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NFPA 496 Purged and Pressurized Enclosures for Electrical Equipment 1986

National Fire Protection Association Batterymarch Park, Quincy, MA 02269

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Policy Adopted by NFPA Board of Directors on December 3, 1982

The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

Statement on NFPA Procedures

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NFPA 496

Standard for

Purged and Pressurized Enclosures for Electrical Equipment

1986 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 19-22, 1986, in Atlanta, Georgia. It was issued by the Standards Council on June 11, 1986, with an effective date of July 1, 1986, and supersedes all previous editions.

The 1986 edition of this standard has been approved by the American National Standards Institute.

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.

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.

In 1974, the Technical Committee on Electrical Equipment in Chemical Atmospheres presented a complete revision of the entire standard. 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 have been 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 interpretation of the existing test. The 1986 edition of NFPA 496 is the result of this effort.

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 publishing 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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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

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.

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NFPA 496

Standard for

Purged and Pressurized Enclosures for Electrical Equipment

1986 Edition

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

Information on referenced publications can be found in Chapter 10 and Appendix C.

Chapter 1 General

1-1 Scope.

1-1.1* This standard shall apply to purged and pressurized enclosures:

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

(b) for electrical equipment containing sources of flammable vapors or gases and located in either classified or nonclassified areas.

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 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 enclosures, small electrical enclosures, control rooms, motors, motor controllers, electrical switchgear, and similar equipment:

(a) located in areas where flammable gases or vapors may be present in air in concentrations sufficient for the locations to be classified as hazardous, and

(b) that do not have internal sources of flammable vapors, gases, or liquids.

1-3.2 Chapters 5, 6, and 7 of this standard shall apply to instrument enclosures, small electrical enclosures, control rooms, motors, motor controllers, electrical switchgear, and similar equipment located in areas where combustible dusts may be present in quantities sufficient for the locations to be classified as hazardous.

1-3.3 Chapters 8 and 9 of this standard shall apply to instument enclosures, small electrical enclosures, analyzer rooms, and buildings and similar enclosures containing a source of flammable vapor or gas, such as a gas chromatograph or a gas analyzer.

1-4* Degree of Hazard. There are two degrees of hazard for both Class I and Class II locations:

(a) Division 1, or normally hazardous;

(b) Division 2, or hazardous only under abnormal conditions.

1-5* Definitions. For the purpose of this standard, the following terms shall have the meanings given below.

Alarm. A piece of equipment that gives a visual or audible signal whenever the purge system fails.

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

Class I, Division 1. A location (1) in which ignitible concentrations of flammable gases or vapors 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 Article 500-4(b) 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 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 ignitible 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. Electrical conduits and their associated enclosures separated from process fluids by a single seal or barrier shall be classed as a Division 2 location if the outside of the conduit and enclosures is a nonhazardous (classified) location. [*See Article 500-4(b) of NFPA 70, National Electrical Code.*]

Class II, Division 1. A location (1) in which combustible dust is present 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. [*See Article 500-5(a) of NFPA 70, National Electrical Code.*]

Class II, Division 2. A location (1) in which combustible dust will not normally be in suspension 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; or (2) in which dust may be in suspension in the air as a result of infrequent malfunctioning of handling or processing equipment and dust accumulations resulting therefrom may be ignitible by abnormal operation or failure of electrical equipment or other apparatus. [*See Article 500-5(b) of NFPA 70, National Electrical Code.*]

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

Pressurization. The process of supplying an enclosure with clean air or an inert gas with or without continuous flow at sufficient pressure to prevent the entrance of combustible dusts.

Purging. The process of supplying an enclosure with clean air or an inert gas at sufficient flow and positive pressure to reduce to an acceptably safe level the concentration of any flammable gas or vapor initially present and to maintain this safe level by positive pressure with or without continuous flow.

Type X Purging. Reduces the classification within an enclosure from Division 1 to nonhazardous.

Type Y Purging. Reduces the classification within an enclosure from Division 1 to Division 2.

Type Z Purging. Reduces the classification within an enclosure from Division 2 to nonhazardous.

Chapter 2 Purged Instrument and Other Small Enclosures in Class I Locations

2-1 Scope. Chapter 2 shall apply to enclosures with gross internal volume not exceeding 0.3 cu m (10 cu ft).

2-2 General Requirements.

2-2.1 The enclosure 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 purge supply.

2-2.1.2 Excess pressure relieving devices, when required to protect in case of control failure, shall be designed to prevent escape of sparks or burning material to a hazardous area when they function.

2-2.2 Any window in a purged enclosure shall be tempered glass at least 6.3 mm (¼ in.) thick, shatterproof glass, or other shatterproof material.

2-2.3 If hazardous gases or vapors have accumulated within the enclosure, either because the enclosure has been opened or because the purge system has failed, the enclosure shall be purged.

2-2.3.1 Once the enclosure has been purged of hazardous concentrations, positive pressure shall be maintained within the enclosure. No specific flow rate need be maintained.

2-2.4* 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 compartment shall be vented to the main enclosure by nonrestricted top and bottom vents, common to the main enclosure. Each vent shall provide not less than 6.5 sq cm (1.0 sq in.) of vent area for each 6560 cu cm (400 cu in.), with a minimum vent size of 0.64 cm (¼ in.) diameter.

(b) The compartment shall be separately purged.

(c) The equipment in the compartment shall be protected by other means.

2-2.5 To warn of the possible entrance of hazardous concentrations of flammable gas or vapor in the event of opening of the enclosure or failure of the purge system, suitable devices, such as indicators, alarms, or interlocks, shall be provided as specified for the type of purging used.

2-2.6 The purge supply shall be essentially free of dust or liquid that could plug small openings. It shall contain no more than trace amounts of flammable gas or vapor.

2-2.6.1* Air of normal instrument quality shall be considered acceptable for purging, as shall other suitable supplies, such as inert gas.

2-2.6.2 A visual or audible alarm shall be provided to indicate failure of the purge gas supply system. Any part of the purge gas supply system that can be isolated from the rest of the system shall be equipped with an alarm.

2-2.6.3 If compressed air is used, the compressor intake shall be located in a nonhazardous area.

2-2.6.4* If the compressor suction line passes through a hazardous area, it shall be constructed of noncombustible material, designed to prevent leakage of hazardous gases or vapors into the system, and protected against mechanical damage and corrosion.

2-2.7 When double purging is used (e.g., a room purged to a Division 2 classification and containing a device with open contacts protected by purging), the two purge systems shall be independent of each other or automatic shutdown of the device upon failure of one of the systems shall be provided.

2-3* Specific Requirements for Type Z Purging.

2-3.1* Equipment shall not be energized until at least four enclosure volumes of purge gas have passed through the enclosure while maintaining an internal pressure of at least 25 Pa (0.1 in. water).

Exception: Equipment may 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 nonhazardous.

