N **17.3.2** Cryogenic fluid central supply systems shall consist of the following:

(1) One or more main supply vessel, with capacity determined after consideration of the customer usage requirements, delivery schedules, proximity of the facility to alternative supplies, and the emergency plan
(2) A contents gauge on every main vessel
(3) A reserve supply sized for greater than an average day's supply, with the size of vessel or number of cylinders determined after consideration of delivery schedules, proximity of the facility to alternative supplies, and the emergency plan
(4) At least two main vessel relief valves and rupture discs installed downstream of a three-way (i.e., three-port) valve
(5) A check valve located in the primary supply piping upstream of the intersection with a secondary supply or reserve supply

N **17.3.3** Reserve CMG supply systems consisting of either a second cryogenic fluid source or a compressed gas source shall include the following:

(1) Where the reserve source is a compressed gas source, the reserve shall be equipped with the following:
   (a) A cylinder manifold having not less than three gas cylinder connections or as otherwise required for an average of one day's gas supply
   (b) A pressure switch to monitor the pressure in the cylinder manifold
(2) Where the reserve source is a second cryogenic fluid vessel, the reserve tank shall be equipped with the following:
   (a) An actuating switch or sensor to monitor the internal tank pressure
   (b) A contents gauge to monitor the liquid level
(3) Where the reserve source is either a cryogenic fluid or compressed gas source, a check valve shall be provided to prevent backflow into the reserve system.

N **17.3.4** Bulk cryogenic liquid sources shall include automatic means to provide the following functions:

(1) When the main supply is supplying the system, the reserve supply shall be prevented from supplying the system until the main supply is reduced to a level at or below the reserve activation pressure.
(2) When the main supply cannot supply the system, the reserve supply shall automatically begin to supply the system.
(3) Where there is more than one main supply vessel, the system shall operate as follows for primary, secondary, and reserve operation:
   (a) If provided with two liquid container headers, one cryogenic liquid header shall be the primary and the other shall be the secondary, with either being capable of either role.
   (b) If provided with one liquid container header and one gas cylinder header (i.e., a hybrid arrangement), the liquid container header shall be the primary and the gas cylinder header shall be the secondary.
   (c) When the primary header is supplying the system, the secondary header shall be prevented from supplying the system.
   (d) When the primary header is depleted, the secondary header shall automatically begin to supply the system.
(4) Where there are two or more cryogenic vessels, they shall be permitted to alternate (e.g., on a timed basis) in the roles of primary, secondary, and reserve, provided that an operating cascade (i.e., primary–secondary–reserve) is maintained at all times.
(5) Where a cryogenic vessel is used as the reserve, the reserve vessel shall include a means to conserve the gas produced by evaporation of the cryogenic liquid in the reserve vessel and to discharge the gas into the line upstream of the final line regulator assembly.

N **17.4 Main Supply System.** The main supply vessel for a cryogenic fluid central supply system shall be a cryogenic storage tank.

N **17.5 Reserve Supply System.**

N **17.5.1** A CMG reserve supply system shall consist of either of the following:

(1) A secondary cryogenic vessel
(2) A high-pressure compressed gas source

N **17.5.2** A cryogenic source reserve supply shall have a switch or sensor to monitor the tank pressure.

N **17.5.3** A compressed gas reserve supply shall meet the following requirements:

(1) It shall be manifolded with no fewer than three gas cylinders.
(2) It shall have a pressure switch or sensor to monitor the contents using manifold pressure.
(3) It shall have a check valve to prevent backflow into the system.
(4) It shall have a check valve at each connection on the cylinder header to minimize loss of gas from the reserve system.

N **17.6 Cryogenic Fill System.** Cryogenic fluid central supply systems shall include a fill mechanism consisting of the following components:

(1) A nonremovable product-specific fill connection in compliance with CGA V-6, *Standard Cryogenic Liquid Transfer Connection*
(2) A means to cap and secure the fill connection inlet
(3) A check valve to prevent product backflow from the fill inlet
(4) A fill hose purge valve
(5) Supports that hold the fill piping off the ground
(6) A secure connection between the bulk tank and the fill piping
(7) Supports, as necessary, to hold the fill line in position during all operations associated with the filling procedure

N **17.7 Vaporizers.**

N **17.7.1** Vaporizers used to convert cryogenic CMG to a gaseous state shall meet the following requirements:

(1) Vaporizers shall be permitted to operate by either ambient heat transfer or external thermal source (e.g., electric heater, hot water, steam).
(2) Vaporizers using a heat source other than ambient air shall be protected in the event of a loss of the energy source.

N 17.7.2 Vaporizers shall be designed to provide capacity for the customer's use under the following conditions:

(1) Customer's average and peak flows
(2) Local conditions (e.g., structures that obstruct air circulation or sunlight)
(3) Seasonal conditions (e.g., freeze periods)

N 17.7.3 A system design that uses switching vaporizers shall meet all of the following requirements:

(1) Valves shall be permitted to be manual or automatic.
(2) Valves and piping shall allow an operating vaporizer or an operating section of a vaporizer to be switched to a nonoperating condition for deicing.
(3) The system design shall provide continuous flow of CMG to the health care facility during vaporizer switchover.
(4) The system design shall provide continuous flow of CMG to the health care facility if vaporizer switchover fails.

N 17.7.4 Where a vaporizer uses an external thermal source, the flow of the CMG shall be unaffected by the loss of the external thermal source by one of the following methods:

(1) Reserve ambient heat transfer vaporizers sized for at least one day's average supply and piped so that the flow of the CMG is unaffected by flow stoppage through the external thermal source vaporizer
(2) A noncryogenic source capable of providing at least one day's average supply

N 17.7.5 Where vaporizers are used in the reserve system, they shall be as follows:

(1) Sized by the supplier to provide a source of vaporized CMG from the reserve bulk liquid storage vessel during times when the reserve system is operational
(2) Able to provide a flow rate equal to at least that of the main system vaporizer(s); however, the duration of flow might be different
(3) Indirectly heated by ambient air

N 17.7.6 Low-temperature protection systems that interrupt or reduce flow shall not be used on the reserve system of cryogenic fluid central supply systems.

