NFPA No.

496-T

Tentative

Tentative Standard for

PURGED AND VENTILATED ENCLOSURES FOR ELECTRICAL EQUIPMENT IN HAZARDOUS LOCATIONS

May, 1966

CAUTION

Readers are warned that this text does not present official recommendations of the National Fire Protection Association in its present form and is subject to major revision.

This pamphlet circulates for review and comment these recommendations of the Sectional Committee on Electrical Equipment in Chemical Atmospheres of the Committee on Chemicals and Explosives which were Tentatively Adopted at the 1966 NFPA Annual Meeting.

Comments are solicited on these Tentative Recommendations from all those interested. Such comments should be forwarded to the NFPA Office by September 12, 1966 to receive full Committee consideration.

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National Fire Protection Association
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Purged and Ventilated Enclosures for Electrical Equipment in Hazardous Locations

NFPA NO. 496-T-1966

This text was developed by the Sectional Committee on Electrical Equipment in Chemical Atmospheres of the NFPA Committee on Chemicals and Explosives. It was processed in accordance with NFPA Regulations Governing Technical Committees and was adopted as a Tentative Standard at the 1966 NFPA Annual Meeting, held May 16-20 in Chicago, Illinois.

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Tentative Standard for

Purged and Ventilated Enclosures for Electrical Equipment in Hazardous Locations

NFPA NO. 496-T-1966

CHAPTER 1. GENERAL PROVISIONS

11. Object and Scope

111. The object of this Standard is to provide information for the design of purged enclosures for the purpose of eliminating or reducing within the enclosure a Class I hazardous location classification, as defined in Article 500 of the National Electrical Code, NFPA No. 70. By this means, equipment which is not otherwise acceptable for hazardous locations may be safely utilized.

12. Processes and Equipment Covered

121. This Standard applies to locations where flammable gases or vapors may be present in concentrations sufficient for the locations to be classified as hazardous.

122. This Standard applies to instruments, control rooms, motors, motor controllers, switchgear, and similar equipment.

13. Degree of Hazard

131. In conformance with good engineering practice, electrical equipment should be located in an area having as low a degree of hazard classification as practicable.

132. Having decided that a location is hazardous, the next step is to determine the degree of hazard, i.e., normally hazardous (Division 1), or hazardous only under abnormal conditions (Division 2).

133. The degree of hazard may be safely reduced (Division 1 to Division 2), or may be eliminated (Division 1 or Division 2 to nonhazardous) by purging, provided the installations are properly designed, installed, and maintained.

14. Definitions

141. In this Standard the following terms are used as defined below:

DIVISION 1 LOCATIONS are those (1) in which hazardous concentrations of flammable gases or vapors exist continuously, intermit-

tently, or periodically under normal operating conditions; (2) in which hazardous 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 which might release hazardous concentrations of flammable gases or vapors might also cause simultaneous failure of electrical equipment.

DIVISION 2 LOCATIONS are those (1) in which volatile flammable liquids or flammable gases are handled, processed or used, but in which the hazardous 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; (2) in which hazardous concentrations of gases or vapors are normally prevented by positive mechanical ventilation, but which might become hazardous through failure or abnormal operation of the ventilating equipment; or (3) which are adjacent to Division 1 locations, and to which hazardous 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.

PURGING is 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 gases or vapors 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. INSTRUMENTS

21. Instrument Enclosures

211. Scope. Chapter 2 applies to enclosures with a gross internal volume not exceeding 10 cubic feet. For larger enclosures see Chapters 3 and 4.

212. The ratio of the maximum internal dimension to the minimum shall not exceed 10 to 1.

NOTE: The 10 to 1 limitation on the maximum internal dimensions to the minimum internal dimension is considered to describe normal enclosure practice. Further, this limitation permits the insertion of purging gas at a single point to purge the entire enclosure volume. This would not necessarily be true in elongated shapes outside of this limitation.

213. An internal enclosure or an adjacent enclosure that is being considered as part of and purged with the main instrument enclosure must have nonrestricted top and bottom vents, common to the purged main enclosure, having a minimum size for each vent of 1 square inch per 400 cubic inches of the volume of the internal or adjacent enclosure.

