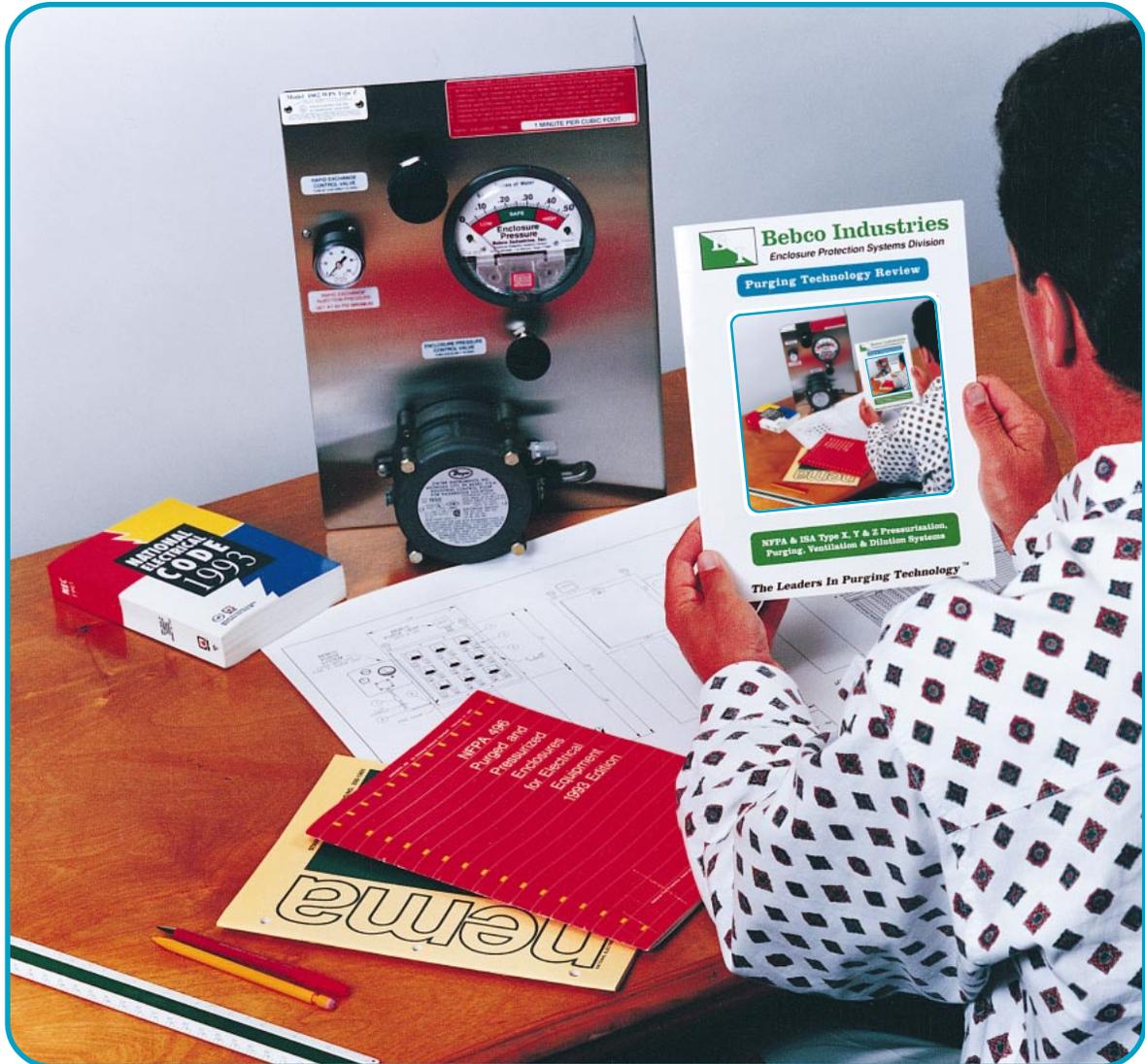


Bebco Industries

Enclosure Protection Systems Division

Purging Technology Review

For Internal Use ONLY! Do Not Distribute



**NFPA & ISA Type X, Y & Z Pressurization,
Purging, Ventilation & Dilution Systems**

The Leaders In Purging Technology™

Forward

Thank you for taking the time to review this document. We appreciate your interest in Bebcu EPS® Division Products and the innovative technology of purging.

This Purging Technology Review has been developed to educate and inform, while exposing readers to methods which achieve the safe and effective use of our products. Through careful study, you'll gain confidence and expertise in this technology and discover the benefits and uses of Bebcu Enclosure Protection Systems.

Most importantly, you'll gain specific knowledge about purging technology

- You'll know that purging offers superior equipment protection.
- You'll understand common terms, definitions and requirements.
- You'll learn how to alarm, mark, wire and operate purged enclosures.
- You'll see how to design enclosures and protect a variety of equipment.

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IMPORTANT NOTE:

ALL RECOMMENDATIONS PRESENTED HEREIN SHOULD BE CONSIDERED AS THE VIEWS AND OPINIONS OF BEBCO INDUSTRIES, INCORPORATED, UNLESS A SPECIFIC SECTION NUMBER OF THE 1993 NFPA 496 IS EXPRESSLY REFERENCED

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.



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

However, 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. In addition, most modern electronic equipment is expensive and delicate. For this reason, it requires environmental protection which 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 purging.

As you learn more about purging, 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 Bebcu.