2-3.2* Under normal operating conditions, neither the temperature of the external surface of the enclosure nor that of the purge gas leaving the enclosure shall exceed 80 percent of the autoignition temperature (in degrees Celsius) of the flammable vapor or gas involved as determined by the *Method of Test for Autogenous Ignition Temperatures of Petroleum Products*, ASTM D 2155, or the *Standard Method for Determining the Autoignition Temperature of Liquid Chemicals*, ASTM E 659.

Exception: Temperature limits may be exceeded if it can be shown by test that excessively hot components will not ignite the vapor or gas involved.

2-3.3* Failure of an individual enclosure purge shall be detected by an alarm or an indicator. Safety interlocks need not be provided.

2-3.3.1 If an alarm is used:

(a) The alarm shall be visual or audible and shall be located so that it is readily seen or heard.

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

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

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

(e) Any restriction between the alarm actuator and the enclosure shall have passages no smaller than the smallest passage before the actuator to avoid plugging.

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

2-3.3.2 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 purge supply.

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

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

2-3.4 A warning nameplate shall be mounted on the enclosure in a prominent location so that it is visible before the enclosure can be opened. The nameplate shall contain the following, or an equivalent, statement:

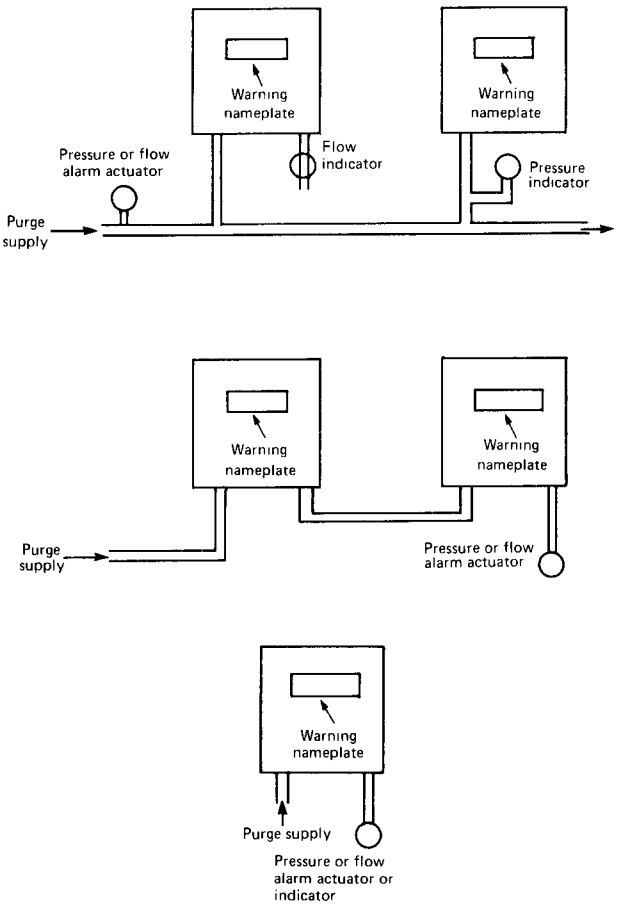


Figure 2-3.3 Acceptable Installations for Types Y and Z Purging.

"Enclosure shall not be opened unless the area is known to be nonhazardous or unless all devices within have been deenergized. Power shall not be restored after enclosure has been opened until enclosure has been purged for _____ minutes."

2-3.4.1 The manufacturer shall recommend purge conditions and flow rate necessary to pass at least four enclosure volumes of purge gas in the time period specified on the label.

2-3.5 The maximum surface temperature of any component within the enclosure shall not exceed 80 percent of the autoignition temperature (in degrees Celsius) of the flammable vapor or gas involved, as determined by the procedures referenced in 2-3.2.

Exception: Temperature limits may be exceeded if it can be shown by test that the excessively hot component will not ignite the vapor or gas involved.

2-3.5.1 If a component has not been tested and its surface temperature exceeds the limit stated in 2-3.5, then:

(a) The warning nameplate shall contain a statement that such conditions exist and that the enclosure shall be deenergized for _____ minutes (time period specified to be sufficient to permit the component to cool to a safe temperature) before the enclosure is opened unless the area is demonstrated to be nonhazardous at the time; or

(b) The component shall be separately housed so that the surface temperature of the housing is below the stated temperature limit. This housing shall be purged or sealed and shall be provided with a warning nameplate stating that its cover shall not be removed for _____ minutes after deenergizing unless the area is demonstrated to be nonhazardous at the time. (Time period specified to be sufficient to permit the component to cool to a safe temperature.)

2-4* Specific Requirements for Type Y Purging.

2-4.1 All requirements in 2-3.1 through 2-3.5 shall be complied with.

2-4.2 Equipment and devices within the enclosure shall conform to the requirements for Division 2 locations as follows:

2-4.2.1* Make-and-break or sliding contacts shall be either immersed in oil, enclosed within a chamber hermetically sealed against entrance of gases or vapors, or in circuits that, under normal conditions, do not release sufficient energy to ignite the specific hazardous atmosphere involved.

2-4.2.2* The maximum surface temperature of any component within the enclosure shall not exceed 80 percent of the autoignition temperature (in degrees Celsius) of the flammable vapor or gas involved, as determined by the procedures referenced in 2-3.2.

Exception No. 1: Temperature limits may be exceeded if it can be shown by test that the excessively hot component will not ignite the vapor or gas involved.

Exception No. 2: Temperature limits may be exceeded if the excessively hot component is enclosed in a chamber hermetically sealed against entrance of gases or vapors.

2-4.2.3 When line voltage wiring enters the enclosure, precautions shall be taken to ensure that a fault (e.g., a short circuit) between the line voltage wiring and the enclosure cannot burn through the enclosure or otherwise raise the external surface temperature of the enclosure to greater than 80 percent of the autoignition temperature (in degrees Celsius) of the gas or vapor involved. Such precautions may include overcurrent protection for such wiring in conjunction with enclosure thickness and material. (*See Appendix B.*)

2-4.3 If the requirements of 2-4.2 are met, it shall be acceptable to locate the equipment in a Division 2 location in a general purpose enclosure without purging.

2-5* Specific Requirements for Type X Purging.

2-5.1 A timing device shall be used to prevent energizing of electrical equipment within the enclosure until at least four volumes of purge gas (ten volumes for motors) have passed through the enclosure while maintaining an internal pressure of at least 25 Pa (0.1 in. water).

2-5.1.1 The timing device shall be suitable for the location in which it is installed.

2-5.1.2 The purge conditions and flow rate necessary to pass four enclosure volumes in the stated time shall be determined.

2-5.2 The enclosure shall be maintained under a positive pressure of not less than 25 Pa (0.1 in. water) when the equipment is energized.

2-5.3 A cutoff switch shall be incorporated to remove power automatically from all circuits within the enclosure not suitable for Division 1 upon failure of the purge system. (*See 2-5.6.*)

2-5.4* If the enclosure can be readily opened without the use of a key or tools, an interlock shall be provided to immediately deenergize all circuits within the enclosure that are not suitable for Division 1 locations when the enclosure is opened.

