NFPA 496 Standard for Purged and Pressurized Enclosures for Electrical Equipment 1998 Edition

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NFPA 496

Standard for

Purged and Pressurized Enclosures for Electrical Equipment

1998 Edition

This edition of NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment*, was prepared by the Technical Committee on Electrical Equipment in Chemical Atmospheres and acted on by the National Fire Protection Association, Inc., at its Annual Meeting held May 18–21, 1998, in Cincinnati, OH. It was issued by the Standards Council on July 16, 1998, with an effective date of August 5, 1998, and supersedes all previous editions.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

This edition of NFPA 496 was approved as an American National Standard on August 6, 1998.

Origin and Development of NFPA 496

This standard was developed in two parts by the Technical Committee on Electrical Equipment in Chemical Atmospheres. The first part, addressing purged enclosures for electrical equipment in Class I hazardous (classified) locations, was adopted as a tentative standard at the 1966 NFPA Annual Meeting and as an official standard at the 1967 NFPA Annual Meeting. The second part, addressing pressurized enclosures for electrical equipment in Class II hazardous (classified) locations, was tentatively adopted at the 1970 NFPA Annual Meeting and officially adopted at the 1971 NFPA Annual Meeting.

The Technical Committee on Electrical Equipment in Chemical Atmospheres presented a complete revision of the entire standard in 1974. In 1980, the committee began another complete revision. This work culminated in the 1982 edition.

In 1983, the Technical Committee on Electrical Equipment in Chemical Atmospheres recognized the need for specific requirements applicable to process control analyzers that have internal sources of a flammable or combustible material, such as a direct connection to the process stream. Two chapters were added to address analyzer enclosures and analyzer rooms or buildings. Additional changes were also made to certain existing portions of the text specifically to address problems in the interpretation of the existing test. The 1986 edition of NFPA 496 was the result of this effort.

In 1987, the Technical Committee on Electrical Equipment in Chemical Atmospheres recognized a need for editorial revisions to the figures in Chapter 2 as well as some minor editorial changes in Chapters 2 and 9 and Appendix A. The 1989 edition was the result of this effort.

Beginning in 1990, an ad hoc committee consisting of members of the Technical Committee on Electrical Equipment in Chemical Atmospheres started a major rewrite of this document to develop a more comprehensive standard and to reduce redundancy in the text. Definitions were added for further clarity, and references to Class III were deleted, since the standard did not cover this application and could create some confusion. References to *purging* were replaced with *pressurizing*, and *protective gas* was introduced as a new term. The requirements based on gross internal volume were deleted and replaced with general and specific requirements for all pressurized enclosures used in Class I and Class II locations. The result of this rewrite was the 1993 edition.

In 1997, the Technical Committee on Electrical Equipment in Chemical Atmospheres entered NFPA 496 in the revision cycle to update the requirements. The standard has been updated to include definitions and references to Article 505 in NFPA 70, *National Electrical Code*®, which deals with Class I, Zone 1 and Zone 2 locations. It has also been changed to provide an exception for control rooms where doors and other openings used solely for equipment relocation are permitted to be excluded from the calculation for outward air velocity from the central room.

The NFPA Technical Committee on Electrical Equipment in Chemical Atmospheres wishes to gratefully acknowledge the efforts of the Instrument Society of America, through its Committee SP12, in the development of the basic requirements for purged and pressurized enclosures. These efforts resulted in the publication of ISA S12.4, *Instrument Purging for Reduction of Hazardous Area Classification*. ISA S12.4 was the basis for NFPA 496.

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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 (1) developing data on the properties of chemicals enabling proper selection of electrical equipment for use in atmospheres containing flammable gases, vapors, or dusts; (2) making recommendations for the prevention of fires and explosions through the use of continuously purged pressurized, explosionproof, or dustproof and ignitionproof electrical equipment where installed in such chemical atmospheres.

Contents

NFPA 496

Standard for

Purged and Pressurized Enclosures for Electrical Equipment

1998 Edition

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

Information on referenced publications can be found in Chapter 8 and Appendix B.

Chapter 1 General

1-1* Scope.

1-1.1 This standard shall apply to purging and pressurizing for the following:

(a) Electrical equipment located in areas classified as hazardous by Article 500 or Article 505 of NFPA 70, *National Electrical Code®*

(b) Electrical equipment containing sources of flammable vapors or gases and located in either classified or unclassified areas

(c) Control rooms or buildings located in areas classified as hazardous by Article 500 or Article 505 of NFPA 70

(d) Analyzer rooms containing sources of flammable vapors or gases and located in areas classified as hazardous by Article 500 or Article 505 of NFPA 70, *National Electrical Code*

1-1.2 This standard does not apply to electrical equipment located in areas classified as Class I, Zone 0 or Class III.

1-2 Purpose. This standard is intended to provide information on the methods for purging and pressurizing enclosures to prevent ignition of a flammable atmosphere. Such an atmosphere may be introduced into the enclosure by a surrounding external atmosphere or by an internal source. By these means, electrical equipment that is not otherwise acceptable for a flammable atmosphere may be utilized in accordance with Article 500 or Article 505 of NFPA 70, *National Electrical Code.*

1-3 Applicability.

1-3.1 Chapters 2, 3, and 4 of this standard shall apply to electrical instrument and process control equipment, motors, motor controllers, electrical switchgear, and similar equipment that are installed in Class I or Class II locations and that *do not contain an internal source* of flammable vapor, gas, or liquid.

1-3.2 Chapter 5 of this standard shall apply to control rooms that are located in Class I or Class II locations and that *do not contain an internal source* of flammable vapor, gas, or liquid.

1-3.3* Chapter 6 of this standard shall apply to electrical instrument and process control equipment and similar enclosed equipment, such as a gas chromatograph or a gas analyzer, that *do contain an internal source* of flammable vapor, gas, or liquid.

1-3.4 Chapter 7 of this standard shall apply to analyzer rooms and buildings.

1-4 Definitions. For the purpose of this standard, the following terms shall have the meanings given below.

Alarm.* A piece of equipment that generates a visual or audible signal that attracts attention.

Analyzer Room or Building. A specific room or building containing analyzers, one or more of which is piped to the process.

Approved. Acceptable to the authority having jurisdiction.

NOTE: 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.

Authority Having Jurisdiction. The organization, office, or individual responsible for approving equipment, an installation, or a procedure.

NOTE: The phrase ''authority having jurisdiction'' 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.

Class I, Division 1. A location (1) in which ignitible concentrations of flammable gases or vapors can exist under normal operating conditions; or (2) in which ignitible concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or (3) in which breakdown or faulty operation of equipment or processes might release ignitible concentrations of flammable gases or vapors and might also cause simultaneous failure of electrical equipment. *[See Section 500-7(a) of NFPA 70, National Electrical Code.]*

Class I, Division 2. A location (1) in which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation of equipment; or (2) in which ignitible concentrations of gases or vapors that are normally prevented by positive mechanical ventilation and that might become hazardous through failure or abnormal operation of the ventilating equipment; or (3) that is adjacent to a Class I, Division 1 location and to which ignitible concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventila-

tion from a source of clean air, and effective safeguards against ventilation failure are provided. *[See Section 500-7(b) of NFPA 70, National Electrical Code.]*

Class II, Division 1. A location (1) in which combustible dust is in the air under normal operating conditions in quantities sufficient to produce explosive or ignitible mixtures; or (2) where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitible mixtures to be produced and might also provide a source of ignition through simultaneous failure of electrical equipment, operation of protection devices, or from other causes; or (3) in which combustible dusts of an electrically conductive nature may be present in hazardous quantities. *[See Section 500-8(a) of NFPA 70, National Electrical Code.]*

Class II, Division 2. A location where combustible dust is not normally in the air in quantities sufficient to produce explosive or ignitible mixtures, and dust accumulations are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus, but combustible dust may be in suspension in the air as a result of infrequent malfunctioning of handling or processing equipment and where combustible dust accumulations on, in, or in the vicinity of the electrical equipment may be sufficient to interfere with the safe dissipation of heat from electrical equipment or may be ignitible by abnormal operation or failure of electrical equipment. *[See Section 500-8(b) of NFPA 70, National Electrical Code.]*

Class I, Zone 0. A location (1) in which ignitible concentrations of flammable gases or vapors are present continuously; or (2) in which ignitible concentrations of flammable gases or vapors are present for long periods of time.