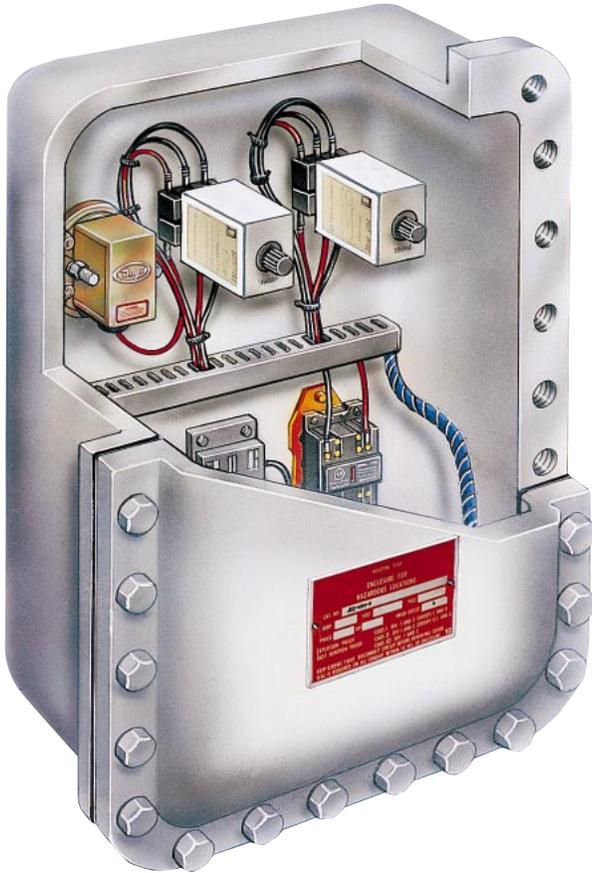


A Bebcu Rapid Exchange™ Purging System and several accessories make this enclosure acceptable for Class I, Group C & D, Division 2 hazardous locations.

Bebcu EPS® Products Satisfy All Protection Needs

- Reduces Heat Build-Up
- Enhances Access & Use
- Reduces Area Classification
- Increases Equipment Life span
- Prevents Moisture & Corrosion
- Eliminates Dust Contamination

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 and mechanical switchgear. They can also contain rugged electronic instruments, if modified to meet NEMA 4 performance requirements. 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
- No Electronics
- No Moving Parts

DISADVANTAGES

- Cannot Indicate Failure of Containment Capability
- Cost of Protection per Cu Ft Increases with Enclosure Size
- 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. However, if these devices fail, protected equipment will malfunction.

ADVANTAGES

- Limits Energy to Device
- Requires Low Maintenance
- No Moving Parts
- Ideal for Sensors

DISADVANTAGES

- One Barrier is Required for Each Conductor
- Project Cost Increases with Number of Conductors
- Offers No Protection against Heat, Moisture & Dust
- Requires Protection or Installation in Nonclassified Area
- 24 VDC, 50 ma Maximum Power & Signal Strength Limit

Bebco Enclosure Protection Systems

INTENT

Bebco 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 and calibration equipment.

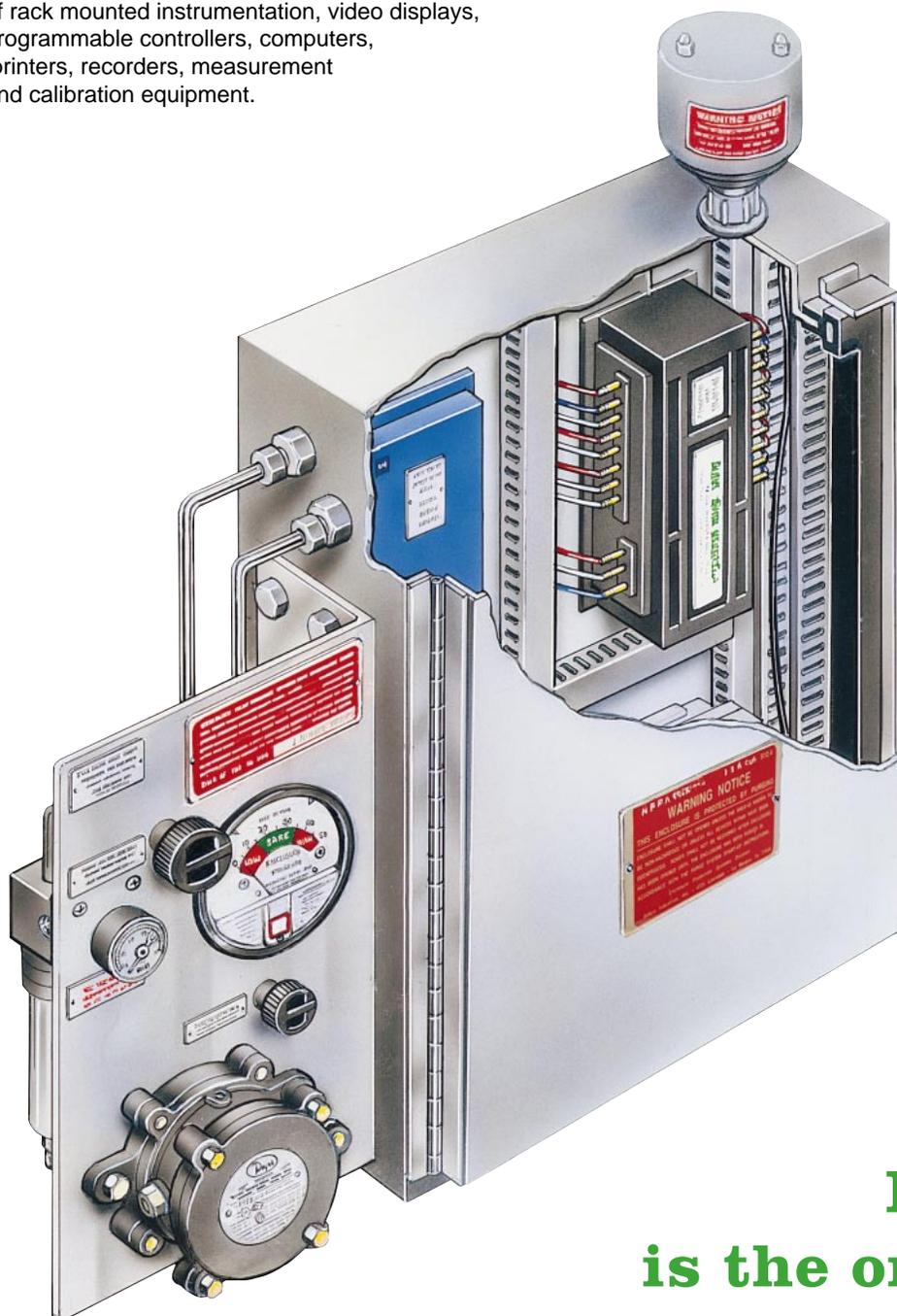
One of the best benefits is the slow but continuous flow of protective gas, which can be specifically used to eliminate problems like heat, moisture, dust and corrosion. And unlike explosion proof enclosures and intrinsic safety barriers, failure of a Bebcos Enclosure Protection System does not create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

ADVANTAGES

- Reduces Heat Build-Up
- Inhibits Metal Corrosion
- Requires Low Maintenance
- Increases Equipment Longevity
- Allows Fast Access to Equipment
- Reduces Moisture & Dust Build-Up
- Reduces Classification within Enclosure
- Continuous System Status Indication
- Protects Enclosures up to 450 Cu Ft
- Allows Use of any Enclosure Shape
- Cost of Protection per Cubic Foot Decreases with Enclosure Size

DISADVANTAGES

- Contains Moving Parts
- Requires Instrument Air Supply
- Some Systems Contain Electronics
- Some Systems Require Electrical Power



**Pressurization
is the only technology
that can prevent explosions
and extend your equipment's life**

Common Questions

What is purging?

