# Rupture Pin or rupture disk:
## which is the clear choice for pressure relief?


**Abstract**

The fundamentals of pressure relief applications are safety, efficiency, maintenance level, downtime duration, operating costs and environmental friendliness. Does the Rupture Pin alleviate the issues that go with such applications, or is the rupture disk a more sensible option? This article diskusses the juxtaposition between the two and gives an insight as to which is the clear choice for pressure relief.



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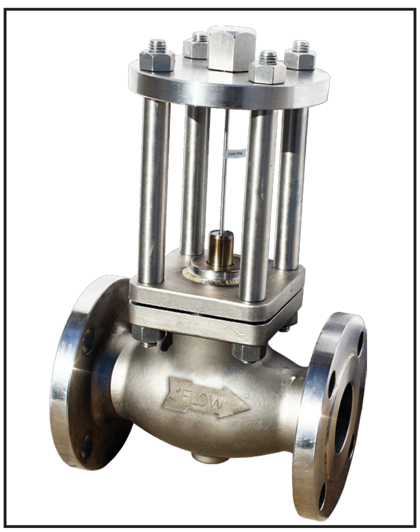
**Introduction**

There are two basic, non-reclosing primary methods outlined by ASME section VIII for pressure relief: the Rupture Pin and rupture disk. It is important to understand the advantages and disadvantages of each so that the correct selection for a specific pressure relief application can be made.



*Typical Rupture Pin and rupture disk*

According to ASME Section VIII Division I, both Rupture Pins and rupture disks may be used as primary or sole relieving device (see Figure 1).The one caveat to remember about non-reclosing relief devices is that once they are open, they remain open. They will not reclose until the Rupture Pin or disk is manually replaced.

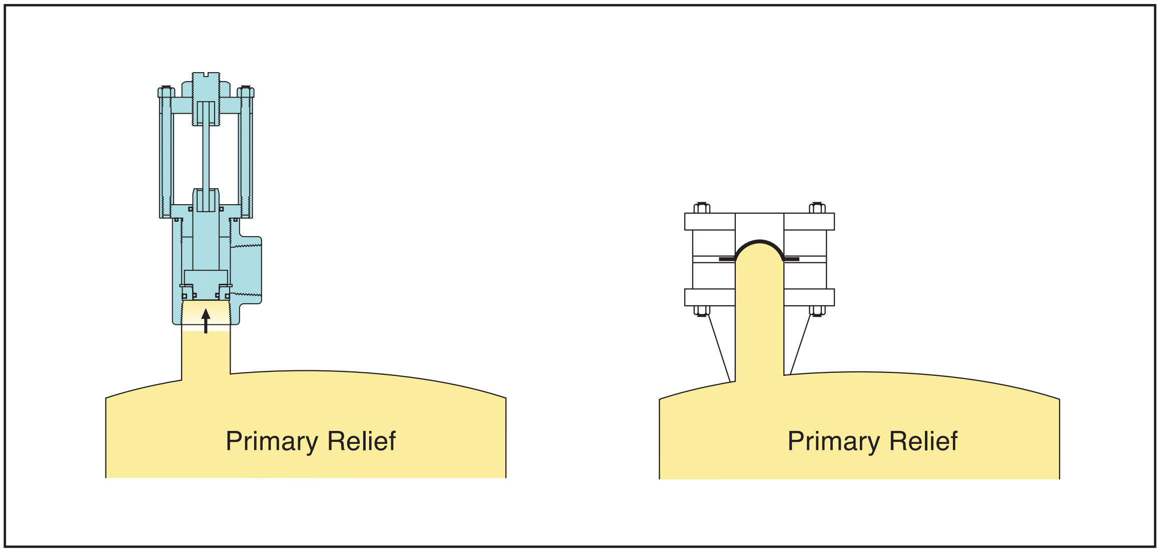



Fig 1: Rupture Pin and rupture disk used as primary or sole relieving device.