Class I, Zone I. A location (1) in which ignitible concentrations of flammable gases or vapors are likely to exist under normal operating conditions; or (2) in which ignitible concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or (3) in which equipment is operated or processes are carried on, of such a nature that equipment breakdown or faulty operations could result in the release of ignitible concentrations of flammable gases or vapors and also cause simultaneous failure of electrical equipment in a mode to cause the electrical equipment to become a source of ignition; or (4) that is adjacent to a Class I, Zone 0 location from which ignitible concentrations of vapors could be communicated, unless communication is prevented by adequate positive-pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

Class I, Zone 2. A location (1) in which ignitible concentrations of flammable gases or vapors are not likely to occur in normal operation and if they do occur will exist only for a short period; or (2) in which volatile flammable liquids, flammable gases, or flammable vapors are handled, processed, or used, but in which the liquids, gases, or vapors normally are confined within closed containers or closed systems from which they can escape only as a result of accidental rupture or breakdown of the containers or system, or as the result of the abnormal operation of the equipment with which the liquids or gases are handled, processed, or used; or (3) in which ignitible concentrations of flammable gases or vapors normally are prevented by positive mechanical ventilation, but which may become hazardous as the result of failure or abnormal operation of the ventilation equipment; or (4) that is adjacent to a Class I, Zone 1 location from which ignitible concentrations of flammable gases or vapors could be communicated, unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

Enclosure Volume. The volume of the empty enclosure without internal equipment.

The enclosure volume for motors, generators, and other rotating electric machinery is the volume within the enclosure minus the volume of the internal components, e.g., rotors, stators, and field coils.

Ignition-Capable Equipment. Equipment that, under normal operation, produces sparks, hot surfaces, or a flame that can ignite a specific flammable atmosphere.

Ignition Temperature.* The autoignition temperature of a flammable gas or vapor or the lower of either the layer ignition temperature or cloud ignition temperature of a combustible dust.

Indicator. A piece of equipment that shows flows or pressure and is monitored periodically, consistent with the requirement of the application.

Power Equipment. Equipment that utilizes power greater than 2500 VA or switches loads greater than 2500 VA.

Pressurization. The process of supplying an enclosure with a protective gas with or without continuous flow at sufficient pressure to prevent the entrance of a flammable gas or vapor, a combustible dust, or an ignitible fiber.

Pressurizing System.* A grouping of components used to pressurize and monitor a protected enclosure.

Protected Enclosure. The enclosure pressurized by a protective gas.

Protected Equipment. The electrical equipment internal to the protected enclosure.

Protective Gas. The gas used to maintain pressurization or to dilute a flammable gas or vapor.

Protective Gas Supply. The compressor, blower, or compressed gas container that provides the protective gas at a positive pressure. The supply includes inlet (suction) pipes or ducts, pressure regulators, outlet pipes or ducts, and any supply valves not adjacent to the pressurized enclosure.

Purging. The process of supplying an enclosure with a protective gas at a sufficient flow and positive pressure to reduce the concentration of any flammable gas or vapor initially present to an acceptable level.

Shall. Indicates a mandatory requirement.

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

Specific Particle Density.* The density of individual dust particles, as opposed to the bulk density of the material.

Type X Pressurizing. Reduces the classification within the protected enclosure from Class I, Division 1 or Class I, Zone 1 to unclassified.

Type Y Pressurizing. Reduces the classification within the protected enclosure from Division 1 to Division 2 or Zone 1 to Zone 2.

Type Z Pressurizing. Reduces the classification within the protected enclosure from Class I, Division 2 or Class I, Zone 2 to unclassified.

Ventilated Equipment. Equipment, such as motors, that requires airflow for heat dissipation as well as pressurization to prevent entrance of flammable gases, vapors, or dusts.

Chapter 2 General Requirements for Pressurized Enclosures

2-1 Scope. This chapter shall apply to enclosures containing electrical equipment that are located in Class I or Class II locations.

2-2 Enclosure.

2-2.1 The protected enclosure, including windows, shall be constructed of material that is not likely to be damaged under the conditions to which it may be subjected.

2-2.1.1 Precautions shall be taken to protect the enclosure from excessive pressure of the protective gas supply.

2-2.1.2 Excess pressure–relieving devices, where required to protect in the case of a control failure, shall be designed to prevent the discharge of ignition-capable particles to a Division 1 location.

2-2.2* Normal discharge of the protective gas from a designated enclosure outlet shall be to an unclassified location.

Exception No. 1: The discharge shall be permitted to be to a Division 2 location if the equipment does not create ignition-capable particles during normal operation.

Exception No. 2: The discharge shall be permitted to be to a Division 1 or Division 2 location if the outlet is designed to prevent the discharge of ignition-capable particles during normal operation.

2-2.3* In Division 1 locations, where the conduit or raceway entry into a pressurized enclosure is not pressurized as part of the approved protection system, an explosionproof conduit seal shall be installed as close as practicable to, but not more than 18 in. (458 mm) from, the pressurized enclosure.

In Division 2 locations, an explosionproof conduit seal shall not be required at the pressurized enclosure

2-3 Pressurizing System.

2-3.1* The protected enclosure shall be constantly maintained at a positive pressure of at least 25 Pa (0.1 in. water) above the surrounding atmosphere during operation of the protected equipment.

2-3.2 If positive pressure is not maintained in a protected enclosure, a suitable device such as an indicator, alarm, cutoff, or interlock switch shall warn the user to take action or shall automatically de-energize power from ignition-capable equipment. The type of device should be dependent on the type of pressurization used.

2-3.3 An alarm shall be provided to indicate failure of the protective gas supply to maintain the required pressure.

Exception: An alarm shall not be required to be provided when the protective gas supply is used only to supply Type X pressurized equipment.

2-3.4 All pressurizing system components that may be energized in the absence of the protective gas shall be approved for the classified location in which they are installed.

2-3.5 Adequate instructions shall be provided for the pressurization system to ensure that the system can be used properly and that the enclosure will be protected from excessive pressure.

2-4 Protective Gas System.

2-4.1* The protective gas shall be essentially free of contaminants or foreign matter and shall contain no more than trace amounts of flammable vapor or gas. All protective gas supplies shall be carefully designed to minimize chances for contamination.

2-4.1.1* Air of normal instrument quality, nitrogen, or other nonflammable gas shall be considered acceptable as a protective gas.

2-4.2 Piping for the protective gas shall be protected against mechanical damage.

2-4.3 If compressed air is used, the compressor intake shall be located in an unclassified location.

2-4.4* If the compressor intake line passes through a classified location, it shall be constructed of noncombustible material, designed to prevent leakage of flammable gases, vapors, or dusts into the protective gas, and protected against mechanical damage and corrosion.

2-4.5 The electrical power for the protective gas supply (blower, compressor, etc.) shall be supplied either from a separate power source or from the protected enclosure power supply before any service disconnects to the protected enclosure.

2-4.6 When "double pressurization" is used (e.g., a Division I enclosed area pressurized to a Division 2 classification that contains ignition-capable equipment also protected by pressurization), the protective gas supplies shall be independent.

2-5 Determination of Temperature Marking.

2-5.1* The temperature identification number (T Code) marked on the enclosure shall represent (under normal conditions) the highest of the following:

(a) The hottest enclosure external surface temperature
(b) The hottest internal component surface
(c) The temperature of the protective gas leaving the enclosure.

The actual temperature in degrees Celsius may be marked in place of the T Code wherever the T Code is referenced in this standard.

Exception: Internal components may exceed the marked T Code rating if they comply with one of the following:

(a) The enclosure is marked as required in 2-11.3 with the time period sufficient to permit the component to cool to the marked T Code.

(b) The component is separately housed so that the surface temperature of the housing is below the marked T Code. This housing shall be pressurized or sealed. If the housing can be readily opened, then the housing shall be marked as required in 2-11.3.