The word "purging" is commonly used to describe the basic process of supplying sealed electrical enclosures or devices with a protective gas. This basic process is performed to remove flammable gases or prevent accumulation of ignitable dust, while maintaining a positive enclosure pressure. **NOTES:** To align their definitions with International Electrical Codes, American organizations now define this basic process as "pressurization." In addition, "purging" now only defines the sub-routine of expelling flammable gases in Class I locations.

What is used to purge an enclosure?

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; however, they are usually expensive and impractical.

What is the pressure requirement?

Most purging applications require a minimum enclosure pressure of 0.10 inches of water. This pressure is equivalent to 1/270 of 1 PSI. In some circumstances, a minimum enclosure pressure of 0.50 inches 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 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 at a 0.10 inch enclosure pressure should fall somewhere between 0.1 to 3.5 scfh per cubic foot 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.

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, Bebcos 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 14.

What kinds of devices can be purged?

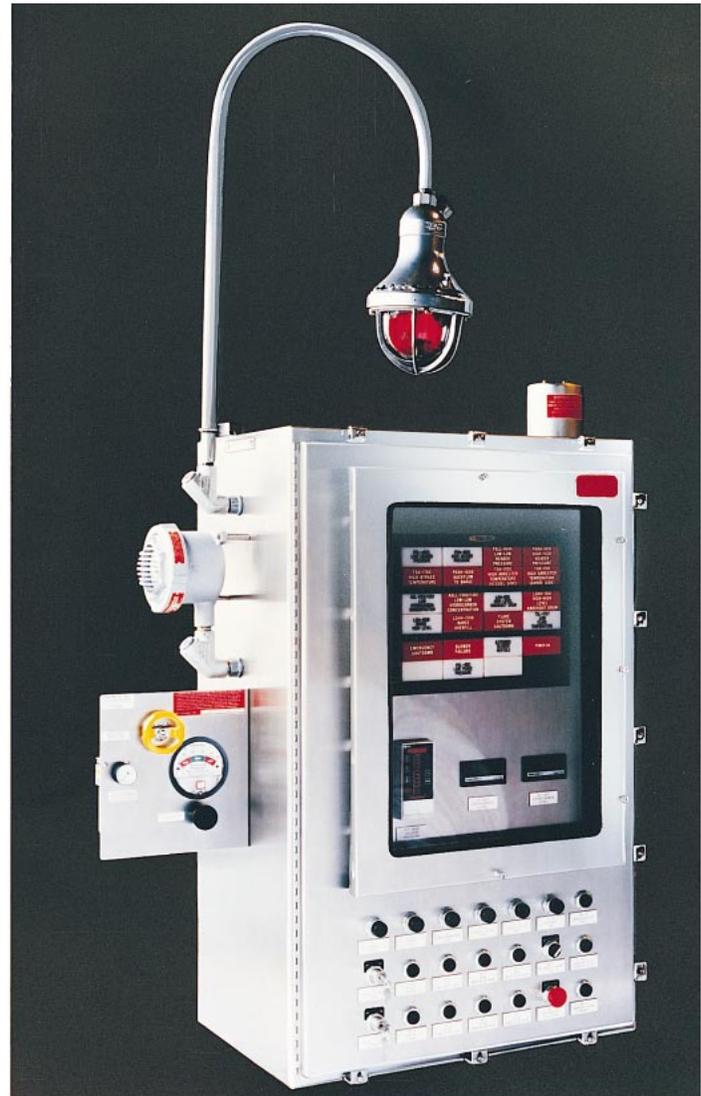
Virtually any basic electrical device can be purged, if all "live" or energized components can be isolated from the surrounding environment. Devices such as push-buttons, relays, timers and programmable controllers only need to be installed in a sealed enclosure. Motors only require a totally enclosed housing. In addition, Bebcos has developed methods to protect sophisticated devices, such as printers, analyzers and computer equipment. For more information on this subject, see page 16.

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 is 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 (see page 16). Advanced pressurization systems, like Bebcos Rapid Exchange™ Purging Systems can maintain a positive pressure, by increasing the flow of protective gas while the access door is open.

For information on special equipment requiring frequent access or exposure to the surrounding atmosphere, see pages 16 and 17.



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

Defining Hazardous Areas

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 non-profit 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 which specifies recommended practices for pressurization and purging.



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

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.

A hazardous location rating of "Class I, Group C, Division 2," for example, defines an area which contains gases or vapors that could be released into the atmosphere under abnormal conditions. Ratings can also be combined to cover multiple situations and substances, such as a rating of "Class I & II, Groups C, D & G, Division 2." Many conditions are examined to establish hazardous locations. Therefore, only qualified personnel should be permitted to establish or change area classifications.

Class Ratings

Classes are used to define the explosive or ignitable substances which 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

IMPORTANT NOTES:

Division 1 areas must be surrounded by Division 2 areas. Class II, Group E areas must be rated as Division 1 areas.

REFERENCE PUBLICATIONS:

See rear cover of this document for reference publication titles, names and release dates, along with current ordering information.

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, as well as control room ventilation and pressurization.

Bebco has proudly served on both committees since 1987. As the first American purging system manufacturer, we have also been honored with appointments to special subcommittees of both groups to rewrite their documents. Our first effort, the revised NFPA 496, was officially adopted for release in 1993. The NFPA document is now the American standard for design, marking and performance of enclosures and pressurization systems. The ISA document will address construction, installation and testing of protected enclosures and pressurization systems, and should be released in 1994.

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. This is because 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 nonclassified. 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, or be hermetically sealed. Automatic power control is not required.

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 is not required.

