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## Defining the Need

The need to place general purpose equipment in hazardous (classified) locations is not new, yet in the last three decades the need has intensified dramatically. This is primarily due to the following facts:

- Process control, measuring and recording equipment that was once primarily pneumatic is now primarily general purpose electronic equipment.
- Motors and switchgear now use electronic accessories to satisfy the needs for position, speed or process control and energy efficiency, which often renders the equipment unsuitable for use in hazardous locations.
- Newly developed equipment, such as robotic manipulators, CNCs, batch weigh/count and filling systems, analyzers, programmable controllers and CRT work stations are rapidly becoming more prevalent in the industrial work environment.

While the demand for these new devices continues to grow, most of them cannot be economically installed in a hazardous location by using explosion proof enclosures or intrinsic safety barriers, alone. Most modern electronic equipment is expensive and delicate. For this reason, it requires environmental protection that cannot be provided by explosion proof enclosures or intrinsic safety barriers.

Therefore, the need for an alternative to explosion proof enclosures and intrinsic safety barriers has become extremely critical.

### The alternative is purge and pressurization.

As you learn more about purge and pressurization, it will become apparent that this technology is exactly what you require. It will then become obvious that this technology offers the safest and most economical means of installing electrical equipment in a hazardous location. In addition, this technology will undoubtedly impress you as the only definitive way to enhance your equipment's performance and access, while increasing the life expectancy of delicate instruments. Finally, you'll learn the most important point of all:

***The answer to your need is Pepperl+Fuchs Bebcu EPS.***



*This MSA Monitor is protected with a Pepperl+Fuchs Bebcu Model 1001A Type "Z" Purging System making it suitable for Class I, Group A-D, Division 2 hazardous locations.*



*A Pepperl+Fuchs Bebcu Rapid Exchange™ Purging System and several accessories make this enclosure acceptable for Class I, Group C & D, Division 2 hazardous locations.*

# Examining the Solutions

## Explosion Proof Enclosures



### Intent

These enclosures are designed to contain an explosion if an electrical device ignites flammable substances within the enclosure, thus preventing ignition of the surrounding atmosphere. These enclosures are commonly used for circuit breakers, mechanical switchgears and high-powered equipment. The failure to properly tighten all bolts and screw covers on these enclosures is the greatest problem facing end users.

### Advantages

- Explosion Containment
- Requires Low Maintenance
- High-Powered Equipment
- No Electronics
- No Moving Parts

### Disadvantages

- Cannot Indicate Failure of Containment Capability
- Danger to Equipment After Explosions
- Possibility of Installation/Maintenance Errors
- Cost of Protection per ft<sup>3</sup> Increases With Enclosure Size
- Windows are Limited
- Promotes Condensation
- Cumbersome, Limited Access
- Causes Harmful Heat Build up
- Limited Sizes
- Bulky Designs
- Excessive Weight

## Intrinsic Safety Barriers



### Intent

These devices are designed to limit the current and voltage conducted through a device's power or signal wiring. This limitation prevents shorting and arcing of the wires or device, thus preventing ignition of the surrounding atmosphere. They are commonly used for protection of instruments that operate at extremely low power levels and are suitable for exposure to the environment.

### Advantages

- The Only Protection Allowed for Zone 0
- Eliminates Possibility of Explosion
- Requires Low Maintenance
- Ideal for Low-Power Devices
- No Hot Permits
- No Special Cables
- Limits Energy to Device

### Disadvantages

- Requires Documentation of I.S. Circuits and Installation
- Can be Used Only With Low-Power Devices

# Pepperl+Fuchs Bebcos EPS

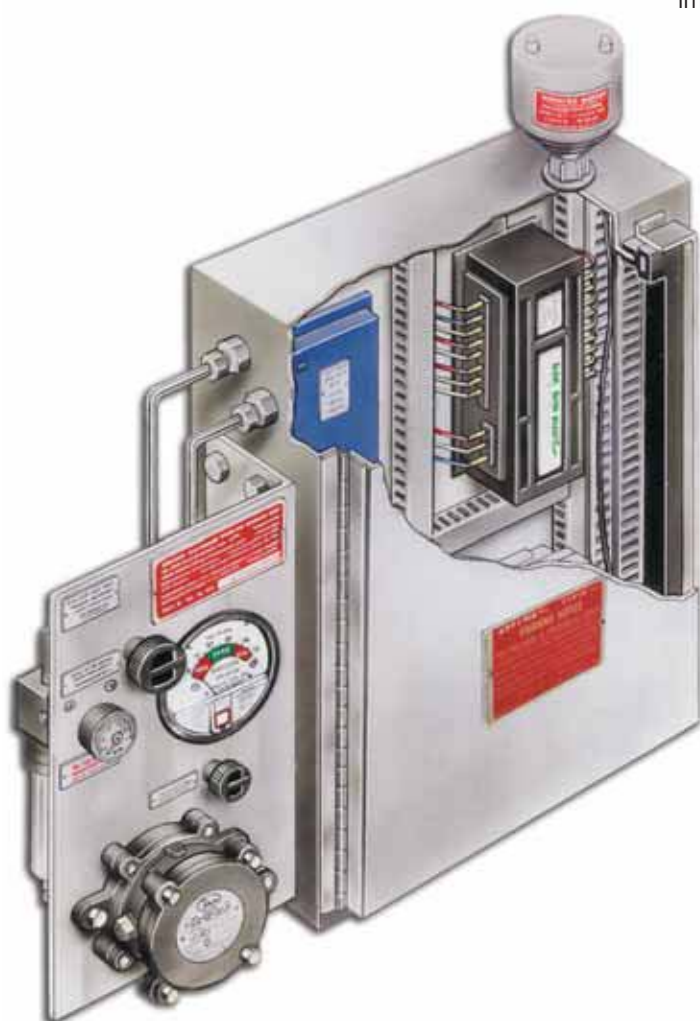
## Enclosure Protection Systems

### Intent

Pepperl+Fuchs Bebcos EPS® Division Products are designed to supply one or more protected enclosures with a clean instrument air or inert gas. This process removes flammable gases or prevents the accumulation of ignitable dusts within the protected enclosure(s). This method of protection is not limited by the quantity, configuration, power requirements, or location of the protected equipment. These systems are commonly used for all applications involving basic electronics, electrical equipment, motors and switchgear.