Both Rupture Pins and rupture disks offer some advantages over spring or pilot operated relief valves such as in applications where the possibility of rapid pressure build-up exists and instantaneous relief is a requirement, e.g. endothermic or exothermic reactions, or in deflagration or detonation venting. Rupture Pins and rupture disks excel as they allow for full-bore openings in millisecond response times.
Both can be used for secondary or backup relief. In Figure 2 the primary relief valve is designed to conserve material during minor pressure excursions. The secondary pin or disk device is to protect against unlikely but major events that require greater relief capacities.

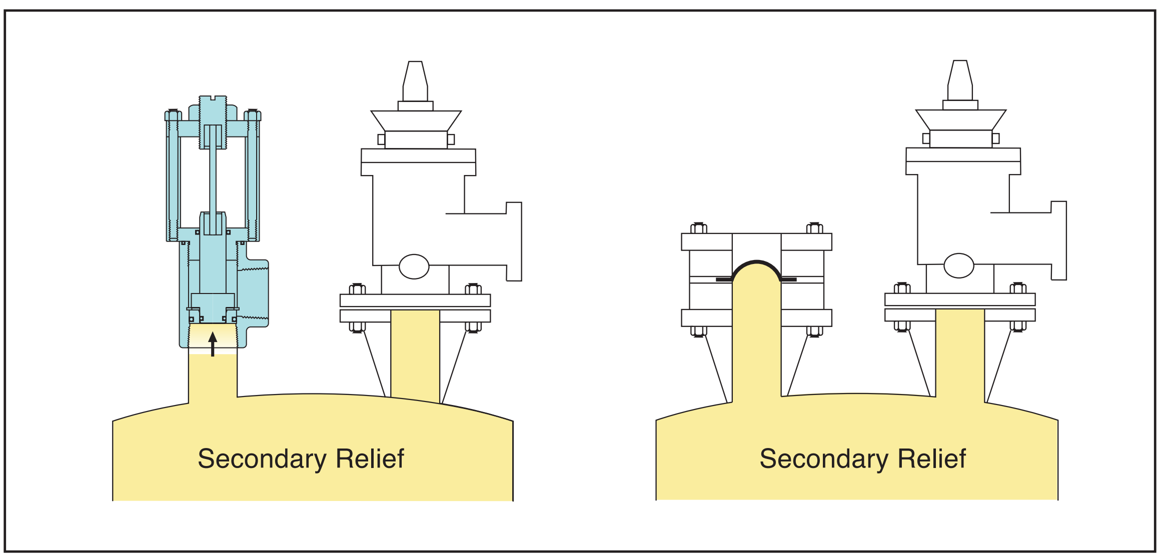



Fig. 2: Rupture Pin and rupture disk used for secondary relief

Another Rupture Pin or rupture disk application includes being used in series with a relief valve (see Figure 3). In series, applications incorporate a Rupture Pin or rupture disk device installed between the process media and the inlet side of a safety relief valve.

This protects the safety relief valve from being constantly exposed to the process media and eliminates the potential of plugging or corrosion.