N 17.8 High-Pressure Manifolds.

N 17.8.1 Manifold assemblies shall be fit for service and shall have supports that are independent of the cylinders.

N 17.8.2 Cylinders on the manifold shall be secured against falling.

N 17.8.3* Cylinders on the manifold shall have the same service pressure rating or the filled pressure of each cylinder shall not exceed the service pressure rating of the lowest rated cylinder on the manifold.

N 17.9 Pressure Control Devices. The final pressure control device assembly or assemblies shall not be fabricated on-site.

N 17.10 Pressure Relief Devices.

N 17.10.1 Pressure relief devices (PRDs) shall meet the following requirements:

(1) PRDs shall have a relief pressure setting not higher than the maximum allowable working pressure (MAWP) of the component with the lowest working pressure rating in the portion of the system being protected.
(2) PRDs shall be of brass or bronze construction.
(3) PRDs shall be designed for the specific gas service.
(4) PRDs shall have the discharge protected to prevent the entry of rain or snow.
(5) PRDs shall be designed in accordance with ASME B31.3, *Pressure Process Piping*.

N 17.10.2 PRDs shall have an identifier that contains the date of manufacture or test.

N 17.10.3 The final line pressure relief valves shall be approved by a nationally recognized organization and shall have a relief capacity greater than or equal to the maximum throughput of the final line regulator.

N 17.10.3.1 The pressure relief valve shall be set at 50 percent above the normal working pressure, but no higher than the MAWP, of the health care facility pipeline.

N 17.10.3.2 The relief valve information shall be permanently identified either on the nameplate of the relief valve or on a permanently attached metal tag.

N 17.11 Tubing and Valves.

N 17.11.1 New, hard-drawn Type K or L copper tube shall be used for all process piping.

N 17.11.1.1 Tubing shall comply with ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems*.

N 17.11.1.2 Tubing shall be capped and bear the marking OXY or MEDICAL or be otherwise packaged and labeled to indicate it is clean for oxygen service according to the supplier's policy.

N 17.11.2 Copper Tubing.

N 17.11.2.1 Instrumentation tubing shall be constructed of annealed copper tubing or seamless stainless steel tubing.

N 17.11.2.2 Copper tubing shall comply with ASTM B88, *Standard Specification for Seamless Copper Water Tube*.

N 17.11.3 Valves of quick-open or quarter-turn designs, such as ball or plug valves, shall not be permitted in the portion of an oxygen piping system operating above 435 psi.

N 17.11.4 Alternate Materials.

N 17.11.4.1* Alternate materials of construction for piping, tubing, valves, and instruments shall be permitted for installation at the request of the health care facility or the supplier.

N 17.11.4.2 Technical documentation of alternate materials shall be submitted to the health care facility QA representative to demonstrate equivalency.

N 17.12* Alarms. The cryogenic fluid central supply system shall have a local signal that visibly indicates the operating status of the equipment and an indicator at all master alarms under the following conditions:

(1) When, or at a predetermined set point before, the main supply reaches an average day's supply, indicating low contents
(2) When, or at a predetermined set point before, the reserve supply begins to supply the system, indicating reserve is in use
(3) When, or at a predetermined set point before, the reserve supply contents fall to one day's average supply, indicating low reserve
(4) If the reserve is a cryogenic vessel, when, or at a predetermined set point before, the reserve internal pressure falls

too low for the reserve to operate properly, indicating reserve failure

(5) Where there is more than one main supply vessel, when, or at a predetermined set point before, the secondary vessel begins to supply the system, indicating changeover

Annex A Explanatory Material

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

A.1.1.1 The term "portable" points out the application of this code to systems other than those considered to be permanent; i.e., systems where the equipment is installed on foundations and meant to stay in place for a considerable period of time. This code applies to portable and temporary systems, including the two types listed below:

(1) Equipment that is ordinarily used for the transportation and delivery of compressed gases or cryogenic fluids but that is located at a customer (end user) location and used for storage of compressed gases or cryogenic fluids. One example is a compressed gas tube trailer that is dropped at a customer location and left in place to supply the compressed gas to the customer use point. Another example is a cryogenic liquid trailer that is left at a customer location to supply cryogenic liquids to the customer use point (or vaporized into gas before going to the use point).

(2) Equipment used for the temporary supply of compressed gases or cryogenic fluids at a customer location. An example is a portable cryogenic tank that is mounted on a trailer and dropped at the customer location and not always connected to foundations by anchor bolts. Such a supply system may be in place for a matter of weeks as opposed to a more permanent system that is left in place for years.

Some of the requirements of this code are not applicable to this type of equipment. For example, some sections of this code mandate that the equipment be anchored to permanent foundations. Equipment with wheels for transportation do not need to be anchored. However, auxiliary equipment, such as pressure reducing stations, would need to be anchored to a foundation. The user must determine which sections of the code apply to equipment and which sections do not apply.

It is not the intent of this code to regulate transportation and delivery equipment when that equipment is used only to deliver product to a storage system at a customer location. For example, a cryogenic liquid trailer that delivers product into a storage system (and does not stay on site after delivering product) does not have to meet the requirements of this code. The trailer is governed by DOT/TC requirements. Another example is a compressed gas tube trailer that delivers product to a permanent storage system and does not stay on site to supply product to the end user.

Portable equipment is sometimes transported with product loaded in the storage vessel or may be shipped with the vessel empty, to be filled at the customer location. Equipment that is designed to be transported with product in it is governed by DOT/TC regulations. Nothing in this code is intended to overrule the DOT/TC regulations governing the use of such equipment.

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

A.1.1.2(3) Cryogenic fluid central supply 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. See Section 17.1.2.

A.1.1.2(5) For information, see NFPA 52, or NFPA 58.

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.

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*.

A.1.2 Reference is made to other material-specific standards published by NFPA where appropriate. The material-specific standards are limited in number, and controls are focused on select materials through the use of those standards. NFPA 55 is intended to be generic and applicable to all materials in the gaseous or cryogenic state.

