construction site as the result of an uncontrolled release of flammable gas that was being used to clean the interior of the fuel piping system. The incident investigation resulted in urgent recommendations being issued by the U.S. Chemical Safety Board (CSB) for NFPA to develop requirements for the "safe conduct of fuel gas piping cleaning operations." In response, the NFPA Standards Council established the Technical Committee on Gas Process Safety and tasked that committee with developing a standard to address piping system cleaning and purging operations. As a result of the CSB's urgent recommendation, NFPA issued provisional standard NFPA 56 (PS), *Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems,* which prohibits the use of flammable gas as an agent for the interior cleaning of piping systems. NFPA 56 (PS) expanded on the CSB recommendations by including cleaning and purging of all flammable gas piping systems at any inlet pressure for electric-generating plants and for industrial, commercial, and institutional applications.

In addition to the use of flammable gas for cleaning and purging, the provisional standard addressed training requirements for personnel as well as notification of hazards for personnel not directly involved in cleaning or purging procedures. The standard required development of written procedures for cleaning and purging activities and that all such written procedures undergo a safety validation performed by a competent person. The definition of *competent person* was extracted directly from federal Occupational Safety and Health Administration (OSHA) regulations. NFPA 56 (PS) also adopted terminology commonly used by the petrochemical industry for those procedures: *purging into service* for the process of replacing air in a piping system with inert or flammable gas and *purging out of service* for the process of replacing flammable gas in the piping system with inert gas or air.

In accordance with ANSI requirements for provisional standards, NFPA 56 (PS) was immediately submitted for revision in accordance with the NFPA Regulations Governing Committee Projects. As a result, NFPA 56 is no longer a provisional standard and will no longer be designated with the suffix "PS."

In the 2014 edition, new requirements were added to address the use of pressure relief valves and their associated piping in purging and cleaning processes. NFPA 55, *Compressed Gases and Cryogenic Fluids Code,* was exempted from the scope of NFPA 56 in recognition of new requirements added to NFPA 55 to address cleaning and purging of flammable gas piping systems within the NFPA 55 scope.

Also, the term source valve was defined and added to the scope because it is the term used in the compressed/industrial gas industry to demarcate the point of delivery to the piping system. The 2014 edition also included additional annex text to further clarify existing and new requirements.

In the 2017 edition, the requirements for written procedures for cleaning and purging activities were modified to include additional topics. The procedures were required to address nonconductive components in temporary piping assemblies in order to account for the static charge that might be

induced by those components. Additionally, the written procedures were created to address protection and rescue of personnel; this included the selection of fire-resistant clothing based on a hazard analysis in accordance with NFPA 2113, *Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Short-Duration Thermal Exposures*. New requirements were added to the training requirements in Chapter 5 to ensure that knowledge transfer was evident in the training program and to make sure the appropriate information was maintained in the training records.

In the 2020 edition, the technical committee further specified where the standard is not applicable including: gas-consuming equipment; gathering lines from well pads to gas processing facilities, since these systems are addressed in other publications such as the AGA *Purging Manual*; and well padding systems, because of the complexity and range of issues that make NFPA 56 inadequate for this type of application. Well pad piping systems can contain significant amounts of flammable and combustible liquids that are not addressed in this standard.

Cleaning and purging activities were revised in Chapter 4. Associated guidance information was added in Annex A to address gaps within requirements that were identified in the previous edition.

Guidance information was added to Annex A to: provide guidelines for the development of an emergency response plan (ERP); assist the users of this standard develop a comprehensive training program; and verify that personnel can perform their duties prior at the start of the cleaning or purging activity.

Extracts from other NFPA documents have been updated to the latest revisions of the source documents. Information in Annex B that has been extracted from the AGA *Purging Manual* was revised to be consistent with the latest edition of the publication.

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

Committee Scope: This committee shall have primary responsibility for documents on the commissioning and maintenance of flammable gas piping systems in commercial, industrial, and power plant applications, extending from the point of delivery to the equipment isolation or shutoff valve except for those already covered by the NFPA National Fuel Gas Code Technical Committee and/or the NFPA Hydrogen Technologies Technical Committee.

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NFPA 56

Standard for

Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems

2020 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. 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 and extracted publications can be found in Chapter 2 and Annex D.

Chapter 1 Administration

1.1 Scope.

1.1.1 Applicability. This standard shall apply to fire and explosion prevention during cleaning and purging activities for new and existing flammable gas piping found in electric-generating plants and in industrial, institutional, and commercial applications.

1.1.1.1* Coverage of fuel gas piping systems shall extend from the point of delivery or source valve to the gas-consuming equipment isolation valve.

Δ **1.1.1.1.1** For other than undiluted liquefied petroleum gas (LP-Gas) systems, the point of delivery shall be the outlet of the service meter assembly or the outlet of the service regulator or service shutoff valve where no meter is provided. [**54:**1.1.1.1(A)]

1.1.1.1.2 For undiluted LP-Gas systems, the point of delivery shall be considered to be the outlet of the final pressure regulator, exclusive of line gas regulators where no meter is installed. Where a meter is installed, the point of delivery shall be the outlet of the meter. [**54:**1.1.1.1(A)]

1.1.1.1.3 For facilities that produce flammable gas for consumption on site, the point of delivery or source valve shall be the discharge isolation valve for the gas-producing equipment.

1.1.1.2* Coverage of flammable gas piping systems other than fuel gas piping systems shall extend from the source valve serving the gas supply system to the gas-consuming equipment isolation valve.

1.1.2 Nonapplication of Standard. This standard shall not apply to the following items:

(1)* Piping systems covered by NFPA 2
(2)* Piping systems covered by NFPA 51
(3) Fuel-dispensing facilities covered by NFPA 52
(4)* Piping systems covered by NFPA 54
(5)* Piping systems covered by NFPA 55
(6)* Piping systems covered by NFPA 58
(7)* LP-Gas (including refrigerated storage) at utility gas plants *(see NFPA 59)*
(8)* LNG facilities covered by NFPA 59A
(9)* Vehicle fuel dispensers
(10) Commissioning and maintenance of gas-consuming equipment
(11) Vent lines from pressure relief valves or devices unless such vent lines are also used for purging of flammable gas piping systems
(12)* Systems regulated by U.S. Department of Transportation (DOT) 49 CFR 100–199
(13)* Gathering lines from well pads to gas processing facilities
(14) Well pad piping systems

Δ **1.2* Purpose.** This standard provides minimum safety requirements for the cleaning and purging of flammable gas piping systems, including cleaning new or existing piping systems, and purging piping systems into or out of service.

1.2.1 For the purposes of this document, a piping system shall be understood to mean a complete piping system, including valves, regulators, and other appurtenances, and any segment thereof that can be isolated from the system.

1.3* Coordination. Coordination of the flammable gas piping system design and construction, including any temporary piping, and the minimum safety requirements for cleaning and purging specified in Chapters 6, 7, and 8 shall be required.

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

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

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

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

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

Chapter 2 Referenced Publications

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

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

NFPA 2, *Hydrogen Technologies Code,* 2020 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2018 edition.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment,* 2020 edition.

NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes,* 2018 edition.

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

NFPA 52, *Vehicular Natural Gas Fuel Systems Code,* 2019 edition.

NFPA 54, *National Fuel Gas Code,* 2018 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code,* 2020 edition.

NFPA 58, *Liquefied Petroleum Gas Code,* 2020 edition.

NFPA 59, *Utility LP-Gas Plant Code,* 2018 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG),* 2019 edition.

NFPA 69, *Standard on Explosion Prevention Systems,* 2019 edition.

NFPA 70®, National Electrical Code®, 2020 edition.

NFPA 2113, *Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire,* 2020 edition.

2.3 Other Publications.

2.3.1 ASME Publications. American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

ASME B31.1, *Power Piping*, 2016.

ASME B31.3, *Process Piping*, 2016.

ASME B31.12, *Hydrogen Piping and Pipelines*, 2014.

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

Title 29, Code of Federal Regulations, Part 1926.32(f), Safety and Health Regulations for Construction.

Title 49, Code of Federal Regulations, Parts 100–185, Hazardous Material Regulations.

Title 49, Code of Federal Regulations, Parts 190–199, Pipeline Safety Regulations.

2.3.3 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

NFPA 54, *National Fuel Gas Code,* 2018 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code,* 2016 edition.

Chapter 3 Definitions

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

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

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

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

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

3.2.7 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1* Cleaning Media. Materials used to clean piping systems.

3.3.2 Closed Piping System. Interconnected piping that is designed to contain the flammable gas under pressure during normal operations and incorporates provisions for controlled release of contents.

3.3.3* Competent Person. One who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them. **[29 CFR 1926.32(f)]**

3.3.4* Detection Equipment. Monitoring equipment necessary for detecting and/or measuring the concentration of flammable gas or oxygen present in air.

3.3.5 End Point. Attainment of concentration (percent by volume) of inert substance in the closed system being purged such that subsequent admission of air, if purging out of service, or admission of gas or vapor, if purging into service, will not result in formation of a flammable mixture.

3.3.6 Equipment Isolation Valve. A manual shutoff valve for shutoff of the flammable gas to each piece of equipment.

3.3.7* Flammable Gas. A material that is a gas at 68°F (20°C) or less at an absolute pressure of 14.7 psi (101.3 kPa), that is ignitible at an absolute pressure of 14.7 psi (101.3 kPa) when in a mixture of 13 percent or less by volume with air, or that has a flammable range at an absolute pressure of 14.7 psi (101.3 kPa) with air of at least 12 percent, regardless of the lower limit. [**55,** 2016]

3.3.8* Inert Gas. A nonreactive, nonflammable, noncorrosive gas such as argon, helium, krypton, neon, nitrogen, and xenon. [**55,** 2016]

3.3.9 Pig. A device that is inserted into a pipeline to perform a specific task within the pipeline and that travels freely through the pipeline pulled by a cable; propelled by air, water, or another medium; or driven by the product flow.

3.3.10 Purge. To free a gas conduit of air or gas, or a mixture of gas and air. [**54,** 2018]

3.3.10.1 ***Purge into Service.*** To replace the air or inert gas in a closed system by a flammable gas.

3.3.10.2 ***Purge out of Service.*** To replace the normal flammable content of a closed system by inert gas, air, or water.

3.3.11 Source Valve. A shutoff valve on the piping system serving a gas supply system where the gas supply, at service pressure, first enters the supply line.

Chapter 4 General Requirements

4.1 Piping System Construction. Flammable gas piping systems shall be designed, constructed, inspected, and tested in accordance with ASME B31.1, *Power Piping*; ASME B31.3, *Process Piping*; ASME B31.12, *Hydrogen Piping and Pipelines*; NFPA 55; NFPA 54; or other approved codes or standards.

Δ **4.1.1** The requirement of Section 4.1 shall not be required to be applied retroactively.

Δ **4.1.2* Pressure Testing and Inspection.** Prior to cleaning, pressure testing, or purging a new system that has not been in service, piping systems shall be inspected to determine that the materials, design, fabrication, and installation practices comply with the requirements of this standard and the intended application.

4.1.2.1* Pressure testing and inspection procedures shall be documented.

4.1.2.2 Where piping is designed and installed in accordance with NFPA 54, pressure testing and inspection shall be in accordance with Chapter 8 of NFPA 54.

Δ **4.1.2.3** Where piping is designed and installed in accordance with ASME B31.1, *Power Piping*, pressure testing and inspection shall be in accordance with ASME B31.1.

4.1.2.4* Where piping is designed and constructed in accordance with ASME B31.3, *Process Piping*, leak testing and inspection shall be in accordance with Chapter VI of ASME B31.3.

Δ **4.1.2.5*** Where pneumatic testing is conducted, the test medium shall be air or an inert gas. Oxygen shall never be used.

4.2* Temperature and Pressure. The delivered temperature and pressure of cleaning or purging media shall be compatible with the flammable gas piping system.

4.3 Notification of Hazards. Personnel in the affected area(s), as determined by the cleaning or purging procedure, shall be informed of the hazards associated with the activity prior to the initiation of any such activity.

4.4* Cleaning and Purging Procedures. Written cleaning and purging procedures shall be developed and implemented by a competent person.

Δ **4.4.1* Cleaning and Purging Activities.** The written procedure for each cleaning and purging activity shall address, as a minimum, the following items:

(1) Scope of work and site-specific purge procedure development
  (a) Cleaning and purging method
  (b) Piping and instrument diagrams (PIDs)
  (c) Chemical and physical properties of flammable gas, cleaning media, purge media, and discharge gas
  (d) Determination of purge end point introducing flammable gas, inert gas, or air
  (e) Assessment and control of purge inlet and discharge locations
  (f)* Mitigation or capture strategies
  (g) Temporary piping system design
  (h) Management review and approval
  (i) Restoration of service
  (j) Target design, launcher/receiver venting review for pigging operations
  (k) Regulatory permits
  (l) Evaluation of engineering controls that allow gases from depressurization to be consumed in a controlled manner instead of vented (e.g., flaring or controlled combustion in process equipment).
  (m) Written stand-down instructions to stop activity in a controlled manner
  (n)* Precautions for gases that have toxic, highly toxic, unstable reactive, corrosive, or other deleterious properties beyond flammability

(o)* Preparation of a valve line-up table or chart to show the state of critical valves during each state of the purge

(2) Environmental conditions and work locations
- (a)* Establishment and clear identification of exclusion zones, including plume release threat zones, where flammable gas–air mixtures are likely to exist
- (b) Limited access for personnel not directly involved with purge operations
- (c) Assessment of potential for gas migration (e.g., building openings, adjacent structures)
- (d) Prohibition of hot work within exclusion zones
- (e) Lockout/tagout
- (f) Impact of environmental conditions (e.g., wind speed and direction, temperature, barometric pressure) on purge operations
- (g) Vehicular and air traffic, if applicable
- (h) Topography
- (i) Noise control/monitoring

(3) Communication plans
- (a) Pre-job briefings
- (b) Work permits
- (c) Roles and responsibilities
- (d)* Emergency response plan
- (e) Facility alarm, alert, and warning systems
- (f) General facility notification prior to start of purge operations
- (g) General facility notification at the conclusion of purge operations
- (h) Notification of regulatory authorities as required (local emergency responders, utility operators, community officials, environmental authorities, etc.)

(4) Control of ignition sources
- (a)* Bonding and grounding considerations
- (b) No smoking or spark-producing work within exclusion zones
- (c) Elimination of hot work within exclusion zone
- (d) Static electricity ignition sources at discharge point
- (e)* Nonconductive piping, hose, or fittings in temporary piping assemblies

(5) Pre-purge piping system assessment
- (a) Assessment of piping system for trapped liquids, pyrophoric solids, and other flammable or combustible deposits within the piping system
- (b) Ensuring that the piping system is properly isolated
- (c) Limiting site conditions that impact the safety of the activity
- (d) Verification that no isolation valves are seized in position
- (e) Review of on-site tools and sealants for tri-union mounted ball valves
- (f) Review of piping for mechanical integrity, including fastener's grade, type, and condition, and external corrosion of fasteners and piping systems
- (g) Servicing of lubricated plug valves according to manufacturer's instructions
- (h) Review of previous temporary repairs that could include fiberglassing, wraps, or mechanical clamps
- (i) Review of hanger integrity and spacing

(6)* Purge monitoring and instrumentation
- (a) Ensuring that monitoring instruments are appropriate for gas being purged
- (b) Training
- (c) Calibration
- (d) Monitoring frequency and reporting
- (e) Appropriate selection of sample point(s)
- (f) General atmosphere checks in vicinity of purge gas release

(7) Protection and rescue of personnel
- (a) Training requirements for personnel involved in the work efforts
- (b) Personal protective equipment
- (c) Selection of fire-resistant clothing (FRC) based on a hazard analysis in accordance with NFPA 2113
- (d) Rescue equipment, including self-contained breathing apparatus and breathing air escape packs
- (e) Standby rescue personnel
- (f) Primary and secondary assembly areas
- (g) Assignment of personnel for alerting and accounting of personnel

(8)* Management and use of inerts
- (a) Reviewing the form of inerts that will be used for purging (bottles, tube trailer, vaporizers) to understand the benefits, limitations, and safety aspects of each
- (b) Establishing training requirements regarding the handling of inerts, including asphyxiation hazards and temperature issues with cryogenic or liquefied inerts
- (c) Specifying that hoses used for inerts are compatible with inert materials, temperatures, and services pressures
- (d) Specifying the use of hose safety restraints or other temporary constraints for all inert hose connections
- (e) Specifying required flow rate and pressure drop limitations to ensure the proper amount of flow for the duration of the purge, either by integral or field-installed regulating equipment

4.4.2 Stand-Down. If the conditions during the purging or cleaning activity deviate from those indicated in the written procedure, resulting in a safety hazard, the purging or cleaning activity shall be discontinued according to the stand-down instructions.

4.5* Safety Validation. A written safety validation shall be performed for cleaning and purging procedures.

4.5.1* The safety validation shall be conducted independently after the procedure has been written and shall evaluate hazards, errors, and malfunctions related to each step in the procedure to validate the measures prescribed in the procedure or make recommendations for additional hazard mitigation measures if necessary.

4.5.2* Recommendations (also called "action items") resulting from the safety validation shall be resolved prior to the activity being conducted.

4.5.3* Prior to initiation of a cleaning or purging activity, the safety validation shall be approved by a designated individual who is competent and knowledgeable in the procedure and hazards and who is authorized to provide such approval.

4.6* Management of Change. Written procedures to manage change to process materials, technology, equipment, procedures, and facilities shall be established and implemented.

4.6.1 The management-of-change procedures shall ensure that the following issues are addressed prior to any change:

(1) The technical basis for the proposed change
(2) The safety and health implications
(3) Whether the change is permanent or temporary
(4) Modifications to cleaning and purging procedures
(5) Employee training requirements
(6) Authorization requirements for the proposed change

4.6.2* Implementation of the management-of-change procedures shall not be required for replacements-in-kind.

4.6.3 The written cleaning and purging procedure, as required by Section 4.4, shall be updated to incorporate the change.

4.7 Documentation.

4.7.1 Cleaning and purging procedures shall be documented and available at the job site.

4.7.2 The safety validation documentation shall include the following items:

(1) Names, company names, and addresses of the primary developer and other principal team members responsible for the safety validation
(2) Name(s), company name, and address of the principal operational personnel representing the plant owner or operator
(3) Date of preparation and any applicable modification dates
(4) The completed safety validation in accordance with Section 4.5
(5) Any procedures related to the safety validation and any limiting conditions identified in the management-of-change assessment required by Section 4.6

4.7.3 The safety validation and the cleaning and purging procedures shall be retained for at least 2 years following completion of the activity.

4.8 Notification of Hazards. Personnel in the affected area(s), as determined by the cleaning or purging procedure, shall be informed of the hazards associated with the activity prior to the initiation of any such activity.

4.9 Evacuation of Affected Area. Personnel not involved in cleaning or purging activities shall be evacuated from the affected area(s) as determined by the procedure.

