



Metal Rupture Disk Handbook

2018 Edition



Safety through knowledge and performance.

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WHAT IS A RUPTURE DISK?

A rupture disk is a thin diaphragm (generally a solid metal disk) designed to rupture (or burst) at a designated pressure. It is an engineered “weak spot” designed to protect vessels, piping, personnel, and equipment from unexpected excessive pressure.

“A rupture disk is to a pressurized system what a fuse is to an electrical system”

The rupture disk industry dates back as far as the mid 1930’s when customers required a simple flexible device that would protect their equipment from rupturing due to an unplanned overpressure. The concept of a device having no moving parts, that was tamperproof and inexpensive was just what customers were looking for and the Rupture Disk industry was born. The earliest rupture disk was simply a piece of flat sheet metal clamped between a pair of pipe flanges. Today rupture disks are much more sophisticated and manufacturing them requires a fundamental knowledge of the behavior of metals to make them perform reliably under a broad range of operating conditions. There is a rupture disk that is correct for each application, but no single rupture disk can meet all requirements. ZOOK has been manufacturing Metal rupture disks since 1952 and has developed the required skills to specify and manufacture the correct rupture disk for any application.

WHY USE A RUPTURE DISK?

- Provide protection to personnel, equipment and plant
- Passive non-mechanical device. No moving parts.
- Bubble-tight “ZERO leakage”
- Extremely fast opening providing instantaneous relief
- Available in a wide variety of corrosion resistant materials
- Low cost
- Protects safety relief valves against corrosion, plugging, and leakage
- Cost effective maintenance

WHERE ARE RUPTURE DISKS USED?

Rupture disks may be used as either primary relief, secondary relief or in series with a relief valve.

As primary relief, the rupture disk is the only device utilized for providing pressure relief. Advantages of a rupture disk in primary relief include instantaneous response time, minimum pressure drop, high reliability and low cost.

Disadvantages include venting until the system pressure is equal with downstream pressure and the need to replace the disk after each overpressure occurrence.

As a secondary relief device, the rupture disk provides pressure relief in support of the primary relief device, usually a relief valve. The rupture disk typically provides additional protection in the event that the relief capacity of the primary relief device is exceeded or the device fails to operate.

When a rupture disk is used in series with a pressure relief valve, the rupture disk is usually installed upstream of the relief valve and is designed to protect the valve from process media leaks. The space between the rupture disk device and the pressure relief valve requires a pressure gauge, a try cock, free vent or suitable tell-tale indicator. This will monitor and eliminate the possibility of pressure build-up between the relief valve and rupture disk, which could affect the performance of the rupture disk. Consideration should be given to proper rupture disk selection to limit fragmentation of the rupture disk which could damage downstream equipment.

WHICH INDUSTRIES USE RUPTURE DISKS?

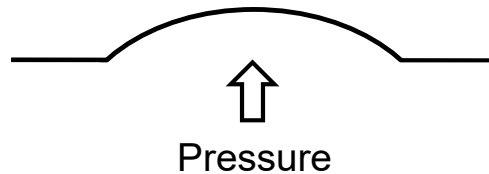
- Chemical Plants
- Utilities / Power Generation
- Nuclear
- Oil and Gas
- Aerospace
- Aviation
- Railway
- Trucking
- Shipping
- Food Processing
- Pharmaceutical
- Brewing
- Synthetics / Rubber
- Pulp and Paper

RUPTURE DISK FUNDAMENTALS

The first metal rupture disk was simply a piece of flat metal foil clamped between two standard flanges exposed to the system pressure. As the system's pressure increases the flat thin disk foil is placed under tension and begins to yield (dome) in proportion to the system pressure, eventually rupturing well before the more substantial and thicker wall of the pressure vessel it was protecting. The burst pressure is dependent on the thickness of the foil and the tensile strength of the material it is made from. The Flat Design was simple and effective but suffered from creep and fatigue caused by exposure to changing system pressures and temperatures. Nowadays there are two major types of rupture disks available, tension-loaded and compression-loaded rupture disks, each having several variations.

TENSION LOADED DESIGNS

In 1931 the first "Pre-Bulged" (PB65) rupture disk design was patented that included factory pre-bulging or crowning of the disk material and a unique angle seat to help improve the creep and fatigue resistance.



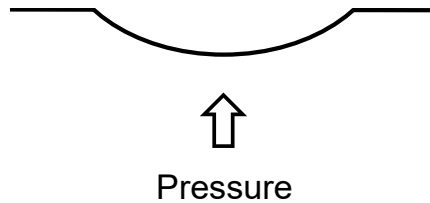
These changes combined to increase service life at static system pressures up to 70% of the marked burst pressure. This simple pre-bulged angle seated design quickly became a mainstay for the industry and is used today in thousands and thousands of applications around the world.

As the use of rupture disks flourished so did the demands for a more flexible design that could be fine-tuned for use in more demanding applications where the pre-bulged was not satisfactory for one reason or another. The “Composite” (D80) design was developed to meet the challenge and included three basic improvements to the Pre-bulged design. The composite disk consists of two matched, pre-bulged components each with an angular seat assembled together as a single unit. In this configuration, the lower component, known as the seal, is made of metal or plastic and provides the pressure seal to the assembly. The upper layer, known as the control cap, is made from relatively thick metal that is weakened by a series of variable cut through slits. As the system pressure rises, the seal is pushed into the control cap, placing it into tension. The cap fails when the system pressure load overcomes the tensile strength of the cap material between adjacent slits, initiating complete rupture of the disk. Secondly, virtually unlimited burst pressures can be achieved by either adjusting the location of the slits in the cap, changing the material thickness of the cap or changing the material and/or thickness of the seal. Finally the thick cap material is very stable and resists flexing and further bulging from the increasing system pressure, thus permitting static system pressures up to 80% of the marked burst pressure.

In 1971 “Scored Forward-Acting” (SFA) rupture disks were introduced as a more substantial rugged design made from a single piece of material, 4 to 6 times thicker than other tension-loaded disks with the same burst pressure. This design incorporated precision mechanical scores on the atmospheric side of the dome to control both the rupture pressure and the opening pattern. The precision scoring process, adjustable in 1/10,000th of an inch increment added additional flexibility to adjust the burst pressure. The relatively thick material used to make the disk, combined with the score lines, further reduces fatigue and creep of the disk material during tensile loading up to 85% of the marked burst.

COMPRESSION LOADED DESIGNS

A new revolutionary “**Knife-Blade Reverse-Acting**” (SB90) design was introduced in 1965, unlike conventional disks that are installed with the system pressure acting on the concave side of the pre-bulged dome placing the disk material under tension the reverse acting design is installed with the system pressure acting on the convex side of the pre-bulged dome placing the disk material under compression. Increasing system pressure proportionally increases compression-loading of the disk material until the point of dome instability and reversal. Disk materials under compression are much less effected by fatigue and creep and can be used where system pressures up to 90% of the marked burst while significantly increasing service life up to 100 fold.



The design required a set of razor sharp knife blades welded to the holder outlet to cut the disk material into three or four equal pie-shaped segments as the disk material is accelerated or pushed back through the neutral position (by the energy of the expanding gas) into the blades. The burst pressure is controlled by varying the material thickness and the dome height with the burst pattern being controlled by the knife-blades. Knife-blade reverse acting designs are very effective when applied correctly but rely on the presence and condition of the knife-blades to function correctly and CANNOT be used on liquid service. Educating maintenance personnel of these requirements, field inspection, and servicing of the knife-blades is a serious problem, for this reason **ZOOK ONLY SUPPORTS EXISTING INSTALLATION OF KNIFE-BLADE REVERSE ACTING DESIGNS.**

Scored Reverse-Acting (SRA) rupture disks were developed in 1984 to offer a safer alternative to the knife-blade design. The combination of compression loaded dome design + precision “cross” scoring technology produced a reverse acting disk with the operating advantages of the original knife-blade design without the need of knife-blades making it a safer more versatile design. The burst pressure is controlled by varying the material thickness, dome height, and score depth with the burst pattern being controlled by scoring pattern. In addition the deep scores limit the tensile burst pressure to less than 2:1 if damaged or accidentally installed upside down with the pressure applied to the concave side. Cross Scored Reverse-Acting rupture disks are a better alternative to knife-blade designs but CANNOT be used on liquid service and are limited in low and high pressure applications.

In 1999 ZOOK introduced our first High Performance Reverse-Acting (URA) rupture disk designed to operate on both compressible (gas) and incompressible (liquid) services at both low and high burst pressures. This “universal” design combines the simplicity and reliability of original compression loaded dome with a new highly efficient shear ring permanently attached to the downstream side of the disk replacing the knife-blades. Built-in shear ring support into the disk holder insures trouble free operation throughout its wide range of available burst pressures.

Various “boutique” reverse acting designs have been introduced over the years to address specific applications such as ultra-high and low burst pressures all relying on the sturdiness and reliability of a compression loaded reverse action domes. Many designs flooded the market making it very confusing for engineers to decipher the differences between them and accordingly specify the best most suitable design.

In 2006 ZOOK simplified reverse acting disk design with the introduction of the “RA” series disks and holders replacing redundant overlapping disk designs with a few simple straight forward designs that offer tangible benefits from one design to another. These four disks cover a broad range of applications from ultra-low to high burst pressures, liquid or gas application, high or low temperatures.

UNION TYPE HOLDER

Union type holders are a 3 part design having an inlet, outlet, and threaded nut. The tightening of the nut supplies the required clamping force to the device to make a gas-tight seal and prevent disk creep or slippage. Union type holders are small and lightweight and can be used where space is limited and frequent disk change out is expected.

- Standard sizes are ½", ¾", 1", 1 ½", and 2".
- Available inlet and outlet connections are female pipe thread, butt weld or socket weld. Female pipe thread is the most common.
- Standard pressure ratings are 1200#, 3000#, and 6000#. The rating of the Union should always be equal to or greater than the marked rating of the corresponding disk to be installed.
- Standard 30° angle seat with heavy duty lip (HDL) in 6000# rating.
- Accepts type PB, and D series rupture disk designs.

SCREW TYPE HOLDER

Screw-type holders are a 3 part design having an inlet, outlet, and hold-down ring. The outlet is threaded into the inlet using straight threads and when tightened supplies the required clamping force to the device to make a gas-tight seal and prevent disk creep or slippage. Screw-type holders are used on autoclaves, gas cylinders, and high pressure equipment.

- Standard inlet and outlet connections are ¼" and ½" male pipe thread
- Maximum 15,000 psi (g) (1,034 bars) pressure rating.
- Standard ½" 30° angle seat. Available with flat ½" or 11/16" seat design on request.
- Accepts type ½" PB and D series and 11/16" FD series disk designs.

INSERT-TYPE HOLDER

Standard bolted-type holders are a 2-part design, having an inlet and an outlet. The device uses the piping studs and nuts to hold the assembly together and supply the required clamping force to the device to make a gas-tight seal and prevent disk creep or slippage.

- Standard size range: ½" thru 24", larger sizes available on request.
- Standard seat designs include 30° angle, 30° angle with HDL, and flat seat.
- Standard pressure ranges include all ANSI and DIN pressures.
- Available inlet and outlet configurations include: female pipe thread, free vent, butt weld, socket weld, and insert. The most common is the insert which is designed to fit within the bolt circle of standard pipe flanges

PRE-TORQUE INSERT TYPE HOLDER

Modern rupture disk holders are designed with integral pre-torque bolts that allow the disk to be installed in the convenience of the maintenance or instrument shop prior to field installation with the recommended torque load to ensure proper engagement of the “bite” type seal. Once assembled, the device can be installed in the field where the additional load of the companion flange bolting provides for complete functionality of the device.

In addition, pre-torque assemblies allow for the removal of the assembly from the piping system for inspection and re-installation without disturbing the seal integrity. Fluoropolymer coated bolts are standard to provide corrosion resistance and much lower frictional coefficient.

- Standard size range: 1” thru 12”, larger sizes available on request.
- Standard flat seat design.
- Standard pressure ranges include all ANSI 150 thru 600 and DIN 10 thru 40 pressure ratings.
- Inlet and outlet configurations are limited to insert type.

FULL DIAMETER BOLTED-TYPE HOLDER

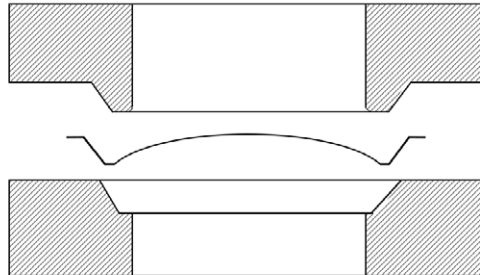
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- Standard size range: ½” thru 24”, larger sizes available on request.
- Standard seat designs include 30° angle, 30° angle with HDL, and flat seat.
- Standard pressure ranges include all ANSI and DIN pressure ratings.
- Available inlet and outlet configurations include: female pipe thread, free vent, butt weld, socket weld, and insert. The most common configuration is the insert-type which is designed to fit within the bolt circle of standard pipe flanges.

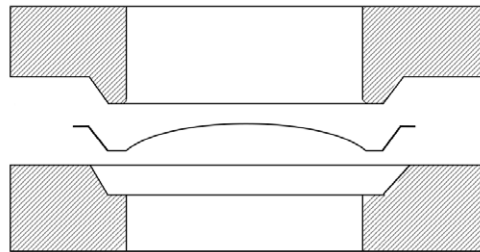
LONG PATTERN BOLTED TYPE HOLDER

Long pattern bolted-type holders are designed so that both the unburst disk dome and the burst disk petal are contained within the inlet and outlet of the holder. This approach is useful in installations that have equipment immediately downstream of the rupture disk device that could block the disk from opening properly. In addition removal of the assembly after rupture is impaired by the disk material protruding downstream into the piping particularly with thicker materials required for higher burst pressures.

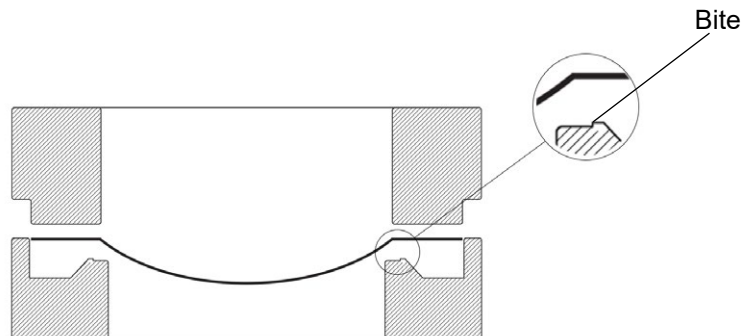
30° ANGLE SEAT FOR NORMAL OPERATING PRESSURES



30° ANGLE SEAT WITH HEAVY DUTY LIP (HDL) FOR HIGH PRESSURE APPLICATIONS.



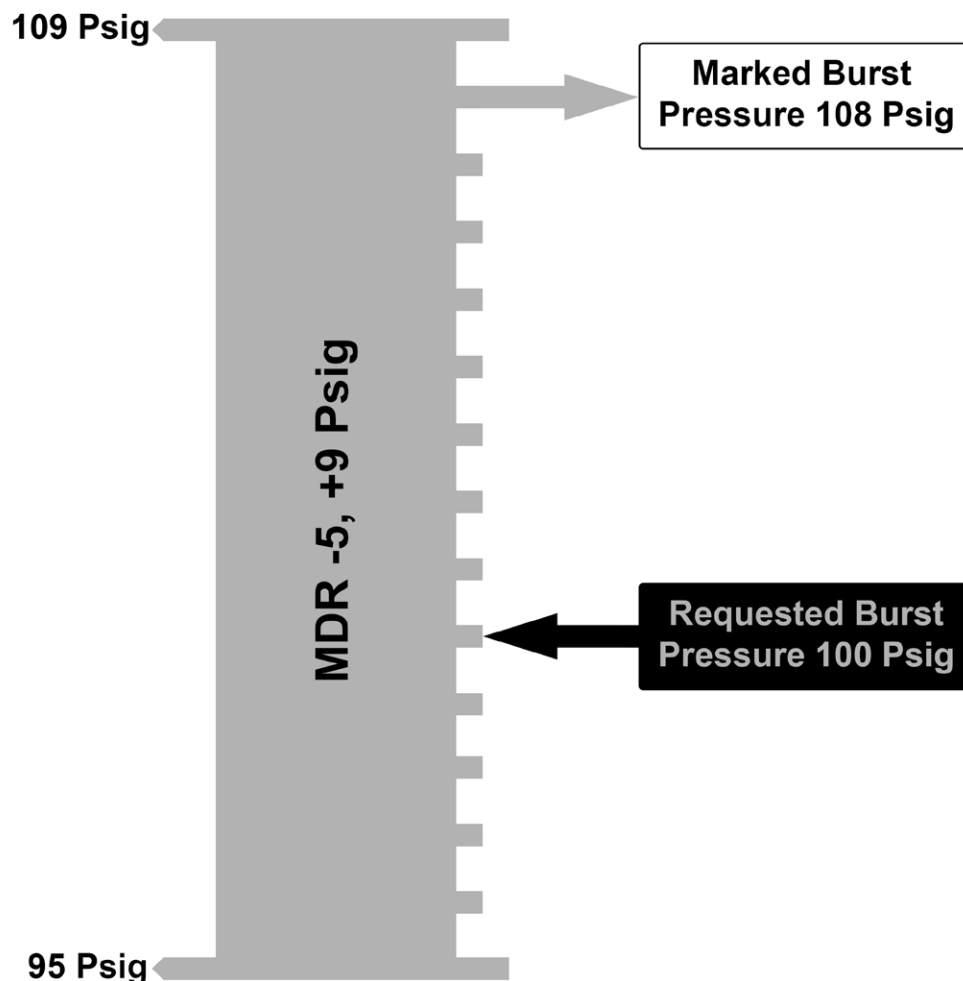
FLAT "BITE" TYPE SEAT FOR UNIVERSAL APPLICATION



WHAT IS THE ASME BOILER AND PRESSURE VESSEL CODE?

ASME is an acronym for “American Society of Mechanical Engineers” and is the primary code used in North America. Section VIII, Division 1, paragraph UG-125 thru UG-137 deals with the application, sizing, marking and certification process required to permit the manufacturer to affix the ASME “UD” mark to a product, thus designating that it is in full compliance with all applicable sections of the code.

The code is revised and a new edition published every three (3) years with annual addendum. The typical format used to define the code effective date is “04E06A” which means 2004 Edition, 2006 Addenda. New editions and addenda become effective 6 months after publication. Complete excerpts of the relevant code pages are included in Appendix “A” of this manual.