A.1.4.1 It is generally not necessary to modify systems to meet code requirements that were not in effect at the time of installation as long as the system met the then-current standard and remains in its original location and condition. When the system is upgraded or moved to a new location, the current code requirements generally take effect. Normal maintenance and replacement of parts are not considered an upgrade to the system.

Typically, the code changes are in the nature of exposure distances. Where a system is closer to an exposure than the current code allows, but the system met the code in effect at the time of installation, the system is generally allowed to stay in place if no upgrades are made to the system. Once upgrades are made or the system is relocated, the current separation distances are applicable. When newer exposures are added, they must meet the current code separation distances and not the distances that were in effect at the time of installation.

An upgrade is considered as one of the following:

(1) An equipment change that would materially affect the original exposure distances

(2) Installation of new hazards and exposures adjacent to the existing installation

Changing of regulators, controls, or piping systems normally would not be considered an upgrade. The replacement of a

bulk vessel with one of the same nominal size is not considered an upgrade.

For example, liquid hydrogen systems installed per the 2010 and later editions of NFPA 55 must have a minimum horizontal separation distance of 15 ft (4.6 m) from overhead piping containing hazardous materials. Previous editions of NFPA 55 mandated only that the hazardous material piping not be over the liquid hydrogen system. A system that was installed in 2005 and has a horizontal separation of 10 ft (3.0 m) from overhead hazardous materials piping met the 2005 edition of NFPA 55 and generally does not need changing. However, the existing hazardous materials piping is not allowed to be moved closer to the hydrogen system because that action is a change to the system. Similarly, if a new hazardous materials pipeline is installed, it must meet the current 15 ft (4.6 m) minimum separation distance because it is a change to the system.

A.2.3.5 Applicable equivalent regulations apply in the country of use.

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.3.2.3 Code. The decision to designate a standard as a "code" is based on such factors as the size and scope of the document, its intended use and form of adoption, and whether it contains substantial enforcement and administrative provisions.

A.3.2.5 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 Absolute Pressure. Measured from this reference point, the standard atmospheric pressure at sea level is an absolute pressure of 14.7 psi (101.3 kPa).

A.3.3.2 Acetylene. Acetylene when compressed and packaged into cylinders is dissolved in a solvent, typically acetone or dimethylformamide (DMF). The solvent is absorbed into a porous material that fills the inside of an acetylene cylinder. This method of packaging is unique to acetylene, and the U.S. Department of Transportation prohibits the use of acetylene cylinders for any other gases.

A.3.3.6.4 Use Area. Piping systems are used to transport gas (and liquids) from a point of storage to the actual point of use where the gas is deployed. Piping alone does not create a condition of "use" where the material is being consumed or otherwise released from a closed pipe system. On the other hand, piping that connects to "process equipment," which is acting to raise or lower the energy in the system, or that either consumes or releases the material must be viewed as "active," and as a result the material is viewed as being "placed into action" at the point of delivery or connection to the process equipment.

A.3.3.8 Assembly Occupancy. Assembly occupancies might include the following:

(1) Armories
(2) Assembly halls
(3) Auditoriums
(4) Bowling lanes
(5) Club rooms
(6) College and university classrooms, 50 persons and over
(7) Conference rooms
(8) Courtrooms
(9) Dance halls
(10) Drinking establishments
(11) Exhibition halls
(12) Gymnasiums
(13) Libraries
(14) Mortuary chapels
(15) Motion picture theaters
(16) Museums
(17) Passenger stations and terminal of air, surface, underground, and marine public transportation facilities
(18) Places of religious worship
(19) Pool rooms
(20) Recreation piers
(21) Restaurants
(22) Skating rinks
(23) Special amusement buildings, regardless of occupant load
(24) Theaters

Assembly occupancies are characterized by the presence or potential presence of crowds with attendant panic hazard in case of fire or other emergency. These are generally open or occasionally open to the public, and the occupants, who are present voluntarily, are not ordinarily subject to discipline or control. Such buildings are ordinarily occupied by able-bodied persons and are not used for sleeping purposes. Special conference rooms, snack areas, and other areas incidental to, and under the control of, the management of other occupancies, such as offices, fall under the 50-person limitation. Restaurants and drinking establishments with an occupant load of fewer than 50 persons should be classified as mercantile occupancies. For special amusement buildings, see 16.4.7 of *NFPA 5000*.

A.3.3.15 Cathodic Protection. This protection renders a metallic container or piping system or component negatively charged with respect to its surrounding environment.

A.3.3.19 Chime Ring. These rings protect the drum but are not intended for lifting purposes.

A.3.3.20 Cleaning Media. Cleaning methods that incorporate chemical washing techniques can include the use of chemical substances, usually liquid, capable of dissolving or dispersing a foreign substance or contaminants and techniques such as rinsing, heating, steaming, or vacuuming applied either individually or in combination with other techniques. Air, inert gas, steam, and water are acceptable cleaning media.

N **A.3.3.22 Compressed Medical Gases (CMG).** CMG classifications are defined in 201(g)(1) of the Federal Food, Drug, and Cosmetic Act, 21 USC 321(g)(1). This includes gases recognized in the current *United States Pharmacopeia and National Formulary (USP-NF)* or supplements and gases intended for direct use or as a component of gases in the diagnosis, cure, mitigation, treatment, or prevention of diseases in man or in animals that achieves its intended purpose through chemical rather than physical means.

A.3.3.33 Cylinder Pack. *Six-packs* and *twelve-packs* are terms used to further define cylinder packs with a specific number of cylinders. The characteristic internal water volume of individual cylinders in a cylinder pack ranges from 1.52 scf to 1.76 scf (43 L to 50 L) or a water capacity of 95 lb to 110 lb (43 kg to 50 kg).

A.3.3.40 Exhausted Enclosure. Such enclosures include laboratory hoods, exhaust fume hoods, and similar appliances and equipment used to retain and exhaust locally the gases, fumes, vapors, and mists that could be released. Rooms or areas provided with general ventilation, including rooms, such as control areas, with dedicated hazardous vapor/gas exhaust systems, in and of themselves, are not exhausted enclosures.