4.10 Segment Cleaning. Piping system segments that can be isolated for cleaning prior to completion of the entire piping system shall be permitted to be cleaned, tested, and secured in a clean condition in accordance with Section 6.7.

4.11 Hangers and Supports. Hangers, supports, or other means capable of restricting the movement of piping shall be installed prior to initiating cleaning or purging activities in accordance with the procedure.

4.12* Nonflammable Atmosphere. Fluid media for testing or cleaning shall not introduce a flammable atmosphere into or create a fire hazard in the piping system being tested or cleaned.

4.13 Utility Coordination. Where utilities such as steam, water, or compressed air are used in quantities or for a duration that can disrupt distribution or operations internal or external to the facility, cleaning or purging activities shall be coordinated with the managing authority of the utilities.

4.14 Restricted Access. Access to all parts of the piping system during cleaning or purging activities shall be restricted in accordance with the procedure.

4.15 Hot Work Safety. Cutting, welding, and allied processes shall be in accordance with NFPA 51B.

4.15.1 Hot work shall not be permitted within the exclusion zone where flammable gas–air mixtures are likely to exist, as determined by the procedure.

Chapter 5 Training Requirements

5.1* Training. Persons whose duties fall within the scope of this standard shall be provided with training that is consistent with the scope of their job activities and assigned tasks for the cleaning or purging work to be performed. Evidence of knowledge transfer shall be included as part of the training program.

5.1.1 Topics covered by such training shall include hazards of flammable gas, hazards of compressed gases used for cleaning or purging, safe handling practices of flammable gas and compressed gas as applicable, and company emergency action plans and procedures.

5.1.2 Personnel training shall be conducted by a competent person knowledgeable in the subject matter and shall be documented.

Δ **5.1.3*** Training records, including dates of training, name of instructor(s), content or curriculum covered, evidence of knowledge transfer, and demonstration of applicable skills, shall be maintained for a period not less than 5 years from the date of completion of the activity.

Chapter 6 Cleaning

6.1 Cleaning of Flammable Gas Piping.

6.1.1 General.

6.1.1.1 Flammable gas shall not be used for internal cleaning of piping.

6.1.1.2 Notification shall precede the start of cleaning in accordance with the written cleaning procedure.

6.2* Cleaning Media. Air, inert gas, steam, and water shall be acceptable cleaning media.

6.2.1* Other cleaning media, except flammable gas, shall be permitted to be used in accordance with the written cleaning procedure.

6.2.2* Use and disposal or recovery of flammable liquid solvents shall be in accordance with NFPA 30.

6.2.2.1* A copy of the safety data sheet for the flammable liquid solvent shall be provided to personnel developing the cleaning procedure, personnel performing the cleaning procedure, and personnel developing the procedures for the handling and dispensing of the flammable liquid solvent.

6.2.2.2 The compatibility of the flammable solvent with the pipe materials, with the flammable gas in the pipe, and with

other materials used during cleaning shall be established prior to the use of the solvent.

6.2.2.3 The hazards associated with the presence of residual flammable liquid solvent in the piping after cleaning shall be assessed prior to the purging of the piping into service.

6.3* Temporary Power/Fuel Supply.

6.3.1 Where electric power is used to power the equipment necessary to implement the pipe cleaning, it shall be connected in accordance with *NFPA 70*.

6.3.2 Where fuel gas is used to power the equipment necessary to implement the pipe cleaning, it shall be piped and connected in accordance with NFPA 54 or NFPA 58, as applicable.

6.3.3 Where fuel oil is used to power the equipment necessary to implement the pipe cleaning, it shall be piped and connected in accordance with NFPA 31.

6.4 Temporary Piping (Including Hose Assemblies). Temporary piping systems, including hose assemblies, used to connect the cleaning media supply source to the piping system shall be in accordance with ASME B31.1, *Power Piping*, paragraph 122.10, or the same code or standard used for the permanent piping system.

6.5 Pig Cleaning. Pigs shall be permitted to be used to clean piping systems.

6.5.1 Prior to placing a piping system into service, the fluid used to propel the pig through the piping system shall be water, steam, air, or inert gas.

6.5.2* A pig shall be permitted to be used to accomplish cleaning and purging into service simultaneously in accordance with 6.5.2.1 through 6.5.2.4.

6.5.2.1* Pig cleaning using flammable gas as the propellant shall utilize a closed piping system.

6.5.2.2* Where a pig is used to accomplish cleaning and purging simultaneously, the pig shall be sized to minimize unintended commingling of flammable gas and air.

6.5.2.3* A pig shall be permitted to be used to clean a piping system that is filled with flammable gas where the flammable gas in the piping system is being consumed by end-use equipment or flares and the residual flammable gas in the launcher or receiver is discharged in accordance with 8.3.2.

6.5.2.4 Where flammable gas is used as the pig propellant, the residual gas from the launcher or receiver shall be discharged in accordance with 8.3.2.

6.6* Target. Where a target is used to indicate debris during the cleaning process, it shall be designed and secured to withstand the velocity and pressure of the exiting media and debris without breaking or failing.

6.7 Isolation and Protection of Clean Piping Systems or Segments. Where piping systems are cleaned in stages during fabrication or field assembly, the clean piping shall be isolated and protected against infiltration of contaminants.

Chapter 7 Purging into Service

7.1 Charging Piping System with Flammable Gas.

7.1.1 Where gas piping containing air is placed in operation, the air in the piping first shall be displaced with an inert gas, which then shall be displaced with flammable gas in accordance with Section 7.2.

Δ **7.1.2*** If an electric generating plant is operated by the serving natural gas supplier, natural gas piping between the point of delivery or source valve and the plant shall be permitted to be purged into service in accordance with the serving natural gas supplier's written procedures.

7.1.2.1 The natural gas supplier's written procedures shall include a safety validation in accordance with Section 4.5.

7.1.2.2 The natural gas supplier's written procedures and process shall be coordinated with the plant operational personnel.

7.2 Discharge of Purged Gases.

7.2.1 Vent Pipe Termination. The discharge from a piping system being purged into service shall discharge to a specified unconfined outdoor location determined by the written procedure or shall be captured or further processed before release.

7.2.2 Purging operations shall comply with the requirements in 7.2.2.1 through 7.2.2.6.

7.2.2.1 The vent line from a piping system being purged into service shall be equipped with a readily accessible or remotely actuated shutoff valve.

7.2.2.2 During purging, the discharge from the piping system shall be monitored with detection equipment that complies with Section 7.3.

7.2.2.3* Purging operations introducing inert gas shall continue in accordance with the written procedure until the oxygen concentration detected at the discharge point of the piping system is less than 60 percent of the limiting oxidant concentration as determined in accordance with 7.2.3 of NFPA 69.

7.2.2.4* Except as permitted in 7.2.2.5, purging operations that introduce flammable gas shall continue in accordance with the written procedure until at least 90 percent flammable gas by volume or the minimum concentration established by the purging procedure is detected at the discharge of the piping system.

7.2.2.5 Where a piping system containing inert gas is purged into service, it shall be permitted to discharge the gas downstream in lieu of venting in accordance with the following parameters:

(1) The piping system design can accommodate the activity.
(2) The end-point concentration of inert gas does not prevent complete combustion or consumption of the flammable gas in the end-use equipment or process.
(3) The inert gas–flammable gas mixture is released in a controlled manner to end-use equipment or process equipment.

7.2.2.6 Where permitted by the piping design code, a vent line serving a pressure relief valve or pressure relief device used to also vent purge gases shall be sized to comply with the following parameters:

(1) The purge flow shall not compromise the operation of pressure relieving valves or devices.
(2) Operation of the relief valve or device shall not compromise the integrity of the purge flow.
(3)* Purge flows through such a vent line shall not compromise any connected systems.

7.3 Detection Equipment.

7.3.1* Sense of smell shall not be used to detect the presence of flammable gas.

7.3.2* Detection equipment shall be listed or approved for the gas being monitored and the environment where it is used and shall be calibrated in accordance with the manufacturer's instructions.

7.3.3* Combustible gas indicators shall numerically display the gas concentration by volume scale from 0 percent to 100 percent in measurement increments determined by the procedure.

7.3.4* Lower flammability limit (LFL) monitors shall numerically display the gas concentration as a percentage of the LFL from 0 percent to 100 percent, or the equivalent percent by volume, in measurement increments determined by the procedure.

7.3.5 Oxygen monitors shall numerically display the oxygen concentration by volume from 0 percent to 25 percent or higher in measurement increments determined by the procedure.

Chapter 8 Purging Out of Service

8.1 Isolation. Flammable gas piping shall be isolated from the flammable gas supply and downstream piping and equipment prior to purging out of service.

8.2 Charging with Inert Gas. Where existing gas piping is purged out of service, the residual flammable gas in the piping shall be displaced with an inert gas.

Δ **8.2.1*** If an electric generating plant is operated by the serving natural gas supplier, natural gas piping between the point of delivery or source valve and the plant shall be permitted to be purged out of service in accordance with the serving natural gas supplier's written procedures.

8.2.1.1 The natural gas supplier's written procedures shall include a safety validation in accordance with Section 4.5.

8.2.1.2 The natural gas supplier's written procedures and process shall be coordinated with the plant operational personnel.

8.3 Discharge of Purged Gases.

8.3.1* Pressurized flammable gas systems shall be depressurized prior to being purged out of service in accordance with the written purge procedure.

8.3.2 The discharge from a piping system being purged out of service shall discharge to a specified unconfined outdoor location determined by the written procedure or shall be captured or further processed before release.

8.3.3 Purging operations shall comply with the requirements in 8.3.3.1 through 8.3.3.5.

8.3.3.1 The vent line from a piping system being purged out of service shall be equipped with a readily accessible or remotely actuated shutoff valve.

8.3.3.2 During purging, the discharge from the piping system shall be monitored in accordance with the written procedure with detection equipment that complies with Section 8.4.

8.3.3.3* Purging operations that introduce inert gas shall continue in accordance with the written procedure until the flammable gas concentration detected at the discharge of the piping system is such that the inert gas–flammable gas mixture is not ignitible when released in air.

8.3.3.4 Purging operations that introduce air to displace inert gas shall continue in accordance with the written procedure until at least 19.5 percent oxygen by volume is detected at the discharge of the piping system.

8.3.3.5 Where permitted by the piping design code, a vent line serving a pressure relief valve or pressure relief device used to also vent purge gases shall be sized to comply with the following parameters:

(1) The purge flow shall not compromise the operation of pressure relieving valves or devices.
(2) Operation of the relief valve or device shall not compromise the integrity of the purge flow.
(3)* Purge flows through such a vent line shall not compromise any connected systems.

8.4 Detection Equipment.

8.4.1* Sense of smell shall not be used to detect the presence of flammable gas.

8.4.2* Detection equipment shall be designed and listed for the gas being monitored and the environment where it is used and operated in accordance with the manufacturer's instructions.

8.4.2.1 Where listed gas detection equipment is not available for the specific gas being detected, the gas detection equipment shall be recommended for the application by the manufacturer and approved.

8.4.3* Lower flammability limit (LFL) detectors shall be capable of measuring the gas concentration in accordance with 8.3.3.3.

8.4.4 Oxygen detectors shall be capable of measuring the oxygen concentration in accordance with 8.3.3.4.

Annex A Explanatory Material

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

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A.1.1.1.1 The piping system includes segments located between pieces of equipment, such as gas conditioning or compressing equipment. This document does not cover the commissioning or maintaining of such equipment. However,

the standard can be applied to the commissioning or maintaining of those piping segments and equipment as a system where the complete system is purged into or out of service as a unit. The equipment manufacturer's written instructions should be included as part of the written purge procedure. The equipment isolation valve is intended to be the final isolation valve prior to the manufacturer's or supplier's equipment gas train. For some common pieces of equipment in NFPA standards, the isolation valve is identified and referenced as follows:

(1) NFPA 37 uses the term *equipment isolation valve* in 5.2.1.
(2) NFPA 85 uses the term *manual shutoff valve* in Figure A.5.3.2.3 for single burner boilers; in Figure A.6.6.5.1.5.4(a) and Figure A.6.6.5.1.5.4(b) for multiple burner boilers; and in Figure A.8.8.5.8(a) through Figure A.8.8.5.8(c) for heat recovery steam generators.
(3) NFPA 86 uses the term *equipment isolation valve* in 6.2.4.1.
(4) NFPA 87 uses the term *equipment isolation valve* in 6.2.4.3.

A.1.1.1.2 Flammable gas container, cylinder, or tank filling operations are not included in the scope of NFPA 56 because there is no gas-consuming equipment.

A.1.1.2(1) The application of NFPA 2 is included here for the convenience of the user:

1.3 Application. [**2:**1.3]

1.3.1 This code shall apply to the production, storage, transfer, and use of hydrogen in all occupancies and on all premises. [**2:**1.3.1]

1.3.2 The use of hydrogen shall include stationary, portable, and vehicular infrastructure applications. [**2:**1.3.2]

1.3.3 The fundamental requirements of Chapters 1 through 8 [of NFPA 2] shall apply in addition to the use-specific requirements provided in Chapters 9 through 18, as applicable. [**2:**1.3.3]

1.3.4 Exemptions. This code shall not apply to the following:

(1) Onboard vehicle or mobile equipment components or systems, including the onboard GH_2 or LH_2 fuel supply
(2) Mixtures of GH_2 and other gases with a hydrogen concentration of less than 95 percent by volume when in accordance with NFPA 55
(3) The storage, handling, use, or processing of metal hydride materials outside of metal hydride storage systems defined in Chapter 3 [of NFPA 2]

[**2:**1.3.4]

Δ **A.1.1.2(2)** The scope and application of NFPA 51 is included here for the convenience of the user:

1.1 Scope. [**51:**1.1]

1.1.1 This standard applies to the following:

(1) Design and installation of oxygen–fuel gas welding and cutting systems and allied processes *(see 3.3.2)*, except for systems meeting the criteria in 1.1.5
(2) Utilization of gaseous fuels generated from flammable liquids under pressure where such fuels are used with oxygen
(3) Storage on the site of a welding and cutting system installation of the following:
    (a) Gases to be used with such systems where more than one cylinder each of oxygen and fuel gas are stored in any single storage area [includes storage of more than one cylinder each in any single storage area even though all such stored cylinders may be intended for use in systems of the kind described in 1.1.1(1)].
    (b) Calcium carbide

[**51:**1.1.1]

1.1.2 Unless specifically indicated otherwise, the term *welding and cutting systems* shall be considered to include *allied processes* in this standard. [**51:**1.1.2]

1.1.3 Where only a portion of a fuel gas system is to be used for welding, cutting, or allied processes, only that portion of the system need comply with this standard. [**51:**1.1.3]

1.1.4 Where only a portion of an oxygen system is to be used with fuel gas for welding, cutting, or allied processes, only that portion of the system need comply with this standard. [**51:**1.1.4]

1.1.5 This standard shall not apply to the following:

(1) Systems consisting of a single cylinder not exceeding 120 ft^3 (3.4 m^3) of oxygen and a single cylinder not exceeding 120 ft^3 (3.4 m^3) of fuel gas used for welding and cutting
(2) Systems in which fuel gases are not to be used with oxygen, as described in NFPA 54 and NFPA 58
(3) The manufacture of gases and the filling of cylinders
(4) Storage of empty cylinders
(5) Compressed air–fuel gas systems

[**51:**1.1.5]]

Δ **A.1.1.2(4)** The scope of NFPA 54 is included here for the convenience of the user:

1.1 Scope. [**54:**1.1]

1.1.1 Applicability. [**54:**1.1.1]

1.1.1.1 This code is a safety code that shall apply to the installation of fuel gas piping systems, appliances, equipment, and related accessories as shown in 1.1.1.1(A) through 1.1.1.1(F). [**54:**1.1.1.1]

(A)* Coverage of piping systems shall extend from the point of delivery to the appliance connections. For other than undiluted liquefied petroleum gas (LP-Gas) systems, the point of delivery shall be the outlet of the service meter assembly or the outlet of the service regulator or service shutoff valve where no meter is provided. For undiluted LP-Gas systems, the point of delivery shall be considered to be the outlet of the final pressure regulator, exclusive of line gas regulators where no meter is installed. Where a meter is installed, the point of delivery shall be the outlet of the meter. [**54:**1.1.1.1(A)]

A.1.1.1.1(A) The final pressure regulator in an undiluted liquefied petroleum gas (LP-Gas) system can include any one of the following:

(1) The second stage regulator or integral two-stage regulator
(2) A 2 psi (14 kPa) service regulator or integral 2 psi (14 kPa) service regulator

(3) A single-stage regulator, where single-stage systems are permitted by NFPA 58

(B) This code shall apply to natural gas systems operating at a pressure of 125 psi (862 kPa) or less. [**54:**1.1.1.1(B)]

(C) This code shall apply to LP-Gas systems operating at a pressure of 50 psi (345 kPa) or less. [**54:**1.1.1.1(C)]

(D) This code shall apply to gas–air mixture systems operating within the flammable range at a pressure of 10 psi (69 kPa) or less. [**54:**1.1.1.1(D)]

(E) Requirements for piping systems shall include design, materials, components, fabrication, assembly, installation, testing, inspection, operation, and maintenance. [**54:**1.1.1.1(E)]

(F) Requirements for appliances, equipment, and related accessories shall include installation, combustion, and ventilation air and venting. [**54:**1.1.1.1(F)]

A.1.1.2(5) The scope of NFPA 55 is included here for the convenience of the user:

1.1 Scope. [**55:**1.1]

1.1.1 Applicability. This code shall apply to the installation, storage, use, and handling of compressed gases and cryogenic fluids in portable and stationary containers, cylinders, equipment, and tanks in all occupancies. [**55:**1.1.1]

1.1.2 Specific Applications. This code shall not apply to the following:

(1) *Off-site transportation of materials covered by this code
(2) Storage, use, and handling of radioactive gases in accordance with NFPA 801
(3) *Use and handling of medical compressed gases at health care facilities in accordance with NFPA 99
(4) Systems consisting of cylinders of oxygen and cylinders of fuel gas used for welding and cutting in accordance with NFPA 51
(5) *Flammable gases used as a vehicle fuel when stored on a vehicle
(6) *Storage, use, and handling of liquefied and nonliquefied compressed gases in laboratory work areas in accordance with NFPA 45
(7) Storage, use, and handling of liquefied petroleum gases in accordance with NFPA 58
(8) Storage, use, and handling of compressed gases within closed-cycle refrigeration systems complying with the mechanical code
(9) Liquefied natural gas (LNG) storage at utility plants under NFPA 59A
(10) Compressed natural gas (CNG) and liquefied natural gas (LNG), utilized as a vehicle fuel in accordance with NFPA 52
(11) *Compressed hydrogen gas (GH2), or liquefied hydrogen gas (LH2) generated, installed, stored, piped, used, or handled in accordance with NFPA 2 when there are no specific or applicable requirements in NFPA 55
(12) Nonflammable mixtures of ethylene oxide with other chemicals
(13) Ethylene oxide in chambers 10 scf (0.283 Nm^3) or less in volume or for containers holding 7.05 oz (200 g) of ethylene oxide or less

