



The Crosby Style HL Safety Valve is a high capacity, flanged steel safety valve specifically designed in accordance with ASME Section I and Section VIII.

Features

- The guide is held in place using the method employed by all the leading high-pressure safety valve manufacturers, thus eliminating the age-old industry problem of the guide-to-body threads corroding in service, which can require major repairs.
- The HL valve has a full nozzle that threads into the body, making it easy to remove and less expensive to repair should it be damaged in service. The full nozzle is designed with spanner wrench slots for easy removal and installation.
- An external blowdown adjustment makes final minor blowdown adjustments in the field very easy and minimizes the testing time.
- The HL's Flexi-Disc®, which is more common in high pressure safety valves, offers improved seat tightness.
- The special designed cover and overlap collar form a unique back pressure chamber for improved blowdown and prevents steam from heating the spring, which might affect set pressure.
- The built-in mechanical lift stop prevents overlift and ensures stability during the relieving cycle.

Technical Data

- Saturated and superheated steam
- Flanged inlet
- Sizes: 1¼ F 1½ through 6 Q 8
- Inlet Ratings: CL 300, CL 600
- Pressures to 725 psig [50 barg]
- Temperatures to 1000°F [538°C]



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Parts and Materials

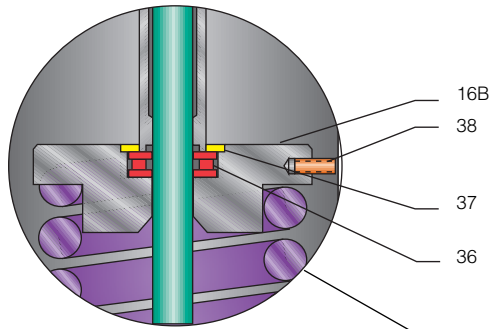
Part No.	Part Name	Material
1	Nozzle*	Stainless Steel
2	Body	ASME SA216 Gr. WCB (Max. Temp. 750°F) ASME SA217 Gr. WC6 (Max. Temp. 1000°F)
3	Plug	Steel
4	Nozzle Ring Pin	Stainless Steel
5	Nozzle Ring	Stainless Steel
6	Disc*	17-4 PH SST
7	Disc Holder (L-Q Orifice)	Stainless Steel
8	Guide Ring Pin	Stainless Steel
9	Guide Ring	Stainless Steel
10	Guide	Stainless Steel (Max. Temp. 750°F) Nickel Alloy (Max. Temp. 1000°F)
11	Adjusting Screw	Stainless Steel
12	Adjusting Screw Nut	Stainless Steel
13	Cover	Steel
14	Stud Nut	ASME SA194 Gr. 2H
15	Stud	ASME SA193 Gr. B7
16	Spring Washer	Steel
16B	Upper Spring Washer (L-Q Orifice)	Steel
17	Spring	Chrome Steel (Max. Temp. 750°F) Alloy Steel (Max. Temp. 1000°F)
18	Bonnet	ASME SA216 Gr. WCB (Max. Temp. 750°F) ASME SA217 Gr. WC6 (Max. Temp. 1000°F)
19	Spindle	Stainless Steel
20	Compression Screw	Brass (F-K Orifice) Alloy Steel (L-Q Orifice)
21	Compression Screw Nut	Brass (F-K Orifice) Stainless Steel (L-Q Orifice)
22	Lever	Malleable Iron
23	Lever Pin	Steel
24	Fork	Malleable Iron
25	Cap	Malleable Iron (F-K Orifice) Steel (L-Q Orifice)
26	Release Nut	Steel
27	Fork Pin	Steel
28	Lever/Fork Pin Cotter	Steel
29	Release Nut Cotter	Steel
30	Cap Set Screw	Steel
31	Overlap Collar Cotter	Steel
32	Overlap Collar	Stainless Steel
33	Lift Adjusting Spacer	Stainless Steel
34	Disc Holder Retainer (L-Q Orifice)	Stainless Steel
35	Disc Holder Retainer Cotter (L-Q Orifice)	Steel
36	Bearing (N-Q Orifice CL 300; L-Q Orifice CL 600)	Alloy Steel
37	Bearing Cover (N-Q Orifice CL 300; L-Q Orifice CL 600)	Stainless Steel
38	Spring Washer Set Screw (L-Q Orifice)	Steel
39	Bushing (L-Q Orifice)	Stainless Steel

* Critical spare parts

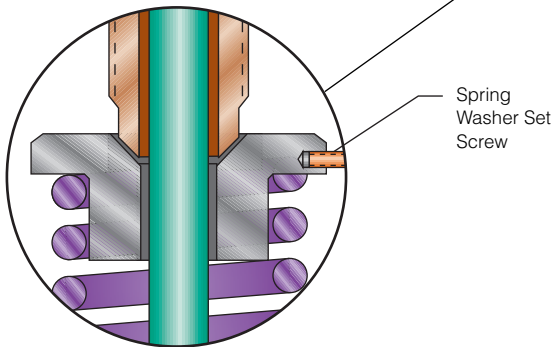
Notes

1. Crosby recommends that sufficient inventory of critical spare parts be maintained to support process requirements. Always be sure to use genuine Crosby parts to ensure continued product performance and warranty.
2. For information on installation and care, the Installation, Maintenance, and Adjustment Instructions for the Crosby Style HL Low Pressure, Full Nozzle Steel Safety Valves (CROMC-6203-US) is available upon request.

