

## Weight-Loaded Vent Performance

### PROTECTOSEAL FULL PERFORMANCE VENTS

Protectoseal weight-loaded vents have been designed and developed to maximize their overall value to the end user. This value is not limited to the simple mechanical functioning of the vents, although this is a very important consideration. The availability of information, technical support and other resources required to insure that vent users can be fully satisfied that their facilities and processes are adequately protected is a key element in an overall performance evaluation.

Vent designs that provide low leakage rates, competitive flow rates and resealing characteristics that actually result in emissions reductions are provided. Protectoseal's decades of experience has resulted in the ability to balance individual design parameters and enhance the overall performance of our vents.

Protectoseal has developed the resources needed to generate accurate, informative and easy to understand technical data. When combined with our highly trained Sales and Technical Representative network, Protectoseal's ability to provide full service to the industry is unsurpassed.

### INDUSTRY BACKGROUND

The low pressure venting industry is defined by vent set points of 15 PSIG or less. These low settings generally take this equipment out of the family of products covered by internationally accepted Pressure Vessel Codes and other such performance defining standards. In the United States, the performance characteristics of low pressure venting devices are developed and monitored solely by the individual manufacturers. Some sections of OSHA do relate to low pressure venting. These are concerned with the volume of vapors that must be relieved from a tank under various operating conditions. The American Petroleum Institute (API) and the National Fire Protection Association (NFPA) provide some advisory (non-mandatory) guidelines applicable to low pressure venting situations. They do not, however, address the functional requirements for vents. The lack of specific design and performance criteria gives manufacturers the freedom to design, develop, market and sell their low pressure, weight-loaded venting equipment with little oversight from empowered regulatory bodies.

One result of this situation is that an end user must rely on the manufacturer to provide accurate and reliable information concerning the capabilities of their equipment. Manufacturers must be encouraged to provide such information in an open and consistent manner that allows for ease of understanding and use by a customer. Manufacturers of low pressure venting equipment naturally desire to portray themselves in a favorable position relative to their competition. They must balance this desire against their responsibility to identify and publish valid, accurate information that may be relied on by system designers and operators. End users of low pressure venting equipment must be aware of this situation and must be confident that their supplier has a full commitment to honest and open communication on all issues concerning the design, function and capabilities of their equipment.

### DESIGN CLAIMS

A weight-loaded pressure/vacuum relief vent is the most common device in the low pressure industry. The basic design and functional characteristics of these vents have evolved over decades of service. The Protectoseal Company manufactured its first weight-loaded vent in 1926 and has continued to incorporate advantageous features into its designs. Claims of radical improvements in the functionality of weight-loaded vents should be evaluated from both technical and marketing points of view. The ability to separate actual improved performance from sales and marketing rhetoric must be developed by all concerned parties (manufacturer, specifier and end user). It may be useful to examine a few recent examples of such claims.

**Claim 1: Full Lift/Full Open Technology** - This allows a weight-loaded vent pallet assembly to open "fully" at a tank pressure 10% above the vent's set point. The capability is accomplished by using a pallet design that includes a turned down outer edge providing a larger secondary lift area once the pallet has been raised slightly from its seating surface. By adjusting the relationships among the seat diameter, pallet diameter, geometry and finish of the turned down pallet edge, etc., this "Full Lift" capability is achieved. However, "Full Lift" must be defined and understood (Page 2).

**Claim 2: Very Low Leakage Rates** - Vents are designed to reduce leakage as the tank's vapor space pressure approaches the set point of the vent to levels well below those of competitive devices. This is accomplished by use of a smooth diaphragm material bridging a grooved air space created in the shaped pallet. The vent seat contacts the diaphragm in the area of the air cushion groove, providing a resilient sealing joint.

**Claim 3: Reduced Blowdown/Improved Resealing Capabilities** - Certain manufacturers claim that their vent design insures that as tank pressure is reduced below the vent set point, once the vent has opened, the pallet assembly will reseal more quickly than a competitor's device. Such claims should be evaluated as part of a review of the total performance of the vent, considering leakage, opening, closing and flow characteristics.

**Claim 4: Elimination of Pallet Assembly "Fluttering" or "Chattering"** - This capability is supposedly accomplished by the optimized design of the pallet/seat and by adjustment of mechanical components on a pallet assembly.

