



Rupture Disk Devices Combined with Safety Relief Valves

Introduction

Codes & Standards permit the use of a rupture disk device at both a safety relief valve inlet and outlet. This combination, first recognized by the ASME Boiler & Pressure Vessel Code in the United States has been echoed in the practices of EN 4126-3 in Europe and internationally by ISO 4126-3. The combination of rupture disk devices and safety relief valves continues to grow driven by the user benefits of valve isolation:

- Optimal leak tightness
- Increased operating pressure
- Extended valve life
- Reduced valve maintenance
- Improved corrosion resistance
- Viscous media compatibility
- Increased reliability

User Benefits

Optimal Leak Tightness – Isolating safety relief valves with rupture disk devices reduces the risk of fugitive emissions. API Standard 526 defines that orifice F and smaller conventional safety relief valves shall have a maximum allowable leakage rate of 40 bubbles per minute (approximately 6 cubic feet or 0.16 cubic meters per 24 hours). A solid metal rupture disk used at the inlet of the relief valve acts as a barrier to this leakage.

Increased Operating Ratio – The most advanced reverse buckling rupture disk technology permits operation to 95% of marked burst pressure (100% of minimum burst pressure) isolating a safety relief valve from the most aggressive pressure service conditions.

Extended Valve Life – The process barrier provided by the rupture disk device prevents product buildup from adhering to mechanical components of the valve that otherwise would affect valve performance and safety of the protected pressure system. The process media does not come in contact with internal surfaces and parts of the valve, it will remain in new condition until called upon to relieve an overpressure event.

Reduced Valve Maintenance – With the valve internals not normally exposed to process contamination, they remain in ‘like new’ condition, allowing longer periods between major overhauls & less maintenance activity at each mandated cycle.

Improved Corrosion Resistance – The large initial cost of a safety valve can be reduced by selecting less costly material and isolating it with a rupture disk device. As an example, a Carbon Steel valve with Hastelloy® trim might save 65% compared to the cost of a Hastelloy® valve. The savings will fund the rupture disk device manufactured from Hastelloy®.

Viscous Media Compatibility – Viscous fluids that might develop a blockage inside a valve mechanism due to leakage can be isolated from the safety valve by a rupture disk device, increasing the integrity of the pressure relief system. Rupture disks have typically a much lower thermal mass than a valve, protecting the relief system from product solidification under normal service conditions.

Increased Reliability – The simplicity of rupture disk technology with no moving parts and no maintenance requirements adds to the reliability of relief system design. The integrity of a safety relief valve that remains in ‘like new’ condition under normal process operating conditions maximizes the opportunity for valve performance to meet the planned design safety requirements.

Safety Relief Valve Isolation

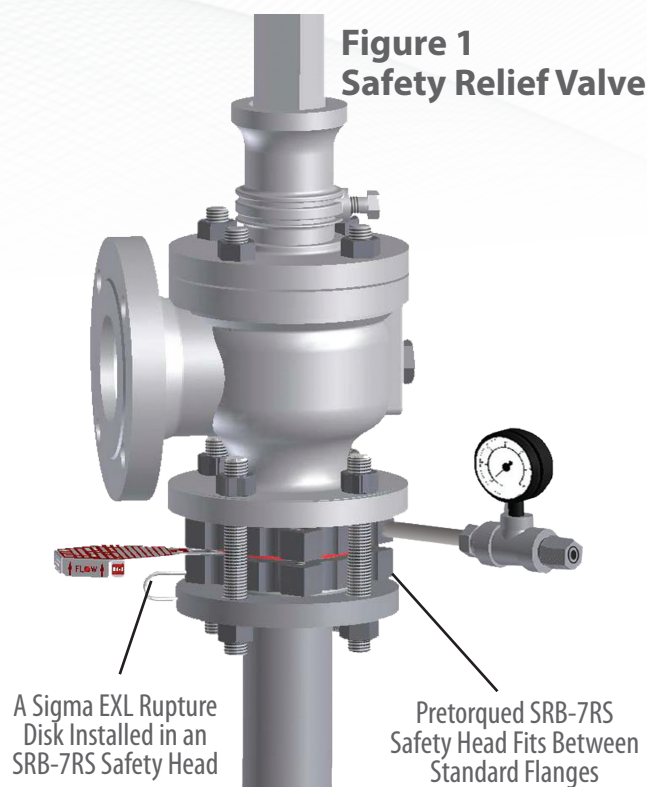
Inlet Isolation

BS&B recommends the Sta-Saf® system reverse buckling rupture disk devices when isolating safety relief valves. Sta-Saf products cover most ranges of safety relief valve pressures ranging from 5 psig (0.34 barg) to 6000 psig (414 barg).