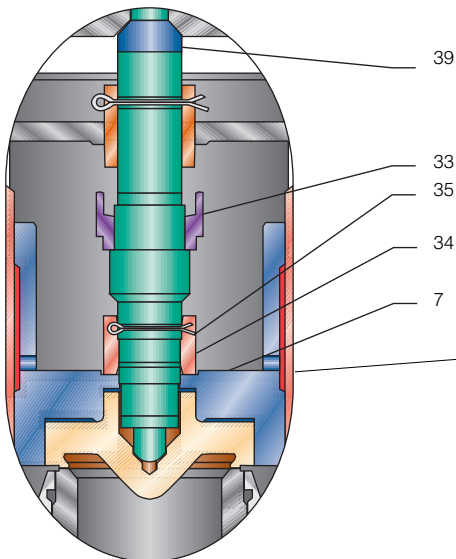
Parts and Materials



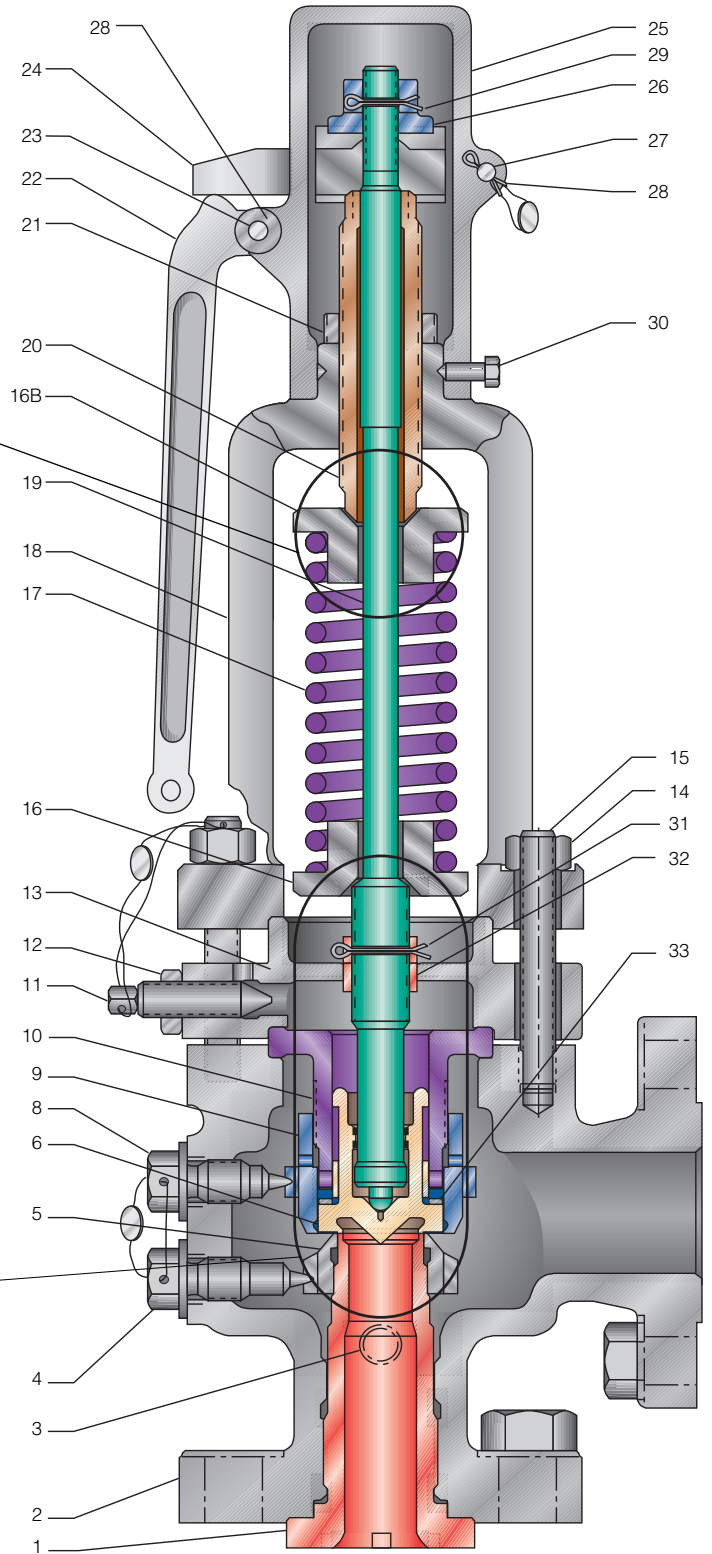
L - Q Orifice CL 150
L Orifice CL 300



N - Q Orifice CL 300
L - Q Orifice CL 600



L - Q Orifice



Pressure/Temperature Limits

CL 300 - ANSI Raised Face Flange CL 300 Inlet

Valve Size Inlet Orifice Outlet	Orifice Area		Maximum Set Pressure ¹		Style Designation Standard Body Material and Maximum Temperature		Standard Flanged Outlet Class	Optional Inlet and Outlet Sizes	
	square inch	square mm	psig	[barg]	SA216 Gr. WCB 750°F [399°C]	SA217 Gr. WC6 1000°F [538°C]		Inlet	Outlet
1¼ F 1½	0.339	218.7	330	22.76	HL-36	HL-38	Class 150	1½, 2	
1¼ G 1½	0.553	356.8	330	22.76	HL-36	HL-38	Class 150	1½, 2	
1½ H 2½	0.868	600.0	330	22.76	HL-36	HL-38	Class 150	2, 2½	
1½ J 2½	1.327	856.1	330	22.76	HL-36	HL-38	Class 150	2, 2½	
2 K 3	2.046	1320.0	330	22.76	HL-36	HL-38	Class 150	2½, 3	4
2½ L 4	3.167	2043.2	330	22.76	HL-36	HL-38	Class 150	3, 4	6
3 M 4	3.955	2551.6	330	22.76	HL-36	HL-38	Class 150		6
4 N 6	4.831	3116.8	330	22.76	HL-36	HL-38	Class 150		
4 P 6	7.031	4536.1	330	22.76	HL-36	HL-38	Class 150		
6 Q 8	12.174	7854.2	330	22.76	HL-36	HL-38	Class 150		

CL 600 - ANSI Raised Face Flange CL 600 Inlet

Valve Size Inlet Orifice Outlet	Orifice Area		Maximum Set Pressure ¹		Style Designation Standard Body Material and Maximum Temperature		Standard Flanged Outlet Class	Optional Inlet and Outlet Sizes	
	square inch	square mm	psig	[barg]	SA216 Gr. WCB 750°F [399°C]	SA217 Gr. WC6 1000°F [538°C]		Inlet	Outlet
1¼ F 1½	0.339	218.7	725	50	HL-46	HL-48	Class 150	1½, 2	
1¼ G 1½	0.553	356.8	725	50	HL-46	HL-48	Class 150	1½, 2	
1½ H 2½	0.868	600.0	725	50	HL-46	HL-48	Class 150	2, 2½	
1½ J 2½	1.327	856.1	725	50	HL-46	HL-48	Class 150	2, 2½	
2 K 3	2.046	1320.0	725	50	HL-46	HL-48	Class 150	2½, 3	4
2½ L 4	3.167	2043.2	725	50	HL-46	HL-48	Class 150	3, 4	6
3 M 4	3.955	2551.6	725	50	HL-46	HL-48	Class 150		6
4 N 6	4.831	3116.8	725	50	HL-46	HL-48	Class 150		
4 P 6	7.031	4536.1	725	50	HL-46	HL-48	Class 150		
6 Q 8	12.174	7854.2	725	50	HL-46	HL-48	Class 150		

Body Material: SA 217 Gr. WC6¹

**Working Pressure by Classes,
psig [barg]**

Temperature °F [°C]	ANSI Standard Class			
	CL 300		CL 600	
950 510	320	22.1	640	44.1
1000 538	215	14.8	430	29.6

Note

Set pressure is limited to either the inlet pressure limit per ASME/ANSI B16.34 or the maximum set pressure listed in the tables above, whichever is lower.