2-5.4.1 The interlock, even though located within the enclosure, shall be suitable for Class I, Division 1 locations.

2-5.5* The maximum surface temperature of any component within the enclosure shall not exceed 80 percent of the autoignition temperature (in degrees Celsius) of the flammable vapor or gas involved, as determined by the procedures referenced in 2-3.2.

Exception No. 1: Temperature limits may be exceeded if it can be shown by test that the excessively hot component will not ignite the vapor or gas involved.

Exception No. 2: Temperature limits may be exceeded if the excessively hot component is enclosed in a chamber hermetically sealed against entrance of gases or vapors.

2-5.5.1 Equipment such as motors, transformers, and other equipment that may be overloaded shall be provided with appropriate devices to detect any increase in temperature beyond design limits of the equipment and to automatically deenergize the equipment, upon detection of such increase.

2-5.5.2 When line voltage wiring enters the enclosure, precautions shall be taken to ensure that a fault (e.g., a short circuit) between the line voltage wiring and the enclosure cannot burn through the enclosure or otherwise raise the external surface temperature of the enclosure to greater than 80 percent of the autoignition temperature (in degrees Celsius) of the gas or vapor involved. Such precautions may include overcurrent protection for such wiring in conjunction with enclosure thickness and material. (*See Appendix B.*)

2-5.6 The cutoff switch provided to remove power upon failure of the purge system shall be either flow or pressure actuated. (*See Figure 2-5.6.*)

2-5.6.1 The cutoff switch shall be suitable for use in the location in which it is installed.

2-5.6.2 No valves shall be permitted between the cutoff switch and the enclosure.

2-5.6.3 The pressure or flow device shall be capable of removing power when the purge pressure or flow is inade-

quate to maintain a static pressure within the enclosure of at least 25 Pa (0.1 in. of water).

2-5.6.4 The cutoff switch shall take its signal from the enclosure and shall not be installed between the enclosure and the purge supply.

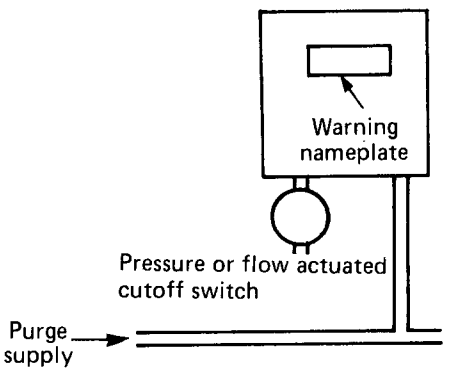


Figure 2-5.6 Typical Installation for Type X Purging.

2-5.7 A warning nameplate shall be affixed to the enclosure in a prominent location so that it is visible before the enclosure can be opened. The nameplate shall contain the following, or an equivalent, statement:

"Enclosures shall not be opened or any cover removed unless the area is known to be nonhazardous or unless all devices within have been deenergized. Power shall not be restored after the enclosure has been opened until the enclosure has been purged for ____ minutes."

2-5.7.1 The manufacturer shall recommend purge conditions and flow rate necessary to pass at least four enclosure volumes of purge gas in the time period specified on the label.

Chapter 3 Purged Control Rooms in Class I Locations

3-1 General.

3-1.1* These requirements shall apply to buildings or portions of buildings commonly referred to as control rooms.

3-1.2* If the control room is in a classified location, it shall be designed to prevent the entry of flammable vapors, flammable gases, or flammable liquids.

3-2 Considerations Relating to Positive Pressure Ventilation.

3-2.1 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 process units, including relief valves, vent stacks, and emergency relief systems, and to prevailing wind.

3-2.2* The source of air for purging control rooms shall be free of hazardous concentrations of flammable vapors and gases, contaminants, and any other foreign matter.

3-2.2.1* The source of air shall be determined from the nature of the process and the physical layout.

3-2.2.2 Any ducts shall be constructed of noncombustible materials. The fan suction line shall be free of leaks and given suitable protection from mechanical damage and corrosion to prevent hazardous concentrations of flammable gases or vapors from being drawn into the purge system.

3-2.2.3 The purge system shall be designed to provide positive pressure for all areas of the control room.

3-3 Requirements for Positive Pressure Air Systems.

3-3.1* The positive pressure air system shall be capable of:

(a) Maintaining a pressure of at least 25 Pa (0.1 in. of 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. A drop in pressure below the 25 Pa (0.1 in. of water) specified in 3-3.1(a) is permissible while meeting the requirements of 3-3.1(b).

3-3.1.1 The positive pressure air system may include heating, ventilation, and air conditioning equipment, as well as any auxiliary equipment necessary to comply with 3-3.1.

3-3.2 If there is an air consuming device 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.

3-3.3 If Type X purging is required, all power to the control room shall be interrupted upon failure of the positive pressure air system. The effect of such immediate interruption of power on processes shall be considered.

3-3.4 Immediate interruption of power upon air system failure shall not be required for Types Y and Z purging.

3-3.5* Failure of the positive pressure air system shall be detected at the discharge end of the fan and shall be signaled by a visible or audible alarm at a constantly attended location.

3-3.6 Provisions shall be made to energize the control room safely after an air system interruption. Such provisions include checking the atmosphere in the control room with a flammable vapor detector to determine that the atmosphere is safe.

3-3.7* The switch, electrical disconnect, and motor for the air system fan shall be suitable for the area as it would be classified in the absence of positive pressure ventilation.

3-3.8 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.

Chapter 4 Purged Power Equipment Enclosures in Class I Locations

4-1 Scope.

4-1.1 This chapter shall apply to equipment enclosures that exceed 0.3 cu m (10 cu ft) in volume, but that are not control rooms.

4-1.2 For the purpose of this chapter, electrical power equipment is divided into two groups:

(a) *Purged Equipment.* Equipment, such as switchgear and motor controllers, that does not require airflow for heat dissipation, but that requires pressurization to prevent entrance of flammable gases or vapors.

(b) *Ventilated Equipment.* Equipment, such as motors, that requires airflow for heat dissipation as well as to prevent entrance of flammable gases or vapors.

4-2 Requirements for Purged Equipment.

4-2.1 Enclosures shall be of substantial noncombustible construction and shall be reasonably tight. Gaskets shall be permitted.

4-2.1.1 Precautions shall be taken to protect the enclosure from excessive pressure of the purge supply.

4-2.2 The source of air shall be free of hazardous concentrations of flammable vapor or gas, contaminants, and any other foreign matter.

4-2.3 Piping for air or inert gas (if used) shall be protected against mechanical damage.

4-2.4 Regardless of the type of purging (i.e., X, Y, or Z), at least ten enclosure volumes of purge gas shall be passed through the enclosure while maintaining an internal pressure of 25 Pa (0.1 in. of water) before the enclosure is energized. This pressure shall be maintained continuously.

Exception: In the cases of Types Y and Z purging, power may be turned on immediately if a pressure of at least 25 Pa (0.1 in. water) exists and the atmosphere within the enclosure is known to be nonhazardous.