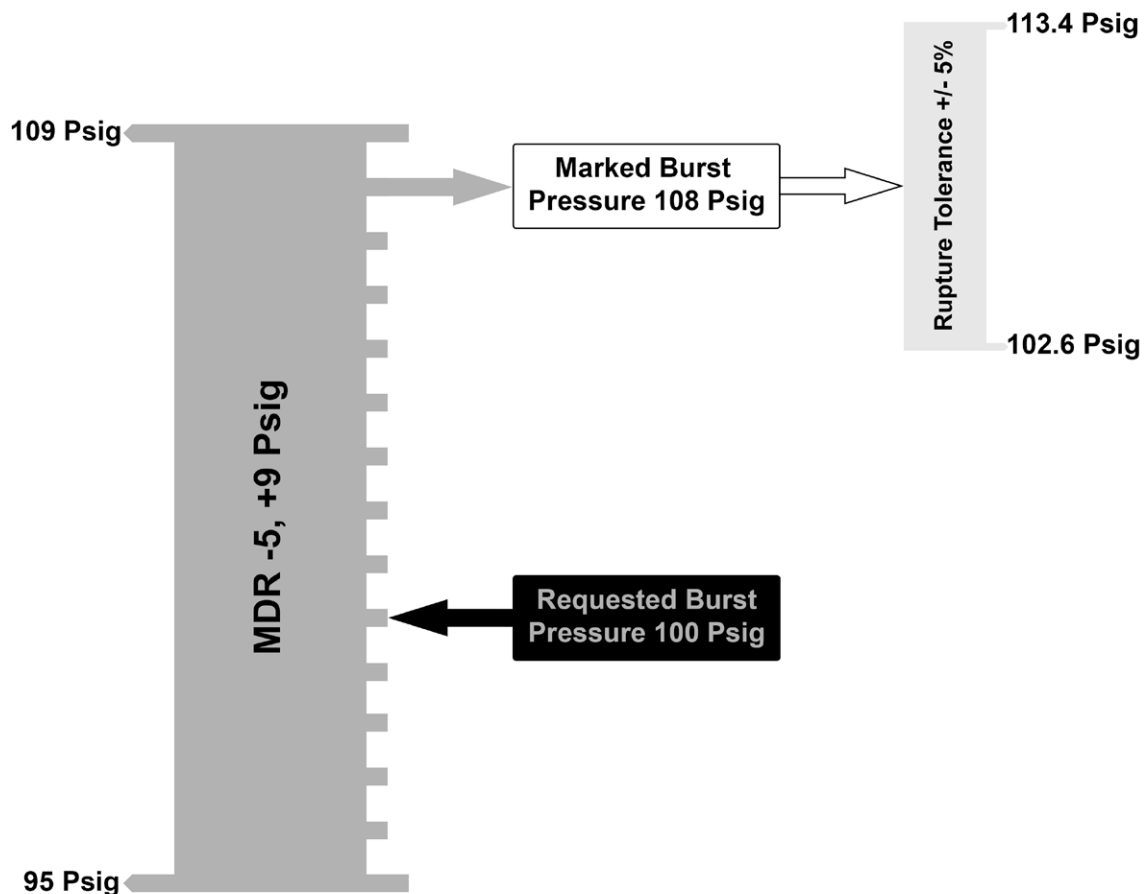
UG-127(A) (1) - MANUFACTURING DESIGN RANGE

Manufacturing Range is confusing and is the source of many errors in specifying and re-ordering rupture disks. Extra attention needs to be taken in order to fully understand manufacturing design range.

ASME UG-127(a)(1) defines manufacturing design range (MDR) as “the range of pressure within which the marked burst pressure must fall to be acceptable for a particular requirement as agreed upon between the rupture disk manufacturer and the user or his agent”. The MDR simplifies the manufacturing and testing process and accordingly provides an economic benefit to the user. All Rupture Disk manufacturers publish their standard MDR for each disk style in either a table or as a percentage of the specified rupture pressure.

CAUTION: The MDR must be considered during the selection process to ensure that the stamped burst pressure is not greater than the MAWP of the pressure vessel.

CAUTION: Always specify the original lot number when re-ordering replacement disks. This will guarantee the disk will be manufactured to the original specifications. Do not re-order based solely on the marked burst pressure on the disk tag.



UG-134(E) - BURST PRESSURE TOLERANCE

All products are manufactured to a specified tolerance and Rupture Disks are no exception. ASME UG-134(e) specifies that “the burst pressure tolerance for rupture disk devices at the specified disk temperature shall not exceed +/- 2.0 psi of marked burst pressure up to 40 psi and +/- 5% of marked burst pressure 40 psi and over”. Simply put, the burst pressure tolerance is the range of pressure over which a rupture disk is expected to burst.

CAUTION: The burst pressure tolerance does not consider the MDR and is not cumulative with the MDR. In fact it is possible to have a disk fail to burst within the burst pressure tolerance while bursting within the MDR as per the illustration above. In this case the lot would be considered scrap.

UG-125(4) (C) – SIZING OF RUPTURE DISK DEVICES

1. Single Device - Sized to prevent pressure from rising more than 10% above the MAWP.
2. Fire condition - Additional protection to required due to exposure to fire other external heat source sized to prevent the pressure from rising more than 121% of MAWP.
3. Multiple Devices - Sized to prevent the pressure rising more than 16% above MAWP.
4. The same device can be used to satisfy all of the above.

UG-127(3) – APPLICATION OF RUPTURE DISKS

1. **Primary Relief (Single Device)** - “A rupture disk may be used as the sole pressure relieving device for primary protection of vessels”.
 - a. Permissible overpressure while discharging is 110% of MAWP (121% fire condition).
 - b. Set pressure at or below MAWP
2. **Primary Relief (Multiple Devices)** - “A rupture disk may be used as the sole pressure relieving device for primary protection of vessels”.
 - a. Permissible overpressure while discharging is 110% of MAWP (121% fire condition).
 - b. Set pressure first device at or below MAWP, additional devices 105% of MAWP or below.
3. **In Series** - “A rupture disk may be installed between the pressure relief valve and the vessel provided; the space between the disk device and the pressure relief valve shall be provided with a pressure gauge, try cock, free vent, or tell-tale indicator”. The intent of the ASME Code is that the user provides a means to monitor the cavity against differential pressure accumulation.
 - a. Permissible overpressure while discharging is 110% of MAWP (121% fire condition).
 - b. Set pressure at or below MAWP
4. **Secondary Relief** - Not formerly covered by the Code but does discuss providing for unknown exothermic or runaway reactions.
 - a. The primary relief device must be per Code.
 - b. The secondary device can be any size or set pressure.


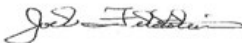


UG-130 - ASME CERTIFICATION UD STAMP

1. Qualified manufacturing, production, testing, and quality control.
2. Audit by ASME Designee allowed at any time on random production samples.
3. Use of the UD Code Stamp requires:
 - a. Facility Quality Audit
 - b. KR flow testing by an ASME Certified Test Lab.
 - c. All product designs are confirmed by and witnessed by ASME Designee

UG-131 - ASME CERTIFIED FLOW RESISTANCE FACTOR

KR Certified Flow Resistance Factor is used to calculate velocity head loss resulting from a rupture disk device in a pressure relief system. The KR can be used to determine pressure relief flowing capacity when used with piping fittings and other components.

ZOOK CANADA INC. - ASME CERTIFICATE OF AUTHORIZATION

The American Society of Mechanical Engineers		CERTIFICATE OF AUTHORIZATION
	<small>This certificate accredits the named company as authorized to use the indicated symbol of the American Society of Mechanical Engineers (ASME) for the scope of activity shown below in accordance with the applicable rules of the ASME Boiler and Pressure Vessel Code. The use of the Code symbol and the authority granted by this Certificate of Authorization are subject to the provisions of the agreement set forth in the application. Any construction stamped with this symbol shall have been built strictly in accordance with the provisions of the ASME Boiler and Pressure Vessel Code.</small>	
	COMPANY:	ZOOK Canada Inc. 4400 South Service Road Burlington, Ontario, L7L 5R8 Canada
	SCOPE:	Manufacture of pressure vessel pressure relief devices at the above location only
	AUTHORIZED:	October 25, 2007
EXPIRES:	March 17, 2011	
CERTIFICATE NUMBER:	30,895	
	 Chairman of The Boiler And Pressure Vessel Committee	
	 Director, Accreditation and Certification	
		

PRE-BULGED RUPTURE DISKS

PB SERIES

ZOOK type “PB” Pre-Bulged series rupture disks is the most commonly used style of rupture disk. It is sometimes referred to as the “Granddaddy” of the industry. Its simple fail-safe design may be used on liquid or gas filled systems and is available in many different sizes and materials. It is installed into a holder (called a Safety Head) with a machined 30° angular seat that provides a positive, gas-tight seal between the disk and holder without the need of a gasket. The holder design also prevents disk creep or slippage.

How It Works

PB rupture disks are made from a thin metal foil known as the “seal”. The burst pressure is dependent on the thickness of the seal and the tensile strength of the material the seal is made from. In some instances the seal can be stacked together or laminated to achieve the desired thickness. As the diameter increases the resulting burst pressure decreases. For example, if a given thickness of a metal seal has a burst pressure of 500 psi in a 1” bore, the same seal in a 2” bore will produce a burst pressure of approximately a 250 psi. The service temperature also affects the tensile strength of the seal material and the resulting burst pressure. As the temperature increases, the burst pressure decreases.

The seal is generally pre-bulged (crowned) at the factory to 70% of its rupture pressure. This pre-bulging reduces flexing of the seal during normal operation, thus reducing metal fatigue and resulting premature failures. If an occasional operating vacuum is expected, a vacuum support having the same curvature of the seal is attached to the concave side of the seal protecting the seal from collapsing during vacuum cycles. Every effort is made to ensure a good fit between the seal and vacuum support but some movement is inevitable which will cause increased fatigue. If the seal is exposed to higher than expected system pressures which further bulge the seal and increase the space between the two layers, and then vacuum is applied to the system, the seal will collapse onto the vacuum support causing a turtle-back appearance on the seal and will accelerate fatigue and premature failures. If the system is designed to operate continuously between positive and vacuum pressures, alternate disk designs should be considered.

The disk is installed with the concave side facing the system pressure so that increasing pressure subjects the seal material to increased tensile stress. When the system pressure exceeds the 70% factory pre-bulged pressure, the crown expands and continues to rise until the point of rupture. The tensile strength of the disk material controls the burst pressure of the disk.

Features

- Fail Safe design. Disks damaged or installed incorrectly will rupture at or below the stamped rupture pressure with the exception of vacuum supported disks having a marked burst pressure less than 22 psi (d).
- Can be ordered in accordance with ASME Section VIII.
- Can be ordered in compliance with the European Pressure Equipment Directive (PED).

- Tamperproof design.
- 1/4" thru 24" Size Range.
- Operating Ratio: 70% of Marked Pressure or 75% of the low side of the applicable performance/rupture tolerance for burst pressures greater than 40 psi or 70% of the low side of the applicable performance/rupture tolerance for burst pressure less than 40 psi.
- Limited cycle resistance typically less than 1,000 cycles from atmospheric to 70% of the disks marked rating.
- Liquid or gas service.
- Occasional vacuum service (vacuum support required).

Options

Vacuum Support (-V) - Type PB disks require the addition of a vacuum support when operating under vacuum or back pressure conditions. All vacuum supports are designed to withstand 15 psi (d) backpressure but can be supplied for higher backpressure on request.

Plastic Liner (-L) - In some installations it is desirable to protect the metal seal from corrosive attack from the atmospheric or process sides. In this case, a Teflon liner can be attached to both sides of the disk to provide the required protection. Alternatively, a protective coating can be applied in lieu of the Teflon liner. Coatings are not guaranteed to be pin hole free.

Protective Ring (-R) - The seal material in a type PB disk can be very thin and subject to damage by foreign substances on the lip of the safety head. A heavier gauge ring should therefore be mounted to one or both sides of the disk to provide support and protection to the thin disk. Refer to the product literature for protective ring guidelines.

Cover (-C) - A cover is provided to protect the seal from any debris or objects falling on the top (atmospheric) side of the disk. It is formed to a much higher height than the disk and therefore any dents or creases caused from the falling debris will not be transferred to the disk material.

Common Model Numbers

PB	Standard rupture disk with 30° angular seat
PB-V	Standard. Disk with vacuum support
PB-R	Standard Disk with bottom protective ring
R-PB-R	Standard Disk with top and bottom protective ring
R-PB-V	Standard Disk with top protective ring and vacuum support
R-PB-LV	Standard Disk with top protective ring, vacuum support & bottom liner

¹Always describe the disk from the top (atmospheric) side and work down through the different layers of the disk.

²All the above models can be supplied with available seat designs

Available Seat Design

Standard 30° angle - Designed for installation into all bolted type 30° angle seat disk holders. For installation into Union type or screw type holders specify "UT" or "ST" respectively and the information tag will be supplied loose.

Heavy Duty Lip - Designed for higher pressure applications. Add the suffix "HDL" to the standard model number i.e. "PBHDL". Designed for installation into all bolted type 30° angle seat disk holders with heavy duty lip.

COMPOSITE RUPTURE DISKS

D SERIES

Composite rupture disk was developed to handle operating conditions outside the limits of standard PB disk. Its simple fail-safe design may be used on liquid or gas filled systems and is available in many different sizes and materials. Its wide range of burst pressures and ability to withstand alternating positive to vacuum pressure conditions make it one of the most versatile designs available. Type "D" disks are installed into a holder (called a Safety Head) with a machined 30° angular seat that provides a positive, gas-tight seal between the disk and holder without the need of a gasket and prevents disk creep or slippage.

How It Works

The type "D" Disk consists of two matched, pre-bulged disks, which are assembled as a single unit. In this configuration the lower layer, known as the Seal is made from metal or plastic and provides the pressure seal to the assembly. The upper layer, known as the Cap is made from relatively thick metal that is weakened by a series of six (6) pie shaped precision laser cut radial slits. As the system pressure rises, the seal is pushed into the cap placing it into tension. The cap fails when the system pressure load overcomes the tensile strength of cap material between adjacent slits initiating complete rupture of the disk. The burst pressure is adjusted by changing the location of the slits in the cap.

The disk is installed with the concave side facing the system pressure, placing the disk in tension. The thick cap material is very stable and resists flexing and further bulging from the increasing system pressure, permitting static system pressures up to 80% of the marked burst pressure. If the system is designed to operate continuously between positive to vacuum pressures, a vacuum support having the same curvature of the disk is attached to the concave side of the seal to protect the cap and seal from collapsing during vacuum cycles. Every effort is made to insure a good fit between the cap, seal and vacuum support but some movement is inevitable which will cause fatigue when a metal seal is used. For these applications a Teflon seal should be considered.

Features

- Lower burst pressures.
- Can be ordered in accordance with ASME Section VIII.
- Can be ordered in compliance with the European Pressure Equipment Directive (PED).
- Operating Ratio: 80% of Marked Pressure or 85% of the low side of the applicable performance/rupture tolerance for burst pressures greater than 40 psi or 80% of the low side of the applicable performance/rupture tolerance for burst pressure less than 40 psi.
- Good cycle resistance typically in excess of 3,000 cycles from atmospheric to 80% of the disks marked rating.
- Non-fragmenting design (Teflon seals only).

- Teflon seal protects the cap from corrosion.
- Fail Safe design, disks damaged or installed incorrectly will rupture at or below the stamped rupture pressure with the exception of vacuum supported disks having a marked burst pressure less than 22 psi (d).
- 22 psi (d).
- Tamperproof design.
- 1/2" thru 24" Size Range.
- Liquid or gas filled service.
- Vacuum service (Teflon seal recommended, vacuum support required).

Options

Vacuum Support (-V) - Type D disks require the addition of a vacuum support when operating under vacuum or back pressure conditions. All vacuum supports are designed to withstand 15 psi (d) backpressure but can be supplied for higher backpressure on request.

Plastic Liner (-L) - In some installations it is desirable to protect the metal cap from corrosive attack from the atmospheric or process sides. In this case, a Teflon liner can be attached to either side of the cap to provide the required protection.

Protective Ring (-R) - The seal material in a type D disk is very thin and subject to damage by foreign substances on the lip of the safety head. A heavier gauge ring should therefore be mounted to one or both sides of the disk to provide support and protection to the thin seal.

Cover (-C) - A cover is provided to protect the seal from any debris or objects falling on the top (atmospheric) side of the disk. It is formed to a much higher height than the disk and therefore any dents or creases caused from the falling debris will not be transferred to the disk material.

Common Model Numbers

D	Standard rupture disk with 30° angular seat
D-V	Standard Disk with vacuum support
D-R	Standard Disk with bottom protective ring
R-D-R	Standard Disk with top and bottom protective rings
R-D-V	Standard Disk with top protective ring and vacuum support
R-D-LV	Standard Disk with top protective ring, vacuum support & bottom liner

¹Always describe the disk from the top (atmospheric) side and work down through the different layers of the disk.

²All the above models can be supplied with available seat designs

Available Seat Design

Standard 30° angle - Designed for installation into all bolted type 30° angle seat disk holders. For installation into Union type or screw type holders specify "UT" or "ST" respectively and the information tag will be supplied loose.



ZOOK METAL DISK DESIGNS TENSION LOADED DESIGNS

Heavy Duty Lip - Designed for higher pressure applications. Add the suffix "HDL" to the standard model number i.e. "PBHDL". Designed for installation into all bolted type 30° angle seat disk holders with heavy duty lip.

Holders

The D series rupture disks are designed for use in Bolted, Union or Screw Type holders machined with one of the above mentioned standard seat configurations. Gaskets between the disk and holder are not required for a gas-tight seal.

Vacuum Support Design

ZOOK uses a single hinge or toilet seat design vacuum support. This design is very strong and requires very low energy to open fully which results in it being used at low burst pressures.

TLD SERIES

The TLD series (Teflon Lined D) was developed for applications where corrosive attack of the metal cap is a concern. It retains all of the attributes of the D design and includes a Teflon seal and atmospheric liner to protect the metal cap from corrosion. It is supplied with standard top and bottom metal protective rings allowing for assembly and protection of the Teflon components against damage.

Type "TLD" disks are installed into a holder (called a Safety Head) with a machined 30° angular seat that provides a positive, gas-tight seal between the disk and holder without the need of a gasket and prevents disk creep or slippage.