In addition these systems can also meet the demands of rack mounted instrumentation, video displays, programmable controllers, computers, printers, recorders, measurement, gas analyzers and calibration equipment.

One of the best benefits is the slow but continuous flow of protective gas, which can be specifically used to eliminate problems like heat, moisture, dust and corrosion. And unlike explosion proof enclosures, failure of a Pepperl+Fuchs Bebcos Enclosure Protection System does not create an immediate danger.



### Advantages

- Reduces Heat Build up
- Inhibits Metal Corrosion
- Requires Low Maintenance
- Increases Equipment Longevity
- No Special Enclosures Required
- Allows Fast Access to Equipment
- Reduces Moisture & Dust Build up
- Reduces Classification Within the Enclosure
- Continuous System Status Indication
- Protects Enclosures up to 450 ft<sup>3</sup>
- Allows use of any Enclosure Shape
- Cost of Protection per ft<sup>3</sup> Decreases With Enclosure Size

### Disadvantages

- Contains Moving Parts
- Requires Instrument Air Supply
- Some Systems Require Electronics
- Hot Permits Required

Purge and Pressurization is the only technology that meets the demand for general purpose equipment with standard enclosures inside hazardous locations

# Defining Hazardous Areas



Today's modern refineries and manufacturing complexes often contain both flammable gases and ignitable dusts, making area classification of Division 1 and Division 2 locations an important but tricky task.

## Hazardous Area Definition

Hazardous (classified) locations are those areas in an industrial complex where the atmosphere contains flammable concentrations of gases or vapors by leakage, or ignitable concentrations of dusts or fibers by suspension or dispersion.

### The National Fire Protection Association

The National Fire Protection Association (NFPA), formed in 1896, is a nonprofit organization devoted to fire safety standards and codes. It currently retains over 40,000 members who work to determine safe practices and establish standards for all areas of commercial, industrial and residential construction. They publish many documents including NFPA 70 - better known as the National Electric Code and NFPA 496 - the document that specifies recommended practices for pressurization and purging.

### Area Classification Methods

The NFPA establishes area classifications using three factors. Identified as Classes, Groups and Divisions, these factors are combined to define conditions of specific areas.

### Important Notes:

Division 1 areas must be surrounded by Division 2 areas.

## Class Ratings

Classes are used to define the explosive or ignitable substances that are present in the atmosphere.

- Class I** - Flammable gases or liquid vapors
- Class II** - Ignitable metal, carbon or organic dusts
- Class III** - Ignitable fibrous materials

## Group Ratings

Groups are used to define substances by rating their explosive or ignitable nature, in relation to other known substances.

### TYPICAL CLASS I SUBSTANCES

- Group A** - Acetylene
- Group B** - Hydrogen or > 30% Hydrogen by Volume
- Group C** - Ethyl Ether & Ethylene
- Group D** - Acetone, Ammonia, Benzene & Gasoline

### TYPICAL CLASS II SUBSTANCES

- Group E** - Aluminum, Magnesium & Alloys
- Group F** - Carbon, Coke & Coal
- Group G** - Flour, Grain, Wood, Plastic & Chemicals

## Division Ratings

Divisions are used to define the degree of hazard by determining the explosive or ignitable substance's expected concentration in the atmosphere.

- Division 1** - Contains substances under normal conditions
- Division 2** - Contains substances under abnormal conditions

## Zone Ratings

Zones are used to define the degree of hazard by determining the explosive or ignitable substance's expected concentration in the atmosphere.

- Zone 0** - Contains substances under normal conditions (Continuously)
- Zone 1** - Contains substances under normal conditions (Intermittently)
- Zone 2** - Contains substances under abnormal conditions

# Common Questions ?

## What is purging?

Purging is the process of supplying enclosures with compressed air or inert gas at the proper flow and pressure in order to reduce the hazardous gas inside the enclosure to a safe level. Pressurization is the process of bringing compressed air or inert gas within an enclosure to a pressure where there is no ingress of hazardous gasses or combustible gas. Both purging and pressurization are required in a Class I, gas atmosphere. Only pressurization is required in a Class II, dust atmosphere.

## What is used to purge/pressurize?

The most common and practical protective gas is compressed instrument quality air that contains no more than trace amounts of combustible vapor. Inert gases, such as nitrogen or argon are acceptable. Although they are usually expensive and impractical, they may be required for some gas analysis applications.

## What is the pressure requirement?

Most purging applications require a minimum enclosure pressure of 0.10 inches (2.5 mm) of water. One psi is equal to 27.7 inches of water. In some circumstances, a minimum enclosure pressure of 0.50 inches (12.7 mm) of water is required to protect against ignitable dust. But in all cases, a higher enclosure pressure should be maintained to create a reasonable safety factor. In rare circumstances, enclosure pressures as high as 2.5 inches (63.5 mm) of water may be required to offset sudden atmospheric pressure fluctuations, such as those created near missile launching or off-shore drilling platforms.

## How much purging gas is used?

Average protective gas consumption during pressurization at a 0.10 inch (2.5 mm) enclosure pressure should fall somewhere between 0.1 to 3.5 scfh per cubic foot (2.83 to 99.11 l/hr) of enclosure volume. However, use will depend on the protected enclosure's integrity and normal pressure setting. Use is also dependent on the quantity and size of covers and doors as well as devices which penetrate the surface. Advanced forms of protection such as cooling or dilution may require continuous flow rates of 30 to 100 scfm (849.38 to 2831.26 l/m). Purging requires a much higher flow rate than pressurization, but only for a short period of time.

