NFPA 496

Standard for

Purged and Pressurized Enclosures for Electrical Equipment

2003 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 NFPA at its May Association Technical Meeting held May 18–21, 2003, in Dallas, TX. It was issued by the Standards Council on July 18, 2003, with an effective date of August 7, 2003, and supersedes all previous editions.

This edition of NFPA 496 was approved as an American National Standard on July 18, 2003.

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 text. 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 was 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 also was 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.

In 2001, the Technical Committee on Electrical Equipment in Chemical Atmospheres entered NFPA 496 into the May 2003 revision cycle. The 2003 edition has been significantly revised and reorganized for conformance with the 2000 NFPA *Manual of Style*. These organizational and editorial changes enhance the standard's usability. Additionally, technical changes include revision of the term *alarm* to clarify its function with protected enclosures, and a revision that permits the use of a means other than a timing device to ensure that electrical equipment within a protected enclosure is not energized until the specified amount of protective gas has passed through the enclosure.

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

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

Committee Scope: 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, explosion-proof, or dust-ignition-proof electrical equipment where

installed in such chemical atmospheres.

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

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the technical change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

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

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

Chapter 1 Administration

1.1 Scope.

1.1.1 This standard applies to purging and pressurizing for the following:

(1) Electrical equipment located in areas classified as hazardous by Article 500 or Article 505 of NFPA 70

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

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

(4) 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

1.1.2* This standard does not apply to electrical equipment located in:

(1) Areas classified as Class I, Zone 0

(2) Areas classified as Class III

(3) Areas where flammable liquids may be splashed or spilled on the electrical equipment

1.2 Purpose.

This standard provides 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.

1.3 Application.

1.3.1 Chapters 4, 5, and 6 of this standard apply to electrical instrument and process control equipment, motors, motor controllers, electrical switchgear, and similar equipment that is installed in Class I or Class II locations and that does not contain an internal source of flammable vapor, gas, or liquid.

1.3.2 Chapter 7 of this standard applies 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 8 of this standard applies to electrical instrument and process control equipment and similar enclosed equipment, such as a gas chromatograph or a gas analyzer, that does contain an internal source of flammable vapor, gas, or liquid.

1.3.4 Chapter 9 of this standard applies to analyzer rooms and buildings.

1.4 Equivalency.

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

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

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

1.5 Units of Measurement.

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

1.5.2 Compliance. Compliance with the numbers shown in either the SI system or the inch-pound system shall constitute compliance with this standard.

1.6 Mandatory Rules, Permissive Rules, and Explanatory Material.

1.6.1 Mandatory Rules. Mandatory rules of this standard are those that identify actions that are specifically required or prohibited and are characterized by the use of the terms *shall* or *shall not*.

1.6.2 Permissive Rules. Permissive rules of this standard are those that identify actions that are allowed but not required, are normally used to describe options or alternative methods, and are characterized by the use of the terms *shall be permitted* or *shall not be required*.

1.6.3 Explanatory Material. Explanatory material is located in Annex A. The information contained in Annex A is explanatory only and is not enforceable as part of this standard.

Chapter 2 Referenced Publications

2.1* General.

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

2.2 NFPA Publication.

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

NFPA 70, *National Electrical Code®,* 2002 edition.

2.3 Other Publications.

2.3.1 ISA Publication.

ISA-Instrumentation, Systems, and Automation Society, 67 Alexander Drive, P.O. Box 12277, Research Triangle Park, NC 27709.

ANSI/ISA 12.13.01-2000, *Performance Requirements for Combustible Gas Detectors*.

Chapter 3 Definitions

3.1 General.

The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not included, common usage of the terms shall apply.

3.2 NFPA Official Definitions.

3.2.1* **Approved.** Acceptable to the authority having jurisdiction.

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

equipment, materials, an installation, or a procedure.

3.3 General Definitions.

3.3.1* **Alarm.** A piece of equipment that generates a visual or audible signal that is intended to attract attention.

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

3.3.3 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.

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

3.3.5* **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.

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

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

3.3.8 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 ignitable fiber.

3.3.8.1 ***Type X Pressurizing.*** Reduces the classification within the protected enclosure from Division 1 or Zone 1 to unclassified.

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

3.3.8.3 ***Type Z Pressurizing.*** Reduces the classification within the protected enclosure from Division 2 or Zone 2 to unclassified.

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

3.3.10 Protected Enclosure. An enclosure pressurized by a protective gas.

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

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

3.3.13 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.

3.3.14 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.

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

3.3.16 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.

3.4 *NEC*® Extracted Definitions.