How It Works

The type "TLD" Disk consists of three matched, pre-bulged disks, which are assembled as a single unit. In this configuration, the metal control Cap is sandwiched between two Teflon liners providing both a pressure seal to the assembly and a corrosion barrier to the cap. The cap is made relatively thick metal that is weakened by a series of six (6) pie shaped precision laser cut radial slits. As the system pressure rises, the lower liner is pushed into the cap placing it into tension. The cap fails when the system pressure load overcomes the tensile strength of cap material between adjacent slits initiating complete rupture of the disk. The burst pressure is adjusted by changing the location of the slits in the cap.

The disk is installed with the concave side facing the system pressure, placing the disk in tension. The thick cap material is very stable and resists flexing and further bulging from the increasing system pressure, permitting static system pressures up to 80% of the marked burst pressure. If the system is designed to operate positive to vacuum pressures, a specially designed "Vacuum Cap" is required to protect the disk from collapsing during vacuum cycles.

Features

- Lower burst pressures.
- Can be ordered in accordance with ASME Section VIII.
- Can be ordered in compliance with the European Pressure Equipment Directive (PED).
- Operating Ratio: 80% of Marked Pressure or 85% of the low side of the applicable performance/rupture tolerance for burst pressures greater than 40 psi or 80% of the low side of the applicable performance/rupture tolerance for burst pressure less than 40 psi.
- Good cycle resistance typically in excess of 3,000 cycles from atmospheric to 80% of the disks marked rating.
- Non-fragmenting design.
- Top and bottom Teflon liners protects the cap from corrosion.
- Fail Safe design, disks damaged or installed incorrectly will rupture at or below the stamped rupture pressure with the exception of vacuum supported disks having a marked burst pressure less than 22 psi (d).
- Tamperproof design.
- 1/2" thru 24" Size Range.
- Liquid or gas filled service.
- Vacuum service (Vacuum support cap design required).

Options

Vacuum Support Cap (-V) - Type TLD disks require a specially designed cap to operate under vacuum or back pressure conditions. All vacuum support caps are designed to withstand 15 psi (d) backpressure but can be supplied for higher backpressure on request.

Common Model Numbers

TLD	"Teflon Lined D" c/w top and bottom Teflon liners and metal protective rings
TLDV	"Teflon Lined D" c/w specially designed vacuum cap design, top and bottom Teflon liners and metal protective rings

¹Always describe the disk from the top (atmospheric) side and work down through the different layers of the disk.

²All the above models can be supplied with available seat designs

Available Seat Design

Standard 30° angle - Designed for installation into all bolted type 30° angle seat disk holders. For installation into Union type or screw type holders specify "UT" or "ST" respectively and the information tag will be supplied loose.

Heavy Duty Lip - Designed for higher pressure applications. Add the suffix "HDL" to the standard model number i.e. "PBHDL". Designed for installation into all bolted type 30° angle seat disk holders with heavy duty lip.

HOLDERS

The TLD series rupture disks are designed for use in Bolted, Union or Screw Type holders machined with one of the above mentioned standard seat configurations. Gaskets between the disk and holder are not required for a gas-tight seal.

Vacuum Support Design

ZOOK uses a single hinge or toilet seat design vacuum support cap. This design is very strong and requires very low energy to open fully which results in it being used at low burst pressures.

FAC AND FDZ SERIES

Flat Seated Composite rupture disks were developed to complement scored forward acting disks by offering much lower burst pressures. Its simple fail-safe design may be used on liquid or gas filled systems and is available in many different sizes and materials. Its wide range of burst pressures and ability to withstand alternating positive to vacuum pressure conditions make it one of the most versatile designs available. Both series are designed for installation into holders with a machined flat seat with integral bite type seal that provides a positive, gas-tight seal between the disk and holder without the need of a gasket and prevents disk creep or slippage.

How It Works

The disk consists of two matched, pre-bulged disks, which are assembled as a single unit. In this configuration the lower layer, known as the Seal is made from metal or plastic and provides the pressure seal to the assembly. The upper layer, known as the Cap is made from relatively thick metal that is weakened by a series of six (6) pie shaped precision laser cut radial slits. As the system pressure rises, the seal is pushed into the cap placing it into tension. The cap fails when the system pressure load overcomes the tensile strength of cap material between adjacent slits initiating complete rupture of the disk. The burst pressure is adjusted by changing the location of the slits in the cap.

The disk is installed with the concave side facing the system pressure, placing the disk in tension. The thick cap material is very stable and resists flexing and further bulging from the increasing system pressure, permitting static system pressures up to 80% of the marked burst pressure. If the system is designed to operate continuously between positive to vacuum pressures, a vacuum support having the same curvature of the disk is attached to the concave side of the seal to protect the cap and seal from collapsing during vacuum cycles. Every effort is made to insure a good fit between the cap, seal and vacuum support but some movement is inevitable which will cause fatigue when a metal seal is used. For these applications a Teflon seal should be considered.

Features

- Lower burst pressures.
- Can be ordered in compliance with the European Pressure Equipment Directive (PED).

- Operating Ratio: 80% of Marked Pressure or 85% of the low side of the applicable performance/rupture tolerance for burst pressures greater than 40 psi or 80% of the low side of the applicable performance/rupture tolerance for burst pressure less than 40 psi.
- Good cycle resistance typically in excess of 3,000 cycles from atmospheric to 80% of the disks marked rating.
- Non-fragmenting design (Teflon seals only).
- Teflon seal protects the metal cap from process corrosion.
- Fail Safe design, disks damaged or installed incorrectly will rupture at or below the stamped rupture pressure with the exception of vacuum supported disks having a marked burst pressure less than 22 psi (d).
- Tamperproof design.
- 1/2" thru 24" Size Range.
- Liquid or gas filled service.
- Vacuum service (Teflon seal recommended, vacuum support required).

Options

Vacuum Support (-V) - Type D disks require the addition of a vacuum support when operating under vacuum or back pressure conditions. All vacuum supports are designed to withstand 15 psi (d) backpressure but can be supplied for higher backpressure on request.

Plastic Liner (-L) - In some installations it is desirable to protect the metal cap from corrosive attack from the atmospheric or process sides. In this case, a Teflon liner can be attached to either side of the cap to provide the required protection.

Protective Ring (-R) - The seal material in a type D disk is very thin and subject to damage by foreign substances on the lip of the safety head. A heavier gauge ring should therefore be mounted to one or both sides of the disk to provide support and protection to the thin seal.

Cover (-C) - A cover is provided to protect the seal from any debris or objects falling on the top (atmospheric) side of the disk. It is formed to a much higher height than the disk and therefore any dents or creases caused from the falling debris will not be transferred to the disk material.

Common Model Numbers

FAC	Standard rupture disk
FAC-V	Standard Disk with vacuum support
FAC-R	Standard Disk with bottom protective ring
R-FAC-R	Standard Disk with top and bottom protective rings
R-FAC-V	Standard Disk with top protective ring and vacuum support
R-FAC-LV	Standard Disk with top protective ring, vacuum support & bottom liner
FDZ	Standard rupture disk
FDZ-V	Standard Disk with vacuum support
FDZ-R	Standard Disk with bottom protective ring
R-FDZ-R	Standard Disk with top and bottom protective rings



ZOOK METAL DISK DESIGNS TENSION LOADED DESIGNS

R-FDZ-V	Standard Disk with top protective ring and vacuum support
R-FDZ-LV	Standard Disk with top protective ring, vacuum support & bottom liner

¹Always describe the disk from the top (atmospheric) side and work down through the different layers of the disk.

²All the above models can be supplied with available seat designs

Holders

The FAC rupture disk is designed for use in the “FAH” insert style pre-torque disk holder. The flat seat design of the FAH holder’s “bite-type” seal, makes the assembly leak-tight without the need of any gaskets. The inlet bore is slightly reduced to provide proper disk support around the transition radius of the disk to improve the vacuum capability of the disk. The FAH holder is designed to fit between standard ANSI, DIN, and JIS pipe flanges Standard pre-torque assembly bolts, flange bolt alignment thru holes and available long pattern all but guarantee a trouble free installation.

The FDZ rupture disk is designed for use in the “UHZ” insert style disk holder. The flat seat design of the UHZ holder’s “bite-type” seal, makes the assembly leak-tight without the need of any gaskets. The disk and outlet fit into a machined counter bore in the inlet guarantying perfect alignment without the need of troublesome alignment pins. The inlet bore is slightly reduced to provide proper disk support around the transition radius of the disk to improve the vacuum capability of the disk. The UHZ holder is designed to fit between standard ANSI, DIN, and JIS pipe flanges.

Vacuum Support Design

ZOOK uses a single hinge or toilet seat design vacuum support. This design is very strong and requires very low energy to open fully which results in it being used at low burst pressures.

FLANGE MOUNTED

Flange geometry establishes the critical dimensions of all flange mounted disks. The flange bolt circle and bolt hole diameter determines the disk outside diameter, the flange bore or inside diameter determines the burst diameter. Incorrect flange specifications can lead to installation problems and out of tolerance bursts. Various flange standards ANSI, API, DIN, or JIS and flange designs weld-neck, slip-on, or threaded have different dimensions that need to be considered for a successful installation. All standard ZOOK flange mounted disks are designed for installation directly between standard bore, ANSI 150# flanges.

“ARD” SERIES

ZOOK type “ARD” Atmospheric Rupture Disk is a flat seated flat contour composite type rupture disk. It is supplied complete with integral compressed fiber gaskets top and bottom. The disk contour is flat and, therefore, its maximum operating pressure is limited to 50% of the stamped burst pressure. Type ARD Disks are available in four (4) different configurations;

- ARD** Designed to burst at the same pressure in either direction, positive or negative.
- ARD-S** Designed to burst at different pressures in the positive and negative directions.
- ARD-V** Designed to burst in one direction only while holding full vacuum in the other direction. The vacuum support is non-opening resulting in reduced net flow area.
- ARD-L** Designed to burst in one direction only at pressure lower than available in the other designs.

Note: ARD series disks are marked with the specified burst pressure and subject to a total rupture tolerance depending on the burst pressure

How It Works

ARD rupture disk consists of a single metal cap that has a plastic seal on both the vent and process sides, thus providing a completely plastic lined disk. The Cap is made from relatively thick metal that is weakened by a series of six (6) pie shaped precision laser cut radial slits. As the system pressure rises, the seal is pushed into the cap placing it into tension. The cap fails when the system pressure load overcomes the tensile strength of cap material between adjacent slits initiating complete rupture of the disk. The burst pressure is adjusted by changing the location of the slits in the cap.

The disk is installed directly between standard pipe flanges placing the disk into tension. The flat cap material flexes immediately as the system pressure increases, and accordingly is limited to static system pressures up to 50% of the marked burst pressure.

Features

- Simple Tamperproof design.
- Can be ordered in compliance with the European Pressure Equipment Directive (PED) for burst pressure greater than 0.5 bar.
- Low burst pressure available.
- No special holder required.
- Gaskets permanently attached to the Disk.
- 2" thru 36" Size Range.
- Operating Ratio: 50% of the low side of the applicable performance/rupture tolerance.
- Limited cycle resistance.
- Liquid or gas filled service.

Common Model Numbers

ARD	Bi-directional rupture disk, Teflon/Metal/Teflon construction
ARD-S	Different burst pressure in both directions, Metal/Teflon/Metal construction
ARD-V	Unidirectional with vacuum support
ARD-L	Unidirectional ultra-low pressure disk

¹Always describe the disk from the top (atmospheric) side and work down through the different layers of the disk.

FD SERIES

ZOOK type “FD” series is a flat seated domed contour composite type rupture disk that is designed to fit directly between standard bore, ANSI 150# flanges. It is supplied complete with integral

compressed fiber gaskets top and bottom. The disk contour is domed and, therefore, its maximum operating pressure is 80% of the stamped burst pressure. FD disks are used primarily in large diameter applications where traditional holders are cost prohibitive. Its simple fail-safe design may be used on liquid or gas filled systems and is available in many different sizes and materials. Its wide range of burst pressures and ability to withstand alternating positive to vacuum pressure conditions make it one of the most versatile designs available.

How It Works

The type “FD” disk consists of two matched, pre-bulged disks, which are assembled as a single unit. In this configuration the lower layer, known as the Seal is made from metal or plastic and provides the pressure seal to the assembly. The upper layer, known as the Cap is made from relatively thick metal that is weakened by a series of six (6) pie shaped precision laser cut radial slits. As the system pressure rises, the seal is pushed into the cap placing it into tension. The cap fails when the system pressure load overcomes the tensile strength of cap material between adjacent slits initiating complete rupture of the disk. The burst pressure is adjusted by changing the location of the slits in the cap.

The disk is installed with the concave side facing the system pressure, placing the disk in tension. The thick cap material is very stable and resists flexing and further bulging from the increasing system pressure, permitting static system pressures up to 80% of the marked burst pressure. If the system is designed to operate continuously between positive to vacuum pressures, a vacuum support having the same curvature of the disk is attached to the concave side of the seal to protect the cap and seal from collapsing during vacuum cycles. Every effort is made to insure a good fit between the cap, seal and vacuum support but some movement is inevitable which will cause fatigue when a metal seal is used. For these applications a Teflon seal should be considered.

Features

- Low burst pressures.
- Operating Ratio: 80% of Marked Pressure or 85% of the low side of the applicable performance/rupture tolerance for burst pressures greater than 40 psi or 80% of the low side of the applicable performance/rupture tolerance for burst pressure less than 40 psi.
- Good cycle resistance typically in excess of 3,000 cycles from atmospheric to 80% of the disks marked rating.
- Non-fragmenting design (Teflon seals only).
- Teflon seal protects the metal cap from process corrosion.
- Fail Safe design, disks damaged or installed incorrectly will rupture at or below the stamped rupture pressure with the exception of vacuum supported disks having a marked burst pressure less than 22 psi (d).
- Tamperproof design.
- 2” thru 36” Size Range.
- Liquid or gas filled service.
- Vacuum service (vacuum support required).

Options

Vacuum Support (-V) - Type D disks require the addition of a vacuum support when operating under vacuum or back pressure conditions. All vacuum supports are designed to withstand 15 psi (d) backpressure but can be supplied for higher backpressure on request.

Plastic Liner (-L) - In some installations it is desirable to protect the metal cap from corrosive attack from the atmospheric or process sides. In this case, a Teflon liner can be attached to either side of the cap to provide the required protection.

Protective Ring (-R) - The seal material in a type D disk is very thin and subject to damage by foreign substances on the lip of the safety head. A heavier gauge ring should therefore be mounted to one or both sides of the disk to provide support and protection to the thin seal.

Cover (-C) - A cover is provided to protect the seal from any debris or objects falling on the top (atmospheric) side of the disk. It is formed to a much higher height than the disk and therefore any dents or creases caused from the falling debris will not be transferred to the disk material.

Common Model Numbers

FD	Standard rupture disk with 30° angular seat
FD-V	Standard Disk with vacuum support
FD-R	Standard Disk with bottom protective ring
R-FD-R	Standard Disk with top and bottom protective rings
R-FD-V	Standard Disk with top protective ring and vacuum support
R-FD-LV	Standard Disk with top protective ring, vacuum support & bottom liner

¹Always describe the disk from the top (atmospheric) side and work down through the different layers of the disk.

²All the above models can be supplied with available seat designs

HOLDERS

No holder required, standard product fits directly between standard bore ANSI flanges. It is very important to consult the factory on the availability of alternate flange standards, types, and bores before quoting.

Vacuum Support Design

ZOOK uses a single hinge or toilet seat design vacuum support. This design is very strong and requires very low energy to open fully which results in it being used at low burst pressures.

SCORED FORWARD ACTING

SFA SERIES

Scored tension loaded rupture disk were introduced to the market in the mid 1960's as a more durable and flexible alternative to either pre-bulged or composite designs. Precision formed grooves usually in a cross pattern on the atmospheric side of the disk used to control both the bursting pressure and the opening pattern of the disk. The "SFA" series rupture disk is ZOOK's original design that is designed as a non-fragmenting (4) four petal opening disk. This tension-loaded disk is scored before crowning on the convex side, away from the process and is then crowned into a relatively low crown height resulting in limited vacuum or cycling capabilities and a maximum operating ratio of 80%

How It Works

SFA series rupture disks are made from material three (3) to four (4) times thicker than other tension-loaded disks. Precision scoring process side of the disk controls both the rupture pressure and the opening pattern. Increasing system pressure increases stress in the score lines in an otherwise stable dome until burst. The single layer solid metal design is very stable at operating pressure up to 80% of its marked burst. Higher and lower bursting pressures are available but may have less cycle resistance and increased potential to fragment.

Features

- Fail Safe Design. Disks damaged or installed incorrectly will rupture at or below the stamped rupture pressure.
- Can be ordered in accordance with ASME Section VIII.
- Can be ordered in compliance with the European Pressure Equipment Directive (PED).
- Limited vacuum capacity at lower burst ratings.
- Smooth process side eliminates the potential for product buildup.
- 1/2" thru 24" Size Range.
- Available in 0%, -5% and -10% Manufacturing Range.
- Operating Ratio: 80% of Marked Pressure or 95% of the low side of the applicable performance/rupture tolerance for burst pressures greater than 40 psi or 80% of the low side of the applicable performance/rupture tolerance for burst pressure less than 40 psi.
- Designed to be Non-Fragmenting, opens along pre-weakened score lines.
- Liquid or Gas Systems.

Options

Plastic Liner (-L) - In some installations, it is desirable to protect the metal disk material from corrosive attack from the atmospheric or process sides. In this case, a Teflon liner can be attached to either side of the cap to provide the required protection.

Protective Ring (-R) - For disks having low burst pressure, the flat seat is very fragile and needs to be supported by the ring. In addition, the ring can provide a strong and stiff point of attachment for the identification tag.

Common Model Numbers

SFA	Standard disk design
SFA-L	Standard disk with process side liner

HOLDERS

The SFA rupture disk is designed for use in the “SF7A” insert type disk holder. The flat seat design of the SF7A holder’s “bite-type” seal, makes the assembly leak-tight without the need of any gaskets. The inlet bore is slightly reduced to provide proper disk support around the transition radius of the disk to improve the vacuum capability of the disk. 3 alignment pins are used to insure correct installation of the disk into the holder. The SF7A holder is designed to fit between standard ANSI pipe flanges.