4-2.5 For Type Z purging, the temperature of the external surface of the enclosure or the egress air shall not, under normal operating conditions, exceed 80 percent of the autoignition temperature (in degrees Celsius) of the vapor or gas involved as determined by the procedures referenced in 2-3.2.

Exception: Temperature limits may be exceeded if it can be shown by test that excessively hot components will not ignite the vapor or gas involved.

4-2.6 For Type X purging, power to the equipment shall be immediately removed upon loss of pressurization, unless immediate loss of power would result in a more hazardous condition.

4-2.6.1 In cases where immediate power removal is not provided, both audible and visual signals to warn of loss of pressurization shall be provided at a constantly attended location. Such alarm devices shall be suitable for the area in which they are installed.

4-2.7 For Types Y and Z purging, loss of pressurization shall energize an audible or visual alarm at a constantly attended location. Removal of power shall not be required for failure of Types Y or Z purging.

4-2.8 A warning nameplate shall be mounted on the enclosure in a prominent location so that it is visible before the enclosure can be opened. The nameplate shall contain the following, or an equivalent, statement:

"Enclosure shall not be opened unless the area is known to be nonhazardous or unless all devices within have been deenergized. Power shall not be restored after enclosure has been opened until enclosure has been purged for _____ minutes."

4-2.8.1 The manufacturer shall recommend purge conditions and flow rate necessary to pass at least ten enclosure volumes of purge gas in the time period specified on the label.

4-2.9 The maximum surface temperature of any component within the enclosure shall not exceed 80 percent of the autoignition temperature (in degrees Celsius) of the flammable vapor or gas involved, as determined by the procedures referenced in 2-3.2.

Exception: Temperature limits may be exceeded if it can be shown by test that the excessively hot component will not ignite the vapor or gas involved.

4-2.9.1 If a component has not been tested and its surface temperature exceeds the limit stated in 4-2.9 then:

(a) The warning nameplate shall contain a statement that such conditions exist and that the enclosure shall be deenergized for _____ minutes (time period specified to be sufficient to permit the component to cool to a safe temperature) before the enclosure is opened unless the area is demonstrated to be nonhazardous at the time; or

(b) The component shall be separately housed so that the surface temperature of the housing is below the stated limit. This housing shall be purged or sealed and shall be provided with a warning nameplate stating that its cover shall not be removed for _____ minutes after deenergizing unless the area is demonstrated to be nonhazardous at the time. (Time period specified to be sufficient to permit the component to cool to a safe temperature.)

4-2.9.2 For Type X purging, equipment such as motors, transformers, and other equipment that may be overloaded shall be provided with appropriate devices to detect any increase in temperature of the equipment beyond its design limits and to deenergize the equipment automatically upon detection of such increase.

4-3 Requirements for Ventilated Equipment.

4-3.1 The enclosure shall be of substantial noncombustible construction with necessary openings limited to minimum practical size and kept as airtight as possible.

4-3.2 The enclosure shall be purged by at least ten air changes before the electrical equipment is energized. The auxiliary air equipment shall be suitable for the location.

4-3.3 The enclosure shall be constantly maintained at a pressure of at least 25 Pa (0.1 in. of water) above the surrounding atmosphere during operation of the equipment.

4-3.4* The source of air for ventilation shall be free of hazardous concentrations of flammable gases or vapors, contaminants, and any other foreign matter.

4-3.5 Air discharge from the enclosure shall be to an area classified as nonhazardous or Division 2.

4-3.6 Airflow through the enclosure shall be as uniform as possible so as to avoid air pockets.

4-3.7* The flow of air shall be sufficient to keep the equipment adequately cooled, depending on operating and design requirements.

4-3.8 For equipment in Division 2 locations, the maximum temperature of any surface exposed to the atmosphere shall not exceed 80 percent of the autoignition temperature (in degrees Celsius) of the flammable vapor or gas involved, as determined by the procedures referenced in 2-3.2.

Exception: Temperature limits may be exceeded if it can be shown by test that excessively hot components will not ignite the vapor or gas involved.

4-3.9 The electrical circuits of the equipment within the enclosure shall be interlocked with the ventilating equipment so that:

(a) The equipment cannot be energized until the purge cycle has been completed; and

(b) The equipment will be automatically deenergized when the equipment stops.

Exception: If automatic deenergizing of equipment would result in unsafe conditions, it shall be acceptable to provide both audible and visual alarms at a constantly attended location, in lieu of compliance with 4-3.9 (b).

4-4 Requirements for both Purged and Ventilated Equipment.

4-4.1 Provision shall be made to ensure that power to the enclosure is not restored following failure of the purge system until the atmosphere within the enclosure is safe.

4-4.2 The electrical disconnect, switch, and motor for the purge gas fan system shall be suitable for the area classification based on the absence of the positive pressure purge gas system.

4-4.3 The electrical power for the purge system shall be supplied either from a separate power source or from the enclosure power supply before any service disconnects to the power equipment enclosure.

Chapter 5 Pressurized Instrument and Other Small Enclosures in Class II Locations

5-1 Scope. Chapter 5 shall apply to enclosures with a gross internal volume not exceeding 0.3 cu m (10 cu ft).

5-2 General Requirements.

5-2.1 The enclosure shall be reasonably tight and shall be constructed of material that is not likely to be damaged under the conditions to which it may be subjected.

5-2.1.1 Precautions shall be taken to protect the enclosure from excessive internal pressure.

5-2.1.2 Excess pressure relieving devices, when required to protect in case of control failure, shall be designed to prevent escape of sparks or burning material to a hazardous area when they function.

5-2.2 Any window in a pressurized enclosure shall be tempered glass at least 6.3 mm (¼ in.) thick, shatterproof glass, or other shatterproof material.

5-2.3 If combustible dust has accumulated within the enclosure, the enclosure shall be opened and the dust removed before pressurization.

5-2.4 Compartments within the main enclosure or adjacent enclosures connected to the main enclosure may be collectively pressurized to prevent the entrance of dust if there is adequate communication to maintain the specified pressure at all points.

5-2.5 Suitable indicators, pressure switches, or interlocks shall be provided to safeguard the installation if the enclosure is opened or if the pressurizing system fails.

5-2.6 The pressurizing supply shall be essentially free of dust and liquids that can plug small openings. It shall contain no more than trace amounts of flammable gases or vapors.

5-2.6.1 Air of normal instrument quality shall be considered acceptable for pressurizing, as shall other suitable supplies such as inert gas. (*See A-2-2.6.1.*)

5-2.6.2 If compressed air is used, the compressor suction line shall be designed to prevent leaks that might permit hazardous gases, vapors, or dusts to be drawn into the compressor.

5-2.6.3 If compressed air is used, the compressor intake shall be located in a nonhazardous area.

5-2.6.4* If the compressor suction line passes through a

hazardous area, it shall be constructed of noncombustible material; designed to prevent leakage of hazardous gases, vapors, or dusts into the system; and shall be protected against mechanical damage and corrosion.

5-3* Specific Requirements for Pressurizing.