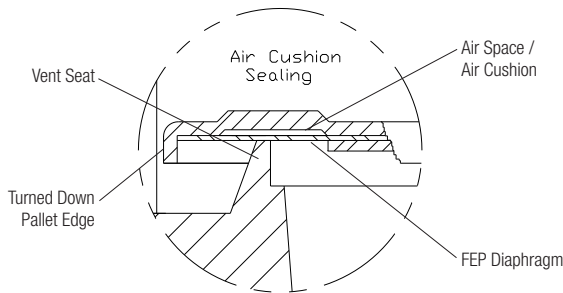
**Claim 5: Improved Flow Capacity** - A unique vent design results in flow rates that are significantly higher than those provided by comparable size and style vents provided by competitors. Evaluations of such claims must include an understanding of flow test protocols.

### PROTECTOSEAL PATENTED VENT DESIGN - PERFORMANCE ENHANCEMENT

On July 30, 1968, Patent Number 3,394,732 was issued to The Protectoseal Company. This patent covers an improved valve sealing mechanism for weight-loaded vents. The claims granted in this patent encompass a weight-loaded vent pallet assembly design that includes

# VENT VIEWPOINT

a formed recessed area bridged by a smooth diaphragm material (such as FEP) so that the vent seat contacts the diaphragm in the “air cushion” sealing area of the pallet. The pallet is comprised of a smooth, formed, thin metal disc that includes a turned down outer edge. The patent claims state that the purpose of this outer rim is to provide a supplemental lift action to the pallet assembly. As the pallet lifts off the seat, vapors from the tank act on the larger area created by the turned down pallet edge. This sealing mechanism for weight-loaded vents, coupled with the turned down edge of the pallet - as developed by Protectoseal - was, in fact, new and patentable in 1968. The patent has expired. The concepts are now in the public domain and available for use by other manufacturers. Certain manufacturers now claim these design concepts as new technology. Since 1968, Protectoseal has been working with the concepts outlined in the original patent to optimize our products’ performance and value to the end user.



Low leakage rates can also be achieved with other properly designed and manufactured pallet configurations (metal-to-metal seating, elastomer diaphragms, etc.) These are not new concepts. Protectoseal can provide a full range of pallet assembly designs to meet any customer requirements.

## TERMINOLOGY CLARIFICATION - ‘FULL LIFT / FULL OPEN’

As previously stated, there are no mandatory design specifications for weight-loaded vents in the United States. There are no standardized orifice sizes for these vents, no minimum flow requirements by size, no mandatory leakage criteria and virtually no regulatory restrictions on their design. This can have an impact on an end user’s understanding of a device’s capabilities. For example, it must be realized that there is no universally accepted definition of “Full Lift” in the weight-loaded, low pressure venting industry. Manufacturers are free to use the term “Full Lift” and then to define it as they see fit, to best serve their needs.

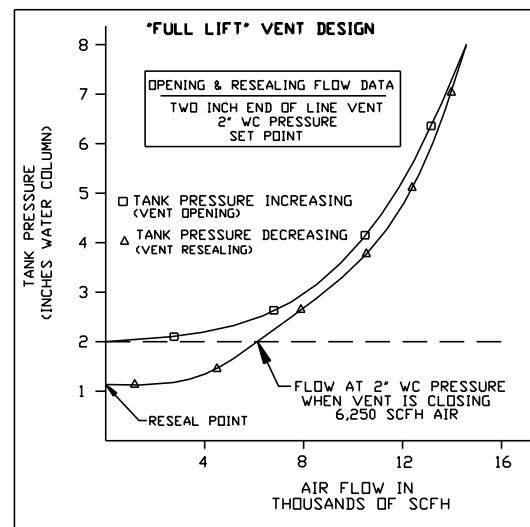
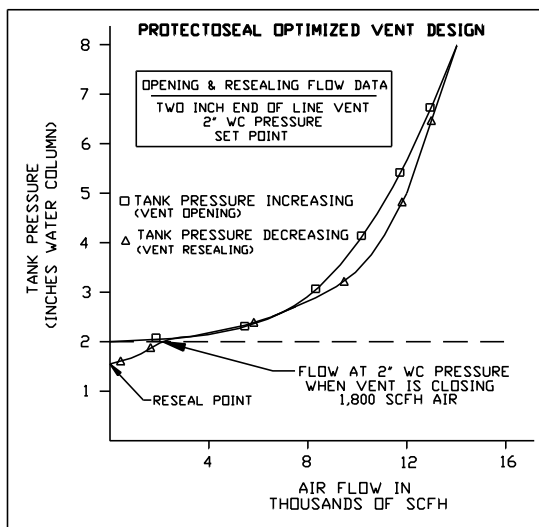
Consider the following definitions:

1. “Full Lift” of a weight-loaded vent is that point where the efficiency of flow through the vent is no longer increasing (the point where additional flow is due strictly to increases in tank pressure).
2. “Full Lift” is the point where the annular flow area between the pallet and the seat is equal to the flow area of the pipe to which the vent is connected.
3. “Full Lift” is the point where the manufacturer has chosen to place a mechanical stop to limit additional pallet assembly movement.
4. “Full Lift” is the distance that the pallet assembly lifts when the tank pressure is 10% above the vent’s set point.

All of these are perfectly valid definitions of “Full Lift” in the low pressure venting industry. The possibility of confusion or misunderstanding by an end user is obvious. The Protectoseal Company prefers to not use such misleading terminology as “Full Lift”. The flow capability of Protectoseal equipment is defined by our published flow data. A customer should evaluate a vent based on its actual flow capability under specific pressure conditions as opposed to some undefined “Full Lift” criteria. Obviously, it is critical that the data provided by manufacturers is accurate.

## VENT DESIGNS SHOULD MAXIMIZE OVERALL PERFORMANCE

It is certainly possible to design a pallet assembly to maximize lift capabilities. A manufacturer should, however, realize that focusing on pallet assembly lift characteristics does not necessarily result in improvement in overall vent performance. Protectoseal has chosen to refine its designs to provide overall vent performance that best meets the needs of our customers. The design characteristics that allow a pallet assembly to lift more quickly also cause it to be more difficult to reseal. This is a simple concept that can be easily overlooked. It is true that no matter what the specific pallet assembly design, all weight-loaded pressure vents reseal at approximately 70% of their set point. Therefore, a pallet assembly designed to maximize initial lift will also flow significantly more vapor as the tank pressure approaches the resealing point (see chart below). With such a pallet design, the loss of vapors/nitrogen through the vent as tank pressure is reduced, below the set point to the resealing point, can be substantial. With Protectoseal vents designed to provide excellent overall performance, these losses are minimized while not compromising the tank’s safety. The ability to provide required flow capacities at low overpressures is accommodated by refining other components of the vent design.



## COMMUNICATING VENT FLOW PERFORMANCE

When focusing on the communication of accurate and easy to understand information, the format of flow curves available from manufacturers is a significant issue. The simplest, easiest to read and most useful flow curve is plotted on standard, linear coordinate grids. Such curves readily define a vent's flow capabilities from the set point through higher tank pressure ranges (Fig. A). Some manufacturers choose to only provide flow curves plotted on log/log grids. These curves have the disadvantage of not showing a "zero flow" point for the vent. That is, the vent set point cannot be determined from the curve (Fig. B). Such log/log curves do have some value when flows at high tank pressures

are being documented, but they do not convey the true overall performance of a vent from set point through higher tank pressures. If a customer does not completely understand what information is being presented in a log/log flow curve, the chance of misunderstanding and incorrect interpretation of the data is very real. The majority of low pressure vent applications involve relatively low overpressures. Flow curves using linear coordinate grids provide the most accurate picture of the vent performance and facilitate evaluation by the customer. Flow curves in both formats should be readily available from any reputable manufacturer.