[**55:**1.1.2]

A.1.1.2(1) For regulations on the transportation of gases, see 49 CFR 100–185, "Transportation," and *Transportation of Dangerous Goods Regulations*. [**55:**A.1.1.2(1)]

A.1.1.2(3) Bulk compressed gas and cryogenic fluid system installations are intended to be covered by the requirements of this code. Instrumentation and alarms that are attendant to the system and designed to interface with the application in a health care facility are to be retained within the purview of NFPA 99.[**55:**A.1.1.2(3)]

A.1.1.2(5) For information, see NFPA 52 or NFPA 58. [**55:**A.1.1.2(5)]

A.1.1.2(6) The storage and use of compressed gases and cryogenic fluids outside the boundaries of laboratory work areas are covered by this code. [**55:**A.1.1.2(6)]

A.1.1.2(11) NFPA 55 is used as the source document for the fundamental requirements for compressed hydrogen gas (GH_2), or liquefied hydrogen gas (LH_2) system installations. Correlation between NFPA 55 and NFPA 2 is the responsibility of the two technical committees involved. The installation requirements for bulk GH_2 or LH_2 are viewed as fundamental provisions. On the other hand, use-specific requirements for designated applications such as vehicular fueling are not resident in NFPA 55 and are under the purview of the NFPA 2 Technical Committee. Where there are specific provisions or controls included in NFPA 55, the specific controls of NFPA 55 will govern except that modifications made to provisions that have been extracted can be followed when the modifications have been made within NFPA's extract procedure as indicated in the *Manual of Style for NFPA Technical Committee Documents*. [**55:**A.1.1.2(11)]

A.1.1.2(6) The scope of NFPA 58 is included here for the convenience of the user:

1.1 Scope. This code shall apply to the storage, handling, transportation, and use of liquefied petroleum gas (LP-Gas). [**58:**1.1]

1.2 Purpose. (Reserved) [**58:**1.2]

1.3 Application. [**58:**1.3]

1.3.1 Application of Code. This code shall apply to the operation of all LP-Gas systems, including the following:

(1) Containers, piping, and associated equipment, when delivering LP-Gas to a building for use as a fuel gas.
(2) Highway transportation of LP-Gas.
(3) The design, construction, installation, and operation of marine terminals whose primary purpose is the receipt of LP-Gas for delivery to transporters, distributors, or users, except for marine terminals associated with refineries, petrochemicals, gas plants, and marine terminals whose purpose is the delivery of LP-Gas to marine vessels.
(4) The design, construction, installation, and operation of pipeline terminals that receive LP-Gas from pipelines under the jurisdiction of the U.S. Department of Transportation (DOT) whose primary purpose is the receipt of LP-Gas for delivery to transporters, distributors, or users. Coverage shall begin downstream of the last pipeline valve or tank manifold inlet.

[**58:**1.3.1]

A.1.1.2(7) The scope of NFPA 59 is included here for the convenience of the user:

1.1 Scope. [**59:**1.1]

1.1.1* This code shall apply to the design, construction, location, installation, operation, and maintenance of refrigerated and nonrefrigerated utility gas plants including LP-gas containers, piping, and associated process equipment, and controls and fire protection. Coverage begins at:

(1) The point of transfer when delivery is by cargo tank vehicle or railcar
(2) The liquid inlet isolation valve located downstream of hazardous liquid pipeline under the jurisdiction of 49 CFR Part 195, "Transportation of Hazardous Liquids by Pipeline."
(3) Coverage shall extend to the point where LP-Gas vapor or mixture of LP-Gas vapor and air is introduced into the utility distribution system under the jurisdiction of 49 CFR Part 192, "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards."

[**59:**1.1.1]

1.1.2 Installations that have an aggregate water capacity of 4000 gal (15.14 m^3) or less shall conform to NFPA 58. [**59:**1.1.2]

A.1.1.1 See Figure A.1.1.2(7) for a graphical representation of the scope of coverage of NFPA 59. [**59:**A.1.1.1]

Δ **A.1.1.2(8)** The scope of NFPA 59A is included here for the convenience of the user:

1.1 Scope. [**59A:**1.1]

1.1.1 This standard shall apply to the following:

(1) The siting, design, construction, maintenance, and operation of facilities that produce, store, and handle liquefied natural gas (LNG)
(2) The training of all personnel involved with LNG

[**59A:**1.1.1]

1.1.2 This standard shall not apply to the following:

(1) Frozen ground containers
(2) Portable storage containers stored or used in buildings
(3) All LNG vehicular applications, including fueling of LNG vehicles

[**59A:**1.1.2]

A.1.1.2(9) Vehicle fuel dispensers are covered by NFPA 2, NFPA 30A, NFPA 52, and NFPA 58.

A.1.1.2(12) DOT regulations in 49 CFR 100–199 govern the transport of gases in commerce by pipelines, motor vehicles, and rail systems. The transportation of compressed gases or cryogenic fluids, including offsite pipeline transmission systems and loading and unloading functions as regulated by 49 CFR, is not within the scope of NFPA 56.

N **A.1.1.2(13)** AGA *Purging Manual* provides guidance for purging gathering lines and other pipelines into and out of service.

A.1.2 Any activities related to the introduction of flammable gas into a piping system are included in the scope of this standard, regardless of the project phase or operational status.

N **A.1.3** The design process should address the need for important purging system–related components like purge points, line blind spacers, and purged gas venting lines so that gas is not released indoors.

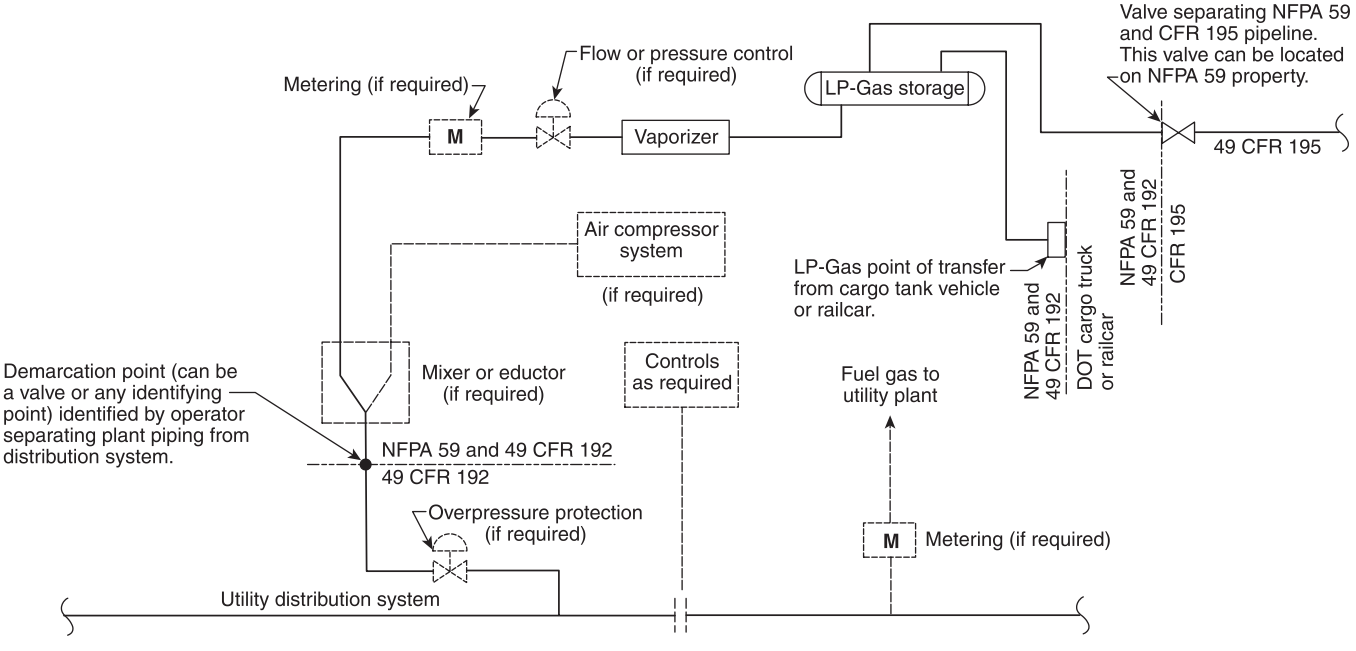

FIGURE A.1.1.2(7) Typical Installation of an LP-Gas or an LP-Gas Air Facility. [59:Figure A.1.1.1]

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

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

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.1 Cleaning Media. Cleaning media include liquids, gases, and solids. Chemical washing uses chemical substances (usually liquid) capable of dissolving or dispersing foreign substances or contaminants and can involve steaming or vacuuming to remove the chemical residue. When a pig is used to clean a piping system, the pig itself is considered to be the cleaning medium. Several solvents frequently used as cleaning media present flammability or other hazards related to personnel exposure. Use of these solvents requires special precautions beyond those developed for noncombustible cleaning media.

A.3.3.3 Competent Person. The OSHA website states that "by way of training and/or experience, a competent person is knowledgeable of applicable standards, is capable of identifying workplace hazards relating to the specific operation, and has the authority to correct them. Some standards add additional specific requirements which must be met by the competent person." *(See U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), Safety and Health Topics, "Competent Persons," http://www.osha.gov/SLTC/competentperson/index.html.)*

A.3.3.4 Detection Equipment. Detection equipment can include combustible gas indicators, lower flammability limit (LFL) monitors, and oxygen monitors. The LFL is sometimes called the lower explosive limit, or LEL. There can also be devices capable of monitoring and displaying gas concentration, oxygen concentration, percentage of LFL, or any combination thereof.

A.3.3.7 Flammable Gas. Pyrophoric gases such as silane or silicon tetrahydride are classified as such under the definition for pyrophoric materials found in NFPA 1, NFPA 400, or NFPA 55. The control strategy used for the regulation of pyrophoric materials is somewhat different from that for materials that do not autoignite on release to the atmosphere. Pyrophoric gases are not considered to be flammable gases per se.

A.3.3.8 Inert Gas. Inert gases do not react readily with other materials under normal temperatures and pressures. For example, nitrogen combines with some of the more active metals such as lithium and magnesium to form nitrides, and at high temperatures it will also combine with hydrogen, oxygen, and other elements. The gases neon, krypton, and xenon are considered rare due to their scarcity. Although these gases are commonly referred to as inert gases, the formation of compounds is possible. For example, xenon combines with fluorine to form various fluorides and with oxygen to form oxides; the compounds formed are crystalline solids. Radon is inert under the definition provided, but because it is radioactive, it is not considered inert for the purposes of NFPA 55. [**55,** 2016]

A.4.1.2 Where pressure testing is completed before the piping system is cleaned of dirt and debris, operators should release the media and debris in such a way that does not pose a risk to personnel. Operators can consider the following methods to discharge the pressure test media:

(1) Releasing test media at a rate that prevents the ejection of debris or liquids at high velocity
(2) Providing means to capture debris or liquids exiting the system
(3) Locating the discharge point a safe distance from any person, vehicle, or structure

N **A.4.1.2.1** Inspections of piping systems prior to testing should include reviewing threaded bolted connections for integrity, hanger loadings and spacings, and valve functionality.

A.4.1.2.4 ASME B31.3, *Process Piping*, requires a "leak test" wherein piping systems are subjected to pressures at least 1.5 times the design operating pressure and such pressure is held for at least 10 minutes. NFPA 54, and ASME B31.1, *Power Piping*, require a similar test procedure and parameters but refer to the test as a "pressure test."

A.4.1.2.5 ASME B31.1, *Power Piping*, and ASME B31.3, *Process Piping*, require the use of a "nonflammable and nontoxic" gas as the test medium for pneumatic testing. NFPA 56 specifically limits the acceptable media to air or inert gas. Oxygen is specifically prohibited because of the possible subsequent introduction of flammable gas and the risk of developing a flammable atmosphere. In addition, pneumatic testing is prohibited in ASME B31.1 and B31.3 at certain pressures without the owner's approval.

A.4.2 The person or agency performing cleaning or purging operations should coordinate with the system designer or facility operator to ensure that the medium is being supplied at a temperature and pressure that is compatible with the flammable gas piping system materials and construction.

A.4.4 A sample written procedure, for informational purposes only, is included in Annex C.

A.4.4.1 It is recognized that purging as part of routine maintenance of small piping segments can be accomplished safely,

provided that the written procedure (standard practice) is incorporated into a plant or facility operations and maintenance (O&M) manual that addresses the potential hazards occurring at the time of the purging operations. Purging should be conducted by competent personnel trained in purging operations, including recognition of potential hazards associated with purging. It is not intended that a new written procedure and/or safety validation be required each time the activity occurs within a facility.

Some items will not be applicable to all procedures or installations. Items that are not applicable can be noted as such in the procedure. The basis for non-applicability should be noted in the written procedure for safety validation.

A.4.4.1(1)(f) Gases that have hazards other than flammability could be subject to mitigation strategies such as scrubbing, flaring, afterburning, thermal oxidizing, or capture.

A.4.4.1(1)(n) Gases with properties in addition to flammability might require capture, scrubbing, or other engineered disposal methods. These gases might not be suitable for release to the atmosphere outdoors.

N **A.4.4.1(1)(o)** An example of a valve line-up table that shows the state of critical valves during each state of the purge is illustrated in Figure A.4.4.1(1)(o).

Example Project Valve Line-Up
Mode: Gas Intro-Unit #2 #21

Valve Name	Description	Beginning Position	Ending Position
1	Manual shutoff valve owned by NFG (located at bottom of hill)	Closed	Closed
2	New main header purge point manual shutoff valve (to be added at NFG outlet)	Closed	Closed
3	Manual shutoff valve at top of hill (to be replaced)	Closed	Closed
4	New main header purge point manual shutoff valve (to be added at top of hill)	Closed	Closed
5	Manual shutoff valve at top of hill on bypass (to be replaced)	Closed	Closed
6	Manual shutoff valve, isolation of knockout pot	Open	Open
7	Manual shutoff valve at top of hill on regulator bypass line	Open	Open
8	Manual shutoff valve at top of hill, generator set feed isolation valve	Open	Open
9	Manual shutoff valve on Unit #5 scrubber (upstream)	Closed	Open
10	Manual shutoff valve on Unit #5 scrubber (downstream)	Closed	Open
11	Manual shutoff valve on Unit #5 (scrubber bypass)	Open	Closed
12	Manual shutoff valve on Unit #5 (stainless steel vent)	Closed	Closed
13	Manual shutoff valve on Unit #5 (yellow gas vent)	Closed	Closed
14	Manual shutoff valve on Unit #4 scrubber (upstream)	Closed	Open
15	Manual shutoff valve on Unit #4 scrubber (downstream)	Closed	Open

N **FIGURE A.4.4.1(1)(o) Example Project Valve Line-Up.**

A.4.4.1(2)(a) There are many factors that should be used to identify an exclusion zone. During a purging into or out of service, the procedure should address gas migration and dispersion based on wind direction, wind speed, and physical characteristics of the gas. Affected areas can include threat zones from releases of inerts and flammable gases. Models are available from the EPA website, such as ALOHA, for identifying the likely path of plumes. Hazards that can impact large areas also include the possibility of pressure release explosions and debris from pneumatic cleaning.

A.4.4.1(3)(d) An emergency response plan (ERP) should be established for each facility and hazard. The ERP should provide descriptions of actions to be taken and assign those responsibilities to specific members of the personnel performing the cleaning or purging activity. As a minimum, the ERP should identify the following:

(1) Notifier(s) – The notifier is responsible for contacting outside emergency response services and any fire protection personnel not involved with the cleaning/purging activity. The ERP should provide an emergency phone list and guidance on the priority in which emergency services should be contacted based on the type of emergency and level of response needed. The emergency phone list should include the following: contact information for emergency response team members and alternates, emergency services, ambulances, hospitals, air rescue (helicopter services), local emergency planning committee, state response center, national response center, state and local law enforcement, fire departments, operators and contractors, and gas supplier, including distribution emergency personnel, emergency leak repair, and valve service contractors.
(2) Fire protection personnel – Fire protection personnel include, as applicable, the members of an on-site industrial fire brigade, sprinkler valve operator, fire pump operator, and fire service liaison. (The sprinkler valve operator, fire pump operator, and fire service liaison should not be the same person.) The ERP should include a facility layout diagram that can be provided to fire service personnel to demonstrate the location of the emergency, hose connections or hydrants, and critical fire protection water valves. For facilities still under construction, a general block diagram showing approximate locations of major equipment should be maintained until substantial completion of the facility.
(3) Personnel evacuation coordinator(s) – The ERP should contain an evacuation plan for all personnel, including a facility layout showing the evacuation route(s) or identified gathering areas. The ERP should identify one or more personnel evacuation coordinators to direct personnel to a marked evacuation route or safe location. The evacuation coordinator should also have access to a list of personnel on site, including contractors, to ensure that all personnel are accounted for following evacuation.

A.4.4.1(4)(a) Bonding requirements can be found in *NFPA 70* and NFPA 77. Users should consider grounding of the piping system to dissipate any electrical charge on the piping.

