How to Select a Pepperl+Fuchs Enclosure Protection Vent

Purge and Pressurization Products

Technical White Paper



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Chris Romano
Product Portfolio Manager
Purge and Pressurization Systems

Introduction

Purge and pressurization is a type of protection that allows standard enclosures containing non-hazardous electrical equipment to operate safely in explosive atmospheres.

A properly designed purge and pressurization system must meet all requirements specified in the relevant standards.

One requirement that is sometimes overlooked, especially by DIY users, is the enclosure protection vent (EPV), also known as a pressure relief vent. This white paper explains why an enclosure protection vent is essential to system safety and performance and outlines how to select the appropriate vent from the many options available.

Abstract

Purge and pressurization systems provide protection for conventional electrical equipment in standard enclosures, allowing it to operate safely within hazardous areas. Compared to the explosionproof or flameproof type of protection, this approach is more cost-effective and helps prevent explosions before they occur.

This white paper does not cover the standards or procedures required for commissioning and operating purge and pressurization systems. Instead, it focuses on the requirements for enclosure protection vents and the cost of air needed to operate these systems. Selecting an enclosure protection vent depends on several factors and system parameters. Air consumption is evaluated for both purging and pressurization modes, which are required in hazardous gas environments. The cost of air is often overlooked but should be considered when selecting the type of protection and corresponding enclosure protection vent.

Purge and Pressurization Terms

Pressurization

A method of preventing ingress of the external atmosphere into an enclosure by maintaining a protective gas at a pressure higher than the surrounding environment. (Source: IEC 60079-2:2014; CENELEC - EN 60079-2 Explosive atmospheres - Part 2: Equipment protection by pressurized enclosure “p”)

Pressurized Enclosure

Enclosure in which a protective gas is maintained at a pressure greater than that of the external atmosphere. (Source: IEC 60079-2:2014)

Pressurization Control System

Also referred to as a pressurization system or a pressurizing system, this is a collection of safety devices designed to monitor and maintain the safety on which pressurization relies.

Protective Gas

Air or inert gas is used to maintain overpressure and, when required, for dilution and purging. (Source: IEC 60079-2:2014)

Protected Equipment

The equipment internal to the pressurized enclosure, protected by pressurization.

Overpressure

The positive pressure differential inside a protective enclosure that prevents the surrounding, potentially explosive atmosphere from entering the enclosure.

Maximum Overpressure

The maximum pressure that can be safely handled by the pressurized enclosure.

Minimum Overpressure

The minimum amount of pressure required to maintain safety within the pressurized enclosure.

Pressurized Equipment

An overall assembly of a pressurized enclosure, pressurization control system, and the protected equipment.

Purge Pressure

Pressure inside the pressurized enclosure during the purge cycle.

Purge Cycle

The period during which a high volume of protective gas flows through the pressurized enclosure to flush the enclosure and its contents.

Safety Device

Device used to implement or maintain the integrity of the type of protection. (Source: IEC 60079-2:2014)

Ignition-Capable Equipment

quipment that can serve as a source of ignition for a specified potentially explosive atmosphere during normal operation.
(Source: IEC 60079-2:2014)

Pressurization – Function Principle

To better understand the concept of explostion protection, it is helpful to consider the ignition triangle. The vertices of this triangle represent the three essential elements needed to create a fire or explosion hazard in a gas- or vapor-related applications:

- A source of ignition
- The right amount of oxygen
- The correct concentration of fuel

According to this fundamental concept, ignition cannot occur if the concentration of a material is below the minimum threshold, known as the “lower flammable limit” (LFL), provided that oxygen levels remains at normal atmospheric conditions. The existence of a minimum concentration required for flammable or combustible materials to pose a fire or explosion hazard is a key concept essential to explosion protection methods.

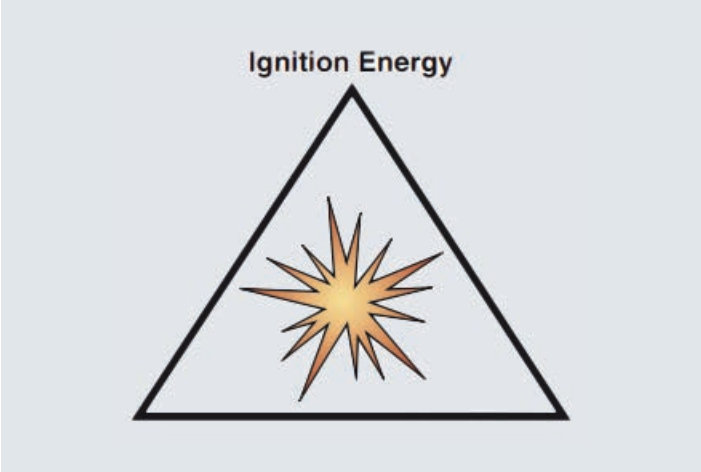


Figure 1 The ignition triangle consists of 3 components

Gas Applications

Pressurization works by creating an environment within pressurized equipment that maintains gas levels significantly below the lower flammability limit (LFL) of the surrounding, potentially explosive gas atmosphere. Initially, an enclosure containing ignition-capable equipment undergoes a purge cycle. The purpose of this cycle is to flush out any remaining gas trapped inside the enclosure, ensuring that levels after the purge cycle are far below the LFL of the flammable or combustible materials for which the equipment is designed. Following the purge cycle, a positive pressure is established within the protected equipment in relation to the surrounding, potentially explosive atmosphere. This positive pressure, known as minimum overpressure, prevents the surrounding, potentially explosive atmosphere from entering the now “clean” enclosure. Once the internal volume of the pressurized equipment is considered safe, energy can be applied to the ignition-capable electrical equipment within the pressurized enclosure, allowing it to operate normally. If the minimum overpressure level is compromised, the system either alerts the operator to take immediate action or automatically initiates a shutdown to maintain the safety of the equipment in the hazardous area.

Dust Applications

Dust explosions involve the three elements of the ignition triangle, along with confinement and dispersion.
For dust applications, the purge cycle is replaced with a physical cleaning process. This process is conducted to remove all hazardous dust from the internal components of the pressurized enclosure used for the equipment. Once the cleaning is complete, the enclosure is pressurized.