## What kinds of enclosures can be purged?

Any enclosure can be purged, but enclosures featuring gasketing and multiple door fasteners are ideal. Therefore, in the absence of official construction requirements for purged enclosures, Pepperl+Fuchs Bebco recommends enclosures which meet or exceed the National Electrical Manufacturer's Association rating of NEMA 4 or NEMA 12. For more information on this subject, see page T12.

## What kinds of devices can be purged?

Virtually any basic electrical device can be purged, if all "live" or energized components can be isolated from the surrounding environment. Devices such as push-buttons, relays, timers and programmable controllers only need to be installed in a sealed enclosure. Motors only require a totally enclosed housing.

## How can the equipment be accessed?

Equipment mounted in the protected enclosure can be accessed if the area is known to be nonhazardous, or if all power to the protected equipment has been de-energized. In other words, internal equipment should be treated as if located in an explosion proof enclosure. However, a cooling period may be required before accessing hot components, such as transformers or variable speed drives, which would otherwise be unacceptable for use in the hazardous location.

Equipment mounted through the surface of a protected enclosure may require a sealed access door if the equipment is not suitable for exposure to the surrounding atmosphere. Advanced pressurization systems, like Pepperl+Fuchs Bebco Rapid Exchange™ Purging Systems can maintain a positive pressure, by increasing the flow of protective gas while the access door is open.



*In this application, a stainless steel enclosure features an access door for control adjustments and maintenance, along with a very unique audible and visual alarm system.*

# NFPA & ISA Design Standards

## Pressurization Standards

Committee SP12 of the Instrument Society of America (ISA) established the first Design Standard in 1966, entitled "ISA s12.4 - Instrument Purging For Reduction Of Hazardous Area Classification." In 1967, the NFPA Technical Committee on Electrical Equipment in Chemical Atmospheres established recommended practices, entitled "NFPA 496 - Purged and Pressurized Enclosures for Electrical Equipment." Since then, the NFPA has expanded their document by adding recommendations for enclosure ventilation and dilution.

The NFPA document is the American standard for design, marking and performance of enclosures and pressurization systems. The ISA document addresses construction, installation and testing of protected enclosures and pressurization systems.

## Pressurization "Types"

The NFPA and ISA define "Types" of pressurization based on the Division rating of a hazardous location and electrical ratings of the protected equipment. General purpose and Division 2 rated electrical equipment require different means of protection, depending on their location.

### Type "X"

#### Protects general purpose equipment in Division 1 Areas

This system reduces the classification within protected enclosures from Division 1 to nonhazardous. It is required to automatically control electrical power to all protected equipment.

### Type "Y"

#### Protects Division 2 rated equipment in Division 1 Areas

This system reduces the classification within protected enclosures from Division 1 to Division 2. All protected equipment must be rated for Division 2. Automatic power control disconnects are not required, but visual and/or audible alarms must be initiated when there is loss of pressure.

### Type "Z"

#### Protects general purpose equipment in Division 2 Areas

This system reduces the classification within protected enclosures from Division 2 to nonclassified. Automatic power control disconnects are not required, but visual and/or audible alarms must be initiated when there is loss of pressure.

## Purging and Pressurizing Methods

The NFPA and ISA define several techniques for protecting equipment. Most equipment requires only basic pressurization in Class II areas or purging in Class I areas. Ventilation and dilution are advanced protection methods for heat producing or flammable gas analyzing equipment.

## Purging

### Common equipment in Class I Areas

As strictly defined by NFPA 496, this method is a start-up process of Class I area pressurizing which removes flammable vapors from a protected enclosure. This is accomplished by exchanging a known volume of protective gas, while maintaining a minimum positive enclosure pressure of 0.10 inches (2.5 mm) of water. The 2003 edition of NFPA 496 recommends 4 volume exchanges for all enclosures and 10 volume exchanges for all motors.

## Pressurization

### Common equipment in Class I & II Areas

This method prevents the entrance of flammable gas or combustible dust into protected enclosures. In Class II areas, this is accomplished by manually removing any dust and then applying a protective gas supply to maintain a positive enclosure pressure of 0.50 inches (12.7 mm) of water. In Class I areas, this is accomplished by "purging" as defined below, and by then maintaining a minimum positive enclosure pressure of 0.10 inches (2.5 mm) of water. Power can then be applied to the protected equipment under conditions established by the Division rating.

## Ventilation

### Hot equipment in Class I & II Areas

This method provides protection as outlined above and also removes or dissipates heat from electrical devices within a protected enclosure. This method is commonly used to cool equipment or reduce enclosure surface temperatures. Ventilation requires high air flow and is commonly performed with blowers for high voltage switchgear devices.

## Dilution

### Analytical equipment in Class I Areas

This method provides protection as outlined above and also continuously removes or dissipates flammable gases within a protected enclosure. Dilution may require the use of nitrogen to blanket the enclosure. Otherwise, a higher flow of instrument air will likely be required.

# Pressurization System Designs

## Choosing a System

There are four primary factors that determine which purge system is appropriate for your application:

- Classification of the area.
- Ratings of the equipment inside the enclosure.
- Enclosure size, position of doors, windows and any accessories.
- Power requirement to the enclosure (type X systems).

### Area Classification

The area classification determines the type of purge system needed. For Division 1 areas, the equipment inside the enclosure determines whether a Type X system (equipment rated for general-purpose) or a Type Y system (equipment rated for Division 2) can be used.

### Equipment Ratings

The rating on the equipment inside the enclosure becomes important in evaluating which purge system to use in a Division 1 area. If the Division 1 area contains at least one general-purpose component, a Type X system is required. If all devices in the enclosure are rated for Division 2, then a Type Y system can be used. Special conditions exist for enclosures such as gas analyzers and chromatographs that contain a flammable gas. Refer to NFPA 496 2003 for more information.

### Enclosure Size

The size of the enclosure determines the size of the purge system. How the system is mounted depends on the position of doors, windows and cable entrances.