(c) The small component has been shown to be incapable of igniting a test gas associated with a lower T Code or will not ignite the flammable vapor, gas, or dust involved.*

2-5.2* Table 2-5.2 lists the temperature index numbers (T Codes) as defined in Table 500-5(d) of NFPA 70, *National Electrical Code*. Table 505-10(b)(3) shows similar information

for Zone applications but does not include T Codes with letter suffixes.

Table 2-5.2 Temperature Identification Numbers (T Codes)

Maximum Temperature		
°C	°F	T Code
450	842	T1
300	572	T2
280	536	T2A
260	500	T2B
230	446	T2C
215	419	T2D
200	392	T3
180	356	T3A
165	329	T3B
160	320	T3C
135	275	T4
120	248	T4A
100	212	T5
85	185	T6

2-6* Ventilated Equipment. The flow of protective gas shall be sufficient to keep the equipment adequately cooled.

2-7* Power Equipment. Enclosures containing power equipment shall be of substantially noncombustible construction and shall be reasonably tight. Gaskets shall be permitted.

NOTE: Nonmetallic enclosure flammability ratings of 94 V-0 or 94 5V are considered as substantially noncombustible. (See ANSI/UL94-1996, *Safety Test for Flammability of Plastic Materials for Parts in Devices and Appliances,* for description of flammability ratings.)

2-8* Type Z Pressurization. See Figure 2-8.

2-8.1* Failure to maintain positive pressure within an individual protected enclosure shall be detected by an alarm or an indicator, but it is not necessary to de-energize the protected equipment.

2-8.2 Any protected enclosure that can be isolated from the protective gas supply shall be equipped with an alarm.

Exception: The protected enclosure shall be permitted to be equipped with an indicator if the isolation is done with a valve(s) that is immediately adjacent to the protected enclosure and the valve(s) is intended for use only during servicing of the protected enclosure. The valve(s) shall be marked as required in 2-11.4.

2-8.3 If an alarm is used:

(a) The alarm shall be located at a constantly attended location.

(b) The alarm actuator shall take its signal from the protected enclosure and shall not be installed between the enclosure and the protective gas supply.

(c) The alarm actuator shall be mechanical, pneumatic, or electrical.

(d) Electrical alarms and electrical alarm actuators shall be approved for the location in which they are installed.

(e) No valves shall be permitted between the alarm actuator and the enclosure.

NOTE: This alarm also satisfies the requirement in 2-3.3 to provide an alarm on the protective gas supply.

2-8.4 If an indicator is used:

(a) The indicator shall be located for convenient viewing.

(b) The indicator shall not be installed between the enclosure and the protective gas supply.

(c) The indicator shall indicate either pressure or flow.

(d) No valves shall be permitted between the indicator and the enclosure.

(e) The protective gas supply shall have an alarm that is located at a constantly attended location to fulfill the requirement in 2-3.3.

2-9* Type Y Pressurization.

2-9.1 All applicable requirements in Section 2-8 shall be complied with.

2-9.2 Equipment within the protected enclosure shall be approved for Division 2 locations.

2-9.3 Ventilated equipment that would develop temperatures hotter than the marked T Code rating upon failure of the ventilation shall be automatically de-energized when the flow of protective gas stops.

2-10* Type X Pressurization.

2-10.1* A cutoff switch shall be incorporated to de-energize power automatically from all circuits within the protected enclosure not approved for Division 1 upon failure of the protective gas supply to maintain positive pressure.

Exception: Power to the circuits shall be permitted to be continued for a short period if immediate loss of power would result in a more hazardous condition and if both audible and visual alarms are provided at a constantly attended location.

2-10.1.1 The cutoff switch provided to de-energize power upon failure of the protective gas supply to maintain positive pressure shall be either flow actuated or pressure actuated.

2-10.1.2 The cutoff switch shall be approved for use in the location in which it is installed.

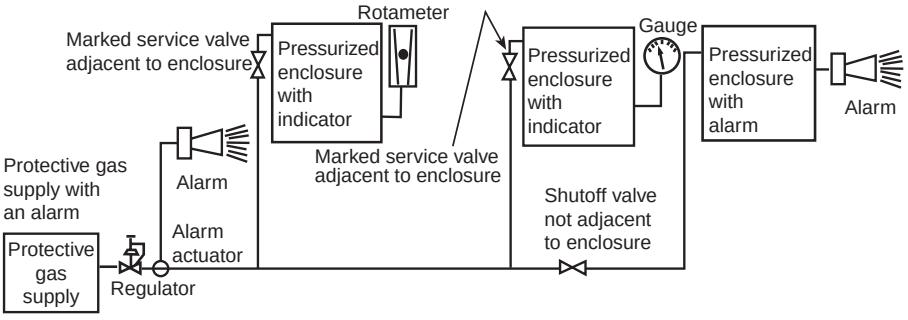
2-10.1.3 No valves shall be permitted between the cutoff switch and the protected enclosure.

2-10.1.4 The cutoff switch shall take its signal from the protected enclosure and shall not be installed between the enclosure and the protective gas supply.

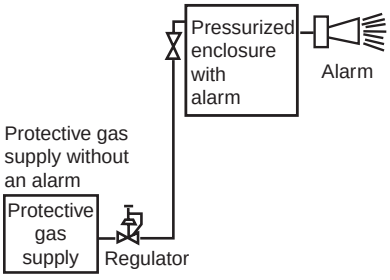
2-10.2* Equipment, such as motors or transformers, that may be overloaded shall be provided with appropriate devices to detect any increase in temperature of the equipment beyond its design limits and shall de-energize the equipment automatically.

Exception: Power to the circuits shall be permitted to be continued for a short period if immediate loss of power would result in a more hazardous condition and if both audible and visual alarms are provided at a constantly attended location.

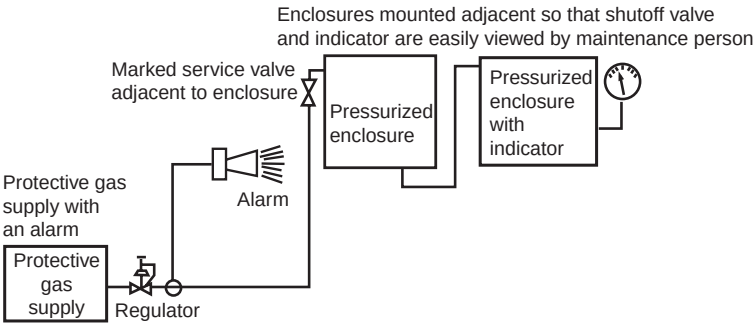
2-10.3 For ventilated equipment, the flow of protective gas shall provide sufficient cooling even during overload conditions or the equipment subject to overloading shall be provided with appropriate devices to detect any increase in



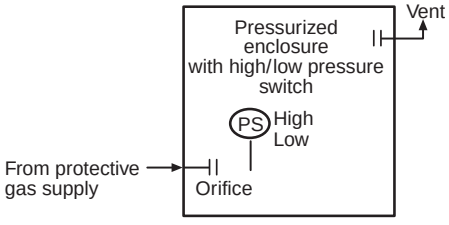
Example 1: Shows indicators may be used if protective gas supply has an alarm and the shutoff valve is adjacent to the enclosure.



Example 2: Shows enclosure alarm can also fulfill requirement for protective gas supply alarm.



Example 3: Shows multiple enclosures can be series purged.



Example 4: Shows enclosure with internal fail-safe, high/low pressure switch arranged to alarm in an attended location that can fulfill Chapter 2 requirements.

Figure 2-8 Typical alarm and indicator configurations for Types Y and Z pressurization. Purge outlet devices that could be provided are not shown for clarity.

temperature beyond its design limits and to de-energize that equipment automatically.

Exception: Power to the circuits shall be permitted to be continued for a short period if immediate loss of power would result in a more hazardous condition and if both audible and visual alarms are provided at a constantly attended location.

2-11 Markings.