Sizes, Connections, Dimensions and Weights

CL 300 - ANSI Raised Face Flange CL 300 Inlet

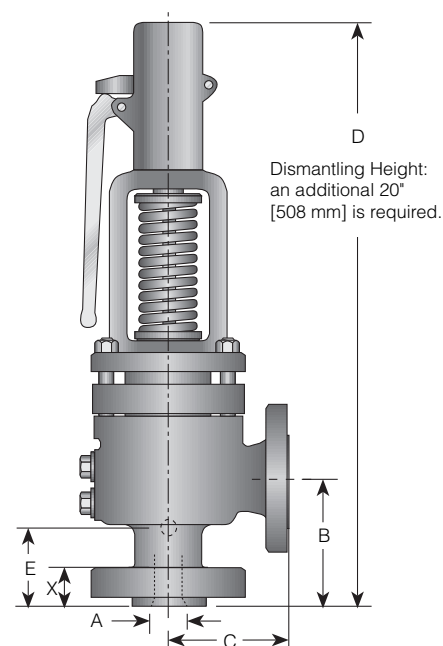
Valve Size Inlet Orifice Outlet	HL Valve Style	Inlet ID "A"		Center-to-face Inlet "B"		Center-to-face Outlet "C"		Used to Find Bolt Length "X" ¹		Approximate Height "D"		Drain Height "E"		NPT Drain Size	Approximate Weight	
		in	mm	in	mm	in	mm	in	mm	in	mm	in	mm		lb	kg
1¼ F 1½	3()	1¼	31.8	4 ¹³ / ₃₂	111.9	4 ³ / ₁₆	106.4	1 ³ / ₁₆	30.5	20	507	2 ¹ / ₁₆	68	¼	42	19
1¼ G 1½	3()	1¼	31.8	4 ¹³ / ₃₂	111.9	4 ³ / ₁₆	106.4	1 ³ / ₁₆	30.5	20	507	2 ¹ / ₁₆	68	¼	44	20
1½ H 2½	3()	1½	38.1	4¾	120.7	4 ⁷ / ₈	123.8	1¼	32.5	22 ⁷ / ₈	580	2 ⁵ / ₈	66	¾	66	30
1½ J 2½	3()	1½	38.1	4¾	120.7	4 ⁷ / ₈	123.8	1¼	32.5	23½	598	2 ⁵ / ₈	66	¾	75	34
2 K 3	3()	2	50.8	5¼	133.4	5 ⁹ / ₁₆	141.3	1½	37.5	27¾	703.5	3 ¹ / ₈	80	¾	106	48
2½ L 4	3()	2½	63.5	6 ¹ / ₈	155.6	6 ⁵ / ₁₆	160.3	1 ¹³ / ₁₆	45.5	34 ⁷ / ₈	885.5	3 ⁷ / ₈	98	½	192	87
3 M 4	3()	3	76.2	6½	165.1	6 ⁷ / ₁₆	163.5	1 ⁷ / ₈	47.5	37	938	4 ³ / ₁₆	107	½	229	104
4 N 6	3()	4	101.6	7¼	184.2	7 ⁷ / ₁₆	188.9	2 ¹ / ₈	54	39 ⁵ / ₈	994	4¼	108	¾	331	150
4 P 6	3()	4	101.6	7 ⁷ / ₁₆	188.9	8 ³ / ₁₆	207.9	2 ¹ / ₈	54	40¾	1034	4 ⁷ / ₁₆	113	¾	375	170
6 Q 8	3()	6	152.4	9 ³ / ₈	250.8	9 ³ / ₈	238.1	2½	62.5	51	1296	4 ¹³ / ₁₆	122	¾	661	300

CL 600 - ANSI Raised Face Flange CL 600 Inlet

Valve Size Inlet Orifice Outlet	HL Valve Style	Inlet ID "A"		Center-to-face Inlet "B"		Center-to-face Outlet "C"		Used to Find Bolt Length "X" ¹		Approximate Height "D"		Drain Height "E"		NPT Drain Size	Approximate Weight	
		in	mm	in	mm	in	mm	in	mm	in	mm	in	mm		lb	kg
1¼ F 1½	4()	1¼	31.8	4 ¹³ / ₃₂	111.9	4 ³ / ₁₆	106.4	1 ³ / ₁₆	30.5	20	507	2 ¹ / ₁₆	68	¼	42	19
1¼ G 1½	4()	1¼	31.8	4 ¹³ / ₃₂	111.9	4 ³ / ₁₆	106.4	1 ³ / ₁₆	30.5	20	507	2 ¹ / ₁₆	68	¼	44	20
1½ H 2½	4()	1½	38.1	4¾	120.7	4 ⁷ / ₈	123.8	1¼	32.5	22 ⁷ / ₈	580	2 ⁵ / ₈	66	¾	66	30
1½ J 2½	4()	1½	38.1	4¾	120.7	4 ⁷ / ₈	123.8	1¼	32.5	23½	598	2 ⁵ / ₈	66	¾	77	35
2 K 3	4()	2	50.8	5¼	133.4	5 ⁹ / ₁₆	141.3	1½	37.5	27¾	703.5	3 ¹ / ₈	80	½	108	49
2½ L 4	4()	2½	63.5	6 ¹ / ₈	155.6	6 ⁵ / ₁₆	160.3	1 ¹³ / ₁₆	45.5	34 ⁷ / ₈	885.5	3 ⁷ / ₈	98	½	214	97
3 M 4	4()	3	76.2	6½	165.1	6 ⁷ / ₁₆	163.5	1 ⁷ / ₈	47.5	37	938	4 ³ / ₁₆	107	¾	251	114
4 N 6	4()	4	101.6	7 ¹ / ₁₆	195.2	7 ⁷ / ₁₆	188.9	2 ¹ / ₈	54	39 ⁵ / ₈	1005	4¼	108	¾	368	167
4 P 6	4()	4	101.6	7 ¹ / ₁₆	195.2	8 ³ / ₁₆	207.9	2 ¹ / ₈	54	45¼	1148	4 ⁷ / ₁₆	113	¾	417	189
6 Q 8	4()	6	152.4	10 ⁹ / ₁₆	261.9	9 ³ / ₈	238.1	2½	62.5	55¾	1415	4 ¹³ / ₁₆	122	¾	728	330

Note

Bolt holes straddle centerline on flanged connections.



Saturated Steam Capacities

Pounds per Hour at 3% Overpressure, USCS* Units/Section I

Set Pressures 15 – 725 psig

Set Pressure (psig)	Orifice Area (sq in)									
	F .339	G .553	H .868	J 1.327	K 2.046	L 3.167	M 3.955	N 4.831	P 7.031	Q 12.174
15	481	785	1231	1883	2903	4493	5611	6854	9975	17271
20	557	908	1426	2180	3360	5202	6496	7935	11548	19995
30	709	1156	1814	2773	4276	6619	8266	10097	14695	25444
40	860	1403	2203	3367	5192	8036	10036	12259	17841	30892
50	1012	1651	2591	3961	6107	9454	11806	14421	20988	36340
60	1164	1898	2979	4555	7023	10871	13576	16583	24135	41788
70	1317	2148	3372	5155	7948	12303	15364	18767	27313	47291
80	1473	2403	3772	5767	8891	13762	17187	20993	30554	52903
90	1629	2658	4172	6378	9834	15222	19010	23220	33795	58515
100	1786	2913	4572	6990	10777	16682	20833	25447	37036	64126
110	1942	3168	4972	7602	11720	18142	22656	27674	40277	69738
120	2098	3423	5372	8213	12664	19602	24479	29901	43518	75350
130	2254	3678	5773	8825	13607	21062	26302	32128	46759	80962
140	2411	3933	6173	9437	14550	22522	28125	34355	50000	86573
150	2567	4187	6573	10048	15493	23981	29948	36582	53241	92185
160	2723	4442	6973	10660	16436	25441	31772	38809	56482	97797
170	2880	4697	7373	11272	17379	26901	33595	41036	59723	103409
180	3036	4952	7773	11884	18322	28361	35418	43262	62964	109020
190	3192	5207	8173	12495	19265	29821	37241	45489	66205	114632
200	3348	5462	8573	13107	20209	31281	39064	47716	69446	120244
210	3505	5717	8973	13719	21152	32741	40887	49943	72687	125856
220	3661	5972	9374	14330	22095	34200	42710	52170	75928	131467
230	3817	6227	9774	14942	23038	35660	44533	54397	79169	137079
240	3973	6482	10174	15554	23981	37120	46356	56624	82410	142691
250	4130	6737	10574	16165	24924	38580	48179	58851	85651	148302
260	4286	6992	10974	16777	25867	40040	50003	61078	88892	153914
270	4442	7246	11374	17389	26810	41500	51826	63305	92133	159526
280	4598	7501	11774	1800	27754	42960	53649	65531	95374	165138
290	4755	7756	12174	18612	28697	44420	55472	67758	98615	170749
300	4911	8011	12574	19224	29640	45879	57295	69985	101856	176361
310	5067	8266	12975	19836	30583	47339	59118	72212	105097	181973
320	5224	8521	13375	20447	31526	48799	60941	74439	108338	187585
330	5380	8776	13775	21059	32469	50259	62764	76666	111579	193196
340	5536	9031	14175	21671	33412	51719	64587	78893	114820	198808
350	5692	9286	14575	22282	34355	53179	66410	81120	118061	204420
360	5849	9541	14975	22894	35299	54639	68234	83347	121302	210032
370	6005	9796	15375	23506	36242	56098	70057	85574	124543	215643
380	6161	10050	15775	24117	37185	57558	71880	87801	127784	221255
390	6317	10305	16175	24729	38128	59018	73703	90027	131025	226867

* United States Customary System

Capacity formula:

$$W = (51.5 \times AP \times K)$$

Where

W = Rated capacity, lbs/hr.