### Power Requirement

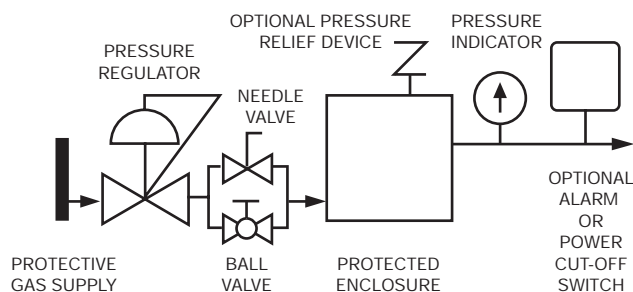
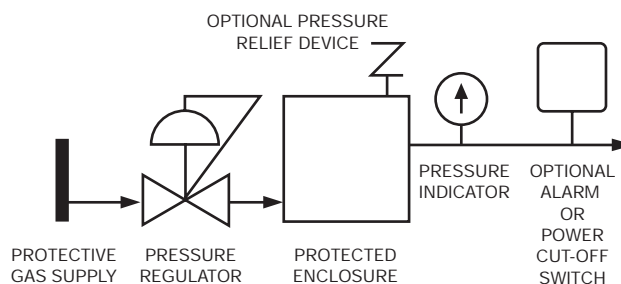
For Type X systems, the control unit operates the power disconnect to the enclosure. If the power requirement for the enclosure exceeds the contact ratings on the control unit, a control relay must be added. If the control relay is located in the hazardous area, it must be rated for that hazardous location. As power increases inside the enclosure, high temperatures become a problem. Refer to NFPA 496 2003 for more information.

## Requirements for Alarms

For Type Y and Z purge systems, audible alarms or visual indicators must be used to notify operators that pressure inside the enclosure is below the NFPA minimum.

Alarms are connected directly to the enclosure and monitor the differential air pressure between the enclosure and the environment outside it. These alarms are activated by the reduction in flow or pressure within the protective enclosure and have a direct connection to the enclosure, eliminating the need for an alarm on the protective gas supply.

- The alarm must be located where the operator can see it easily.
- The alarm must take its measurement from the enclosure only.
- Alarms located in the hazardous area must be rated for the area.
- Valves cannot be connected between the alarm and the enclosure.



These pressurization system diagrams represent the basic designs of modern pneumatic systems.

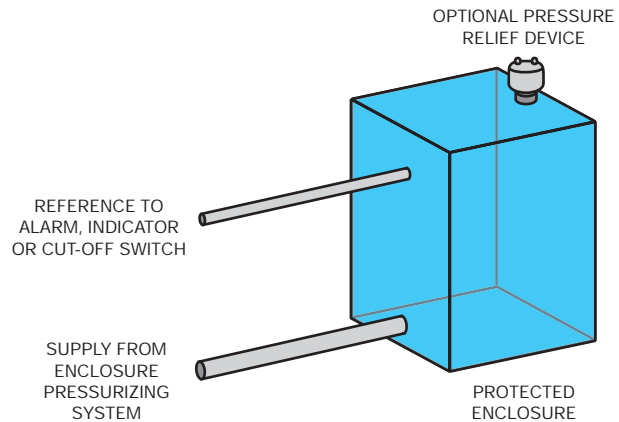


# Typical Enclosure Connections

## Single Enclosures

### General Recommendations

1. The pressurizing system should be located immediately adjacent to the protected enclosure(s) when possible.
2. The pressurizing system should be installed at eye level, in a prominent location, for convenient viewing.
3. No valves should be installed between the pressurizing system and the protected enclosure(s).
4. The reference connection from the protected enclosure(s) should be installed in a location which is not directly affected by air flow through the protected enclosure(s).
5. All tubing, piping and connection fittings should be suitable for the location in which they are installed and should be protected against mechanical damage.



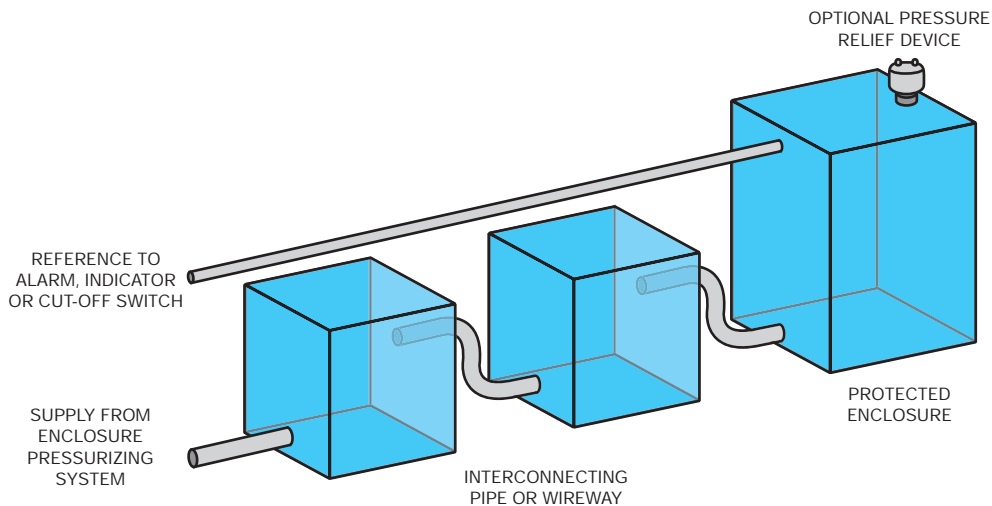
## Multiple Enclosures

### Multiple Enclosure Recommendations

1. Protected enclosures should be connected from the smallest to largest enclosure in series.
2. Connections should be sized to allow proper operation of the pressurization system.
3. Conduit or wireways may be utilized as protected enclosures or as connections between protected enclosures.\*

4. All pressurized conduit and wireways should be sized to allow proper protective gas flow through the protected enclosures.

\* The NFPA recognizes the use of electrical conduit or wireways as a part of an "approved system". The NFPA term "approved system" refers to a complete purged assembly that has been approved by the authority having jurisdiction.



### Class I Area Recommendations

If flammable gases are lighter than air, the supply connection to each enclosure should enter near a bottom corner and the connection for an optional vent or piping to the next protected enclosure should exit near an extreme opposite top corner.