A.3.3.42 Explosion Control. NFPA 68 provides guidance on the use of deflagration venting systems in buildings and other enclosures. The primary purpose of a venting system is to relieve the overpressure produced in an explosion to limit the potential damage to the building where the explosion occurs. Although some structural damage can be anticipated, the use of relief venting is expected to prevent massive building failure and collapse. In cases where detonation is probable, venting is often used in conjunction with barricade construction where the pressure-resistant portions of the building have been constructed to resist the pressures anticipated should an explosive event occur. Design of barricade systems is highly specialized and the subject of military standards applicable to the subject. NFPA 69 provides guidance on the use of suppression, ventilation systems, and the limiting of oxidants as a means to prevent the occurrence of an explosion. When relief vents are to be used as a means to provide explosion relief, the fundamental requirements of the building code for structural elements, including snow, wind, and seismic events, should be considered. In some instances, the requirements for wind resistance can impose more rigorous requirements on the relief vents than required by the engineering analysis used to determine the relief pressure. In such cases, users must demonstrate that the relief vents will not become airborne or release in such a manner as to create secondary hazards within or external to the building in which they are installed. Specific designs might require approval by the AHJ.

A.3.3.44 Fire Barrier. A fire barrier, such as a wall or floor assembly, might be aligned vertically or horizontally. Although the continuity of a fire barrier will often limit the transfer of smoke, it should not be confused with either a smoke barrier or a smoke partition. [**5000,** 2018]

A.3.3.48 Flammable Liquid (Class I). Materials that boil at a temperature of less than 68°F (20°C) are compressed gases. Users are cautioned that the use of the definitions found in NFPA 30 can result in the misclassification of certain liquefied compressed gases as flammable liquids (Class IA). Liquefied hydrogen is classed as a flammable compressed gas by the U.S. Department of Transportation. It is regulated as a cryogenic fluid within this code.

A.3.3.51.1 Compressed Gas. The states of a compressed gas are categorized as follows:

(1) Nonliquefied compressed gases are gases, other than those in solution, that are in a packaging under the charged pressure and are entirely gaseous at a temperature of 68°F (20°C).
(2) Liquefied compressed gases are gases that, in a packaging under the charged pressure, are partially liquid at a temperature of 68°F (20°C). Cryogenic fluids represent a transient state of a gas that is created through the use of refrigeration. Cryogenic fluids cannot exist in the liquid form or partial liquid form at temperatures of 68°F (20°C); hence, they are not "compressed gases" as defined.
(3) Compressed gases in solution are nonliquefied gases that are dissolved in a solvent.
(4) Compressed gas mixtures consist of a mixture of two or more compressed gases contained in a packaging, the hazard properties of which are represented by the properties of the mixture as a whole.

A.3.3.51.6 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.

A.3.3.51.8 Other Gas. A gas classified as an "other gas" might be a nonflammable gas or an inert gas.

A.3.3.51.14 Unstable Reactive Gas. Unstable reactive materials are subdivided into five classifications. Class 4 materials are materials that in themselves are readily capable of detonation or explosive decomposition or explosive reaction at normal temperatures and pressures. They include the following:

(1) Materials that are sensitive to localized thermal or mechanical shock at normal temperatures and pressures
(2) Materials that have an instantaneous power density (product of heat of reaction and reaction rate) at 482°F (250°C) of 1000 W/mL or greater

Class 3 materials are materials that in themselves are capable of detonation or explosive decomposition or explosive reaction

but require a strong initiating source or heat under confinement before initiation. Class 3 materials include the following:

(1) Materials that have an instantaneous power density (product of heat of reaction and reaction rate) at 482°F (250°C) at or above 100 W/mL and below 1000 W/mL
(2) Materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures
(3) Materials that react explosively with water without requiring heat or confinement

Class 2 materials are materials that readily undergo violent chemical change at elevated temperatures and pressures, including the following:

(1) Materials that have an instantaneous power density (product of heat of reaction and reaction rate) at 482°F (250°C) at or above 10 W/mL and below 100 W/mL
(2) Materials that react violently with water or form potentially explosive mixtures with water

Class 1 materials are materials that in themselves are normally stable but that can become unstable at elevated temperatures and pressures, including the following:

(1) Materials that have an instantaneous power density (product of heat of reaction and reaction rate) at 482°F (250°C) at or above 0.01 W/mL and below 10 W/mL
(2) Materials that react vigorously with water, but not violently
(3) Materials that change or decompose on exposure to air, light, or moisture

Class 0 materials are materials that in themselves are normally stable, even under fire conditions, including the following:

(1) Materials that have an instantaneous power density (product of heat of reaction and reaction rate) at 482°F (250°C) below 0.01 W/mL
(2) Materials that do not react with water
(3) Materials that do not exhibit an exotherm at temperatures less than or equal to 932°F (500°C) when tested by differential scanning calorimetry

A.3.3.52 Gas Cabinet. Doors and access ports for exchanging cylinders and accessing pressure-regulating controls are permitted to be included as part of a gas cabinet.

A.3.3.58 Hazard Rating. The criteria for hazard rating are as defined in NFPA 704.

Δ **A.3.3.59 Health Care Facilities.** Health care facilities include, but are not limited to, hospitals, nursing homes, limited care facilities, clinics, medical and dental offices, and ambulatory health care centers, whether permanent or movable. This definition applies to normal, regular operations and does not pertain to facilities during declared local or national disasters. A health care facility is not a type of occupancy classification as defined by NFPA *101*. Therefore, the term health care facility should not be confused with the term health care occupancy. All health care occupancies (and ambulatory health care occupancies) are considered health care facilities: however, not all health care facilities are considered health care occupancies, as health care facilities also include ambulatory health care occupancies and business occupancies. [**99**, 2018]

A.3.3.60 Immediately Dangerous to Life and Health (IDLH). This level is established by the National Institute for Occupational Safety and Health (NIOSH). If adequate data do not exist for precise establishment of IDLH, an independent certified industrial hygienist, industrial toxicologist, or appropriate regulatory agency should make such determination.