P = (1.03 x set pressure) + 14.7 = absolute pressure, psia

K = 0.869 = average coefficient of discharge

A = nozzle throat (orifice) area, sq. in.

Notes

1. For steam capacities at 10% overpressure, multiply the capacity from the above table by the ratio $\frac{1.10p + 14.7}{1.03p + 14.7}$ where "p" is set pressure (psig).
2. For superheated steam, multiply the saturated steam capacities by Superheat Correction Factor K_{sh} on page 9.

Saturated Steam Capacities - continued

Pounds per Hour at 3% Overpressure, USCS* Units/Section I

Set Pressures 15 – 725 psig

Set Pressure (psig)	Orifice Area (sq in)									
	F .339	G .553	H .868	J 1.327	K 2.046	L 3.167	M 3.955	N 4.831	P 7.031	Q 12.174
400	6474	10560	16576	25341	39071	60478	75526	92254	134266	232479
410	6630	10815	16976	25953	40014	61938	77349	94481	137507	238090
420	6786	11070	17376	26564	40957	63398	79172	96708	140748	243702
430	6942	11325	17776	27176	41900	64858	80995	98935	143989	249314
440	7099	11580	18176	27788	42844	66317	82818	101162	147230	254926
450	7255	11835	18576	28399	43787	67777	84641	103389	150471	260537
460	7411	12090	18976	29011	44730	69237	86465	105616	153712	266149
470	7568	12345	19376	29623	45673	70697	88288	107843	156953	271761
480	7724	12600	19777	30234	46616	72157	90111	110070	160194	277372
490	7880	12854	20177	30846	47559	73617	91934	112296	163435	282984
500	8036	13109	20577	31458	48502	75077	93757	114523	166676	288596
510	8193	13364	20977	32069	49445	76537	95580	116750	169917	294208
520	8349	13619	21377	32681	50389	77996	97403	118977	173158	299819
530	8505	13874	21777	33293	51332	79456	99226	121204	176399	305431
540	8661	14129	22177	33905	52275	80916	101049	123431	179640	311043
550	8818	14384	22577	34516	53218	82376	102872	125658	182881	316655
560	8974	14639	22977	35128	54161	83836	104696	127885	186122	322266
570	9130	14894	23378	35740	55104	85296	106519	130112	189364	327878
580	9286	15149	23778	36351	56047	86756	108342	132339	192605	333490
590	9443	15404	24178	36963	56990	88215	110165	134565	195846	339102
600	9599	15658	24578	37575	57934	89675	111988	136792	199087	344713
610	9755	15913	24978	38186	58877	91135	113811	139019	202328	350325
620	9911	16168	25378	38798	59820	92595	115634	141246	205569	355937
630	10068	16423	25778	39410	60763	94055	117457	143473	208810	361549
640	10224	16678	26178	40022	61706	95515	119280	145700	212051	367160
650	10380	16933	26578	40634	62649	96975	121103	147927	215292	372771
660	10536	17188	26978	41246	63592	98435	122926	150154	218533	378382
670	10692	17443	27378	41858	64535	99895	124749	152381	221774	383993
680	10848	17698	27778	42470	65478	101355	126572	154608	225015	389604
690	11004	17953	28178	43082	66421	102815	128395	156835	228256	395215
700	11160	18208	28578	43694	67364	104275	130218	159062	231497	400826
710	11316	18463	28978	44306	68307	105735	132041	161289	234738	406437
720	11472	18718	29378	44915	69250	107195	133864	163516	237979	412048
725	11550	18845	29578	45221	69721	107924	134775	164629	239599	414853

* United States Customary System

Capacity formula:

$$W = (51.5 \times AP \times K)$$

Where

W = Rated capacity, lbs/hr.

P = (1.03 x set pressure) + 14.7 = absolute pressure, psia

K = 0.869 = average coefficient of discharge

A = nozzle throat (orifice) area, sq. in.

Notes

- For steam capacities at 10% overpressure, multiply the capacity from the above table by the ratio $\frac{1.10p + 14.7}{1.03p + 14.7}$ where "p" is set pressure (psig).
- For superheated steam, multiply the saturated steam capacities by Superheat Correction Factor K_{sh} on page 9.

Saturated Steam Capacities

Kilograms per Hour at 3% Overpressure

Set Pressures 1.034 – 50 barg

Set Pressure [barg]	Orifice Area [sq mm]									
	F [218.7]	G [356.8]	H [560.0]	J [856.1]	K [1320.0]	L [2043.2]	M [2551.6]	N [3116.8]	P [4536.1]	Q [7854.2]
1.034	218	356	559	854	1317	2038	2545	3109	4524	7834
2	315	513	805	1231	1898	2938	3670	4482	6524	11295
3	414	676	1061	1622	2501	3871	4834	5905	8594	14879
4	514	839	1316	2013	3103	4803	5998	7327	10664	18464
5	615	1003	1575	2408	3713	5747	7177	8766	12759	22091
6	718	1171	1838	2810	4333	6707	8376	10231	14891	25783
7	821	1339	2102	3213	4954	7668	9575	11696	17023	29474
8	924	1507	2365	3615	5574	8628	10775	13161	19155	33166
9	1026	1674	2628	4018	6194	9588	11974	14626	21287	36858
10	1129	1842	2891	4420	6815	10549	13173	16091	23419	40549
11	1232	2010	3154	4822	7435	11509	14373	17556	25551	44241
12	1335	2177	3418	5225	8056	12469	15572	19021	2768	47933
13	1438	2345	3681	5627	8676	13430	16771	20486	29815	51624
14	1540	2513	3944	6030	9297	14390	17971	21951	31947	55316
15	1643	2680	4207	6432	9917	15351	19170	23416	34079	59008
16	1746	2848	4470	6834	10537	16311	20369	24881	36211	62699
17	1849	3016	4734	7237	11158	17271	21569	26346	38344	66391
18	1952	3183	4997	7639	11778	18232	22768	27811	40476	70083
19	2054	3351	5260	8042	12399	19192	23967	29276	42608	73774
20	2157	3519	5523	8444	13019	20152	25167	30741	44740	77466
21	2260	3687	5786	8846	13640	21113	26366	32206	46872	81158
22	2363	3854	6050	9249	14260	22073	27565	33671	49004	84849
23	2466	4022	6313	9651	14880	23033	28765	35136	51136	88541
24	2568	4190	6576	10054	15501	23994	29964	36601	53268	92233
25	2671	4357	6839	10456	16121	24954	31163	38066	55400	95924
26	2774	4525	7103	10858	16742	25915	32362	39530	57532	99616
27	2877	4693	7366	11261	17362	26875	33562	40995	59664	103308
28	2980	4860	7629	11663	17983	27835	34761	42460	61797	106999
29	3082	5028	7892	12066	18603	28796	35960	43925	63929	110691
30	3185	5196	8155	12468	19223	29756	37160	45390	66061	114382
31	3288	5363	8419	12870	19844	30716	38359	46855	68193	118074
32	3391	5531	8682	13273	20464	31677	39558	48320	70325	121766
33	3494	5699	8945	13675	21085	32637	40758	49785	72457	125457
34	3596	5867	9208	14078	21705	33597	41957	51250	74589	129149
35	3699	6034	9471	14480	22326	34558	43156	52715	76721	132841
36	3802	6202	9735	14882	22946	35518	44356	54180	78853	136532
37	3905	6370	9998	15285	23566	36479	45555	55645	80985	140224
38	4008	6537	10261	15687	24187	37439	46754	57110	83117	143916
39	4110	6705	10524	16090	24807	38399	47954	58575	85250	147607
40	4213	6873	10788	16492	25428	39360	49153	60040	87382	151299