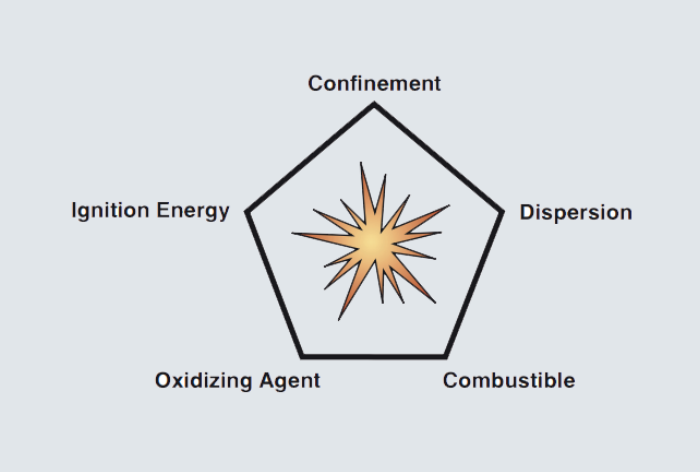


Figure 2 The ignition pentagon for dust adds confinement and dispersion

Purging Enclosures in Dust Atmospheres

A high-airflow purge cycle is not used when purging an enclosure in a dust hazardous area. Such a purge cycle could disperse dust inside the pressurized enclosure, creating an additonal hazard. It could also cause dust dispersion outside the enclosure, which must likewise be avoided. In both cases, dispersion is a risk that needs to be avoided. Furthermore, dust cannot be fully purged from the enclosure through purging in the same way that gases or vapor can.

The interior of the pressurized equipment should be cleaned using methods that minimize the risk of creating a dust cloud. For example, using a vacuum cleaner is preferred over blowing out the equipment with pressurized air. The vacuum cleaner itself may also need to be approved for use in the applicable hazardous area. All areas within the enclosure must be thoroughly cleaned, including any components or surfaces inside the protected equipment where dust may accumulate.

After cleaning the inside, the enclosure is closed and immediately brought to the required positive minimum overpressure. Once again, this positive pressure prevents the surrounding, potentially explosive atmosphere from entering the now “clean” enclosure. Once the area within the pressurized enclosure is considered safe, energy can be applied to the electrical devices within the pressurized enclosure and they can be allowed to operate normally. In the event that the minimum overpressure level is lost, the system either alerts the operator to take immediate action or initiates an automatic shutdown in order to maintain the safety of the equipment in the hazardous area.

The explanations provided earlier generally describe the process of pressurization in common applications. The enclosures used in these applications are not completely sealed, which means a continuous supply of protective gas is required to maintain a minimum overpressure. This common pressurization scenario is referred to as leakage compensation, which is the main focus of this white paper.

However, there are special considerations for gas and vapor applications where a hazardous substance is directly introduced into the pressurized enclosure as part of the pressurized equipment. In these cases, a modification to the standard pressurization principle, known as dilution, is generally implemented. For more information, please refer to the chapter titled “Dilution Applications” on page 18.

Types of Purge and Pressurization

For Class/Division applications, the Types of pressurization systems covered by NFPA 496 are defined as the following:

Type X

This designation allows unclassified equipment to be located in a protected enclosure and operated in a Division 1 location, following a successful purging (if not affected by dust) and pressurization process of the protected enclosure. If the pressure within the enclosure drops below the minimum overpressure threshold, the power to the enclosure must be turned off and cannot be restored until after a successful purge cycle has been completed.

Type Y

Allows Division 2-rated equipment to be located in the protected enclosure and operated in a Division 1 location after successful purging (if not dust) and pressurization of the protected enclosure. Unlike a Type X system, all equipment within the protected enclosure must be Division 2 rated. If the pressure within the enclosure drops below the minimum overpressure threshold, the power to the enclosure must be turned off and cannot be restored until after a successful purge cycle has been completed, or the power can remain on but an audible and/or visual alarm has to be initiated.

Type Z

Allows unclassified equipment to be located in the protected enclosure and operated in a Division 2 location after successful purging (if not dust) and pressurization of the protected enclosure. If the pressure within the enclosure drops below the minimum overpressure threshold, the power to the enclosure must be turned off and cannot be restored until after a successful purge cycle has been completed, or the power can remain on but an audible and/or visual alarm has to be initiated. For Zone applications, IEC 60079-2 gives a similar definition of the types of pressurization systems:

For Zone applications, IEC 60079-2 provides similar definitions for pressurization system types:

pxb

pxb follows the same principle as Type X, which allows ignition-capable equipment to be safely installed inside a pressurized enclosure for Zone 1 or 21 applications.

pyb

pyb follows the same principle as Type Y, which allows Zone 2 or 22-rated equipment to be safely installed inside a pressurized enclosure for Zone 1 or 21 applications.

pzc

pzc follows same principle as Type Z, which allows ignition-capable equipment to be safely installed inside a pressurized enclosure for Zone 2 or 22 applications.

Although the classification levels appear similar, the specific requirements for each protection concept can differ. It is important to understand the requirements applicable to the installation, based on Zone or Class/Division. Please refer to the relevant standards for guidance.

What Is an Enclosure Protection Vent?

An enclosure protection vent is required during purging or pressurization to manage maximum overpressure in gas and dust environments. These vents serve two critical functions: they act as pressure relief devices and facilitate the release of protective gas that accumulates the during purging process. In Division 1/Zone 1 applications, these devices also measure the flow through the vent, ensuring proper purging.

Although purging is not required for dust applications, excessive airflow into the protective enclosure can still cause major system failure. Without an enclosure protection vent, pressure may build up beyond safe limits, leading to enclosure or system failure.

A properly designed enclosure protection vent must include a spark and particle barrier at the point where gas is exhausted from the vent. This gas often exits the vent into a hazardous area. Since the equipment inside the enclosure can be operating and may include ignition-capable devices, it is crucial that any sparks generated within the enclosure do not escape into the hazardous area. This is achieved through the use of a spark barrier. Given its important role in the purge and pressurization system, it is essential to install a vent and spark arrestor that have been evaluated and certified by a recognized third-party agency.



EPV-7500 enclosure protection vent, showing the wire mesh spark and particle barrier

Vent Mounting

Gravity-dependent vents maintain the protective enclosure below the breaking pressure and must be used in their designated orientation.



