

CONSIDERATIONS FOR THE USE OF DOUBLE DISC RUPTURE DISC ASSEMBLIES

Double disc or “back-to-back” configurations of rupture disc devices consists of two rupture discs installed within a holder comprised of three separate components: 1) Base, 2) Mid-flange, and 3) Hold Down. See Illustration 1. Such configurations can be equipped with forward-acting, reverse-acting, or a combination of forward and reverse-acting discs for special process applications. Double disc arrangements can also be comprised of individual single rupture disc assemblies however these combinations may require specific testing and qualification to assure proper performance.

APPLICATIONS

A common application for use of a double disc assembly is to isolate the upstream or “primary” rupture disc from sources of variable back pressure. For example, this condition can occur when multiple rupture disc assemblies, protecting multiple processes, discharge into a common header. If one rupture disc assembly bursts, the resulting discharge into the common header could subject the remaining rupture disc assemblies to a transient elevated back pressure condition. The downstream or “secondary” rupture disc is selected to withstand high back pressure events leaving the primary disc to burst within its specified rating.

Another widely promoted application of double disc assemblies is within processes containing corrosive, toxic, and/or otherwise valuable media with the objective of reducing the possibility of leakage to the environment or loss of valuable products. This concept is accomplished by monitoring the pressure within the mid-flange volume to detect leakage through the primary disc possibly resulting from cyclic fatigue, Sulfide Stress Cracking, or other forms of deterioration and then subsequently replacing the rupture disc upon indication of leakage. It is critical in this application that the pressure in the mid-flange volume is actively and continuously monitored, and that replacement of the disc(s) is accomplished immediately upon detecting any increase in pressure.

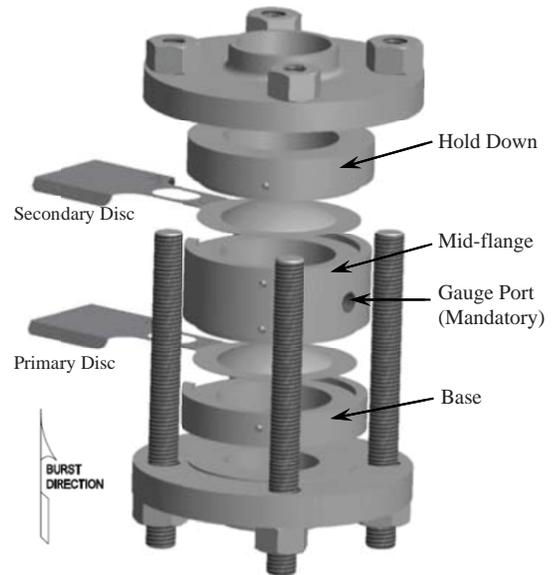


Illustration 1

A double disc assembly/installation should never be used to postpone a system shutdown if leakage of the primary rupture disc is detected, or to lengthen routine maintenance intervals.

A special use of a double disc assembly is in the design of a fast-acting (opening) valve (FAV). In this case the mid-flange pressure is actively controlled to prevent opening and, on command, initiate opening of the rupture discs. This use of an actively controlled double disc must be considered as a special engineered solution to insure that the design and installation meets all intended operational requirements. The user should work with a Fike Pressure Relief Applications Specialist to develop an appropriate solution.

OPERATIONAL CHARACTERISTICS OF DOUBLE DISC ASSEMBLIES

Typical passive operation of any double disc assembly requires that the mid-flange be equipped with a means to guarantee the space between the primary and secondary rupture discs remains at atmospheric pressure while in service. Pressure must not be allowed to accumulate above atmospheric pressure in the mid-flange volume (between the primary and secondary discs). All rupture discs operate by virtue of a specific pressure differential existing across the seal member of the disc. An increase in mid-flange pressure will directly influence (increase) the pressure required to activate the primary disc. If allowed to persist, the overall safety of the process system will be compromised.

The following example scenario demonstrates this effect (see Illustration 2).

Within a typical industrial process, the normal process pressure is stable at 12.4 PSIG. Primary and secondary rupture discs are marked for a burst pressure of 15 PSIG \pm 2 PSIG. A small leak develops in the primary disc allowing the mid-flange pressure to slowly increase and eventually stabilize at 12.4 PSIG. Process monitoring of the mid-flange pressure has resulted in an alarm notifying the system operator or maintenance staff that the primary disc has developed a leak. Since the system pressure stable (in this example), the operator elects to continue running the process.