NOTE: 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 it and the main enclosure. The area required to provide adequate venting will obviously depend upon the internal or adjacent enclosure. It is considered that meeting this requirement will prevent the formation of unpurged pockets of gas within the enclosure. It is not intended to imply that internal or adjacent enclosures not meeting these venting requirements are prohibited but that such enclosures must be provided with their own purging gas connections. (Refer to 222.)

214. The enclosure shall be of such noncombustible material and construction that is not likely to be broken under conditions to which it is likely to be subjected.

215. Any window in a purged enclosure shall be tempered glass at least ¼ inch thick, shatterproof glass or other shatterproof material.

22. General Requirements

221. If hazardous vapors or gases have collected within the enclosure, either because the door has been opened or the purge has failed, then the enclosure must be purged.

2211. Once the enclosure has been purged of hazardous concentrations, it is not obligatory to maintain any given flow rate. It is only necessary that positive pressure be maintained within the enclosure.

222. Since the intent is to purge an enclosure to reduce the concentration of hazardous vapors or gases to an acceptably safe level, enclosures within the instrument or adjacent enclosures connected to the instrument must be considered separately.

2221. They must be adequately vented to the main enclosure. (Refer to 213.)

2222. They may be separately purged.

2223. Equipment contained therein may be protected by other approved means.

223. It is assumed that any purging system may fail to supply an adequate pressure to exclude the entrance of flammable vapors or gases. This may happen when the instrument door is opened or if a failure occurs to the purge system. Suitable precautions such as indicators, interlocks, etc., must be provided to safeguard the installation.

224. The purging supply shall be essentially free of dust and liquids, which can plug small openings. It shall contain no more than trace amounts of flammable vapors or gases.

2241. Air of normal instrument quality is acceptable as are other suitable supplies such as inert gas.

NOTE: Ordinary plant compressed air is usually not suitable.

2242. The compressor suction line should preferably not pass through any area having hazardous atmospheres. The compressor intake must be located in a nonhazardous area.

2243. If the compressor suction line passes through a hazardous area, it must be of noncombustible material suitably protected against mechanical damage and corrosion.

2244. Leaks which might permit hazardous vapors to be drawn into the compressor suction must be avoided.

225. When double purging is used, i.e., a room ventilated to make it Division 2 and containing a device with open contacts protected by purging, the two sources of air must be independent or automatic shutdown must be provided.

23. Specific Requirements for Type "Z" Purging

NOTE: Type "Z" purging reduces the classification within an enclosure from Division 2 to nonhazardous. A hazard is created under Type "Z" conditions only if the purge should fail at the same time the area which is normally nonhazardous becomes hazardous. Because of this, it is not considered essential to remove power from the equipment upon failure of the purge but only that adequate warning must be provided to prevent continuing operation without purge protection.

231. Before power is turned on, at least four enclosure volumes of purge gas must have passed through the enclosure while maintaining an internal enclosure pressure of at least 0.1 inch of water.

NOTE: Any time the enclosure has been opened or the purging gas removed, there exists the possibility that explosive gases or vapors have accumulated within the enclosure.

2311. EXCEPTION: Power may be turned on immediately if a pressure of at least 0.1 inch of water exists and if the atmosphere within the enclosure is known to be nonhazardous.

232. The enclosure must be maintained under a positive pressure of not less than 0.1 inch of water when the power is on.

NOTE: 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 velocities.

233. Under normal operation and with 125 percent of rated voltage applied to the instrument, the external enclosure temperature or the temperature of the egress air shall not exceed 80 percent of the ignition temperature (°C) of the vapor or gas involved as determined by Method of Test for Autogenous Ignition Temperatures of Petroleum Products, ASTM D286-58T.

NOTE: In the event that an external enclosure temperature in excess of the ignition temperature of the gas or vapor involved existed, it is obvious the purging cannot prevent an explosion; therefore, it is essential that excessive surface temperature be prevented.