EPV-_-SA-00: designed for top-mount configurations only



Newer design, universal mount

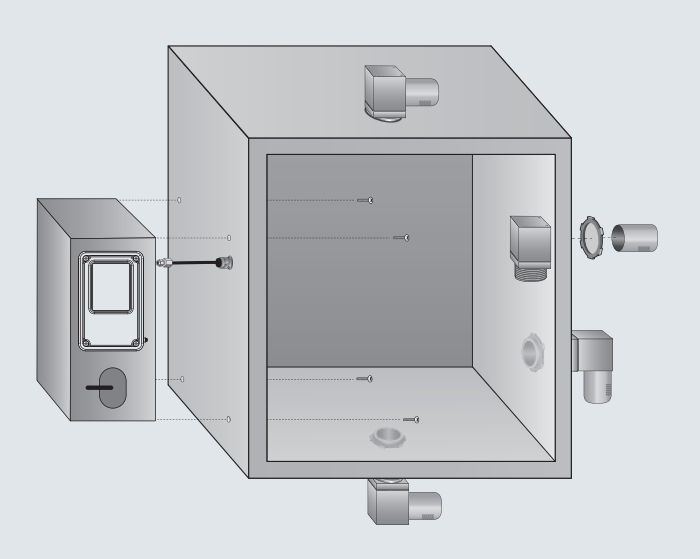


EPV-_-SA-90: designed for side-mount configurations only

Pepperl+Fuchs' next generation of vents are not gravity dependent, allowing the customer to use the same unit for various mounting configurations.



Newer design, universal mount



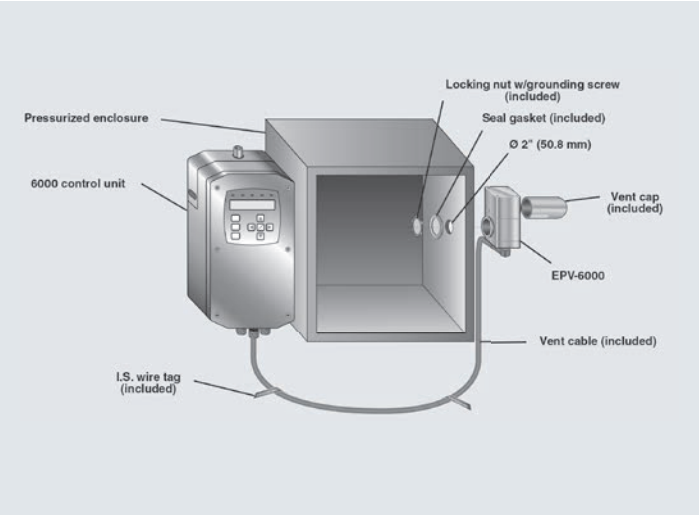
When working with enclosure protection vents for purging and pressurization, it is important to recognize that the vent may release pressure from inside the enclosure while the equipment is operating. This creates an ingress point that allows outside elements to enter the enclosure. Therefore, the vent should be placed in a location that minimizes vulnerability to dirt, dust, and water ingress.

One of the main advantages of these universal-mount vents is that users can change the orienation of the mounting on the enclosure at any time. These vents can be mounted either entirely outside the enclosure or inside, with only the vent cap remaining outside.

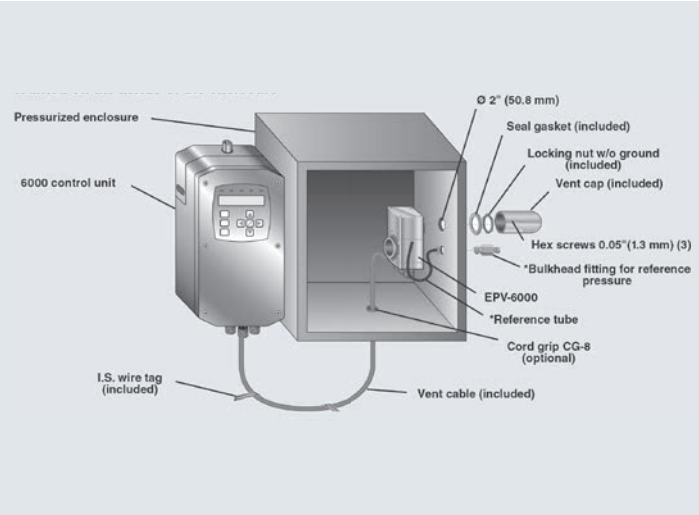
The illustration below shows how to mount the EPV-7500 or EPV-5500 vents. As these vents contain no electronics, both internal or external mounting is straightforward.

The differential pressure sensors in the EPV-6000 and EPV-6500 vents measure airflow and take pressure readings from both inside and outside the enclosure. When the vent is mounted on the outside of the enclosure, there is no need for additional tubing, as the enclosure pressure reading is captured through the tube that extends from the vent inlet. (The vent inlet is always located inside the enclosure, while the external pressure port is situated on the vent body, which is outside the enclosure.) However, when the vent is mounted inside the enclosure, the external pressure port is now inside. In this case, a connection to the outside of the enclosure is required.

Vent mounted on the outside of the enclosure



Vent mounted on the inside of the enclosure



*Reference tubing and hardware included with EPV-6000-SS models

EPV – Breaking Pressure

The breaking pressure of an enclosure protection vent is the internal pressure at which the vent begins to open. Below this pressure, the vent remains closed, although minor leakage may occur due to the design. Once the breaking pressure is reached, the vent starts to release pressure from the enclosure. The flow of protective gas from the enclosure depends on the enclosure pressure, and many vents provide variable flow that adjust according to the internal pressure.

EPV – Maximum Pressure

The mechanisms inside enclosure protection vents enable variable flow based on the enclosure pressure above the breaking pressure. During purge cycles, flow is determined either through a flow sensor integrated in the vent or by correlating flow to enclosure pressure. The vent's maximum allowable pressure is defined by the maximum pressure the enclosure can safely withstand. For certification of the complete system, a proof test must verify that the enclosure shows no permanent deformation when subjected to an overpressure test at 1.5 times its maximum rated pressure. Each vent is characterized by flow and pressure data, typically presented as curves or tabulated values, showing the relationship between pressure and flow. This test is commonly performed with the vent mounted on the enclosure to ensure accurate and representative results.

Normally the vent is unaffected by higher flow at elevated enclosure pressure. The enclosure's integrity must be assessed to determine the maximum flow it can safely withstand. During purging, the internal pressure can reach up to 4 inch w.c. For reference, 27.7 in. w.c. (69.2 mbar) is equivalent to 1 psi, a force capable of causing significant structural damage to an enclosure.