A.3.3.62 ISO Module. The characteristic internal water volume of individual tubular cylinders is 43 scf (1218 L) or a water capacity of 2686 lb (1218 kg). The frame of an ISO container module and its corner castings are specially designed and dimensioned to be used in multimodal transportation service on container ships, special highway chassis, and container-on-flatcar railroad equipment.

A.3.3.64.1 Ceiling Limit. The ceiling limits utilized are those published in 29 CFR 1910.1000.

A.3.3.64.2 Permissible Exposure Limit (PEL). The maximum permitted time-weighted average exposures to be utilized are those published in 29 CFR 1910.1000.

A.3.3.64.3 Short-Term Exposure Limit (STEL). STEL limits are published in 29 CFR 1910.1000.

A.3.3.71 Mobile Acetylene Trailer System (MATS). This system includes the mobile acetylene trailer, pressure regulator(s), flash arresters, protective devices, meter (optional), and interconnecting piping. The system terminates at the point where acetylene at service pressure enters the user's piping system.

A.3.3.72 Mobile Supply Unit. Examples include ISO modules, tube trailers, and cylinder packs.

A.3.3.76 Normal Temperature and Pressure (NTP). There are different definitions of normal conditions. The normal conditions defined here are the ones most commonly used in the compressed gas and cryogenic fluid industry.

A.3.3.79 Piping System. Equipment such as a compressor or an intermediate storage vessel should be considered individual pieces of equipment. The equipment is not piping within the context of the definition of a piping system.

N **A.3.3.80 Press-Connect Fittings.** Press-connect fittings could include an elastomeric seal and corrosion-resistant mechanical grip or bite ring. Connections such as pushfit or other separable connections are not included as part of this definition.

A.3.3.82 Protection Level. NFPA uses the concept of protection levels in a manner that is analogous to Group H occupancies in other model codes. Although NFPA 1 and *NFPA 5000* do not have unique occupancy classifications for occupancies containing hazardous materials, Protection Levels 1 to 5 in NFPA codes and standards reflect increased building safety requirements that are applicable to occupancies containing hazardous materials, which generally correlate to the Group H, Division 1 to 5 occupancy classifications in other codes.

A.3.3.87 Secondary Containment. Examples of secondary containment include dikes, curbing, remote impoundment, and double-walled tanks. [**400,** 2019]

A.3.3.90 Source Valve. The source valve is located at a point downstream of a bulk gas supply system and used as the defined point of termination of the bulk supply. It is a point that differentiates between the "supplier" side of the system and what is commonly referred to as the "user" or "customer" side of the system.

A.3.3.93 Sterilization Building. This building can include the mechanical room, electrical room, nitrogen tank and vaporiz-

ers area, chiller area, preconditioning room or preconditioning cells, conveyance rooms, preheat room, sterilizer room, aeration room or cells, emissions control area, ethylene oxide drum storage room, gas transfer room, shipping and receiving office(s), unprocessed and processed product storage areas, control room, maintenance areas, offices for the process support personnel, and any other rooms or systems as applicable in supporting the sterilization process.

A.3.3.95.2 Bulk Inert Gas System. The bulk system terminates at the source valve, which is commonly the point where the gas supply, at service pressure, first enters the supply line or a piece of equipment that utilizes the gas or the liquid. The containers are either stationary or movable, and the source gas is stored as a compressed gas or cryogenic fluid.

Bulk inert gas systems can be used to supply gas in either its compressed gaseous or liquefied form. Systems that may be used to supply both gaseous and liquid forms are referred to as hybrid systems. The following bulk inert gas systems are typical of those in use:

When the primary supply of the gas as stored is from a compressed gaseous source that is used in the compressed and gaseous form, the bulk inert gas system is said to be a bulk inert compressed gas system.

When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer only liquid, the system is said to be a bulk liquefied inert gas system.

When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer or store the gas in a compressed gaseous form, with or without a feature that may also allow the subsequent transfer and use of liquid, the bulk inert gas system is said to be a hybrid bulk inert gas system.

For the purposes of the application of the code, a hybrid system is viewed as a bulk liquefied inert gas system.

A.3.3.95.3 Bulk Oxygen System. The bulk oxygen system terminates at the source valve, which is commonly the point where oxygen at service pressure first enters the supply line or a piece of equipment that utilizes the oxygen gas or liquid. The oxygen containers are either stationary or movable, and the oxygen is stored as a compressed gas or cryogenic fluid.

Bulk oxygen systems can be used to supply gas in either its compressed gaseous or liquefied form. Systems that may be used to supply both gaseous and liquid forms are referred to as hybrid systems. The following bulk oxygen systems are typical of those in use:

(1) When the primary supply of the gas as stored is from a compressed gaseous source that is used in the compressed and gaseous form, the bulk oxygen system is said to be a bulk compressed oxygen gas system.
(2) When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer only liquid, the system is said to be a bulk liquefied oxygen system.
(3) When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer or store the gas in a compressed gaseous form, with or without a feature that may also allow the subsequent transfer and use of liquid, the bulk oxygen system is said to be a hybrid bulk oxygen system. For the purposes of the application of the code, a hybrid system is viewed as a bulk liquefied oxygen system.

A.3.3.95.4 Compressed Gas System. A compressed gas system can consist of a compressed gas container or containers, reactors, and appurtenances, including pumps, compressors, and connecting piping and tubing.

A.3.3.95.8 Fast-Acting Fire Detection System. Examples for outdoor installations are optical (UV/IR) systems that detect visible flames and do not rely on products of combustion to be transported by the energy of the heat plume to the location of the detector. For indoor installations, examples include high sensitivity smoke detection (HSSD), optical (UV/IR), or other early detection systems.

A.3.3.95.9 Gaseous Hydrogen System. The system includes stationary or portable containers, pressure regulators, pressure-relief devices, manifolds, interconnecting piping, and controls as required.

A.3.3.95.9.1 Bulk Hydrogen Compressed Gas System. The bulk system terminates at the source valve, which is the point where the gas supply, at service pressure, first enters the supply line, or at a piece of equipment that utilizes the hydrogen gas, such as a hydrogen dispenser. The containers are either stationary or movable, and the source gas for the system is stored as a compressed gas.

