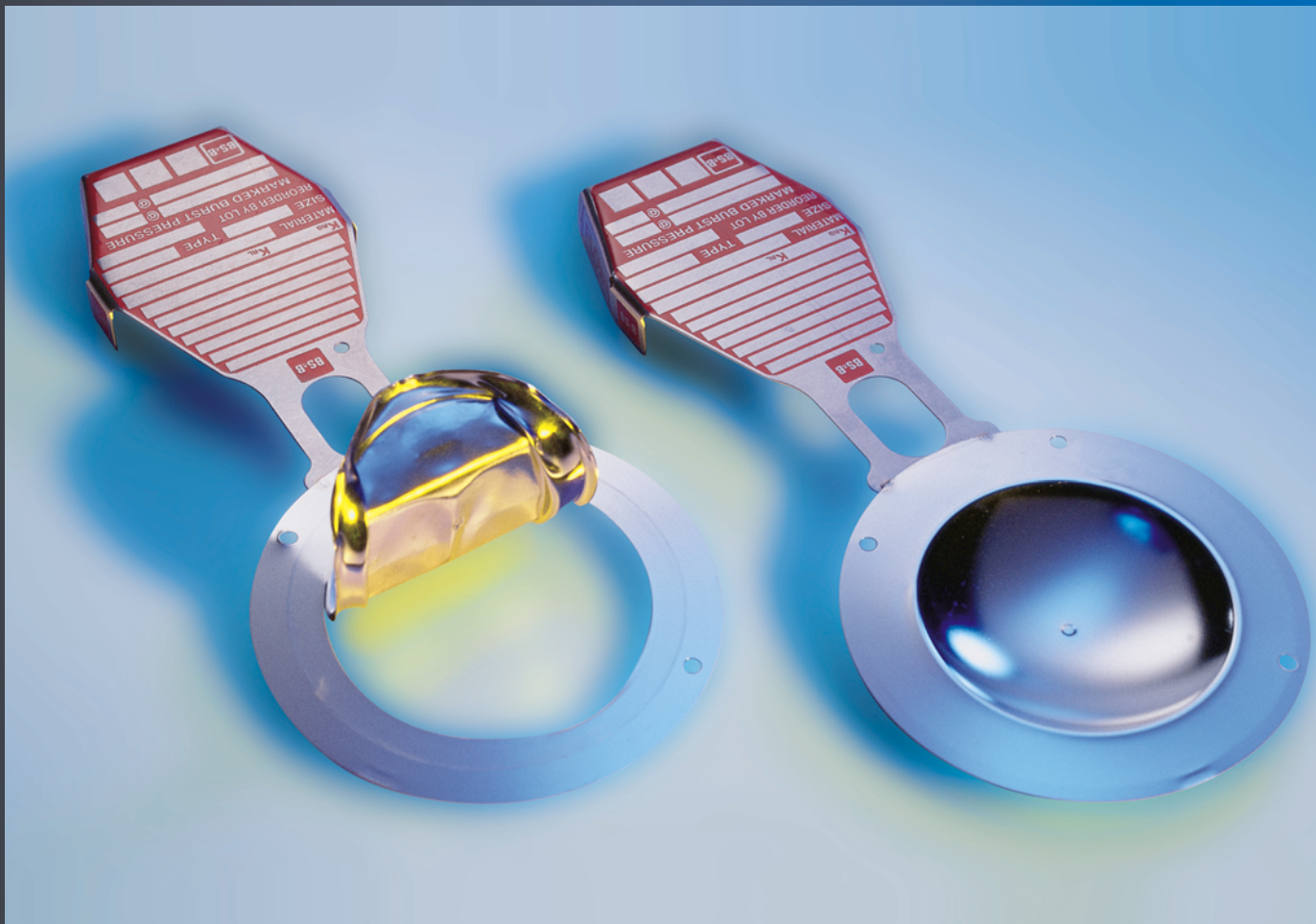




BS&B SAFETY SYSTEMS, L.L.C.
BS&B SAFETY SYSTEMS LTD

The Sure-Saf[®] System



The Fail-Safe CSI[™] Reverse Buckling Disk and CSR-7RS Safety Head

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The Fail-Safe CSI Reverse Buckling Disk and CSR-7RS Safety Head

CSI Disk Features:

- ◆ Reverse Buckling Disk in Sizes

1"/25mm ~ 8"/200mm
- ◆ Non-Fragmenting Design
- ◆ Designed for Gas, Liquid, or

2-phase Flow Conditions
- ◆ Fail Safe: Reversal Safety Ratio ≤ 1
- ◆ Fail Safe: Damage Safety Ratio ≤ 1
- ◆ High Operating Ratio: 90% of

Marked Burst Pressure
- ◆ High Operating Ratio: 95% of

Minimum Burst Pressure
(ISO & European Codes)
- ◆ Uses SAF™ Technology
- ◆ Vacuum Resistant
- ◆ Standard 0% Manufacturing

Design Range
- ◆ Optional -5% & -10%

Manufacturing Design Range

The Sure-Saf® System

The Sure-Saf® System has been developed to provide optimal safety using rupture disk pressure relief technology. The CSI™ Rupture Disk combined with the CSR-7RS® Safety Head provides accuracy and reliability. This unique partnership ensures the CSI disk bursts at or below its certified burst pressure in the event that the disk is installed in the wrong direction or becomes damaged.

The CSI Rupture Disk uses SAF™ technology (structural apex forming), the central feature on the disk dome which enhances accuracy of burst pressure. At its burst pressure, the CSI Rupture Disk dome reverses and opens by shearing around a circular score line located at the perimeter of the dome. The CSR-7RS Safety Head outlet contains an energy absorbing hinge that aligns with an unscored portion of the CSI disk perimeter that retains the CSI disk upon opening, avoiding fragmentation.

Reversal Safety Ratio <1

Should the CSI Rupture Disk in its CSR-7RS Safety Head be accidentally installed the wrong way, it will burst at or typically below its burst pressure. This “fail safe” design feature is called the reversal safety ratio. With a value of 1 or less, the CSI disk will relieve pressure at a reduced burst pressure should improper installation cause pressure to be applied to the disk’s concave side. Installed in the wrong direction, the CSI Rupture Disk interacts along its circular score line with stress raising features in the CSR-7RS Safety Head to open at a reduced burst pressure.

Damage Safety Ratio <1

If the CSI Rupture Disk is accidentally damaged, it will relieve pressure by bursting at or typically below its marked burst pressure. This fail safe design feature is called the damage safety ratio. With a value of 1 or less, the CSI disk will relieve pressure at a reduced burst pressure if damaged. When the domed structure of the CSI Rupture Disk is damaged, it will reverse at a reduced pressure and interact along its circular score line with stress raising features in the CSR-7RS Safety Head to open at a reduced burst pressure.

Burst Tolerance

Burst tolerance is the +/- range of pressure over which a rupture disk can be expected to burst. Burst tolerance is either +/-5% of burst pressure or +/-2psi (+/-0.138 bar) for disks rated below 40 psi/2.76 bar.

CSI Rupture Disk Material Options

The CSI Rupture Disk is available in a range of corrosion resistant materials (see table). For each material, the upper temperature limit has been determined through the recommendations of material manufacturers and user experience. While Hastelloy C-276 is the standard grade used, Hastelloy B & Hastelloy C-22 may be available upon request.

Fluorocarbon film liners are available as an additional corrosion barrier attached to the inlet side of CSI Rupture Disks. FEP is the standard liner material. PTFE above 400 degrees F/204 degrees C. PFA is available. Teflon® materials are typically used.

Minimum Net Flow Area/ Net Relief Area

Disk Size		MNFA	NRA
in	mm	(in2)	(cm2)
1	25	0.86	5.55
1 1/2	40	1.89	12.19
2	50	3.36	21.68
3	80	7.29	47.03
4	100	11.20	72.26
6	150	22.65	146.13
8	200	42.72	275.61

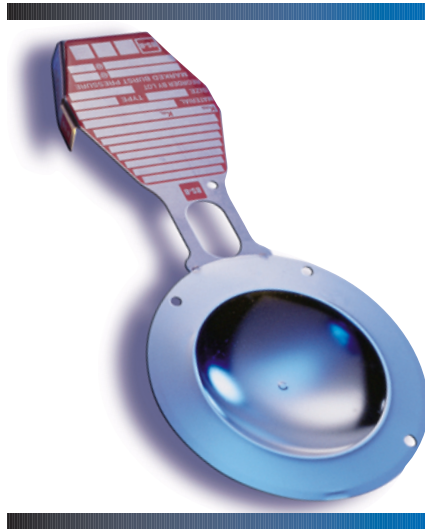
In the case of the CSI Rupture Disk, the MNEA & the NRA are the same. MNEA is expressed in square inches to facilitate sizing calculations in line with ASME practices. NRA is expressed in square centimeters for use when sizing in line with ISO, European Standards and forthcoming CEN practices.