The Sta-Saf system provides the user with a solid metal rupture disk designed for non fragmentation and optimum leak tightness. The pretorqued safety heads of the Sta-Saf system allow for removal of the rupture disk device from service for inspection, cleaning and then reinstallation provided the capscrews remain in place to secure the rupture disk to the seat in the safety head.

For isolating safety relief valves already installed with rigid discharge piping, the Type SVI rupture disk assembly is recommended. The SVI assembly is both rupture disk and safety head combined in a compact configuration that fits into inlet piping with its thin flange only having to be accommodated by the piping arrangement.

Application Summary Chart		
Application	Inlet	Outlet
New construction	Sta-Saf	AV Disk or Sta-Saf
Retro free vent	Sta-Saf	AV Disk or Sta-Saf
Retrofit fixed	SVI	AV Disk or Sta-Saf
Outlet piping	SVI	AV Disk or Sta-Saf
Liquid service	Sigma, RLS, LPS, SKr, SSR	AV Disk or Sta-Saf



Cavity Space Monitoring

As rupture disk devices & most safety / pressure relief valves are differential pressure sensitive, International Codes & Standards require attention to the pressure that might arise in the volume between the isolation rupture disk device and the valve.

- * ASME Section VIII Division 1(2017 edition, paragraph UG 127) indicates the following, 'the space between a rupture disk device and a pressure relief valve shall be provided with a pressure gage, a try cock, free vent or suitable telltale indicator. This arrangement permits detection of disk rupture or leakage.
- EN 4126-3 and ISO 4126-3 (2006 edition, chapter 5) indicates the following:
 - 5.5: The space between the bursting disc safety device and the safety valve or CSPRS shall be provided with a connection to prevent or detect an unacceptable buildup in pressure.

Note: Bursting discs, being pressure-differential devices require a higher pressure in the protected equipment to burst the bursting disc if pressure builds up in the space between the bursting disc and the safety valve or the CSPRS. This occurs when leakage develops through the bursting disc due to corrosion, due to back pressure in the discharge piping or other cause.

Note: Specifiers and users are urged to remain up to date with Code & Standard evolution. For example, ASME shall implement Section XIII for pressure relief devices and the EN/ISO Standards will be updated.

CSPRS = Controlled Safety Pressure Relief Systems

Outlet Isolation

With the global focus on emissions control, safety relief valves are commonly manifolded together at their discharge side rather than venting to atmosphere. This results in variable back pressure reaching valves in a manifold system when one or more relief devices is flowing process fluid. Rupture disk devices provide a reliable means to isolate such devices from variable back pressure. Care shall be taken to select the burst pressure of such a rupture disk device to maintain the proper function of safety relief valve and isolate the variable back pressure. Rupture disk material selection shall account for all process media conditions that may be present, both upstream and downstream.

All Sta Saf system rupture disks have the ability to resist back pressure at least equal to their burst pressure. Where a low burst pressure is appropriate for downstream safety relief valve isolation, the Type AV rupture disk is a simple option not requiring a safety head.