If flammable gases are heavier than air, connections should be reversed.

These Class I area recommendations exceed the requirements of NFPA 496. They are presented by Pepperl+Fuchs Bebcos as a method to enhance the removal of flammable gases by the use of gravity.

These Class I area recommendations only apply to enclosure volumes exceeding two cubic feet.

# Indicators, Alarms & Cutoffs

## Requirements for Indicators

Indicators can be used when there is an alarm for the protective gas supply and the enclosure is isolated with a valve immediately adjacent to the enclosure. The valve must have an appropriate warning label and can be used only for the enclosure. Refer to NFPA 496 2003, section 4.8.4 for more information.

- The indicator must be located where the operator can see it easily.
- The indicator must show either pressure or flow.
- The indicator cannot be installed between the enclosure and protective gas supply.
- No valves shall be connected between the indicator and the enclosure.
- The protective gas supply shall have an alarm located in a constantly attended area and fulfill requirements in 4.3.2.

## Requirements for Disconnects

The disconnect switch immediately cuts off power to the enclosure when pressure drops below a safe level. This switching is required for Type X systems but can be used in Type Y and Z systems.

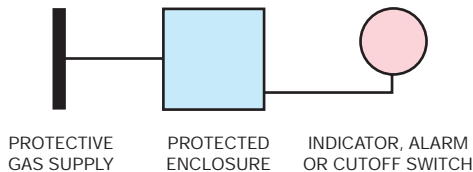
There are exceptions to the disconnect rule for Type X systems, because in some instances, a power loss represents a greater hazard than operating the system under low pressure. An alarm is acceptable in those circumstances, but only for a short time and special requirements may be necessary.

Requirements for disconnect switches:

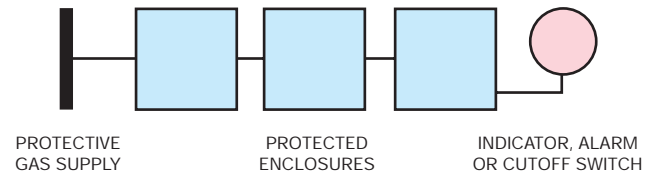
- Must be actuated by either the protective gas flow rate or the differential pressure inside the enclosure.
- Must be approved for its location.
- No valves shall be connected between the disconnect switch and the enclosure.
- Shall take its signal from the protected enclosure and shall not be installed between the enclosure and the protective gas supply. Refer to NFPA 496, section 4.10.1 for more information.

## Protected Enclosure Device Details

### Single Enclosure Applications

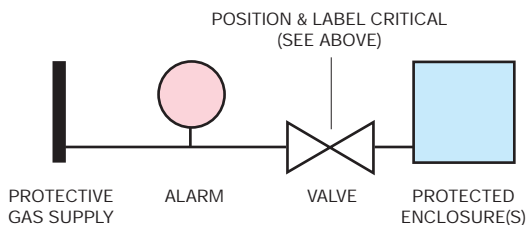


### Multiple Enclosure Applications

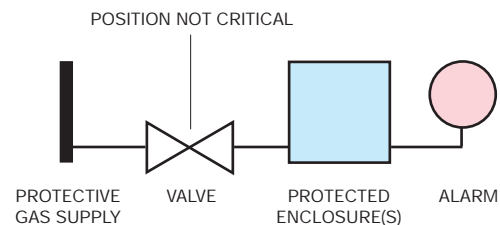


## Protective Gas Supply Alarm Details

### Upstream Alarm Application



### Downstream Alarm Application



# Enclosure Marking & Wiring

## Enclosure Marking Requirements

Sections 4.11 & 6.3 of the 2003 NFPA 496 require markings on all protected enclosures with a "permanent label," located in a "prominent location," near all doors and access covers. The labels must include the following or equivalent statements:

### Class I Locations:

#### "WARNING - PRESSURIZED ENCLOSURE"

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

### Class II Locations:

#### "WARNING - PRESSURIZED ENCLOSURE"

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

Section 5.3 requires the following or equivalent statement in addition to the statement required by Section 4.11 above. "Power shall not be restored after enclosure has been opened until enclosure has been purged for \_ minutes at a flow rate of \_"

A Note to Section 5.3 permits the use of minimum pressure in place of flow rate if the pressure can positively indicate a known flow rate.

An Exception to Section 5.3 allows placement of the start-up instructions on the pressurizing system, if they are referenced by the permanent label on the protected enclosure.

In addition, all permanent labels must include three other markings:

**Section 4.11:** Class, Group and Division of surrounding area

**Section 4.11:** NFPA pressurization Type X, Y, or Z

**Section 4.11:** T Code (temperature identification number): see NFPA 70, The National Electric Code, Article 500, Table 500-3(d)

**Exception No. 1** allows omission of the T Code marking if the hottest temperature does not exceed 100°C.

**Exception No. 2** allows omission of the T Code marking for equipment which is marked for specific use in gas or dust atmospheres and does not exceed 80% of the flammable or ignitable atmosphere's ignition temperature.

## Special Marking Requirements

Exceptions to Section 4.5 require enclosures to be marked with the following or equivalent statement if they house equipment which can exceed the T-Code rating, to comply with Section 4.11.4:

#### "WARNING - HOT INTERNAL PARTS"

"This enclosure shall not be opened unless the area is known to be nonflammable or unless all equipment within has been de-energized for \_ minutes."

An Exception to Section 4.8.2 permits the use of an indicator on the protected enclosure if all isolation valves are adjacent to the enclosure (see page 11) and marked to comply with Section 4.11.5:

#### "WARNING - PROTECTIVE GAS SUPPLY VALVE"

"This valve must be kept open unless the area is known to be nonflammable or unless all equipment within the protected enclosure is de-energized."