Burst Pressure Capability

Disk Size		Nickel 200				316 SS				Inconel 600				Monel 400				Hastelloy C276			
		psig		barg		psig		barg		psig		barg		psig		barg		psig		barg	
in	mm	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	25	70	500	4.83	34.48	90	500	6.21	34.48	80	500	5.52	34.48	70	500	4.83	34.48	90	500	6.21	34.48
1 1/2	40	50	500	3.45	34.48	80	500	5.52	34.48	50	500	3.45	34.48	50	500	3.45	34.48	80	500	5.52	34.48
2	50	50	500	3.45	34.48	75	500	5.17	34.48	50	500	3.45	34.48	50	500	3.45	34.48	75	500	5.17	34.48
3	80	45	500	3.10	34.48	70	500	4.83	34.48	45	500	3.10	34.48	45	500	3.10	34.48	70	500	4.83	34.48
4	100	45	500	3.10	34.48	65	500	4.48	34.48	45	500	3.10	34.48	45	500	3.10	34.48	65	500	4.48	34.48
6	150	30	500	2.07	34.48	30	500	2.07	34.48	30	500	2.07	34.48	30	500	2.07	34.48	30	500	2.07	34.48
8	200	30	500	2.07	34.48	30	500	2.07	34.48	30	500	2.07	34.48	30	500	2.07	34.48	30	500	2.07	34.48

Temperature

The burst pressure of each lot of CSI Rupture Disks is tested at the user indicated temperature condition: Should the disk be rated above or below ambient temperature, burst testing for product certification shall be conducted at this coincident burst temperature to ensure the best product accuracy. For applications that have operating temperatures that may exceed the burst temperature, please review with BS&B Safety Systems, Inc.



Manufacturing Design Range

Manufacturing Design Range (MDR) is a range of pressure, always applied to the minus side of the user requested burst pressure for CSI Rupture Disks, that simplifies disk fabrication testing and provides economic benefit to the user where such an added tolerance can be accommodated by the application. The CSI Rupture Disk is available with a standard “0” MDR, and the options of “-5%” and “-10%”. The standard “0” range provides the user with the tightest margin between normal service pressure and burst pressure.

Example: Requested burst pressure 100 %
 User selected Manufacturing Design Range -10%
 Applicable burst tolerance +/-5%

Then following the two different Code approaches to these tolerances:

Maximum Recommended Temperature

Material	Temp °F	Temp °C
Nickel Alloy 200	750°	399°
316 Stainless Steel	900°	482°
Inconel Alloy 600*	900°	482°
Monel® Alloy 400	800°	427°
Hastelloy® Alloy C-276	900°	482°
Fluorocarbon Liner (FEP)	400°	204°
Fluorocarbon Liner (PFA)	400°	204°
Fluorocarbon Liner (PTFE)	500°	260°

*Inconel CSI Disks can be specially fabricated at temperatures of up to 1100 deg F/593 deg C. Hastelloy is a trademark of Haynes International Inc., Monel and Inconel are trademarks of Inco Alloys International. Teflon is a trademark of DuPont. BS&B may use equivalent materials from other sources.

ASME/North American Codes and Standards

Marked burst pressure lies between 90 ~ 100%

Lowest possible burst pressure is 90 less 5%
 burst tolerance = 85.5%

Highest possible burst pressure is 100 plus 5%
 burst tolerance = 105%

If marked burst pressure is 95%, lowest burst pressure is 90.25%, highest is 99.75%

European and International/ISO Standards

Burst pressure is 100%

Minimum burst pressure is 100 less 10% MDR less 5% burst tolerance = 85.5%

Maximum burst pressure is 100 plus 5%
 burst tolerance = 105%

Alternatively the tolerances may be expressed as a +5%/ 15% performance tolerance on 100%.

Marked burst pressure is always either Min/Max or 100% with a performance tolerance

Operating Pressure Ratio

CSI Reverse Buckling Disks can be operated to 90% of their marked burst pressure, or 95% of their minimum burst pressure, whichever is lower. For disks certified with a European/ISO ‘Performance Tolerance’, the CSI disk can be operated to 95% of the burst pressure less the negative performance tolerance.