234. Safety interlocks to remove power upon failure of purging supply are not required.

235. Acceptable installations are shown in Figures No. 1, 2, and 3.

236. An alarm or indication of purge system failure must be provided. The device may be mechanical, pneumatic or electric, and the signal may be audible or visual.

2361. If electrical, it must meet the requirements for its location.

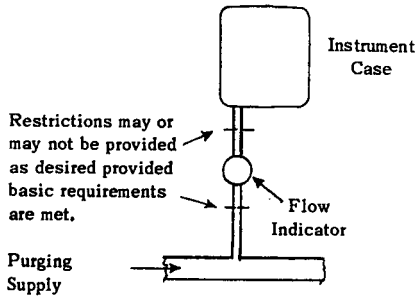

FIGURE 1

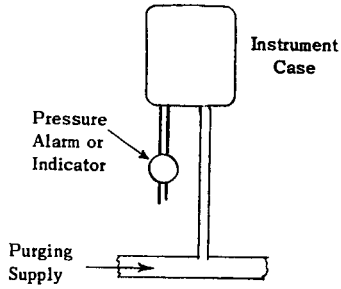

FIGURE 2

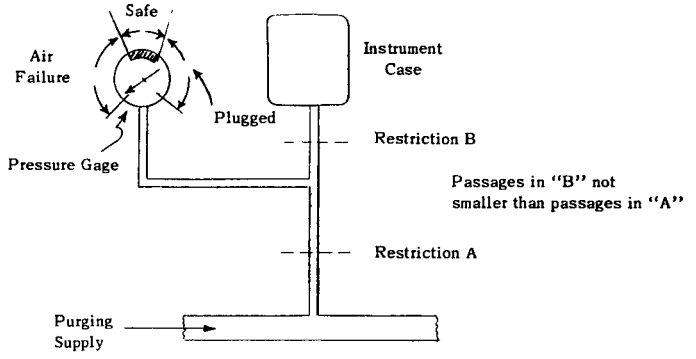

FIGURE 3

2362. To avoid plugging when a pneumatic device is used, any restrictions between the pneumatic device and the enclosure shall have passages no smaller than the smallest passage before the pneumatic device.

2363. If a pneumatic indicator is used, no valve between the device and the enclosure shall be permitted.

2364. The pressure or flow device must be capable of indicating (or actuating an alarm) when the purging pressure or flow is inadequate to maintain a static pressure within the enclosure of at least 0.1 inch of water.

237. A red warning nameplate must be mounted on the instrument. The nameplate shall be mounted in a prominent location and be visible before the enclosure is opened. It shall state:

Enclosure shall not be opened unless area is known to be nonhazardous or unless the power has been removed from all devices within the enclosure. Power shall not be restored after enclosure has been opened until enclosure has been purged for X minutes.

NOTE: The manufacturer is to recommend purge conditions and flow rate necessary to pass at least four enclosure volumes in the stated time X.

238. The maximum operating temperature of any internal surface exposed to the atmosphere within the enclosure shall not exceed 80 percent of the ignition temperature (°C) of the gases or vapors involved, as determined by ASTM D286-58T.

2381. If any temperature exists over 80 percent of the ignition temperature of the gases or vapors involved, then

(a) The warning nameplate shall contain a statement that such conditions exist and that power must be removed for X minutes (period to be determined and specified by the manufacturer to be sufficient to permit unit to cool to safe limit) before the door is opened unless the area is demonstrated to be nonhazardous at the time, or:

(b) The unit may be separately housed and this housing purged so that the surface of the enclosure is below safe limits. The unit must have a warning nameplate stating that its cover may not be removed for X minutes (period to be determined and specified by the manufacturer to be sufficient to permit unit to cool to safe limit) unless the area is demonstrated to be nonhazardous at the time.

24. Specific Requirements for Type "Y" Purging

NOTE: Type "Y" purging reduces the classification within an enclosure from Division 1 to Division 2. The equipment that can be included within the enclosure under type "Y" conditions must be suitable for Division 2. This requires that it does not normally contain a source of ignition. Thus, a hazard is created within the enclosure only upon failure of the purging system simultaneously with a failure of the internal equipment causing it to produce a source of ignition. Therefore, it is not considered essential that on failure of the purging system the power be automatically removed from the equipment but that a warning be provided to prevent continuing operation without purge protection.