Example: Overpressure Required for a Typical Control Cabinet

A typical control cabinet with a 3 ft. × 6 ft. (0.9 m × 1.83 m) door has a surface area of 2592 in2 (1.67 m2). At the minimum overpressure specified in NFPA 496 and in IEC 60079-2:2014 for a pzc of 0.1 w.c. (25 Pa), the force on the door is approximately 9.4 lbs. (4.2 kg). While acceptable under normal conditions, opening the door under pressure can pose a hazard if unexpected. Additionally, during a purge cycle, internal pressures may rise to about 4.0 w.c. (1,000 Pa) or higher, resulting in a door force of roughly 376 lbs. (170.5 kg). This far exceeds the capacity of a typical single-point latch..

This example shows the significant forces that an enclosure experiences during overpressure tests. It highlights the critical need for a multiple-door-latch system, especially in large enclosures, and underscores the operational risks of neglecting these requirements. Thorough consideration must be given to enclosure design and selection. These strength requirements exclude the use of plastic or polymer materials for enclosure construction, as non-metallic materials may also present UV and electrostatic hazards.

Type X/pxb, Type Y/pyb, or Type Z/pzc Vents

EPV-6000: Type X/pxb | EPV-6500: Type X/pxb and Y/pyb

The EPV-6000 and EPV-6500 are very similar in design. The IEC 60079-2 standard requires that all purging systems in a Zone 1 application monitor the flow at the exhaust of the vent. The EPV-6000/6500 vents have an internal flow sensor that measures the flow. They also have a differential pressure sensor to indicate the enclosure pressure. These vents work with their corresponding control unit, which provides intrinsically safe (IS) power and communications for reporting flow and pressure levels. The flow sensor is located in the center of the vent opening for accurate flow measurement. The differential pressure sensor requires a low and high port for measurement. The high port side is measured through a tube that extends approximately ¾ inch beyond the vent's opening. The low-pressure port, typically used to measure atmospheric pressure, is located on the side of the vent and features a sintered element to protect against dirt, water, and insects. It also includes the required spark arrestor. The vent exhaust can be rotated to face away from environmental hazards and is equipped with a spark arrestor as required.

These vents are designed to be mounted either externally on the enclosure, via a locknut, or internally, through a hole in the enclosure wall, placing the vent body inside the enclosure and the cap on the outside. When mounting internally, the sintered element is removed so that a tube fitting can be attached to reference the outside pressure through tubing and a bulkhead fitting. The stainless steel models (EPV—SS-—) include the fittings and tubing needed for an internal mount, while the aluminum models (EPV-—-AA-—) do not. This is because the '-SS' vent features a marine-grade aluminum body and a stainless steel cap. This design ensures that only the cap is exposed externally; all wetted materials are stainless steel.



EPV-6000 / EPV-6500 Class I or II, Division 1 / Zone 1 or 21

EPV-7500 and EPV-5500: Type Z/pzc

The EPV-5500 and EPV-7500 are very similar in design with the exception that the EPV-5500 has an exhaust cap with two rows of slots and the EPV-7500 has three rows of slots. Vents with more slots are able to accommodate higher purge flows. Both vents contain no electronics, as flow and pressure are measured by the 5500 or 7500 control unit, and standards do not require flow measurement at the exhaust. Since the vent opening and cap designs match those of the EPV-6000/6500 vents, the mounting remains unchanged.



EPV-5500 / EPV-7500 Class I or II, Division 2 / Zone 2 or 22

Types of Vents

Levels of EPV Operation

- During the purging process, the vents must open to allow excess pressure and flow to be released from the enclosure. The NFPA 496 and IEC 60079-2 standards require that the free volume of the enclosure be flushed multiple times before it can be considered free of hazardous gas. Specifically, NFPA 496 mandates four volume exchanges, while IEC60079-2 requires five volume exchanges. For motors, both standards specify ten volume exchanges; however, when calculating this, the stator volume can be deducted from the free volume.
- After purging or pressurizing the enclosure, the flow rate must be reduced to account for any leakage through the enclosure and vent. Even if the vent is sealed, slight leaks may still occur through the flapper or plunger mechanism.
- If, during operation and pressurization of the system, the pressure inside the enclosure begins to rise, the vent will open to release the excess pressure. The pressure point at which the vent starts to open is known as the breaking pressure.

The enclosure protection vents can be selected based on their flow rate, enclosure pressure, and leakage rate during pressurization. These options are incorporated into the nomenclature of the EPV family. For example, the available material and configuration options for the EPV-7500 vent are illustrated below.

Material

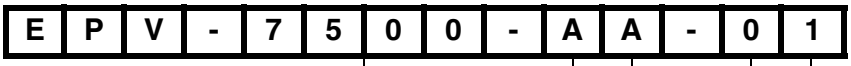
In situations where the vent specifications require stainless steel construction, the “SS” option of Pepperl+Fuchs vents offers the customer a cap and spark arrestor made of 316 stainless steel. However, the body of the “SS” vents is made of marine-grade aluminum. The body of the vent is mounted inside the enclosure, while only the cap is located outside. The ‘-AA’ comes with both the cap and body made of marine-grade aluminum.

Note

When the body of the EPV-6000 and 6500 is mounted inside an enclosure, the ambient pressure port located on the side of the vent must be connected to the pressure outside the pressurized enclosure. The ‘SS’ version of the EPV-6000/6500 includes fittings and tubing to extend the port to the outside.

Configuration

This defines the flow rate and enclosure pressure during the purging process. It also specifies the breaking pressure of the vent and the leakage that may occur through the vent when the enclosure pressure is below the breaking pressure, which is crucial during pressurization.



Configuration

01	35 SCFM (990 l/min) max flow, brk. press. 0.8" wc (2 mbar)
02	35 SCFM (990 l/min)max flow, brk. press. 1.4" wc (3.5 mbar)
03	16 SCFM (452 l/min) max flow, brk. press. 1.5" wc (3.8 mbar)
04*	14 SCFM (396 l/min) max flow, brk. press. 1.4" wc (3.5 mbar)

Material

AA	Body and cap: 6061T aluminum
SS	Body: 6061T aluminum, cap: 316L stainless steel

Series of vent

7500	7500 Series

* The only possible combination with these options is “EPV-7500-AA-04”

Flow Rate

The vent controls flow using either a flapper or plunger mechanism mounted inside the vent. The choice of design depends on the specific configuration requirements. Both designs use a spring to keep the vent closed.

Flapper design: Available in single- or double-spring versions. The spring(s) hold the flapper(s) against the aluminum opening to form a seal. The single-spring version provides the highest flow rate at the lowest enclosure pressure during purging, but it also has the highest leakage during pressurization.