Bulk hydrogen compressed gas systems can include a bulk storage source, transfer piping and manifold system, compression system, and other components. The gaseous source can include a tube trailer, tube bank, or other high pressure storage vessels used to serve the piping system that transports hydrogen to the end user. Compressors can be installed downstream of the storage supply to boost the pressure of the source gas, and intermediate high pressure storage might be present. This is done where the end use requires hydrogen at a pressure higher than that of the bulk supply. In these instances, there may be intermediate storage vessels used to store the gas at elevated pressures. It is not uncommon for the bulk supply as delivered to be furnished at nominal gauge pressure of 3000 psi (20,684 kPa), and the intermediate high pressure storage to be stored at gauge pressures up to 15,000 psi (103,421 kPa). See Figure A.3.3.95.9.1(a) through Figure A.3.3.95.9.1(f).

Δ **A.3.3.95.10.1 Bulk Liquefied Hydrogen System.** The bulk system terminates at the source valve, which is commonly the point where the gas supply, at service pressure, first enters the supply line or a piece of equipment that utilizes the gas or the liquid, such as a hydrogen dispenser. The containers are either stationary or movable, and the source gas for the system is stored as a cryogenic fluid.

A bulk liquefied hydrogen system can include a liquid source where the liquid is vaporized and subsequently compressed and transferred to storage in the compressed gaseous form. It is common for liquid hydrogen systems to be equipped with vaporizers that are used to gasify the cryogen for ultimate use in the compressed state; however, there are also systems that can be used to transfer liquid in the cryogenic state. For systems that are composed of combined gaseous and liquefied hydrogen storage systems and have separate source valves for both systems, the system can be viewed as having two source valves for determining minimum separation distances for bulk storage systems in accordance with 10.4.2.2 and 11.3.2.2. Identifying two source valves means that each portion of the system is subject to its respective minimum separation distances in accordance with 10.4.2.2 or 11.3.2.2.

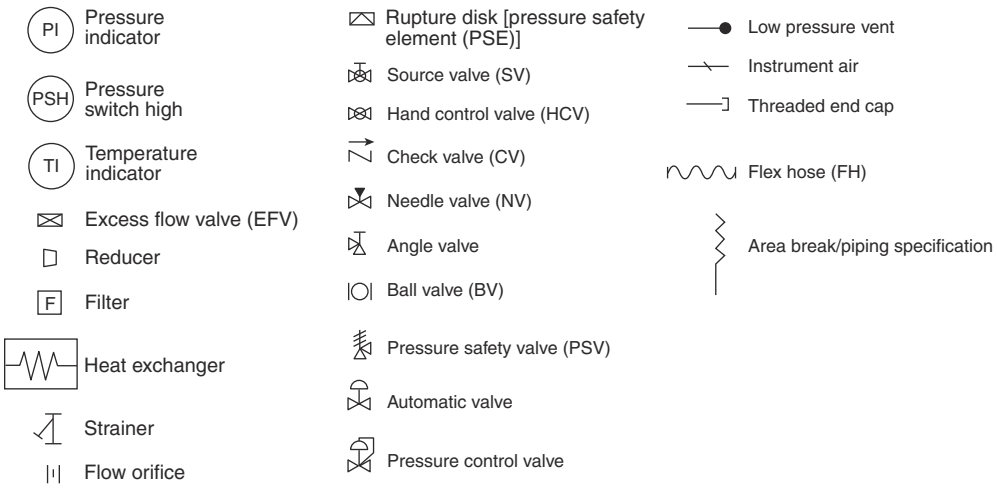

FIGURE A.3.3.95.9.1(a) Symbol Legend for Figure A.3.3.94.9.1(b) through Figure A.3.3.94.9.1(f).

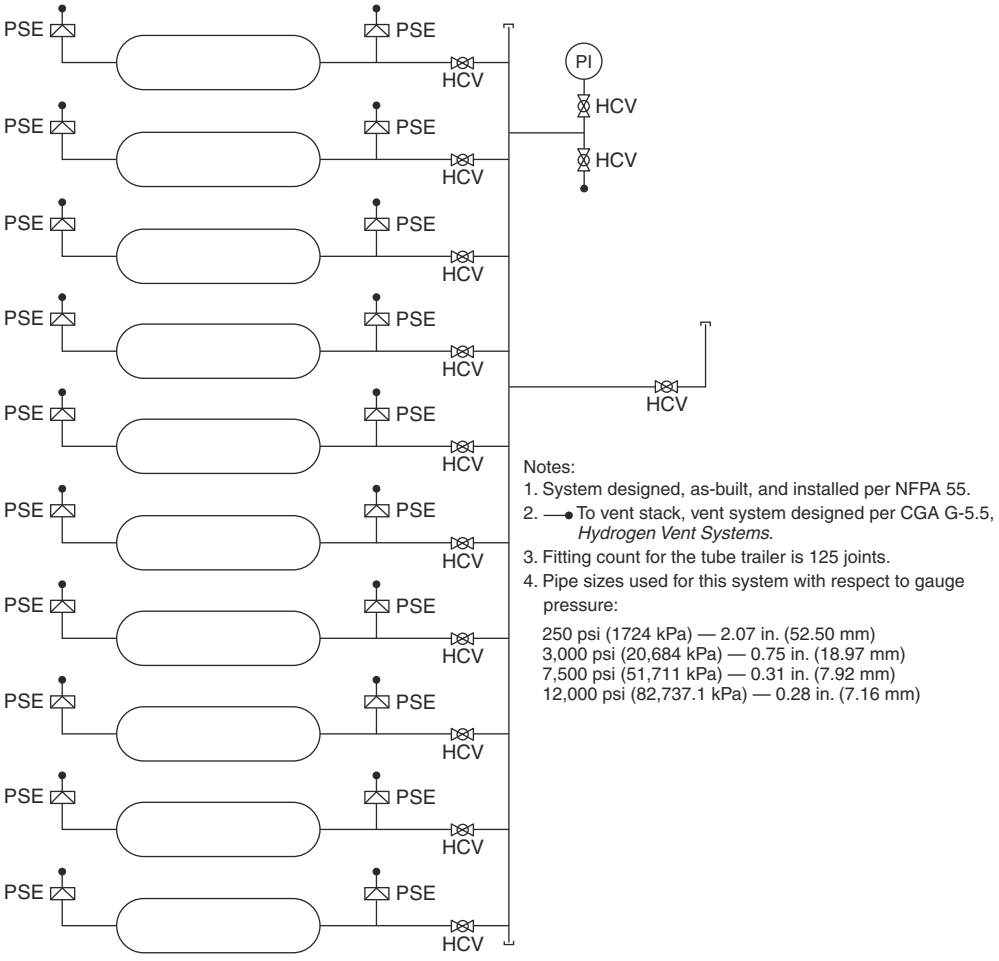

FIGURE A.3.3.95.9.1(b) Typical Tube Trailer.