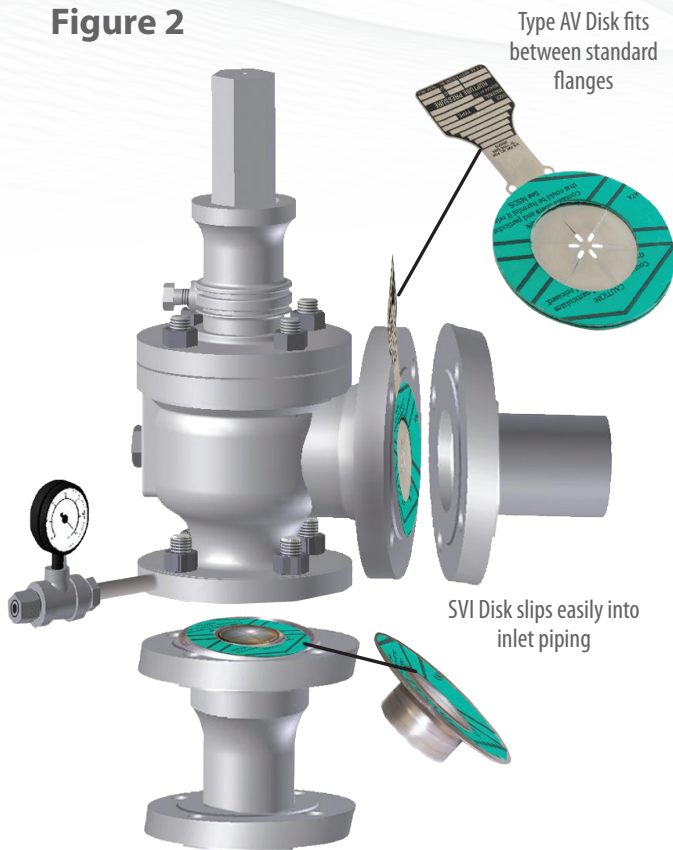
Combination Capacity Factors

Where rupture disk devices & pressure relief valves are applied in combination International Codes & Standards indicate requirements for the proper consideration of amendment to the pressure relief valve capacity. This is an important relief system design consideration for the specifier and user.

- * ASME Section VIII Division 1 (2017 edition) indicates the following, *the capacity of the combination of the rupture disk device and the pressure relief valve may be established in accordance with the appropriate paragraphs of UG-132;* UG-132 indicates means for 3rd party witnessed flow testing of specific rupture disk types with specific pressure relief valve types resulting in a 'certified combination capacity factor' (CCF), or a default factor of 0.9 may be applied to the pressure relief valve rated capacity according to the requirements of paragraph UG-127.
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Example of Valve Isolated by SVI disk option at inlet side and AV disk option at the outlet side.

Figure 2



EN 4126-3 and ISO 4126-3 (2006 edition, chapter 7) indicates the following;

- 7.4 The combination shall be characterized by a combination discharge capacity factor, F_d , determined according to Clause 8, 9, or 10 and to be applied in accordance with Clause 12.
- 8 Determination of combination discharge capacity factor, F_d , by testing
- 9 Derivation of combination discharge capacity factor, F_d
- 10 Alternative to testing for F_d

As an alternative to testing to determine F_d according to Clause 8, the use of a default combination discharge capacity factor of 0.9 is permitted. The safety valve or CSPRS pressure loss calculation and the determination of the reaction force should be performed with the safety valve or CSPRS coefficient of discharge.

CSPRS = Controlled Safety Pressure Relief Systems
 CCF and F_d may not be equivalent to each other; refer to Standards

Other Considerations

Depending upon location and jurisdiction, the specifier and end user are responsible for following local Codes and Standards and always applying Recognized And Generally Accepted Good Engineering Practices (RAGAGEP). Sources of RAGAGEP include API (American Petroleum Institute), Crane Technical Papers, VDI Standards (Verein Deutscher Ingenieure), and Industry Group White Papers.

When to Use a Rupture Disk, Relief Valve Combination

Pressure relief systems protect life and property from dangerous overpressure events within process pressure systems, serving as an important safeguard in establishing a safe, Code compliant, industrial working environment.

Pressure relief valves, rupture disks, or combination of both, function as the pressure relief system, discharging excessive pressure. Individually, a rupture disk is an excellent choice for overpressure protection. However, a rupture disk / relief valve combination will sometimes be the unrivaled choice when:

- 1) A leak tight seal of the system is needed because the system contains a corrosive or hazardous substance and there is a concern that a relief valve may leak.
- 2) The system contains highly viscous substances that may clog the relief valve over time causing it to become inoperable. The installation of a rupture disk upstream serves as a barrier between the process and the relief valve.
- 3) Cost savings - BS&B rupture disks are 100% leak proof serving as a solid metal barrier between the valve and the process. The disk prevents product buildup from adhering to mechanical components of the valve. Since the process media will not come in contact with internal surfaces and parts of the valve, the valve will remain in new condition until called upon to activate.

The BS&B rupture disk metal tab (pictured to the right) shows stamped lot number, disk size, and rated rupture pressure at temperature.

BS&B rupture disks are manufactured in accordance with the requirements of international codes and standards when specified including: ASME Section XIII (UD stamped) and Section III and EU Pressure Equipment Directive (CE marking EN 4126-2: Bursting disk safety devices).