3.4.1 Class I, Division 1. A Class I, Division 1 location is a location: (1) In which ignitable concentrations of flammable gases or vapors can exist under normal operating conditions, or (2) In which ignitable 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 ignitable concentrations of flammable gases or vapors and might also cause simultaneous failure of electrical equipment in such a way as to directly cause the electrical equipment to become a source of ignition. [**70:**500.5(B)(1)]

3.4.2 Class I, Division 2. A Class I, Division 2 location is 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 ignitable concentrations of gases or vapors are normally prevented by positive mechanical ventilation, and which 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 ignitable concentrations of gases or vapors might occasionally 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. [**70:**500.5(B)(2)]

3.4.3 Class II, Division 1. A Class II, Division 1 location is a location: (1) In which combustible dust is in the air under normal operating conditions in quantities sufficient to produce explosive or ignitable mixtures, or (2) Where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitable mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, through 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. [**70:**500.5(C)(1)]

3.4.4 Class II, Division 2. A Class II, Division 2 location is a location: (1) Where combustible dust is not normally in the air in quantities sufficient to produce explosive or ignitable 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 (2) 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 ignitable by abnormal operation or failure of electrical equipment. [**70:**500.5(C)(2)]

3.4.5 Class I, Zone 0. A Class I, Zone 0 location is a location in which: (1) Ignitable concentrations of flammable gases or vapors are present continuously, or (2) Ignitable concentrations of flammable gases or vapors are present for long periods of time. [**70:**505.5(B)(1)]

3.4.6 Class I, Zone 1. A Class I, Zone 1 location is a location: (1) In which ignitable concentrations of flammable gases or vapors are likely to exist under normal operating conditions; or (2) In which ignitable 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 ignitable 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 ignitable 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. [**70:**505.5(B)(2)]

3.4.7 Class I, Zone 2. A Class I, Zone 2 location is a location: (1) In which ignitable 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 of closed systems from which they can escape, only as a result of accidental rupture or breakdown of the containers or system, or as a result of the abnormal operation of the equipment with which the liquids or gases are handled, processed, or used; or (3) In which ignitable concentrations of flammable gases or vapors normally are prevented by positive mechanical ventilation but which may become hazardous as a result of failure or abnormal operation of the ventilation equipment; or (4) That is adjacent to a Class I, Zone 1 location, from which ignitable 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. [**70:**505.5(B)(3)]

Chapter 4 General Requirements for Pressurized Enclosures

4.1 Applicability.

This chapter contains the general requirements for pressurized enclosures containing electrical equipment.

4.2 Enclosure.

4.2.1 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.

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

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

4.2.2* Normal discharge of the protective gas from a designated enclosure outlet shall be to an unclassified location, unless the discharge meets the conditions specified in 4.2.2.1 or 4.2.2.2.

4.2.2.1 The discharge shall be permitted to be to a Division 2 or Zone 2 location if the equipment does not create ignition-capable particles during normal operation.

4.2.2.2 The discharge shall be permitted to be to a Division 1 or Division 2 location or to a Zone 1 or Zone 2 location if the outlet is designed to prevent the discharge of ignition-capable particles during normal operation.

4.2.3* In Division 1 and Zone 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 450 mm (18 in.) from, the pressurized enclosure.

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

4.3 Pressurizing System.

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

4.3.2 Where the protective gas supply is used to supply other than Type X pressurized equipment, an alarm shall be provided to indicate failure of the protective gas supply to maintain the required pressure.

4.3.3 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.

4.3.4 Installation, operating, and maintenance instructions shall be provided for the pressurizing system.

4.4 Protective Gas System.

4.4.1* 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.

4.4.1.1 All protective gas supplies shall be designed to minimize chances for contamination.

4.4.1.2* Air of normal instrument quality, nitrogen, or other nonflammable gas shall be permitted as a protective gas.

4.4.2 Piping for the protective gas shall be protected against mechanical damage.

4.4.3 Where compressed air is used, the compressor intake shall be located in an unclassified location.

4.4.4* Where 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.

4.4.5 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.

4.4.6 Where "double pressurization" is used (e.g., a Division 1 enclosed area pressurized to a Division 2 classification that contains ignition-capable equipment also protected by pressurization), the protective gas supplies shall be independent.

4.5* Determination of Temperature Marking.

4.5.1* The temperature class (T Code) marked on the enclosure shall represent (under normal conditions) the highest of the following:

(1) The hottest enclosure external surface temperature

(2)* The hottest internal component surface temperature

(3) The temperature of the protective gas leaving the enclosure

Exception: The surface temperature of the internal components shall be permitted to exceed the marked temperature class (T Code) in accordance with any one of the following conditions:

(1) The enclosure is marked as required in 4.11.4 with the time period sufficient to permit the component to cool to the marked temperature class (T Code).

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

(3) The component is separately housed so that the surface temperature of the housing is below the marked temperature class (T Code), and the housing complies with (a) and (b).

(a) The housing shall be pressurized or sealed.

(b) Where the housing can be readily opened, then the housing shall be marked as required in 4.11.4.

4.5.2 It shall be permitted to mark the actual temperature in degrees Celsius in place of the temperature class (T Code).