FAX, SFAZ, AND SFA-II SERIES

Description

SFA-II second generation scored forward acting design includes three dimensional scoring technology developed to improve the service life, cycle resistance, and vacuum capacity when compared to the original SFA design. Precision scoring done after the disk has been formed into a high crown height allows the following performance improvements:

- Formed grooves usually in a cross pattern on the atmospheric side of the disk are used to control both the bursting pressure and the opening pattern of the disk.
- Higher dome geometry withstands full vacuum (at ambient temperature) without a separate vacuum support at the minimum specified burst pressures. Lower bursting pressures are available but with only hold partial vacuum.
- 33% thicker material improves dome stability, cycle resistance, and increases service life.
- Improved scoring process adjustable in 1/10,000th of an inch increments improves flexibility and the technician’s ability to fine tune the required burst pressure.
- Fits improved UH series insert holders.

The “**SFAZ**” builds on the success of the SFA-II but has a smaller outside diameter to allow for installation into European DIN and Japanese JIS flange standards. Fits UHZ series insert holders.

The “**FAX**” includes all the attributes of the SFA-II & SFAZ designs. Fits into the feature rich FAH pre-torque holder.

How It Works

Precision scoring process controls both the rupture pressure and the opening pattern. Increasing system pressure increases stress in the score lines in an otherwise stable dome until burst. The single layer solid metal design that is scored after forming into a high dome is very stable at operating pressure up to 85% of its marked burst. Higher and lower bursting pressures are available but may have less cycle resistance and increased potential to fragment

Features

- Fail Safe Design. Disks damaged or installed incorrectly will rupture at or below the stamped rupture pressure.
- Can be ordered in accordance with ASME Section VIII.
- Can be ordered in compliance with the European Pressure Equipment Directive (PED).
- Full Vacuum Rated disk will withstand full vacuum (15 psi(d) minimum at ambient temperature), without vacuum support at the minimum specified burst pressures. Lower bursting pressures are available but will only hold partial vacuum.
- Smooth process side eliminates the potential for product buildup.
- 1/2" thru 24" Size Range.
- Available in 0%, -5% and -10% Manufacturing Range.
- Operating Ratio: 85% of Marked Pressure or 90% of the low side of the applicable performance/rupture tolerance for burst pressures greater than 40 psi or 85% of the low side of the applicable performance/rupture tolerance for burst pressure less than 40 psi
- Cyclic Positive-to-Negative duty typically in excess of 50,000 cycles from full vacuum to 85% of the disks marked rating. Cycle life is affected by actual process conditions such as the magnitude, frequency, medium, and burst rating of the disk. For example installation on the outlet of a positive displacement pump will reduce the cycle life of the disk.
- Non-Fragmenting, opens along pre-weakened score lines.
- Liquid or Gas Systems.
- Ideal for PRV/SRV isolation not requiring test-in-place capacity.

Options

Plastic Liner (-L) - In some installations, it is desirable to protect the metal disk material from corrosive attack from the atmospheric or process sides. In this case, a Teflon liner can be attached to either side of the cap to provide the required protection.

Protective Ring (-R) - For disks having low burst pressure, the flat seat is very fragile and needs to be supported by the ring. In addition the ring can provide a strong and stiff point of attachment for the identification tag.

Common Model Numbers

FAX	Standard disk design
FAX-L	Standard disk with process side liner
SFAZ	Standard disk design
SFAZ-L	Standard disk with process side liner
SFA-II	Standard disk design
SFA-II-L	Standard disk with process side liner

HOLDERS

The FAX rupture disk is designed for use in the "FAH" insert style pre-torque disk holder. The flat seat design of the FAH holder's "bite-type" seal, makes the assembly leak-tight without the need of any gaskets. The inlet bore is slightly reduced to provide proper disk support around the transition radius of the disk to improve the vacuum capability of the disk. The FAH holder is designed to fit between standard ANSI, DIN, and JIS pipe flanges.

Note: Standard pre-torque assembly bolts, flange bolt alignment thru holes and available long pattern all but guarantee a trouble-free installation.

The SFAZ rupture disk is designed for use in the “UHZ” insert style disk holder. The flat seat design of the UHZ holder’s “bite-type” seal, makes the assembly leak-tight without the need of any gaskets. The disk and outlet fit into a machined counter bore in the inlet guarantying perfect alignment without the need of troublesome alignment pins. The inlet bore is slightly reduced to provide proper disk support around the transition radius of the disk to improve the vacuum capability of the disk. The UHZ holder is designed to fit between standard ANSI, DIN, and JIS pipe flanges.

The SFA-II rupture disk is designed for use in the “UH” insert type disk holder. The UH disk holder is identical to the UHZ design but will only fit between standard ANSI pipe flanges.

ZOOK METAL DISK DESIGNS COMPRESSION LOADED DESIGNS

KNIFE-BLADE REVERSE ACTING

“SB” SERIES RUPTURE DISK

Description

The type “SB” Snap-Back rupture disk is a solid metal, conventional reverse-acting rupture disk that uses a set of razor sharp knife blades in the outlet flange of the disk holder to cut the disk open during reversal. Compression- loading enables the disk to operate up to 90% of its stamped burst pressure without fatigue. The forming- pressure is approximately four (4) to five (5) times the reversal pressure and therefore never requires a separate vacuum support.

Note: The SB series disk should not be used on a hydraulic system

It should be noted that the SB disk is a mechanical device and is not fail-safe. Extra effort is required to insure the disk is installed without damage, on the correct service, using the recommended torque values. Improper installation can result in the disk bursting higher than its marked burst pressure.

How It Works

The ZOOK type “SB” rupture disk is installed with the system pressure acting on the convex side of the disk, placing the dome of the disk into compression. Pressure relief is achieved in two stages. In the first stage, as the system pressure increases, compression-loading of the disk increases until the dome collapses or reverses. In the second stage, the disk is accelerated or pushed back through the neutral position (by the energy of the expanding gas) into a set of razor sharp knife blades that cut



ZOOK METAL DISK DESIGNS COMPRESSION LOADED DESIGNS

the disk into three or four equal pie shaped segments. The burst pressure is controlled by varying the height of the disk dome. Increasing the height will cause a higher reversal pressure while decreasing the dome height will lower the reversal pressure. The burst pattern is controlled by the knife blade pattern.

Features

- Full Vacuum Rated, disk will withstand full vacuum without vacuum support.
- Can be ordered in accordance with ASME Section VIII.
- Can be ordered in compliance with the European Pressure Equipment Directive (PED).
- Available in 0%, -5% and -10% Manufacturing Range.
- Operating Ratio: 90% of Marked Pressure or 95% of the low side of the applicable performance/rupture tolerance for burst pressures greater than 40 psi or 90% of the low side of the applicable performance/rupture tolerance for burst pressure less than 40 psi.
- Longest cycle life of any rupture disk design. Typically in excess of 200,000 cycles from full vacuum to 90% of the disks marked rating.
- Non-Fragmenting, the Disk is cut into three or four equal segments by the knife blades.
- Gas Systems only.
- Cyclic Positive-to-Negative Duty.
- The disk is thicker than a standard seal of a PB series disk and will offer greater corrosion resistance for an equivalent burst pressure.

Options

Plastic Liner (-L) - In some installations it is desirable to protect the metal disk material from corrosive attack on the process side. In this case, a Teflon liner can be attached to provide the required protection. Adding a Teflon liner to the atmospheric side of the disk is strongly discouraged because its soapy texture increases the possibility of material creep and inconsistent burst pressures.

Common Model Numbers

SB	Standard disk design
SB-L	Standard disk with process side liner

HOLDERS

The SB rupture disk is designed for use in the “SB7A” insert-type disk holder or full bolted-type “SB7”. The flat seat design of the SB7 & SB7A holders “bite-type” seal makes the assembly leak-tight without the need of any gaskets. The outlet bore is slightly reduced to provide proper disk support around the transition radius of the disk. The SB7 & SB7A holders are designed to fit between standard pipe flanges.

CROSS SCORED REVERSE ACTING

“SRA” SERIES RUPTURE DISK

Description

The ZOOK type “SRA” rupture disk is a solid metal, scored Reverse-Acting rupture disk that opens in a predetermined burst pattern. The disk is cross-scored on the concave side, away from the process and does not depend on knife blades to cut the disk open upon reversal. Compression loading enables the disk to operate up to 90% of its stamped burst pressure without fatigue. The reversal pressure is greater than the forming pressure and therefore never requires a separate vacuum support.

Note: The SRA series disk should not be used on a hydraulic system

It should be noted that the SRA disk is a mechanical device and is not fail-safe. Extra effort is required to insure the disk is installed without damage, on the correct service, using the recommended torque values. Improper installation can result in the disk bursting higher than its marked burst pressure.

How It Works

The ZOOK type “SRA” rupture disk is installed with the system pressure acting on the convex side of the disk, placing it into compression. Pressure relief is achieved in two stages. In the first stage, as the system pressure increases, compression-loading of the disk increases until the dome collapses or reverses. In the second stage the disk is accelerated or pushed back through the neutral position (by the energy of the expanding gas) tearing the disk material along the pre-weakened score lines on the outlet (vent) side of the Disk. The burst pressure is controlled by changing the depth of the score lines (adjustable to 1/10,000th of an inch) and varying the dome height. The burst pattern is controlled by the score pattern.

Features

- Full Vacuum Rated, Disk will withstand full vacuum without vacuum support.
- 1” thru 8” Size Range.
- Can be ordered in accordance with ASME Section VIII.
- Can be ordered in compliance with the European Pressure Equipment Directive (PED).
- Operating Ratio: 90% of Marked Pressure or 95% of the low side of the applicable performance/rupture tolerance for burst pressures greater than 40 psi or 90% of the low side of the applicable performance/rupture tolerance for burst pressure less than 40 psi.
- High cycle life typically in excess of 200,000 cycles from full vacuum to 90% of the disks marked rating.
- Non-Fragmenting, opens along pre-weakened score lines.
- Gas Systems only.
- Cyclic Positive-to-Negative Duty.
- Heavy Pulsating Duty.
- Designed for Safety Relief Valve Isolation.



ZOOK METAL DISK DESIGNS COMPRESSION LOADED DESIGNS

Options

Plastic Liner (-L) – In some installations it is desirable to protect the metal disk material from corrosive attack from the process side. In this case, a Teflon liner can be attached to provide the required protection. Adding a Teflon liner to the atmospheric side of the disk is strongly discouraged because its soapy texture increases the possibility of material creep and inconsistent burst pressures.

Common Model Numbers

SRA	Standard disk design
SRA-L	Standard disk with process side liner

HOLDERS

The SRA rupture disk is designed for use in the ZOOK “SR7A” insert type disk holder or full bolted type “SR7”. The flat seat design of the SR7 & SR7A holders “bite-type” seal makes the assembly leak-tight without the need of any gaskets. The outlet bore is slightly reduced to provide proper disk support around the transition radius of the disk. Three alignment pins guarantee correct installation of the disk and alignment of the inlet & outlet rings. The SR7 & SR7A holders are designed to fit between standard pipe flanges.

HIGH PERFORMANCE REVERSE ACTING

“URA” SERIES RUPTURE DISKS

Description

The type “URA” Universal Reverse-Acting rupture disk is a non-scored solid metal, high performance reverse- acting rupture disk that uses an efficiently designed shear ring permanently attached to the outlet side of the disk to shear the disk open on contact. This unique shear ring design enables the disk to operate on compressible (gas) or incompressible (liquid) service offering high or low burst pressures. Compression loading enables the disk to operate at up to 90% of its stamped burst pressure without fatigue. The forming pressure is approximately four (4) times the reversal pressure and therefore never requires a separate vacuum support. The disk is designed to be non-fragmenting due to the predetermined burst pattern defined by the shear ring.

It should be noted that the URA disk is a mechanical device and is not fail-safe. Specially designed holders having a cast alignment pin guarantee proper installation of the disk into its holder however extra effort is required to insure the device (disk and holder) is installed into the piping without damage, with the flow arrows pointing in the correct direction, and using the recommended torque values. Improper installation can result in the disk bursting higher than its marked burst pressure.

How It Works

The ZOOK type “URA” rupture disk is installed with the system pressure acting on the convex side of the disk, placing the dome of the disk into compression. Pressure relief is achieved in two stages. In the first stage, as the system pressure increases, compression loading of the disk increases until the

dome collapses or reverses. In the second stage the disk is accelerated or pushed back through the neutral position into the shear ring that shears the disk material in a predetermined pattern allowing the disk to fold onto its hinge. The disk is not torque sensitive because of its attachment to the shear ring which eliminates material creep as the system pressure increases. The burst pressure is controlled by varying the height of the disk dome. Increasing the height will cause a higher reversal pressure while decreasing the dome height will lower the reversal pressure.

Features

- No Score lines (unique among its class).
- Can be ordered in accordance with ASME Section VIII.
- Can be ordered in compliance with the European Pressure Equipment Directive (PED).
- Full Vacuum Rated, Disk will withstand full vacuum without vacuum support.
- 1" thru 24" Size Range.
- Not torque-sensitive.
- Available in 0%, -5% and -10% Manufacturing Range.
- Operating Ratio: 90% of Marked Pressure or 95% of the low side of the applicable performance/rupture tolerance for burst pressures greater than 40 psi or 90% of the low side of the applicable performance/rupture tolerance for burst pressure less than 40 psi.
- Longest cycle life of any rupture Disk designs. Typically in excess of 200,000 cycles from full vacuum to 90% of the disks marked rating.
- Non-Fragmenting, predetermined single hinge pattern.
- Gas or liquid service.
- Cyclic Positive-to-Negative Duty.
- The disk is thicker than a standard seal of a PB series disk and will offer greater corrosion resistance for an equivalent burst pressure.

Options

Plastic Liner (-L) – In some installations it is desirable to protect the metal disk material from corrosive attack from the process side. In this case, a Teflon liner can be attached to provide the required protection. Adding a Teflon liner to the atmospheric side of the disk is strongly discouraged because its soapy texture increases the possibility of material creep and inconsistent burst pressures.

Common Model Numbers

URA	Standard disk design
URA-L	Standard disk with process side liner

HOLDERS

The URA rupture disk is designed for use in the "URA-I" or "URA-PT" pre-torque insert-type design. The flat "bite- type" seal makes the assembly leak-tight without the need of any gaskets. The outlet bore has the same cloverleaf shape to provide support to the shear ring for higher pressure disks. The URA-I and URA-PT holders are designed to fit between standard pipe flanges.

“RLP” SERIES RUPTURE DISKS

Description

The type “RLP” Reverse Low Pressure rupture Disk is a non-scored solid metal, high performance reverse acting rupture Disk that is designed for low pressure liquid and gas applications. Its unique two step dome design and shear ring permanently attached to the outlet side of the Disk provide market leading low pressure liquid and gas relief. Compression loading enables the disk to operate up to 90% of its stamped burst pressure without fatigue. The design does require a vacuum ring for low burst pressures. The disk is designed to be non- fragmenting due to the predetermined burst pattern defined by the shear ring.

It should be noted that the RLP disk is a mechanical device and is not fail-safe. Special designed holders having a cast alignment pin guarantee proper installation of the disk into its holder however extra effort is required to insure the device (disk and holder) is installed into the piping without damage, with the flow arrows pointing in the correct direction, and using the recommended torque values. Improper installation can result in the disk bursting higher than its marked burst pressure.

How It Works

The ZOOK type “RLP” rupture Disk is formed with 2 progressive domes; the height of the first dome, located near the perimeter controls the reversal pressure while the inner dome is formed to a very high dome to support the system pressure. The disk is installed with the system pressure acting on the convex side of the Disk, placing the dome of the disk in compression. Pressure relief is achieved in two stages. In the first stage, as the system pressure increases, compression loading of the Disk increases until the first dome collapses or reverses. In the second stage the Disk is accelerated or pushed back through the neutral position into a teeth ring that cuts the disk material in a predetermined pattern allowing the disk to fold onto its hinge. The disk is not torque sensitive because its attachment to the teeth ring which eliminates material creep as the system pressure increases. The burst pressure is controlled by varying the height of the first dome. Increasing the height will cause a higher reversal pressure while decreasing the height will lower the reversal pressure.

Features

- No score lines (unique among its class).
- Can be ordered in accordance with ASME Section VIII.
- Can be ordered in compliance with the European Pressure Equipment Directive (PED).
- Full Vacuum Rated (may require a vacuum ring at low burst pressures).
- 1” thru 24” Size Range.
- Not torque sensitive.
- Available in 0%, -5% and -10% Manufacturing Range.
- Operating Ratio: 90% of the low side of the applicable performance/rupture tolerance.
- Good cycle resistance typically in excess of 2,000 cycles from atmospheric to 90% of the disks marked rating.
- Non-Fragmenting, predetermined single hinge pattern.
- Gas or liquid service.
- Cyclic Positive-to-Negative Duty.

Options

Plastic Liner (L) – In some installations it is desirable to protect the metal disk material from corrosive attack from the process side. In this case, a Teflon liner can be attached to provide the required protection. Adding a Teflon liner to the atmospheric side of the disk is strongly discouraged because its soapy texture increases the possibility of material creep and inconsistent burst pressures.

Common Model Numbers

RLP	Standard disk design
RLP-L	Standard disk with process side liner

HOLDERS

The RLP rupture disk is designed for use in the “RLP-I” or “RLP-PT” pre-torque insert type design. The flat “bite type” seal makes the assembly leak tight without the need of any gaskets. The outlet bore has the same clover leaf shape to provide support to the shear ring for higher pressure disks. The RLP-I and RLP-PT holders are designed to fit between standard pipe flanges.

“RA” SERIES RUPTURE DISKS AND HOLDERS

The “Simple” Approach

Over the past 75 years there have been many advancements in rupture disk technology resulting in many different styles of rupture disk that are now made from exotic materials that are able to handle more demanding service conditions and more reliable than ever before. Many of these advancements have resulted in overlapping feature and benefits that have made it very difficult for the user to sift through and establish the correct style of disk that is best overall for the required application.

ZOOK’s new “Simple” approach addresses this confusion by replacing redundant overlapping disk designs with a few simple straight forward designs that offer tangible benefits from one design to another.

Reverse Acting “RA” Series Rupture Disks

The RA series of rupture disk are designed for installation into a single full featured RAH series holder and are currently available in four (4) designs that cover the full range of applications from liquid to gas, ultra-low pressure to high pressure and low temperature to high temperature.

RA4 Rupture Disk

The “RA4” is an ultra-low pressure reverse acting, liquid or gas service rupture disk designed to fit into the RAH series holders. It is identical to the RLP design.