Plunger design: Features a spring and an O-ring for optimal sealing during pressurization. However, it delivers the lowest flow rate and the highest enclosure pressure during purging.

Eliminating One Configuration

On initial inspection, the flapper vents, both the single- and double-spring versions, may appear to perform similarly, making selection between them seem difficult.

However, each is optimized for specific applications. The vent with two springs (double-spring flapper) is intended for specialized applications requiring a more complete seal to minimize leakage and was developed prior to the plunger-style vent. Since the introduction of the plunger-style vent, far fewer applications require the double-spring version. Although still available, it is no longer recommended for vent specification. Accordingly, the graph below presents only the single-spring and plunger-style vents.

The two-spring vents are designated as follows:

- EPV-7500/5500-...02
- EPV-6000-...03/04
- EPV-6500-...03



Flapper design (one or two spring)

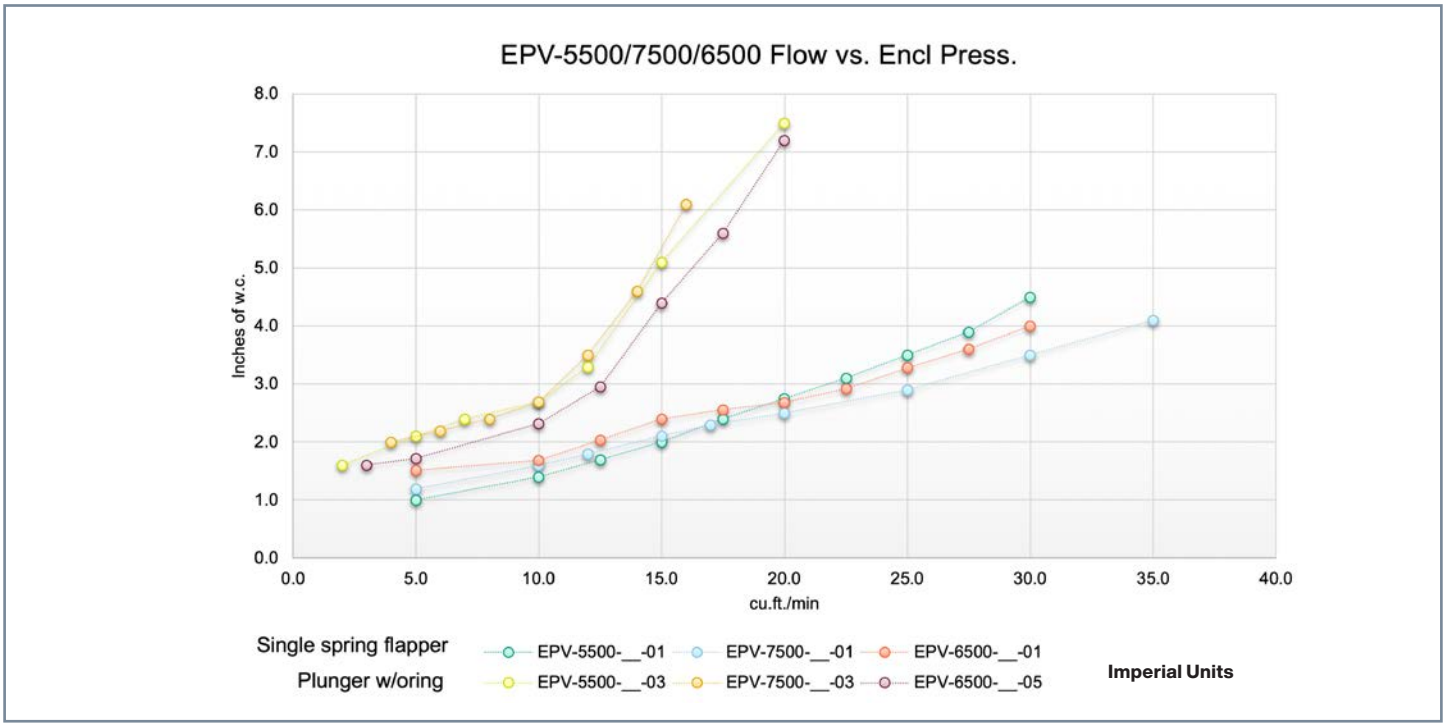


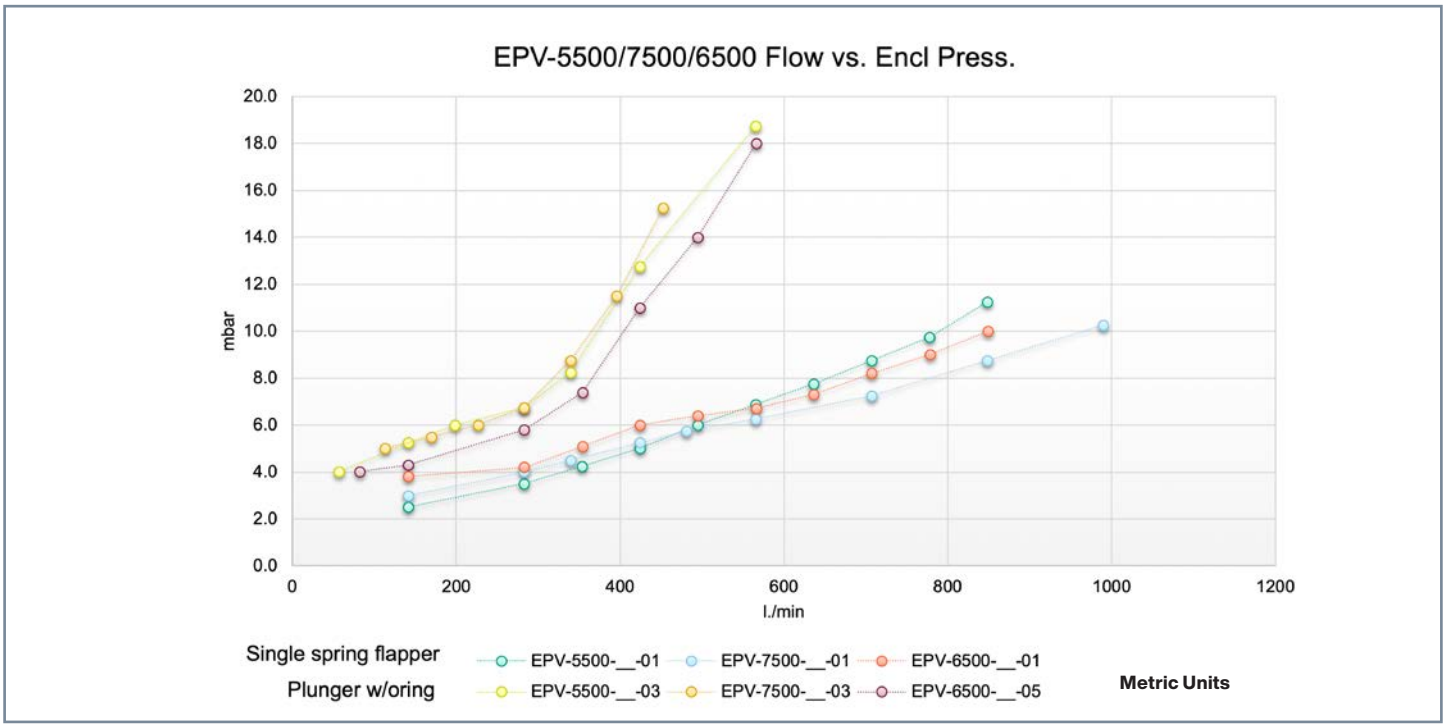
Plunger design

The graphs below demonstrate that the plunger-style vent maintains a higher enclosure pressure at the same flow rate compared to the single-spring flapper vents. The difference is primarily due to the plunger-style vent's superior sealing capability when the enclosure is pressurized and below its breaking pressure.

For clarity, the EPV-6000 vent is not included in the graph, but the flow and pressure data are based on four flow rates: 5, 12, 20, and 30 cu.ft./min (141, 339, 565, 848 l/min). The pressure measurements for these flow rates are very similar to those of the EPV-6500 vents.

The leakage rate of a vent is the amount of flow that escapes when the pressure inside the enclosure is lower than the vent's breaking pressure. Althought the vents are technically sealed at this pressure, small openings in the flapper and plunger design remain unavoidable. Additionally, some pressure is applied to the flapper by the minimal pressurization needed for safe operation of the equipment. The orientation of the vent also impacts the integrity of the seal. While these vents can be mounted in various orientations, a more effective seal is achieved when the flapper or plunger mechanism is positioned horizontal and facing upwards rather than downwards. Gravity contributes to this effect, even though the vents are sealed with a spring. The leakage rates shown reflect the highest expected leakage rates when the vents are facing down. When oriented upwards, leakage can be reduced by 5–15%.





Leakage rate at pressurization in cu.ft. /min (L/min)

	at 0.25 in wc (0.63 mbar)	at 0.75 in wc (1.9 mbar)	Type
EPV-5500-__-01	0.35 (9.88)	0.97 (27.33)	Single spring
EPV-7500-__-01	0.35 (9.88)	0.97 (27.33)	Single spring
EPV-6000-__-01/02	0.35 (9.88)	0.97 (27.33)	Single spring
EPV-6500-__-01	0.35 (9.88)	0.97 (27.33)	Single spring
EPV-5500-__-03	0.03 (1)	0.03 (1)	Plunger
EPV-7500-__-03	0.03 (1)	0.03 (1)	Plunger
EPV-6000-__-05/06	0.03 (1)	0.03 (1)	Plunger
EPV-6500-__-05	0.03 (1)	0.03 (1)	Plunger

The 6000 purge system can utilize two vents for a single control unit. The EPV-6000 vents are assigned different addresses for communication back to the control unit, which is why two vents are indicated in the table above. Aside from their communication addresses, the vents are identical.