4.5.3 Temperature class (T Codes) shall be as shown in Table 4.5.3 for equipment marked

for Class I, Divisions 1 or 2, or Class II, Divisions 1 or 2.

Table 4.5.3 Temperature Class (T Codes) for Class I, Divisions 1 or 2, or for Class II, Divisions 1 or 2 Locations

Maximum Temperature		Temperature Class (T Code)
°C	°F	
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

[**70:** Table 500.8(B)]

4.5.4 Temperature class (T Codes) shall be as shown in Table 4.5.4 for equipment marked for Class I, Zones 1 or 2.

Table 4.5.4 Temperature Class (T Codes) for Class I, Zone 1 and 2 Applications

Temperature Class (T Code)	Maximum Surface Temperature (°C)
T1	≤450
T2	≤300
T3	≤200
T4	≤135
T5	≤100
T6	≤85

[**70:**505.9(D)(1)]

4.6* Ventilated Equipment.

The flow of protective gas shall keep the equipment adequately cooled.

4.7* Power Equipment.

Enclosures containing power equipment shall be of substantially noncombustible

construction and shall be reasonably tight. Gaskets shall be permitted.

4.8* Type Z Pressurizing.

4.8.1 Detection shall be provided to indicate failure to maintain positive pressure within a protected enclosure.

4.8.1.1* Failure to maintain the positive pressure within a protected enclosure shall be communicated by an alarm or an indicator.

4.8.1.2 It shall not be required to de-energize the protected equipment upon detection of the failure to maintain positive pressure within a protected enclosure.

4.8.2 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 where the isolation is done with a valve(s) that complies with the following:

(1) The valve is immediately adjacent to the protected enclosure.

(2) The valve(s) is intended for use only during servicing of the protected enclosure.

(3) The valve(s) is marked as required in 4.11.5.

4.8.3 Where an alarm is used:

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

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

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

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

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

(6) The alarm shall be permitted to satisfy the requirement in 4.3.2 to provide an alarm on the protected gas supply.

4.8.4 Where an indicator is used:

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

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

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

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

(5) The protective gas supply shall have an alarm that is located at a constantly attended location to fulfill the requirement in 4.3.2.

4.9* Type Y Pressurizing.

4.9.1 All of the requirements in Section 4.8 shall apply.

4.9.2 Equipment within a protected enclosure shall be approved for Division 2 or Zone 2 locations.

4.9.3 Ventilated equipment that would develop temperatures higher than the marked temperature class (T Code) upon failure of the ventilation shall be automatically de-energized when the flow of protective gas stops.

4.10* Type X Pressurizing.

4.10.1* A cutoff switch shall be incorporated to de-energize power automatically from all circuits within the protected enclosure not approved for Division 1 or Zone 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.

4.10.1.1 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.

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

4.10.1.3 No valves shall be permitted between the cutoff switch and the protected enclosure.

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

4.10.2* Equipment, such as motors or transformers, that may be overloaded shall be provided with 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.

4.10.3 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 devices to detect any increase in 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.

4.11 Markings.

4.11.1 A permanent marking shall be on the protected enclosure in a prominent location so that it is visible before the protected enclosure can be opened.

4.11.2 The marking required by 4.11.1 shall include the information specified as follows:

(1) The following statement, or an equivalent statement:
W A R N I N G — PRESSURIZED ENCLOSURE — This enclosure must not be opened unless the area atmosphere is known to be below the ignitable concentration of combustible materials or unless all devices within have been de-energized.

(2) The external area classification for the protected enclosure

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

(4) The temperature class (T Code) or the operating temperature in degrees Celsius as determined in Section 4.5

Exception No. 1: The temperature class (T Code) or operating temperature marking shall not be required where the highest temperature does not exceed 100°C.

Exception No. 2: For equipment marked for use in a specific gas or dust atmosphere, the temperature class (T Code) or operating temperature marking shall not be required where the highest 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 higher temperature shall not be permitted to exceed the lower of either 80 percent of the layer/cloud ignition temperature, or 165°C.

4.11.3 The additional markings specified in Sections 5.3 and 6.3 may also be included in the permanent marking described in 4.11.2.

4.11.4 Where 4.5.1, Exception (1) or (2) is used, the following or equivalent statement shall appear as permanent marking:

W A R N I N G — HIGH TEMPERATURE INTERNAL PARTS — This enclosure must not be opened unless the area atmosphere is known to be below the ignitable concentration of combustible materials or unless all equipment within has been de-energized for _____ minutes.

4.11.5 Where 4.8.2, Exception is used, the following or equivalent statement shall appear in a permanent marking:

W A R N I N G — PROTECTIVE GAS SUPPLY VALVE — This valve must be kept open unless the area atmosphere is known to be below the ignitable concentration of combustible materials, or unless all equipment within the protected enclosure is de-energized.