5-3.1 Before the equipment in the enclosure is energized, the interior of the enclosure shall be free of dust. If combustible dusts have collected within the enclosure, it shall be opened and the dust removed before pressurization.

5-3.2* The enclosure shall be maintained under a positive pressure dependent on the specific particle density of the dust as long as equipment in the enclosure is energized. The positive pressure shall comply with Table 5-3.2.

Table 5-3.2

Specific Particle Density		Pressure	
lb per cu ft	*kg per cu m*	*in. H_2O*	*Pa*
≤ 130	≤ 2083	≥ 0.1	≥ 25
> 130	> 2083	≥ 0.5	≥ 125

5-3.3* In Class II, Division 1 locations, a door switch shall be provided on the enclosure arranged to deenergize all circuits within the enclosure that are not suitable for Division 1 if the enclosure can be readily opened without the use of a key or tools. No door switch is required for Division 2 locations.

5-3.4* A warning nameplate shall be mounted on the enclosure in a prominent location so that it is visible before the enclosure can be opened. The nameplate shall contain the following, or an equivalent, statement:

"Enclosure shall not be opened unless the area is known to be nonhazardous or unless all devices within the enclosure have been deenergized. Power shall not be restored after the enclosure has been opened until combustible dusts have been removed and the enclosure repressurized."

5-3.5* Under normal operating conditions, neither the temperature of the external surface of the enclosure nor that of the gas leaving the enclosure shall exceed 80 percent of the layer ignition temperature (in degrees Celsius) of the combustible dust involved, and in all cases shall be at least 25 °C (77 °F) below such temperature.

5-3.5.1 If the ignition temperature of the dust is not known, maximum surface temperatures shall not exceed those stated in Table 502-1 of NFPA 70, *National Electrical Code*.

5-3.5.2* Equipment installed in Class II locations shall 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.

5-3.6 When line voltage wiring enters the enclosure, precautions shall be taken to ensure that a fault (e.g., a short circuit) between the line voltage wiring and the enclosure cannot burn through the enclosure or otherwise raise the external surface temperature above 80 percent of, and at least 25 °C (77 °F) below, the layer ignition temperature (in degrees Celsius) of the dust involved. Such precautions may include overcurrent protection for such wiring in conjunction with enclosure thickness and material. (*See Appendix B.*)

5-3.7* Any internal component having a surface temperature approaching the layer ignition temperature of the combustible dust involved shall be protected in accordance with 5-3.7.1.

5-3.7.1 If any internal component has a maximum surface temperature greater than that indicated in 5-3.5, the component shall be enclosed within a chamber hermetically sealed or suitably gasketed against the entrance of combustible dusts and of a size that will limit its exterior surface temperature to the temperatures specified in 5-3.5.

Exception No. 1: If the chamber containing the component is not sealed or gasketed, a warning nameplate shall be mounted on the outside of the enclosure stating that such conditions exist and that power shall be removed for _____ minutes (time period specified to be sufficient to permit unit to cool to a safe limit) before the door is opened unless the area is known to be nonhazardous at the time.

Exception No. 2: If the chamber containing the component is not sealed or gasketed, the component shall be separately housed so that the surface temperature of the housing is below safe limits. The housing shall be pressurized or sealed and provided with a warning nameplate stating that its cover shall not be removed for _____ minutes (time period specified to be sufficient to permit unit to cool to a safe limit) unless the area is known to be nonhazardous at the time.

5-3.7.2 Equipment such as motors and transformers that may be overloaded and that is exposed directly to the dusty atmosphere shall be provided with appropriate devices to detect any increase in temperature beyond design limits and to deenergize the equipment automatically.

Exception: If immediate interruption of power would result in a condition more hazardous than that created by failure to remove the power, audible and visible alarms shall be provided at a constantly attended location in lieu of compliance with 5-3.7.2.

5-3.8 An alarm shall be provided to indicate failure of the pressurizing system. The alarm may be mechanically, pneumatically, or electrically actuated and may be visual or audible.

5-3.8.1 The alarm shall be located so that it is readily seen or heard. The alarm actuator shall take its signal from the enclosure and shall not be installed between the enclosure and the pressurizing gas supply.

5-3.8.2 No valves shall be permitted between the alarm actuator and the enclosure.

5-3.8.3 The alarm actuator shall be capable of actuating the alarm when the pressure or flow of the pressurizing gas is not adequate to maintain the static pressure specified in 5-3.2. (*See Figure 5-3.8.*)

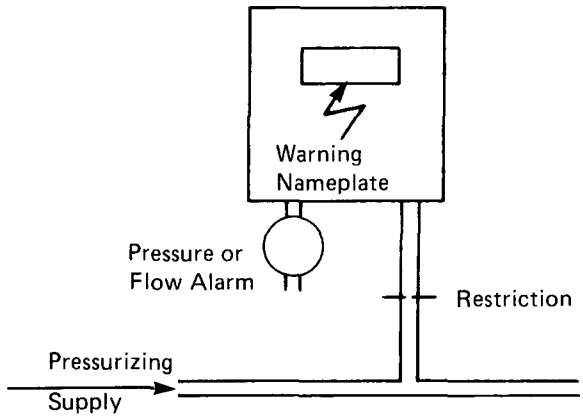


Figure 5-3.8 Typical Installation for Pressurizing.

Chapter 6 Pressurized Control Rooms in Class II Locations

6-1 General.

6-1.1 These requirements apply to buildings or portions of buildings commonly referred to as control rooms. (*See A-3.1.1.*)

6-1.2 If the control room is in a Class II location, it shall be designed to prevent the entry of combustible dusts. To prevent the entry of combustible dusts, it shall be acceptable to use positive pressure ventilation from a source of clean air and the equipment in the building need not be housed in special enclosures for safe operation.

6-2 Considerations Relating to Positive Pressure Ventilation.

6-2.1 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 process units and potential sources of dust, such as bucket elevator legs, belt conveyors, and vent stacks.

6-2.2* The source of air for pressurizing control rooms shall be free of hazardous concentrations of flammable vapors and gases, combustible dusts, contaminants, and any other foreign matter.

6-2.2.1* The source of air shall be determined from the nature of the process and the physical layout.

6-2.2.2 Any ducts shall be constructed of noncombustible materials. The fan suction line shall be free of leaks and given suitable protection from mechanical damage and corrosion to prevent hazardous concentrations of combustible dusts from being drawn into the pressurizing system.

6-2.2.3 The pressurizing system shall be designed to provide positive pressure ventilation for all areas of the control room.

6-3 Requirements for Positive Pressure Air Systems.

6-3.1 The positive pressure air system shall be capable of:

(a) maintaining a pressure of at least 25 Pa (0.1 in. of 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.

A drop in pressure below the 25 Pa (0.1 in. of water) specified in 6-3.1 (a) is permissible while meeting the requirements of 6-3.1(b). (*See A-3-3.1.*)

6-3.1.1 The positive pressure air system may include heating, ventilating, and air conditioning equipment, as well as any auxiliary equipment necessary to comply with 6-3.1.