These leakage rates should be considered as only one of several sources of leakage from the enclosure. It is expected that IP64, NEMA 4 enclosures will experience some degree of leakage when pressurized. In practice, overall enclosure leakage is typically greater than vent leakage. Enclosures are designed to minimize the entry of dust, dirt, and moisture, but they are not specifically intended to prevent pressurized air from escaping.

The breaking pressure values for the vents indicate the amount of pressure needed to open the vent. If the enclosure pressure falls below this threshold, the vents remain closed, though slight leakage may occur due to their design.

Breaking pressure

Vent type	In. wc. (mbar)	Type
EPV-5500-__-01	0.8 (2.0)	Single spring
EPV-7500-__-01	0.8 (2.0)	Single spring
EPV-6000-__-01/02	0.8 (2.0)	Single spring
EPV-6500-__-01	0.8 (2.0)	Single spring
EPV-5500-__-03	1.5 (3.8)	Plunger
EPV-7500-__-03	1.5 (3.8)	Plunger
EPV-6000-__-05/06	1.5 (3.8)	Plunger
EPV-6500-__-05	1.5 (3.8)	Plunger

Selecting the Right Vent for Any Application

The selection of an enclosure protection vent is determined by two key system parameters. The first parameter is the area classification, which is based on Class/Division or Zone. Once the appropriate control unit is chosen for the application, the final selection of the vent depends on three factors: purge flow, enclosure pressure, and leakage.

Below are a few examples that showcase different enclosure sizes and demonstrate the performance differences between a single-spring vent and a plunger vent.

The following applies to the examples below:

$$\text{Purge time} = \frac{\#\text{ of exchanges} \times \text{enclosure volume}}{\text{flow rate}} = \#\text{ min.}$$

$$\text{Force on door} = \frac{(H'' \times L'') \times \text{purge pressure}}{27.7\text{ in / psi}} = \#\text{ lbs.}$$

Example 1: Small Enclosure Purging

- Enclosure volume = H × L × W = 24 in × 24 in × 6 in = 2 cu.ft. (0.054 cu. meters)
- No. of volume exchanges = 4
- Vent selected: EPV-7500-__-01

Example 2: Same as Example 1, Using -03 vent

- Enclosure volume = H × L × W = 24 in × 24 in × 6 in = 2 cu.ft. (0.054 cu. meters)
- No. of volume exchanges = 4
- Vent selected: EPV-7500-__-03

Flow rate – cu.ft./min. (L/min.)	Purging pressure – in wc (mbar)	Purge time – minutes	Force on door (H × L) – lbs. (kg)
5 (141)	1.3 (3.3)	1.6	27 (12.2)
10 (339)	1.6 (4.0)	0.8	33 (15.0)
20 (565)	2.5 (6.3)	0.4	52 (23.6)
30 (848)	3.5 (8.8)	0.3	72 (32.6)

Example 1: Small enclosure purging using EPV-7500-__-01 (single spring)

Flow rate – cu.ft./min. (L/min.)	Purging pressure – in wc (mbar)	Purge time – minutes	Force on door (H × L) –lbs. (kg)
4 (113)	2.0 (5)	2.0	41 (18.5)
10 (282)	2.7 (6.8)	0.8	56 (25.3)
16 (452)	6.1 (15)	0.5	127 (57.5)
30 (848)	n/a	n/a	n/a

Example 2: Same as example 1, but using EPV-7500-__-03 (plunger)

The results of the example calculations show that the single spring vent, EPV-7500-__-01, is more suitable for larger enclosures due to its higher flow rate at lower enclosure pressures. This characteristic allows the enclosure to purge more quickly without causing excessive stress on the enclosure during the purging process. While the leakage during pressurization is greater than what is typically expected for plunger vents, it is common for larger enclosures to experience a leakage rate that significantly exceeds the leakage rate of the vent. Therefore, the leakage from the enclosure is relatively insignificant in the overall assessment.