Notes

1. For superheated steam, multiply the saturated steam capacities by Superheat Correction Factor K_{sh} on page 9.
2. For steam capacities at 10% overpressure up to 103.4 barg, multiply the capacity from the above table by the ratio $\frac{1.10p + 1.0136}{1.03p + 1.0136}$ where "p" is set pressure [barg].

Capacity formula:

Capacity is calculated by converting valve set pressure in barg to psig, calculating in pounds per hour by ASME Section I Capacity formula, and converting to kilograms per hour.

Saturated Steam Capacities - continued

Kilograms per Hour at 3% Overpressure

Set Pressures 1.034 – 50 barg

Set Pressure [barg]	Orifice Area [sq mm]									
	F [218.7]	G [356.8]	H [560.0]	J [856.1]	K [1320.0]	L [2043.2]	M [2551.6]	N [3116.8]	P [4536.1]	Q [7854.2]
41	4316	7040	11051	16894	26048	40320	50352	61505	89514	154991
42	4419	7208	11314	17297	26669	41280	51552	62970	91646	158682
43	4522	7376	11577	17699	27289	42241	52751	64435	93778	162374
44	4624	7543	11840	18102	27910	43201	53950	65900	95910	166066
45	4727	7711	12104	18504	28530	44161	55150	67365	98042	169757
46	4830	7879	12367	18907	29150	45121	56350	68830	100174	173448
47	4933	8047	12630	19310	29770	46081	57550	70295	102306	177139
48	5036	8215	12893	19713	30390	47041	58750	71760	104438	180830
49	5139	8383	13156	20116	31010	48001	59950	73225	106570	184521
50	5242	8551	13419	20519	31630	48961	61150	74690	108702	188212

Capacity formula:

Capacity is calculated by converting valve set pressure in barg to psig, calculating in pounds per hour by ASME Section I Capacity formula, and converting to kilograms per hour.

Notes

1. For superheated steam, multiply the saturated steam capacities by Superheat Correction Factor K_{sh} on page 9.
2. For steam capacities at 10% overpressure up to 103.4 barg, multiply the capacity from the above table by the ratio $\frac{1.10p + 1.0136}{1.03p + 1.0136}$ where "p" is set pressure [barg].

Superheat Correction Factor - K_{sh}

Flowing' Pressure psia [bara]	Total Temperature Superheated Steam													
	400°F [204°C]	450°F [232°C]	500°F [260°C]	550°F [288°C]	600°F [316°C]	650°F [343°C]	700°F [371°C]	750°F [399°C]	800°F [427°C]	850°F [454°C]	900°F [482°C]	950°F [510°C]	1000°F [538°C]	
50	3.4	.987	.957	.930	.905	.882	.861	.841	.823	.805	.789	.774	.759	.745
100	6.9	.996	.963	.935	.909	.885	.864	.843	.825	.807	.790	.775	.760	.746
150	10.3	.984	.970	.940	.913	.888	.866	.846	.826	.808	.792	.776	.761	.747
200	13.8	.979	.977	.945	.917	.892	.869	.848	.828	.810	.793	.777	.762	.748
250	17.2		.972	.951	.921	.895	.871	.850	.830	.812	.794	.778	.763	.749
300	20.7		.968	.957	.926	.898	.874	.852	.832	.813	.796	.780	.764	.750
350	24.1		.968	.963	.930	.902	.877	.854	.834	.815	.797	.781	.765	.750
400	27.6			.963	.935	.906	.880	.857	.836	.816	.798	.782	.766	.751
450	31.0			.961	.940	.909	.883	.859	.838	.818	.800	.783	.767	.752
500	34.5			.961	.946	.914	.886	.862	.840	.820	.801	.784	.768	.753
550	37.9			.962	.952	.918	.889	.864	.842	.822	.803	.785	.769	.754
600	41.4			.964	.958	.922	.892	.867	.844	.823	.804	.787	.770	.755
650	44.8			.968	.958	.927	.896	.869	.846	.825	.806	.788	.771	.756
700	48.3				.958	.931	.899	.872	.848	.827	.807	.789	.772	.757
750	51.7				.958	.936	.903	.875	.850	.828	.809	.790	.774	.758
800	55.2				.960	.942	.906	.878	.852	.830	.810	.792	.774	.759

Note

Flowing pressure is the valve set pressure plus the overpressure plus the atmospheric pressure (14.7 psia) in psia or bara.