## Typical Enclosure Wiring Methods

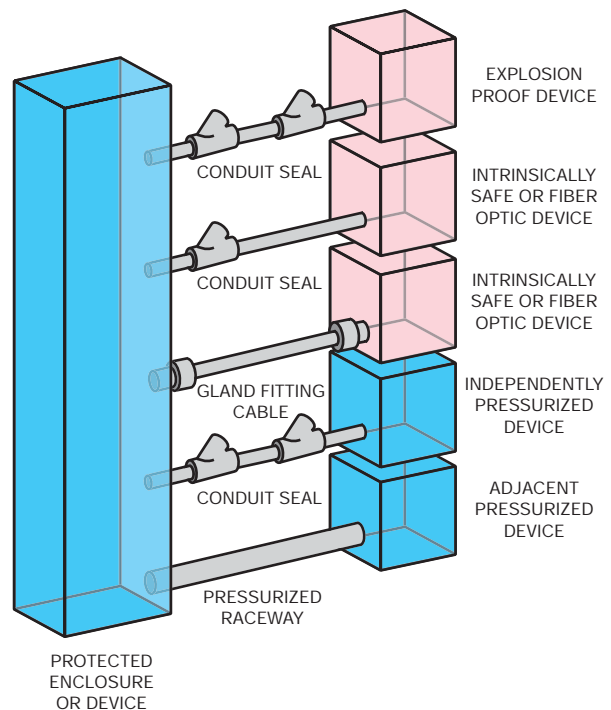
In a general sense, protected enclosures should be wired similar to explosion proof enclosures, in accordance with Article 500 of the National Electric Code - **NFPA 70**.

Single conductor wiring should be placed in rigid metal conduit, seal-flex conduit or other mediums approved for use in the hazardous location surrounding the protected enclosure. Additionally, **NFPA 496** requires the use of approved seals on all pressurized enclosure conduit wiring entries, in accordance with **NFPA 70**. Furthermore, the use of an approved seal is simply the most practical way to prevent excessive leakage through conduit connections.

However, while explosion proof enclosures require conduit seals on all cable entries, in accordance with **NFPA 70**. Other methods of sealed cable entries that are suitable for hazardous locations can be used, such as compression glands.

In conclusion, there are two primary goals. First, the installer should ensure that all associated wiring and cable is protected by pressurization or other means, such as explosion proof conduit or intrinsic safety barriers. Secondly, the installer should ensure that all associated conduit and wireways are sealed to conserve protective gas, unless they are used to supply protective gas to other enclosures or devices.

## Typical Enclosure Wiring Connection



# Basic Operating Procedures

## Class II, Div. 1 Pressurization

### Start-Up Conditions

Protection Method: Type "X" Pressurization System  
 Powering Method: Automatic Power Control Unit or Local Disconnect Switch  
 System Status: Protected Equipment De-energized Alarm System and Air Supply On

### Operating Procedures

1. Remove hazardous substance from the protected enclosure. A vacuum device is the preferred tool for dust removal.
2. Check operation of enclosure pressure relief device (if utilized) and seal the protected enclosure.
3. Pressurize the protected enclosure to set and maintain a positive pressure of 0.50 inches (12.7 mm) of water.
4. System will apply power automatically when pressure is set and maintained at a positive pressure of 0.50 inches (12.7 mm) of water.
5. Loss of pressurization must automatically de-energize protected equipment power immediately.  
**Exception:** Automatic power control is not required if the enclosure is designed to prevent the entrance of dust and the pressurization system activates an audible or visual alarm in a constantly attended location.
6. Equipment that may overload or overheat, such as motors or transformers, require thermal overload cutoff switches or alarms.

## Class I, Div. 1 Purge/Pressurization

### Start-Up Conditions

Protection Method: Type "X" Purge/Pressurization System  
 Powering Method: Automatic Power Control Unit  
 System Status: Protected Equipment De-energized Alarm System and Air Supply On

### Operating Procedures

1. Check operation of enclosure pressure relief device (if utilized) and seal the protected enclosure.
2. Pressurize the protected enclosure to set and maintain a minimum positive pressure of 0.10 inches (2.5 mm) of water.
3. Exchange the recommended volumes of purging gas.
4. System will deny power automatically until recommended volume exchange is complete and pressure is set and maintained at a minimum positive pressure of 0.10 inches (2.5 mm) of water.
5. Loss of pressurization must automatically de-energize protected equipment power immediately.  
**Exception:** Power may be maintained for a short period if immediate loss of power would result in a more hazardous condition and if the system activates both audible and visual alarms in a constantly attended location.
6. Equipment that may overload or overheat, such as motors or transformers, require thermal overload cutoff switches or alarms.

## Class II, Div. 2 Pressurization

### Start-Up Conditions

Protection Method: Type "Z" Pressurization System  
 Powering Method: Local Disconnect Switch  
 System Status: Protected Equipment De-energized Alarm System and Air Supply On

### Operating Procedures

1. Remove hazardous substance from the protected enclosure. A vacuum device is the preferred tool for dust removal.
2. Check operation of enclosure pressure relief device (if utilized) and seal the protected enclosure.
3. Pressurize the protected enclosure to set and maintain a positive pressure of 0.50 inches (12.7 mm) of water.
4. Energize the protected equipment power manually with a disconnect switch or breaker rated for the hazardous location.
5. Loss of pressurization requires immediate attention or the manual de-energizing of protected equipment power.
6. Excessively hot equipment must be isolated in a separate protected enclosure, unless the enclosure is marked with a warning which indicates a required cool-down time period before access.

## Class I, Div. 2 Purge/Pressurization

### Start-Up Conditions

Protection Method: Type "Z" Purge/Pressurization System  
 Powering Method: Local Disconnect Switch  
 System Status: Protected Equipment De-energized Alarm System and Air Supply On

### Operating Procedures

1. Check operation of enclosure pressure relief device (if utilized) and seal the protected enclosure.
2. Pressurize the protected enclosure to set and maintain a minimum positive pressure of 0.10 inches (2.5 mm) of water.
3. Exchange the recommended volumes of purging gas.  
**Exception:** Power may be energized immediately if the protected enclosure atmosphere is known to be nonflammable.
4. Energize the protected equipment power manually with a disconnect switch or breaker rated for the hazardous location.
5. Loss of pressurization requires immediate attention or the manual de-energizing of protected equipment power.
6. Excessively hot equipment must be isolated in a separate protected enclosure, unless the enclosure is marked with a warning which indicates a required cool-down time period before access.