2-11.1 A permanent label shall be mounted on the protected enclosure in a prominent location so that it is visible before the protected enclosure can be opened. Labeling shall include the following:

(a) The following statement, or an equivalent statement:

WARNING—
PRESSURIZED ENCLOSURE
This enclosure shall not be opened unless the area is known to be free of flammable materials or unless all devices within have been de-energized.

(b) The area classification for the protected enclosure

(c) The pressurization type, e.g., Type X, Type Y, or Type Z

(d) The temperature identification number (T Code) or the actual temperature in degrees Celsius as determined in Section 2-5

Exception No. 1: The T Code marking shall not be necessary if the hottest temperature does not exceed 100°C.

Exception No. 2: For equipment marked for use in a specific gas or dust atmosphere, the T Code marking shall not be necessary when the hottest temperature does not exceed 80 percent of the ignition temperature (in degrees Celsius) of the flammable vapor, gas, or dust involved. If the dust involved is an organic dust that may dehydrate or carbonize, the hottest temperature shall not be permitted to exceed the lower of either 80 percent of the layer/cloud ignition temperature or 165°C.

2-11.2 The additional markings specified in Sections 3-3 and 4-3 may also be included on the permanent label described in 2-11.1.

2-11.3 Where 2-5.1, Exception (a) or (b) is used, the following or equivalent statement shall appear on a permanent label:

WARNING—
HOT INTERNAL PARTS
This enclosure shall not be opened unless the area is known to be nonflammable or unless all equipment within has been de-energized for _____ minutes.

2-11.4 Where 2-8.2 Exception is used, the following or equivalent statement shall appear on a permanent label:

WARNING—
PROTECTIVE GAS SUPPLY VALVE
This valve must be kept open unless the area is known to be nonflammable or unless all equipment within the protected enclosure is de-energized.

Chapter 3 Pressurized Enclosures in Class I Locations

3-1 Scope. This chapter shall apply to enclosures containing electrical equipment that are located in Class I locations.

3-2 General Requirements.

3-2.1 All the applicable requirements of Chapter 2 shall be met.

3-2.2 If the enclosure has been opened or if the protective gas supply has failed to maintain the required positive pressure, the enclosure shall be purged.

3-2.3 Airflow through the enclosure during purging shall be designed to avoid air pockets.

3-2.4 Once the enclosure has been purged of flammable concentrations, only positive pressure shall be required to be maintained within the enclosure. No specific flow rate shall be required to be maintained.

3-2.5* Compartments within the main enclosure or adjacent enclosures connected to the main enclosure shall be considered separately, and protection shall be provided by one of the following methods:

(a) The internal compartment shall be vented to the main enclosure by nonrestricted top and bottom vents that are common to the main enclosure. Each vent shall provide not less than 6.5 cm^2 (1.0 $in.^2$) of vent area for each 6560 cm^3 (400 $in.^3$), with a minimum vent size of 6.3 mm (¼ in.) diameter.

(b) The internal compartment or adjacent enclosure shall be purged in series or shall be purged separately.

(c) The equipment in the internal compartment or adjacent enclosure shall be protected by other means (e.g., explosion proof, intrinsic safety, hermetic sealing, nonincendive, encapsulation, etc.).

NOTE 1: Cathode ray tubes (CRTs) are hermetically sealed components.

NOTE 2: Components with a free internal volume less than 20 cm^3 (1.22 $in.^3$) are not considered to be internal compartments requiring protection as long as the total volume of all such components is not a significant portion of the protected enclosure volume.

NOTE 3: Components considered to be environmentally sealed such as transistors, microcircuits, capacitors, etc., are not included in the percent of volume analysis.

3-3 Markings. A permanent label containing the start-up conditions shall be mounted on the protected enclosure in a prominent location. The label shall contain the following, or an equivalent, statement:

Power shall not be restored after enclosure has been opened until enclosure has been purged for _____ minutes at a flow rate of _____.

NOTE: The minimum pressure may be used in place of the flow rate if the pressure is a positive indication of the correct flow.

Exception: Start-up conditions shall be permitted to alternately be mounted on an adjacent pressurizing system if referenced on the protected enclosure.

3-4* Additional Requirements for Type Y or Type Z Pressurization. The protected equipment shall not be energized until at least four enclosure volumes of the protective gas (ten volumes for motors, generators, and other rotating electric machinery) have passed through the enclosure while maintaining an internal pressure of at least 25 Pa (0.1 in. water).

Exception: Equipment shall be permitted to be energized immediately if a pressure of at least 25 Pa (0.1 in. water) exists and the atmosphere within the enclosure is known to be nonflammable.

3-5 Additional Requirements for Type X Pressurization.

3-5.1 A timing device shall be used to prevent energizing of electrical equipment within the protected enclosure until at least four enclosure volumes of the protective gas (ten volumes for motors, generators, and other rotating electric machinery) have passed through the enclosure while maintaining an internal pressure of at least 25 Pa (0.1 in. water).

3-5.2* If the enclosure can be readily opened without the use of a key or tools, an interlock shall be provided to immediately de-energize all circuits within the enclosure that are not approved for Class I, Division 1 or Class I, Zone 1 locations when the enclosure is opened.

3-5.2.1 The interlock, even though located within the enclosure, shall be approved for Class I, Division 1 or Class I, Zone 1 locations.

3-5.2.2 Protected enclosures that contain hot parts requiring a cooldown period shall not be readily opened without the use of a key or tool.

Chapter 4 Pressurized Enclosures in Class II Locations

4-1 Scope. This chapter shall apply to enclosures containing electrical equipment that are located in Class II locations.

4-2 General Requirements.

4-2.1 All applicable requirements in Chapter 2 for each type of pressurization shall be complied with, except as modified below.

4-2.2* If combustible dust has accumulated within the protected enclosure, the protected enclosure shall be opened and the dust removed before pressurization.

NOTE: Protected enclosures should normally be kept closed whether the equipment is in operation or not.

4-2.3 Adjacent enclosures connected to the main enclosure shall be permitted to be collectively pressurized to prevent the entrance of dust if there is adequate communication to maintain the specified pressure at all points.

4-2.4* The protected enclosure shall be constantly maintained at a pressure above the surrounding atmosphere, dependent upon the specific particle density during operation of the protected equipment. The positive pressure shall comply with Table 4-2.4.

4-2.5* If the ignition temperature of the dust is not known, maximum surface temperatures shall not exceed those stated in Table 500-5(f) of NFPA 70, *National Electrical Code.*

4-3* Markings. A permanent label containing the start-up conditions shall be mounted on the protected enclosure in a

Table 4-2.4 Minimum Enclosure Pressure Versus Dust Density

Specific Particle Density		Specific Gravity	Minimum Pressure	
lb/ft^3	kg/m^3		in. H_2O	Pa
< 130	< 2083	< 2.083	0.1	25
> 130	> 2083	> 2.083	0.5	125

prominent location. The label shall contain the following, or an equivalent, statement:

Power shall not be restored after the enclosure has been opened until combustible dusts have been removed and the enclosure repressurized.

4-4* Additional Requirements for Type X Pressurization. An alarm, provided at a constantly attended location, shall be permitted to be used in place of the cutoff switch specified in 2-10.1 if the enclosure is tightly sealed to prevent the entrance of dust.

4-5 Additional Requirements for Ventilated Equipment. The discharge of protective gas shall not create a combustible atmosphere by disturbing layers of dusts.

Chapter 5 Pressurized Control Rooms

5-1* Scope. This chapter shall apply to buildings or portions of buildings commonly referred to as control rooms.

5-2 Protective Gas.

5-2.1 The protective gas shall be air.

5-2.2* The air shall be essentially free of contaminants or foreign matter and shall contain no more than trace amounts of flammable vapor or gas.

5-2.3* The source of air shall be determined from the nature of the process and the physical layout but shall not be from a classified location.

5-2.4 Any ducts shall be constructed of noncombustible materials. The fan suction line shall be free of leaks and shall be given suitable protection from mechanical damage and corrosion to prevent hazardous concentrations of flammable gases, vapors, or dusts from being drawn into the control room.

5-3 Considerations Relating to Positive Pressure Ventilation.