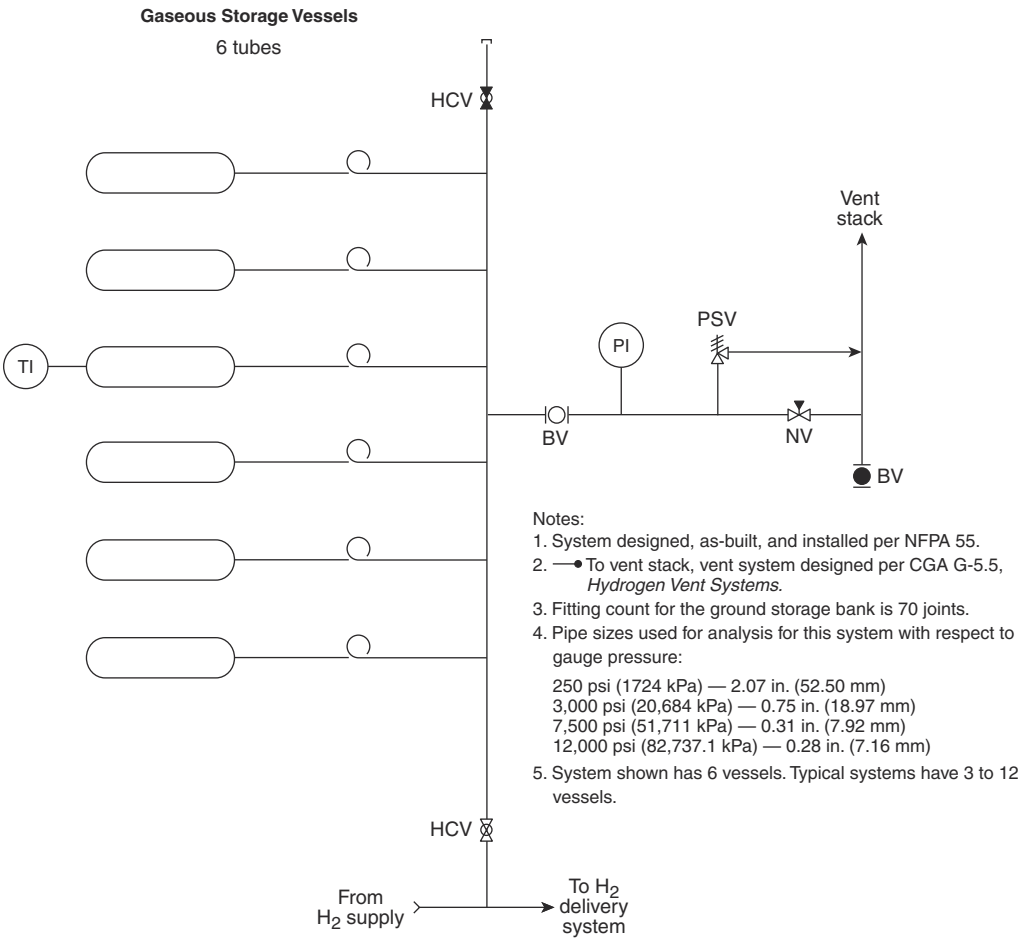

FIGURE A.3.3.95.9.1(c) Typical Bulk Compressed Gaseous Storage System.

A.3.3.95.11 Non-Bulk Flammable Gas System. Non-bulk systems can have more than 5000 scf (141.6 Nm^3) as long as the volume of any individual container or connected system is less than 5000 scf (141.6 Nm^3). Table 7.6.2 shows exposure distances for non-bulk flammable gases with a total storage of up to 200,000 scf (5664 Nm^3).

A.3.3.96.1 Portable Tank. A portable tank does not include any cylinder having less than 1000 lb (453.5 kg) water capacity, cargo tank, tank car tank, or trailers carrying cylinders of over 1000 lb (453.5 kg) water capacity.

A.3.3.96.2 Stationary Tank. A stationary tank does not include a cylinder having less than 1000 lb (453.5 kg) water capacity.

A.3.3.98 Tube Trailer. The characteristic internal water volume of individual tubular cylinders ranges from 43 scf to 93 scf (1218 L to 2632 L) or a water capacity of 2686 lb to 5803 lb (1218 kg to 2632 kg).

A.3.3.100 Use. Use includes production, filling, and withdrawal of compressed gases and cryogenic fluids to or from containers.

A.4.4 Out-of-service systems should not be abandoned in place. Systems that remain out of service should be maintained in a usable condition to ensure that the appropriate safeguards are in place. Permits should be maintained in a current state so that the AHJ remains aware of the installation until such time that the system is removed.