A.4.4.1(4)(e) Temporary piping may be comprised of an assembly of solid piping, flexible hose, and flexible tubing. It is preferable to use only conductive components in the temporary piping system; however, the use of non-conductive components may be necessitated by the constraints of the installation or process. Specific guidance on grounding and bonding of non-conductive components is provided in Section 10.3 of NFPA 77, included here for the convenience of the user:

Flexible hose and flexible tubing are available in metal, lined metal, nonconductive plastic, reinforced rubber and plastic, and composite-ply types. [**77:**10.3]

Where nonconductive hose or tubing must be used because of process conditions, the hazards of static electric charge generation should be thoroughly investigated. [**77:**10.3.1]

As a minimum, all conductive couplings (e.g., end fittings) and components should be bonded and grounded. [**77:**10.3.2]

If hose[s] are used immediately downstream of filters in nonconductive liquid [fluid] service, they should be of metal or other conductive material. Semiconductive liners might be necessary to prevent charge accumulation and pinhole damage to the hose. [**77:**10.3.3]

Conductive hose[s] should be electrically continuous, and the continuity should be periodically checked. [**77:**10.3.4]

Hose[s] with more than one internal spiral should not be used because it is not possible to determine if one of the spirals has lost its continuity. [**77:**10.3.4.1]

For all-metal conductive hose, the resistance to ground from any point normally should be 10 ohms or less. For conductive hose that contain a continuous bonding element, such as wire or braid, the resistance to ground from any metal connector normally should be 1000 ohms per meter or less, with the same exception being applicable. Resistance to ground through semiconductive hose with a current-limiting design that eliminates a low-resistance bonding element and resistance to ground through insulating flanges should be between 10^3 ohms/m and 10^5 ohms/m. In either case, the total resistance to ground from a metal hose connector should not exceed 10^6 ohms. [**77:**A.10.3]

While a resistance to ground of less than 10^6 ohms will prevent accumulation of static electric charge in most cases, if periodic testing reveals a significant increase in the as-installed resistance, that increase could be the result of corrosion or other damage, which could lead to sudden loss of continuity. The hose, insulating flange, or both should be inspected to determine the need for replacement. [**77:**A.10.3]

Where conductive hose has double spirals, one for bonding and the other for mechanical strength, continuity between the end connectors confirms the continuity of only one spiral. A fire was reported during draining of toluene from a tank vehicle through such a hose. It was found that the inner spiral was not only broken, but not designed to be bonded to the end connectors. Where handling nonconductive liquids, an option is to use a hose with a semiconductive or conductive liner, so that a broken inner spiral cannot become isolated from ground and form a spark gap. Ideally, the inner spiral should be separately bonded to the end connectors. [**77:**A.10.3]

It is especially important to ensure continuity with end connectors (or nozzles) where a hose is used in an ignitable atmosphere. In general, it is safer to use a properly designed fixed-fill system, such as a dip pipe arrangement, rather than a hose for filling tank vehicles, rather than to use a hose. [**77:**A.10.3]

Where used in flammable atmospheres, such as inside tanks, utility hose should be conductive or semiconductive. In particular, all metal connectors and nozzles should be grounded. Ungrounded hose connectors on nonconductive hose can become charged by a variety of means, such as rubbing, the insertion of a nitrogen hose into a tank containing charged liquid or mist, or streaming currents generated by the flow of steam condensate. While clean and dry gases do not generate a charge, a nonconductive hose will become highly charged by the flow of steam. [**77:**A.10.3]

Additional background information on control of static electricity for fluid systems can be found in API Recommended Practice 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents.*

Δ **A.4.4.1(6)** The procedure for monitoring discharge gases and nearby areas should recognize that the response time of the sampling system could result in a time delay between a hazardous situation developing and its being detected by detection equipment. Where sampling systems are used, the response time should be short relative to the expected period of time in which a hazard could develop.

Separate combustible gas indicators, lower flammability limit (LFL) monitors, and oxygen monitors could be necessary to conduct purging activities. The procedure and safety validation should indicate the type of monitors required at each location where monitoring will be conducted.

N **A.4.4.1(8)** Detection equipment selection should consider possible sample contamination by other commingled gases, moisture, or debris. The sampling system and/or detection equipment selection should consider appropriate mitigation measures such as filtration.

In some cases, gas release processes require the sampling of end points. In such cases, breathing air could be required for working in and around inert materials that have been released or that can create an exposure hazard. It is also important that personnel working in and around releases of gas understand the hazards of inert materials such as nitrogen. All workers should be trained.

A.4.5 A safety validation is an independent, systematic analysis of a procedure to ensure that foreseeable hazards, errors, and malfunctions have been addressed by appropriate measures. Safety validations can be conducted using known techniques. The intent of the safety validation is to identify deficiencies in the procedure and make appropriate recommendations for correcting them. For further information on hazard analyses, users can reference the AIChE Center for Chemical Process Safety publication *Guidelines for Hazard Evaluation Procedures.*

A.4.5.1 The safety validation should not be performed solely by the same person or persons responsible for developing the procedures. It can be performed or reviewed by an independent person or group within the company or department or by a third-party consultant.

A.4.5.2 The recommendations can be resolved by changes made to the written cleaning and purging procedures prior to the activity being conducted. If the person(s) responsible for developing or implementing the procedures disagrees with the recommendations of the safety validation, the facility owner/operator or a designated representative (such as a facility manager or, for facilities under construction, a construction manager) should evaluate technical documentation to resolve the disagreement. The designated representative should be a competent person as defined in 3.3.3 and should have the authority to modify or reject the procedure or the recommendation.

A.4.5.3 It is recognized that purging as part of routine operation or maintenance of small piping segments can be accomplished safely, provided that the written procedure (standard practice) is incorporated into a plant or facility operations and maintenance (O&M) manual that addresses the potential hazards occurring at the time of the purging operations. Purging should be conducted by competent personnel trained in purging operations, including recognition of potential hazards associated with purging. It is not intended that a new written procedure and/or safety validation be required each time the activity occurs within a facility.

A.4.6 Where physical, operational, or personnel changes are made to a plant or facility, the cleaning and purging procedures should be re-evaluated. Such changes can include, but are not limited to, physical changes to piping system design, change to the cleaning or purging media, changes in responsibility for personnel, changes in local conditions such as encroachment by new equipment or nearby development, or changes in the chemical composition of the gas being purged.

A.4.6.2 *Replacement-in-kind* refers to a situation in which a piece of equipment is replaced with equipment of the same design and service.

A.4.12 Compressors can introduce lubricating oil or other flammable constituents into the compressed gas supply. Care should be taken to ensure that flammable constituents are not introduced into the piping system in concentrations that could lead to a flammable atmosphere within the pipe. This can be accomplished by the use of "100 percent oil-free compressors" or filtering systems that remove residuals prior to introduction into the piping system.

N **A.5.1** ANSI/ASSP Z490.1,*Criteria for Accepted Practices in Safety, Health and Environmental Training,* provides guidelines for developing a comprehensive personnel training program.

N **A.5.1.3** Evidence of knowledge transfer and demonstration of skills should include at least the following, as applicable:

(a) Proper use of necessary meters and sampling techniques
(b) Proper connection of inerting hose sections
(c) Proper monitoring of inert flows
(d) Operation of critical valves
(e) Use of emergency communications equipment
(f) Proper use of personal environmental monitors
(g) Use of SCBA equipment if part of the project

A.6.2 This is not intended to exclude specialized cleaning chemicals used in solution with water in accordance with the manufacturer's instructions by competent personnel.

A.6.2.1 Chemical washing uses chemical substances (usually liquid) capable of dissolving or dispersing foreign substances or contaminants and can involve steaming or vacuuming to remove the chemical residue. Solvents used for chemical washing can pose fire, explosion, environmental, or health hazards. The pipe cleaning procedure should identify and address those hazards.

A.6.2.2 Use and disposal or recovery of flammable liquids is specifically covered in Chapter 18 of NFPA 30.

A.6.2.2.1 Safety data sheets were formerly known as material safety data sheets (MSDSs). The user is cautioned that safety data sheets do not address the hazards of every possible application of the material.

A.6.3 This section is applicable only to temporary power and fuel supplies necessary to implement the cleaning procedures. Local building codes and electrical codes should be referenced regarding provision of permanent power and fuel supplies to the facility.

A.6.5.2 Pigging using flammable gas as the propellant can be considered where the system has been designed to accommodate the activity and it is beneficial to accomplish cleaning and purging simultaneously. The pig is designed to fit tightly inside the pipe and will effectively push the air out of the piping system as the volume behind the pig is filled with gas. When the pig reaches the receiver, it is isolated within the receiver, and the discharge valve is closed to ensure that a minimal amount of flammable gas is released. While some small amount of fuel gas can be released due to seepage around the pig, the result is generally a smaller release than traditional purging into service. The purge procedure should identify safe disposal of the residual gas. The use of flammable gas as the propellant eliminates the hazards associated with the intermediate purging step using inert gas in a traditional purge into service. See Figure A.6.5.2 for an example of a pig launcher/receiver arrangement.

A.6.5.2.1 Pigging using flammable gas as the propellant is limited to defined, closed systems. Open-ended systems in which no receiver is installed are permitted where a nonflammable propellant is used. However, users should carefully consider environmental factors and other safety factors associated with open-ended pigging.

A.6.5.2.2 The use of a pig to accomplish cleaning and purging into service simultaneously should be carefully reviewed by competent persons who are knowledgeable and experienced in the use of pigs in flammable gas systems. The pig should be sized to fit tightly in the piping system. Factors to be considered in pig selection include, but are not limited to, pipeline size, wall thickness, minimum bend radius, length of piping to be pigged, propelling media, flow rate/velocity, side connections, and valve type.

A.6.5.2.3 Pigging where the piping is already filled with flammable gas is often referred to as "on-line" or "in-service" pigging. In-service pigging is not limited to cleaning processes, and 6.5.2.3 is not intended to prohibit or prevent other pigging processes. Other in-service pigging processes can include various types of inspection pigs.

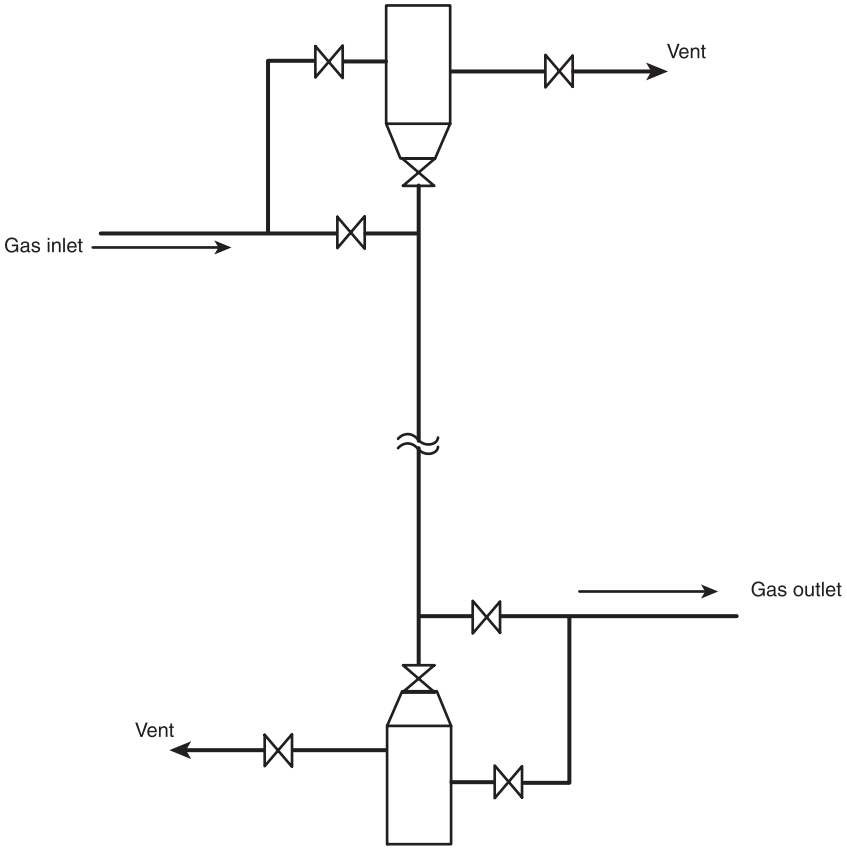

FIGURE A.6.5.2 Simplified Pig Launcher and Receiver System for Piping Segment.

A.6.6 Targets are devices used for identifying the amount of debris that might remain within a piping system. Targets are installed at the discharge end in such a manner as to receive impacts from debris. The design and installation of targets can divert gases discharging from the end of the piping systems in directions that were not intended. If targets are placed too close to the end of the pipe, they can also create a restriction and accentuate tangential velocities of gas flows.

A.7.1.2 There are instances in which a plant is located on a large piece of land and the point of delivery or source valve is on or beyond the perimeter of the property, and the piping must travel a significant distance before reaching any piece of equipment associated with the plant or the process. Where the serving natural gas supplier operates the pipeline between the point of delivery or source valve and the plant, the supplier generally has specialized procedures for purging and operating transmission and distribution lines as required by state regulations and/or federal regulation under the U.S. Department of Transportation, 49 CFR 192.629.

Δ **A.7.2.2.3** When purging is performed with an inert gas, it is generally acceptable to use an oxygen detector to measure the absence of oxygen. When flammable gas is being introduced, an appropriate gas detection device that can operate in the absence of oxygen should be used. Catalytic combustion–type indicators should not be used for purging into service in an oxygen-free environment.

Subsection 7.2.3 of NFPA 69 is extracted as follows for the convenience of the user. [Table C.1(a) of NFPA 69 is reprinted here as Table A.7.2.2.3.]

7.2.3 Limiting Oxidant Concentrations (LOCs). [**69:**7.2.3]

7.2.3.1 Table C.1(a) and Table C.1(b) shall be permitted to be used as a basis for determining LOCs of flammable gases or suspensions of combustible dusts. [**69:**7.2.3.1]

7.2.3.1.1 For gases and vapors, if the LOC values according to ASTM E2079, *Standard Test Methods for Limiting Oxygen (Oxidant) Concentration in Gases and Vapors*, are available, then these shall be used. [**69:**7.2.3.1.1]

7.2.3.1.2 For gases and vapors, if the LOC values according to ASTM E2079 are not available, then the LOC values obtained in flammability tubes shall be used after adjustment by subtracting 1.5 percent by volume oxidant for LOC values of 10 percent or greater or by multiplying by a factor of 0.85 for LOC values less than 10 percent, as indicated in the adjusted columns in Table C.1(a). [**69:**7.2.3.1.2]

7.2.3.2 For fuel, inert, and oxidant combinations not listed in Table C.1(a) or Table C.1(b) or for situations when the process conditions differ from the conditions under which the existing data were obtained, the test methods described in ASTM E2079 shall be permitted to be used. [**69:**7.2.3.2]

7.2.3.3 The extent of oxidant reduction shall be determined by testing where conditions vary significantly from the test conditions under which the data were obtained. [**69:**7.2.3.3]

Δ **A.7.2.2.4** This is not intended to prohibit discontinuation of a purging process if there is a danger to personnel or if another emergency condition is detected. Annex B contains material from the AGA *Purging Manual*, which discusses purging end points for many common flammable gases.

A.7.2.2.6(3) Connected systems can be gas consumption equipment, such as flares or other destructive equipment. Care should be taken to ensure that purge flow does not affect the safe operation of equipment such as flares. It could be necessary to shut down or isolate these connected systems during purging.

A.7.3.1 Odor fade, odor masking, olfactory fatigue, an individual's inability to smell the flammable gas, or the fact that a flammable gas is not odorized can reduce safety and lead to an inadequate warning of a flammable gas–air mixture. Calibrated detection equipment should be used by trained workers whenever the presence of flammable gas is being monitored.

A.7.3.2 Detection equipment should be listed or approved not only for the specific gas or gases being sensed in the process but also for the type of environment the equipment might be subjected to or used in. Detectors for use in hazardous locations as defined in *NFPA 70*, should be listed for such use. This is particularly important for detection equipment used to monitor areas where flammable gas is being discharged. Detection equipment specifications such as response time, limits of measurement range, operating temperature, and gas pressure limitations should be known, and the procedure should be developed such that these factors will not negatively impact the safety of the activity.

A.7.3.3 Combustible gas indicators for fuel gases should display increments of 1 percent or smaller. The procedure and the safety validation should indicate the maximum increment based on gas being detected and the response time. Selection and use of the combustible gas indicator should be appropriate to ensure that a hazard is detected in a timely manner.

A.7.3.4 LFL gas monitors for fuel gases should display increments of 1 percent or smaller. The procedure and the safety validation should indicate the maximum increment based on gas being detected and the response time. Selection and use of the LFL gas monitor should be appropriate to ensure that a hazard is detected in a timely manner.

A.8.2.1 There are instances in which a plant is located on a large piece of land and the point of delivery or source valve is on or beyond the perimeter of the property, and the piping must travel a significant distance before reaching any piece of equipment associated with the plant or the process. Where the serving natural gas supplier operates the pipeline between the point of delivery or source valve and the plant, the supplier generally has specialized procedures for purging and operating transmission and distribution lines as required by state regulations and/or federal regulation under the U.S. Department of Transportation, 49 CFR 192.629.

A.8.3.1 Generally, depressurization results in the piping system being brought down to approximately atmospheric pressure. However, some processes require maintaining slightly higher pressure prior to purging. The final pressure in the piping system following depressurization should be determined by the purge procedure.

Δ **A.8.3.3.3** Annex B contains material from the AGA *Purging Manual*, which discusses purging end points for many common flammable gases. Other resources that provide flammability limits for purging into and out of service include Bureau of Mines Bulletin 680 and the AIChE publication *Understanding Explosions*.

N **Table A.7.2.2.3 Limiting Oxidant Concentrations for Flammable Gases When Nitrogen or Carbon Dioxide Are Used as Diluents**

	Updated or (Adjusted) Data		Original Data	
	N_2 — Air Mixture	CO_2 — Air Mixture	N_2 — Air Mixture	CO_2 — Air Mixture
Gas/Vapor	LOC	LOC	LOC	LOC
Paraffins (alkanes)				
Methane	11.1[a]	(13.1)[b]	12.1[b]	14.6[b]
Ethane	(9.5)[b]	(11.9)[b]	11.0[b]	13.4[b]
Propane	10.7[a]	(12.8)[b]	11.4[b]	14.3[b]
n-Butane	(10.6)[b]	(13.0)[b]	12.1[b]	14.5[b]
Isobutane (methylpropane)	(10.5)[b]	(13.3)[b]	12.0[b]	14.8[b]
n-Pentane	(10.6)[b]	(12.9)[b]	12.1[b]	14.4[b]
Isopentane (2-methylbutane)	(10.5)[c]	(13.0)[c]	12.0[c]	14.5[c]
n-Hexane	(10.4)[b]	(13.0)[b]	11.9[b]	14.5[b]
n-Heptane	(10.0)[c]	(13.0)[c]	11.5[c]	14.5[c]
Cycloparaffins (cycloalkanes, naphthenes)				
Cyclopropane	(10.2)[b]	(12.4)[b]	11.7[b]	13.9[b]
Olefins (alkenes)				
Ethylene (ethene)	8.5[a]	(10.2)[b]	10.0[b]	11.7[b]
Propylene (propene)	(10.0)[b]	(12.6)[b]	11.5[b]	14.1[b]
α-butylene (1-butene)	(10.1)[b]	(12.5)[b]	11.6[b]	14.0[b]
Isobutylene (2-methylpropene)	(10.5)[c]	(13.5)[c]	12.0[c]	15.0[c]
Isopentene (3-methyl-1-butene)	(10.0)[c]	(12.5)[c]	11.5[c]	14.0[c]
Diolefins (dienes)				
1,3-Butadiene	(8.9)[b]	(11.6)[b]	10.4[b]	13.1[b]
Aromatics				
Benzene	11.4[d]	(12.4)[b]	11.4[d]	13.9[b]
Ethylbenzene	9.0[d,e]	—	9.0[d,e]	—
Diethylbenzene	8.5[d,f]	—	8.5[d,f]	—
Divinylbenzene	8.5[d,f]	—	8.5[d,f]	—
Toluene	9.5[g,h]	—	9.5[g,h]	—
Vinyltoluene	9.0[d,i]	—	9.0[d,i]	—
Styrene (phenylethene)	9.0[d,j]	—	9.0[d,j]	—
Alcohols				
Methyl alcohol (methanol)	(8.5)[c]	(10.5)[c]	10.0[c]	12.0[c]
Ethyl alcohol (ethanol)	(9.0)[c]	(11.5)[c]	10.5[c]	13.0[c]
Ethyl alcohol (ethanol)	8.7[g,h]	—	8.7[g,h]	—
n-Propyl alcohol (*n*-propanol)	8.6[g,h]	—	8.6[g,h]	—
Isopropyl alcohol (2-propanol)	9.5[k,h]	—	9.5[k,h]	—
t-Butyl alcohol (*t*-butanol)	—	(15.0)[c,l]	—	16.5[c,l]
Isobutyl alcohol (2-methyl-1-propanol)	9.1[g,h]	—	9.1[g,h]	—
Isohexyl alcohol (2-ethyl-1-butanol)	(7.9)[c,l]	—	9.3[c,l]	—
Esters				
Methyl formate	(8.5)[c]	(11.0)[c]	10.0[c]	12.5[c]
Methyl acetate	(9.5)[c]	(12.0)[c]	11.0[c]	13.5[c]
n-Propyl acetate	10.1[k,h]	—	10.1[k,h]	—
Isopropyl acetate	8.8[g,h]	—	8.8[g,h]	—
n-Butyl acetate	9.0[g,h]	—	9.0[g,h]	—
Isobutyl acetate	9.1[g,h]	—	9.1[g,h]	—
Isobutyl formate	(11.0)[c]	(13.5)[c]	12.5[c]	15.0[c]
Ethers				
Methyl ether	(9.0)[c]	(11.5)[c]	10.5[c]	13.0[c]
Ethyl ether	(9.0)[c]	(11.5)[c]	10.5[c]	13.0[c]
Propylene oxide	(6.6)[m]	—	7.8[m]	—
Ketones				
Acetone	(10.0)[c]	(12.5)[c]	11.5[c]	14.0[c]
Methyl ethyl ketone	(9.5)[c]	(12.0)[c]	11.0[c]	13.5[c]