# Enclosure Design Considerations

## Protected Enclosures

1. All windows should be shatterproof and sized as small as possible.
2. All NFPA 496 required markings should be placed on or near all doors and covers, and should be easily visible.
3. The enclosure should withstand an internal pressure of five (5) inches of water without sustaining permanent deformation and resist all corrosive elements in the surrounding atmosphere.
4. All lightweight objects in the enclosure, such as paper or insulation, should be firmly secured.
5. The enclosure should be constructed from materials such as metal or polycarbonate to meet NEMA 4 or 12 performance requirements, but does not require 3rd party approval.
6. The installation of obstructions or other barriers which block or impede the flow of protective gas should be avoided.
7. The creation of air pockets or other areas which trap flammable gases within the enclosure should be avoided.
8. The enclosure should be located in an area where impact hazards are minimal.
9. A pressure relief device should be used if it is required to protect the enclosure against pressurization system control failure or to allow proper purging system operation.
10. If the enclosure is non-metallic and contains equipment which utilizes or switches power loads greater than 2500 VA, it should be constructed from substantially non-combustible materials, such as materials designed to meet or exceed ANSI/UL94 ratings of 94 V-0 or 94 5V.
11. The enclosure should have no surface area that exceeds 80% of the flammable or ignitable substance's auto-ignition temperature.
12. If the enclosure is protected by a Type X System and can be opened without the use of a tool or key, the door should be equipped with a Division 1 rated power interlock switch to de-energize all equipment that is not suitable for Division 1 areas.

## Adjacent & Internal Enclosures

1. All internal enclosures (within the protected enclosure) should be protected by one of the following means, if the free volume of the internal enclosure exceeds 1.22 cubic inches (20 cm<sup>3</sup>).
2. Internal enclosures should be ventilated on the top and bottom sides with at least one (1) square inch (6.5 cm<sup>2</sup>) of opening for each four hundred (400) cubic inches (6560 cm<sup>3</sup>) of volume within the internal protected enclosure, with a minimum size of one quarter (1/4) inch diameter (6.3 mm); or,
3. Adjacent and internal enclosures should be purged in series with the protected enclosure or be purged separately; or,
4. Equipment within adjacent and internal enclosures should be protected by other means; e.g. explosion proof enclosures, hermetically sealed housings or intrinsic safety barriers.

## Pressure Relief Devices

1. All pressure relief devices should be designed to minimize air leakage, unless intended for dilution or ventilation.
2. All pressure relief devices should be constructed from flame, shatter and ignition proof substances. In addition, they should be designed to prevent the escape of sparks and burning materials.

## Typical Fastening and Gasketing Methods



*Captive screw and cage nut assemblies can be used to provide multiple point fasteners, and improve enclosure appearance and pressure seals.*



*Some enclosure manufacturers utilize clamping fasteners to meet TYPE 4 performance requirements.*

## Calculation of Enclosure and Device Volumes

1. The total volume of all pressurized enclosures, devices and wireways should be considered.
2. All enclosure, device and wireway volumes should be calculated without consideration of internally consumed space. Exceptions: motor starters, rotors, field coils, etc.
3. Cubical device volumes should be calculated as follows:  
 Height x Width x Depth - in inches ÷ 1728 = ft<sup>3</sup>  
 - in feet = ft<sup>3</sup>
4. Cylindrical device volumes may be calculated as follows:  
 $\varnothing^2 \times \text{Cylinder Length}$  - in inches ÷ 1728 = ft<sup>3</sup>  
 - in feet = ft<sup>3</sup>

**All design considerations presented on this page are intended for basic applications only.**

Most custom and standard enclosures are suitable for purging and pressurization if requirements meet or exceed Type 4 or 12 requirements. However, the use of multiple door fasteners provides a well-sealed enclosure that allows conservation of protective gas.



*This enclosure features a removable gasketing trim, which features a high profile with exceptional memory.*



*In this application, a dual pressurization system is mounted above two identical devices that are separately protected to allow independent access. Both devices feature TYPE 4 cases, which makes them suitable for purging as is.*



*Both assemblies pictured are suitable for Class I, Group C & D, Division 2 hazardous locations.*

*In this application, a custom built stainless steel enclosure is fitted with several Pepperl+Fuchs Bebcos products, including a Rapid Exchange™ Purging System, and an Enclosure Protection Vent.*

## Device Use Considerations

### Preface

Unlike previous subjects, these considerations are based mainly upon common sense and sound engineering practices, because while the NFPA and ISA have addressed many other factors, device use is mostly unregulated. Therefore, while the following considerations are based on applications that have been installed and proven, many are presented in the absence of standards. In addition, this section does not address analytical equipment. Remember, the ultimate responsibility for installation approval, regardless of current regulations, lies with the authority having jurisdiction.

### Protruding Devices

The use of devices that penetrate the surface of a protected enclosure must be carefully scrutinized. Protruding devices will likely contain electrical components that could either be exposed to the hazardous location or be isolated from the flow of protective gas. Conventional wisdom suggests that a protruding device should be acceptable if it is (1) explosion proof, (2) intrinsically safe, (3) proven to emit insufficient energy to ignite the surrounding atmosphere (applicable for Division 2 locations only), (4) constructed so that all electronics within its face are suitably sealed from the surrounding environment and properly ventilated to the protected enclosure, or (5) isolated from the surrounding atmosphere by a sealed window or access door that is properly ventilated to the protected enclosure.

### Controllers, Indicators & Recorders

Today's panel mounted instrumentation is almost strictly electronic. The protruding face of these instruments normally contains LEDs, LCDs and incandescent or florescent lights. Therefore, it is extremely important to isolate all instrumentation from the surrounding atmosphere, unless the face is sealed and all electronics are properly ventilated to the protected enclosure.