5-3.1 The following factors shall be considered in designing a control room suitable for safe operation in a hazardous (classified) location:

(a) The number of people to be housed
(b) The type of equipment to be housed
(c) The location of the control room relative to the direction of the prevailing wind and to the location of process units (e.g., relief valves, vent stacks, and emergency relief systems)

5-3.2* If the control room is in a classified location, it shall be designed to minimize the entry of flammable vapors, gases, liquids, or dusts.

5-4 Requirements for Positive Pressure Air Systems.

5-4.1* The positive pressure air system shall be capable of the following:

(a) Maintaining a pressure of at least 25 Pa (0.1 in. water) in the control room with all openings closed

(b) Providing a minimum outward velocity of 0.305 m/sec (60 fpm) through all openings capable of being opened. The velocity shall be measured with all these openings simultaneously open.

A drop in pressure below the 25 Pa (0.1 in. water) specified in 5-4.1(a) is permissible while meeting the requirements of 5-4.1(b).

Exception No. 1: Doorways or other openings that are used solely for infrequent movement of equipment in or out of pressurized control rooms or analyzer rooms shall be permitted to be excluded from this calculation if, under conditions of management control, these doors are marked to restrict use, are not used for egress, and are secured in the closed position.

Exception No. 2: Gland or bulkhead plates or other similar covers that cannot be removed without the use of a key or tool shall be permitted to be excluded from the calculation.

5-4.1.1 The positive pressure air system may include heating, ventilation, and air conditioning equipment, as well as any auxiliary equipment necessary to comply with 5-4.1.

5-4.2 If there is an air consuming device (such as a compressor or laboratory hood) in the control room, sufficient air shall be supplied to accommodate its needs as well as the needs of the positive pressure air system. Alternatively, the air supply to such a device shall be taken from a separate source.

5-4.3 The positive pressure air system shall be designed to provide the required pressure and flow rate for all areas of the control room.

5-4.4 For Type X pressurizing, a cutoff switch shall be incorporated to de-energize power automatically from all circuits within the control room not approved for Class I, Division 1 or Class I, Zone 1 upon failure of the positive pressure air system.

Exception: Power to the circuits shall be permitted to be continued for a short period if immediate loss of power would result in a more hazardous condition.

5-4.5 For Type Y and Type Z pressurizing, power to the control room shall not be required to be de-energized upon failure of the positive pressure air system.

5-4.6* Failure of the positive pressure air system shall be detected at the discharge end of the fan and shall activate an alarm at a constantly attended location.

5-4.7* Provisions shall be made to energize the control room safely after interruption of the positive pressure air system. Such provisions shall include checking the atmosphere in the control room with a flammable vapor detector (see ANSI/ISA RP12.13-1995, Part I, *Performance Requirements, Combustible Gas Detectors*) to determine that the atmosphere is not flammable or removing hazardous quantities of dust.

5-4.8 The switch, electrical disconnect, and motor for the air system fan shall be approved for the location as it would be classified in the absence of positive pressure ventilation.

5-4.9 The electrical power for the positive pressure air system shall be taken off the main power line ahead of any service

disconnects to the control room or shall be supplied from a separate power source.

Chapter 6 Pressurized Enclosures Having an Internal Source of Flammable Gas or Vapor

6-1 Scope. This chapter shall apply to instruments such as gas chromatographs and gas analyzers and other enclosures that contain an internal source of flammable gas or vapor.

6-2* General Requirements.

6-2.1 The applicable requirements of Chapters 2, 3, and 4 shall apply except as modified herein.

6-2.2* For the purpose of this chapter, every protected enclosure shall be considered to have a ''normal'' and an ''abnormal'' condition. In both conditions, the electrical equipment in the enclosure is assumed to be operating correctly. The types and magnitudes of these conditions are described below.

6-2.2.1 ''Normal'' shall mean the anticipated release of flammable gas or vapor within the enclosure when the system that supplies the flammable gas or vapor is operating properly. The magnitude of this anticipated release may be one of the following:

(a) None — there is no release of flammable gas or vapor, or the release of flammable gas or vapor is documented to reflect that it is of such a low level that without ventilation and/or purge the concentration is not capable of reaching 25 percent of the lower flammable limit; or

(b) Limited — there is a release of flammable gas or vapor, but the release is limited to an amount that can be diluted by the pressurizing system to a concentration less than 25 percent of the lower flammable limit.

6-2.2.2 ''Abnormal'' shall mean the anticipated release of flammable gas or vapor within the enclosure when the system that supplies the flammable gas or vapor is either leaking or is otherwise operating abnormally. The magnitude of this anticipated release is as follows:

(a) Limited—i.e., the release of flammable gas or vapor is limited to an amount that can be diluted to less than 25 percent of the lower flammable limit; or

(b) Unlimited—i.e., the release of flammable gas or vapor is of such magnitude that it cannot be diluted to less than 25 percent of the lower flammable limit.

6-2.3 If all the electrical equipment within the protected enclosure is suitable for Class I, Division 1 or Class I, Zone 1 locations, no pressurization shall be required because of the internal source.

Precautions shall be taken if the abnormal condition release may be great enough to adversely affect an external area classification.

6-2.4* If the electrical equipment within the protected enclosure is suitable for either Class I, Division 2 or Class I, Zone 2 locations or unclassified locations, the pressurization requirements shall be established according to Table 6-2.4.

To determine the pressurization requirements according to Table 6-2.4:

(a) Find the external area classification in column (1).

(b) Find the internal equipment type in column (2).

(c) Determine the pressurization requirement for limited release under abnormal conditions by using the appropriate normal condition in column (3).

(d) Determine any additional requirements from column (4) if the abnormal condition is unlimited release.

6-2.5 Protected enclosures containing an open flame shall be considered to have equipment suitable for unclassified locations for the purposes of determining the pressurization requirement according to Table 6-2.4. The flame shall be automatically extinguished upon failure of the pressurization system regardless of pressurization type.

6-3 Specific Requirements.

6-3.1 Where a release of flammable gas or vapor within an enclosure can occur either in normal operation or under abnormal conditions, protection shall be provided by:

(a) Diluting with air to maintain the concentration of flammable gas, vapor, or mixture to less than 25 percent of its lower flammable limit, based on the lowest value of the lower flammable limit of any individual flammable gas or vapor entering the enclosure; or

(b) Diluting or pressurizing with inert gas to reduce the oxygen content in the enclosure to a level of not more than 5 percent by volume or to 50 percent of the minimum concentration of oxygen required to form a flammable mixture, whichever is lower.

6-3.2 Where the protected enclosure is located in a Class I or Class II area, the pressurizing system shall also prevent entrance of the external atmosphere by providing a minimum internal pressure of 25 Pa (0.1 in. water).

6-3.3 The locations and sizes of gas or vapor outlets in the protected enclosure shall be designed to allow effective removal of both the flammable gas or vapor and the protective gas.

Where an inert protective gas is used, the outlets shall be permitted to be closed after purging to prevent undue loss of inert protective gas, provided that this does not constitute a further danger such as inadequate flow of protective gas or excessive pressure buildup.

6-3.4 In applications where flammable mixtures shall be permitted to be piped into the enclosure through the flammable gas or vapor system, suitable precautions shall be taken to prevent propagation of an explosion back to the process equipment.

6-3.5 The flow rate of protective gas shall be sufficient to maintain the requirements of 6-3.1 and to ensure adequate mixing so that the release of a flammable gas or vapor is limited.

6-3.6 To achieve proper pressurization with air, caution shall be required to ensure that the air pressure used within the enclosure does not exceed the pressure of the flammable gas or vapor system supplying the enclosure, as air could enter the process, causing possible problems such as explosive concentrations of the flammable gas or vapor, corrosion, or oxidation.

6-3.7 Precautions shall be taken to protect the enclosure from excessive pressure of the protective gas supply.