(continues)

N **Table A.7.2.2.3** *Continued*

	Updated or (Adjusted) Data		Original Data	
	N_2 — Air Mixture	CO_2 — Air Mixture	N_2 — Air Mixture	CO_2 — Air Mixture
Gas/Vapor	LOC	LOC	LOC	LOC
Organo-chlorides				
n-Butyl chloride	(12.5)[c]	—	14.0[c]	—
	(10.5)[b,n]	—	12.0[b,n]	—
Methylene chloride	(17.5)[b,o]	—	19.0[b,o]	—
	(15.5)[c,n]	—	17.0[c,n]	—
Ethylene dichloride	(11.5)[c]	—	13.0	—
	(10.0)[b,n]	(15.0)[b,n]	11.5[b,n]	16.5[b,n]
1,1,1-Trichloroethane	(12.5)[c]	—	14.0[c]	—
Trichloroethylene	(7.7)[c,n]	—	9.0[c,n]	—
Vinyl chloride	13.4[d,h]	—	13.4[d,h]	—
Vinylidene chloride	15.0[d]	—	15.0[d]	—
Inorganic compounds				
Carbon disulfide	(4.3)[c]	(6.4)[c]	5.0[c]	7.5[c]
Carbon monoxide (in air)	5.1[a]	(5.1)[c]	5.5[c]	5.5[c]
Hydrogen (in air)	4.6[a]	(4.6)[c]	5.0[c]	5.2[c]
Hydrogen sulfide (in air)	(6.4)[c]	(10.0)[c]	7.5[c]	11.5[c]
Miscellaneous nitrogen-containing compounds				
UDMH (1,1-dimethyl hydrazine)	(6.0)[c]	—	7.0[c]	—
Commercial fuels				
(70/100)	(10.5)[c]	(13.5)[c]	12.0[c]	15.0[c]
(100/130)	(10.5)[c]	(13.5)[c]	12.0[c]	15.0[c]
(115/145)	(10.5)[c]	(13.0)[c]	12.0[c]	14.5[c]
Aviation fuels				
Kerosene	(8.5)[c,l]	(11.5)[c,l]	10.0[c,l]	13.0[c,l]
JP-1 fuel	(9.0)[c,l]	(12.5)[c,l]	10.5[c,l]	14.0[c,l]
JP-3 fuel	(10.5)[c]	(13.0)[c]	12.0[c]	14.5[c]
JP-4 fuel	(10.0)[c]	(13.0)[c]	11.5[c]	14.5[c]
Natural gas				
(Pittsburgh natural gas)	(10.5)[b]	(12.9)[b]	12.0[b]	14.4[b]

Note: All experiments are performed at 25°C (77°F) unless otherwise indicated.

[a]120- L (31.7 gal) apparatus —— I. A. Zlochower and G. M. Green, "Mining Publication: The Limiting Oxygen Concentration and Flammability of Gases and Gas Mixtures" (June 2009).

[b]Flammability tube — Table 44 of Bureau of Mines Bulletin 503, "Limits of Flammability of Gases and Vapors" (1952).

[c]Flammability tube — Table 11 of J. M. Kuchta, A. L. Furno, A. Bartkowiak, and G. H. Martindill, "Effect of Pressure and Temperature on Flammability Limits of Chlorinated Combustibles in Oxygen-Nitrogen and Nitrogen Tetroxide-Nitrogen Atmospheres" (1968).

[d]~5 L (1.3 gal) vessel, ASTM E681, *Standard Test Method for Concentration Limits of Flammability of Chemicals (Vapors and Gases)* (2015) — The Dow Chemical Company (Unpublished).

[e]Experiments performed at 70°C (158°F).

[f]Experiments performed at 114°C (237.2°F).

[g]~5 L (1.3 gal) vessel, ASTM E2079, *Standard Test Methods for Limiting Oxygen (Oxidant) Concentration in Gases and Vapors* (2013) — L. G. Britton, "Using Heats of Oxidation to Evaluate Flammability Hazards," *Process Safety Progress* (2002).

[h]Experiments performed at 60°C (140°F).

[i]Experiments performed at 105°C (221°F).

[j] Experiments performed at 73°C (163.4°F).

[k]~5 L (1.3 gal) vessel, ASTM E2079, *Standard Test Methods for Limiting Oxygen (Oxidant) Concentration in Gases and Vapors* (2013) — L. G. Britton, The Dow Chemical Company, 1999 (Unpublished Report).

[l]Experiments performed at 150°C (302°F).

[m]R. M. Jones, "Reducing the Inflammability of Fumigants with Carbon Dioxide," *Industrial & Engineering Chemistry Research* (1933).

[n]Experiments performed at 100°C (212°F).

[o]Experiments performed at 30°C (86°F).

[**69:**Table C.1(a)]

A.8.3.3.5(3) Connected systems can be gas consumption equipment, such as flares or other destructive equipment. Care should be taken to ensure that purge flow does not affect the safe operation of equipment such as flares. It could be necessary to shut down or isolate these connected systems during purging.

A.8.4.1 Odor fade, odor masking, olfactory fatigue, an individual's inability to smell the flammable gas, or the fact that a flammable gas is not odorized can reduce safety and lead to an inadequate warning of a flammable gas–air mixture. Calibrated detection equipment should be used by trained workers whenever the presence of flammable gas is being monitored.

In facilities where odorized gas has been used, the piping could contain residual odorant. The residual odorant could still be smelled, even though flammable gas might not be present.

A.8.4.2 Detection equipment should be listed or approved not only for the specific gas or gases being sensed in the process but also for the type of environment the equipment might be subjected to or used in. Detectors for use in hazardous locations as defined in *NFPA 70*, should be listed for such use. This is particularly important for detection equipment used to monitor areas where flammable gas is being discharged. Detection equipment specifications such as response time, limits of measurement range, operating temperature, and gas pressure limitation should be known, and the procedure should developed such that these factors will not negatively impact the safety of the activity.

A.8.4.3 LFL gas detectors for flammable gases typically display increments of 1 percent or smaller. The procedure and the safety validation should indicate the maximum increment based on gas being detected and the response time. Selection and use of the LFL gas detector should be appropriate to ensure that a hazard is detected in a timely manner.

Annex B Purge End Points for Common Flammable Gases

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

Δ **B.1** The material in this annex is extracted in part from the AGA *Purging Manual* and is reprinted here with permission.

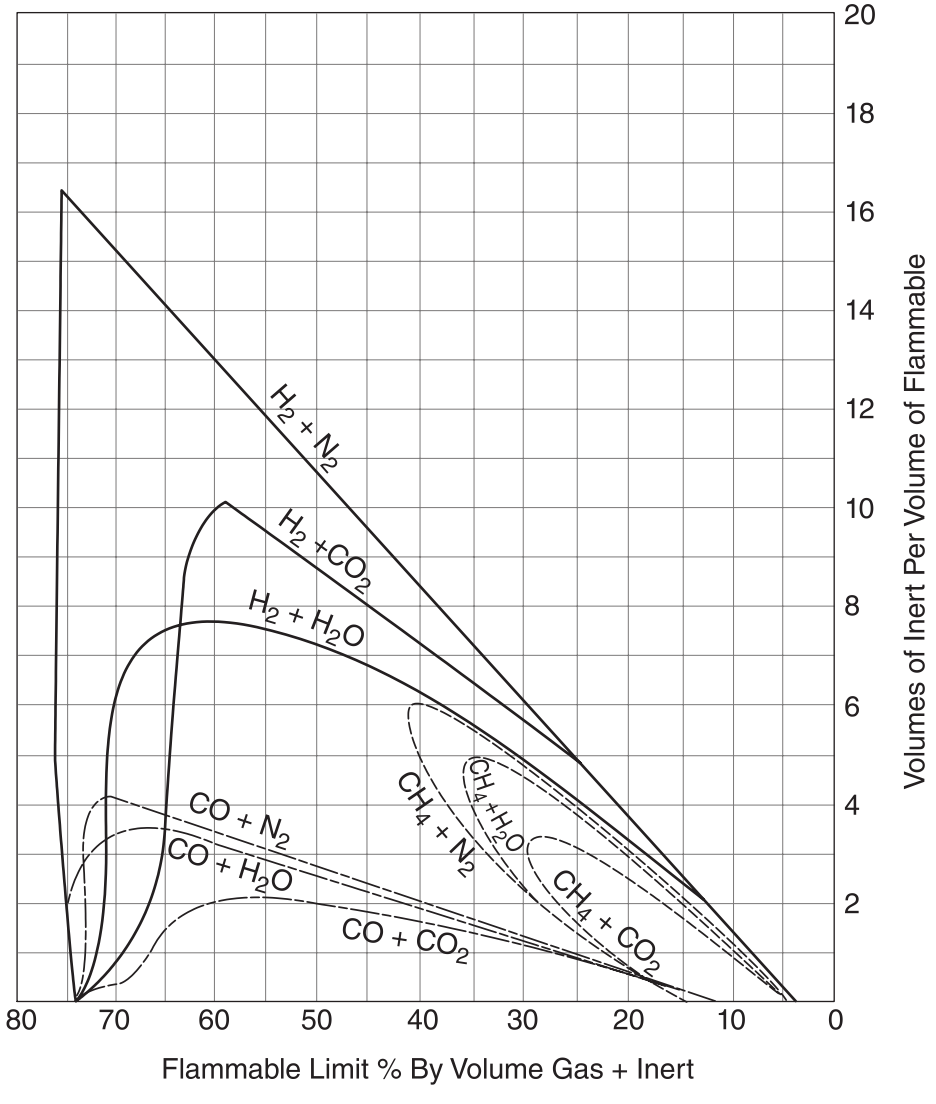

Figure 2-1 Flammable Limits for Hydrogen, Carbon Monoxide and Methane with Nitrogen, Carbon Dioxide and Water Vapor.

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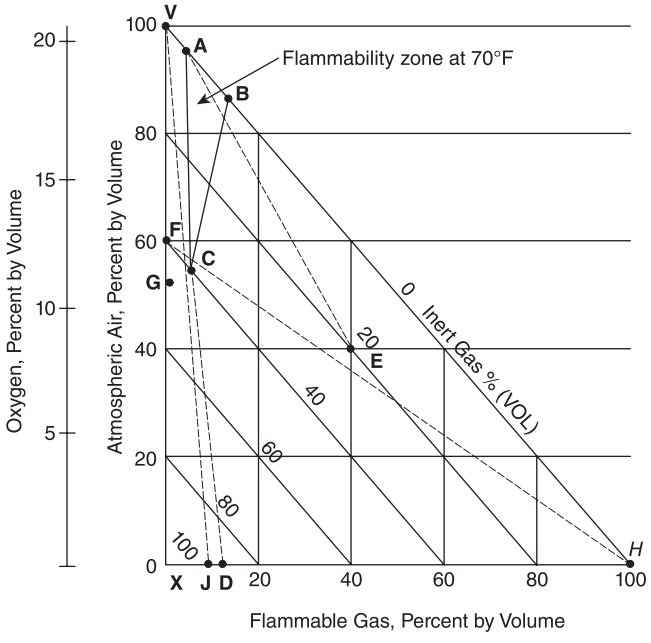

Figure 2-2 Flammability End-point Diagram Air – Flammable Gas (Methane) – Inert Gas (Nitrogen)

Figure 2-2 is a flammability end-point diagram for the purging of air or methane with nitrogen as inert gas at 70˚F at atmospheric pressure. The A and B coordinates are 5 and 15 percent methane, and 0-percentage nitrogen, respectively. The C coordinate is a mixture of approximately 6 percent methane, 36 percent nitrogen and 59 percent air. The triangle formed by the coordinates of A, B and C represent the flammability zone at 70 degrees F. Note: the flammability zone area will increase as the temperature or pressure increases.

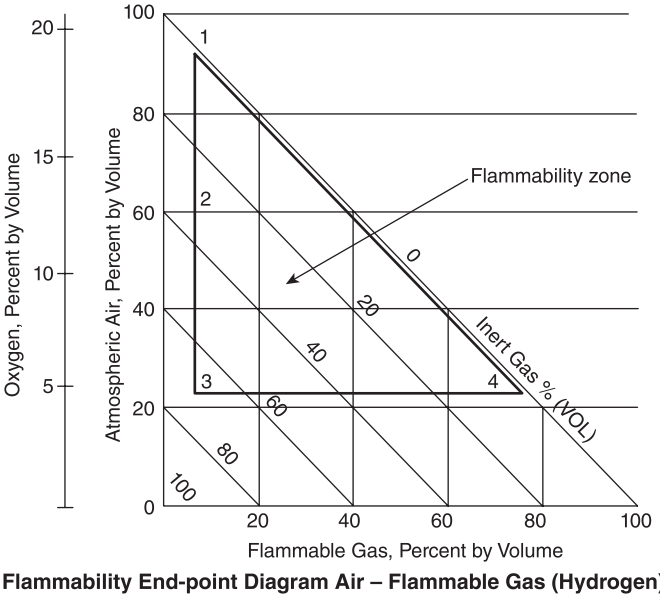

Figure 2-3 Flammability End-point Diagram Air – Flammable Gas (Hydrogen) – Inert Gas (Nitrogen)

Flammability end-point diagram for the purging of hydrogen with nitrogen can be approximated from Figure 2-3. The approximate concentrations of hydrogen, nitrogen and air have been estimated from Figure 2-1 at points 1, 2, 3 and 4 in Figure 2-3. Those same concentrations points are represented as points 1, 2, 3 and 4 above. Note: this method approximates the flammability zone since the interior lines forming the triangle may not be precisely linear.

Δ

2.5 Purging Facilities into Service

A safe purging operation of air from a system subsequently filled with natural gas is generally represented in Figure 2-2. As an inert gas is added, the air concentration drops along ordinate VX to any point G below F. Subsequent addition of natural gas causes the mixture composition to change along line GH, which crosses no part of the flammable zone ABC. In the example shown in Figure 2-2, inert gas should be added until the purged atmosphere contains at least 42 percent inert gas, thereby reducing the air content in the purged atmosphere to 58 percent, or an oxygen concentration of about 12 percent.

To render a given flammable-air mixture non-flammable it is desirable to know what percentage of inert gases is required. Table 2-3 gives the values for a number of flammables investigated by the U.S. Bureau of Mines. To ensure safety, purging shall be continued to a point at least 20 percent beyond the flammable limit. These purging end-points are given on the right side of Table 2-3.

Sometimes it is more convenient to control the purging by determining the oxygen content of the purged gases. In purging into service, inert gas is added to the container until the oxygen concentration of the mixture is decreased to the point where no mixture of this with the flammable gas would be flammable. This data, also presented by the U.S. Bureau of Mines, is given in Table 2-4. Suggested purging end-point data with a 20 percent safety factor are given on the right half of Table 2-4 in terms of percent of oxygen for the purging of containers in preparation to receive the various flammables shown. Note: NFPA 69 requires that oxygen end-points be calculated at 60% of the limiting oxidant concentration. The reader is urged to review both NFPA and US Bureau of Mines safety factors appropriate for their specific purge application.

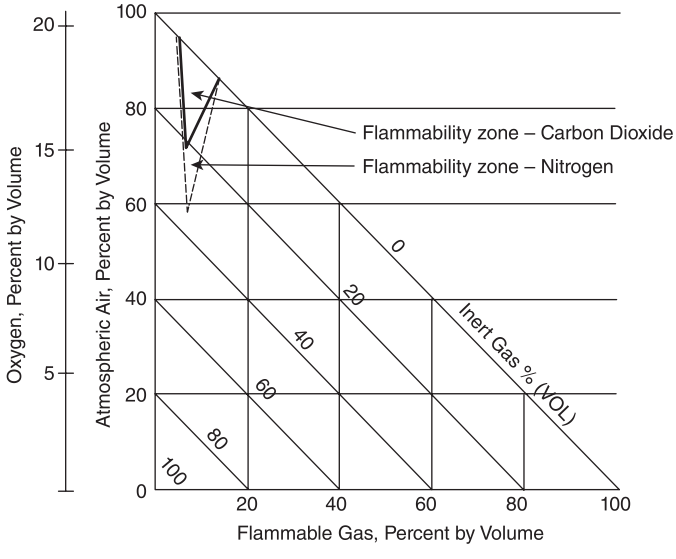

Figure 2-4 Flammability End-Point Diagram Air – Flammable Gas (Methane) – Inert Gases (Nitrogen & Carbon Dioxide)

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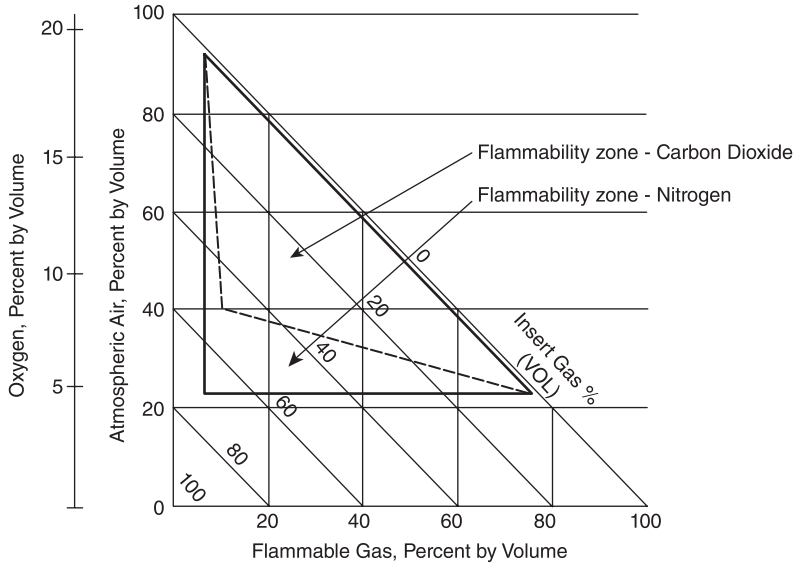

Figure 2-5 Flammability End-point Diagram Air – Flammable Gas (Hydrogen) – Inert Gases (Nitrogen & Carbon Dioxide)

Purge Medium	CO_2	N_2*	CO_2	N_2*
Flammable	**Percent required to render mixtures non-flammable**		**Purging End-Points with 20% Safety Factor**	
Hydrogen	57	71	66	77
Carbon Monoxide	41	58	53	66
Methane	23	36	38	49
Ethane	32	44	46	55
Propane	29	42	43	54
Butane	28	40	42	52
Iso-butane	26	40	41	52
Pentane	28	42	42	54
Hexane	28	41	42	53
Gasoline	29	43	43	55
Ethylene	40	49	52	59
Propylene	29	42	43	54
Cyclopropane	30	41	44	53
Butadiene	35	48	48	49
Benzene	31	44	44	55

* Nitrogen percentages do not include nitrogen of the air in mixtures.