Pressurizing & Purging 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.

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 0.10 or 0.50 inches of water, dependent on particle density. 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 of water. Power can then be applied to the protected equipment under conditions established by the Division rating.

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 of water. The 1993 edition of NFPA 496 recommends 4 volume exchanges for all enclosures and 10 volume exchanges for all motors. **NOTE:** The word "purging" is commonly used as a term to define the complete process of pressurizing protected enclosures in Class I areas.

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

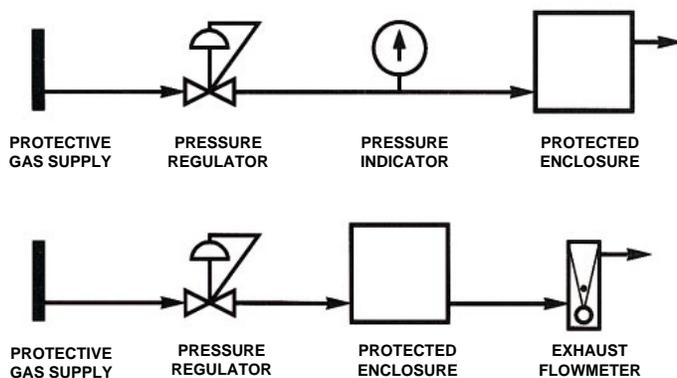
Obsolete Pressurization Systems

Pressurization systems first appeared in American refineries during the early '60s. But in the absence of specific construction standards, many design variations appeared. Most pneumatic systems featured an upstream regulator and a downstream flow meter. Some manufacturers, including *Bebco*, developed pneumatic systems which used an upstream regulator and gauge. Most electrical systems consisted of a blower and intake stack, along with an exhaust vent or louvers.

In addition, these systems were normally formed by mounting loose components in random locations, making them very obscure. In addition, the majority of these early designs failed to indicate enclosure pressure and did not feature audible or visual failure alarms. As the technology improved and gained popularity, these design flaws began to make older systems obsolete, due to the following changes:

- **The use of a flow meter or upstream pressure gauge for indication of enclosure pressure is now prohibited.** NFPA 496 now requires the use of a device which "indicates enclosure pressure" and "is not installed between the enclosure and the protective gas supply".
- **The use of a pressure gauge as a system failure alarm is now prohibited.** NFPA 496 now requires the use of an upstream supply alarm if an indicator is used downstream of the enclosure, unless the enclosure is also equipped with a downstream alarm.
- **The definition for any alarm has been clarified.** Standards now require the use of a device "which generates a signal and draws attention" - clearly indicating the use of a light or horn.

As noted before, these advances have made many of the original designs obsolete when applied against today's standards. In addition, most older systems were designed for individual applications and lack design or component uniformity. Furthermore, changes now effective in the 1993 NFPA 496 make many current 3rd party approved systems non-compliant. Therefore, it is important to examine all existing pressurization systems, regardless of their age.



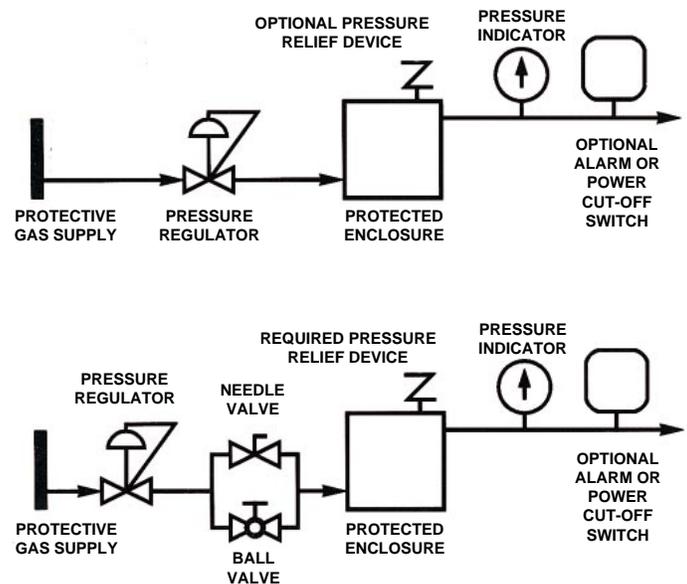
These pressurization system diagrams represent obsolete designs which no longer comply with NFPA 496.

Modern Pressurization Systems

Modern pressurization system designs offer the safest, most economical means of protection yet devised. However, while most designs have greatly improved, some are very elaborate and others still fail to comply with current NFPA and ISA recommendations. In addition, end users, manufacturers and the NFPA have come to consider a pressurization system to be an independent device.

Therefore, in 1985 *Bebco* formed the EPS® Division and became the first American manufacturer to produce a complete line of patented pneumatic pressurization systems. The result was a practical design that provides measurable fail-safe performance, yet most components are readily available and easily replaced or repaired.

In conclusion, *Bebco's* continuing efforts to accelerate the awareness, improvement and advancement of this technology has led to the popular acceptance of our designs as the basic standard. This is evident by the fact that while other manufacturers use different components and subtle design variations, most use our products as a benchmark. We therefore present our designs as a typical example of modern pneumatic pressurization systems:



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



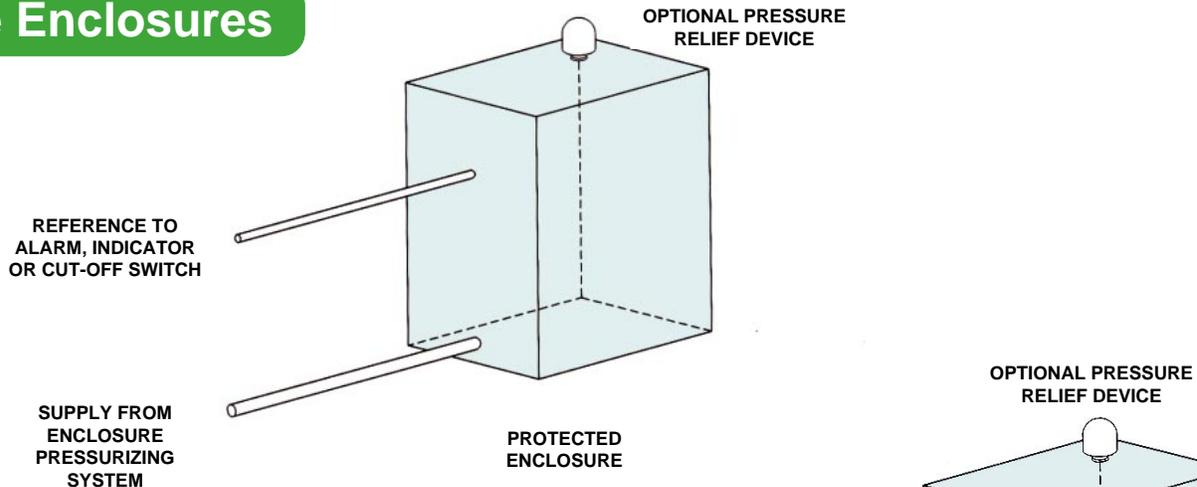
Bebco Model 1011 and 1012 Type Z Systems are fine examples of modern pre-engineered pressurization systems.