Reaction Forces

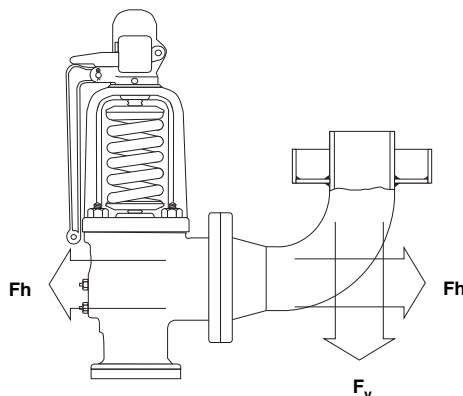
Orifice Designation	F	G	H	J	K	L	M	N	P	Q	Orifice Designation	F	G	H	J	K	L	M	N	P	Q
Outlet Diameter	1½"	1½"	2½"	2½"	3"	4"	4"	6"	6"	8"	Outlet Diameter	1½"	1½"	2½"	2½"	3"	4"	4"	6"	6"	8"
Flowing Pressure psig	Total Outlet Reaction Force - lbs										Flowing Pressure [barg]	Total Outlet Reaction Force - [N]									
25	5	7	14	18	27	45	51	76	100	174	1.72	22	31	62	80	120	200	227	338	445	774
50	11	15	27	37	56	90	104	154	202	352	3.45	49	67	120	165	249	400	463	685	899	1566
75	16	25	41	56	84	137	177	233	305	533	5.17	71	111	182	249	374	609	787	1036	1357	2371
100	22	42	56	89	146	198	302	312	433	729	6.89	98	187	249	396	649	881	1343	1388	1926	3243
125	27	60	70	131	210	297	428	392	652	1107	8.62	120	267	311	583	934	1321	1904	1744	2900	4924
150	36	77	85	172	275	396	555	472	872	1487	10.34	160	343	378	765	1223	1761	2469	2100	3879	6615
175	46	95	112	215	341	496	683	608	1094	1871	12.07	205	423	498	956	1517	2206	3038	2705	4866	8323
200	57	113	139	257	406	596	811	758	1317	2256	13.79	254	503	618	1143	1806	2651	3608	3372	5858	10035
225	68	131	166	300	472	697	941	910	1542	2645	15.51	301	583	740	1333	2101	3102	4184	4049	6859	11765
250	78	149	194	342	539	799	1070	1062	1767	3034	17.24	348	664	862	1523	2396	3554	4760	4726	7859	13494
275	89	167	221	385	605	900	1200	1215	1992	3422	18.96	395	744	983	1713	2692	4005	5336	5403	8860	15224
300	100	185	248	428	671	1002	1329	1367	2217	3811	20.68	443	825	1105	1903	2987	4456	5912	6080	9860	16953
325	110	203	276	471	738	1103	1459	1519	2442	4200	22.41	490	905	1227	2093	3282	4908	6489	6756	10861	18683
350	121	222	303	513	804	1205	1588	1671	2666	4589	24.13	537	985	1349	2284	3577	5359	7065	7433	11861	20412
375	131	240	331	556	871	1306	1718	1823	2891	4978	25.86	585	1066	1470	2474	3872	5810	7641	8110	12861	22142
400	142	258	358	599	937	1408	1847	1975	3116	5367	27.58	632	1146	1592	2664	4168	6261	8217	8787	13862	23872
425	153	276	385	642	1003	1509	1977	2128	3341	5755	29.30	679	1227	1714	2854	4463	6713	8794	9464	14862	25601
450	163	294	413	684	1070	1611	2106	2280	3566	6144	31.03	727	1307	1835	3044	4758	7164	9370	10141	15863	27331
475	174	312	440	727	1136	1712	2236	2432	3791	6533	32.75	774	1388	1957	3234	5053	7615	9946	10818	16863	29060
500	185	330	467	770	1202	1813	2365	2584	4016	6922	34.47	822	1468	2079	3424	5348	8066	10522	11496	17864	30791
525	196	348	495	813	1269	1915	2495	2737	4241	7311	36.20	870	1549	2200	3614	5643	8518	11098	12173	18866	32521
550	206	366	522	855	1335	2016	2624	2889	4466	7700	37.92	917	1629	2322	3804	5938	8969	11673	12851	19867	34251
575	217	384	549	898	1401	2118	2754	3041	4691	8089	39.64	965	1710	2444	3995	6233	9420	12249	13529	20868	35982
600	228	402	577	941	1468	2219	2883	3194	4916	8478	41.37	1013	1790	2565	4185	6529	9871	12825	14206	21869	37712
625	239	421	604	984	1534	2321	3013	3346	5142	8867	43.09	1061	1870	2687	4375	6824	10322	13400	14884	22871	39442
650	249	439	631	1026	1600	2422	3142	3498	5367	9256	44.82	1109	1951	2808	4565	7119	10773	13976	15561	23872	41173
675	260	457	659	1069	1667	2523	3271	3651	5592	9645	46.54	1157	2031	2930	4755	7414	11224	14552	16239	24873	42903
700	271	475	686	1112	1733	2625	3401	3803	5817	10034	48.26	1204	2112	3051	4945	7709	11675	15127	16917	25874	44633
725	282	493	713	1155	1799	2726	3530	3955	6042	10423	49.99	1252	2192	3173	5135	8004	12127	15703	17594	26875	46364

The basic equation for this is:

$$F_v = \frac{WV}{g_c} + (AP_e)$$

Where:

- F_v = Vertical force
- W = Flow in lbs/sec
- V = Velocity, ft/sec
- A = Area of outlet, sq. in.
- P_e = Static pressure in outlet elbow, psia
- g_c = Gravitational Constant



Total Resultant Force at Outlet Elbow²

The figure (left) shows a safety valve open and discharging at full capacity, with a 90° outlet elbow. The horizontal reaction force (F_h) is balanced by the force of discharging steam acting on the 90° elbow.

The vertical force (F_v) at the 90° elbow is unbalanced and exerts a bending moment on the valve. Vertical force (F_v) is the resultant of the reaction due to velocity and the static pressure of the steam acting on the area of the elbow when the valve is open and discharging.

Notes

1. Flowing pressure is the valve set pressure plus the overpressure plus the atmospheric pressure (14.7 psia) in psia or bara.
2. Determination of outlet reaction forces is the responsibility of the designer of the vessel and/or piping.

Sizing ASME Section I Safety Valves

ASME Section I safety valves are devices designed to protect power boilers during an overpressure event. The proper sizing, selection, manufacturing, assembly, testing and maintenance are all critical to obtain optimum protection.

ASME Code Section I

1. Boilers-Safety Valve Requirements (PG-67)

Boilers having more than 500 sq ft of bare tube and boilers having combined bare tube and extended water heating surfaces exceeding 500 sq ft as well as a design steam generating capacity exceeding 4000 lb/hr. must have two or more safety valves. If only two safety valves are used, the relieving capacity of the smaller must not be less than 50% of that of the larger, so if only two valves are used, select valves so that each will relieve approximately half of the total boiler capacity.

2. Superheater Safety Valve Requirements (PG-68)

Boilers having attached superheaters must have at least one valve on the superheater. The valves on the drum must be large enough to relieve at 75% of the total boiler capacity. It is good practice to size the superheater valve to relieve approximately 20% of the total boiler capacity to protect the tubes against overheating.

3. Reheater Safety Valve Requirements (PG-68)

Boilers having reheaters must have at least one safety valve on the reheater outlet capable of relieving a minimum of 15% of the flow through the reheater. The remainder of the flow through the reheater may be discharged by safety valves on the reheater inlet.

4. Sample Calculations - Boiler Set Sizing

Boiler Specifications:

Total steam generation	170,000 lb/hr.
Design Pressure (MAWP)	500 psig
Drum Operating Pressure	450 psig
S. H. Outlet Temperature	550°F
S. H. Outlet Operating Pressure	425 psig

The superheater valve should relieve between 15% and 20% of the total generation capacity, or 25,500 lbs/hr. to 34,000 lbs/hr.

The superheater safety valve should be set to operate before the low set drum valve.

To determine superheater safety valve set pressure:

$$\left(\begin{array}{c} 450 \text{ psig} \\ \text{Drum Operating} \\ \text{Pressure} \end{array} \right) - \left(\begin{array}{c} 425 \text{ psig} \\ \text{Superheater Outlet} \\ \text{Operating Pressure} \end{array} \right) = \left(\begin{array}{c} 25 \text{ psi} \\ \text{SH Pressure} \\ \text{Drop} \end{array} \right)$$

$$500 \text{ psig} \text{ (Design Pressure)} - 25 \text{ psi} - 15 \text{ psig}^1 = 460 \text{ psig} \text{ (Set Pressure}^2)$$

The Superheat Correction Factor K_{sh} is found on page 9. First convert Set Pressure Gage to Flowing Pressure Absolute by:

$$460 \text{ psig} \times 1.03 + 14.7 = 488.5 \text{ psia}$$

At 488.5 psia and 550°F the $K_{sh} = 0.945$

To relieve 25,500 lbs/hr. superheated steam, the superheater valve must relieve $25,500/0.945 = 26,984$ lbs/hr. saturated steam.

From Capacity Table, page 7, a **J** orifice valve set at 460 psig will relieve 29,011 lbs/hr. saturated steam or $29,011 \times 0.945 = 27,415$ lbs/hr. superheated steam.

A **1½ J 2½ HL-46** is required.