Table 2-3 Inert Gas End-Points for Purging Into Service

Δ

Purge Medium	CO_2	N_2	CO_2	N_2
Flammable	Percent of Oxygen below which no mixture is flammable		Purging End-Points with 20% Safety Factor	
Hydrogen	5.9	5.0	4.7	4.0
Carbon Monoxide	5.9	5.6	4.7	4.5
Methane	14.6	12.1	11.7	9.7
Ethane	13.4	11.0	10.7	8.8
Propane	14.3	11.4	11.4	9.1
Butane	14.5	12.1	11.6	9.7
Iso-butane	14.8	12.0	11.8	9.6
Pentane	14.4	12.1	11.5	9.7
Hexane	14.5	11.9	11.6	9.5
Gasoline	14.4	11.6	11.5	9.3
Ethylene	11.7	10.0	9.4	8.0
Propylene	14.1	11.5	11.3	9.2
Cyclopropane	13.9	11.7	11.1	9.4
Butadiene	13.1	10.4	10.5	8.3
Benzene	13.9	11.2	11.1	9.0

Table 2-4 Oxygen End-Points for Purging Into Service

2.6 Purging Facilities Out of Service

The operation of purging natural gas from piping or vessels to be filled subsequently with air may also be illustrated using Figure 2-2. As inert gas is added, the methane concentration decreases from point H (at the right) along abscissa HX to a point J beyond D. Subsequent addition of air results in a change in the mixture composition along line JV, which crosses no part of flammable zone ABC. In the example shown in Figure 2-2, at least 88 percent of methane should be replaced by nitrogen when the container is purged out of service.

To render a given flammable mixture non-flammable if air be added to it in any amount, it is desirable to know what percentages of inert gases are required. Table 2-5 gives the data for a number of flammables investigated by the U.S. Bureau of Mines. To ensure safety, purging shall be continued to a point at least 20 percent beyond the flammable limit. These purging end-points are given on the right side of Table 2-5. Again, the requirements of NFPA 69 implies that U.S. Bureau of Mines oxygen end-points listed in these tables do not meet the safety margins of a 60% limiting oxidant concentration.

NOTE: The reader should be aware and verify the appropriate limiting oxidant concentration for their specific application.

It is sometimes more convenient to control the purging by determining the flammable content of the purged gases. In purging out of service, inert gas is added to the container until the flammable gas concentration of the mixture is decreased to the point where no mixture of this with any amount of air would be flammable. These data are given on Table 2-6. Suggested purging end-point data with a 20 percent safety factor are given on the right side of Table 2-6 in terms of the percent of flammable gas in a mixture which will remain non-flammable regardless of any amount of air which may be added to it.

Δ

Purge Medium	CO_2	N_2	CO_2	N_2
Flammable	Percent required to render mixtures non-flammable when air is added in any amount		Purging End-Points with 20% Safety Factor	
Hydrogen	91	95	93	96
Carbon Monoxide	68	81	74	85
Methane	77	86	82	89
Ethane	88	93	91	95
Propane	89	94	91	95
Butane	91	95	93	96
Iso-butane	91	95	93	96
Pentane	96	97	97	98
Hexane	96	97	97	98
Gasoline	93	96	95	97
Ethylene	90	94	92	95
Propylene	94	96	95	97
Benzene	93	96	95	97

Table 2-5 Inert Gas End-Points for Purging Out of Service

Purge Medium	CO_2	N_2	CO_2	N_2
Flammable	Percent of Flammable below which no mixture is flammable when air is added in any amount		Purging End-Points with 20% Safety Factor	
Hydrogen	9	5	7	4
Carbon Monoxide	32	19	26	15
Methane	23	14	18	11
Ethane	12	7	9	5
Propane	11	6	9	5
Butane	9	5	7	4
Iso-butane	9	5	7	4
Pentane	4	3	3	2
Hexane	4	3	3	2
Gasoline	7	4	5	3
Ethylene	1	6	8	5
Propylene	6	4	5	3
Benzene	7	4	5	3

Table 2-6 Flammable Gas End-Points for Purging Out of Service

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Annex C Sample Purge Procedure

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1 The sample purge procedure in this annex is reprinted here with permission from National Grid and is intended only to provide an example showing the implementation of the cleaning and purging procedures defined in Section 4.4. It should not be used as a procedure applicable to any specific site or facility.

Sample Site Specific Purge Procedure

Electricity Generation Operations—
Operating Procedure For Purging Main and Ignition Gas Lines

Authorized by: Date:

Plant Manager

Operating Procedure for Purging Main and Ignition Gas Lines
Amendments Record

	Date	Summary of Changes/ Reasons	Author(s)	Approved by (Name/Job Title)
1	3/1/2010			
2	3/15/2010	Typographical corrections and procedural alterations		
3	4/1/2010	Typographical corrections and procedural alterations		
4	4/2/2010	Typographical corrections and procedural alterations		
5	6/17/2010	Change to procedure number		

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 These Operating Procedures have been compiled to provide a ready reference and guide for the Operations Section at the xxxxxx Power Station required to accomplish both routine and non-routine tasks.

1.2 These Operating Procedures have been designated as divisional procedures.

1.2.1 Some of the Procedures may require notification of departments outside the Electric Production Department and/or organizations outside the Company.

1.2.2 Some of the actions detailed in these Procedures may be in response to local, state or federal regulations.

1.2.3 Training for implementation of these Procedures is given during on-the-job training at the plant.

1.2.4 This procedure will be reviewed and revised every seven years. If revision is called for during the interim, it will be handled as a partial revision and issued promptly.

2.0 PURPOSE AND SCOPE

2.1 The purpose of these Operating Procedures is to provide a standardized method for the Operations Section to accomplish both routine and non-routine tasks by the use of clearly written, comprehensive procedures which avoid confusion.

2.2 The Operating Procedures are meant to complement the training previously received and the general information provided in the instruction books.

3.0 RESPONSIBILITY

3.1 The Shift Supervisor is directly responsible to see that the procedures covered in these Operations Section Procedures are properly carried out.

3.2 All Operations Section personnel are responsible to be familiar with and understand the procedures covered in these Procedures. Clarification, if necessary, of any procedure is available from your Supervisor.

4.0 DEFINITIONS

4.1 Blowdown Operation: The act of releasing the displaced gas within the pipeline, into the atmosphere.

4.2 Controlled Operation: The process of safely containing and directing the flow of natural gas.

4.3 Gassing-In: The process of introducing natural gas into a gas *main* under a controlled, safe operation.

4.4 Inert Gas: For the purpose of this procedure, the gas utilized to displace (or replace) gas within a pipeline in order to safely control the purge operation (e.g., nitrogen or carbon dioxide.)

4.5 Inerting: The act of replacing air or gas within a pipeline, with a non-combustible substance. The inert operation is performed in such a manner as to prevent the formation of explosive air/gas mixtures.

4.6 M&C Station: Refers to the xxxxxx Power Station Gas Metering and Control Station. This area is located inside the plant at elevation 27'.

4.7 M&R Station: Refers to the xxxxxx Power Station Gas Metering and Regulator Station. This area is located outside the plant at elevation 15'.

4.8 Maximum Allowable Operating Pressure (MAOP): The maximum pressure at which a pipeline or segment of a pipeline may be operated under compliance with 16 NYCRR 255 (for Gas System) or ASME B31.1 Power Piping Code (for Generation.)

4.9 Purging: The act of displacing either air or gas from within a pipeline. The purge operation must be performed in a manner to minimize the mixture of air and natural gas so as to prevent formation of an explosive mixture.

4.10 Slug Purge: during the purge operation, a small amount of inert gas is inserted into a pipeline to form a “slug” (or piston effect) between the natural gas or air within the pipeline and the natural gas or air being introduced into the pipeline. The slug and the already existing gas or air within the pipeline are pushed along the pipe by the pressure of the gas or air being introduced into the pipeline.

4.11 Specific Gravity: The ratio of a gas to an equal volume of air under prescribed conditions of temperature and pressure. (Ex. The specific gravity of natural gas = 0.65, nitrogen = 0.9694, air = 1.0, and carbon dioxide = 1.532. Therefore, nitrogen and natural gas are lighter than air and carbon dioxide is heavier than air.

5.0 COMMUNICATIONS AND TRAINING

5.1 The purge and gas-in principles and practices discussed herein are methods for safely changing the atmosphere in a pipeline. Since many variables are involved (pipe size, length of pipe to purge, pressure, etc.) common sense and good judgment should be exercised during all purging operations.

5.2 Purging new or existing gas piping into buildings can be highly hazardous due to the possible accumulation of gas above the lower explosive limit and the associated danger of fire and explosion. Wherever practical, directly vent purged gases to

a safe location outdoors, away from people and *ignition* sources. This can be done using a temporary hose or piping or permanently installed vent pipes, depending on the facility design.

5.3 Employees shall be trained in and familiar with the safety related work practices, safety procedures and other safety requirements that pertain to their respective job assignment. Employees shall also be trained in and familiar with any other safety practice, including applicable emergency procedures that are related to their work (i.e.: scaffolding, confined space, etc.) and are necessary for their safety.

5.4 Qualified Employees shall be trained and competent in:

5.4.1 The proper use of the special precautionary techniques, personal protective equipment (PPE), insulating and shielding materials and insulated tools for working on or near exposed energized parts of electric equipment.

5.4.2 Supervision shall determine, through regular inspections that each employee is complying with safety related work practices. Retraining and possible discipline will be initiated if an employee is not complying.

5.5 The training required shall be classroom and on-the-job type. The training shall establish employee proficiency in work practices and shall introduce the necessary procedures. Employment records shall be maintained that certify the required training has been received by each qualified individual.

6.0 BACKGROUND

6.1 The purpose of this procedure is to formalize a methodology to safely and efficiently replace unit #3 and 4 “E” valves, *ignition* gas v-cone flow measuring devices and *main* gas v-cone flow measuring devices.

6.2 Implementation of this procedure will result in the isolation of all main and ignition gas to the steam station. This procedure covers the necessary steps to perform work on either or both units’ main and ignition gas systems.

6.3 Nitrogen will be used to purge the piping for both the *main* and *ignition* gas lines using the M&R station purge connections and v-cone taps, respectively. The M&C normal high point vent at elevation 65' and the burner corner vent piping on unit #3 and 4 will be used to vent displaced gases and to monitor the combustible gas content. Both vents expel gas outside of the building. The volume of *main* gas to be purged is about 934 cubic feet.

7.0 SAFETY AND PROTECTIVE EQUIPMENT

7.1 Prior to performing any maintenance or operation, each employee shall refer to and comply with Office of Generation procedures, OEG-28, Personal Protective Clothing Policy and OEG-29, Personal Protective Equipment Requirements.

7.2 A job briefing shall be given to all personnel prior to implementing this procedure.

7.3 During the safety briefing at the beginning of the procedure, all personnel on site will be accounted for and recorded. Security shall be requested to inform the Shift Supervisor of any personnel entering or exiting the site during the course of the procedure.

7.4 Any existing safety red tags on the M&C gas system piping must be administratively accounted for. Boundaries may be moved to allow for all work related to this procedure.

7.5 This outage will prevent the package boiler from operation. In addition, the gas powered emergency battery charger diesel will be out of service while the *ignition* gas system is purged and tagged.

7.6 “No Smoking” signs shall be placed nearby all gas vents and drains.

7.7 A periodic public address (PA) system announcement shall be made inform all employees not to smoke on unit #3 and 4 and to avoid potential sources of ignition.

7.8 Verify that all windows, specifically in the coal tower, and building openings are closed and remain closed during the duration of the procedure to prevent vented gas from entering the building.

7.9 Gas Instrument and Regulation (I&R) shall shut down the chromatograph for the duration of the procedure.

7.10 Alert all personnel of the dangers of nitrogen gas. Provide material properties.

7.11 Combustible Gas Indicator (CGI) Instruments shall be used to monitor gas concentrations during purging operations. Never rely on odor alone to detect releases of fuel gases.

7.12 Before use, verify that all CGI’s are properly calibrated and have not exceeded their calibration expiration date.

7.13 Plant and Gas I&R personnel shall continuously monitor for combustible gas throughout the duration of the work procedure. If gas is detected at the M&C station, the area will be evacuated and the procedure will be stopped.

7.14 All purging equipment shall be electronically bonded to the metallic pipe to dissipate static charges. An electrical bond shall be made between the purge cylinder and the gas *main,* using a minimum bonding wire size of 14 AWG. Use an alligator clip or magnetic jumper.

7.15 Personnel should be wearing fire retardant clothing. In addition, approved fire extinguisher should be located in the immediate vicinity of each purge site.

7.16 During purging operations, the removal or neutralization of all potential sources of *ignition* is required, prior to starting the purging operation.

7.16.1 Extinguish all open flames (e.g. pilot lights, cutting torches, cigarettes, etc.)

7.16.2 Eliminate or remove all potential sources of sparks or arcs (e.g. non-approved flashlights, hand lights, engines and motors, hand tools, cutting and grinding equipment, static electricity, and welding equipment.)

7.16.3 Allow heated metals and lights time to cool down (e.g. electric lights, glowing metals and flowing filaments.)

7.17 Establish and maintain communications between all personnel during the purging procedure.

7.18 All hand-held radios in use during the procedure must be intrinsically safe. Indentifying features of intrinsically safe radios include a green dot at the bottom of the device or battery, or the words “Factory Mutual Approved” or “Intrinsically Safe” printed on the device.

7.19 Ensure personnel involved in gas purging operations are fully trained and knowledgeable about safe gas venting practices, the proper use of Baskum Turner GMI’s (combustible gas detectors provided by Gas I&R,) and the danger of relying on the sense of smell alone to detect gas releases.

7.20 Gases shall not be vented within the building. Connect hoses to all drains that are to be used on the M&C station during the procedure. The other end of the hose shall be brought outside.

7.21 Use suitable nitrile green gasket. All removed gaskets shall be replaced and not reused.

8.0 PROCEDURE

8.1 PHASE I — PREREQUISITES

8.1.1 Confirm nitrogen bottle inventory at the M&R and M&C stations before commencing procedure.

8.1.2 Electric System Operations (ESO) and Gas System Operations (GSO) must be notified that a duel unit outage is required to conduct this procedure.

8.1.3 Refer to section 11.1 for familiarization with valve locations at the M&R station.

8.1.4 Refer to section 11.2 for familiarization with valve location for *main* gas piping at the M&C station.

8.1.5 Refer to section 11.3 for familiarization with valve location for *ignition* gas piping at the M&C station.

8.1.6 Six separate hold-offs will be required to perform this operation safely. The necessary hold-offs are as follows:

8.1.6.1 The M&R *main* gas systems (five *main* isolation valves: V-102, V-202, V-103, V-203, and V-303.) See section 11.1 for reference.

8.1.6.2 The M&R *ignition* gas system isolation valves (V-401 and V-402) and *main* system *ignition* gas backup (V-403.) See section 11.1 for reference.

8.1.6.3 The (16) unit #3 *main* gas cock block valves at the burner corners on elevation 52' for the M&C Station *main* gas system. See section 10.7 for reference.

8.1.6.4 The (16) unit #4 *main* gas cock block valves at the burner corners on elevation 52' for the M&C Station *main* gas system. See section 10.8 for reference.

8.1.6.5 The M&C station unit #3 *ignition* gas system valves (the ignition gas control valve outlet isolation valve and the control valve bypass valve.) See section 10.9 and 11.3 for reference.

8.1.6.6 The M&C station unit #4 *ignition* gas system valves (the ignition gas control valve outlet isolation valve and the control valve bypass valve.) See section 10.10 and 11.3 for reference.

8.2 PHASE II—MAIN AND IGNITION GAS PURGE PROCEDURE

8.2.1 Gas I&R shall isolate the *main* gas system at the M&R station. Close and tag the two isolation valves (V-102 and V-202) located past the gas meters at the M&R station.

8.2.2 Open unit #3 and 4 6" and 8" *main* gas inlet and outlet manual isolation valves on the M&C station.

8.2.3 Gas I&R shall isolate the *ignition* gas piping by closing the isolation valve (V-401) located upstream of the *ignition* gas meter at the M&R station.

8.2.4 On the M&C station, close and tag unit #3 *ignition* gas control valve outlet isolation valve, and control valve bypass valve.

8.2.5 On the M&C station, close and tag unit #4 *ignition* gas control valve outlet isolation valve, and control valve bypass valve.

8.2.6 Gas I&R shall open the *main* gas system backup supply to the *ignition* gas piping valve V-403. During the process of operating valve V-403, be sure to throttle the valve adequately so not to release safety valve on the *ignition* gas piping. The safety valve is set for 115 PSI.

8.2.7 If available, allow the package boiler to burn the remaining gas from the *ignition* and *main* gas piping. Manually trip the package boiler when gas has been exhausted to about 3 PSI. If the package boiler is not available, continue to 8.2.9.

8.2.8 Considering the weather conditions, drain package boiler steam piping to prevent damage due to freezing.

8.2.9 With assistance from Controls, open all control and trip valves associated with *main* gas piping on the M&C station.

8.2.10 Throttle and vent the *ignition* gas and *main* gas piping to 0 PSI using the high point vent at elevation 65' and at the burner corner vent piping on unit #3 and 4. Note that the high point vent at elevation 65' is a manual vent and the vents at the burner corner vent piping are controlled by motor operated valves at the burner corners. Ensure that the *main* system backup supply to the *ignition* gas piping valve (V-403) is cycled open and then tagged and closed by Gas IR during this step.