Typical Enclosure Connections

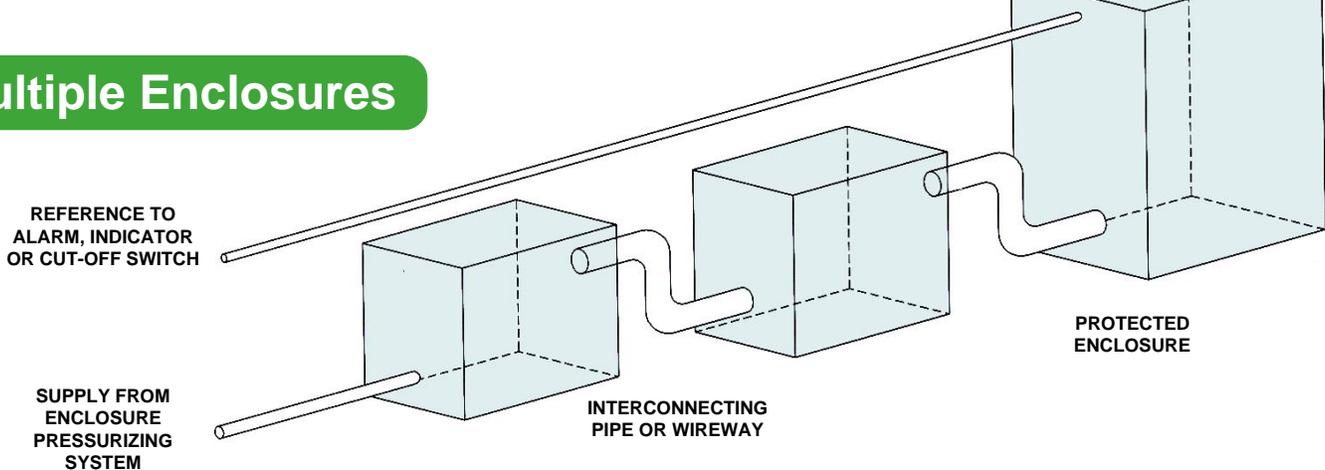
General Recommendations

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.
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 which has been approved by the authority having jurisdiction.

Single Enclosures



Multiple Enclosures



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 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

Protected Enclosure Requirements

The 1993 NFPA 496 **Section 2-3.2** requires the use of an alarm, indicator or cutoff switch on all protected enclosures. These devices are required to alert the user (Type Y & Z) or automatically de-energize power to all protected equipment (Type X), upon the loss of positive pressure within the protected enclosure(s).

Alarm and indicator requirements are specified for Type Y and Z systems under **Section 2-8.3 and 2-8.4**. Cutoff switch requirements are specified for Type X systems under **Section 2-10**.

Summary of Sections 2-8.3, 2-8.4 & 2-10

1. The device (indicator, alarm or cutoff) shall take its signal from the protected enclosure and shall not be installed between enclosure and protective gas supply.
2. The device shall be approved for the area in which it is installed and no valves shall be permitted between the device and the protected enclosure.
3. Indicators shall display either pressure or flow and shall be located for convenient viewing.
4. Alarms shall be mechanically, electrically or pneumatically actuated and shall be located in a constantly attended location.
5. Cutoff switches shall be pressure or flow actuated and shall automatically remove power from all protected devices upon loss of positive enclosure pressure.

Exceptions to **Sections 2-10** permit the continuation of power for a "short period" (undefined), if a loss of power to the protected equipment would result in a more hazardous condition than the loss of positive pressure. These exceptions are granted for normal, overload capable and ventilated equipment when the protected enclosure is equipped with an audible and visual alarm in a constantly attended location.

Protective Gas Supply Requirements

Section 2-3.3 requires an alarm to indicate failure of the protective gas supply. This section is primarily intended to prevent the use of an enclosure indicator as the only pressurization failure sensing device on Type Y and Z installations. Unfortunately, the 1993 NFPA 496 does not specify the location or installation requirements of a protective gas supply alarm. However, this device is usually located upstream of the protected enclosure in a position that can only indicate failure of the protective gas supply, not enclosure pressure. Therefore, an upstream protective gas supply alarm is not recommended by Bebcos, unless the protected enclosure is located in a constantly attended location.

To enforce Section 2-3.3 requirements, **Section 2-8.2** requires the use of an alarm on all Type Y and Z protected enclosures that can be isolated (with valves) from the protective gas supply. However, when an indicator is used on a protected enclosure, an exception to Section 2-8.2 allows isolation of the enclosure, if all valves are specifically labeled in accordance with **Section 2-11.4** (see page 12). In addition, the valves should only be used for maintenance and must be located immediately adjacent to the protected enclosure.

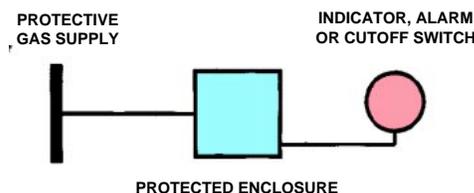
When considering the use of a device for the protected enclosure (to satisfy 2-3.2), an examination of NFPA 496 reveals the following:

1. If an alarm is used, it will satisfy the protective gas supply alarm requirement of Section 2-3.3.
2. If an indicator is used, a protective gas supply alarm is required to comply with Section 2-3.3.
3. If a cutoff switch is used, a protective gas supply alarm is technically required, because no exception or note permits the cutoff switch to satisfy Section 2-3.3.