Chapter 5 Pressurized Enclosures for Class I

5.1 Applicability.

This chapter applies to enclosures containing electrical equipment that are located in Class I

locations, and in conjunction with the requirements of Chapter 8, to enclosures located in unclassified locations that contain an internal source of flammable gas or vapor.

5.2 General Requirements.

5.2.1 The requirements of Chapter 4 shall be met.

5.2.2 Where the enclosure has been opened or if the protective gas supply has failed to maintain the required positive pressure, the enclosure shall be purged.

5.2.3 Airflow through the enclosure during purging shall be designed to avoid air pockets.

5.2.4 Once the enclosure has been purged of flammable concentrations, only positive pressure shall be required to be maintained within the enclosure.

5.2.5 A specific flow rate shall not be required for the positive pressure required by 5.2.4.

5.2.6* 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:

(1) 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.

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

(3)* The equipment in the internal compartment or adjacent enclosure shall be protected by other means (e.g., explosionproof, intrinsic safety, hermetic sealing, nonincendive, encapsulation, and so forth).

5.2.6.1 Components with a free internal volume less than 20 cm^3 (1.22 $in.^3$) shall not be required to be considered as internal compartments requiring protection, provided the total volume of all such components is not a significant portion of the protected enclosure volume.

5.2.6.2 It shall not be required to include components considered to be environmentally sealed such as transistors, microcircuits, capacitors, and so forth, in the percent of volume analysis.

5.3 Markings.

A permanent marking containing the start-up conditions shall be on the protected enclosure in a prominent location.

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

5.3.1 The marking shall contain the following, or an equivalent, statement:

WARNING — Power must not be restored after enclosure has been opened until enclosure has been purged for _____ minutes at a

flow rate of _____.

5.3.2 The minimum pressure shall be permitted to be used in place of the flow rate where the pressure is a positive indication of the correct flow.

5.4* Additional Requirements for Type Y or Type Z Pressurizing.

The protected equipment shall be energized only under the conditions specified in 5.4.1 or 5.4.2.

5.4.1 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. of water).

5.4.2 Protected equipment shall be permitted to be energized immediately where a pressure of at least 25 Pa (0.1 in. of water) exists, and the atmosphere within the enclosure is known to be below the ignitable concentration of the combustible material.

5.5 Additional Requirements for Type X Pressurizing.

5.5.1 A means 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. of water).

5.5.2* 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 the location when the enclosure is opened.

5.5.2.1 The interlock, even though located within the enclosure, shall be approved for external area classification.

5.5.2.2 Protected enclosures that contain hot parts requiring a cool-down period shall be designed to require the use of a key or tool for opening.

Chapter 6 Pressurized Enclosures for Class II

6.1 Applicability.

This chapter applies to enclosures containing electrical equipment that are located in Class II locations.

6.2 General Requirements.

6.2.1 The requirements in Chapter 4 for each type of pressurizing shall be complied with, except as modified in this chapter.

6.2.2* Where combustible dust has accumulated within the protected enclosure, the protected enclosure shall be opened and the dust removed before pressurizing.

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

6.2.4* The protected enclosure shall be constantly maintained at a pressure above the surrounding atmosphere, depending on the specific particle density during operation of the protected equipment, and shall not be less than that specified in Table 6.2.4.

Table 6.2.4 Minimum Enclosure Pressure Versus Dust Density

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

6.2.5* Where the ignition temperature of the dust is not known, maximum surface temperatures shall not exceed those stated in Table 6.2.5.

Table 6.2.5 Class II Temperatures

Class II Group	Equipment Not Subject to Overloading		Equipment (Such as Motors or Power Transformers) that May Be Overloaded			
			Normal Operation		Abnormal Operation	
	°C	°F	°C	°F	°C	°F
E	200	392	200	392	200	392
F	200	392	150	302	200	392
G	165	329	120	248	165	329

[**70:** Table 500.8(C)(2)]

6.3 Markings.

Start-up conditions shall be permanently marked in a prominent location on the protected enclosure.

6.4 Marking Information.

The marking required by Section 6.3 shall contain the following, or an equivalent, statement:

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

6.5* Additional Requirements for Type X Pressurizing.

An alarm, provided at a constantly attended location, shall be permitted to be used in place of the cutoff switch specified in 4.10.1, if the enclosure is tightly sealed to prevent the entrance of dust.

6.6 Additional Requirements for Ventilated Equipment.

The discharge of protective gas shall not create a combustible atmosphere by disturbing layers of dusts.

Chapter 7 Pressurized Control Rooms

7.1* Applicability.

This chapter applies to buildings or portions of buildings commonly referred to as control rooms.

7.2 Protective Gas.

7.2.1 The protective gas shall be air.

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

7.2.3* 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.

7.2.4 Any ducts shall be constructed of noncombustible materials.

7.2.5 The fan suction line shall be free of leaks and shall be given protection from mechanical damage and corrosion to prevent ignitable concentrations of flammable gases, vapors, or dusts from being drawn into the control room.