8.2.11 Gas I&R shall close and tag the *main* gas system backup supply to the *ignition* gas piping valve (V-403.)

8.2.12 Gas I&R shall close and tag the main gas three isolation valves (V-103, v-203, and V-303) and the ignition gas isolation valve (V-402) at the M&R station.

8.2.13 On the M&C station, close and tag isolation valves for the package boiler and the emergency battery charger diesel.

8.2.14 Gas I&R shall purge unit #3 and 4 *main* gas piping with nitrogen once prior steps are completed. Nitrogen shall be injected into the piping at the M&R station.

8.2.15 Gas I&R shall purge unit #3 and 4 *ignition* gas piping with nitrogen. Nitrogen shall be injected at the M&R station and into the v-cone taps at the M&C station. The high point vent at elevation 65' shall be used as a flow path for both purges.

8.2.16 Gas samples will be monitored at the high point vent located on elevation 65' and at the burner corner vent piping on unit #3 and 4.

8.2.17 Secure all nitrogen bottles when purge is completed.

8.3 PHASE III—UNIT #3 WORK PERMITS AND PROCEDURES

8.3.1 Work permits may be issued to complete the following tasks if applicable to the work plan:

8.3.1.1 The removal and installation of unit #3 *ignition* gas v-cone meter.

8.3.1.2 The removal and installation of unit #3 *main* gas v-cone meter.

8.3.1.3 The removal and installation of unit #3 “E” valve.

8.4 PHASE IV—UNIT #4 WORK PERMITS AND PROCEDURES

8.4.1 Work permits may be issued to complete the following tasks if applicable to the work plan:

8.4.1.1 The removal and installation of unit #4 *ignition* gas v-cone meter.

8.4.1.2 The removal and installation of unit #4 *main* gas v-cone meter.

8.4.1.3 The removal and installation of unit #4 "E" valve.

8.5 PHASE V—IGNITION GAS GAS-IN PROCEDURE

8.5.1 Secure all vents and drains and introduce air into the *ignition* gas piping. Pressurize to 80 PSI and test all new fittings for leaks.

8.5.2 After testing all new fittings for leaks, slowly open the high point vent on elevation 65' associated with *ignition* gas piping. Vent piping to 0 PSI.

8.5.3 Gas I&R shall inert *ignition* gas system with nitrogen to evacuate system of air in order to prevent mixture with oxygen before natural gas is reintroduced.

8.5.4 While pushing nitrogen through, close the high point vent on elevation 65' associated with the *ignition* gas piping and pressurize. Open drains and close again when all remaining air has been pushed out of the system.

8.5.5 Secure all nitrogen bottles when purge is completed.

8.5.6 Gas I&R shall open valves V-401 and V-402 at the M&R station while keeping valve V-403 closed to allow gas into the *ignition* gas piping while purging nitrogen through vent.

8.5.7 Once gas-in is completed, clear all hold-offs associated to *ignition* gas piping and open the *ignition* gas control valve outlet isolation valves associated with unit #3 and 4 on the M&C station.

8.5.8 Return the emergency battery charger diesel and the package boiler to service.

8.5.9 Perform a test run of the emergency battery charger diesel.

8.6 PHASE VI—MAIN GAS GAS-IN PROCEDURE

8.6.1 Upon completion of work permits related to *main* gas piping, gas-in procedure may commence.

8.6.2 Secure all vents and drains and introduce air into the *main* gas piping. Pressurize to 80 PSI and test all new fittings for leaks.

8.6.3 After testing all new fittings for leaks, slowly open the high point vent on elevation 65' associated with *main* gas piping and at the burner corner vent piping on unit #3 and #4. Vent piping to 0 PSI.

8.6.4 Gas I&R shall inert with nitrogen to evacuate system of air and prevent mixture with oxygen when natural gas is reintroduced.

8.6.5 While pushing nitrogen through, close the high point vent on elevation 65' associated with the *main* gas piping and at the burner corner vent piping on

unit #3 and 4. Pressurize with nitrogen. Open drains and close again when all remaining air has been pushed out of the system.

8.6.6 Secure all nitrogen bottles when purge is completed.

8.6.7 Gas I&R shall open valves V-102, V-202, V-103, V-203, and V-303 at the M&R station to allow gas into the *main* gas piping.

8.6.8 Ensure that nitrogen has been fully vented and the *main* gas system is fully gassed-in.

8.6.9 Clear all hold-offs associated with *main* gas piping.

9.0 ACCEPTANCE CRITERIA

9.1 All ignition and main v-cone gas meter bolted joints and "E" valve bolted joints verified to be leak tight.

10.0 REFERENCES

10.1 xxxxx Power Station Unit #3 & #4—Addition or Gas Firing System Familiarization Manual.

10.2 Gas Operations PURG-5010: Purge and Gas-In Mains and Services.

10.3 Chemical Safety Board Safety Bulletin—September 2009.

10.4 U.S. Chemical Safety and Hazard Investigation Board: Urgent Recommendations—February 4, 2010.

10.5 AGA Purging Principles and Practice.

10.6 Gas I&R Work Instruction for xxxxx Steam Plant Gas Header Purge.

10.7 xxxxx Power Station Unit #3 Gas Conversion, P&I Diagram, Main Fuel Gas System (Drawing PJPS3-MM-04000-00.)

10.8 xxxxx Power Station Unit #4 Gas Conversion, P&I Diagram, Main Fuel Gas System (Drawing PJPS4-MM-04000-00.)

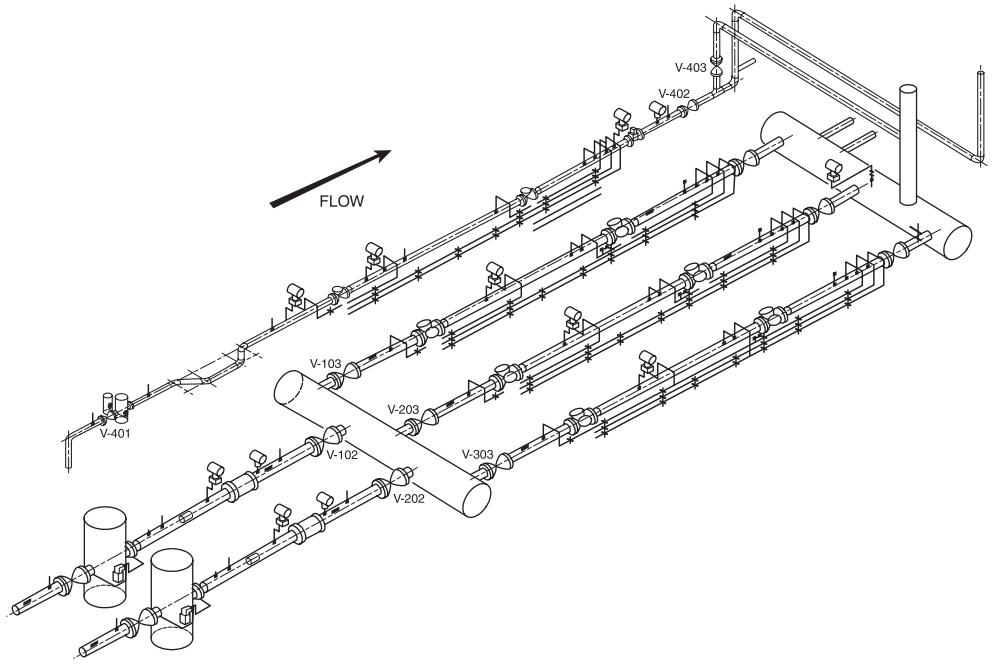
10.9 xxxxx Power Station Unit #3 Gas Conversion, P&I Diagram, Ignition Gas System (Drawing PJPS3-MM-04001-2.)

10.10 xxxxx Power Station Unit #4 Gas Conversion, P&I Diagram, Ignition Gas System (Drawing PJPS4-MM-04001-00.)

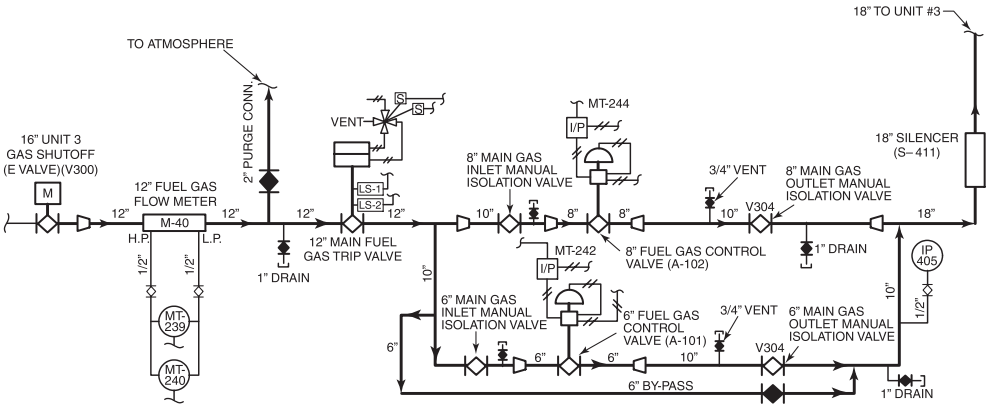
10.11 Natural Gas Meter and Regulation Station for Unit 3 & 4 Gas Firing, Piping Plan, Sections, and Details (Drawing PJMRY-MM-02000-3.)

11.0 ATTACHMENTS

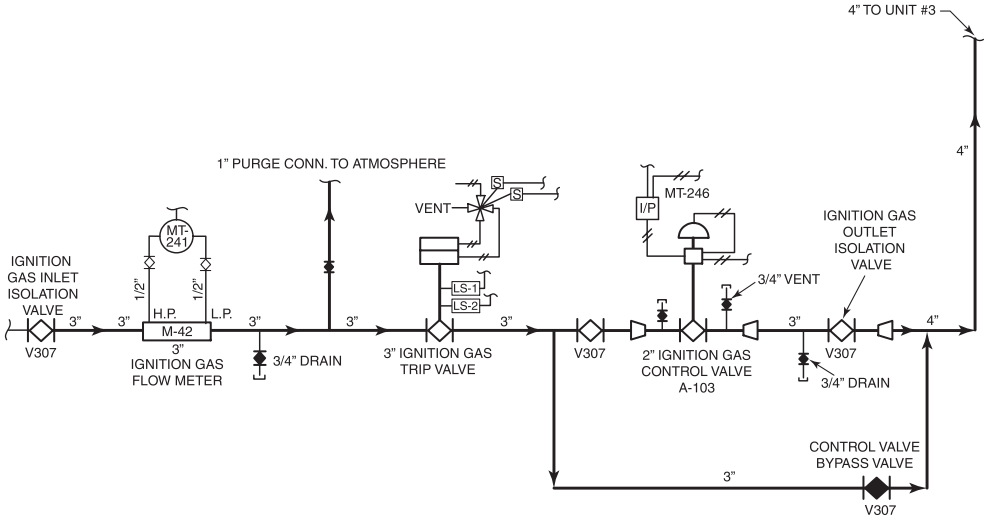
11.1 xxxxx Power Station Gas Metering and Regulator Station.



11.2 xxxxx Power Station Main Fuel Gas Metering and Control Station.0



11.3 xxxxx Power Station Ignition Gas Metering and Control Station.



11.4 Inert Amounts Table.

Pipe Size and Minimum Amount of Inertant Needed When Purging by Completely Filling Line

Nominal Pipe Size (in.)	*Volume (V) of Inerts (cu. ft.) Per 100 ft. of Pipe
6	40
8	70
10	140
12	160
16	280
20	440
24	630
30	1000
36	1500

** This data includes a 2.0 safety factor adjustment.*

11.5 Full Cylinder Data.

	Volume (cu. ft.)	Pressure (psig)
N2	220	2200
CO2	520	830

11.6 Slug Volume Requirements.

VOLUME OF SLUG OF CARBON DIOXIDE/NOTROGEN REQUIRED FOR VARIOUS PIPE SIZES AND PIPE LENTHS CHART

Purging Velocity 200 Lineal Pipe Feet per Minute or Higher
Pipe Diameter Nominal – Inches

Pipe Length (ft.)	4"	6"	8"	10"	12"	16"	18"	20"	22"	24"	30"
	Volume of Nitrogen Slug—Cubic Feet										
1,000 or less	7	24	54	107	184	430	588	806	1,070	1,390	2,722
1,000–2,000	8	28	73	126	216	580	686	940	1,250	1,624	3,390
2,000–4,000	11	36	83	165	282	632	902	1,240	1,640	2,142	4,180
4,000–6,000	13	44	103	200	368	784	1,118	1,540	2,000	2,580	5,100
6,000–8,000	15	52	123	236	418	936	1,334	1,840	2,380	3,120	6,080
8,000–10,000	18	60	143	270	484	1,088	1,550	2,040	2,790	3,620	7,060
10,000–15,000	24	82	188	372	640	1,530	2,046	2,800	3,720	4,860	9,520
15,000–20,000	30	102	238	468	808	1,800	2,580	3,540	4,680	6,120	12,000
20,000–25,000	36	124	288	528	976	2,170	3,014	4,280	5,640	7,400	14,400
25,000–30,000	42	146	338	588	1,144	2,540	3,448	5,020	6,600	8,620	16,900
30,000–40,000	55	186	432	1,042	1,470	3,280	4,680	6,420	8,520	11,120	21,800
40,000–50,000	67	228	530	1,234	1,820	4,000	5,720	7,960	10,440	13,680	26,800
50,000–60,000	80	270	630	1,426	2,170	4,720	6,760	9,500	12,320	16,200	31,700
60,000–70,000	92	312	730	1,618	2,520	5,440	7,900	11,040	14,300	18,700	36,500
70,000–80,000	101	354	830	1,812	2,870	6,160	8,940	12,580	16,200	21,220	41,400

General Notes:

1. The same volume of a slug applies for nitrogen usage.
2. For exhaust gases, add 20%.
3. The number of large cylinders of nitrogen required can be obtained be dividing the volume required by 224 cubic feet.

For total displacement: locate the length of pipe and the size of the pipe, look up the intersecting volume (cubic feet) and divide by 224 cubic feet to establish the number of cylinders required.

12.0 Procedure Checklist

The following checklist is to be utilized as a guideline to perform operations within the criteria described in the purging procedure for xxxxx Power Station Unit #3 and #4 main and ignition gas lines.

The checklist below is only intended as a guide. Every operating condition cannot be taken into account in preparing such a guide. The operator shall refer to the documented operations procedure for supplemental detail.

Each step in this procedure must be initialed as being completed by the Shift Supervisor. All changes that deviate from this checklist or are non-applicable (N/A) shall only be marked as such by the Operations and Controls Manager. Comments shall be written for these actions in the field provided.

PHASE I—PREREQUISITES AND SAFETY			
NO.	**DESCRIPTION**	**COMP.**	**COMMENTS**
1	Notify ESO and GSO of the dual unit outage.		
2	A job briefing shall be given to all personnel prior to implementing this procedure and all associated work.		
3	Account for and record all personnel on site.		
4	Alert all personnel of the dangers of nitrogen gas.		
5	Verify that all personnel are wearing fire retardant clothing and are equipped with appropriate PPE.		
6	Establish and maintain communications between all personnel.		
7	“No Smoking” signs shall be placed nearby all gas vents and drains.		
8	Perform periodic announcements on the PA system to inform all personnel not to smoke.		
9	Verify that all windows and other building openings are closed.		
10	Gas I&R to shut down chromatograph.		

11	Verify that all CGI's are calibrated and have not exceeded their calibration expiration date.		
12	Plant and Gas I&R personnel shall continuously monitor for combustible gas throughout the duration of the work procedure.		
13	All purging equipment shall be electronically bonded to metallic pipe.		
14	Remove all sources of ignition, such as open flames and all electrical equipment.		
15	Verify that hoses have been connected to all relevant drains on the M&C station piping.		
16	Confirm nitrogen bottle inventory at the M&R and M&C station.		
17	Prepare hold-off for M&R main gas system (valves V-102, V-202, V103, V-203, and V-303.)		
18	Prepare hold-off for M&R ignition gas system (valves V-401, V-402, and V-403.)		
19	Prepare hold-off for unit #3 M&C main gas system.		
20	Prepare hold-off for unit #4 M&C main gas system.		
21	Prepare hold-off for unit #3 M&C ignition gas system.		
22	Prepare hold-off for unit #4 M&C ignition gas system.		
23	Shift Supervisor has verified and confirmed that all safety actions and prerequisites have been accounted for before beginning the purging procedure.		

PHASE II—MAIN AND IGNITION GAS PURGE PROCEDURE

NO.	DESCRIPTION	COMP.	COMMENTS
1	Gas I&R shall isolate the main gas system at the M&R station. Close and tag V-102 and V-202.		

2	Open unit #3 and 4 6" and 8" main gas inlet and outlet manual isolation valves on the M&C station.		
3	Gas I&R shall isolate the ignition gas system at the M&R station. Close and tag V-401 at the M&R station.		
4	On the M&C station, close and tag unit #3 and 4 ignition gas inlet isolation ball valves, ignition gas control valve outlet isolation valves, and control valve bypass valves.		
5	Gas I&R shall open and throttle valve V-403.		
6	Allow the package boiler to burn off remaining gas in main and ignition gas piping. Manually trip at 3 PSI.		
7	Drain package boiler steam piping (per weather conditions.)		
8	Open all control and trip valves associated with main gas piping on the M&C station.		
9	Throttle and vent the ignition gas and main gas piping to 0 PSI using the high point vent at elevation 65' and at the burner corner vent piping on unit #3 & 4. Gas I&R shall cycle V-403 at the M&R station open and tag closed during this step.		
10	Gas I&R shall close and tag V-402 and V-403 at the M&R station.		
11	Gas I&R shall close and tag valves V-102, V-202, and V-302 at the M&R station.		
12	At the M&C station, close and tag isolation valves for the package boiler and the emergency battery charger diesel.		
13	Gas I&R shall inject nitrogen into taps at M&R station and the v-cone taps at the M&C station, and purge ignition and gas piping.		

14	Monitor gas samples at the high point vent located on elevation 65' and at the burner corner vent piping on unit #3 and 4.		
15	Secure all nitrogen bottles when purge is completed.		

PHASE III—UNIT #3 WORK PERMITS AND PROCEDURES (IF APPLICABLE)

NO.	DESCRIPTION	COMP.	COMMENTS
1	Issue work permit for unit #3 “E” valve.		
2	Remove unit #3 “E” valve.		
3	Install new “E” valve into unit #3.		
4	Issue work permit for unit #3 ignition gas v-cone.		
5	Remove unit #3 ignition gas v-cone.		
6	Install new ignition gas v-cone into unit #3.		
7	Issue work permit for unit #3 main gas v-cones.		
8	Remove unit #3 main gas v-cone.		
9	Install new main gas v-cone into unit #3.		
10	Return all work permits.		