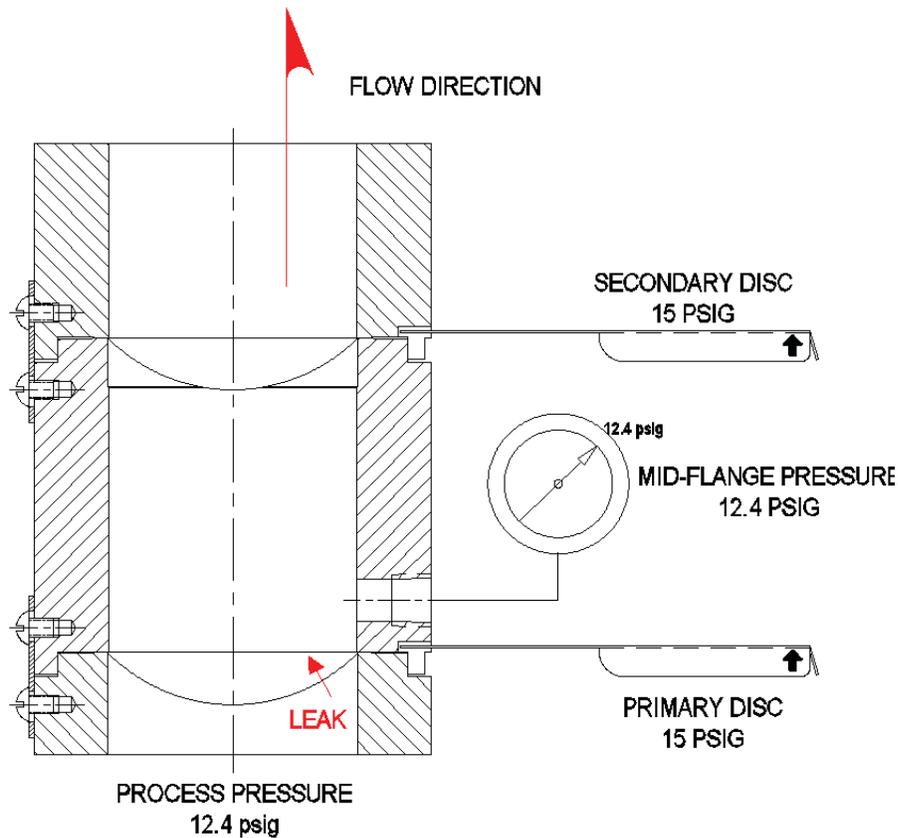


Illustration 2

An unplanned process upset condition then occurs. The process pressure suddenly increases exceeding the 15 PSIG marked burst pressure of the primary rupture disc. The rupture disc fails to open since the differential pressure required has been compromised by the leak. The mid-flange pressure continues to slowly rise (as controlled by the leak path) until the secondary disc reaches its burst pressure and releases the mid-flange pressure. Only then, with the sudden drop in mid-flange pressure, the primary disc will open relieving the process vessel pressure.

All rupture discs actuate due to a pressure differential across the disc membrane. If the mid-flange pressure increases, so does the actual pressure necessary to burst the primary disc. Below are actual test data of the preceding scenario.

Test C_001_011612
0.060" Leak in Primary Disc
Stabilized at 12.4 psig Before Simulated Upset Condition