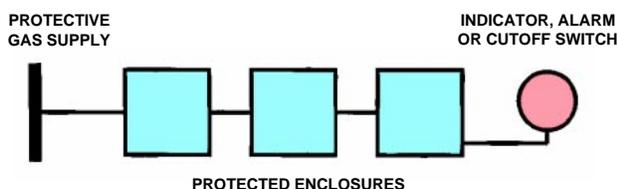
NOTE: Protective gas supply alarms and valve labels should be used on all installations, but NFPA 496 does not specifically refer to the use of these devices with Type X Systems (see Section 2-10).

Protected Enclosure Device Details

SINGLE ENCLOSURE APPLICATIONS

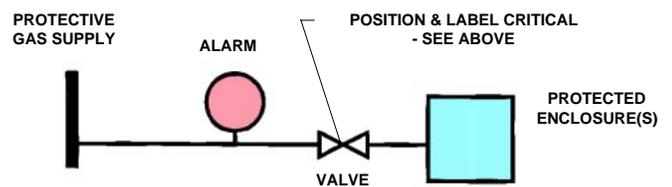


MULTIPLE ENCLOSURE APPLICATIONS

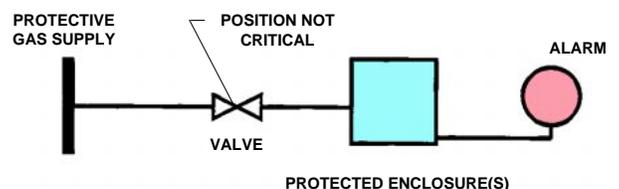


Protective Gas Supply Alarm Details

UPSTREAM ALARM APPLICATION



DOWNSTREAM ALARM APPLICATION



BOTH SETS OF DETAILS ABOVE MUST BE CONSIDERED INDEPENDENTLY TO ENSURE COMPLIANCE WITH THE SEPARATE NFPA 496 REQUIREMENTS FOR PROTECTED ENCLOSURES & PROTECTIVE GAS SUPPLIES

Enclosure Marking & Wiring

Enclosure Marking Requirements

Sections 2-11 & 4-3 of the 1993 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 - **Section 2-11.1.1:**

"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 - **Section 4-3:**

"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 3-3 requires the following or equivalent statement in addition to the statement required by Section 2-11.1.1 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 3-3 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 3-3** 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 2-11.1.2: Class, Group and Division of surrounding area

Section 2-11.1.3: NFPA pressurization Type X, Y, or Z

Section 2-11.1.4: T Code (temperature identification number): see NFPA 70, The National Electric Code, Article 500, Table 500-3(d)

Exception No. 1 to Section 2-11.1.4 allows omission of the T Code marking if the hottest temperature does not exceed 100°C.

Exception No. 2 to Section 2-11.1.4 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 2-5 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 2-11.3:**

"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 2-8.2** 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 2-11.4:**

"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

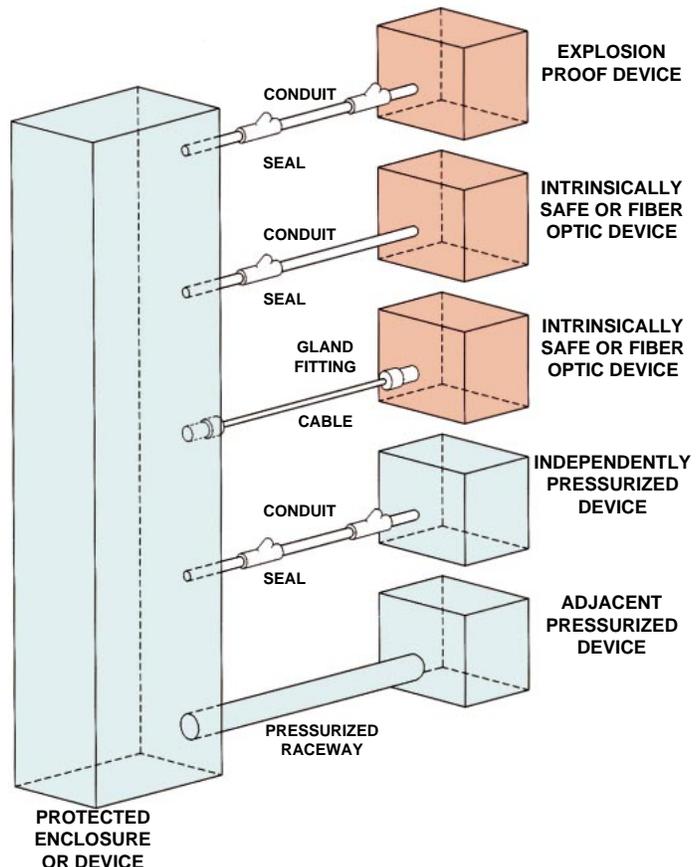
In a general sense, protected enclosures should be wired similar to explosion proof enclosures, in accordance with **Article 500** of the 1993 National Electric Code - **NFPA 70**.

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 Section 2-2.2** requires the use of approved seals on all pressurized enclosure conduit wiring entries, in accordance with **NFPA 70, Section 501-4**. 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, Sections 501-5 (d) & (e)**, protected enclosure cable entries can be sealed in accordance with **Section 501-5 (e) (4)** which permits the use of compression gland fittings or other sealed cable entry fittings, as opposed to approved conduit seals, if the wiring method is otherwise suitable for the hazardous location.

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 Connections



Basic Operating Procedures

Class II, Division 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 0.10 or 0.50 inches of water, dependent on particle density.
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, Division 2 Purging

START-UP CONDITIONS

Protection Method: Type "Z" Purging 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 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.

Class II, Division 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. Follow steps 1 through 3 above.
2. System will apply power automatically when pressure is set and maintained at a positive pressure of 0.10 or 0.50 inches of water (dependent on particle density).
3. 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.
4. Equipment that may overload or overheat, such as motors or transformers, require thermal overload cutoff switches or alarms.

Class I, Division 1 Purging

START-UP CONDITIONS

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

OPERATING PROCEDURES

1. Follow steps 1 through 3 above. **Step 3 exception is invalid.**
2. 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 of water.
3. 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.
4. Equipment that may overload or overheat, such as motors or transformers, require thermal overload cutoff switches or alarms.