7.3 Considerations Relating to Positive Pressure Ventilation.

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

(1) The number of people to be housed

(2) The type of equipment to be housed

(3) 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)

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

7.4 Requirements for Positive Pressure Air Systems.

7.4.1* The positive pressure air system shall meet the requirements of the following:

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

(2) Provide a minimum outward velocity of 0.305 m/sec (60 ft/min) through all openings capable of being opened. The velocity shall be measured with all these openings simultaneously open, and a drop in pressure below the 25 Pa (0.1 in. of water) specified in 7.4.1(1) shall be permitted while meeting this requirement.

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 remain closed where all of the following conditions are met:

(1) The control room is under management control.

(2) These doors are marked to restrict use.

(3) These doors are not used for egress.

(4) These doors 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 remain closed.

7.4.2 The positive pressure air system shall be permitted to include heating, ventilation, and air conditioning equipment, as well as any auxiliary equipment necessary to comply with 7.4.1.

7.4.3 Where there is not a separate air supply source to an air-consuming device (such as a compressor or laboratory hood) in the control room, air shall be supplied to accommodate its needs as well as the needs of the positive pressure air system.

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

7.4.5 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 the external area classification, 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.

7.4.6 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.

7.4.7* 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.

7.4.8* Provisions shall be made to energize the control room safely after interruption of the positive pressure air system. Such provisions shall include:

(1) Checking the atmosphere in the control room with a flammable vapor detector *(see ANSI/ISA 12.13.01-2000)* to determine that the atmosphere contains less than the ignitable concentration of gases or vapors.

(2) Removing accumulations of combustible dust.

7.4.9 The switch, electrical disconnect, and motor for the air system fan shall be approved for the external area classification.

7.4.10 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 8 Pressurized Enclosures Having an Internal Source of Flammable Gas or Vapor

8.1 Applicability.

This chapter applies to instruments such as gas chromatographs, gas analyzers, and other enclosures that contain an internal source of flammable gas or vapor.

8.2* General Requirements.

8.2.1 The requirements of Chapters 4, 5, and 6 shall apply, except as modified in this chapter.

8.2.2* For the purpose of this chapter, every protected enclosure shall be considered to have a "normal" per 8.2.2.1 and an "abnormal" per 8.2.2.2 condition, and the electrical equipment in the enclosure is assumed to be operating correctly in both conditions.

8.2.2.1 "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 is one of the following:

(1) 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.

(2) 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.

8.2.2.2 "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 one of the following:

(1) Limited — The release of flammable gas or vapor 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.

(2) Unlimited — The release of flammable gas or vapor is of such magnitude that it cannot be diluted by the pressurizing system to a concentration less than 25 percent

of the lower flammable limit.

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

8.2.3* Pressurizing requirements shall be established according to Table 8.2.3.

Table 8.2.3 Pressurizing Requirements for Enclosures Subje

(1) External Area Classification	(2) Classified or Unclassified Location that Internal Equipment is Suitable for	(3) Pressurizing Requirements for Under Abnormal Con	
		No Release Under Normal Conditions	Li
Class I, Division 1 (Class I, Zone 1)	Class I, Division 1 (Class I, Zone 1)	None	
	Class I, Division 2 (Class I, Zone 2)	Y	
	Unclassified	X	
Class I, Division 2 (Class I, Zone 2)	Class I, Division 1 (Class I, Zone 1)	None	
	Class I, Division 2 (Class I, Zone 2)	None	
	Unclassified	Z	
Class II	Class I, Division 1 (Class I, Zone 1)	None	
	Class I, Division 2 (Class I, Zone 2)	None	
	Unclassified	Z	
None	Class I, Division 1 (Class I, Zone 1)	None	
	Class I, Division 2 (Class I, Zone 2)	None	
	Unclassified	Z	

Note: To determine the pressurizing requirements according to Table 8.2.3:
(1) Find the external area classification in column (1).
(2) Find the internal equipment type in column (2).
(3) Determine the pressurizing requirement for limited release under abnormal conditions by using the approp
(4) Determine any additional requirements from column (4) if the abnormal condition is unlimited release.
[1] See A.8.2.3.
[2] See 8.2.2.3.

8.2.4 Protected enclosures containing an open flame shall comply with 8.2.4.1 and 8.2.4.2.

8.2.4.1 Protected enclosures containing an open flame shall be considered to have equipment suitable for unclassified locations for the purposes of determining the pressurizing requirement according to Table 8.2.3.

8.2.4.2 Open flames within a protected enclosure shall be automatically extinguished upon

failure of the pressurization system, regardless of the type of pressurizing.

8.3 Specific Requirements.

8.3.1 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 one of the following:

(1) 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

(2) 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.

8.3.2 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. of water).

8.3.3 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.

8.3.4 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.

