HANDBOOK
SAFETY DEVICES

Castel®
Italian technology

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CHAPTER 1
SAFETY VALVES IN SERIES 3030

GENERAL DESCRIPTION

The valves in series 3030 are unbalanced, conventional direct-loaded safety valves. The valve is opened by the thrust from the fluid under pressure below the shutter, when said thrust exceeds, under the calibrated conditions, the opposing force of the spring acting on the shutter.
Valves are identified by means of:

- a model number formed of an alphanumerical code that includes:
  - the family identity (for ex. 3030/44)
  - the type of connection (C = NPT ; G = Gas)
  - the set pressure, expressed in bar, multiplied by 10 (for ex. 250)
- An alphanumerical serial number

CONSTRUCTION

Body: squared, obtained through hot moulding and subsequent machining. It houses the following elements:

- the nozzle with flat sealing seat
- the shutter guide
- the set spring slot
- the threaded seat of the setting adjustment ring nut

In the body, above the shutter guide, a small pressure relief hole is provided through which the spring slot communicates with the atmosphere. For this reason, during relief, there is a gas leak through this orifice.
Material used: EN 12420-CW617N brass

Shutter: obtained through machining from bar stock and fit with gasket, it ensures the required degree of tightness on the valve seat. The gasket is made from PTFE (Polytetrafluorethylene), a material that, during the valve's estimated service life, maintains good strength and does not cause the shutter to stick on the seat. The shutter is properly guided in the head and the guide action cannot fail. There are no glands or retaining rings that hamper its movement.
Material used: EN 12164-CW614N brass

Spring: it opposes the pressure and the fluid dynamic forces, and always ensures closing of the valve following pressure relief. When the shutter has reached the maximum height determined by the mechanical stop, the spring compression does not exceed 85% of the total compression.
Material used: DIN 17223-1 steel for springs.

Calibration system: hex-head threaded ring nut to be screwed inside the upper portion of the head, compressing the spring below. When calibration is complete, the position of the ring nut is maintained unchanged by applying to the threaded coupling a high mechanical strength and low viscosity bonding agent. The low viscosity promotes penetration. The calibration system is protected against subsequent tampering by means of a threaded cap nut, screwed on outside the head and sealed with a Castel lead seal.

SCOPE

Use: protection against possible overpressure of the apparatuses listed below, with regard to the operating conditions for which they have been designed:

- Refrigeration system or heat pump components, for instance: condensers, liquid receivers, evaporators, liquid accumulators, positive displacement compressor discharge, heat exchangers, oil separators, or piping. (reference standard: EN 378-2:2016)
- Simple pressure vessels (reference Directive: 2009/105/EC)

Fluids: the valves in series 3030 can be used with:

a. Refrigerant fluids in vapour or gaseous state belonging to Group 2:
   - HCFC (R22)
   - HFC (R134a , R404A , R407C , R410A , R507)
   - HFO and HFO/HFC mixtures (R1234ze , R448A , R449A , R450A , and R452A)
   - R744

with reference to Article 13, Para. 1(b) of Directive 2014/68/EU (EC Regulation No. 1272/2008).

b. Air and nitrogen (reference Directive: 2009/105/EC)

For specific applications with refrigerant fluids not listed above, please contact Castel Technical Department.

MARKING

In compliance with the provisions of Article 19 of Directive 2014/68/EC, the following information is reported on the valve body:

- Manufacturer's mark
- Country of manufacturing
- Indication of flow direction
- Maximum allowable pressure
- CE marking
- Identification number of the notified body involved in the production control phase

Again, on the body, the following information is laser marked:

- Valve model
- Serial number
- Set pressure
- Temperature range allowed
- Kd discharge coefficient
- Flow section
- Production date

DOCUMENTATION

The safety valves in series 3030 are supplied with the following documentation provided in the packaging:

- operating instructions for the user, containing all information useful for safety in terms of assembly, commissioning, use, and maintenance.
- Compliance Statement for the equipment according to Directive 2014/68/EU, required in Article 17 and issued in compliance with Annex IV of the same directive.
- Calibration certificate for the safety valve, printed on the reverse side of the Compliance Statement.