241. All requirements in 231 to and including 237 must be met.

242. Equipment shall conform to the requirements for Division 2 locations.

NOTE: The requirement for equipment to be used in Division 2 locations is that it should not normally contain a source of ignition. Such sources of ignition may be make-and-break contacts or high surface temperatures in contact with the atmosphere which may become hazardous.

243. Specific requirements are:

2431. Make-and-break or sliding contacts shall be either immersed in oil, or enclosed within a chamber hermetically sealed against the entrance of gases or vapors, or in circuits which under normal conditions do not release sufficient energy to ignite a specific hazardous atmosphere mixture.

NOTE: Examples of contacts normally operating at energy levels which would not cause ignition are: slide-wire and switching contacts in thermocouple circuits, resistance thermometer, strain gauge and pH electrode, etc.

2432. The maximum operating temperature of any surface exposed to the atmosphere within the enclosure shall not exceed 80 percent of the ignition temperature (°C) of the gases or vapors involved, as determined by ASTM D286-58T.

2433. If any temperature exists over 80 percent of the ignition temperature (°C) of the gases or vapors involved, the surface having this temperature shall be enclosed within a chamber hermetically sealed against the entrance of gases or vapors.

NOTE: Internal temperatures above the ignition temperature of the gas or vapor involved, such as vacuum tube filaments, are hermetically sealed to prevent them from normally coming in contact with the atmosphere which may become hazardous. It is essential, that in such enclosures the surface of the glass envelope, which does come in contact with the atmosphere, not have a temperature in excess of 80 percent of the ignition temperature of the gas or vapor involved.

NOTE: If the conditions specified under 242 and 243 are met, the equipment can be located in a Division 2 location in a general purpose enclosure without purging.

25. Specific Requirements for Type "X" Purging

NOTE: Type "X" purging reduces the classification within an enclosure from Division 1 to nonhazardous. Because the probability of a hazardous concentration of gas or vapor external to the enclosure is high and the enclosure normally contains a source of ignition, it is essential that any disruption of the purging will result in the removal of power from the equipment. It is also essential that the power within the enclosure be limited to minimize the possibility that an internal fault can raise the external surface temperature to a hazardous degree.

251. A device must be incorporated to remove potential automatically from all circuits within the enclosure not suitable for Division 1 upon failure of the purging supply. (Refer to 257.)

252. A door switch must be provided to remove potential automatically from all circuits within the enclosure not suitable for

Division 1 if the enclosure can be readily opened without the use of a key or tools. The door switch, even though located within the enclosure, must be suitable for Division 1 locations.

NOTE: It is considered essential that any door or other opening which can be opened by untrained people without tools be protected with door interlock switches. Consistent with the practice which has been established with explosionproof enclosures, it is considered that the commonly displayed warning nameplate is adequate protection for the enclosure that can only be opened by the use of suitable tools.

253. A timing device must be incorporated to prevent power from being applied until after the elapse of a time sufficient to permit at least four enclosure volumes of purge gas to have passed through the enclosure while maintaining an internal pressure of at least 0.1 inch of water. The timing device must meet the requirements of its location.

NOTE: The manufacturer is to recommend purge conditions and flow rate necessary to pass four enclosure volumes in a stated time.

254. The enclosure must be maintained under a positive pressure of not less than 0.1 inch of water when the power is on.

255. The maximum operating temperature of any surface exposed to the atmosphere within the enclosure shall not exceed 80 percent of the ignition temperature (°C) of the gases or vapors involved, as determined by ASTM D286-58T.

2551. If any temperature exists over 80 percent of the ignition temperature (°C) of the gases or vapors involved, the surface having this temperature shall be enclosed within a chamber hermetically sealed against the entrance of gases or vapors.

NOTE: Because the source of ignition caused by high temperature is not immediately removed by cutting off power to the equipment, it is considered essential that no surface temperature approaching the ignition temperature of the gas or vapor involved should be permitted to come in contact with the internal enclosure atmosphere.