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

8.3.6 The flow rate of protective gas shall be sufficient to maintain the requirements of 8.3.1 and to ensure adequate mixing, so that the release of a flammable gas or vapor is limited.

8.3.7 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.

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

Chapter 9 Pressurized Analyzer Rooms Containing a Source of Flammable Gas, Vapor, or Liquid

9.1 Applicability.

This chapter applies to analyzer rooms and buildings containing electrical equipment having

process streams of flammable liquid, vapor, or compressed flammable gas piped into the equipment.

9.2 General.

9.2.1 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:

(1) 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.

(2) 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.

(3) Unlimited — There is a release of flammable gas or vapor, and 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.

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

9.2.3 Where 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.

9.2.4 The requirements of Chapter 7 for control rooms shall apply except as modified in this chapter.

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

9.2.6 Flow of air through the room shall ensure adequate air distribution.

9.2.7* Flammable vapors shall be removed as close to their source as is practical.

9.2.8* The following shall apply where personnel can enter an analyzer room that is purged with inert gases:

(1) Administrative controls combined with training and safe entry procedures shall be established.

(2) Warning signs advising of the hazard of inert gas shall be posted.

(3)* Inert gas shall not be used for purging an entire analyzer room where personnel shall be permitted to enter.

9.3 Specific Requirements.

9.3.1 Flow-Limiting Devices.

9.3.1.1 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.

9.3.1.2 Orifices or other flow-limiting devices shall be located outside and close to the wall of the building or room.

9.3.2* Where 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.

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

9.3.4 Process piping within the analyzer room shall be minimized.

9.3.5 Means for emergency isolation of the process from the analyzers shall be provided outside the analyzer building.

9.3.6 False ceilings and floors shall not be used in analyzer rooms.

9.3.7* Ventilation fans shall be constructed to minimize the possibility of sparking.

9.3.8 In the event of pressurizing failure the following shall be required:

(1) An audible and visual alarm shall be activated at a constantly attended location.

(2)* Electrical power to ignition-capable equipment within the analyzer room shall be automatically shut down.

(3) Open flames shall be automatically extinguished.

(4) Power shall not be restored until the analyzer room is below ignitable concentration of the combustible material.

Exception: Automatic shutdown shall not be required under any of the following conditions:

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

(2) 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.

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

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

9.3.9 Where gas or vapor mixtures within the flammable range are piped to the analyzer room, precautions shall be taken to prevent propagation of an explosion back to the process equipment.

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.1.1.2 Electrical equipment should be located in an area having as low a degree of hazard classification as is practical. 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.2.1 Editions of the referenced documents are the editions used in preparation of this document. It is important that the authority having jurisdiction (AHJ) be aware that later editions might exist. Compliance with later editions should be considered when the requirements of the most current edition of the referenced documents have changed.

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

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

A.3.3.1 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.3.3.5 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.

A.3.3.9 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.3.3.15 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 kilograms per cubic meter (pounds per cubic foot). 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 2083 kg/m^3 (130 lb/ft^3) while the bulk density of pulverized sulfur dust is about 801 kg/m^3 (50 lb/ft^3).

A.4.2.2 During brief periods of purging, the area around the vent may contain a concentration of flammables that requires caution.

A.4.2.3 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.4.3.1 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.4.4.1 Air filtration may be desirable.

A.4.4.1.2 Ordinary plant compressed air is usually not suitable for purge or pressurizing systems, due to contaminants that may cause equipment to malfunction.

A.4.4.4 The compressor suction line should not pass through any area having a hazardous atmosphere, unless it is not practical to do otherwise.

A.4.5 The T Code is based on the ambient temperature surrounding the pressurized equipment not exceeding 40°C (104°F). The maximum ambient temperature rating of the equipment must not be exceeded.

A.4.5.1 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.4.5.1(2) The ignition temperature of gases and vapors that is listed in reference documents such as NFPA 497 is determined under conditions where a significant volume of

gas is at the same temperature. The condition specified in 4.5.1(2), Exception (2) indicates that 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 (428°F to 572°F) to ignite diethyl ether whose ignition temperature is 160°C (320°F). Similar values have been measured in ignition tests of carbon disulfide whose ignition temperature is 100°C (212°F).

A.4.6 Airflow required for cooling may be more than that required for purging.

A.4.7 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. Nonmetallic enclosure flammability ratings of 94 V-0 or 94 5V are considered as substantially noncombustible. *(See ANSI/UL94-1996 for description of flammability ratings.)*

A.4.8 Type Z pressurizing reduces the classification within an enclosure from Division 2 to unclassified. With Type Z pressurizing, a hazard is created only if the pressurizing system fails simultaneously with the area outside of the enclosure becoming ignitable due to the release of normally contained flammable liquids or gases, or combustible dust. For this reason, it is not considered essential to remove power from the equipment upon failure of the pressurizing system.