By providing this example in percentage terms, real pressures can be input using any unit. Effectively, the ASME and CEN approaches could deliver the same product, although generally the ASME approach will not consume the whole of the Manufacturing Design Range.

CSR-7RS Safety Head Dimensions

Nominal Size		Safety Head Flange Rating			Safety Head Flange Thickness		Dimensions			
							X		Y	
in	mm	ANSI	DIN	JIS	in	mm	in	mm	in	mm
1	25	150	-	-	1 1/2	38.0	2 5/8	66.7	2 5/8	66.7
1	25	300/600	10/16/25/40	10/16/20/30/40	1 1/2	38.0	2 7/8	73.0	2 7/8	73.0
1 1/2	40	150	-	10/16/20	1 5/8	43.0	3 3/8	85.7	3 3/8	85.7
1 1/2	40	300/600	10/16/25/40	30/40	1 5/8	43.0	3 3/4	95.2	3 3/4	95.2
2	50	150/300/600	10/16/25/40	10/16/20/30/40	1 3/4	47.0	4 1/8	104.8	4 1/8	104.8
3	80	150/300/600	10/16/25/40	16/20/30/40	2 1/8	55.0	5 1/4	133.3	5 1/4	133.3
3	80	-	-	10	2 5/8	66.7	4 3/4	120.6	4 3/4	120.6
4	100	150/300	10/16/25/40	16/20/30/40	2 7/8	73.0	6 1/4	158.7	6 1/4	158.7
4	100	-	-	10	2 3/4	69.9	Flower Petal			
4	100	600	-	-	2 5/8	66.7	7 5/8" OD/193.7 mm OD			
6	150	150/300	10/16/25/40	10/30/40	3 11/16	93.7	Flower Petal			
6	150	-	-	16/20	4 1/5	106.7	Flower Petal			
6	150	600	-	-	3 1/8	79.4	10 3/8" OD/263.5 mm			
8	200	150/300	10	-	3 3/4	95.3	Flower Petal			

Flow Performance/Kr Values/ Rupture Disk Sizing

Flow resistance factor "Kr" may be used to determine the relieving capacity of a system when using techniques such as those described in Crane Technical Paper No. 410. Individual Kr values have been established for both Gas & Liquid service for the CSI Disk. These are experimentally determined at the BS&B Safety Systems Inc. flow laboratory following ASME procedures and witnessed by ASME representatives. Care must be taken to use the correct value for sizing purposes. When Kr values are marked on the CSI Disk tag, those for gas service are shown as "Krg", and those for liquid service are shown as "Krl" (alternate marking Kr (GAS) and Kr (LIQ) may be used).

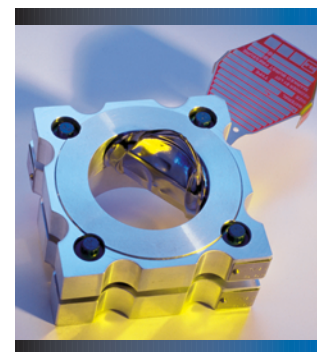
When using Kr value for sizing calculations, the nominal pipe size (assuming schedule 40 pipe) of the vent system is used. When using 'coefficient of discharge' sizing techniques, the Minimum Net Flow Area or Net Relief Area of the Rupture Disk device is used.

Patent Information

CSI Disk: Worldwide patents & US 5167337. US and worldwide patents pending.
CSR-7RS Safety Head: Worldwide patents and US 4751938 & 5005722

CSR-7RS Safety Head

- Asymmetric locating pins center the disk in the safety head eliminating disk slippage and ensuring correct installation.
- The CSR-7RS can be pretorqued in the workshop for exact calibration permitting simple and correct installation.
- For further installation assurance, a J-bolt is fitted which mates with a hole drilled in the inlet companion flange.
- The CSR-7RS fits multiple international flange ratings including ANSI, DIN, BS and JIS, thus reducing inventory.
- Metal to metal bite-type seal 2 inches and above.
- Unique stress raising features in the bore of the CSR-7RS interact with the CSI Disk circular score line to provide a Reversal Safety Ratio & Damage Safety Ratio of 1 or less.
- Materials available: 316SS, Carbon Steel, Inconel Alloy 600, Monel Alloy 400 and Hastelloy-C276/Alloy C-276.



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