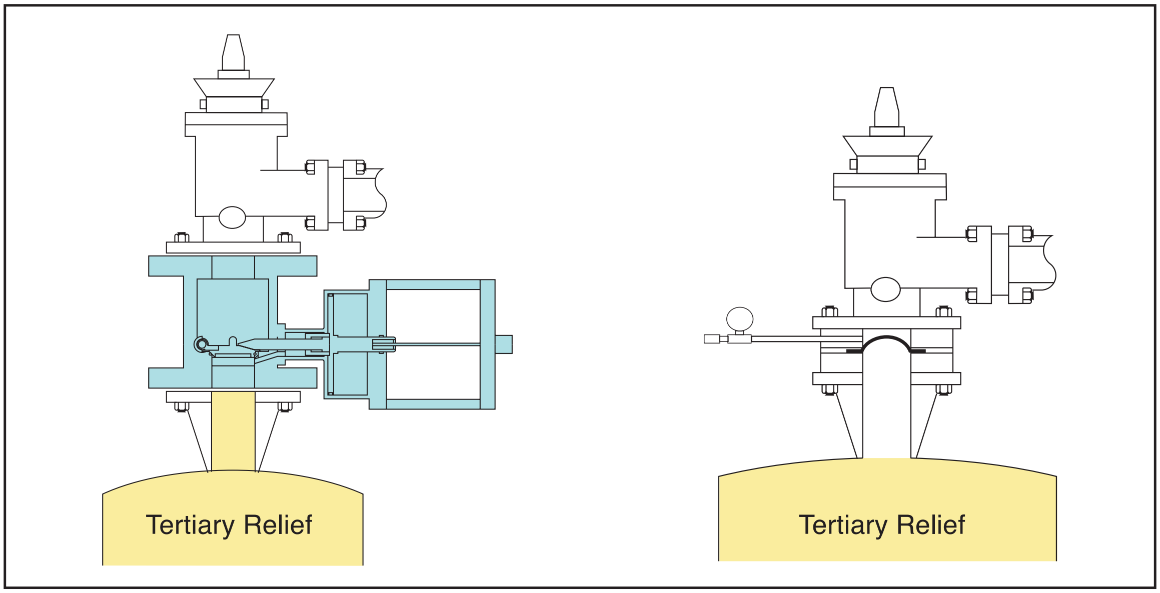



Fig 3: Rupture Pin used beneath a spring type relief valve.

In manifold discharge systems, a Rupture Pin or rupture disk device may be used on the outlet side of a safety relief valve to prevent the relief valve from being exposed to process materials from the discharge side. Like a rupture disk, the Rupture Pin is the sensor and the actuator.

Rupture Pin Technology has been making relief and shutdown valves from 1/8" to 48" for over 25 years with set pressure from 1 PSI to 43000 PSI. These valves are successfully fabricated from castings, forgings, pipe and fittings. The price increases greatly with large sizes, low order quantity and high pressures. To lower prices on large valves a Rupture Pin pilot is used to turn any quarter turn valve into a relief valve or an emergency shutdown valve.