PHASE IV—UNIT #4 WORK PERMITS AND PROCEDURES (IF APPLICABLE)

NO.	DESCRIPTION	COMP.	COMMENTS
1	Issue work permit for unit #4 “E” valve.		
2	Remove unit #4 “E” valve.		
3	Install new “E” valve into unit #4.		
4	Issue work permit for unit #4 ignition gas v-cone.		
5	Remove unit #4 ignition gas v-cone.		
6	Install new ignition gas v-cone into unit #4.		
7	Issue work permit for unit #4 main gas v-cones.		
8	Remove unit #4 main gas v-cone.		

9	Install new main gas v-cone into unit #4.		
10	Return all work permits.		

PHASE V—IGNITION GAS GAS-IN PROCEDURE

NO.	DESCRIPTION	COMP.	COMMENTS
1	Secure all vents and drains.		
2	Introduce air into ignition piping, pressurize to 80 PSI, and test all new fittings for leaks.		
3	Open high point vent on elevation 65' associated with ignition gas piping and vent to 0 PSI.		
4	Gas I&R shall inert ignition gas piping with nitrogen gas to purge all air through vents.		
5	Close vents and pressurize system.		
6	Open drains and close again when all remaining air has been evacuated from the system.		
7	Secure all nitrogen bottles when purge is completed.		
8	Gas I&R shall open valve V-401 and V-402 at the M&R station to allow gas back into the ignition system.		
9	Once gas-in is completed, clear all hold-offs associated to ignition gas piping.		
10	Open ignition gas control valve outlet isolation valves associated with unit #3 and 4 on the M&C station.		
11	Return the emergency battery charger diesel to service.		
12	Perform a test run of the emergency battery charger diesel.		
13	Return the package boiler to service.		

PHASE VI—MAIN GAS GAS-IN PROCEDURE			
NO.	**DESCRIPTION**	**COMP.**	**COMMENTS**
1	Secure all vents and drains.		
2	Introduce air into main piping, pressurize to 80 PSI, and test all new fittings for leaks.		
3	Open high point vent on elevation 65' associated with main gas piping and the burner corner vent piping. Vent to 0 PSI.		
4	Gas I&R shall inert main gas piping with nitrogen to purge all air through the high point vent on elevation 65' and the burner piping vent piping on unit #3 and 4.		
5	Close vents and pressurize system.		
6	Open drains and close again when all remaining air has been evacuated from the system.		
7	Secure all nitrogen bottles when purge is completed.		
8	Gas I&R shall open valves V-102, V-202, V-103, V-203, and V-303 at the M&R station and allow gas back into the main gas system.		
9	Ensure that nitrogen has been fully vented from the main gas system.		
10	Clear all hold-offs associated with main gas piping.		

Annex D Informational References

D.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

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

NFPA 1, *Fire Code*, 2018 edition.

NFPA 2, *Hydrogen Technologies Code*, 2020 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2018 edition.

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2018 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 2018 edition.

NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*, 2019 edition.

NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes*, 2018 edition.

NFPA 52, *Vehicular Natural Gas Systems Code*, 2019 edition.

NFPA 54, *National Fuel Gas Code*, 2018 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2020 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2020 edition.

NFPA 59, *Utility LP-Gas Plant Code*, 2018 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*, 2019 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2019 edition.

NFPA 70®, *National Electrical Code®*, 2020 edition.

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

NFPA 85, *Boiler and Combustion Systems Hazards Code*, 2019 edition.

NFPA 86, *Standard for Ovens and Furnaces*, 2019 edition.

NFPA 87, *Standard for Fluid Heaters*, 2018 edition.

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

NFPA 400, *Hazardous Materials Code*, 2019 edition.

NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*, 2020 edition.

Manual of Style for NFPA Technical Committee Documents, 2004 edition.

D.1.2 Other Publications.

Δ **D.1.2.1 AGA Publications.** American Gas Association, 400 North Capitol Street, NW, Washington, DC 20001.

Purging Manual, 4th edition, 2018.

D.1.2.2 AIChE Publications. American Institute of Chemical Engineers, 120 Wall Street, FL 23, New York, NY 10005-4020.

Crowl, D. A., *Understanding Explosions*, 2010.

Guidelines for Hazard Evaluation Procedures, 3rd edition, 2008.

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

API Recommended Practice 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*, 8th Edition, 2015.

D.1.2.4 ASME Publications. American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

ASME B31.1, *Power Piping*, 2016.

ASME B31.3, *Process Piping*, 2016.

N **D.1.2.5 ASSP Publications.** American Society of Safety Professionals, 520 N. Northwest Hwy, Park Ridge, IL 60068.

ANSI/ASSP Z490.1, *Criteria for Accepted Practices in Safety, Health and Environmental Training*, 2016.

D.1.2.6 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM E681, *Standard Test Method for Concentration Limits of Flammability of Chemicals (Vapors and Gases)*, 2009, reapproved 2015.

ASTM E2079, *Standard Test Methods for Limiting Oxygen (Oxidant) Concentration in Gases and Vapors*, 2013.

D.1.2.7 U.S. Government Publications. U.S. Government Publishing Office, 732 North Capitol Street, NW, Washington, DC, 20401-0001.

Title 49, Code of Federal Regulations, Parts 100–185, "Hazardous Material Regulations." 49 CFR 100–185.

Title 49, Code of Federal Regulations, Parts 192.629, "Purging of Pipelines." 49 CFR 192.629.

Title 49, Code of Federal Regulations, Parts 190–199, "Pipeline Safety Regulations." 49 CFR 190–199.

U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), *Safety and Health Topics*, "Competent Persons," http://www.osha.gov/SLTC/competentperson/index.html.

Δ **D.1.2.8 Other Publications.**

Britton, L. G., "Using Heats of Oxidation to Evaluate Flammability Hazards," *Process Safety Progress* 20, no. 1 (March 2002): 31–54.

Bulletin 503, "Limits of Flammability of Gases and Vapors," 1952.

Bulletin 680, "Investigation of Fire and Explosion Accidents in the Chemical, Mining, and Fuel-Related Industries — A Manual," 1985.

Jones, R. M., "Reducing the Inflammability of Fumigants with Carbon Dioxide," *Industrial & Engineering Chemistry Research* 25 (1933): 394–396.

Kuchta, J. M., A. L. Furno, A. Bartkowiak, and G. H. Martindill, "Effect of Pressure and Temperature on Flammability Limits of Chlorinated Combustibles in Oxygen-Nitrogen and Nitrogen Tetroxide-Nitrogen Atmospheres," *Journal of Chemical and Engineering Data* 13, no. 3 (July 1968): 421.

Zlochower, I. A., and G. M. Green, "The Limiting Oxygen Concentration and Flammability of Gases and Gas Mixtures," *Journal of Loss Prevention in the Process Industries* 22, no. 4 (June 2009): 499–505.

D.2 Informational References. The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

D.2.1 ASSE Publications. American Society of Safety Professionals, 520 N. Northwest Hwy, Park Ridge, IL 60068.

ANSI/ASSE/ISO Z690.1, *Vocabulary for Risk Management*, 2011.

ANSI/ASSE/ISO Z690.2, *Risk Management — Principles and Guidelines*, 2011.

ANSI/ASSE/ISO 690.3, *Risk Assessment Techniques*, 2011.

N **D.2.2 Other Publications.**

Zabetakis, M. G., "Flammability Characteristics of Combustible Gases and Vapors," Bulletin 627, U.S. Bureau of Mines, Pittsburgh, PA, 1965.

Zabetakis, M. G., and B. H. Rosen, "Considerations Involved in Handling Kerosine," *Proceedings*, API, Vol. 37, Sec. III, 1957, p. 296.

D.3 References for Extracts in Informational Sections. NFPA 2, *Hydrogen Technologies Code*, 2016 edition.

NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes*, 2018 edition.

NFPA 54, *National Fuel Gas Code*, 2018 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2016 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2017 edition.

NFPA 59, *Utility LP-Gas Plant Code*, 2018 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*, 2019 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2019 edition.

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

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Sequence of Events for the Standards Development Process

Once the current edition is published, a Standard is opened for Public Input.

Step 1 – Input Stage

- Input accepted from the public or other committees for consideration to develop the First Draft
- Technical Committee holds First Draft Meeting to revise Standard (23 weeks); Technical Committee(s) with Correlating Committee (10 weeks)
- Technical Committee ballots on First Draft (12 weeks); Technical Committee(s) with Correlating Committee (11 weeks)
- Correlating Committee First Draft Meeting (9 weeks)
- Correlating Committee ballots on First Draft (5 weeks)
- First Draft Report posted on the document information page

Step 2 – Comment Stage

- Public Comments accepted on First Draft (10 weeks) following posting of First Draft Report
- If Standard does not receive Public Comments and the Technical Committee chooses not to hold a Second Draft meeting, the Standard becomes a Consent Standard and is sent directly to the Standards Council for issuance (see Step 4) or
- Technical Committee holds Second Draft Meeting (21 weeks); Technical Committee(s) with Correlating Committee (7 weeks)
- Technical Committee ballots on Second Draft (11 weeks); Technical Committee(s) with Correlating Committee (10 weeks)
- Correlating Committee Second Draft Meeting (9 weeks)
- Correlating Committee ballots on Second Draft (8 weeks)
- Second Draft Report posted on the document information page

Step 3 – NFPA Technical Meeting

- Notice of Intent to Make a Motion (NITMAM) accepted (5 weeks) following the posting of Second Draft Report
- NITMAMs are reviewed and valid motions are certified by the Motions Committee for presentation at the NFPA Technical Meeting
- NFPA membership meets each June at the NFPA Technical Meeting to act on Standards with "Certified Amending Motions" (certified NITMAMs)
- Committee(s) vote on any successful amendments to the Technical Committee Reports made by the NFPA membership at the NFPA Technical Meeting

Step 4 – Council Appeals and Issuance of Standard

- Notification of intent to file an appeal to the Standards Council on Technical Meeting action must be filed within 20 days of the NFPA Technical Meeting
- Standards Council decides, based on all evidence, whether to issue the standard or to take other action

Notes:

1. Time periods are approximate; refer to published schedules for actual dates.
2. Annual revision cycle documents with certified amending motions take approximately 101 weeks to complete.
3. Fall revision cycle documents receiving certified amending motions take approximately 141 weeks to complete.

Committee Membership Classifications[1,2,3,4]

The following classifications apply to Committee members and represent their principal interest in the activity of the Committee.

1. M *Manufacturer:* A representative of a maker or marketer of a product, assembly, or system, or portion thereof, that is affected by the standard.
2. U *User:* A representative of an entity that is subject to the provisions of the standard or that voluntarily uses the standard.
3. IM *Installer/Maintainer:* A representative of an entity that is in the business of installing or maintaining a product, assembly, or system affected by the standard.
4. L *Labor:* A labor representative or employee concerned with safety in the workplace.
5. RT *Applied Research/Testing Laboratory:* A representative of an independent testing laboratory or independent applied research organization that promulgates and/or enforces standards.
6. E *Enforcing Authority:* A representative of an agency or an organization that promulgates and/or enforces standards.
7. I *Insurance:* A representative of an insurance company, broker, agent, bureau, or inspection agency.
8. C *Consumer:* A person who is or represents the ultimate purchaser of a product, system, or service affected by the standard, but who is not included in (2).
9. SE *Special Expert:* A person not representing (1) through (8) and who has special expertise in the scope of the standard or portion thereof.

NOTE 1: "Standard" connotes code, standard, recommended practice, or guide.

NOTE 2: A representative includes an employee.

NOTE 3: While these classifications will be used by the Standards Council to achieve a balance for Technical Committees, the Standards Council may determine that new classifications of member or unique interests need representation in order to foster the best possible Committee deliberations on any project. In this connection, the Standards Council may make such appointments as it deems appropriate in the public interest, such as the classification of "Utilities" in the National Electrical Code Committee.

NOTE 4: Representatives of subsidiaries of any group are generally considered to have the same classification as the parent organization.

Submitting Public Input / Public Comment Through the Online Submission System

Following publication of the current edition of an NFPA standard, the development of the next edition begins and the standard is open for Public Input.

Submit a Public Input

NFPA accepts Public Input on documents through our online submission system at www.nfpa.org. To use the online submission system:

- Choose a document from the List of NFPA codes & standards or filter by Development Stage for "codes accepting public input."
- Once you are on the document page, select the "Next Edition" tab.
- Choose the link "The next edition of this standard is now open for Public Input." You will be asked to sign in or create a free online account with NFPA before using this system.
- Follow the online instructions to submit your Public Input (see www.nfpa.org/publicinput for detailed instructions).
- Once a Public Input is saved or submitted in the system, it can be located on the "My Profile" page by selecting the "My Public Inputs/Comments/NITMAMs" section.

Submit a Public Comment

Once the First Draft Report becomes available there is a Public Comment period. Any objections or further related changes to the content of the First Draft must be submitted at the Comment Stage. To submit a Public Comment follow the same steps as previously explained for the submission of Public Input.

Other Resources Available on the Document Information Pages

Header: View document title and scope, access to our codes and standards or NFCSS subscription, and sign up to receive email alerts.

Research current and previous edition information.

Follow the committee's progress in the processing of a standard in its next revision cycle.

View current committee rosters or apply to a committee.

For members, officials, and AHJs to submit standards questions to NFPA staff. Our Technical Questions Service provides a convenient way to receive timely and consistent technical assistance when you need to know more about NFPA standards relevant to your work.

Provides links to available articles and research and statistical reports related to our standards.

Discover and purchase the latest products and training.

View related publications, training, and other resources available for purchase.

Information on the NFPA Standards Development Process

I. Applicable Regulations. The primary rules governing the processing of NFPA standards (codes, standards, recommended practices, and guides) are the NFPA *Regulations Governing the Development of NFPA Standards (Regs)*. Other applicable rules include NFPA *Bylaws*, NFPA *Technical Meeting Convention Rules*, NFPA *Guide for the Conduct of Participants in the NFPA Standards Development Process*, and the NFPA *Regulations Governing Petitions to the Board of Directors from Decisions of the Standards Council*. Most of these rules and regulations are contained in the *NFPA Standards Directory*. For copies of the *Directory*, contact Codes and Standards Administration at NFPA headquarters; all these documents are also available on the NFPA website at "www.nfpa.org/regs."

The following is general information on the NFPA process. All participants, however, should refer to the actual rules and regulations for a full understanding of this process and for the criteria that govern participation.

II. Technical Committee Report. The Technical Committee Report is defined as "the Report of the responsible Committee(s), in accordance with the Regulations, in preparation of a new or revised NFPA Standard." The Technical Committee Report is in two parts and consists of the First Draft Report and the Second Draft Report. (See *Regs* at Section 1.4.)

III. Step 1: First Draft Report. The First Draft Report is defined as "Part one of the Technical Committee Report, which documents the Input Stage." The First Draft Report consists of the First Draft, Public Input, Committee Input, Committee and Correlating Committee Statements, Correlating Notes, and Ballot Statements. (See *Regs* at 4.2.5.2 and Section 4.3.) Any objection to an action in the First Draft Report must be raised through the filing of an appropriate Comment for consideration in the Second Draft Report or the objection will be considered resolved. [See *Regs* at 4.3.1(b).]

IV. Step 2: Second Draft Report. The Second Draft Report is defined as "Part two of the Technical Committee Report, which documents the Comment Stage." The Second Draft Report consists of the Second Draft, Public Comments with corresponding Committee Actions and Committee Statements, Correlating Notes and their respective Committee Statements, Committee Comments, Correlating Revisions, and Ballot Statements. (See *Regs* at 4.2.5.2 and Section 4.4.) The First Draft Report and the Second Draft Report together constitute the Technical Committee Report. Any outstanding objection following the Second Draft Report must be raised through an appropriate Amending Motion at the NFPA Technical Meeting or the objection will be considered resolved. [See *Regs* at 4.4.1(b).]

V. Step 3a: Action at NFPA Technical Meeting. Following the publication of the Second Draft Report, there is a period during which those wishing to make proper Amending Motions on the Technical Committee Reports must signal their intention by submitting a Notice of Intent to Make a Motion (NITMAM). (See *Regs* at 4.5.2.) Standards that receive notice of proper Amending Motions (Certified Amending Motions) will be presented for action at the annual June NFPA Technical Meeting. At the meeting, the NFPA membership can consider and act on these Certified Amending Motions as well as Follow-up Amending Motions, that is, motions that become necessary as a result of a previous successful Amending Motion. (See 4.5.3.2 through 4.5.3.6 and Table 1, Columns 1-3 of *Regs* for a summary of the available Amending Motions and who may make them.) Any outstanding objection following action at an NFPA Technical Meeting (and any further Technical Committee consideration following successful Amending Motions, see *Regs* at 4.5.3.7 through 4.6.5) must be raised through an appeal to the Standards Council or it will be considered to be resolved.

VI. Step 3b: Documents Forwarded Directly to the Council. Where no NITMAM is received and certified in accordance with the *Technical Meeting Convention Rules*, the standard is forwarded directly to the Standards Council for action on issuance. Objections are deemed to be resolved for these documents. (See *Regs* at 4.5.2.5.)

VII. Step 4a: Council Appeals. Anyone can appeal to the Standards Council concerning procedural or substantive matters related to the development, content, or issuance of any document of the NFPA or on matters within the purview of the authority of the Council, as established by the *Bylaws* and as determined by the Board of Directors. Such appeals must be in written form and filed with the Secretary of the Standards Council (see *Regs* at Section 1.6). Time constraints for filing an appeal must be in accordance with 1.6.2 of the *Regs*. Objections are deemed to be resolved if not pursued at this level.

VIII. Step 4b: Document Issuance. The Standards Council is the issuer of all documents (see Article 8 of *Bylaws*). The Council acts on the issuance of a document presented for action at an NFPA Technical Meeting within 75 days from the date of the recommendation from the NFPA Technical Meeting, unless this period is extended by the Council (see *Regs* at 4.7.2). For documents forwarded directly to the Standards Council, the Council acts on the issuance of the document at its next scheduled meeting, or at such other meeting as the Council may determine (see *Regs* at 4.5.2.5 and 4.7.4).

IX. Petitions to the Board of Directors. The Standards Council has been delegated the responsibility for the administration of the codes and standards development process and the issuance of documents. However, where extraordinary circumstances requiring the intervention of the Board of Directors exist, the Board of Directors may take any action necessary to fulfill its obligations to preserve the integrity of the codes and standards development process and to protect the interests of the NFPA. The rules for petitioning the Board of Directors can be found in the *Regulations Governing Petitions to the Board of Directors from Decisions of the Standards Council* and in Section 1.7 of the *Regs*.

X. For More Information. The program for the NFPA Technical Meeting (as well as the NFPA website as information becomes available) should be consulted for the date on which each report scheduled for consideration at the meeting will be presented. To view the First Draft Report and Second Draft Report as well as information on NFPA rules and for up-to-date information on schedules and deadlines for processing NFPA documents, check the NFPA website (www.nfpa.org/docinfo) or contact NFPA Codes & Standards Administration at (617) 984-7246.

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