*** ASME Pressure Vessel Code Section VIII, Division 1, 2017 Edition: Rupture Disks and Safety Relief Valves Defined**

UG-126: Pressure Relief Valves⁴⁵

(Meeting the Requirements of ASME CODE, 2017 Section VIII - Division 1)

- (a) Safety, safety relief, and relief valves shall be of the direct spring loaded type.
- (b) Pilot operated pressure relief valves may be used, provided that the pilot is self-actuated and the main valve will open automatically at not over the set pressure and will discharge its full rated capacity if some essential part of the pilot should fail.
- (c) The set pressure of a pressure relief device shall not be adjusted outside the range of set pressure specified by the device manufacturer. The initial adjustment shall be performed by the Manufacturer, his authorized representative, or an Assembler, and a valve data tag shall be provided that identifies the set pressure capacity and date. The valve shall be sealed with a seal identifying the Manufacturer, his authorized representative, or the set pressure tolerances, plus or minus, of pressure relief valves shall not exceed 2psi (15kPa) for pressures up to and including 70 psi (500kPa) and 3% for pressures above 70 psi (500kPa).

UG-127: Nonreclosing Pressure Relief Devices

(a) Rupture Disk Devices⁴⁶

General. Every rupture disk shall have a marked burst pressure established by rules of UG-137 (d)(3) within a manufacturing design range⁴⁷ at a specified disk temperature⁴⁸ and shall be marked with a lot⁴⁹ number. The burst pressure tolerance at the specified disk temperature shall not exceed +2 psi (+ 15kPa) for marked burst pressure up to and including 40 psi (300 kPa) and + 5% for marked burst pressure above 40 psi (300kPa).

*** Footnotes to ASME Code**

⁴⁵ A safety valve is a pressure relief valve actuated by inlet static pressure and characterized by rapid opening or pop action. A relief valve is a pressure relief valve actuated by inlet static pressure which opens in proportion to the increase in pressure over the opening pressure. A safety relief valve is a pressure relief valve characterized by rapid opening or pop action, or by opening in proportion to the increase in pressure over the opening pressure, depending on application. A pilot operated pressure relief valve is a pressure relief valve in which the major relieving device is combined with and is controlled by a self-actuated auxiliary pressure relief valve.

⁴⁶ A rupture disk device is a nonreclosing pressure relief device actuated by inlet static pressure and designed to function by the bursting of a pressure containing disk. A rupture disk is the pressure containing and pressure sensitive activation component of a rupture disk device. Rupture disks may be designed in several configurations, such as plain flat, prebulged, or reverse buckling. A rupture disk holder is the structure that encloses and clamps the rupture disk in position.

⁴⁷ The manufacturing design 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 designated agent. The manufacturing design range must be evaluated in conjunction with the specified burst pressure to ensure that the marked burst pressure of the rupture disk will always be within applicable limits of UG-13 4. Users are cautioned that certain types of rupture disks have manufacturing ranges that can result in a marked burst pressure greater than the specified burst pressure.

⁴⁸ The specified disk temperature supplied to the rupture disk manufacturer shall be the temperature of the disk when the disk is expected to burst.

⁴⁹ A lot of rupture disks is those disks manufactured of a material at the same time, of the same size, thickness, type, heat, and manufacturing process including heat treatment.

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* Meeting ASME Code Capacity of Combination

In order to meet the ASME code, the capacity of the combination of the safety relief valve and rupture disk must be determined one of two ways:

- A) Flow test the combination to arrive at a "certified combination capacity factor". Testing must be done in accordance with Paragraph UG-132 and approved by the National Board of Boiler and Pressure Vessel Inspectors.

Rupture disk / relief valve combinations with flow tests will be allowed a relieving capacity of the valve multiplied by a correction factor obtained from actual flow tests of the rupture disk/relief valve combination.

The combination capacity factor shall be used as a multiplier to derate the ASME rated relieving capacity of the safety relief valve in all sizes of the design.

Refer to BS&B Catalog 77-1006A for "Combination Capacity Factors"

- B) UG-127(a)(3)(b)(2), In lieu of testing, a factor of 0.90 must be applied to the capacity of the relief valve.

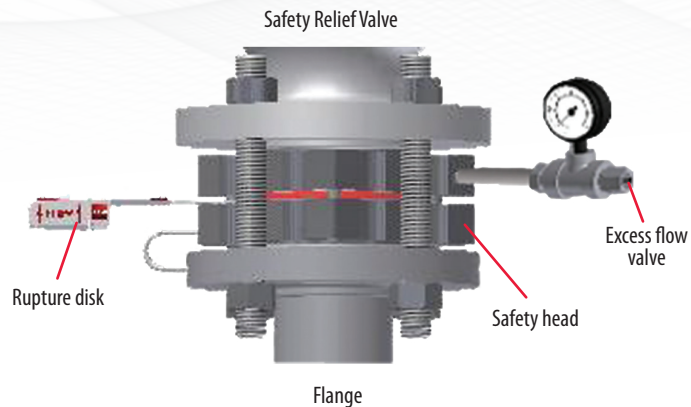
Rupture disk / relief valve combinations, which have not been flow tested as a combination, must be rated in allowable relieving capacity to 90% of the rated relieving capacity stamped of the valve.