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.
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 pressurization 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 which 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.

Calculation of Enclosure & 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.
3. Cubical device volumes should be calculated as follows:

$$\text{Height} \times \text{Width} \times \text{Depth} - \text{in inches} \div 1728 = \text{Cubic Feet}$$

$$- \text{in feet} = \text{Cubic Feet}$$
4. Cylindrical device volumes may be calculated as follows:

$$\pi r^2 \times \text{Cylinder Length} - \text{in inches} \div 1728 = \text{Cubic Feet}$$

$$- \text{in feet} = \text{Cubic Feet}$$

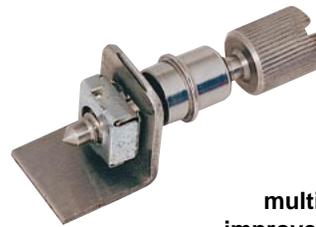
Adjacent & Internal Enclosures

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:
 2. Internal enclosures should be ventilated on the top and bottom sides with at least one (1) square inch of opening for each four hundred (400) cubic inches of volume within the internal protected enclosure, with a minimum size of quarter inch diameter; 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, if located in a Division 1 hazardous location.

Typical Fastening Methods



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



Some enclosure manufacturers utilize clamping fasteners to meet NEMA 4 or NEMA 4X performance requirements.

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

Typical Gasketing Methods



This enclosure door features a hard rubber trim, secured with adhesives and a spot welded metal gasket retainer.



This enclosure door features a polyurethane "foam in place" chemically bonded gasket.



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

Both custom built and standard enclosures are suitable for purging, if constructed to meet or exceed NEMA 4 or 12 performance requirements. However, regardless of origin, the use of enclosures featuring gasketing and multiple door fasteners is ideal.



In this application, a custom built stainless steel enclosure is fitted with several Bebcu products, including a Rapid Exchange™ Purging System, a Purgeable Instrument Access Door and an Enclosure Protection Vent.



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

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

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 which 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.

CONTROLLERS, INDICATORS & RECORDERS

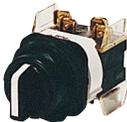
Today's panel mounted instrumentation is almost strictly electronic. The protruding face of these instruments normally contain light-emitting diode arrays, liquid crystal displays and incandescent or florescent lights. Therefore, it is extremely important to isolate all instrumentation from the surrounding atmosphere, unless the face is sealed and all electronics are properly ventilated to the protected enclosure.

Due to the limitations established above, most instruments will require isolation through the use of a sealed access door (see page 6). 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 products such as Bebcos Rapid Exchange™ Purging Systems and Bebcos Purgeable Instrument Access Doors. 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.



OPERATORS

Panel mounted operators such as push buttons and selector switches should be NEMA 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

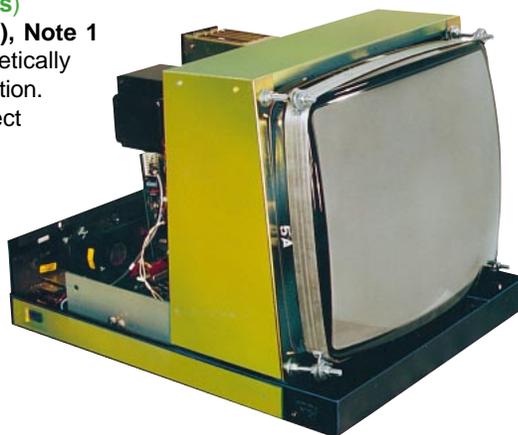
A pilot light is normally unacceptable unless rated for use in the hazardous location. However, some authorities having jurisdiction permit the use of LED clusters and VDC bulbs, after determining they have insufficient power to ignite the surrounding atmosphere. Other concerns should include impact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

Protruding Devices

The use of devices which penetrate the surface of a protected enclosure must be carefully scrutinized. This is because protruding devices will likely contain electrical components which 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.

CATHODE RAY TUBES (CRT's)

The 1993 NFPA 496, **Section 3-2.5 (c), Note 1** states that cathode ray tubes are hermetically sealed devices and do not require pressurization. Therefore, impact resistance is the only direct consideration. However, all associated devices and wiring should be pressurized and isolated from intrinsic safe circuits.



PERIPHERAL DEVICES & INSTRUMENT KEYPADS

Technically speaking, it is impossible to pressurize many peripheral devices, even if they are NEMA 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 safe 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.

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.



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 14). 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.

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.

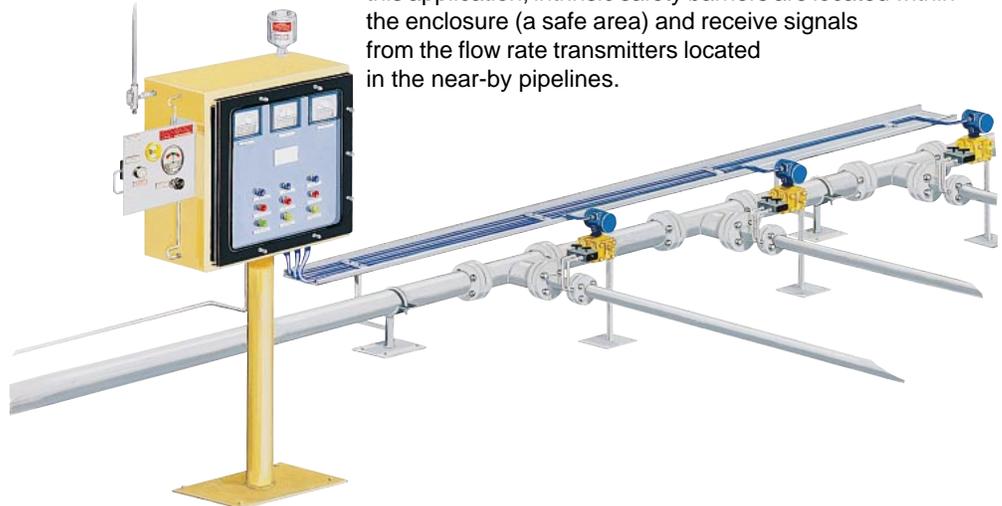
Displays & Annunciators

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.