Chapter 7 Pressurized Analyzer Rooms Containing a Source of Flammable Gas, Vapor, or Liquid

7-1 Scope. This chapter shall apply to analyzer rooms containing electrical equipment having process streams of flam-

Table 6-2.4 Pressurization Requirements for Enclosures Subject to Internal Release

(1)	(2)	(3)		(4)
		Pressurization Requirements for Limited Release Under Abnormal Conditions		
External Area Classification	Internal Equipment Suitable for	No Release Under Normal Conditions	Limited Release Under Normal Conditions	Additional Requirements for Unlimited Release Under Abnormal Conditions
Class I, Division 1 (Class I, Zone 1)	Class I, Div. 1 (Class I, Zone 1)	None	None	None
	Class I, Div. 2 (Class I, Zone 2)	Y	Y	None
	Unclassified	X	X	Inert[1]
Class I, Division 2 (Class I, Zone 2)	Class I, Div. 1 (Class I, Zone 1)	None	None	None
	Class I, Div. 2 (Class I, Zone 2)	None	Z	None
	Unclassified	Z	X	Inert[1]
Class II	Class I, Div. 1 (Class I, Zone 1)	None	None	None
	Class I, Div. 2 (Class I, Zone 2)	None	Z	None
	Unclassified	Z	X	Inert[1]
None	Class I, Div. 1 (Class I, Zone 1)	None	None	None[2]
	Class I, Div. 2 (Class I, Zone 2)	None	Z	None[2]
	Unclassified	Z	X	Inert[1]

[1]See A-6-2.4.
[2]Precautions shall be taken if unlimited release is large enough to alter the external area classification.

mable liquid, vapor, or compressed flammable gas piped into the equipment.

7-2 General.

7-2.1 For the purpose of this chapter, every pressurized analyzer room containing a source of flammable gas, vapor, or liquid, shall be considered to have one of the following types of anticipated releases:

(a) None — there is no release of flammable gas or vapor, or the release of flammable gas or vapor is documented to reflect that it is of such a low level that, without ventilation and/or purge, the concentration is not capable of reaching 25 percent of the lower flammable limit.

(b) Limited — there is a release of flammable gas or vapor, but the release is limited to an amount that can be diluted by the pressurizing system to a concentration less than 25 percent of the lower flammable limit.

(c) Unlimited — there is a release of flammable gas or vapor, but the release is of such a magnitude that it cannot be diluted by the pressurizing system to a concentration less than 25 percent of the lower flammable limit.

7-2.2 If the analyzer room is in a hazardous (classified) location, it shall be designed to prevent the entry of flammable gases and vapors, flammable liquids, and combustible dusts.

7-2.3 The applicable requirements of Chapter 5 for control rooms shall apply except as modified herein.

7-2.4* Analyzer rooms shall be separated from control rooms by distance or by a wall impermeable to vapors.

7-2.5* Flow of air through the room shall ensure adequate air distribution. Flammable vapors shall be removed as close to their source as practical.

7-2.6 Leakage of inert gases used for purging or pressurization of enclosures in an analyzer room can deplete the room's oxygen. Where personnel can enter the analyzer room, administrative controls combined with adequate training and safe entry procedures shall be established. Warning signs advising of the hazard of inert gas shall be posted. Inert gas shall not be used for purging an entire analyzer room where personnel shall be permitted to enter. (See NFPA 69-1997, *Standard on Explosion Prevention Systems.*)

7-2.7 The magnitude of the anticipated release within the analyzer room shall be "none" or "limited" based on the largest single failure.

7-3 Specific Requirements.

7-3.1 To prevent an unlimited release in the analyzer room, process streams shall have orifices or other flow-limiting devices on the inlets and on the outlet, if the outlet can constitute a source of uncontrolled leakage from the process. Orifices or other flow-limiting devices shall be located outside and close to the wall of the building or room.

7-3.2* If flammable vapor, gas, or liquid is discharged from an enclosure (e.g., analyzer enclosure), it shall not create a hazard within the analyzer house or to the surroundings.

7-3.3 Sample conditioning equipment (such as equipment used for heating, cooling, or drying) shall be suitable for the area electrical classification.

7-3.4 Process piping within the analyzer room shall be minimized. Means for emergency isolation of the process from the analyzers shall be provided outside the analyzer building.

7-3.5 False ceilings and floors shall not be used in analyzer rooms.

7-3.6* Ventilation fans shall be constructed to minimize the possibility of sparking.

7-3.7* In the event of pressurization failure, an audible and visual alarm shall be activated at a constantly attended location. Electrical power to ignition-capable equipment within the analyzer room shall be automatically shut down and open flames shall be automatically extinguished. Power shall not be restored until the analyzer room is free of any ignitible atmosphere mixtures.

Exception: Automatic shutdown shall not be required:

(a) If the anticipated release is "none," the analyzer room is unclassified, and the area outside the analyzer room is unclassified.

(b) If the anticipated release is "none," the analyzer room is unclassified, and the area outside the analyzer room is classified Class I, Division 2 or Class I, Zone 2.

(c) If the anticipated release is "limited," and the analyzer room is classified as Class I, Division 2 or Class I, Zone 2.

(d) If the analyzer room is classified as Class I, Division 1 or Class I, Zone 1.

7-3.8 If gas or vapor mixtures within the flammable range must be piped to the analyzer room, suitable precautions shall be taken to prevent propagation of an explosion back to the process equipment.

Chapter 8 Referenced Publications

8-1 The following documents or portions thereof are referenced within this standard as mandatory requirements and shall be considered part of the requirements of this standard. The edition indicated for each referenced mandatory document is the current edition as of the date of the NFPA issuance of this standard. Some of these mandatory documents might also be referenced in this standard for specific informational purposes and, therefore, are also listed in Appendix B.

8-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 69, *Standard on Explosion Prevention Systems*, 1997 edition.

NFPA 70, *National Electrical Code®*, 1999 edition.

8-1.2 ISA Publication. Instrument Society of America, 67 Alexander, P.O. Box 12277, Research Triangle Park, NC 27709.

ANSI/ISA RP12.13-1995, Part I, *Performance Requirements, Combustible Gas Detectors.*

Appendix A Explanatory Material

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

A-1-1 Electrical equipment should be located in an area having as low a degree of hazard classification as practical.

This standard does not address exclusion of flammable liquids that may be splashed or spilled on such enclosures. Where there is probability of flammable liquid exposure, additional means should be taken to avoid ingress.

A-1-3.3 The flammable gas or vapor is piped internally to the enclosure so that process parameters can be measured. The source of release could be fittings or vents. It is not intended that fumes or vapors from components within the electrical equipment be considered, e.g., from decomposing insulation.

A-1-4 Alarm. An alarm is intended to alert the user that the pressurizing system should be immediately repaired or that the electrical equipment protected by the failed pressurizing system should be removed from service.

A-1-4 Ignition Temperature. Normally, the minimum ignition temperature of a layer of a specific dust is lower than the minimum ignition temperature of a cloud of that dust. Since this is not universally true, the lower of the two minimum ignition temperatures is listed in NFPA 499, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.*

A-1-4 Pressurizing System. The pressurizing system may include components such as the alarm actuator, indicator, cutoff switch, or components of the protective gas supply. The components may be mounted in a separate enclosure/panel or be included within the protected enclosure.

A-1-4 Specific Particle Density. Specific particle density (sometimes referred to as the true density) is the mass per unit volume or, more commonly, weight per unit volume and is expressed as pounds per cubic foot (kilograms per cubic meter). It refers only to the material making up the particle. The term *bulk density* is obtained by placing granular or powdered material in a specified volume and calculating the density. Bulk density includes the void space between the particles created because of the irregular particle shape. As an example, the specific particle density of sulfur is about 130 lb/ft^3 while the bulk density of pulverized sulfur dust is about 50 lb/ft^3.

A-2-2.2 During brief periods of purging, the area around the vent may contain a concentration of flammables that requires caution.

A-2-2.3 Pressurized raceways do not need to be sealed if they have been properly designed as part of pressurized systems with the required alarms or indicators. The exception is not meant to allow the user to install the equipment and ignore proper installation of classified location wiring. The exception allows the same raceway to be used for electrical wiring and the protective gas. The design must consider the restriction of protective gas flow when conductors are installed in the raceway.