The plunger style EPV-7500-__-03, when used with smaller enclosures, results in a purging time that is comparable to the spring style. However, it generates a higher enclosure pressure during the purging process. For smaller enclosures, this increased pressure is generally less of a concern due to their size and the advantage of a lower leakage rate during pressurization. Smaller enclosures are generally better sealed and experience less leakage than larger ones, as the vent plays a significant role in calculating the total leakage rate.

Example 1a: Large Enclosure Purging

- Enclosure volume = H × L × W = 72 in × 72 in × 36 in = 108 cu.ft. (3.01 cu. meters)
- No. of volume exchanges = 4
- Vent selected: EPV-7500-__-01

Example 2a: Same as Example 1a, Using -03 Vent

- Enclosure volume = H × L × W = 72 in × 72 in × 36 in = 108 cu.ft. (3.01 cu. meters)
- No. of volume exchanges = 4
- Vent selected: EPV-7500-__-03

Flow rate – cu.ft./min. (L/min.)	Purging pressure – in. wc (mbar)	Purge time – minutes	Force on door (H × L) – lbs. (kg)
5 (141)	1.3 (3.3)	86	243 (110)
10 (339)	1.6 (4.0)	43	300 (136)
20 (565)	2.5 (6.3)	21	467 (211)
30 (848)	3.5 (8.8)	14	655 (297)

Example 1a: Same as example 1, but using EPV-7500-__-01 (single spring)

Flow rate – cu.ft./min. (L/min.)	Purging pressure – in wc (mbar)	Purge time – minutes	Force on door (H × L) – lbs. (kg)
4 (113)	2.0 (5)	108	374 (169)
10 (282)	2.7 (6.8)	43	505 (229)
16 (542)	6.1 (15)	27	1141 (517)
30 (848)	n/a	n/a	n/a

Example 2a: Same as example 1a, but using EPV-7500-__-03 (plunger)

Dilution Applications – The EPV-6500-__-07/08 Continuous Vent

The plunger-style vent is selected for nitrogen-based purge systems that use nitrogen as the purging gas. The cost and availability of nitrogen can become problematic when there are significant leaks from the enclosure. Nitrogen is often transported and stored in compressed gas cylinders. By reducing leakage from the enclosure, the amount of gas consumed by the system can be decreased, minimizing the number of cylinder exchanges needed. Additionally, nitrogen-based systems present a risk of asphyxiation around the enclosure, particularly in enclosed spaces. If the vent cannot be extended away from the enclosure, choosing the vent with the lowest leakage rate is the safest option to avoid asphyxiation.

From an operational perspective, a better-sealed vent will prove more cost-effective over the system's lifespan. When considering only the leakage rate of the vent and not the enclosure, the cost of air can accumulate, especially with multiple systems in operation. If the cost of air is estimated to be $0.28 USD per 1000 cubic feet, based on an average-sized compressor and an electric rate of $0.1 USD per kilowatt-hour, the cost of air through these vents when operating below their breaking pressure is as follows:

The cost of air = Leakage from vent × time on × $0.28/1000 cu.ft. producing air

Based on operation 8 hours per day, 260 days per year

Vent type	at 0.25 in wc (0.63 mbar)	at 0.75 in wc (1.9 mbar)
Single spring	$15 USD	$38 USD
Plunger	$1.10 USD	$1.10 USD

Based on operation of 24 hours per day, 365 days per year

Vent type	at 0.25 in wc (0.63 mbar)	at 0.75 in wc (1.9 mbar)
Single spring	$63 USD	$160 USD
Plunger	$5 USD	$5 USD

The leakage from the vent typically represents only a small portion of the total leakage in the system. If the enclosure is not properly sealed, the leakage from the enclosure can far exceed that from the vent. Therefore, it is important to design the enclosure to ensure a good seal during operation and to periodically check the integrity of the seal throughout its life cycle.

Dilution applications typically use gas analyzers, as the analysis takes place within a pressurized enclosure. This process requires introducting a stream of hazardous gas for analysis. Any equipment, including piping, that contains this hazardous gas within the pressurized enclosure is referred to as a containment system. The containment system may experience leaks under both normal and abnormal conditions, with either a known or unknown leakage rate of the hazardous gas. If the leakage rate is known, the 6500 purge and pressurization system can be employed to dilute the specific area within the pressurized enclosure, allowing the surrounding electronic equipment to function properly. If the leakage rate is unknown, nitrogen is typically used and dilution is not necessary.

Please refer to IEC 60079-2 or NFPA 496 for guidance on evaluating the feasibility of a dilution system and identifying the most suitable type of dilution for a specific application.

Warning!
Please refer to the relevant standard for the required level of dilution to ensure safe ICA operation.

Any equipment operating in the enclosure outside the dilution area must be protected for the hazardous area (e.g., Ex e, m, i).

The following example illustrates the dilution area and how potential leak points in the containment system can affect the placement of equipment. It is recommended that any equipment within the enclosure that is classified as ignition-capable apparatus (ICA) be isolated from the leaking containment system. In the example on the next page, partitions are used to isolate the ICA from the containment system. To ensure safe operation, a protective gas supply is introduced into the enclosure at the location of the ICA, which dilutes the area so that the equipment can function properly when the system is in operation.