ZOOK METAL DISK DESIGNS COMPRESSION LOADED DESIGNS

RA6 Rupture Disk

The RA6 is a low pressure reverse acting, liquid or gas service rupture disk designed to fit into the RA series holders. It is similar to the URA design but employs a specially designed shear ring that has been optimized for non-fragmentation and low pressure liquid or gas applications.

RA8 Rupture Disk

The RA8 is a medium to high pressure reverse acting, liquid or gas service rupture disk designed to fit into the RA series holders. It is similar to the URA design but employs a specially designed shear ring that has been optimized for medium to high pressure liquid or gas applications.

RAX Rupture Disk

The RAX is a medium to high pressure reverse acting, gas only service rupture disk designed to fit into the RAH series holders and is identical to the SRA design.

RAH Series Holder

The RAH series holder is full featured and designed to accept four (4) different style disks that cover a broad range of applications from ultra-low to high burst pressures, liquid or gas application, high or low temperatures. Standard pre-torque assembly bolts, flange bolt alignment thru holes and available long pattern all but guarantee a trouble free installation.

ZOOK METAL DISK DESIGNS SPECIALTY RUPTURE DISK DESIGNS

ULTRA LOW PRESSURE DISKS

TARGET MARKET

Designed specifically for maximum protection of gas or liquid storage vessels from damage caused by unplanned excessive vacuum or over pressure.

PROVAC AND PROPOS

The ProVAC and ProPOS Rupture Disk is a composite double acting rupture disk which will relieve an ultra-low (inches of water column) vacuum pressure or a positive pressure condition. It has been replaced by the Z-VAC and Z-POS series and is currently only sold to support existing installations.

Z-VAC AND Z-POS

The Z-VAC Rupture Disk is a composite double acting rupture disk which will relieve an ultra-low (inches of water column) vacuum pressure or a positive pressure condition. It is specifically designed to provide maximum protection of gas or liquid storage vessels from damage caused by unplanned excessive vacuum or over pressure. The Z-POS Rupture Disk is the reverse of the Z-VAC, it is a double acting rupture disk which will relieve an ultra-low (inches of water column) positive pressure or a vacuum pressure condition. Both designs rely on a razor-sharp knife-blade positioned to cut the Teflon seal open in the low pressure burst direction. Over time the condition of the knife-blades can deteriorate to a point of ineffectiveness and the holder should not be used. The Z-VAC and Z-POS incorporate a unique replaceable knife-blade design allowing simple field replacement if there is any doubt of the “sharpness” of the blade guaranteeing a successful installation.

How It Works

The Z-VAC disk consists of three (3) matched pre-bulged components which are assembled as a single unit and is installed with the concave side of the assembly facing the vessel. In this configuration, the Teflon middle layer, known as the seal provides the pressure seal to the assembly and will move in the direction of the pressure differential across it. In the event of positive internal pressure the seal moves into a perforated and slotted top layer known as the cap which supports the seal until the desired burst pressure is reached. The positive pressure rating is adjusted by varying the position of six (6) precision cut radial slots like a conventional “D” series disk. In the event of vacuum internal pressure the seal moves into the lower layer known as the “girdle” which supports the seal until the desired vacuum burst pressure is reached and the girdle collapses allowing the seal to be cut through by the knife-blades. The vacuum pressure rating is adjusted by varying the collapse strength of the girdle. The Z-POS disk is like the Z-VAC but is installed with the convex side of the assembly facing the vessel and the function of the Cap is to control the vacuum burst pressure and the function of the Girdle is to control the positive burst pressure.

Features

- Hi-Pressure burst direction Operating Ratio: 80% of Marked Pressure or 85% of the low side of the applicable performance/rupture tolerance for burst pressures greater than 40 psi or 80% of the low side of the applicable performance/rupture tolerance for burst pressure less than 40 psi.
- Good cycle resistance typically in excess of 3,000 cycles from atmospheric to 80% of the disks marked rating.
- Non-fragmenting design.
- Tamperproof design.
- 2” thru 12” Size Range.
- Liquid or gas filled service.

Options

BI Sensor (-BI) - is a simple but effective method of remotely monitoring the status of the disk. It monitors the continuity of a copper circuit attached to the atmospheric side of the disk seat. When the disk ruptures from either positive or negative overpressure the strip is broken and the continuity lost.

(-S) - For installation is specially designed holder with sanitary ferrule connections.

(-V) - Unrated perforated cap designed to withstand 15 psi negative pressure.



ZOOK METAL DISK DESIGNS SPECIALTY RUPTURE DISK DESIGNS

Common Model Numbers

Z-VAC	Standard disk design
Z-VAC-BI	Standard disk with integral burst indicator strip attached to the atmospheric side of the seal
Z-VAC-S	Standard disk designed for installation is specially designed holder with sanitary ferrule connections
Z-VAC-BI-S	Standard disk designed for installation is specially designed holder with sanitary ferrule connections c/w integral BI burst sensor
Z-POS	Standard disk design
Z-POS-BI	Standard disk with integral burst indicator strip attached to the atmospheric side of the seal
Z-POS-S	Standard disk designed for installation is specially designed holder with sanitary ferrule connections
Z-POS-BI-S	Standard disk designed for installation is specially designed holder with sanitary ferrule connections c/w integral BI burst sensor

HOLDERS

Standard Z-VAC and Z-POS holders are designed to fit within the bolt circle of standard pipe flanges and have simple user replaceable knife-blade sets or quick release hygienic “Sanitary” fittings with permanent knife-blades.

SANITARY DISKS

TARGET MARKET

ZOOK’s comprehensive range of sanitary rupture disks and holders have been designed specifically for the pharmaceutical, biotech, food, and beverage industries. These rupture discs are available to fit between industry standard sanitary ferrules or NA-CONNECT® flanges.

RAUS SERIES

Description

The type “RAUS” Universal Reverse-Acting rupture disk is a non-scored solid metal, high performance reverse-acting rupture disk that uses an efficiently designed shear ring permanently attached to the outlet side of the disk to shear the disk open on contact. This unique shear ring design enables the disk to operate on compressible (gas) or incompressible (liquid) service offering high or low burst pressures. Compression loading enables the disk to operate at up to 90% of its stamped burst pressure without fatigue. The forming pressure is approximately four (4) times the reversal pressure and therefore never requires a separate vacuum support. The disk is designed to be non-fragmenting due to the predetermined burst pattern defined by the shear ring.

It should be noted that the RAUS disk is a mechanical device and is not fail-safe, extra effort is required to insure the disk is installed into the piping without damage, with the flow arrows pointing in the correct direction, and using the recommended torque values. Improper installation can result in the disk bursting higher than its marked burst pressure.

How It Works

The ZOOK “RAUS” rupture disk is installed with the system pressure acting on the convex side of the disk, placing the dome of the disk into compression. Pressure relief is achieved in two stages. In the first stage, as the system pressure increases, compression loading of the disk increases until the dome collapses or reverses. In the second stage the disk is accelerated or pushed back through the neutral position into the shear ring that shears the disk material in a predetermined pattern allowing the disk to fold onto its hinge. The burst pressure is controlled by varying the height of the disk dome. Increasing the height will cause a higher reversal pressure while decreasing the dome height will lower the reversal pressure. The disk is torque sensitive and fragile, care needs to be taken eliminate damage, uneven piping stress, and over-torquing of the clamp nut. Users are encouraged to use a “Torque-Rite” nut to control the clamping load.

Features

- No Score lines (unique among its class).
- Can be ordered in accordance with ASME Section VIII.
- Can be ordered in compliance with the European Pressure Equipment Directive (PED).
- Typical surface finish for wetted parts is 8-16 micinch (0.2-0.4 microns).
- Full Vacuum Rated, Disk will withstand full vacuum without vacuum support however a process side ring is encouraged to help stabilize the disk dome.
- 1” thru 4” Size Range.
- Wide range of gasket materials available.
- Available in 0%, -5% and -10% Manufacturing Range.
- Operating Ratio: 90% of Marked Pressure or 95% of the low side of the applicable performance/rupture tolerance for burst pressures greater than 40 psi or 90% of the low side of the applicable performance/rupture tolerance for burst pressure less than 40 psi.
- Non-Fragmenting, predetermined single hinge pattern.
- Gas or liquid service.

Options

Plastic Liner (L) – In some installations it is desirable to protect the metal disk material from corrosive attack from the process side. In this case, a Teflon liner can be attached to provide the required protection. Adding a Teflon liner to the atmospheric side of the disk is strongly discouraged because its soapy texture increases the possibility of material creep and inconsistent burst pressures.

BI Sensor (BI) – is a simple but effective method of remotely monitoring the status of the disk. It monitors the continuity of a copper circuit attached to the atmospheric side of the disk seat. When the disk ruptures from either positive or negative overpressure the strip is broken and the continuity lost.



ZOOK METAL DISK DESIGNS SPECIALTY RUPTURE DISK DESIGNS

Common Model Numbers

RAUS	Standard disk design
RAUS-L	Standard disk with process side liner

HOLDERS

RAUS series rupture disks are available to fit between industry standard sanitary Tri-Clover® ferrules or NA-CONNECT® flanges. Other ferrule standard such as BS 4825-3, ISO 2852, or DIN 32676 can be accommodated if requested at extra cost.

“RLPS” SERIES RUPTURE DISKS

Description

The ZOOK type “RAUS” rupture disk is installed with the system pressure acting on the convex side of the disk, placing the dome of the disk into compression. Pressure relief is achieved in two stages. In the first stage, as the system pressure increases, compression loading of the disk increases until the dome collapses or reverses. In the second stage the disk is accelerated or pushed back through the neutral position into the shear ring that shears the disk material in a predetermined pattern allowing the disk to fold onto its hinge. The burst pressure is controlled by varying the height of the disk dome. Increasing the height will cause a higher reversal pressure while decreasing the dome height will lower the reversal pressure. The disk is torque sensitive and fragile, care needs to be taken eliminate damage, uneven piping stress, and over-torqueing of the clamp nut. Users are encouraged to use a “Torque-Rite” nut to control the clamping load.

How It Works

The ZOOK “RLPS” rupture Disk is formed with 2 progressive domes; the height of the first dome, located near the perimeter controls the reversal pressure while the inner dome is formed to a very high dome to support the system pressure. The disk is installed with the system pressure acting on the convex side of the Disk, placing the dome of the disk in compression. Pressure relief is achieved in two stages. In the first stage, as the system pressure increases, compression loading of the Disk increases until the first dome collapses or reverses. In the second stage the Disk is accelerated or pushed back through the neutral position into a teeth ring that cuts the disk material in a predetermined pattern allowing the disk to fold onto its hinge. The burst pressure is controlled by varying the height of the first dome. Increasing the height will cause a higher reversal pressure while decreasing the height will lower the reversal pressure. The disk is torque sensitive and fragile, care needs to be taken eliminate damage, uneven piping stress, and over-torqueing of the clamp nut. Users are encouraged to use a “Torque-Rite” nut to control the clamping load.

Features

- No score lines (unique among its class).
- Can be ordered in compliance with the European Pressure Equipment Directive (PED).
- Typical surface finish for wetted parts is 8-16 mircoinch (0.2-0.4 microns).
- Full Vacuum Rated (requires a vacuum ring).

- 1" thru 4" Size Range.
- Available in 0%, -5% and -10% Manufacturing Range.
- Operating Ratio: 90% of the low side of the applicable performance/rupture tolerance.
- Non-Fragmenting, predetermined single hinge pattern.
- Gas or liquid service.

Options

Plastic Liner (L) – In some installations it is desirable to protect the metal disk material from corrosive attack from the process side. In this case, a Teflon liner can be attached to provide the required protection. Adding a Teflon liner to the atmospheric side of the disk is strongly discouraged because its soapy texture increases the possibility of material creep and inconsistent burst pressures.

BI Sensor (BI) - is a simple but effective method of remotely monitoring the status of the disk. It monitors the continuity of a copper circuit attached to the atmospheric side of the disk seat. When the disk ruptures from either positive or negative overpressure the strip is broken and the continuity lost.

Common Model Numbers

RLPS	Standard disk design
RLPS-L	Standard disk with process side liner

HOLDERS

RLPS series rupture disks are available to fit between industry standard sanitary Tri-Clover® ferrules or NA- CONNECT® flanges. Other ferrule standards such as BS 4825-3, ISO 2852, or DIN 32676 can be accommodated if requested at extra cost.

TRANSPORTATION DISKS

TCP SERIES

Description

The TCP Series provide over-pressure protection for railroad tank cars and tanker trailers.

Features

- Fits standard tank car safety vents or mount between ASME B16.5 Class flanges
- Conforms to AAR, ICC and CTC standards
- Total performance tolerance: +0% –15%
- Comes equipped with TFE gasket

Common Model Numbers

TCP-R	Reversible Disks
TCP-NR	Non-Reversible Disks
TCP-S	Solid Metal Disks



ICP SERIES

Description

Ideal for overpressure protection for Intermodal Tank Containers

Features

- Scored, forward-acting, non-fragmenting design
- Fits standard tank car safety vents or mount between ASME B16.5 Class 150 and ISO standard flanges
- Operating ratios up to 90% of the minimum tolerance
- Total performance tolerance $\pm 5\%$

WELDED ASSEMBLIES

CUSTOM WELDED ASSEMBLIES

Description

ZOOK offers custom welded designs for a wide variety of applications with custom fittings and connections for stringent applications such as ultra-high vacuum, OEM markets, military, aerospace, defense and many other industries that require customized solutions.

Features

- 100% Helium leak testing
- Burst testing
- Weld & body pressure testing
- Digital inspection of threads & body dimensions
- Ultra sonically cleaned
- 100% Material traceability

Industries Served

- Research Universities and Laboratories
- Ultra-Pure Applications
- OEM (Original Equipment Manufacturers)
- Magnetic Resonance Imaging
- Military
- Aviation
- Oil & Gas
- Outer Space Equipment
- Power and Energy
- Extrusion

Extrusion Burst Plugs

Description

ZOOK Extrusion Burst Plugs are pressure relief devices designed for over-pressure protection of plastic extrusion processes.

Features

- All ZOOK Extrusion Burst Plugs utilize a welding procedure replacing outdated soldering methods
- Comprehensive material traceability and origin
- Burst test documentation as a standard
- 100% Leak Tested
- Electronic thread verification, statistically controlled
- Each EBP is Ultra-sonic cleaned
- Burst tolerance $\pm 10\%$ with typical standard deviation of $\pm 1\%$

Options

- Standard disk material is Inconel. Other materials are available
- Various OEM Custom Welded Assemblies are available. Please contact ZOOK for more information
- Burst ratings 1,000 psig to 15,000 psig (for higher pressures contact ZOOK)
- Private labeling, custom packaging and other options available
- Burst indication available upon request

SKID-SAFE

Description

ZOOK has designed a revolutionary unit ready for immediate installation. Reduce the number of premature failures and unsafe operations on well-head skids with ZOOK's Skid-Safe Unit; a unique pressure protection system for the Oil and Gas industry.

The components of the Skid-Safe unit are:

1. Reverse Acting Disk
2. RAH Pre-Torque Holder
3. Z-Alert – magnetic sensor and non-intrusive proximity switch

Features

- Fully assembled and ready for immediate installation between flanges, substantially reduces installation time and assembly difficulties
- Reverse acting disk has full dome membrane protection from the RAH holder
- Skid-Safe unit can be easily installed using integral flange bolt holes
- Self-centralization of the Skid-Safe unit within the pipework
- Specific integral flange guide holes ensure the Skid-Safe unit cannot be installed into non-compatible flange ratings
- Installation only needs one engineer. Simply hang or locate one flange bolt through the pipework flange and through the guide hole in the Skid-Safe unit



- Z-Alert is tested for function and continuity during assembly as part of a comprehensive Inspection and Test plan
- Skid-Safe unit arrives in internationally accepted packaging and can be taken directly from the crate and installed immediately

Options

- Various disk materials available
- Holder available in a variety of flange ratings and materials including Carbon Steel, Stainless Steel, NORSOK certified Super-Duplex and Duplex amongst others
- Dual certification of the disk to ASME UD and PED CE available
- Proximity switch certified to ATEX, IP66 to 68, UL, IECExd, TRCU, and SIL2
- Various gasket materials available

BURST INDICATION

BA Series

Description

When a pressure surge causes a relief valve to open, it also destroys the rupture disk under the valve. This leaves the valve vulnerable to chemical attack. The BA Burst Sensor reduces this threat by constantly monitoring the disk. When connected to an electrical alarm, the BA Burst Sensor alerts personnel to take immediate action to protect system components from further damage.

How it Works

When a disk bursts, flow pulls one end of the BA Burst Sensor's conductor out of its retaining slot and opens the electrical circuit. The BA Burst Sensor can be reset by re-inserting the conductor into the retaining slot.

Features

- Re-useable
- Sizes 1" thru 24"
- Electrically conductive
- Installs on vent side of the disk holder or alone
- Requires minimal flange face-to-face clearance
- Adapts to virtually all makes/types of rupture disks, including Graphite types
- Fits easily into existing pipe systems
- Optional leak detection (BA-LD) for damaged rupture disks or fugitive emissions from relief valves or atmospheric designed systems
- BA-LD functions with or without a rupture disk

Options

- For optional leak detection specify BA-LD. The LD is a TFE seal affixed between two gaskets. When installed on the BA a build-up in pressure causes the BA Burst Sensor Conductor to pull out of its retaining slot and opens the electrical circuit.
- The BA Burst Sensor works with ZOOK ZAM Plus Alarm Monitor or any other monitoring system. Consult ZOOK for additional information

RDI Series

Description

The Rupture Disk Indicator RDI is a simple and effective means of indicating when the process media ruptures a disk or opens a relief valve.

How it Works

The RDI installs onto the vent side of a rupture disk assembly or onto the discharge side of a relief valve. Upon rupture of the disk or discharge of the relief valve, the RDI alarm circuit is opened by the flowing media

Features

- One time use, LOW COST
- Sizes 1" thru 24"
- Compatible with Metal or Graphite Rupture Disks or for stand alone use (relief valve applications)
- Resistant to most chemicals
- Minimizes downtime due to immediate burst indication
- Supplied ready for installation
- Installs easily into existing pipe systems
- Furnished with attached 6 foot PTFE sheathed lead wire (cable)
- No routine maintenance required
- Installs on outlet side of rupture disk or rupture disk holder isolating the RDI from the process media

Options

- For optional leak detection specify RDI-LD. The LD is a TFE seal affixed between two gaskets. When installed a build-up in pressure causes the RDI to open the electrical circuit. The LD is always installed on the pressure side of the RDI.
- The RDI Rupture Disk Indicator works with ZOOK ZAM Plus Alarm Monitor or any other monitoring system. Contact ZOOK for additional information.