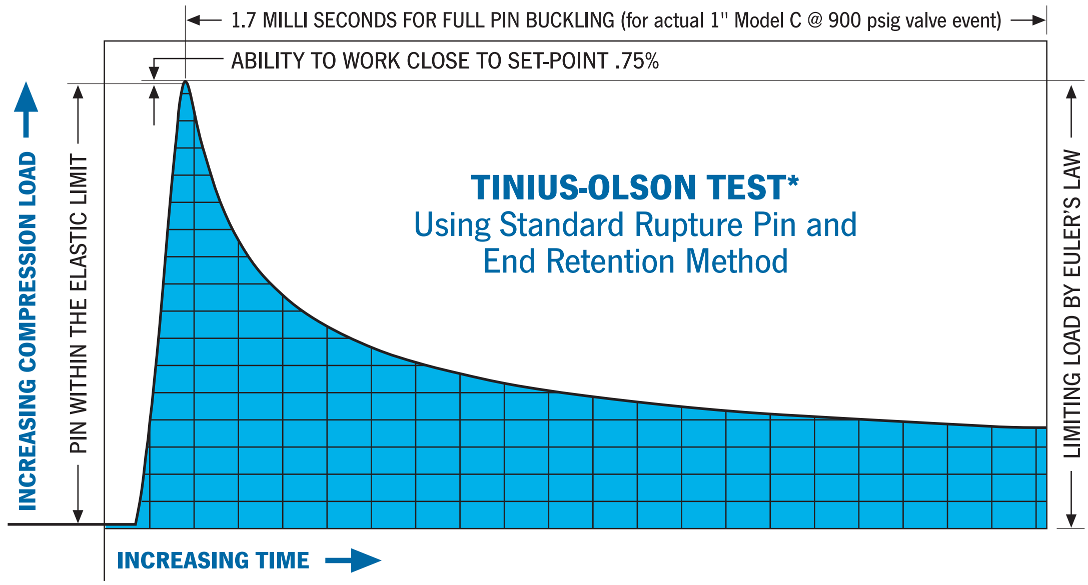
## Pin Advantages

- Greater accuracy- Standard tolerance +/- 5%. Average result less than 2%.
- No breaking the line to change the pin
- Pulsating pressures - no problem
- Extreme high or low pressures - no problem
- Telling when the pin has buckled is obvious
- No metal debris to foul the relief valve in series
- Can sense upstream, downstream or differential pressure
- Minimal down time to change the pin or set pressure
- Pins can be stored at the valve
- Full bore relief in milliseconds
- With toxic fluids no suiting up to change the pin (does require a valve designed for the application)
- Reliability can be checked in operation under pressure
- Bubble tight seal

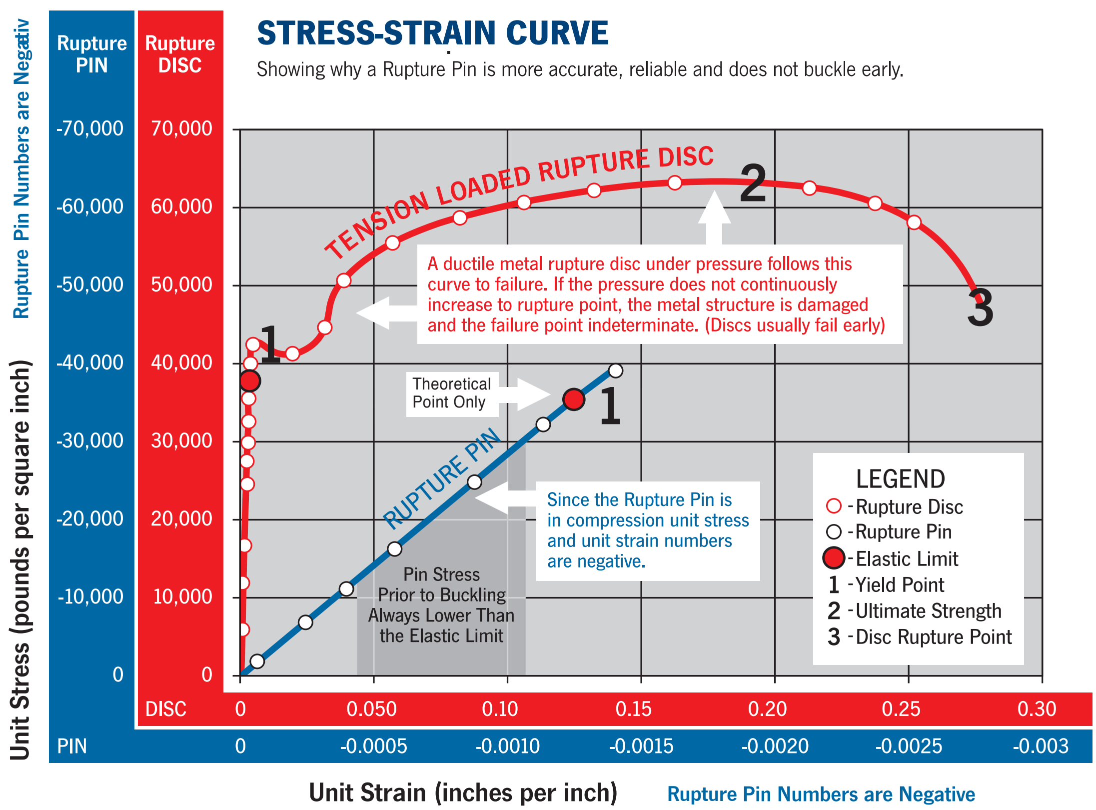
**30" Model F-B Butterfly Valve with pilot operated Model W-B**