256. Acceptable installations are shown in Figures No. 4, 5, and 6.

257. The power cutoff switch provided to remove power upon failure of the purging system *shall* be either flow or pressure actuated.

2571. It must conform to the requirements of its location.

2572. To avoid plugging when a pneumatic device is used, any restrictions between the device and the enclosure *shall* have passages no smaller than the smallest passage before the device.

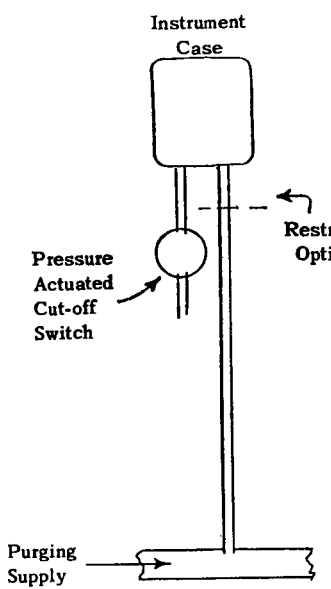

FIGURE 4

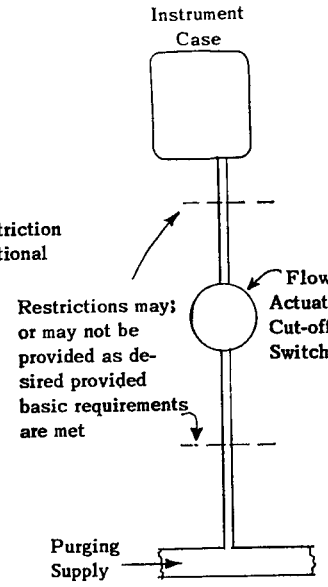

FIGURE 5

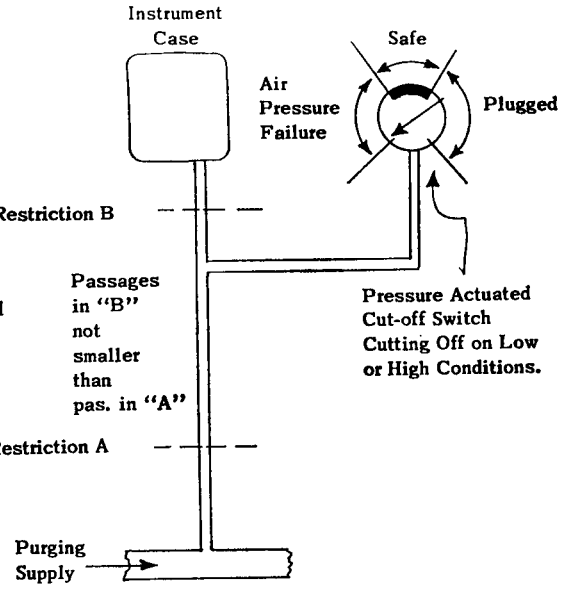

FIGURE 6

2573. If a pneumatic device is used, no valve between the device and the enclosure *shall* be permitted.

2574. The pressure or flow device must be capable of cutting off power when the purging pressure or flow is inadequate to maintain a static pressure within the enclosure of at least 0.1 inch of water.

2575. If a pressure device (Fig. 6) is used, it must be capable of cutting off power if pressure falls below a predetermined value.

258. A red warning nameplate must be mounted on the instrument. The nameplate *shall* be mounted in a prominent location and be visible before the enclosure is opened. It shall state:

> Enclosure shall not be opened or any cover removed unless area is known to be nonhazardous or unless the power has been removed from all devices within the enclosure. Power shall not be restored after enclosure has been opened until enclosure has been purged for X minutes.
>
> NOTE: The manufacturer is to recommend purge conditions and flow rate necessary to pass at least four enclosure volumes in the stated time X.

CHAPTER 3. CONTROL ROOMS

31. General

311. The design of buildings to house process control equipment and operating personnel is dictated by operational and safety requirements. These requirements apply to buildings, commonly referred to as control rooms, when located close to areas which may contain flammable atmospheres. A necessary design consideration for control rooms is the assurance of an adequate degree of safety at all times including such abnormal conditions as power failures, equipment failures, ruptures and fires.