Alarm and indicator configurations for Types Y and Z pressurizing are shown in Figure A.4.8.

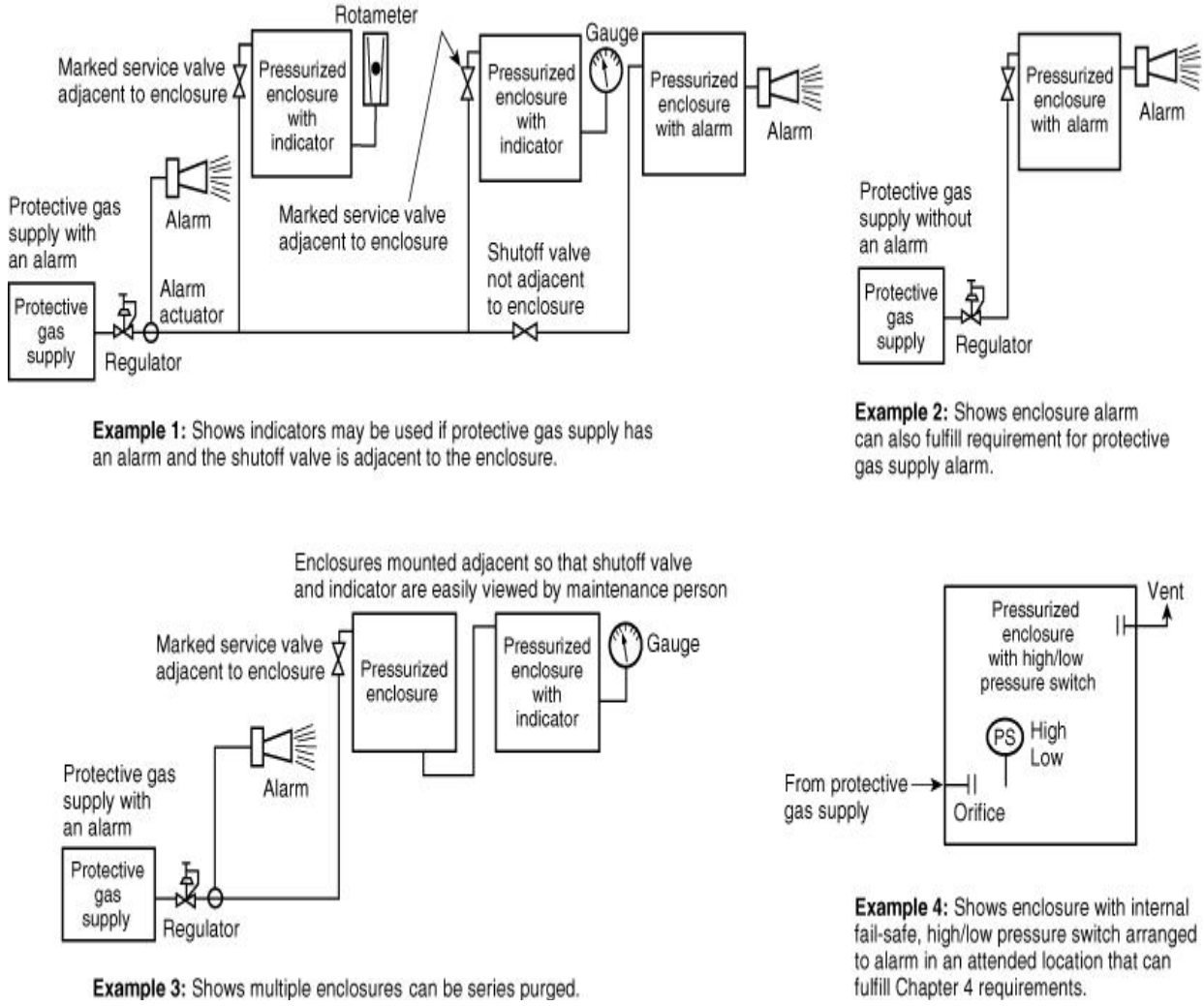

FIGURE A.4.8 Typical Alarm and Indicator Configurations for Types Y and Z Pressurizing. Purge outlet devices that could be provided are not shown for clarity.

A.4.8.1.1 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.4.9 Type Y pressurizing 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 pressurizing 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 pressurizing system.

A.4.10 Type X pressurizing reduces the classification within an enclosure from Division 1 to unclassified. 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 pressurizing 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.4.10.1 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 pressurizing should be used if it is necessary to continue operating the process to prevent a more hazardous condition.

A.4.10.2 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.5.2.6 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 systems.

A.5.2.6(3) Cathode ray tubes (CRTs) are hermetically sealed components.

A.5.4 Any time the enclosure has been opened or the pressurizing system has failed, the possibility exists that an ignitable mixture may have accumulated in the enclosure. For enclosures that are effectively subdivided by internal parts, a greater purge volume may be necessary.