A-2-3.1 The reason for requiring that a positive pressure be maintained is to prevent flammable vapors or gases from being forced into the enclosure by external air currents.

A-2-4.1 Air filtration may be desirable.

A-2-4.1.1 Ordinary plant compressed air is usually not suitable for purge or pressurizing systems, due to contaminants that may cause equipment to malfunction.

A-2-4.4 The compressor suction line should not pass through any area having a hazardous atmosphere, unless it is not practical to do otherwise.

A-2-5.1 Because a high-temperature source of ignition is not immediately removed by de-energizing the equipment, additional precautions are necessary for hot components.

If the external temperature of the enclosure is greater than the autoignition temperature (in degrees Celsius) of the gas or vapor, it is obvious that purging will not prevent an explosion. Thus, it is essential that excess surface temperature be prevented, unless it has been specifically shown to be safe by a qualified testing laboratory. Dust that is carbonized or excessively dry is highly susceptible to spontaneous ignition.

Sources of internal temperatures above the autoignition temperature (in degrees Celsius) of the gas or vapor involved, such as vacuum tube filaments, are hermetically sealed to prevent them from contacting the atmosphere that may become hazardous. However, it is essential that the surface of the glass envelope does not exceed the 80 percent limit, unless shown by test to be safe.

A-2-5.1 Exception (c) The ignition temperature of gases and vapors that is listed in reference documents such as NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, is determined under conditions where a significant volume of gas is at the same temperature. When ignition is attempted with a small component, convection effects and partial oxidation at the surface of the component decrease the rate of heat transfer to the gas. Therefore, the component must be at a temperature much higher than the quoted ignition temperature to ignite the flammable mixture. Typical transistors, resistors, and similar small components must have a surface temperature of 220°C to 300°C to ignite diethyl ether whose ignition temperature is 160°C. Similar values have been measured in ignition tests of carbon disulfide whose ignition temperature is 100°C.

A-2-5.2 The T Code is based on the ambient temperature surrounding the pressurized equipment not exceeding 40°C (104°F). Higher temperatures will require adjustment of the marked T Code rating. For example, equipment marked T5 would be considered as T4A if used in a 60°C (140°F) ambient. The maximum ambient temperature rating of the equipment must not be exceeded.

A-2-6 Airflow required for cooling may be more than that required for purging.

A-2-7 Enclosures containing power equipment are more likely to produce ignition-capable particles. It is necessary to have an enclosure through which these particles cannot burn or escape from openings other than the vents. Other techniques may be used to ensure that ignition-capable particles are contained in the enclosure.

A-2-8 Type Z pressurization reduces the classification within an enclosure from Division 2 to nonhazardous. With Type Z purging, a hazard is created only if the purge system fails at the same time that the normally nonhazardous area becomes hazardous. For this reason, it is not considered essential to remove power from the equipment upon failure of the purge system.

A-2-8.1 An alarm is preferred, but an indicator is acceptable if the protected enclosure is much less likely to fail than the protective gas supply. Excessive leakage from the protected enclosure is only likely during servicing, at which time the indicator will assist the maintenance personnel in determining when the enclosure is adequately sealed to maintain pressure.

A-2-9 Type Y pressurization reduces the classification within an enclosure from Division 1 to Division 2. Equipment and devices within the enclosure must be suitable for Division 2. This requires that the enclosure does not contain an ignition source. Thus, a hazard is created within the enclosure only upon simultaneous failure of the purge system and of the equipment within the enclosure. For this reason, it is not considered essential to remove power from the equipment upon the failure of the purge system.

A-2-10 Type X pressurization reduces the classification within an enclosure from Division 1 to nonhazardous. Because the probability of a hazardous atmosphere external to the enclosure is high and the enclosure normally contains a source of ignition, it is essential that any interruption of the purging results in de-energizing of the equipment. Also, it is essential that the enclosure be tight enough to prevent escape of molten metal particles or sparks.

A-2-10.1 Power to the circuits may be continued for a short period where the Division 1 location only has a flammable concentration on an intermittent basis and where entrance of the external atmosphere would be slow because the protected enclosure is tightly sealed. Where flammable concentrations occur frequently or enclosure failure may be catastrophic, Type Y pressurization should be used if it is necessary to continue operating the process to prevent a more hazardous condition.

A-2-10.2 Overload conditions need only be a concern where the motor load or the transformer load is not determined by the product but by external variable loading in the actual application.

A-3-2.5 In order for any internal or adjacent enclosure to be automatically purged as the main enclosure is purged, adequate vents must be provided to permit air circulation between the two enclosures. The area required to provide adequate venting will depend on the volume of the internal or adjacent enclosure. It is considered that meeting this requirement will prevent the formation of unpurged pockets of gas or vapor within the enclosure. This does not imply that internal or adjacent enclosures not meeting these requirements are prohibited but that such enclosures must be provided with their own purge system.

A-3-4 Any time the enclosure has been opened or the purge system has failed, the possibility exists that an explosive mixture may have accumulated in the enclosure. For enclosures that are effectively subdivided by internal parts, a greater purge volume may be necessary.

A-3-5.2 It is essential that any door access that can be opened by untrained personnel be protected with interlock switches. Consistent with the practice that has been established with explosionproof enclosures, it is considered that the commonly displayed warning nameplate is adequate protection for an enclosure that requires the use of a tool to be opened.

A-4-2.2 Cleaning should be done using a method that will not create a dust cloud, e.g., vacuuming or brushing. Use of compressed air should be avoided.

A-4-2.4 The density of 2083 kg per m^3 (130 lb per ft^3) is slightly greater than that of sulfur dust, which was one of the dusts used in performing the tests on which the values in Table 4-2.4 are based. The pressures in the table are based

on the assumption that the maximum crack width exposed to falling dust is 0.4 mm (1/64 in.). The ability of a dust to enter an opening due to the force of gravity against an outward velocity of gas is directly proportional to its specific particle density.

A-4-2.5 Equipment installed in Class II locations should be able to function at full rating without developing surface temperatures high enough to cause excessive dehydration or gradual carbonization of any organic dust deposits that may occur.

A-4-3 If there is not enough room on the enclosure to print the statements required in 2-11.1 and Section 4-3 in type large enough to be legible, equivalent wording such as the following may be used:

De-energize before opening unless area is known to be nonhazardous. Remove dust and repressurize before restoring power.

A-4-4 A hazard is created within an enclosure only after the pressure has failed and enough dust to be explosive penetrates into the enclosure. This takes an appreciable length of time with any normally tight enclosure. Because of this, it is not always considered essential to remove the power from the equipment automatically upon failure of the pressurization. It is necessary only to provide an adequate warning so that operations will not continue indefinitely without pressurization. It is essential that the enclosure be tight enough to prevent escape of sparks or burning material.

Examples of enclosures that are tightly sealed to prevent the entrance of dust are Type 3, Type 3S, Type 4, Type 4X, Type 6, Type 6P, Type 12, or Type 13 enclosures.

A-5-1 Control rooms commonly house one or more of the following facilities:

(a) Process control instruments and panels
(b) Data processing equipment
(c) Communications equipment
(d) Lighting, power equipment, and related equipment
(e) Emergency power equipment
(f) Lunch, restroom, and locker facilities
(g) Offices and maintenance facilities
(h) Heating and ventilating equipment

A-5-2.2 Air filtration may be desirable.

A-5-2.3 Ordinarily, air can be taken from an area to one side of a process area where there is a minimum chance of flammable gases or vapors or combustible dusts being found. The elevation of the fan suction depends on the density of the gases, vapors, or dust under handling temperatures and adverse atmospheric conditions. For a control room in the center of a process area, ducting may be necessary.

A-5-3.2 To prevent entry of flammable vapors, gases, or dusts, positive pressure ventilation using a source of clean air may be used, and the equipment in the control room need not be housed in special enclosures. To prevent entry of flammable liquids, differences in elevation or use of dikes, etc., may be required.

A-5-4.1 A minimum number of doors should be provided so that positive pressures can be maintained, but, at the same time, the number of doors should be adequate for safe exit.