The balance of steam to be relieved by the drum valves; $170,000 - 27,415 = 142,585$ lbs/hr. (Drum valves must relieve a minimum of 75% total boiler capacity).

Low set drum valve must set at 500 psig (MAWP-PG.67.3). High set drum valve $1.03 \times 500 = 515$ psig (PG-67.2).

From Capacity Tables, page 7, at 500 psig; two "L" orifice valves will discharge $75,077 \times 2 = 150,154$ lbs/hr.

Selection should be based on price comparison and also on using as many valves as practical of the same size. In this case, two "L" orifice valves should be used.

Industry practice would be to use two (2) valves on the drum.

Actual valve capacities from Capacity Table, page 7.

1st drum valve, **2½ L 4 HL-46** 500 psig - 75,077 lbs/hr.

2nd drum valve, **2½ L 4 HL-46** 515 psig - 77,266 lbs/hr.

Total capacity drum valves: 152,343 lbs/hr. (89.6%)

Capacity of superheater valve: 27,415 lbs/hr. (16.1%)

Total safety valve capacity: 179,758 lbs/hr. (105.7%)

Rechecking, the drum valves relieve 89.6% of total boiler capacity (complying with ASME Code requirement that drum valves relieve at least 75% of boiler capacity). Superheater valve relieves 16.1% of total boiler capacity - within the desirable range of 15% to 20% of total boiler capacity.

Notes

1. The 15 psig subtracted from the superheater pressure drop is done to ensure that the superheater safety valve opens before the low set drum safety valve.
2. Can round set pressure up or down for even number.

Order Information

Safety valves listed in this catalog are for steam service on steam generators, unfired pressure vessels and pipe lines. To assist customers in selecting proper safety valves, Crosby will recommend the most suitable safety valve, size and style. In order to do this, the following information is required:

Type of Application

- (a) Boiler Drum _____
- (b) Superheater _____
- (c) Reheater _____
- (d) Other _____ (identify)

Applicable ASME Code

- (a) Section I - Power Boilers
- (b) Section VIII - Pressure Vessels
 - Single Valve System _____
 - Multiple Valve System _____

System Requirements

(for Drum, Superheater or Reheater)

- (a) Design Pressure _____ psig
- (b) Design Temperature _____ °F
- (c) Operating Pressure _____ psig
- (d) Operating Temperature _____ °F

Valve Specifications

- (a) Valve Set Pressure _____ psig
- (b) Allowable Overpressure on Valve _____ %
- (c) Relieving Capacity _____ lb/hr.
- (d) Connections
 - Inlet Size and Flange Rating _____
 - Outlet Size and Flange Rating _____

Valve Supplemental Data

- (a) Gag required _____
- (b) Weatherhood required _____
- (c) Export boxing _____
- (d) Other _____ (specify)

For customers who wish to size their own safety valves, orders should include the following data:

Data	Example
Code Requirements	ASME Section I
Quantity of Valves	Two
Size - Inlet x Orifice x Outlet	1¼ G 1½
Style	HL-46
Set Pressure	350/355 psig
Required Capacity (Total) (or indicate actual valve capacity)	9286 lb/hr. - 9413 lb/hr.
Temperature - Saturated or °F	Saturated
Maximum Operating Pressure	
Drum	315
Superheater	None
Connections (Rating and Facing)	Flanged inlet/ANSI RFF CL 600

Safety Valve Installation and Recommendations

Safety valves are intended to open and close within a narrow pressure range; therefore, valve installations require careful and accurate design both as to inlet and discharge piping. The higher the operating pressure and the greater the valve capacity, the more critical becomes the need for proper design of the installation (ASME/ANSI Power Piping Code B31.1).

Inlet Piping

Safety valves should always be mounted in a vertical position directly on nozzles having a well rounded approach that provides smooth, unobstructed flow from the vessel or line to the valve.

A safety valve should NEVER be installed on a nozzle having an inside diameter smaller than the inlet connection to the valve, or on excessively long nozzles.

The pressure drop occurring in the inlet piping between the valve and pressure source should be computed at actual flow of the valve. It is well to remember that the ASME Boiler Code, Section I rating for safety valves is only 90% of actual flow. The safety valve or safety relief valve(s) shall be connected to the boiler independent of any other connection and attached as close as possible to the boiler or the normal steam flow path without any unnecessary intervening pipe or fitting. Such intervening pipe or fitting shall not be longer than the face-to-face dimension of the corresponding tee fitting of the same diameter and pressure under the applicable American National Standard. **The wall thickness of the inlet piping must be heavy enough to resist bending moments due to reaction when the valve discharges.**

Ask for paper by J.R. Zahorsky entitled, "Degradation of Pressure Relief Valve Performance Caused by Inlet Piping Configuration."

Outlet Reaction Forces

The discharge of a safety valve will impose a reactive load on the inlet of the valve and the mounting nozzle and adjacent supporting vessel shell as a result of the reaction force of the flowing stream. The precise nature of the loading and the resulting stresses will depend on the configuration of the valve and the discharge piping. This must be taken into consideration by those responsible for the installation of the safety valve and associated vessel or piping.

Determination of Outlet Reaction Forces is the responsibility of the designer of the vessel and/or piping (see page 10).

Boilers

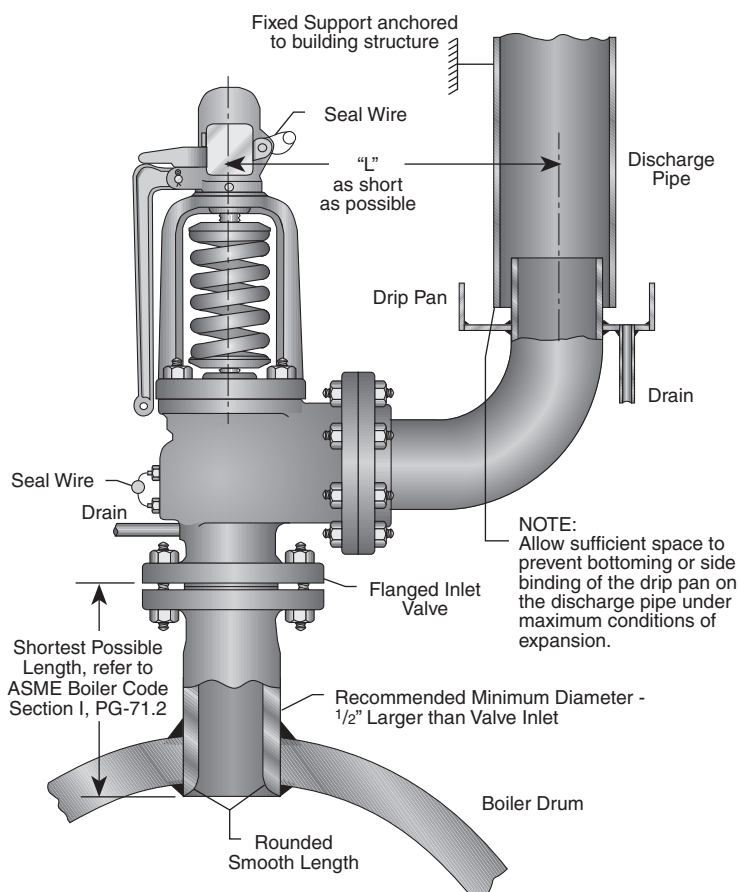
Crosby recommends that the absolute minimum differential pressure, i.e., the pressure between the valve set pressure and operating pressures, be not less than 6% to ensure seat tightness.