6-3.2 If there is an air-consuming device 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.

6-3.3 Failure of the positive pressure air system shall be detected at the discharge end of the fan and shall be signaled by a visual or audible alarm at a constantly attended location. Prompt measures shall be taken to restore pressurization. (*See A-3-3.5.*)

6-3.4 After an interruption of the positive pressure air system, a visual inspection shall be made to determine that the control room is safe from the hazard of combustible dust.

Chapter 7 Pressurized Power Equipment Enclosures in Class II Locations

7-1 Scope.

7-1.1 This chapter shall apply to equipment enclosures that exceed 0.3 cu m (10 cu ft) in volume but that are not control rooms.

7-1.2 For the purpose of this chapter, electrical power equipment is divided into two groups:

(a) *Pressurized Equipment.* Equipment that does not require airflow for heat dissipation, but that requires pressurization to prevent entrance of combustible dusts.

(b) *Ventilated Equipment.* Equipment, such as motors, that requires airflow for heat dissipation as well as to prevent entrance of combustible dusts.

7-2 Requirements for Pressurized Equipment.

7-2.1 The enclosure shall be of substantial noncombustible construction and shall be reasonably tight. Gaskets shall be permitted.

7-2.1.1 Precautions shall be taken to protect the enclosure from excessive pressure of the pressurization system.

7-2.1.2 Excess-pressure relief devices, where required to protect in case of failure of pressure control, shall be designed to prevent escape of sparks or burning material to a hazardous area when they function.

7-2.2 The source of air shall be free of hazardous concentrations of flammable gases, vapors, combustible dusts, contaminants, and any other foreign matter.

7-2.3 Piping for air or inert gas (if used) shall be protected against mechanical damage.

7-2.4 Combustible dust shall be removed from the enclosure before the equipment is energized.

7-2.5 The enclosure shall be maintained under a positive pressure dependent on the specific particle density of the dust as long as the equipment in the enclosure is energized. The positive pressure shall comply with Table 7-2.5.

Specific Particle Density		Pressure	
lb per cu ft	*kg per cu m*	*in. H_2O*	*Pa*
≤ 130	≤ 2083	≥ 0.1	≥ 25
> 130	> 2083	≥ 0.5	≥ 125

7-2.5.1 It shall be acceptable to energize the equipment in the enclosure immediately if the pressure specified in 7-2.5 exists and the atmosphere in the enclosure is not visibly dusty.

7-2.6 Under normal operating conditions, neither the temperature of the external surface of the enclosure nor that of the gas leaving the enclosure shall exceed 80 per cent of the layer ignition temperature (in degrees Celsius) of the combustible dust involved, and in all cases shall be at least 25°C (77°F) below such temperature. (*See A-5-3.5.*)

7-2.6.1 If the ignition temperature of the dust is not known, maximum surface temperatures shall not exceed those stated in Table 502-1 of NFPA 70, *National Electrical Code*.

7-2.6.2 Equipment installed in Class II locations shall 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. (*See A-5-3.5.2.*)

7-2.7* Loss of pressurization shall energize an audible and visual alarm at a constantly attended location. Immediate removal of power shall not be required.

7-2.8 A warning nameplate shall be mounted on the enclosure in a prominent location so that it is visible before the enclosure can be opened. The nameplate shall contain the following, or an equivalent, statement:

"Enclosure shall not be opened unless the area is known to be nonhazardous or unless all devices within the enclosure have been deenergized. Power shall not be restored after the enclosure has been opened until combustible dusts have been removed and the enclosure repressurized."

7-2.9 Equipment that may be overloaded, such as motors and transformers, and that may be exposed directly to the dusty atmosphere shall be provided with suitable devices to detect any increase in temperature beyond the design limits of the equipment and to deenergize the equipment automatically.

Exception: If immediate interruption of power would result in a condition more hazardous than that created by failure to remove the power, audible and visual alarms shall be provided at a constantly attended location, in lieu of compliance with 7-2.9.

7-2.10 If any internal component has a maximum surface temperature exceeding the limits stated in 7-2.6, the component shall be enclosed within a chamber hermetically sealed or suitably gasketed against the entrance of combustible dusts and of a size that will limit its exterior surface temperature to the temperatures stated in 7-2.6.

Exception No. 1: If the chamber containing the component is not sealed or gasketed, a warning nameplate shall be mounted on the outside of the enclosure stating that such conditions exist and that power shall be removed for ____ minutes (time period specified to be sufficient to permit unit to cool to a safe limit) before the door is opened unless the area is known to be nonhazardous at the time.

Exception No. 2: If the chamber containing the component is not sealed or gasketed, the component shall be separately housed so that the surface temperature of the housing is below safe limits. The housing shall be pressurized or sealed and provided with a warning nameplate stating that its cover shall not be removed for ____ minutes (time period specified to be sufficient to permit unit to cool to a safe limit) unless the area is known to be nonhazardous at the time.

7-3 Requirements for Ventilated Equipment.

7-3.1 The enclosure shall be of substantial noncombustible construction with necessary openings limited to minimum practical size and kept as airtight as possible.

7-3.2 Combustible dust shall be removed from the enclosure before the equipment is energized and ventilated.

7-3.3 The source of air for ventilation shall be free of hazardous concentrations of flammable vapors, gases,

combustible dusts, contaminants, and any other foreign matter. (*See A-6-2.2.*)

7-3.4 Air discharge from the enclosure shall be to an area classified nonhazardous or Division 2. (*See A-6-2.2.*)

7-3.5 The flow of air shall be as uniform as possible within the enclosure so as to avoid air pockets.

7-3.6 The flow of air shall be sufficient to keep the equipment adequately cooled, depending on operating and design requirements. (*See A-4-3.7.*)

7-3.7 The enclosure shall be constantly maintained at a pressure of at least 25 Pa (0.1 in. of water) above the surrounding atmosphere during operation of the equipment, unless the surrounding atmosphere is known to be nonhazardous.

7-3.8 The maximum temperature limits of 7-2.6 shall apply.

7-3.9 The electrical circuits of the equipment within the enclosure shall be interlocked with the ventilating equipment, so that the circuits will be automatically deenergized if the ventilating equipment fails.

Exception: If deenergizing the circuits would result in a condition more hazardous than that created by failure to deenergize, audible and visual alarms shall be provided at a constantly attended location, in lieu of compliance with 7-3.9.

Chapter 8 Purged Instrument and Other Enclosures Having an Internal Source of Flammable Gas or Vapor

8-1 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.

8-2* General Requirements.

8-2.1 The requirements of Chapters 2 and 5 shall apply except as modified herein.

8-2.1.1 There shall be no limitation on the size of the enclosures covered by this chapter.

8-2.2* For the purpose of this chapter, every 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.

8-2.2.1 "Normal" means 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:

(a) none; i.e., there is no release of flammable gas or vapor; or

(b) limited; i.e., there is release of flammable gas or vapor but the release is limited to an amount that can be diluted by the purging system to less than 25 percent of the lower flammable limit.