# Device Use Considerations

Due to the limitations established above, most instruments will require isolation through the use of a sealed access door (see page T5). However, while the instruments are then normally inaccessible, some end users permit "limited access" while maintaining a positive pressure, to perform maintenance, calibration and adjustment. The process of limited access may be accomplished by using Pepperl+Fuchs Bebcos Rapid Exchange™ Purging Systems. Special door labeling or purging system automation may also be required. **NOTE:** These designs should be reviewed by all parties, especially the authority having jurisdiction, prior to engineering or fabrication commitments.



## Peripheral Devices & Instrument Keypads

Technically speaking, it is impossible to pressurize many peripheral devices, even if they are Type 4 rated. First, most bar coders and wands feature no internal cavity. Secondly, the membrane assembly of most peripheral keyboards isolates key contacts from the protected gas. Therefore, all peripheral devices not suitable for pressurization should be protected by intrinsic safety barriers. Furthermore, the barriers and all intrinsic safe wiring should be mechanically isolated from all other devices and wiring in the protected enclosure. Most peripheral devices can be easily modified with intrinsic safety barriers, however, its very impractical to modify panel mounted instrument keypads. Accepting this fact, such instruments should be located behind a sealed access door that is properly ventilated to the protected enclosure. **NOTE:** Some end users allow the use of these devices in Division 2 areas without barriers, assuming the normally low energy to these devices will not ignite the surrounding atmosphere. However, the possibility of a ground fault or current overload will always exist without barrier protection.

## Operators

Panel mounted operators such as push buttons and selector switches should be Type 4 rated or oil-tight and should not contain illumination devices such as incandescent bulbs, unless they are protected as noted below. **NOTE:** A majority of end users permit the use of general purpose illuminated operators in Division 2 areas, if they are isolated from impact with guards.

## Pilot Lights

A pilot light is normally unacceptable unless rated for use in the hazardous location. However, some authorities having jurisdiction permit the use of LED clusters and VDC bulbs, after determining they have insufficient power to ignite the surrounding atmosphere. Other concerns should include impact resistance and potential power dissipation, unless the pilot light is protected as noted.

## Internal Devices

Relays, timers, counters, power supplies and other internally mounted electrical equipment should be ventilated or protected in accordance with the considerations for adjacent and internal enclosures (see page T12). In addition all devices should not exceed 80% of the flammable or ignitable substance auto-ignition temperature, unless (1) it can be shown by testing that the device will not ignite the surrounding atmosphere, (2) the device is enclosed in a hermetically sealed chamber, (3) the protected enclosure is equipped with a temperature warning nameplate, or (4) the device is separately housed and pressurized.

## Printers

In addition to considerations for internal equipment, special attention must be given to printing devices. First, in order to dispense the printed material, protected enclosures may require a "chute" to guide it outward. Second, a "slot" must be incorporated to dispense the printed material, while minimizing the leakage of protective gas. Finally, if the slot dispenses printed material through the top of the protected enclosure, or if printed material is only dispensed periodically, the protected enclosure may also require a cover or a sealed access door to prevent enclosure contamination.

## Motors

Totally enclosed motors, with NEMA ratings such as TENV, TEFC or TEAO, are best suited for pressurization, but the following factors should also be considered. (1) All motors should have sufficient cavities and openings to permit the flow of protective gas around the windings. (2) The gas connections for the supply and return of protective gas should be located at extreme opposite ends of the motor. (3) Peripheral devices such as electrical connections, optical encoders and brakes may require a separate housing, purged in series with the motor. (4) Pressure within the motor should not exceed the minimum requirement, because excessive pressure will force grease out of shaft bearing seals. Finally, Class I motors require 10 volume exchanges before energizing power.



# Typical Applications



## Cameras & Monitors

With increased use over the last decade, in areas like security surveillance, thermography and pollution control monitoring, video equipment can reach into many hazardous areas. Most applications normally revolve around modifying or encasing the existing camera, but cost are usually negligible.

## Local Control Panels

Adapting general purpose meters, lights and controls for use in a hazardous area requires little more than a sealed enclosure, a sealed door for limited access, and a protection system. In this application, intrinsic safety barriers are located within the enclosure (a safe area) and receive signals from the flow rate transmitters located in the nearby pipelines.



## Displays & Annunciators

Regardless of their location, displays and annunciators are one of the simplest devices to protect, simply because they require only limited access. Typical installation savings may run into thousands of dollars, and the equipment is protected from all elements of the environment.

# Typical Applications

## Filling & Weighing

Beginning with the controls, protection of a filling or weighing system is simple. Weigh scale platform equipment is usually easy to pressurize, or may be available in intrinsically safe versions. From there, filling equipment, such as solenoids, motors, servos and dribble valves can be protected in a number of ways. Finally, to complete the application, on-site, real-time printouts of tickets, reports or product labels can be obtained by adding custom-built pressurized enclosures for the printing equipment.



## Robotics

Whether they are reciprocal motion or multimotion machines, today's advanced robotic machines are going into many hazardous or toxic areas. Pepperl+Fuchs products are there too, utilized to allow robotic equipment to perform tasks such as automotive paint spraying, silicone chip production and carbon fiber lamination of aerospace parts. Motors, servos, sensors and on-board electronics are easily protected with a combination of intrinsic safety barriers and pressurization, and in most cases these upgrades require only limited modification of the original machine.

## CNC Machinery

Regardless of their purpose, be it milling, grinding, drilling, wrapping or stuffing, CNC (Computer Numerically Controlled) machinery cannot typically be used in a hazardous location, because the majority of market applications drives most manufacturers to only offer conventional designs. However, by carefully examining and modifying various CNC machines, P+F Bebcos has satisfied many applications, including some very unusual needs, such as the milling of plastic explosives for military applications and the stretch wrapping of pallets loaded with bags of highly ignitable dust.



ISC Sales, Inc. Since 1988  
www.iscsales.com  
4421 Tradition Trail  
Plano, TX 75093  
Email: [iscinfon@iscsales.com](mailto:iscinfon@iscsales.com)  
972-964-2700 OR 800-836-7472