Note: *If a rupture disk device is to be used with a relief valve, then an additional nameplate must be installed on the relief valve or safety head. The nameplate must show the valve type, the disk holder type, the type of disk and the flow capacity of the combination, UG-129 (c).*

* Meeting ASME Code: Arrangement of Piping

ASME Code requires that the space between a rupture disk device and a safety relief valve be provided with a pressure gauge, tricock, free vent or suitable telltale indicator, UG-127(a)(3)(b)(4).

Figure 3



A typical piping arrangement is shown in figure 4. The telltale indicator consists of a pipe nipple, tee, an excess flow (flow check valve), and pressure gauge. The outlet side of the excess flow valve has a threaded connection. If free venting is not desirable, a discharge line can be installed to permit dispersion of product to a safe location.

After the relief system has been operated by pressure and the safety relief valve reseats, the prevailing line pressure will force the ball in the excess flow valve to its seat. This permits the line pressure to be indicated on the gauge. After a replacement disk is installed, the chamber between the disk and relief valve is again voided of pressure and gauge reading is at zero.

Another common method is to use a pressure switch instead of a pressure gauge. If pressure builds above the disk cavity, it sets off an alarm device at the site or at a remote location. This pressure increase could be leakage allowing pressure buildup above the disk and thus increasing the pressure required to burst the rupture disk. It could also be caused by the rupture disk bursting.

If a closed system is used with pressure gauge, tricock or other types of telltale indicators, the relief system is then dependent upon a visual or manual check to determine if pressure is present in the cavity between the two relief devices elevating the burst pressure of the disk.

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*** Meeting ASME Code: Rupture Disks Installed on the Outlet (Discharge) Side of the Valve**

UG-127

A rupture disk device may be installed on the outlet side⁵⁴ of a pressure relief valve which is opened by direct action of the pressure in the vessel provided:

- (1) the pressure relief valve will not fail to open at its proper pressure setting regardless of any back pressure that can accumulate between the pressure relief valve disk and the rupture disk. The space between the pressure relief valve disk and the rupture disk shall be vented or drained to prevent accumulation of pressure, or suitable means shall be provided to ensure that an accumulation of pressure does not affect the proper operation of the pressure relief valve.⁵⁵
- (2) the pressure relief valve is ample in capacity to meet the requirements of UG-125(c);
- (3) the marked burst pressure of the rupture disk at the specified disk temperature plus any pressure in the outlet piping shall not exceed the design pressure of the outlet portion of the pressure relief valve and any pipe or fitting between the valve and the rupture disk device. However, in no case shall the marked burst pressure of the rupture disk at the specified disk temperature plus any pressure in the outlet piping exceed the maximum allowable working pressure of the vessel or the set pressure of the pressure relief valve.

- (4) the opening provided through the rupture disk device after breakage is sufficient to permit a flow equal to the rated capacity of the attached pressure relief valve without exceeding the allowable overpressure;
- (5) any piping beyond the rupture disk cannot be obstructed by the rupture disk or fragment
- (6) the system is designed to consider the adverse effects of any leakage through the pressure relief valve or through the outlet side rupture disk device, to ensure system performance and reliability.⁵⁶
- (7) the bonnet of a balancing bellows or diaphragm type pressure relief valve shall be vented to prevent accumulation of pressure in the bonnet.

*** Footnotes to ASME Code**

⁵⁴ This use of a rupture disk device in series with the pressure relief valve is permitted to minimize the loss by leakage through the valve of valuable or of noxious or otherwise hazardous materials, and where a rupture disk alone or disk located on the inlet side of the valve is impracticable, or to prevent corrosive gases from a common discharge line from reaching the valve internals.

⁵⁵ Users are warned that many types of pressure relief valves will not open at the set pressure if pressure builds up in the space between the pressure relief valve disk.

⁵⁶ Some adverse effects resulting from leakage may include obstructing the flow path, corrosion of pressure relief valve components, and undesirable bursts of the outlet side rupture disk.

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