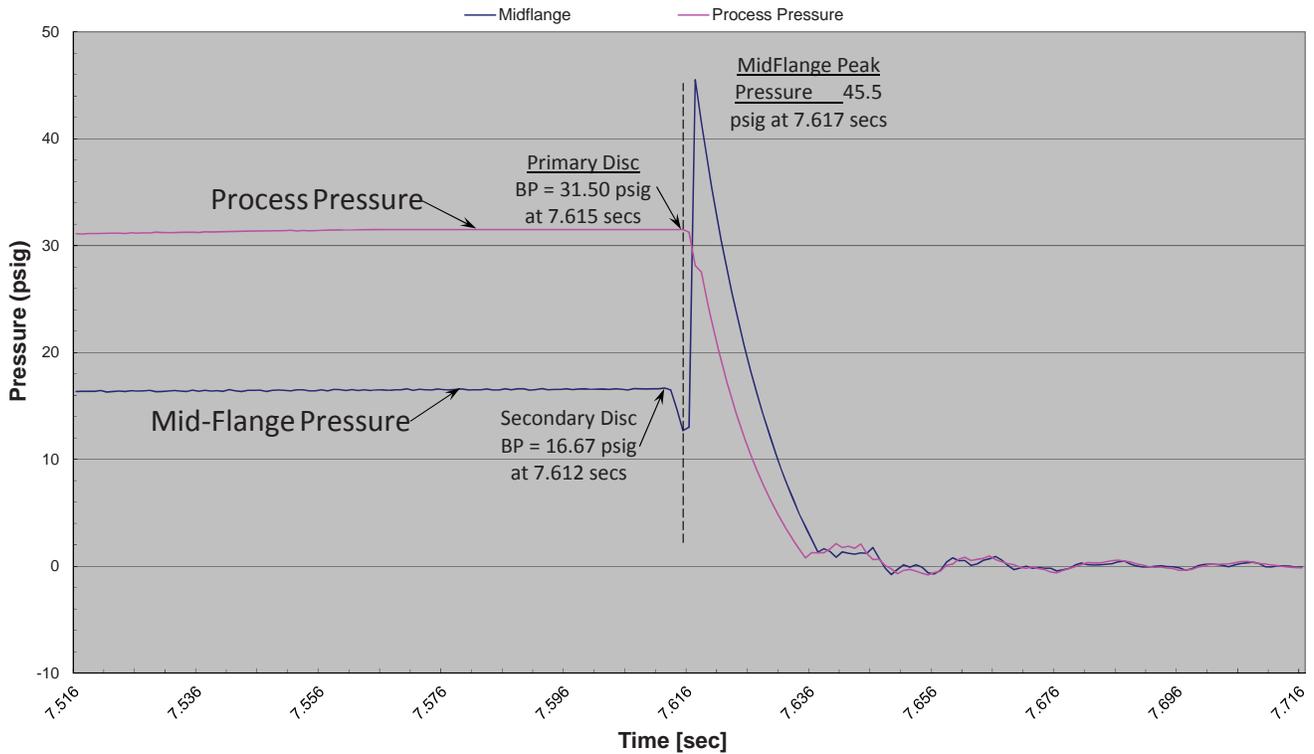


Figure 1

Figure 1 shows the process pressure reaches 31.5 PSIG (> 2 x marked burst pressure of the primary disc) before continued leakage into the mid-flange causes the secondary disc to burst. Opening of the secondary disc vents the mid-flange volume and suddenly increases the differential pressure across the primary disc causing it to open 3 milliseconds later. In this scenario, had the vessel been rated with an MAWP of 15 PSIG, it would have been exposed to over twice its rating before pressure was relieved. While the pressures are low in this example, the potential risk is no less, and the same conditions can develop with discs marked at higher burst pressures. Process pressure can exceed the MAWP of a vessel substantially compromising the safety of the design if a primary disc leakage condition goes unchecked.

Referring again to the above example, it should also be noted that the peak mid-flange pressure reached 45.5 PSIG approximately 2 milliseconds after the primary disc burst. This is due to the dynamic effects of rapid pressure discharge from the upstream vessel. In some cases, the elevated process pressure can contribute to unexpected fragmentation of the primary disc, and the mid-flange peak dynamic pressure can contribute to unexpected fragmentation of the secondary disc. A disc design that is normally a non-fragmenting design can be induced to fragment under such conditions.

REGULATORY CODE CONSIDERATIONS

With regard to double disc assemblies specifically, the ASME BPV Code is silent on the use and/or installation of this kind of rupture disc device or combinations of single disc devices. Historically, industry has accommodated double disc assemblies with the same installation requirements as is defined for rupture discs installed in combination with a pressure relief valve.

Per ASME 2010 ed. 2011 ad. Sec. VIII Div. 1 Para UG127(a)(3)(b)...(4):

“(b) A rupture disc device may be installed between a pressure relief valve and the vessel provided:

(4) the space between a rupture disc 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.53”

“53 Users are warned that a rupture disc will not burst at its design pressure if back pressure builds up in the space between the disk and the pressure relief valve which will occur should leakage develop in the rupture disc due to corrosion or other cause.”

This same caution must be heeded for double disc assemblies since any leakage between the primary and secondary discs will result in the primary disc not bursting at its design (marked) pressure potentially jeopardizing the safety of the overall system.