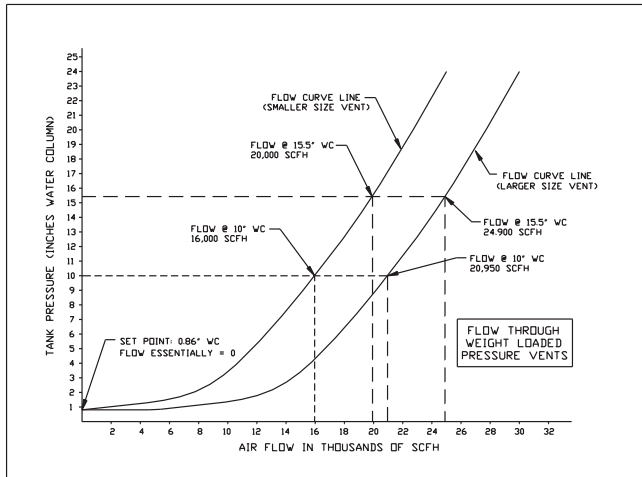


Fig. A  
Linear Coordinate Grid

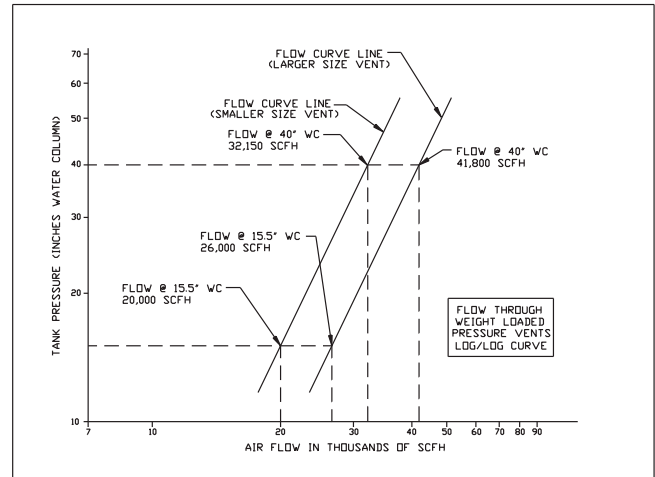


Fig. B  
Log/Log Grid

## VENT LEAKAGE RATES

The issue of leakage rates from low pressure venting devices is one that is often misunderstood. Maximum leakage rates from equipment used in the storage and processing of hazardous and volatile liquids are mandated by the United States Government in the Code of Federal Regulation (40 CFR). These regulations are summarized in Protectoseal Bulletin V-40CFR. These federal requirements are very strict (less than 500 PPM leakage up to set point) for conventional closed venting systems. As a point of reference, a leakage rate of  $\frac{1}{2}$  standard cubic feet per hour (SCFH) is equal to approximately 30,000 PPM leakage. Protectoseal is familiar with very low leakage rates in that we have developed patented designs for vents meeting even these extremely strict EPA requirements. These products are available in our PIN-TECH® Emergency Relief Vent product line. The capability of these emergency venting devices to meet the EPA leakage mandates has been verified by the United States Environmental Protection Agency ([www.epa.gov/etv](http://www.epa.gov/etv)). Many of the individual States have chosen to not enforce these CFR requirements. Conventional weight-loaded vents are, therefore, still utilized as acceptable devices for most tank storage or processing applications.

All weight-loaded end-of-line pressure or pressure/vacuum vents will leak well in excess of 500 PPM to atmosphere as the tank pressure approaches the vent's pressure set point. A manufacturer's claim of less than 500 PPM total leakage from an end-of-line weight-loaded pressure / vacuum vent should be challenged. Independent test data that upholds such performance claims under realistic system operating pressures and vent set pressures should be demanded.

Establishing the leakage rate standards for weight-loaded venting devices is left to the individual manufacturer's discretion. The American Petroleum Institute has published guidelines in Bulletin API #2521 of less than 0.5 SCFH leakage at 75% of the set point for vents 6" and smaller in size, and less than 5 SCFH leakage at 75% of the set point for vents 8" and larger in size. Taking advantage of the air cushioned pallet assembly seating and polished/lapped seating surfaces that were pioneered by Protectoseal in the 1960's, some manufacturers are able to provide leakage rates that are more stringent than those specified in API #2521. Certain manufacturers specify multiple leakage rates that are based on the size, style and set points of the vents.

In order to simplify the concept of leakage rates, Protectoseal has chosen to publish just one standard leakage rate (less than 1 SCFH at 90% of vent set point) for ALL of the sizes (1" through 24"), styles and settings ( $\frac{1}{2}$  oz./in.<sup>2</sup> through 3 PSIG) of our standard weight-loaded vents. It must be stressed that this 1 SCFH rate standard is a maximum allowable leakage. In reality, the vast majority of Protectoseal vents are shipped with leakage rates well below 1 SCFH. It is more difficult to achieve low leakage rates on larger vents than on smaller ones. Protectoseal's 24" emergency vents do, however, meet and exceed the standard 1 SCFH leakage specification. Smaller sized vents exhibit significantly lower leak rates.

While it would be possible to publish lower leakage rates for the majority of Protectoseal vents, the value of such information to the end user is questionable. Even leakage rates of 0.1 SCFH result in very high parts per million (PPM) measurements - well in excess of EPA mandated

levels for closed venting systems. Publishing various leakage rates only causes confusion. If you have a realistic requirement for leakage rates lower than Protectoseal's published standard of less than 1 SCFH at 90% of the set point, please let us know. We will almost certainly be able to accommodate your requirement.