A.5.5.2 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.6.2.2 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. Protected enclosures should normally be kept closed whether the equipment is in operation or not.

A.6.2.4 The density of 2083 kg/m^3 (130 lb/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 6.2.4 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 ($\frac{1}{64}$ 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.6.2.5 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.6.5 A hazard is created within an enclosure only after the pressure has failed and enough

dust to be ignitable 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 pressurizing. It is necessary only to provide an adequate warning so that operations will not continue indefinitely without pressurizing. 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.7.1 Control rooms commonly house one or more of the following facilities:

(1) Process control instruments and panels

(2) Data processing equipment

(3) Communications equipment

(4) Lighting, power equipment, and related equipment

(5) Emergency power equipment

(6) Lunch, restroom, and locker facilities

(7) Offices and maintenance facilities

(8) Heating and ventilating equipment

A.7.2.2 Air filtration may be desirable.

A.7.2.3 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.7.3.2 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, and so forth, may be required.

A.7.4.1 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.7.4.7 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.7.4.8 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.8.2 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 pressurizing system, these consequences may be reduced, 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 ignitable. This increase in concentration is likely to be slowed only slightly by breathing and diffusion.

A.8.2.2 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 8.2.2.

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.8.2.3 Electrical equipment permitted in 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 may provide an ignitable atmosphere. The ignition source is always present, by virtue of the electrical equipment. Purging is, therefore, required, and Type Z pressurizing 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 pressurizing is required. In this case, purging with air is satisfactory. Type X pressurizing requires that the electrical power to the protected enclosure be disconnected upon failure of the pressurizing system. Disconnection is required because, under the conditions described, an ignitable atmosphere may 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 pressurizing, 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 protective gas for such enclosures when the electrical equipment is only suitable for unclassified locations. Inert gas must be used so that an ignitable atmosphere is prevented from developing (unless, of course, the pressurizing 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 ignitable 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 pressurizing system. For Class I, Division 2 or Class I, Zone 2 locations, the pressurizing 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 purging serves only to dilute any flammable gas released within the enclosure.

A.9.2.5 Flammable gases, vapors, or liquids for analysis should not be piped into control rooms because of the danger of ignition.

A.9.2.7 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.9.2.8 Leakage of inert gases used for purging or pressurizing of enclosures in an analyzer room can deplete the room's oxygen.

A.9.2.8(3) See NFPA 69.

A.9.3.2 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 1.5 m (5 ft) away from building openings and at least 3.7 m (12 ft) above

grade level. The vent design and location should further consider possible trapping of vapors by eaves or other obstructions. *(See NFPA 30.)*

A.9.3.7 The fan motor and associated control equipment should be located external to the ductwork or should be suitable for the location.

A.9.3.8(2) 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.

Annex B Informational References

B.1 Referenced Publications.

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

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

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

NFPA 69, *Standard on Explosion Prevention Systems*, 2002 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 Other Publications.

B.1.2.1 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 Informational References.

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

B.2.1 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.2.2 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," Instrument Society of America (Instrumentation, Systems and Automation Society).

ISA RP12.4-1996, *Pressurized Enclosures,* Instrumentation, Systems and Automation Society, Research Triangle Park, NC 27709.

Magison, Ernest. 1998. *Electrical Instruments in Hazardous Locations*, 4th Edition, Instrumentation, Systems and Automation Society, Research Triangle Park, NC.

McMillan, Alan. 1998. *Electrical Installations in Hazardous Areas*, Butterworth-Heinemann 225 Wildwood Ave, Woburn, MA 01801-2041.

Perry, R. H., and D. Green. 1984. *Chemical Engineer's Handbook*, 7th Edition. McGraw-Hill, New York, NY.

Schram, Peter J. and Earley, Mark W. 1997, *Electrical Installations in Hazardous Locations*, 2nd Edition, NFPA, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

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

B.3 References for Extracts.

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

NFPA 70, *National Electrical Code®*, 2002 edition.

Formal Interpretation

Formal Interpretation

NFPA 496

Purged and Pressurized Enclosures for Electrical Equipment

2003 Edition

Reference: 7.4.1
F.I.

Paragraph 7.4.1 requires a positive pressure purge system to:

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

(2) Provide a minimum outward velocity of 0.305 m/sec (60 ft/min) through all openings capable of being opened. The velocity shall be measured with all these openings simultaneously open and a drop in pressure below the 25 Pa (0.1 in. of water) specified in 7.4.1(1) shall be permitted while meeting this requirement.

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 remain closed where all of the following conditions are met:

(1) The control room is under management control.

(2) These doors are marked to restrict use.

(3) These doors are not used for egress.

(4) These doors are secured in the closed position.

Question: Is it the intent of 7.4.1 to require that the purge system function as "(1)" and "(2)" simultaneously?

Answer: No.

Issue Edition: 1974
Reference: 3-3.1
Date: December 1977