A-5-4.6 Suitable devices for detecting loss of air pressure include velocity pressure switches, static pressure switches, and plenum chambers with orifices. Electrical interlocks on the fan motor are not adequate, since belt slippage, loose impellers, or backward rotation of the fan would not be detected.

A-5-4.7 An enforced purge wherein an interlock timer requires proof of purging for a set period of time prior to energizing the control room should be considered.

A-6-2 The consequences of a release of flammable gas or vapor into an enclosure are substantially more serious than a similar release to the open atmosphere. Through the use of a purge system, these consequences may be minimized, and electrical equipment not otherwise acceptable for a flammable atmosphere may be utilized.

The effect of a temporary leak in the open is a transient rise in concentration of flammable gas or vapor in the atmosphere. A leak inside an enclosure, in the absence of purging, remains within the enclosure and if undetected will slowly raise the concentration inside the enclosure until its atmosphere becomes flammable. This increase in concentration is likely to be slowed only slightly by breathing and diffusion.

A-6-2.2 Because of the confining property of electrical equipment enclosures, it is necessary to view ''normal'' and ''abnormal'' conditions in terms of a longer time span than is necessary in considering releases in the open. Normal must include consideration of the probable operation of the apparatus after some years of service and includes degradation of the system components over time.

For no release within an enclosure under normal conditions, there must be a minimum risk (i.e., very low probability) that flammable material will escape from its containment system during the time the apparatus is in service and within the range of service conditions to which it is likely to be subjected. Therefore, materials and types of construction that degrade in service or with age and that are not likely to be maintained or replaced cannot be considered to permit a ''normal condition — no release'' as defined in 6-2.2.

Although specific rules that will apply to all designs cannot be written, in general, a design will be considered to have no normal release: if the flammable gas or vapor is enclosed in metallic pipes, tubes, vessels, or elements such as bourdons, bellows, or spirals; in systems that contain no moving seals; and if prototype systems do not leak when tested at 1.5 times their rated pressure, except in cases where another safety factor is applicable. Joints made with pipe threads, welding, metallic compression fittings, or other equally reliable methods would usually be considered to have no normal release.

Windows, elastomeric seals, and nonmetallic flexible tubing would in most cases not meet the requirement for ''normal condition — no release'' unless it can be demonstrated that time and environment will not degrade them below the leakage level expected of the operating pipe threads and compression seals. Systems that cannot meet a stringent interpretation of these guidelines should be considered ''normal condition — limited release.'' Seals, rotating or sliding seals, flanged joints, and flexible nonmetallic tubing can be assumed to leak minutely after a period of service.

Attention must be given to the possibility that expected degradation of components may result in release of flammable gas or vapor at a rate faster than that which the dilution system can handle. Such situations are not common but, when encountered, they should not be classified as ''normal condition — limited release.'' The prime criterion for ''normal condition — limited release'' is that the dilution capability of the protective system must not be exceeded.

In enclosures having open flames in normal operation, it

is assumed that flame extinguishment is a normal occurrence and should be classified as a normal release unless loss of flame automatically stops the flow of flammable gas or vapor.

A limited abnormal release is one that, by design, is maintained at a level within the dilution capability of the protective system. The limiting element may be a restriction in the flow line. In the case of designs using elastomeric seals, the limiting flow may be considered to be the flow that would exist were the seal not in place.

A-6-2.4 Electrical equipment permitted in nonhazardous (unclassified) locations may contain arcing or sparking contacts or may have hot surfaces. If there is no normal release within the equipment enclosure, a single failure of the system containing the flammable gas will provide the flammable atmosphere. The ignition source is always present, by virtue of the electrical equipment. Purging is, therefore, required, and Type Z purging will provide adequate protection. If, however, there is a limited release under normal conditions and there is limited release under abnormal conditions, then Type X purging is required. In this case, purging with air is satisfactory. Type X purging requires that the electrical power to the purged enclosure be disconnected upon failure of the purge system. Disconnection is required because, under the conditions described, a flammable atmosphere will be generated in the presence of arcing or sparking equipment or hot surfaces.

Electrical equipment suitable for Class I, Division 2 or Class I, Zone 2 locations may present a source of ignition only upon failure or other abnormal conditions. If there is no normal release within the equipment enclosure, no purging is required because there is not normally a source of ignition present, even if the system containing the flammable gas fails. If there is limited normal release and limited abnormal release, then Type Z purging, with air, provides adequate protection. If, however, the abnormal release is unlimited (i.e., beyond the dilution from a single failure of the containment system), then air is not permitted as the purge gas for such enclosures when the electrical equipment is only suitable for unclassified locations. Inert gas must be used so that a flammable atmosphere is prevented from developing (unless, of course, the purge system itself fails).

For an air-purged enclosure containing equipment suitable for Class I, Division 2 or Class I, Zone 2 locations, although an unlimited abnormal release results in a flammable atmosphere, the electrical equipment is assumed to be operating normally and therefore does not present a source of ignition. However, if a failure of the containment system is not obvious, inert gas purging should be used because of the danger that a flammable atmosphere may exist for a prolonged period of time, during which the electrical equipment may also fail and provide the source of ignition.

Whether electrical equipment is located in a Class I, Division 2, a Class I, Zone 2, or an unclassified location does not affect the need for a purge system. For Class I, Division 2 or Class I, Zone 2 locations, the purge system serves two purposes: (1) to prevent the external atmosphere from entering the enclosure, and (2) to dilute any flammable gas released within the enclosure. In an unclassified location, the purge system serves only to dilute any flammable gas released within the enclosure.

A-7-2.4 Flammable gases, vapors, or liquids for analysis should not be piped into control rooms because of the danger of ignition.

A-7-2.5 Flammable hydrocarbon vapors are usually heavier than air and should be removed at floor level. Lighter-than-air gases such as hydrogen and methane should be removed at the ceiling level.

A-7-3.2 Flammable gases or vapors should be discharged at a safe point outside the analyzer room in an upward or horizontal direction to aid in dispersion. The vent discharge should be located at least 5 ft (1.5 m) away from building openings and at least 12 ft (3.7 m) above grade level. The vent design and location should further consider possible trapping of vapors by eaves or other obstructions. (See NFPA 30, *Flammable and Combustible Liquids Code*.)

A-7-3.6 The fan motor and associated control equipment should be located external to the ductwork or should be suitable for the location.

A-7-3.7 It is assumed that the flow of flammable vapors or liquids will continue in case of failure of the ventilation system and that the atmosphere in the analyzer room will reach the flammable range. In these situations, power must be removed to avoid ignition.

Appendix B Referenced Publications

B-1 The following documents or portions thereof are referenced within this standard for informational purposes only and are thus not considered part of the requirements of this standard unless also listed in Chapter 8. The edition indicated here for each reference is the current edition as of the date of the NFPA issuance of this standard.

B-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 30, *Flammable and Combustible Liquids Code*, 1996 edition.

NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, 1997 edition.

NFPA 499, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, 1997 edition.

B-1.2 ASTM Publications. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 659-1994, *Standard Test Method for Determining the Autoignition Temperature of Liquid Chemicals.*

ASTM D 2155-66 (1976), *Method of Test for Autogenous Ignition Temperatures of Petroleum Products.*

B-1.3 UL Publication. Underwriters Laboratories, 333 Pfingsten Road, Northbrook, IL 60062.

ANSI/UL94-1996, *Safety Test for Flammability of Plastic Materials for Parts in Devices and Appliances.*

B-2 Other Publications.

Dorsett, H. G., et al., 1960. *Laboratory Equipment and Test Procedures for Evaluating Explosibility of Dusts*, RI 5624. Pittsburgh, PA: U.S. Bureau of Mines.

Electrical Safety Practices, Monograph 112. 1969. McCarron, R., "Report of an Investigation of the Effect of Internal Arcing Versus External Spot Temperatures of Metal Instrument Cases," Pittsburgh, PA: Instrument Society of America.

Perry, R. H., and D. Green. 1984. *Chemical Engineer's Handbook,* 6th Edition. McGraw-Hill, New York, NY.

Zenz, F. A., and D. F. Othmer. 1960. *Fluidization and Fluid Particle Systems.* Reinhold.

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