## THE "FLUTTERING" OR "CHATTERING" PHENOMENON

The phenomenon of "fluttering" or "chattering" of a weight-loaded vent is usually related to an insufficient volume of vapors flowing through the vent to maintain the pallet in the open position. This is a characteristic of all weight-loaded vents. Based on the assumption that a manufacturer has made proper use of the original Protectoseal design concepts for the pallet and seat arrangement, the most effective way to minimize or eliminate fluttering is to properly size the vent for the application.

## FLOW TESTING PROTOCOLS

Claims of significantly improved flow capacity for a "new" weight-loaded vent design usually have more to do with the equipment that the vent is tested on and the test protocol than they do with the vent design. The American Petroleum Institute (API 2000) has established some fairly rigorous guidelines for low pressure venting device test equipment. These guidelines were established to minimize the impact of test tank configurations and test equipment on the measured flow of vents. They are intended to provide a close simulation of the flow conditions the vent is likely to see in the field. For example, API requires that the test tank have a flat roof no less than five times greater than the nominal size of the vent. The vent is to be mounted in the center of this flat roof. The vent is to be mounted on a short, straight pipe nozzle. No radius on the approach to the vent is to be greater than  $\frac{1}{2}$ ". These restrictions are intended to eliminate flow enhancing effects that are realized from a non-flat, tapered approach to the vent inlet. API 2000

further requires that no high velocity streams of air from the source impinge on the vent inlet.

Protectoseal conducts its weight-loaded vent flow testing in a facility certified to the API 2000 requirements. If a manufacturer claims tested flow data that is significantly higher than a competitor's, it is likely that the tests were conducted in a facility that does not comply with the stringent API 2000 guidelines. In such cases, it is common to see the vent mounted on the side of a round, horizontal tank or to discover that the test system allows for direct impingement of flow from the test supply pipe into the area where the vent is mounted. These are flow enhancing conditions. They result in "measured" pressure flows that overstate the flow capabilities of the vents as they are most likely to be installed in the field. The Protectoseal flow testing facility has been designed and certified to meet the strict requirements established in API 2000.

## SUMMARY

Protectoseal takes our responsibility to provide customers with only the highest quality products, information and support very seriously. In our more than 80 years of manufacturing low pressure venting equipment, we have taken the leading role in product innovation. Our vents are designed to provide an overall level of performance that is unsurpassed in the industry. We have also focused attention on the need to provide end users with accurate technical information so they can make reasoned and informed decisions when evaluating safety equipment for their facilities. Protectoseal is committed to upholding our Company's motto "Safety Without Compromise" in all of our endeavors.

Please feel free to contact Protectoseal or one of our Authorized Representatives if you have any questions.

## Weight-Loaded Venting Devices from Protectoseal

Series 8540H



Protectoseal Series 8540H End-of-Line Pressure / Vacuum Conservation Breather Vent provides pressure and vacuum relief. Pallets in the housing allow intake of air and release of vapors as the tank breathes normally. Keeps tank pressure within permissible range to avoid tank damage.

Series 18540



Protectoseal Series 18540 Pipe-Away Pressure / Vacuum Conservation Vent provides pressure and vacuum relief. Relieving vapors are piped away through a flanged connection.

Series 53000



Protectoseal Series 53300 Emergency Pressure Manhole Cover Vent provides emergency pressure relief for storage tanks where vacuum relief is being provided for by a separate operating vent.

PIN-TECH® Series



PIN-TECH® Series <500 ppm Emergency Pressure or Vacuum Relief Vents provide relief in applications that require bubble-tight sealing to less than 500 ppm to reduce fugitive emissions in compliance with the U.S. Code of Federal Regulations - 40 CFR.

*Protectoseal Storage Tank Fittings, Vents and Accessories are sold and serviced by a technically-oriented network of representatives located across the United States, Mexico, Canada, South America, Europe, Middle / Far East and elsewhere throughout the industrial world.*

*Please call 1-630/595-0800 or visit our website at [www.protectoseal.com](http://www.protectoseal.com) for the name and address of the Protectoseal Representative in your area.*



**THE PROTECTOSEAL COMPANY**

ISO 9001 CERTIFIED

225 Foster Ave., Bensenville, IL 60106-1690  
Ph: 1-630-595-0800 Fax: 1-630-595-8059

**SAFETY WITHOUT COMPROMISE**