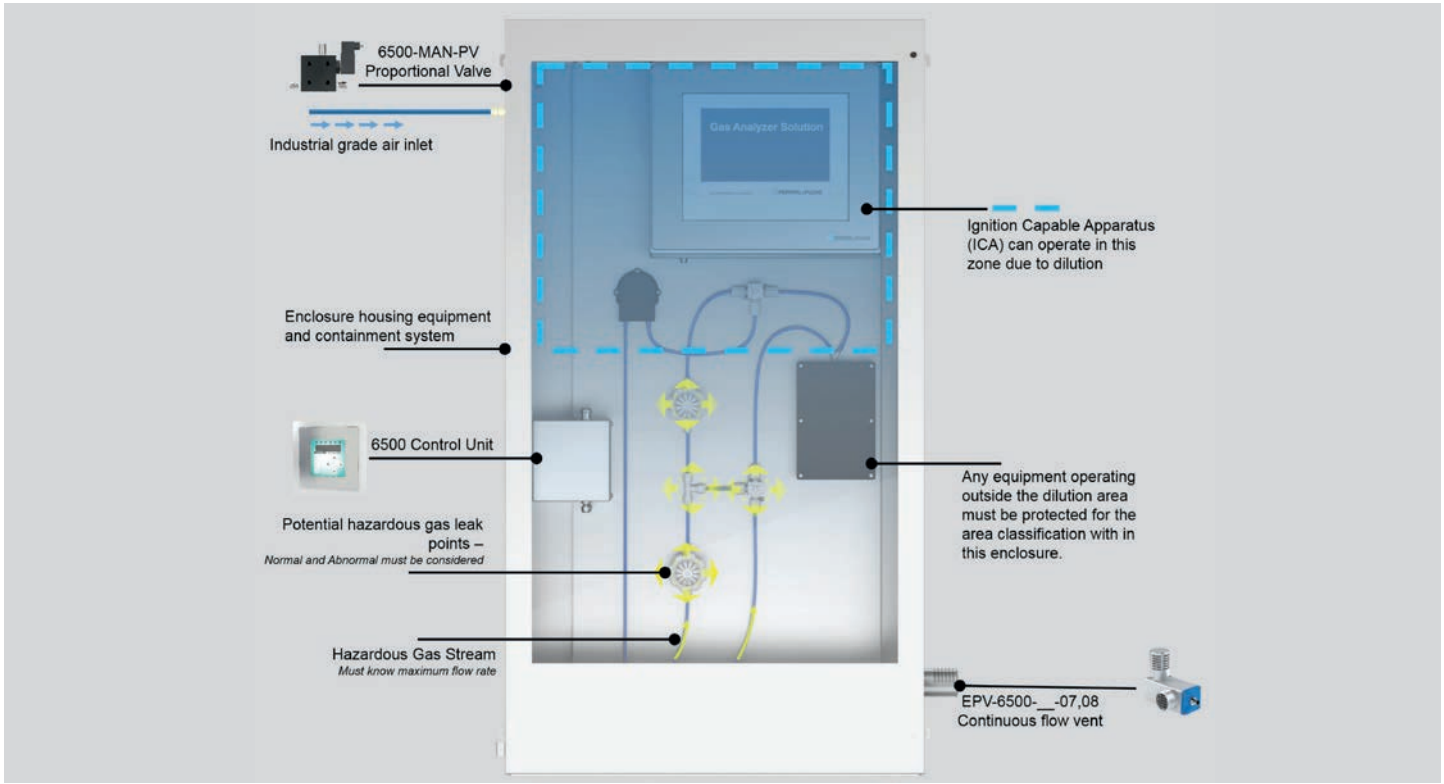
To properly apply dilution within the 6500 system, it is essential to use the continuous vent (EPV-6500-__-07 or -08) along with a proportional valve, such as the 6500-MAN-PV.
This continuous vent accurately measures pressure and flow across an open orifice plate, allowing for the generation of flow vs. pressure curves necessary for determining the dilution requirements.

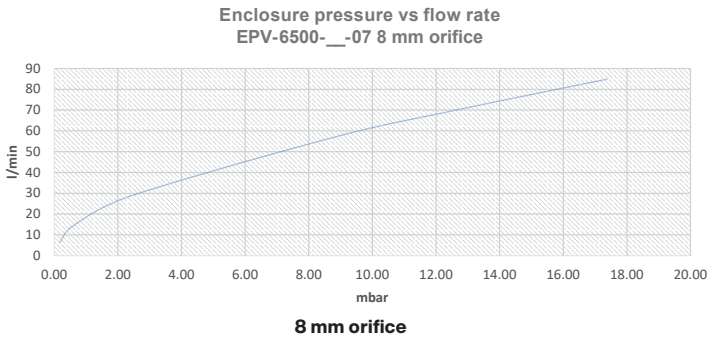
During setup, the 6500 will purge the enclosure at a user-defined flow rate. Once purging is complete, the flow is stabilized at a user-set dilution flow rate. The 6500 menu also includes a MIN FLOW SP (min. flow setpoint) feature, which alerts the user if the dilution flow rate falls below the desired level.

For system shutdown, the vent flow/pressure curves, along with the enclosure pressure corresponding to the shutdown flow indicated in the curves, can be used to establish the minimum overpressure value needed to de-energize the enclosure contacts.

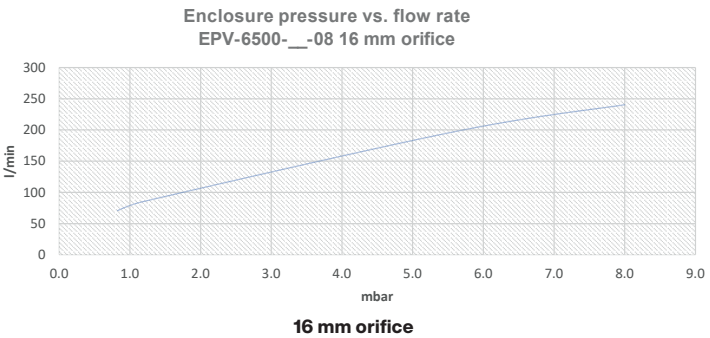
In dilution applications, the hazardous gas flow rate determines vent selection. There are two sizes of EPV-6500 continuous vents designed to accommodate the continuous flow for most applications. Refer to the graphs below to select the proper vent.

The graphs below illustrate flow and pressure rates for each vent type and are not intended for purge time calculation.
They may be used to estimate purge time, but the actual value is automatically calculated by the 6500 control unit. Use the graphs to determine the vent type best suited for the application.





8 mm orifice



16 mm orifice

Conclusion

This white paper serves as a guideline; the specific solutions will vary based on the enclosure, application, and vent used. This information is intended to be a starting point and should assist in selecting an appropriate vent while explaining the reasons for and operation of these vents.

For additional information on purge and pressurization systems, please visit our website and download our purge and pressurization compendium, which covers a variety of topics related to purge and pressurization.

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