8-2.2.2 "Abnormal" means 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:

(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.

8-2.2.3 The possible combinations of release for both conditions are shown in Table 8-2.2.

Table 8-2.2 Magnitudes of Release

Normal Condition	Abnormal Condition
None	Limited
None	Unlimited
Limited	Limited
Limited	Unlimited

8-2.3 If all the electrical equipment within the enclosure is suitable for Class I, Division 1 locations, no purging shall be required.

8-2.3.1 Precautions shall be taken if an abnormal release may be great enough to adversely affect a nonhazardous external area classification.

8-2.4* If the electrical equipment within the enclosure is suitable for either Class I, Division 2 locations or unclassified locations, the purge requirements shall be established according to Table 8-2.4.

8-2.4.1 To determine the purge requirements according to Table 8-2.4:

(a) Find the External Area Classification in Column (a).

(b) Find the Internal Equipment Type in Column (b).

(c) Determine the Purge Requirement for Limited Release under Abnormal Conditions by using the appropriate Normal Condition in Column (c).

(d) Determine any additional requirements from Column (d) if the Abnormal Condition is Unlimited Release.

8-2.5 Enclosures containing an open flame shall be considered to have equipment suitable for unclassified locations for the purposes of determining the purge requirement from Table 8-2.4. The flame shall be automatically extinguished upon failure of the purge system regardless of purge type.

8-3 Specific Requirements.

8-3.1 When a release of flammable gas or vapor within

Table 8-2.4 Purge Requirements for Enclosures Subject to Internal Release

(a)	(b)	(c)		(d)
		Purge 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 Unlimited Release Under Abnormal Conditions
Class I, Division 1	Class I, Div. 1	None	None	None
	Class I, Div. 2	Y	Y	None
	Unclassified	X	X	Inert†
Class I, Division 2	Class I, Div. 1	None	None	None
	Class I, Div. 2	None	Z	None
	Unclassified	Z	X	Inert†
Class II**	Class I, Div. 1	None	None	None
	Class I, Div. 2	None	Z	None
	Unclassified	Z	X	Inert†
None	Class I, Div. 1	None	None	None*
	Class I, Div. 2	None	Z	None*
	Unclassified	Z	X	Inert†

*Precautions must be taken if unlimited release is large enough to alter the nonhazardous external area classification.
**Requirements of Chater 5 also apply.
†See Appendix A-8-2.4.

an enclosure may occur either in normal operation or under abnormal conditions, protection shall be provided by:

(a) purging with air to dilute 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) purging 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 When the electrical equipment is located in a Class I or Class II area, the purge system shall also prevent entrance of the external atmosphere by providing a minimum internal pressure of 25 Pa (0.1 in. water).

8-3.3 The locations and sizes of gas or vapor outlets in the electrical equipment enclosure shall be designed to allow effective removal of both the flammable gas or vapor and the purge gas.

8-3.3.1 When an inert purge gas is used, the outlets may be closed after purging to prevent undue loss of inert purge gas, provided that this does not constitute a further danger such as inadequate flow of protective gas or excessive pressure buildup.

8-3.4 In applications where flammable mixtures may 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.

8-3.5 The flow rate of purge 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.

8-3.6 To achieve proper purging with air, caution is needed 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 consequential damage.

8-3.7 Precautions shall be taken to protect the enclosure from excessive pressure of the purge supply.

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

9-1 Scope. Chapter 9 shall apply to analyzer rooms or 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 If the analyzer room or building is in a hazardous (classified) location, it shall be designed to prevent the entry of flammable gases and vapors, flammable liquids, and combustible dusts.

9-2.2 The requirements of Chapters 3 and 6 for control rooms shall apply except as modified herein.

9-2.3* Analyzer rooms shall be separated from control rooms by distance or by a wall impermeable to vapors.

9-2.4* Flow of air through the room shall ensure adequate air distribution. Flammable vapors shall be removed as close to their source as practical.

9-2.5 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 may enter. (*See NFPA 69, Standard on Explosion Prevention Systems.*)

9-2.6 The analyzer room shall be ventilated with sufficient clean air to dilute any leakage to less than 25 percent of the lower flammable limit based on the largest single failure. (*See NFPA 69, Standard on Explosion Prevention Systems.*)

9-3 Specific Requirements.

9-3.1 Process streams shall have orifices or other flow-limiting devices on the inlets. An orifice or other flow-limiting device shall be installed 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.

9-3.2* 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.

9-3.3 Ventilation shall adequately dilute any internal release of flammable gas or vapor. If the analyzer room or building is located in a hazardous (classified) location, appropriate protection shall be provided against the entry of flammable gases, vapors, liquids, or dusts.

9-3.4 Sample conditioning operations (such as heating, cooling, or drying) shall be located outside the analyzer room or building. Process piping within the analyzer room or building shall be minimized.

9-3.5 All process piping shall be equipped with shutoff valves for emergency isolation located outside of the building or room.

9-3.6 False ceilings and floors shall not be used in analyzer buildings and rooms.

9-3.7* Ventilation fans shall be constructed so as to minimize the possibility of sparking.

9-3.8* In the event of ventilation failure an audible and visual alarm shall be activated at a constantly attended location. All electrical power to the analyzer room or building shall be automatically shut down and open flames shall be automatically extinguished. Power shall not be restored until the analyzer room or building is free of any ignitible atmospheric mixtures.

Exception: Automatic shutdown shall not be required:

(a) If the analyzer room or building is classified as Division 1 and does not contain any open flames, or

(b) If the analyzer room or building is classified as Division 2 and does not contain any open flames and has hard piped equipment, and any flammable vapors are vented to the outside of the room or building.

9-3.9 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 10 Referenced Publications

10-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is current as of the date of the NFPA issuance of this document. These references are listed separately to facilitate updating to the latest edition by the user.

10-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 69-1986, *Standard on Explosion Prevention Systems*

NFPA 70-1984, *National Electrical Code*

10-1.2 ASTM Publications. American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

ASTM E 659, *Standard Method for Determining the Autoignition Temperature of Liquid Chemicals*

ASTM D 2155, *Method of Test for Autogenous Ignition Temperatures of Petroleum Products*

Appendix A Explanatory Material

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

A-1-1.1 Electrical equipment should be located in an area having as low a degree of hazard classification as practical.

A-1-4 For Class I locations, the degree of hazard may be reduced from Division 1 to Division 2 or may be eliminated (i.e., Division 1 or 2 to nonhazardous) by purging, provided the installations are properly designed, installed, and maintained. For Class II locations, the hazard in both Division 1 and 2 locations can be eliminated by pressurization to prevent the entrance of combustible dusts, provided the installations are properly designed, installed, and maintained.

A-1-5 Information on determining the extent of hazardous (classified) locations may be found in NFPA 497, *Recommended Practice for Classification of Class I Hazardous Locations for Electrical Installations in Chemical Plants.*

A-2-2.4 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-2-2.6.1 Ordinary plant compressed air is usually not suitable for purge or pressurizing systems, due to contaminants that may cause equipment to malfunction.