European Standard EN ISO4126-6:2003 more directly addresses double disc assemblies:

“5.4.6 Where a bursting disc safety device is fitted in series with a second bursting disc safety device, the following requirements shall be met:

b) The space between the bursting discs shall be provided with a means for preventing unacceptable build up in pressure.”

“NOTE: Bursting discs, being pressure differential devices, will require a higher pressure in the protected equipment to burst the bursting disc if pressure builds up in the space between the bursting discs which will occur should leakage develop in the bursting disc due to corrosion or other causes.”

CONSIDERATIONS FOR UPSTREAM LIQUID MEDIA

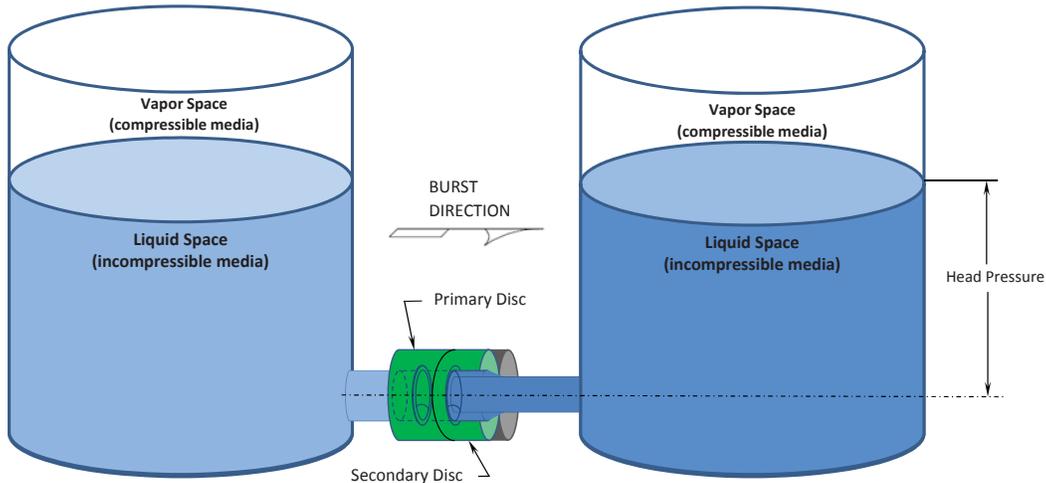
Double disc devices have been developed to operate properly in gaseous or liquid media applications. Liquid media, however, can present specific challenges to a double disc assembly.

For reverse acting designs, if the primary disc develops a leak into the mid-flange volume and slowly fills the mid-flange with liquid, the opening of the primary reverse-acting disc can be severely compromised due to the incompressible media contained in the mid-flange. Also, if the primary disc were to leak allowing the mid-flange to be substantially filled with liquid, the secondary reverse-acting disc may reverse without opening and significantly increase the pressure necessary to open the disc pair.

The safety system designer is cautioned that opening quality (e.g. flow resistance and flow area) of a forward-acting design can also be adversely affected due to liquid accumulation in the mid-flange.

CONSIDERATIONS FOR DOWNSTREAM LIQUID MEDIA

Liquid-phase media should be avoided, if possible, on the downstream side of the secondary disc of a double disc assembly/installation. Liquid back pressure may prevent the opening of some designs of rupture disc devices. Depending on the conditions, reverse-acting discs may not open in the presence of a liquid back pressure, and the opening quality of forward-acting discs could be significantly diminished. For downstream liquid media applications, forward-acting designs are recommended. See Illustration 3.



Notes:

Liquid-burst (liquid upstream, liquid downstream)
NOT Recommended for Reverse Acting Double-Disc Assemblies

When fluid state downstream of the rupture disc is liquid,
forward acting disc types are recommended.

Illustration 3

API RP 520 Part II 8th ed. Section 8, "Drain Piping", specifically addresses the need to remove any liquid from the downstream side of pressure relief devices. See Illustration 4.

"8.1 - Discharge piping from pressure relief systems must be drained properly to prevent the accumulation of liquids on the downstream side of the pressure relief device..."

"Since a rupture disk is a differential pressure device, care must be taken to ensure that the disk [burst] pressure is not elevated by accumulation of fluids on the vent (atmospheric) side of the rupture disk. Periodic verification should be made that the rupture disk discharge line is clear and free from rainwater or other fluids that will cause the rupture disk to activate above its marked burst pressure..."