32. Control Room

321. Control rooms commonly house one or more of the following facilities:

Process control instruments and panels.
Data processing equipment.
Communications equipment.
Electrical lighting and electrical power equipment and controls.
Emergency power-producing equipment to serve lighting and control devices.
Lunch, restroom and locker facilities for operating personnel.
Offices for process supervisors and technical personnel.
Maintenance facilities for calibration and repair of process instruments and control devices.
Heating and ventilating equipment.

322. In processes which can create hazardous atmospheres, the control rooms may serve as a separated location for devices capable of releasing sufficient electrical or thermal energy to cause ignition.

323. If the control room is located in a hazardous area, it must be designed to prevent the entry of flammable liquids and flammable atmospheres. To prevent the entrance of flammable liquids may require differences in elevation and/or the use of dikes, etc. To prevent the entry of flammable atmospheres positive pressure ventilation from a source of clean *air* may be used and the equipment in the building need not be housed in special enclosures for safe operation.

33. Considerations Relating to Positive Pressure Ventilation

331. Factors to be considered in designing a control room suitable for safe operation in hazardous atmospheres are:

The number of people to be housed in the building.
The type of equipment to be housed in the building.
The location of the control room in relation to the process units, including relief valves and vent stacks. The building should be located in the least hazardous part of the process area, preferably upwind from the hazardous or contaminated area.

3311. The source of air for purging control rooms should be free of hazardous concentrations of flammable vapors and gases, contaminants and any other foreign matter. Air filtering may be desirable.

NOTE: The source of air must be determined from the nature of the process and the physical layout. Ordinarily air can be taken from an area to one side of a process area where there is a minimum chance of flammable vapors being found. 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 in the center of a process, ducting may be necessary. Ducting must be constructed of noncombustible material. The fan suction line must be free of leaks and given suitable protection from mechanical damage and corrosion to prevent hazardous concentrations of flammables from being admitted to the control room.

3312. A minimum number of doors should be provided so that positive pressures can be maintained, while at the same time the number of doors should be adequate for safe exit.

3313. The air system should be designed to provide positive-pressure ventilation for all areas of the room.

3314. Monitoring devices such as gas analyzers or similar devices may be needed to detect flammable vapors and gases and give suitable warning.

34. Specific Design Practices for Positive Pressure Air Systems

341. Sufficient air shall be supplied to the control room to provide a minimum outward velocity of 60 feet per minute through all openings. All doors and windows capable of being opened shall be considered as open, and an allowance for other openings shall be included. Normally it is expected that doors are closed, but there is a tendency to leave them open at times. The fan supplying the air must also be capable of maintaining a pressure of at least 0.1 inch of water in the control room with all openings closed.

342. If there is an air-consuming device in the control room, sufficient air must be supplied to handle its needs plus the positive air system requirements or the air must be taken from a separate source.

343. If Type "X" purging is required, all power to the control room must be automatically shut down upon air system failure. Cutting off power to the control room may shut down the process, and this fact must be considered. For Type "Y" and "Z" purging, shutdown of power to the control room is not required.

344. Air system failure should be sensed by the discharge pressure of air from the fan and be signaled by a visible or audible alarm.

NOTE: Velocity pressure switches, static pressure sensing devices and plenum chambers with orifices to provide sufficient pressure to be sensed have been used. Electrical interlocks on the fan motors are not adequate in the event the fan belt slips, the fan impeller becomes loose on the shaft or if the fan rotation is backwards.

345. Provisions must be made to energize the control room safely after an air system interruption. Such provisions are:

3451. Check with a flammable vapor indicator to determine when it is safe to energize the control room.

3452. Provide a switch, motor and disconnect for the fan suitable for the area as it would be classified in the absence of positive pressure ventilation.

3453. An enforced purge wherein an interlock system requires proof of purging for a set period of time prior to energization should be considered if warranted by the conditions.

3454. The electrical power for the air system fan must be taken off the power line ahead of any disconnects that must be energized to return power to the control room.