A.4.6.4 There might be additional regulations that must be complied with to notify other agencies. [**400:**A.6.1.3.4]

A.4.7 The hazard potential of a facility is not dependent on any single factor. Physical size, number of employees, and the quantity and the nature of the hazardous materials are important considerations. The level of training can vary with the complexity of the facility under consideration. [**400:**A.6.1.4]

A.4.7.4 Emergency responders can include on-site personnel that have been designated and trained to respond to emergencies, persons from the public sector such as fire department personnel, or persons from the private sector that can be contracted or otherwise engaged to perform emergency response duties. (See Annex I in NFPA 400 for additional information.) [**400:**A.6.1.4.4]

A.4.7.4.1 OSHA describes an Incident Command System as a standardized on-scene incident management concept designed specifically to allow responders to adopt an integrated organizational structure equal to the complexity and demands of any single incident or multiple incidents without being hindered by jurisdictional boundaries. [**400:**A.6.1.4.4.1]

Notes:
1. System designed, as-built, and installed per NFPA 55.
2. —•To vent stack, vent system designed per CGA G-5.5, *Hydrogen Vent Systems*.
3. Fitting count for the pressure control manifold is 111 joints.
4. Fitting count for the stanchion is 29 joints.
5. Pipe sizes used for analysis for this system with respect to gauge pressure:
   250 psi (1724 kPa) — 2.07 in. (52.50 mm)
   3,000 psi (20,684 kPa) — 0.75 in. (18.97 mm)
   7,500 psi (51,711 kPa) — 0.31 in. (7.92 mm)
   12,000 psi (82,737.1 kPa) — 0.28 in. (7.16 mm)

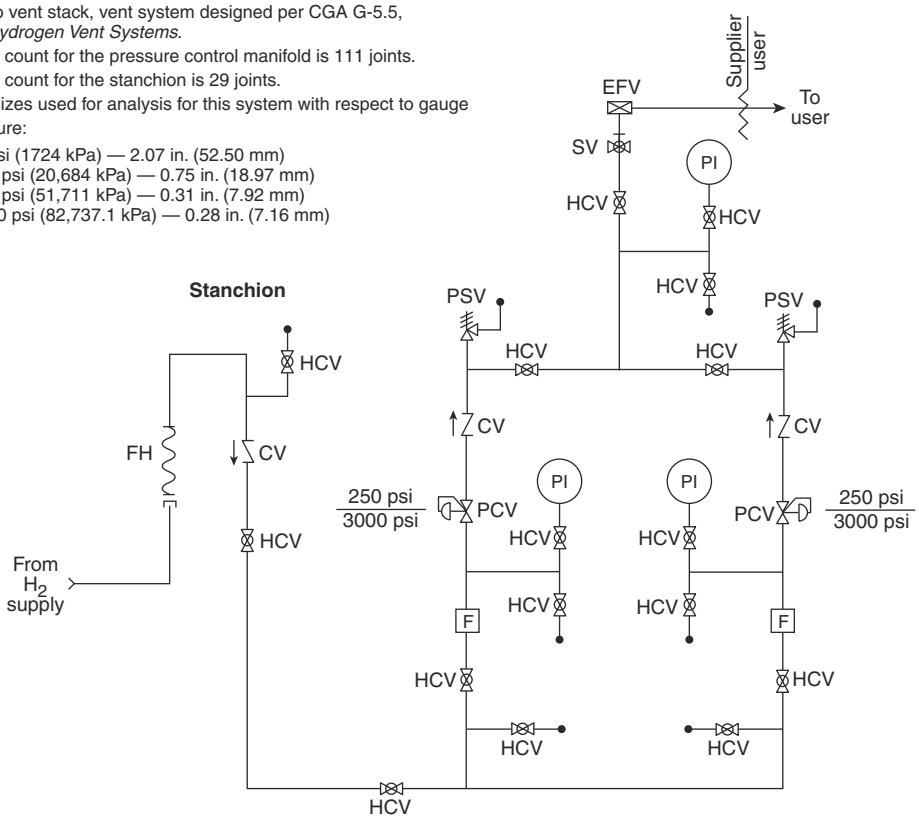

FIGURE A.3.3.95.9.1(d) Typical Tube Trailer Discharge Stanchion and Pressure Control Manifold.

A.4.7.4.2 Responses to releases of hazardous materials where there is no potential safety or health hazard such as fire, explosion, or chemical exposure are not considered emergency responses as defined within the context of this code. [**400:**A.6.1.4.4.2]

A.4.7.4.3 Emergency response training will vary depending on the level of emergency response required and by the requirements of the governmental agency. [**400:**A.6.1.4.4.3]

A.4.9.3.1 The approved powered industrial trucks addressed in NFPA 505 are trucks that are listed by a testing laboratory for the use intended and should be tested and labeled in accordance with ANSI/UL 558, *Standard for Safety Industrial Trucks, Internal Combustion Engine–Powered* or ANSI/UL 583, *Standard for Safety Electric-Battery-Powered Industrial Trucks.* [**400:**A.6.1.5.3.1]

A.4.12 The term *materials* used throughout this section applies to building construction materials and not to hazardous materials, compressed gases, or cryogenic fluids.

A.4.12.1 The provisions of 4.12.1 do not require inherently noncombustible materials to be tested in order to be classified as noncombustible materials. [***101:***A.4.6.13]

A.4.12.1(1) Examples of such materials include steel, concrete, masonry, and glass. [***101:***A.4.6.13.1(1)]

A.4.12.2 Materials subject to increase in combustibility or flame spread index beyond the limits herein established through the effects of age, moisture, or other atmospheric condition are considered combustible. *(See NFPA 259 and NFPA 220.)* [***101:***A.4.6.15.2]

A.5.1.1 Not all hazardous materials are placed into the high hazard category, and some of these materials have been recognized as being of low ordinary hazard, depending on their nature in a fire. Inert compressed gases and cryogenic fluids are one example; there are others. Compressed gases and cryogenic fluids represent the gas phase of an array of hazardous materials. As the genre of hazardous materials is expanded, there are other materials in hazard categories or hazard classes that may in fact be high hazard materials by definition, but which in some cases do not have a MAQ and, therefore, are not required to comply with the requirements for high hazard occupancies. Examples of such materials are Class IIIB combustible liquids, Class 1 unstable reactive materials (including gases), Class 1 water-reactive solids and liquids, Class 1-3 water-reactive gases, Class 1 oxidizing solids and liquids, and Class IV and V organic peroxides.

A.6.6 Bulk hydrogen compressed gas systems terminate at the source valve. In cylinder filling or packaging operations, cylinders located on filling manifolds located downstream of the source valve are not considered to be part of the bulk gas system. For definitions of source valve and bulk hydrogen compressed gas system, see 3.3.90 and 3.3.95.9.1. Additional