European Standard EN 764-7:2002-09 states:

"8.1.4 Whenever possible, pressure relieving devices shall be installed such that the discharge line is free draining to the disposal system. Where this is not possible and there is the possibility of liquid collecting in a discharge line, a drain shall be provided to a safe location and consideration given to the prevention of freezing of any liquid build-up. In a liquid system, the impact of static discharge head on the set pressure of a relief valve shall be taken into account."

"8.1.5 If pressure discharge pipes are fitted with components to prevent ingress of rainwater or foreign bodies, these components shall not obstruct the free and full discharge of the safety devices."

These statements commonly address the need to avoid any liquids accumulating on the downstream (venting) side of rupture discs and therefore potentially affecting proper performance.

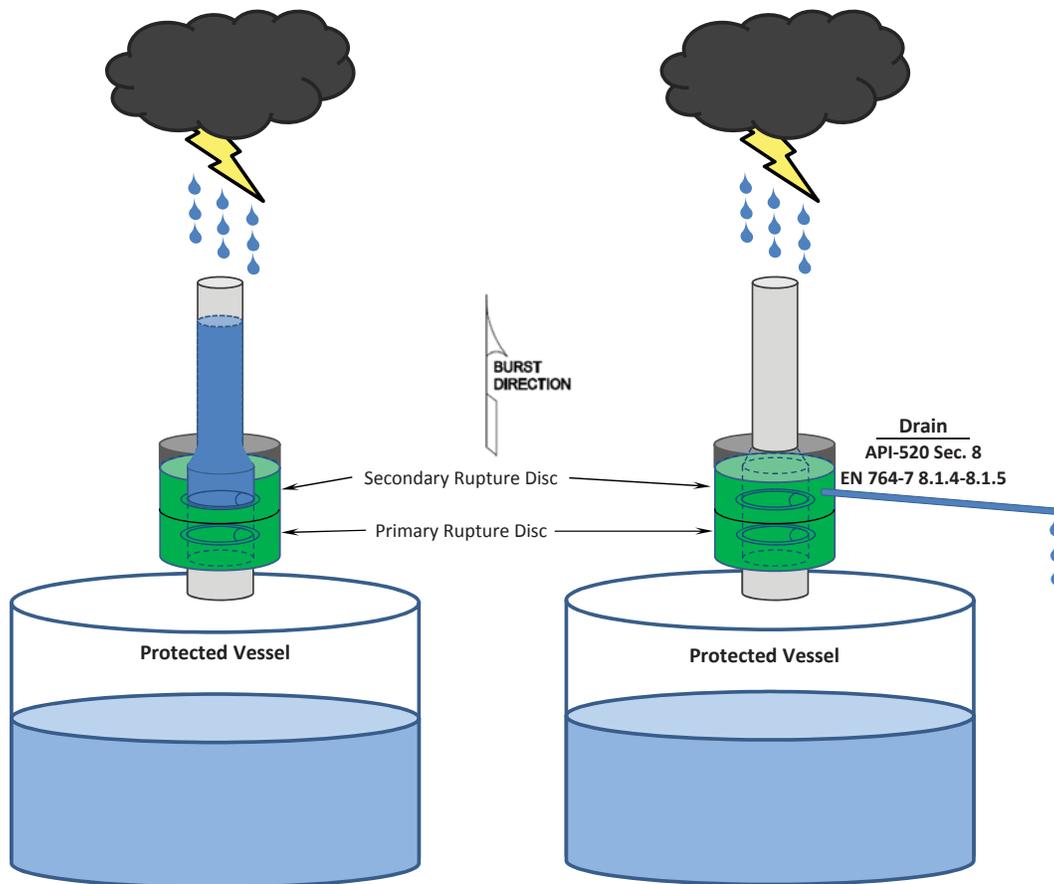


Illustration 4

CONCLUSIONS

If used properly, two rupture discs in series offers benefits to users that can enhance the safety and mechanical integrity of a pressure relief system. It is highly recommended to work closely with the manufacturer to ensure the design will satisfy the regulatory operational and performance objectives. In all cases, the pressure and fluid conditions in the space between the two rupture discs is critical to satisfactory performance. If a double disc protection method is necessary for your application, please contact a Fike Pressure Relief Application Specialist for assistance.