A-2-2.6.4 The compressor suction line should not pass through any area having a hazardous atmosphere, unless it is not practical to do otherwise.

A-2-3 Type Z purging 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-2-3.1 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-2-3.2 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-2-3.3 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.

A-2-4 Type Y purging 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-2-4.2.1 Examples of contacts that normally operate at energy levels insufficient to cause ignition are: slidewire and switch contacts in thermocouple circuits, resistance thermometers, strain gages, and pH electrodes.

A-2-4.2.2 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 Type X purging 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 deenergizing of the equipment. Also, it is essential that the enclosure be tight enough to prevent escape of molten metal particles or sparks.

A-2-5.4 It is essential that any door access that can be opened by untrained personnel be protected with interlock switches. Consistent with the practice established for explosionproof enclosures, it is considered that the commonly displayed warning nameplate is adequate protection for an enclosure that can only be opened with a key or suitable tools.

A-2-5.5 Because the source of ignition caused by high temperature is not immediately removed by removing power to the equipment, it is essential that no surface in contact with the internal atmosphere of the enclosure approach the autoignition temperature (in degrees Celsius) of the gas or vapor involved unless specifically shown to be safe by test.

A-3-1.1 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-3-1.2 To prevent entry of flammable vapors or gases, 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-3-2.2 Air filtration may be desirable.

A-3-2.2.1 Ordinarily, air can be taken from an area to one side of a process area where there is a minimal chance of flammable vapors being present. The elevation of the fan suction depends on the density of the flammable gases

or vapors under handling temperatures and adverse atmospheric conditions. For a control room located in the midst of a process area, ducting may be necessary.

A-3-3.1 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-3-3.5 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 fan belt slippage, loose impellers, or backwards rotation of the fan would not be detected.

A-3-3.7 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-4-3.4 Air filtration may be desirable.

A-4-3.7 Airflow required for cooling may be more than that required for purging.

A-5-2.6.4 The compressor suction line should preferably not pass through any area having a hazardous atmosphere.

A-5-3 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.

A-5-3.2 The density of 2083 kg per cu m (130 lb per cu ft) 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 5-3.2 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-5-3.3 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-5-3.4 If there is not enough room on the enclosure to print the statement given in 5-3.4 in type large enough to be legible, equivalent wording such as the following may be used:

"Deenergize before opening unless area is known to be nonhazardous. Remove dust and repressurize before restoring power."

A-5-3.5 The ignition temperature of the dust layer is determined by the procedure described in U.S. Bureau of Mines Report of Investigations 5624.

A-5-3.5.2 Dust that is carbonized or excessively dry is highly susceptible to spontaneous ignition. In general, maximum surface temperatures, under actual operating conditions, must not exceed 165°C (329°F) for equipment that is not subject to overload and 120°C (248°F) for equipment such as motors, power transformers, etc., that may be overloaded.

A-5-3.7 Because a high temperature source of ignition is not immediately removed by deenergizing the equipment, additional precautions are necessary for hot components.

A-6-2.2 Air filtration may be necessary.

A-6-2.2.1 Ordinarily, air can be taken from an area to one side of a process area where there is a minumum 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 dusts under handling temperatures and adverse atmospheric conditions. For a control room in the center of a process area, ducting may be necessary.

A-7-2.7 A hazard could be created within the enclosure only if the pressure should fail and then it would require an appreciable time for sufficient dust to filter into the interior of a normally tight power enclosure to be hazardous. Thus, it is not considered essential that the equipment be deenergized upon failure of the pressurization system, but only that adequate warning be provided to prevent continued operation without pressure protection. It is essential that the enclosure be tight enough to prevent escape of sparks or burning material.

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 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-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 proba-

bility) 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-8-2.4 Electrical equipment permitted in nonhazardous (nonclassified) 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 Division 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 capability of the purge system) then a flammable atmosphere results from a single failure of the containment system. Therefore, air is not permitted as the purge gas for such enclosures when the electrical equipment is only suitable for nonclassified 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 Division 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, time during which the electrical equipment may also fail and provide the source of ignition.

Whether electrical equipment is located in a Division 2 or a nonclassified location does not affect the need for a purge system. For Division 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 a nonclassified location, the purge system serves only to dilute the any flammable gas released within the enclosure.

A-9-2.3 Flammable gases, vapors, or liquids for analysis should not be piped into control rooms because of the danger of ignition of leakage.

A-9-2.4 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-9-3.2 Flammable gases or vapors should be discharged at a safe point outside the analyzer room or building, 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.*)

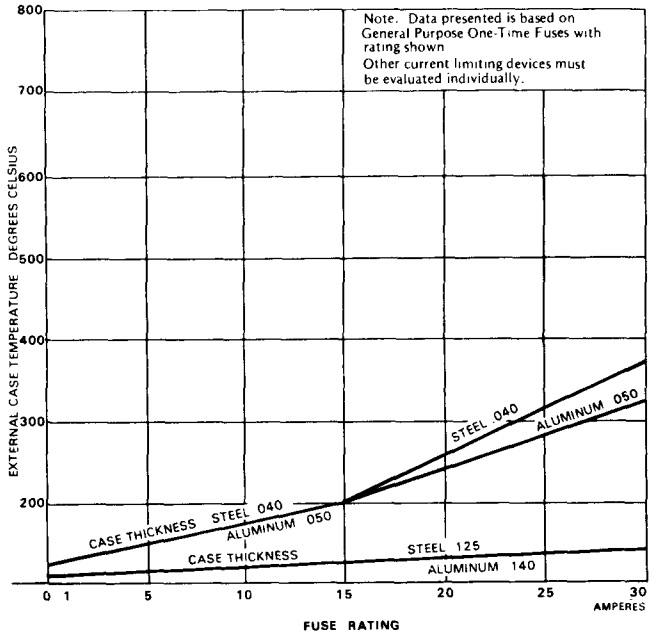
A-9-3.7 The fan motor and associated control equipment should be located external to the ductwork or should be suitable for the location.

A-9-3.8 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 or building will reach the flammable range. In these situations, power must be removed to avoid ignition.

Appendix B External Case Spot Temperatures versus Fuse Rating and Case Thickness for Line Voltage-Case Faults

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only

The data presented on the following graph is based on a particular make and type of general-purpose one-time fuse. Other current-limiting devices must be evaluated individually.



External Case Spot Temperatures vs Case Thickness & Fuse Type & Rating

Appendix C Referenced Publications

C-1 The following documents or portions thereof are referenced within this standard for informational purposes only and thus should not be considered part of the requirements of this document. The edition indicated for each reference is current as of the date of the NFPA issuance of this document. These references are listed separately to facilitate updating to the latest edition by the user.

C-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 30, *Flammable and Combustible Liquids Code*

NFPA 497-1975, *Recommended Practice for Classification of Class I Hazardous Locations for Electrical Installations in Chemical Plants*

C-1.2 Other Publications.

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

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, Pittsburg, PA

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