INFORMATION NEEDED FOR NEW DISK APPLICATION	INFORMATION NEEDED FOR REPLACEMENT DISKS
<ul style="list-style-type: none">• Size• Flange Size & Pressure Rating• Specified Temperature• Burst Ratings• Disk Material• Used in Liquid or Gas• Vacuum or Back Pressure• Operating Pressure• Fragmenting or Non-fragmenting• Cyclic or static• Local or Country Codes	<ul style="list-style-type: none">• Disk Manufacturer• Disk Type• Size• Marked Burst Pressure• Performance Tolerance (if available)• Marked Temperature• Material• Original batch/lot number if available• Holder Reference or Model Number

RUPTURE DISK TYPE SELECTION PROCESS

1. Calculate the ratio of maximum operating pressure to minimum possible marked burst pressure (The minimum possible marked burst pressure is typically the bottom of the manufacturing range or the bottom of the performance tolerance).
2. Select the possible disk type that can handle the operating ratio calculated above.
3. Select the appropriate materials of construction that will handle the corrosion and or temperature requirements.
4. Check the product literature and verify the burst pressure is within the available pressure range for the considered disk type for the selected material. Often a change in size can help.
5. Check the vacuum and fragmentation limitations of the considered disk type are acceptable.
6. Quote the selected disk type for the quantity required. Where small quantities are required always offer pricing up to quantity 6 price break.

API 520 RUPTURE DISK SPECIFICATION SHEETS

60 API RECOMMENDED PRACTICE 520

RUPTURE DISK DEVICE SPECIFICATION SHEET		Sheet No. Page of	
		Requisition No.	
		Job No.	
		Date	
		Revised By	
General			
1. Item Number		3. Service, Line, or Equip. No.	
2. Tag Number		4. Design Code or Standard	
Service Conditions (include applicable units)			
5. Vessel or Piping MAWP			
6. Fluid			
7. Fluid State (initiating rupture)			
8. Fluid State (relieving conditions)			
9. Required Relieving Capacity			
10. Molecular Weight or Specific Gravity			
11. Viscosity at Relieving Temperature			
12. Compressibility Factor (Z)			
13. Specific Heat Ratio			
14. Normal Maximum Operating Pressure			
15. Normal Maximum Operating Temperature			
16. Pressure Fluctuations (static, cyclic, pulsating)			
17. Superimposed Back Pressure			
18. Built-up Back Pressure			
19. Back Pressure			
20. Inlet Vacuum Conditions			
21. Outlet Vacuum Conditions			
22. Disk Located Upstream of Valve (yes/no)			
23. Disk Located Downstream of Valve (yes/no)			
24. Nonfragmenting Design (yes/no)			
Connections			
25. Nominal Pipe Size		27. Flange Face (inlet/outlet)	
26. Flange Standard & Class		28. Piping Schedule or Bore	
Rupture Disk Holder		Rupture Disk	
29. Holder Tag No.		41. Nominal Disk Size	
30. Nominal Holder Size		42. Disk Type	
31. Design Type		43. Model Designator	
32. Model Designator		44. Quantity Required	
33. Quantity Required		45. Manufacturing Range	
34. Holder Material (inlet)		46. Specified Burst Temperature	
35. Holder Material (outlet)		47. Specified Burst Pressure	
36. Gauge Tap (yes/no) & Size		48. Max Marked Burst Pressure	
Accessories		49. Min Marked Burst Pressure	
37. Studs & Nuts (y/n) & Matl		50. Operating Ratio	
38. Jackscrews (yes/no)		51. Max Flow Resistance K_n	
39. Teeltale Assy (y/n) & Matl		52. Rupture Disk Materials	
40. Other			
		53. Manufacturer's Data	

Note: Indicate items to be filled in by the manufacturer with an asterisk (*).

Figure A-1—Rupture Disk Device Specification Sheet

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GENERAL

Rupture Disk

Because a rupture disk is a passive device with no moving parts there is no maintenance that can be performed to extend the service life. It is recommended to inspect the disk after it has been taken out of service for corrosion to insure the disk material is compatible with the process media or the atmospheric conditions. Remember there is no corrosion allowance or safety factor built in to the design of a rupture disk. Any amount of corrosion will affect the disk performance.

Disk Holder

Maintenance of holders can only be performed during disk replacement. At this time inspect the holder's mating surfaces for foreign material. Remove any adhered gasket material from the previous installation and clean the gasket surfaces of the holder thoroughly, dirt and grit on these surfaces can cause leaks.

Inspect the seat area for any scratches, dents, or nicks. Imperfections on these surfaces can cause leaks. **DO NOT SCRAPE OR SCRATCH** any seating surface. If wiping these surfaces with a clean cloth and suitable solvent does not remove surface residue, fine emery cloth or steel wool may be utilized. Care should be exercised not to exert sufficient pressure on the emery cloth or steel wool to cut or groove these sealing surfaces. **DO NOT USE** if any scratches, dents or nicks cannot be removed, contact ZOOK immediately for instructions. The holder must not be machined or modified in any way without prior written approval from ZOOK.

WHEN TO CHANGE A RUPTURE DISK

Each and every installation of a rupture disk has unique operating conditions that cumulatively affect the service life of the disk on an installation by installation basis. Accordingly ZOOK does not recommended how long a disk will last or when it should be replaced. User experience is the best indicator in determining the frequency of planned maintenance change out of a rupture disk. If your installation history shows a trend that your disks routinely rupture after 12 months of service, it may be prudent to schedule a "planned" change out after 8-10 months too avoid a costly "unplanned" rupture. ZOOK cannot help in determining the optimal service life of a disk and cannot guarantee unplanned ruptures even if a conservative replacement schedule is followed. We do offer to test unburst disks removed from service to assist the user in determining maintenance change out indicator. There is no Code requirement governing change out of rupture disks but ZOOK considers annual change out as "good practice".

The following is a list of common terms related to rupture disks.

Terminology	Definition
Absolute Pressure:	Total pressure measured from absolute zero i.e. a perfect vacuum. As a practical matter, gauge pressure plus atmospheric pressure.
ANSI:	American National Standard Institute
ASME:	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
Back Pressure:	Pressure that is applied to the vent side of a rupture disk. This can potentially increase the pressure from the process side required to burst the rupture disk.
Batch Number:	Unique identification number linked to the manufacturers quality records. Also referred to as lot number.
Burst Pressure Tolerance:	The allowable deviation from the marked burst pressure expressed as a plus/minus percentage or value. Typical burst pressure tolerance is plus/minus 5% of the marked burst pressure for marked burst pressures greater than 40 Psi and +/- 2.0 psi for marked burst pressures between 15.0 and 40.0 psi. Consult the factory for Burst Pressure Tolerances for marked burst pressures less than 15.0 Psi.
Bursting Disk:	The pressure-containing and pressure-sensitive element of a bursting disk assembly. Also referred to as Rupture Disk.
CE:	“Conformite Europeene”. A mark that is affixed to a product to designate that it is in full compliance with all applicable European Union legal requirements.
Certified Flow Resistance (KR):	Unit less factor used to calculate the velocity head loss resulting from the presence of a rupture disk in a pressure relief system. ASME Section VIII, Div 1, UG-127
Composite:	A rupture disk made from two (2) or more components.
Damage Ratio:	The expected change from the marked burst pressure of a rupture disk that has been installed properly but damaged prior to or during installation. Usually expressed as a percentage. Sometimes referred to as Safety Ratio.
Differential Pressure Psi(d):	A rupture disk is a differential pressure device. Differential pressure is the difference between the pressures on the process side and the vent side (back pressure). The disk will burst when the differential pressure exceeds the marked burst pressure. If back pressure is present, it must be added to the marked burst pressure to predict the actual burst pressure.
Environmental Testing:	Burst testing performed at the specified coincident temperature.

Terminology	Definition
Fail-Safe:	A rupture disk that is “Fail-Safe” will provide pressure relief at or below its stamped burst pressure, even if the disk is damaged, oriented improperly in the pipe system, or used on the wrong service.
Flow Rate:	The quantity of media (gas or liquid) flowing per unit of time. For example, LBM/Sec. or CF/Min.
Gauge Pressure:	Gauge pressure is the pressure indicated on a gauge. As a pressure is normally measured as a difference from another pressure (typically atmospheric pressure), the gauge will only read the pressure difference, not the absolute pressure. Normally expressed as psi(g)
ISO:	International Standards Organization
Lot Number:	Unique identification number linked to the manufacturers quality records. Also referred to as batch number.
Manufacturing Batch:	A batch of rupture disks are those disks manufactured of a material at the same time, of the same size, thickness, type, heat, and manufacturing process including heat treatment. Also referred to as manufacturing lot
Manufacturing Design Range (MDR):	The manufacturing range is a range of pressure within which the marked burst pressure must fall to be acceptable for a particular requirement as agreed upon between the rupture disk manufacturer and the user or his agent. Refer to the ASME Code section of this handbook for more details.
Manufacturing Lot:	A lot of rupture disks are those disks manufactured of a material at the same time, of the same size, thickness, type, heat, and manufacturing process including heat treatment Also referred to as manufacturing batch.
Marked Burst Pressure:	The nominal burst rating of the disk which is marked on the disk tag.
Maximum Allowable Working Pressure (MAWP):	Pressure limit of vessel as determined by the manufacturer. Typically a Rupture Disk device used as primary relief cannot have a marked burst pressure greater than the MAWP.
Minimum Net Flow Area (MNFA):	The net area after a complete burst of the disk with appropriate allowance for any structural members which may reduce the net flow area through the rupture disk device.
Non-Fragmenting Design:	Predetermined burst pattern that does not allow metal disk material to become unattached and allowed to move freely downstream after the burst.

Terminology	Definition								
Operating Ratio:	<p>Is used to calculate the Safe Operating Range of a rupture disk. Please note the Operating Ratio varies with every disk design. Operating above this limit may shorten disk life expectancy and may cause nuisance bursts.</p> <p>In North America operating ratio is expressed as a percentage of the marked burst pressure. Operating ratio in Europe is expressed as a percentage of the low side of the performance tolerance.</p>								
PED:	European Community Pressure Equipment Directive 97/23/EC								
Prebulged:	Factory forming of the disk material.								
Pressure:	Force measured per unit area. i.e. lbs. /sqin.								
PROQUIP	Trademark of Process Equipment Inc.								
Reversal Ratio:	The expected burst pressure of a rupture disk device when installed into the piping upside down. Usually expressed as a percentage.								
Rupture Disk Device:	A non-reclosing pressure relief device actuated by inlet static differential pressure and designed to function by the bursting of a pressure containing disk and which is the complete assembly of installed components including where appropriate, the rupture disk holder.								
Rupture Disk Holder:	The structure which encloses and clamps the rupture disk in position.								
Rupture Disk:	The pressure-containing and pressure-sensitive element of a rupture disk assembly. Also referred to as Bursting Disk.								
Safe Operating Range:	<p>Is the conservative maximum recommended positive pressure a rupture disk device can be exposed to without introducing excess fatigue. The safe operating range is calculated differently depending on the design standard as follows;</p> <hr/> <p>ASME Greater Than 40 Psi - The safe operating range for a URA disk with a specified rupture pressure of 100 Psi(g) and a -10% manufacturing design range would be calculated as follows;</p> <table style="margin-left: auto; margin-right: auto;"> <tr> <td style="text-align: right;">100</td> <td>Specified or Marked Burst Pressure</td> </tr> <tr> <td style="text-align: right;">x 0.9</td> <td>¹Minus side of the MDR</td> </tr> <tr> <td style="text-align: right;"><u>x 0.9</u></td> <td>Disk max operating Ratio</td> </tr> <tr> <td style="text-align: right;">81.0</td> <td>Safe Operating Range</td> </tr> </table> <p>¹The minus side MDR can be ignored if the marked burst pressure is known</p>	100	Specified or Marked Burst Pressure	x 0.9	¹ Minus side of the MDR	<u>x 0.9</u>	Disk max operating Ratio	81.0	Safe Operating Range
100	Specified or Marked Burst Pressure								
x 0.9	¹ Minus side of the MDR								
<u>x 0.9</u>	Disk max operating Ratio								
81.0	Safe Operating Range								

Terminology	Definition
Safe Operating Range Cont'd:	<p>ASME BP Less Than or Equal to 40 Psi - The safe operating range for a URA disk with a specified rupture pressure of 35.0 Psi(g) and a -10% manufacturing range would be calculated as follows;</p> $ \begin{array}{r} 35 \\ \times 0.9 \\ - 2.0 \\ \hline \underline{\times 0.9} \\ 26.6 \end{array} $ <p style="text-align: right;"> Specified or Marked Burst Pressure ¹Minus side of the MDR Burst Pressure Tolerance Disk max operating Ratio Safe Operating Range </p> <p>¹The minus side MDR can be ignored if the marked burst pressure is known</p> <hr/> <p>PED ISO 4126.2 Method A - The safe operating range for a URA disk with a specified rupture pressure of 100 Psi(g) and a +/-10% performance tolerance would be calculated as follows;</p> $ \begin{array}{r} 100.0 \\ \times 0.90 \\ \hline \underline{\times 0.95} \\ 85.5 \end{array} $ <p style="text-align: right;"> Specified Burst Pressure Minus side of the Performance Tolerance Disk max operating Ratio (PED) Safe Operating Range </p> <hr/> <p>PED ISO 4126.2 Method B - The safe operating range for a URA disk with a specified Minimum and Maximum rupture pressure range of 95 to 105 Psi(g) would be calculated as follows;</p> $ \begin{array}{r} 100.0 \\ \times 0.90 \\ \hline \underline{\times 0.95} \\ 85.5 \end{array} $ <p style="text-align: right;"> Specified Burst Pressure Minus side of the Performance Tolerance Disk max operating Ratio (PED) Safe Operating Range </p> <hr/> <p>PED ISO 4126.2 Method C - The safe operating range for a URA disk with a specified rupture pressure of 100 Psi(g) and a -10 psi + 5 psi performance tolerance would be calculated as follows;</p> $ \begin{array}{r} 100.0 \\ - 10.0 \\ \hline \underline{\times 0.95} \\ 85.5 \end{array} $ <p style="text-align: right;"> Specified Burst Pressure Minus side of the Performance Tolerance Disk max operating Ratio (PED) Safe Operating Range </p>
Safety Ratio:	<p>The expected change from the marked burst pressure of a rupture disk that has been installed properly but damaged prior to or during installation. Usually expressed as a percentage. Sometimes referred to as Damage Ratio</p>

Terminology	Definition
Scored:	Mechanical process used to create lines of weakness in a rupture disk. Score depth controls the rupture pressure and opening pattern of the disk.
Specified Burst Pressure:	The desired burst pressure rating supplied by the user.
Specified Burst Temperature:	The temperature of the disk when the disk is expected to burst. Also known as the coincident temperature
UD:	A mark that is affixed to a product to designate that it is in full compliance with all applicable sections of the ASME Code.
UNS:	Unified Numbering System
Vacuum:	The absence of atmospheric pressure or pressure less than atmospheric pressure. It can be expressed in absolute or gage pressure. At sea level the earth's atmosphere exerts a pressure of 14.7 Pound per square inch (psi) or 100 kPa.
Vacuum Support:	A device added to the rupture disk which allows the rupture disk to operate in an environment where vacuum is present.
Vacuum Resistance:	Vacuum resistance is the maximum vacuum that the disk is rated to hold. This is not the same as burst pressure.

FREQUENTLY ASKED QUESTIONS

QUESTION: How is a rupture disk manufactured?

ANSWER: A “trial-and-error” manufacturing process is employed to establish the final design that will satisfy a customer’s specific requirements. During the manufacturing process, skilled technicians adjust design variables that may include material of construction, material thickness, crown height, score depth (if a scored disk) and often, material thermal treatment (annealing or stress relieving) to determine the best combination of variables that will satisfy the stated requirements. Many test breaks are performed during the manufacturing process to validate the design.

QUESTION: How do I know which is the best rupture disk design for my particular application?

ANSWER: Unless you are rupture disk “literate” we recommend you contact our factory-trained sales representatives or the factory for assistance. We will require complete operating conditions the disk will be exposed too in order to recommend the proper rupture disk design. ZOOK offers “no charge” engineering and technical seminars to educated personnel on rupture disk technology and disk selection.



QUESTION: Can I operate under vacuum?

ANSWER: In general, most tension-loaded or conventional style disks require a vacuum support to withstand full vacuum. Reverse buckling disks will “withstand” or (resist) full vacuum without the use of a vacuum support. Always consult the factory for specific model number confirmation.

QUESTION: Will ZOOK help me size a disk for my application?

ANSWER: ZOOK does not take responsibility for sizing a customer’s application. It is the responsibility of the customer to determine the parameters for correct disk sizing.

QUESTION: Do you have any technical information on Klinger®-Sil gaskets?

ANSWER: Klinger®-Sil is a compressed fiber, non-asbestos gasket material. ZOOK uses Klinger®-Sil C- 4401 for standard alert sensor gasket material and type ARD disks.

QUESTION: Can you cross-reference a competitor’s product?

ANSWER: Most competitors’ products can be identified and cross-referenced by the nomenclature used for the various types of disks and holders.

QUESTION: At what temperature do you specify the rupture disk?

ANSWER: Disks should be specified at the temperature at which the disk will be exposed to when it is required to rupture. ZOOK does elevated temperature testing to ensure the rupture disks they provide will rupture at the customer’s specified pressure/temperature request.

QUESTION: When do I require ASME “UD” stamping of my rupture disk?

ANSWER: Since January 01, 1999 Jurisdictions that require ASME Code compliance require UD certified rupture disks regardless of the application.

QUESTION: Does a Teflon® liner add to the burst pressure of the disk?

ANSWER: This depends on the type of rupture disk and pressure.

QUESTION: What is a temperature shield?

ANSWER: A temperature shield is a non-pressure retaining perforated metal component installed between the disk and the process that can reduce the temperature at the disk as much as 50%. The shield is typically installed between standard flanges as far below the disk as possible and has limited dampening characteristics that can reduce the magnitude of system pressure spikes.

QUESTION: I've heard that we should be installing our rupture disks with a torque wrench. Does it really make much difference?

ANSWER: Yes! Contrary to the sales rhetoric of some manufacturers, installing a rupture disk with the manufacturer's recommended torque can significantly improve the rupture disk's precision and service durability. Although some disks are more forgiving of improper or unbalanced torque, each is an instrument and should be installed with proper torque.