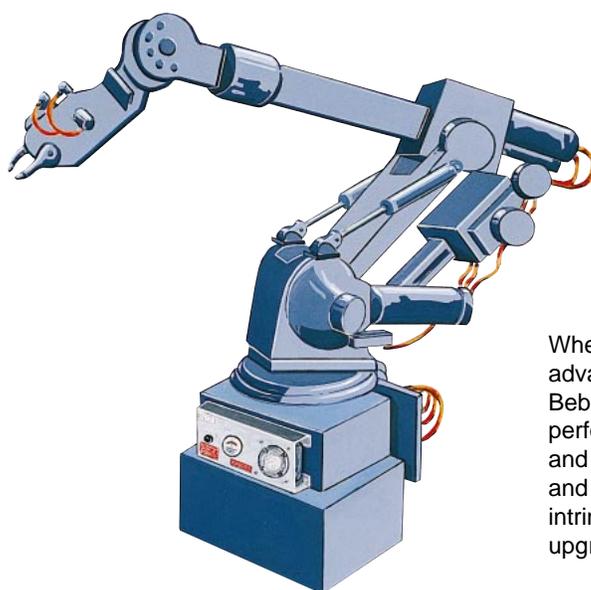
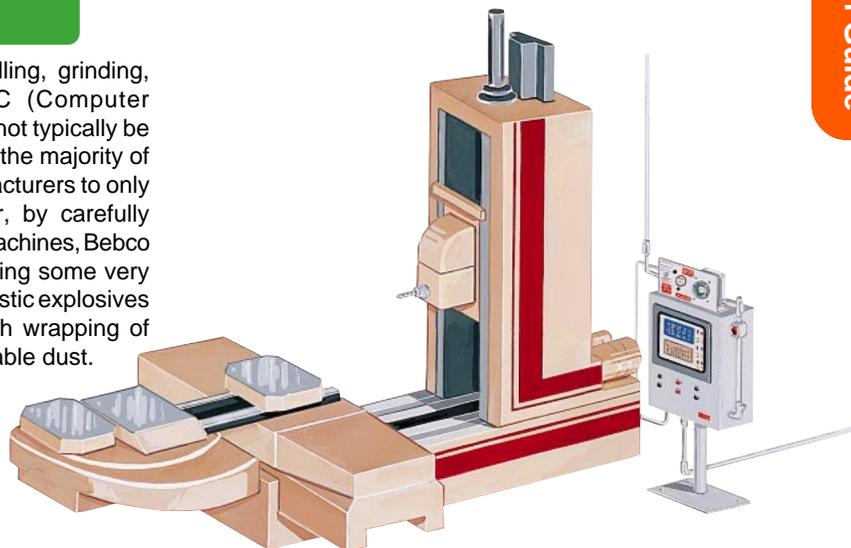
Local Control Panels

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 near-by pipelines.



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, 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.

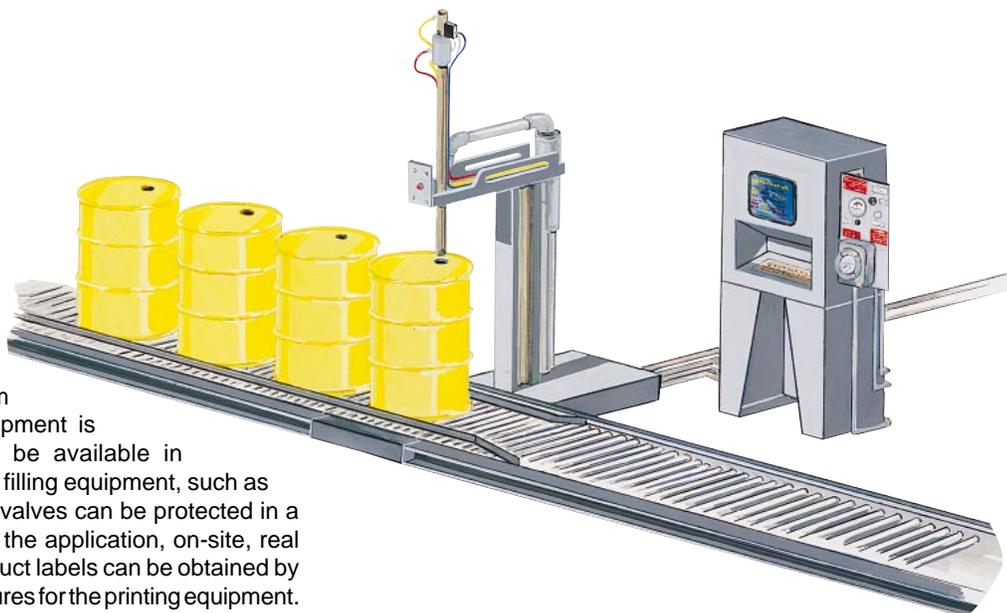


Robotics

Whether they are reciprocal motion or multi-motion machines, today's advanced robotic machines are going into many hazardous or toxic areas. Bebcos 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.

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.



In closing,

Thanks again for reviewing this literature. We hope you were enlightened, and feel more confident about this technology. However, please note that we always welcome your questions. We offer obligation-free assistance at all times, and we are ready and willing to offer advise on any project, regardless of any commitment to utilize our products.

Reference Publications

Document	Title	Edition
NFPA 496	Purged & Pressurized Enclosures for Electrical Equipment	1993
NFPA 497A	Classification of Class I Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas	1991
NFPA 497B	Classification of Class II Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas	1991
NFPA 497M	Classification of Gases, Vapors, and Dusts for Electrical Equipment in Hazardous (Classified) Locations	1991
NFPA 70	National Electric Code	1993
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)	1991
ISA RP12.4	Pressurized Enclosures	1996

Publication Ordering Information

NFPA - National Fire Protection Association
1 Batterymarch Park - PO Box 9146
Quincy, MA 02269-9101
PHN: (800) 344-3555
FAX: (617) 984-7057

NEMA - National Electrical Manufacturer's Association
2101 L Street, NW - Suite 300
Washington, DC 20037-1526
PHN: (202) 457-8474
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ISA - Instrument Society of America
Member & Customer Services - PO Box 12277
Research Triangle Park, NC 27709
PHN: (919) 549-8411
FAX: (919) 549-8288

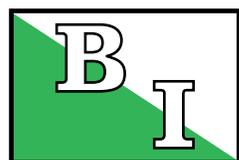
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