Nozzles for safety valves on boiler steam drums must have inside diameters equal to the valve nominal size. Nominal diameter plus ½" or more is recommended, particularly for valves mounted off the center line of the drum.

Headers

On superheaters and reheater headers, inlet nozzle connections for safety valves should be as short as possible. **It is desirable to use piping nozzles having a rounded entrance and larger ID than the valve nominal size.** This is often necessary to keep the inlet pressure drop within limits. Such connections should be away from turns or branches which can cause turbulence.

When safety valves are installed on a header or vertical riser, the connection should be as close and as short as possible. The exit from the header or riser should be larger than the valve inlet, have a well rounded approach and a uniform reduction of diameter with no abrupt changes, preferably with a smooth, gradual taper (similar to a seamless reducing or Y fitting). The design should also result in minimum pressure drop from the header or riser to the safety valve.



Safety Valve Installation and Recommendations

Pipe Lines

Where safety valves are installed to protect a piping system, as on the low pressure side of a reducing valve or on a turbine bypass, the pipe or header must be of sufficient size to maintain flow under the safety valve while it is discharging. On a pressure reducing valve installation, the safety valves should be located at least eight pipe diameters downstream from the pressure reducing valve. Where nozzles are used, they must be as short as possible and preferably one pipe size larger than the valve inlet. Nozzles must be designed to counterbalance the reaction when the valve discharges. Several smaller valves are better than one large valve, and the set pressure of each valve should be staggered within ASME Boiler and Pressure Vessel Code limitations.

Discharge Piping

The discharge piping from safety valves should be equal in size to, or larger than, the nominal valve outlet and should be as simple and direct as possible. Connections with generous clearances are preferred. The discharge pipe above the drip pan should be sized adequately to avoid “blow back” of steam from around the drip pan into the boiler room when the valve is discharging. Where piping extends to a considerable length, it may be necessary to increase the pipe size at the upper part of the stack.

Where flexible hose connections are used in place of or in conjunction with drip pans, they must be of sufficient length and flexibility so as to absorb expansion and impose no strains on the valve outlet when the pressure vessel is at normal operating pressure.

Where solid piping must be used, expansion bends should be employed to accomplish the same purpose.

Discharge Manifolds

Discharge manifold lines are satisfactory if the following “good practices” are observed:

The area of the manifold should be equal to or larger than the areas leading into it. “Stepping up” the size of the manifold at each point where another valve discharge line enters permits smoother flow than simply sizing the manifold to the total area required.

The manifold should be independently supported and not on the valves.

The same precautions should be observed in providing drip pans, flexible connections and expansion bends on the individual discharge valve lines leading into the manifold.

The manifold should be adequately anchored to prevent it from swaying and adequate drains should be provided.

The discharge lines should be led into the manifold at an angle of 45 degrees (less if possible) to the direction of the steam flow.

The manifold should be checked for possible back pressure which might cause steam “blow back” out of individual drip pans. If closed systems are used, back pressure in the manifold resulting when one valve discharges can affect the popping point and the performance of other valves connected to the same system.

While Crosby does not design discharge piping, our engineers will review and advise on discharge piping problems on receipt of drawings showing dimensions.

Design considerations are included in the following articles: “Steam Flow Through Safety Valve Vent Pipes” by H.E. Brandmaier and M.E. Knebel (December 1975), “Analysis of Power Plant Safety and Relief Valve Vent Stacks” by G.S. Liao (November 1974), and “Safety Valve Vent Pipe Sizing for Open Discharge Systems” by J. W. Sale (June 1979). The latter papers are ASME publications.

Drains

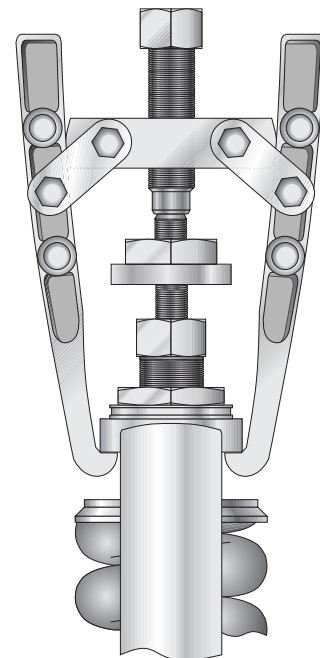
Provisions for drains are located in the valve bodies and should be piped to a drainage system to remove condensate from the valve bodies. Separate drains are recommended to drain the drip pan and on certain types of installations additional drainage from the discharge piping may be provided. This is especially true in marine installations where it is essential that the main atmospheric exhaust stack be provided with a drain pocket at the lowest point, and that a separate drain line be carried from this pocket to the bilge.

CAUTION: All drains and piping in the discharge system must be piped to a safe disposal area to prevent possible personnel injury when the valve discharges.

Hydrostatic Testing of Boilers

When a hydrostatic test is made on the system, it is recommended that blank flanges be used in preference to gagging of the safety valves. Excessive tightening of the gag (test rod) may damage or bend the valve spindle.

Technical literature is provided for Crosby Series HL valves which describes the specific type and use of hydrostatic test equipment available.



Drip Pan Elbows

For optimum safety valve performance, discharge piping should be supported independently of the valve. This can best be accomplished by installing a slip joint arrangement at the inlet to the riser pipe, using a drip pan elbow.

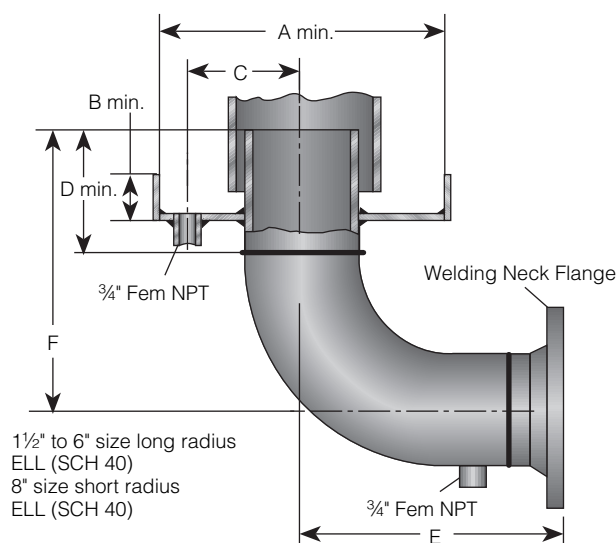
The riser should be sized sufficiently larger than the slip joint to provide clearance during expansion of the boiler, and should be located with enough clearance at the lower end to prevent "bottoming" on the drip pan.

Drain lines should be installed from the discharge elbow and the safety valve body, and piped separately from any other drain or vent line. The size of the drip pan elbow should be at least equal to that of the safety valve outlet size.

The flanged model EFS drip pan elbow should be used without any intermediary connection.

Specifications

Model: EFS
Sizes: 1½", 2½", 3", 4", 6", 8"
Flange ANSI Class: 150 (1½" to 8")
Material: Carbon Steel



Dimensions - Inches

Valve Outlet Size	A	B	C	D	E 150 ANSI Class	F
1½	7	2½	2½	6	4 ¹¹ / ₁₆	9
2½	9	2½	3	7	6½	10¾
3	9	3	3	8	7¼	12½
4	12	3	4	8	9	14
6	14	4	5	8	12½	17
8	16	4	6½	8	12	16

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Crosby HL Safety Valve

High Capacity, Flanged Steel Safety Valve

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