QUESTION: I have an application, which seems to "blow" disks too often. Is there something I am doing wrong which would cause the disk to "blow"?

ANSWER: Certainly the condition of the disk and its proper installation may influence disk service life but quite commonly, the disk is being exposed to pressures that exceed the "maximum operating pressure" of the disk. Some disks are designed to be exposed to system pressures no more than 50% of the marked burst pressure of the disk. Others may be exposed to 90% of their marked burst pressure with only negligible metal fatigue. Exposing a disk to pressures in excess of their designed "maximum operating pressure" (expressed as a percent of the marked burst pressure) can dramatically reduce service life. Should you believe you are not getting the service life you need from your rupture disk, we would be pleased for the opportunity to discuss your service environment and perhaps, recommend a disk design that would offer you longer service. Remember that proper installation can also significantly influence disk service life.

QUESTION: I've been asked to reduce our inventory of rupture disks. Right now we have so many types, materials, and burst pressures; I don't know where to start. Does ZOOK have any recommendations?

ANSWER: In many instances disks for a variety of applications may be consolidated. Certainly size is a prime consideration. Secondly, material of construction is important. In many instances, two disk applications currently manufactured from Alloy 600 and Alloy 400 may be satisfied with a common disk manufactured from Alloy 600. A disk such as the ZOOK RA series can be used in both liquid and vapor service reducing the need for disks of two different descriptions for different service conditions. ZOOK would be pleased to offer assistance.

QUESTION: We always get into "Discussions" about the proper procedure for isolating relief valves with rupture disks. What is the "right" way?

ANSWER: We recommend the practices defined by the ASME Code and API. The rupture disk and the relief valve should be "close coupled" (No intervening spool piece). The disk and relief valve should be set at the same nominal pressures. The cavity between the rupture disk and the relief valve must be monitored to ensure there is no pressure in the cavity. Since rupture disks are differential pressure devices, any pressure downstream of the rupture disk is considered a "back pressure" and will prevent the disk from opening at its marked burst pressure. See specific details on the Code or request assistance from your local ZOOK factory- trained sales representative.

QUESTION: What is a “reverse-buckling” rupture disk?

ANSWER: Also called a “compression-loaded” rupture disk, a “reverse-buckling” rupture disk is one which is installed with the crown of the disk (convex side) facing the system pressure.

QUESTION: What are the advantages of reverse-buckling rupture disks?

ANSWER: Be careful, not all reverse buckling rupture disk designs are equal; accordingly the user should verify the attributes of the specific disk design to insure it will provide the service life and safety required.

Typically reverse-buckling rupture disks are significantly more service-durable than forward-acting (tension- loaded) rupture disks. Most have a maximum operating pressure of 90% (can be exposed to system pressure up to 90% of their marked burst pressure). Almost all reverse-buckling rupture disks are designed for non-fragmentation which makes them most ideally suited for isolation of relief valves from the process environment.

QUESTION: What is a pre-torqued holder?

ANSWER: Modern rupture disk holders are designed with integral pre-torque bolts that allow the disk to be installed in the convenience of the maintenance or instrument shop prior to field installation with the recommended torque load to ensure proper engagement of the “bite” type seal. Once assembled, the device can be installed in the field where the additional load of the companion flange bolting provides for complete functionality of the device.

In addition, pre-torque assemblies allow for the removal of the assembly from the piping system for inspection and reinstallation without disturbing the seal integrity. Fluoropolymer coated bolts are standard to provide corrosion resistance and much lower frictional coefficient.

QUESTION: May a rupture disk be used as a primary relief device?

ANSWER: Yes. The ASME Code recognizes the use of a rupture disk as a primary relief device.

QUESTION: Are sensors available that indicate a rupture disk has burst?

ANSWER: Yes. Depending upon the style of disk selected, a wide variety of sensors (and sensor monitors!) are available. Additionally, ZOOK manufactures a special “leak detector sensor” to assist in determining if a rupture disk is leaking due to improper installation, corrosion, or erosion.

QUESTION: How do I install my sensor?

ANSWER: Every order is supplied with Installation Instructions for proper installation. In general, the sensor is placed between the outlet flange of the holder and the downstream companion flange. For specific instructions please request the Installation Instructions for the specific product type.

QUESTION: Why should I isolate relief valves from the process environment with a rupture disk?

ANSWER: Several answers apply to this question. First, should the rupture disk protecting a relief valve from the process not rupture from exposure to excess process pressures, the relief valve is maintained in a clean, pristine condition. Valve maintenance costs are, accordingly, dramatically reduced. Second, isolation of relief valves with rupture disks is environmentally smart. The “bubble tight seal” of a rupture disk prevents valve leak, seep, weep, and chatter.

QUESTION: What is a “tell-tale” indicator?

ANSWER: When a rupture disk is used to isolate a relief valve from the process environment, the ASME Code requires the cavity between the rupture disk and the valve seat to be monitored. Since a rupture disk is a “differential” pressure relief device, any pressure in the cavity between the rupture disk and the relief valve seat will act to elevate the burst pressure of the rupture disk. A “tell-tale” assembly is a method to satisfy this Code requirement. Other methods may also be used to fulfill this requirement. (See ASME Code)

QUESTION: Are all rupture disks suited for both gas (vapor) and liquid service?

ANSWER: NO! Consult ZOOK catalog literature or contact your local factory-trained sales representative for specific service applications for which disks may be used. ZOOK does offer a broad scope of rupture disks which are suitable to both gas and liquid applications.

QUESTION: Should a rupture disk be “rated” at the MAWP of my system?

ANSWER: This answer to this question is really at the discretion of the user. A rupture disk specified at the system MAWP will typically provide the longest possible service of that particular style of disk (since its marked burst pressure is as far from the system pressure as possible). Some prefer an extra “margin of safety” between the marked burst pressure of the rupture disk and the MAWP and request the disk to be rated less than the MAWP.

QUESTION: What is Section VIII of the ASME Code?

ANSWER: Division I, Section VIII of the ASME Code is the portion of the ASME Code which most commonly applies to rupture disk applications, sizing, selection, and installation for unfired pressure vessels. Other portions of the Code also address rupture disk use in more diverse applications (such as nuclear applications).

QUESTION: May the disk I am ordering be ASME/UD stamped?

ANSWER: Yes providing the manufacturer has a valid Certificate of Authorization issued by the ASME and the product has been successfully flow tested in an ASME approved flow lab in accordance with Section VIII, Division 1, paragraph UG-131. ZOOK’s Chagrin Falls Ohio and Burlington Ontario facilities maintain ASME Certificate of Authorization certificates and the majority of our products have been certified by The National Board Testing Laboratory in Columbus Ohio, the world’s only independent ASME certified flow laboratory.



QUESTION: I need to send in a disk for evaluation, how do I do that?

ANSWER: Call ZOOK and request an RMA authorization number. Make sure you provide ZOOK the lot number, product type, quantity to be returned, contact name and phone number, etc. requested on paperwork along with the authorization number requested from ZOOK. You will send the product back with the appropriate paperwork. Upon evaluation, ZOOK will provide a written report free of charge.

QUESTION: Can you improve the delivery date on my order?

ANSWER: ZOOK understands that sometimes customers need expedited delivery for a particular order. We have a Premium Department to handle emergency orders. Since all rupture disks are custom-manufactured, there is a cost associated with this service. Therefore, it is imperative for both the customer and ZOOK to understand what is needed and when. This helps coordinate Sales, Manufacturing and Shipping to get the disk into the customer's hands exactly as requested and prevents costly mistakes to the customer and ZOOK. Contact the sales representative in your area, or call us direct.

QUESTION: Does "K_R" really mean anything?

ANSWER: Resistance to flow sizing method analyzes the flow capacity of the relief piping. The analysis takes into account frictional losses of the relief piping and all piping components. Piping component losses may include nozzle entrances and exits, elbows, tees, reducers, valves and the rupture disk (note that the rupture disk and its holder are considered a unit). In this method, the rupture disk is considered to be just another piping component, nothing more, and nothing less. Therefore the rupture disk's contribution to the over-all frictional loss in the piping system needs to be determined. This is accomplished by using "KR", which is analogous to the K value of other piping components. KR is determined experimentally in flow laboratories by the manufacturer for their line of products and is certified per ASME Section VIII, Division 1. It is a measure of the flow resistance through the rupture disk and accounts for the holder and the bursting characteristics of the disk.

To evaluate the effect of different rupture disk designs having different KR values has on a relief system a calculation must be performed using the different KR values and the total system capacity evaluated. A 150% increase in rupture disk KR from 0.5 to .75 is significant in isolation, but when evaluated over the entire relief system will typically only reduce the system capacity by less than 3%!

INTRODUCTION

Flow through a pressure relief device and associated piping must be adequate to prevent pressure from increasing above the systems allowable limits, under overpressure relieving conditions.

Rupture disk sizing and final selection must be made by individuals having complete knowledge of the operating conditions and pressure relieving requirements of the system to be protected.

An improperly sized rupture disk may result in damage to the system, equipment and / or personnel.

The design and sizing of adequate venting systems, including piping and the directional flow of such systems is the responsibility of the End User.

The following information is provided as guidance for the End User to determine the proper size rupture Disk for a venting system. These equations are derived from sections of ASME and API codes and standards.

However, the User should consult all pertinent codes and governing regulations and regulatory authorities for proper sizing requirements.

Note: The sizing methods listed are not applicable for explosions, detonations, deflagrations or reactions producing rapid pressure rises.

GENERAL CONSIDERATIONS

When sizing a rupture disk, certain conditions or assumptions must be made for the various sizing methods:

1. The rupture disk device is treated as a sharp edge orifice. Friction losses through these “short nozzles” are neglected.
2. Upstream flow is negligible as the flow area through the rupture disk device is assumed small compared to the size of the tank or vessel on which it is installed on.
3. The rupture disk device is assumed to vent directly to atmosphere. Where there is additional piping, valves, expansions or constrictions either upstream or downstream of the rupture disk device, other methods must be considered for evaluating the entire system.
4. The sizing methods assume that gases and vapors act as perfect or ideal gases.
5. The venting is assumed to be single phase, non-flashing fluid. Two phase flow must be evaluated by other methods, i.e. – Dier’s methodology.
6. These sizing calculations are for normal over pressure conditions.
7. The Coefficient of Discharge (K) for a rupture disk is assumed as $K=0.62$ per ASME Code.
8. The relief area is considered as the smallest area of the inlet pipe bore or the rupture disk holder or the MNFA value of the actual rupture Disk design to be used.

REQUIRED SIZING INFORMATION

In order to properly size the rupture disk, the following information must be known for each of the following service conditions:

A - Fluid Gas and Vapor

1. Rated Bursting Pressure
2. Allowable Overpressure
3. Exit Pressure (atmospheric or disk outlet pressure)
4. Relieving Temperature
5. Molecular weight of commodity
6. Ratio of Specific Heats
7. Compressibility Factor
8. Relieving Capacity (mass (lb/hr) or volumetric (SCFM) flow rate)

B - For Liquids

1. Rated Bursting Pressure
2. Allowable Overpressure
3. Exit Pressure (atmospheric or disk outlet pressure)
4. Viscosity (centipose)
5. Specific Gravity (relative to water) or Weight Density
6. Relieving Capacity (mass (lb/hr) or volumetric (GPM) flow rate)

C - For Steam

1. Rated Bursting Pressure
2. Allowable Overpressure
3. Exit Pressure (atmospheric or disk outlet pressure)
4. Steam conditions:
5. Dry and saturated
6. Superheated (degrees of superheat)
7. Wet steam (steam quality, dryness factor)
8. Relieving Capacity (mass (lb/hr) flow rate)

RUPTURE DISK SIZING FORMULAE

A – Gases and Liquids

In order to determine the correct sizing equations, it is first necessary to determine if the flow will be sonic or subsonic, through the following equation:

For Sonic flow, the pressure ratios are less than or equal to the critical pressure:

$$\frac{P_2}{P_1} \leq \left[\frac{2}{k+1} \right]^{\frac{k}{k-1}}$$

For Subsonic flow, the pressure ratios are greater than the critical pressure:

$$\frac{P_2}{P_1} > \left[\frac{2}{k+1} \right]^{\frac{k}{k-1}}$$

After determining the flow conditions as either sonic or subsonic, determine the rupture disk sizing using the appropriate equation.

Sonic Flow Equation

The following assumptions are made for compressible fluids under sonic flow conditions:
Isentropic flow conditions exist.

The pressure ratio is less than or equal to critical pressure

(ASME) Mass Flow Equation:

$$A = \frac{W}{C_1 K P} \sqrt{\frac{ZT}{M}}$$

Volumetric Flow Equation:

(SCFM Standard Conditions):

$$A = \frac{5.596 Q_A}{C_1 K} \sqrt{\frac{MZ}{T}}$$

(ACFM Actual Conditions):

$$A = \frac{5.596 Q_A}{C_1 K} \sqrt{\frac{MZ}{T}}$$

Sonic Flow Conditions

Constant C1 for Gas of Vapor as a function of the ratio of specific Heats ($k = CP/CV$):

$$C_1 = 520 \sqrt{k \left(\frac{2}{k+1} \right)^{\frac{k+1}{k-1}}}$$

k	C ₁	k	C ₁	k	C ₁
1.00	315	1.26	343	1.52	366
1.02	318	1.28	345	1.54	368
1.04	320	1.30	347	1.56	369
1.06	322	1.32	349	1.58	371
1.08	324	1.34	351	1.60	372
1.10	327	1.36	352	1.62	374
1.12	329	1.38	354	1.64	376
1.14	331	1.40	356	1.66	377
1.16	333	1.42	358	1.68	379
1.18	335	1.44	359	1.70	380
1.20	337	1.46	361	2.00	400
1.22	339	1.48	363	2.20	412
1.24	341	1.50	364	-	-

For hydrocarbons vapors, where the actual value of k is not known, use the conservative value, $k=1.001$ and $C_1 = 315$. For air, use $k=1.4$ and $C_1 = 356$.

Subsonic Flow Equation

The following assumptions are made for compressible fluids under subsonic flow conditions: Isentropic flow conditions exist.

The pressure ratio is greater than critical pressure

(API) Mass Flow Equation:

$$A = \frac{W}{C_2 K P} \sqrt{\frac{Z T}{M}}$$

Volumetric Flow Equation

(SCFM Standard Conditions):

$$A = \frac{Q_s}{6.326 C_2 K P} \sqrt{\frac{M T}{Z}}$$

(ACFM Actual Conditions):

$$A = \frac{5.596 Q_A}{C_2 K} \sqrt{\frac{M Z}{T}}$$

For Subsonic Flow Conditions

Constant C2 for gas or vapor is a function of the ratio of specific heats (k=CP/CV)

$$C_2 = 735 \sqrt{\frac{k}{k-1} \left[\left(\frac{P_2}{P_1} \right)^{\frac{2}{k}} - \left(\frac{P_2}{P_1} \right)^{\frac{k+1}{k}} \right]}$$

Rupture Disk sizing for Liquids

The following assumptions are made:

Fluids are single phase at the inlet and not flashing to vapor (either completely or partially) on venting. The following equations assume the fluid viscosity is less than or equal to that of water.

(ASME) Mass Flow Equation:

$$A = \frac{W}{2407K\sqrt{(P - P_d)w}}$$

Mass Flow Equation:

$$A = \frac{W}{19010K\sqrt{(P - P_d)SG}}$$

Volumetric Flow Equation:

$$A = \frac{W_v\sqrt{SG}}{38K\sqrt{(P - P_d)}}$$

Rupture Disk sizing for Steam

The following assumptions are made:

The following equations for sonic flow where the pressure ratio P2/P1 is less than the Critical Pressure ratio of 0.55.

(Napier’s empirical equation) Initially Superheated Steam:

$$A = \frac{W(1 + 0.00065D)}{51.5KP}$$

(ASME) Dry and Saturated Steam

For pressures up to 1500 psig:

$$A = \frac{W}{51.5KP}$$

Note: For dry saturated steam pressures over 1500 psig and up to 3200 psig, this equation shall be used:

$$A = \frac{W}{51.5KP \left(\frac{0.1906P - 1000}{0.2292P - 1061} \right)}$$

(ASME) Initially Wet Steam

For steam quality (dryness fraction) 0.9 and greater:

$$A = \frac{W_f}{51.5KP}$$

SIZING FOR RUPTURE DISK AND PRESSURE RELIEF VALVES IN COMBINATION

When a rupture Disk and pressure relief valve (PRV) are used in combination (where the rupture Disk is located at the inlet of the PRV) certain codes and regulatory authorities require the credited relieving capacity of the combination to be adjusted. Note: The adjustment is not required when a rupture Disk is located only at the outlet side of PRV.

Where the specific combination of rupture Disk and pressure relief valve has not been tested, the credited relieving capacity of the combination shall be determined by multiplying the rated relieving capacity of the PRV by 0.90.

Where the specific combination has been flow tested and actual combination capacity factors established; these certified combination capacity factors may be used (in lieu of 0.90) to establish the credited relieving capacity of the specific combination by multiplying the PRV rated capacity by the certified combination capacity factor.

For a listing of combination capacity factors consult the “Pressure Relief Device Certification” published by the National Board of Boiler and Pressure Vessel Inspectors.

NOMENCLATURE

A = required Discharge area: sq. inches

C = constant for gas or vapor based on the ratio of specific heats, $k=C_p/C_v$

For Sonic flow:

$$C_1 = 520 \sqrt{k \left(\frac{2}{k+1} \right)^{\frac{k+1}{k-1}}}$$

For Sub Sonic flow:

$$C_2 = 735 \sqrt{\frac{k}{k-1} \left[\left(\frac{P_2}{P_1} \right)^{\frac{2}{k}} - \left(\frac{P_2}{P_1} \right)^{\frac{k+1}{k}} \right]}$$

- D = degrees of superheat, degree F.
f = steam quality, dryness fraction
K= coefficient of Discharge for rupture disk, K=0.62
k = ratio of specific heats, $k=C_p/C_v$
M = molecular weight
P = stamped bursting pressure plus overpressure allowance
(ASME is 10% or 3 psi whichever is greater) plus atmospheric pressure, psia.
 P_1 = upstream relieving pressure absolute, psia
 P_2 = backpressure (exit pressure) absolute, psia
 P_d = pressure on outlet side of rupture disk absolute, psia.
 Q_a = required flow, in cubic feet per minute at actual flowing conditions ACFM
 Q_s = required flow, in cubic feet per minute at standard conditions
(14.7 psia and 60 degree F) SCFM
SG = specific gravity, relative to water @ 60 degree F.
T = absolute flowing temperature, degree F + 460
W = required flow, lb/hr
w = specific weight of liquid, lb/cu.ft.
 W_L = required flow, gallons per minute
Z = compressibility factor. (If Z is unknown, Z=1.0 is commonly used.)