## EULER'S LAW

AXIAL FORCE ON THE PIN CAUSING THE PIN TO BUCKLE (piston/plunger area x system pressure) ~ $\frac{\text{PIN DIAMETER}^4 \times \text{PIN MATERIAL MODULUS OF ELASTICITY}}{\text{PIN LENGTH}^2}$




## RUPTURE PIN vs. TENSION LOADED RUPTURE DISK




**WHY RUPTURE DISKS FAIL**: The main weaknesses of the rupture disk is the fact that the disk's stress at the burst point is much greater than the yield stress. The stress-strain curve of the forward acting/tension loaded rupture disk is shown. Once the disk is pressured beyond its yield point, the disk is irreversibly damaged. Unless the pressure continues to increase to the burst pressure, the disk will fail far below set point, usually at the next pressure increase over yield point. Yes, when the disk breaks early, it "fails safe", but consider the needless pollution, loss of product, downtime, disk replacement cost and labor to replace the disk. With the Rupture Pin, the pin stress is always below the elastic limit. Because its mechanism of failure is Euler's Law, the pin cannot fatigue.

## Pin diameter variations

To demonstrate how the pin diameter affects performance, we conducted a Diameter Variations Test (see below). Four different diameters were used (0.12063”, 0.12571”, 0.15618”, 0.18741”) all cut to the same length (6.9951”). Using five samples of each diameter, the ultimate load at the buckling point was determined on a Tinius Olsen Machine.

| Diameter (in) | % Difference | Ultimate load (lbf) | % Increase |
|---|---|---|---|
| 0.12063 | - | 249.008312 | - |
| 0.12571 | 4.17 | 294.253781 | 18.17 |
| 0.15618 | 30.0 | 564.913319 | 126.87 |
| 0.18741 | 55.8 | 1225.693782 | 392.23 |

*Table 1: Diameter variations test results*

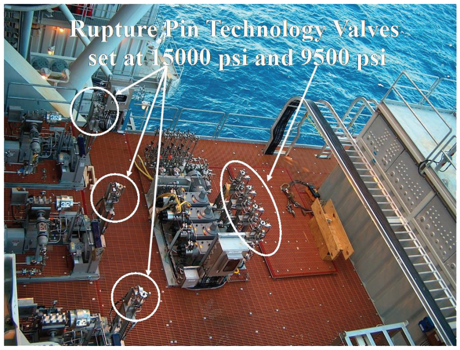
Table 1 shows the average ultimate buckling force for each diameter. As can be seen, even a small increase in the diameter leads to a rapid increase in the capacity of the pin. This illustrates that even a diameter change of 0.00508”can effect the load capacity of the pin and why we are so meticulous in getting the rupture pin measurements right.

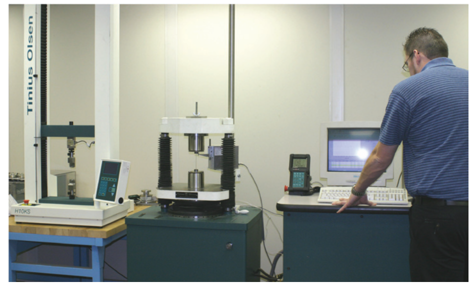
## Pin length variations

In this test, varying lengths (3.9945”,4.0932”, 4.1936”, and 4.2910”) were taken from the same diameter material (0.09005”). Five samples of each length were then tested to determine the ultimate force required to make the rupture pin buckle. Table 2 lists the average values for each length.

| Length (in) | % Length difference | Ultimate load (lbf) | % Decrease |
|---|---|---|---|
| 3.9945 | - | 243.511804 | - |
| 4.0932 | 2.49 | 239.834812 | 1.53 |
| 4.1936 | 4.98 | 232.151709 | 4.89 |
| 4.2910 | 7.43 | 212.647204 | 14.51 |

*Table 2: Pin length variations test results*

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