SAMPLE PROBLEMS AND SOLUTIONS

Sample 1 – Gases

Problem A:

Determine the required rupture Disk size for relieving a single primary vessel with a 10% or 3 psi (which ever is greater) allowable overpressure per ASME code.

- System MAWP: 100 psig.
- Relieving requirements: 10,000 SCFM
- Back pressure: 30 psig
- Flowing Temperature: 150 degree F
- Media: Carbon Dioxide (M=44.01)
- Ratio of specific heats $k=1.30$

Step 1: Determine the pressure ratio:

$$\frac{P_2}{P_1} = \frac{(30 + 14.7)}{(100 \times 1.10 + 14.7)} = \frac{44.7}{124.7} = 0.358$$

Step 2: Calculate the critical pressure ratio:

$$CPR = \left[\frac{2}{k+1} \right]^{\frac{k}{k-1}} = \left[\frac{2}{1.3+1} \right]^{\frac{1.3}{1.3-1}} = 0.546$$

Step 3: Compare the critical pressure ratio to the actual pressure ratio to determine if the flow will be sonic or subsonic.

- Pressure ratio 0.358 < Critical Pressure Ratio 0.546
- Therefore flow is Sonic.

Step 4: Calculate the rupture Disk size:

Since the flow is Sonic, use the sonic volumetric flow equation:

$$A = \frac{Q_s}{6.326 C_1 K P} \sqrt{\frac{MT}{Z}} = \frac{10,000}{6.326 \times 347 \times .62 \times (100 \times 1.1 + 14.7)} \sqrt{\frac{44.01 \times (150 + 460)}{1.0}} = 9.65 \text{ sq. in.}$$

Therefore a rupture Disk with a minimum net flow area of 9.66 sq inches or larger is required. A 4" rupture Disk will suffice.

Sample 2 – Gases

Problem A:

Determine the required rupture Disk size for relieving a single primary vessel with a 10% or 3 psi (which ever is greater) allowable overpressure per ASME code.

- System MAWP: 15 psig.
- Relieving requirements: 100,000 lbs/hr
- Back pressure: 5 psig
- Flowing Temperature: 150 degree F
- Media: Hydrochloric Acid (M=36.50)
- Ratio of specific heats: k=1.41

Step 1: Determine the pressure ratio.

$$\frac{P_2}{P_1} = \frac{(5+14.7)}{(15+3.0+14.7)} = \frac{19.7}{32.7} = 0.602$$

Step 2: Calculate the critical pressure ratio:

$$CPR = \left[\frac{2}{k+1} \right]^{\frac{k}{k-1}} = \left[\frac{2}{1.41+1} \right]^{\frac{1.41}{1.41-1}} = 0.527$$

Step 3: Compare the critical pressure ratio to the actual pressure ratio to determine if the flow will be sonic or subsonic.

- Pressure ratio 0.602 > Critical Pressure Ratio 0.527
- Therefore flow is Subsonic.

Step 4: Calculate the rupture disk size:

- Since the flow is Sonic, use the sonic volumetric flow equation:

$$A = \frac{W}{C_2 K P} \sqrt{\frac{ZT}{M}} = \frac{100,000}{3.52 \times 0.62 \times (15.0 + 3.0 + 14.7)} \sqrt{\frac{1.0 \times (150 + 460)}{36.50}} = 57.28 \text{ sq. in.}$$

- Therefore a rupture Disk with a minimum net flow area of 57.28 sq inches or larger is required. A 10” rupture Disk will suffice.

Sample 3 – Liquids

Problem A:

Determine the required rupture Disk size for relieving a single primary vessel with a 10% or 3 psi (which ever is greater) allowable overpressure per ASME code.

- System MAWP: 15 psig.
- Relieving requirements: 2000 gallons per minute
- Back pressure: 0 psig
- Specific Gravity: 0.899
- Media: Benzene

Note – on this example, 3 psi overpressure is greater than 10%, therefore use 3 psi.

Step 1: Volumetric flow calculation.

$$A = \frac{W_L \sqrt{SG}}{38K \sqrt{(P - P_d)}} = \frac{2,000 \sqrt{0.899}}{38 \times 0.62 \sqrt{((15 + 3 + 14.7) - (0 + 14.7))}} = 18.97 \text{ sq. inch}$$

- Therefore a rupture Disk with a minimum net flow area of 18.97 sq inches or larger is required. A 6” rupture Disk will suffice.

Sample 4 – Steam

Problem A:

Determine the required rupture Disk size for relieving a single primary vessel with a 10% or 3 psi (which ever is greater) allowable overpressure per ASME code. Assume sonic flow where $P_2/P_1 < 0.55$

- System MAWP: 250 psig.
- Relieving requirements: 80,000 lbs/hr
- Steam conditions: Dry and Saturated

Step 1: Dry and Saturated Steam Flow Equation:

$$A = \frac{W}{51.5KP} = \frac{80,000}{51.5 \times 0.62 \times (250 \times 1.10 + 14.7)} = 8.65 \text{ sq. inch}$$

- Therefore a rupture Disk with a minimum net flow area of 8.65 sq inches or larger is required. A 4” rupture Disk will suffice.

Sample 5 – Rupture Disk and Pressure relief Valve Combinations

Problem A:

Determine the credited relieving capacity for a rupture Disk and PRV used in combination per ASME code.

- Application for Non-tested Combination capacity
- Valve size: 3” x 4”
- Orifice size: - “L”
- Valve ASME stamped capacity: 6206 SCFM
- Rupture Disk size: 3”
- Rated (stamped) Bursting pressure: 100 psig
- ASME code combination capacity factor: 0.90

Step 1: Calculate capacity of combination:

- 6206 SCFM x 0.90 = 5585 SCFM.
- Therefore the relieving capacity of the combination is 5585 SCFM.

Problem B:

Determine the credited relieving capacity for a rupture Disk and PRV used in combination per ASME code.

- Application for Tested Combination Capacity as published by the National Board of Boiler and Pressure Vessel inspectors.
- Valve size: 3” x 4”
- Orifice size: - “L”
- Valve ASME stamped capacity: 6206 SCFM
- Rupture Disk size: 3”
- Rated (stamped) Bursting pressure: 100 psig
- Certified combination capacity factor: 0.991

Step 1: Calculate capacity of combination:

- 6206 SCFM x 0.991 = 6150 SCFM.
- Therefore the relieving capacity of the combination is 6150 SCFM.

Table 2 – Gas properties						
Gas	Chemical Symbol	Approx-Molecular Weight	Weight Density. Lbs/Cuft	Specific Gravity Relative To Air	Gas Constant	Ratio of Specific Heats
		M	P	SG	R	k
Acetylene	C ₂ H ₂	26.0	0.682	0.907	59.4	1.3
Air	-----	29.0	0.0752	1.000	53.3	1.4
Ammonia	NH ₃	17.0	0.0448	0.596	91.0	1.32
Argon	A	39.9	0.1037	1.379	38.7	1.67
Butane	C ₄ H ₁₀	58.1	0.1554	2.067	26.5	1.11
Carbon Dioxide	CO ₂	44.0	0.1150	1.529	35.1	1.30
Carbon Monoxide	CO	28.0	0.0727	0.967	55.2	1.40

Table 2 – Gas properties						
Gas	Chemical Symbol	Approx-Molecular Weight	Weight Density. Lbs/Cuft	Specific Gravity Relative To Air	Gas Constant	Ratio of Specific Heats
		M	P	SG	R	k
Chlorine	CL ₂	70.9	0.1869	2.486	21.8	1.33
Ethane	C ₂ H ₆	30.3	0.0789	1.049	51.5	1.22
Ethylene	C ₂ H ₄	28.0	0.0733	0.975	55.1	1.22
Helium	He	4.0	0.01039	0.1381	386.3	1.66
Hydrogen Chloride	HCL	36.5	0.0954	1.268	42.4	1.41
Hydrogen	H ₂	2.0	0.00523	0.0695	766.8	1.41
Hydrogen Sulphide	H ₂ S	34.1	0.0895	1.190	45.2	1.30
Methane	CH ₄	16.0	0.0417	0.554	96.4	1.32
Methyl Chloride	CH ₃ CL	50.5	0.1342	1.785	30.6	1.20
Nitric Oxide	NO	30.0	0.0780	1.037	51.5	1.41
Nitrogen	N ₂	28.0	0.0727	0.967	55.2	1.40
Nitrous Oxide	N ₂ O	44.0	0.1151	1.530	35.1	1.31
Oxygen	O ₂	32.0	0.0831	1.105	48.3	1.40
Propane	C3H8	44.1	0.1175	1.562	35.0	1.15
Propene (propylene)	C3H6	42.1	0.1091	1.451	36.8	1.14
Sulpher Dioxide	SO2	64.1	0.1703	2.264	24.0	1.26

Reprinted from Crane technical Paper No. 410 based on data Table 24 of Mark's Standard Handbook for Mechanical Engineers (seventh edition).



APPENDIX "A" - SIZING

Table 3 – Weight Density & Specific Gravity of Various Liquid

Liquid	Temperature Degree F	Weight Density Pounds / Cubic Foot ρ	Specific Gravity SG
Acetic Acid	77	65.493	1.049
Acetone	77	48.980	0.787
Alcohol, ethyl	77	49.010	0.787
Alcohol, methyl	77	49.100	0.789
Alcohol, propyl	77	49.94	0.802
Ammonia	77	51.411	0.862
Benzene	77	54.550	0.876
Carbon Disulfide	77	78.720	1.265
Carbon Tetrachloride	77	98.910	1.590
Caster Oil	77	59.690	0.960
Chloroform	77	91.440	1.470
Ether	77	44.540	0.715
Ethylene glycol	77	68.470	1.100
Fluorine, Refrigerant R-11	77	92.140	1.480
Fluorine, Refrigerant R-12	77	81.84	1.315
Fluorine, Refrigerant R-22	77	74.530	1.197
Gasoline	60	46.810	0.751
Glycerine	77	78.620	1.263
Heptane	77	42.420	0.681
Hexane	77	40.880	0.657
Kerosene	77	51.200	0.823
Mercury	60	846.320	13.568
Muriatic Acid (40%)	60	75.000	1.200
Nitric Acid (91%)	60	94.000	1.500
Octane	77	43.610	0.701
Pentane	59	38.900	0.624
Phenol	77	66.940	1.071
Propane	77	30.810	0.495
Propylene	77	32.110	0.516
Propylene glycol	77	60.260	0.968

Table 3 – Weight Density & Specific Gravity of Various Liquid

Liquid	Temperature Degree F	Weight Density Pounds / Cubic Foot ρ	Specific Gravity SG
Sea water	60	64.000	1.020
Toluene	77	53.830	0.865
Turpentine	60	54.000	0.864
Water	60	62.371	1.000

Note: These values are based on one (1) atmosphere of pressure.

Disclaimer: The information, specifications and technical data contained in this document is subject to change without notice. The User should verify all technical data and specifications prior to use. ZOOK assumes no responsibility for material and information contained herein or for the use or misuse of said material and information contemplated by the User.

APPENDIX “B” - MATERIAL INFORMATION SHEETS

GAS PERMEABILITY OF FLUOROPOLYMERS

Medium	PTFE	PFA	FEP	PVDF
Water Vapor g/m ² * d * bar	5	8	1	2
Air cm ³ / m ² * d * bar	2000	1150	600	7
Oxygen cm ³ / m ² * d * bar	1500		2900	20
Nitrogen cm ³ / m ² * d * bar	500		1200	30
Helium cm ³ / m ² * d * bar	35000	17000	18000	600
Carbon Dioxide cm ³ / m ² * d * bar	15000	7000	4700	100

Data base on 100 um film thickness at 23°C
 Method: ASTM D1434 for gases and DIN 53122 for water
 Data published in 1980 Kunststoffe paper entitled Fluorocarbon Films

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Keeping Industry Informed of New Applications and Performance Data

E. I. DU PONT DE NEMOURS & CO. (INC.), PLASTICS DEPARTMENT, FLUOROCARBONS DIVISION, WILM., DEL. 19898

TYPICAL PROPERTIES¹ OF "TEFLON" PFA* FLUOROCARBON FILMS

	Property	Typical Value	Gauge (thickness)	Test Condition	Test Method
PHYSICAL	Ultimate Tensile Strength	4000-7000 psi	100-9000	25°C	ASTM-D-882-61T
	Ultimate Tensile Strength	2000 psi	100	260°C	ASTM-D-882-61T
	Stress at 5% Elongation	1700 psi	100	25°C	ASTM-D-882-61T
	Stress at 5% Elongation	220 psi	100	260°C	ASTM-D-882-61T
	Ultimate Elongation	200-600%	100-9000	25°C	ASTM-D-882-61T
	Ultimate Elongation	130%	100	260°C	ASTM-D-882-61T
	Tensile Modulus	60,000-80,000 psi	100-9000	25°C	ASTM-D-882-61T
	Tensile Modulus	4,000 psi	100	260°C	ASTM-D-882-61T
	Folding Endurance (MIT)	>1,000,000 cycles	100	25°C	ASTM-D-643-43
	Tear Strength – Initial (Graves)	300 gm/mil	100-500	25°C	ASTM-D-1004-61
	Tear Strength – Propagating (Elmendorf)	40-70 gm/mil	100-2000	25°C	ASTM-D-1922-61T
	Density	2.13-2.16 ²	–	25°C	ASTM-D-1505-60T
	Area Factor	12,900 sq. in./lb.	100	–	–
	Coefficient of Friction – Kinetic (Film to Film)	0.46	100	25°C	ASTM-D-1894-61T
	THERMAL	Melting Point	575-590°F ²	–	–
Service Temperature		–425° to 500°F	–	–	–
Long-term aging tests have run 10,000 hours at 545°F with no loss in tensile strength, yield, or elongation. ²					
Coefficient of Thermal Expansion – Linear		5.4×10^{-5} in./in. –F ^o	100	25°C	–
Shrinkage		MD +1.0% –1.5%	100-9000	200°C	30 minutes in oven
		TD +1.0% –3.0%	100-9000	200°C	30 minutes in oven
Heat Sealability		Yes	–	–	–
Flammability		–	–	–	–
Average Burn Rate	<5 sec. ²	–	–	ASTM-D-635	
Average Length of Burn	10mm ²	–	–	ASTM-D-635	
Underwriters	94V-0 ²	–	–	UL Test	


¹ These values are preliminary; they will be revised as more data becomes available.
² Base resin data.
 *Teflon® PFA is a Du Pont registered trademark.

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KLINGERSIL® C-4401 GENERAL APPLICATION GASKETING

General Application Gasketing

Distinguishing Characteristics & Applications
See graphs for temperature and pressure limits. Typical values refer to 1/16" material unless otherwise specified.



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C-4401**

- Synthetic Fiber
- Nitrile Binder
- Excellent Sealability
- Excellent Chemical Resistance
- Good Creep Relaxation
- General Purpose Sheet

Creep Relaxation ASTM F38B (1/32")	20%
Sealability ASTM F37A (1/32")	<0.25 ml/hr
Gas Permeability DIN 3535/6	<0.5 ml/min
Compressibility ASTM F36J	7%
Recovery ASTM F36J	50% minimum
Klinger Hot Compression Test	
Thickness Decrease 73°F (23°C)	10.5% initial
Thickness Decrease 572°F (300°C)	17% additional
Weight Increase	
ASTM F146 after immersion in Fuel B 5h/73°F (23°C)	10% maximum
Thickness Increase	
ASTM F146 after immersion in ASTM Oil 1, 5h/300°F (149°C)	0-5%
ASTM Oil IRM903, 5h/300°F (149°C)	0-5%
ASTM Fuel A, 5h/73°F (23°C)	0-5%
ASTM Fuel B, 5h/73°F (23°C)	0-7%
Dielectric Strength	
ASTM D149-95a	14 kV/mm
ASTM F104 Line Call Out	F712121B3E12K6M5
Leachable Chloride Content	
FSA Method (Typical)	100 ppm
Density	112 lb/ft ³ (1.8 g/cc)

TYPICAL PROPERTIES OF TEFLON® PFA FLUOROCARBON FILMS

	Property	Typical Value	Gauge (thickness)	Test Condition	Test Method
ELECTRICAL	Dielectric Strength	4000-5000 V/Mil-AC	100-500	25°C, 60Hz	ASTM-D-149-61
	Dissipation Factor	.00045	100	23°C, 10 ⁵ Hz	ASTM-D-150
	Dielectric Constant	2.06	100	23°C, 10 ⁵ Hz	ASTM-D-150
	Volume Resistivity	>10 ¹⁵ Ohm-cm	100	23°C	ASTM-D-257-61
	Surface Resistivity	>10 ¹⁷ Ohm/Sq.	100	23°C	ASTM-D-257-61
OPTICAL	Refractive Index	1.35 ²	—	25°C	ASTM-D-542-50
	Haze	4%	500	25°C	ASTM-D-1003-52
	Light Transmission				
	UV	55-80% ²	100	.25-.40 microns	Cary Model 14
	Visible	80-87% ²	100	.40-.70 microns	Spectro —
Infrared	87-93% ²	100	.70-2.1 microns	Photometer	
CHEMICAL	<p>Like other "Teflon" fluorocarbon films, "Teflon" PFA films are inert to strong mineral, oxidizing and inorganic acids. They are chemically resistant to bases, halogens, metal salt solutions, organic acids, and anhydrides. Aromatic and aliphatic hydrocarbons, alcohols, aldehydes, ketones, ethers, amines, esters, chlorinated compounds and classic polymer solvents have little effect.</p> <p>Molten alkali metals, fluorine at elevated temperatures, and certain complex halogenated compounds such as chlorine trifluoride at elevated temperatures and pressures will produce noticeable effects.</p> <p>Water absorption is less than 0.03% per ASTM method D-570.</p>				

² Base resin data.

NOTE: These values are typical and preliminary; they are not intended to be used as design data. We believe this information is the best currently available on the subject. It is offered as a possible helpful suggestion in experimentation you may care to undertake along these lines. It is subject to revision as additional knowledge and experience are gained. Du Pont makes no guarantee of results and assumes no obligation or liability whatsoever in connection with this information. This publication is not license to operate under, or intended to suggest infringement of, any existing patents.

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