N.B.: on the website: www.castel.it use the "Certifications" pull-down menu to access the web-page **"Castel Certification Download Center"**. On this page, you can download:

- the Compliance Statement / Calibration Certificate for each valve by entering the 7-digit alphanumeric serial number.
- the general Compliance Statement referring to a specific model of valve 3030 with a specific setting, for ex. 3030/44C250 or 3030/88C420.

VALVE SELECTION

Directive 2014/68/EC requires that pressure equipment, in which permissible limits are reasonably likely to be exceeded, shall be fitted with suitable protection devices, for instance safety devices such as safety valves. Such devices shall prevent pressure from permanently exceeding the maximum allowable pressure (PS) of the equipment they protect. In any case, a short pressure peak limited to 10% of maximum allowable pressure is permitted.

As to the selection and sizing of the suitable protection device, users shall refer to the specific product and sector standards listed below:

- EN ISO 4126-1: 2013: "Safety devices for protection against excessive pressure – Part 1: Safety valves" indicates the general requirements for safety valves regardless of the fluid for which they were designed.
- EN 378-2:2016: "Refrigerating systems and heat pumps – safety and environmental requirements – Part 2: Design, construction, testing, marking and documentation" provides a general outline of the protection devices to be used in refrigerating systems and their characteristics (Para. 6.2.5) and the criteria for the selection of the device suitable for the type and size of the system component to be protected (Para. 6.2.6).
- EN 13136:2013: "Refrigerating systems and heat pumps – Pressure relief devices and their associated piping – Methods for calculation" highlights the possible causes of overpressure in a system and provides users with the tools for sizing pressure relief devices, among which safety valves.

To select the safety valves in series 3030, please see Chapter 5 "Selection Criteria for Safety Valves" in this technical handbook.
Tables 3 and 4 provide the maximum discharge capacities of safety valves, models 3030/44 and 3030/88, as a function of various refrigerants and varying P_{set} for the valve, considering T_o = Steam saturation temperature at discharge pressure, P_o.

VALVE INSTALLATION

Safety valves type 3030 guarantee repeatable performance. This means that, after the valves have operated, open/close, the initial setting conditions are maintained. Nevertheless, it is advisable to replace a 3030 valve once it has discharged as during release debris, such as metal shavings or solder impurities, can deposit on the valve gasket. This can inhibit the safety valve from returning to its original conditions.
To calculate the pressure loss in either the upstream line (between vessel and safety valve) or the downstream line (between safety valve and atmosphere) refer to Chapter 5 "Selection Criteria for Safety Valves" in this technical handbook.

TABLE 1: General Characteristics of valves 3030					
Catalogue Number		3030/44C	3030/44G	3030/66C	3030/88C
Connections	Inlet male	1/2" NPT	1/2" G	3/4" NPT	1" NPT
	Outlet male	3/4" G	3/4" G	3/4" G	1.1/4" G
Inlet connection wrench torque (min/max) [Nm]		21/30	21/30	32/45	50/65
Flow Diameter [mm]		12	12	12	19,5
Flow Section [mm^2]		113	113	113	298
Lift [mm]		4,1	4,1	4,1	6,8
Discharge Coefficient "Kd"		0,90	0,90	0,90	0,83
PS [bar]		55			
TS [°C]		- 50 / + 150			
TA [°C]		- 40 / + 50			
Set Pressure Range at atmospheric back pressure Pset [bar]		9 / 50			
Overpressure		+ 5 % of Pset			
Blowdown		- 15 % of Pset			
Helium tightness		85 % di Pset (9 bar < Pset < 31 bar)			
		90 % di Pset (31,1 bar < Pset < 50 bar)			
Estimated service life		5 years			
Risk Category according to PED Recast		IV			

TABLE 2: Dimensions and Weights of valves 3030							
Catalogue Number	Dimensions [mm]						Weight [g]
	Ø D	L	Ch	H_1	H_2	H_3	
3030/44C	38	38	28	44	115	159	780
3030/44G	38	38	28	44	115	159	780
3030/66C	38	38	28	44	115	159	780
3030/88C	50	56	40	58	158	216	1960

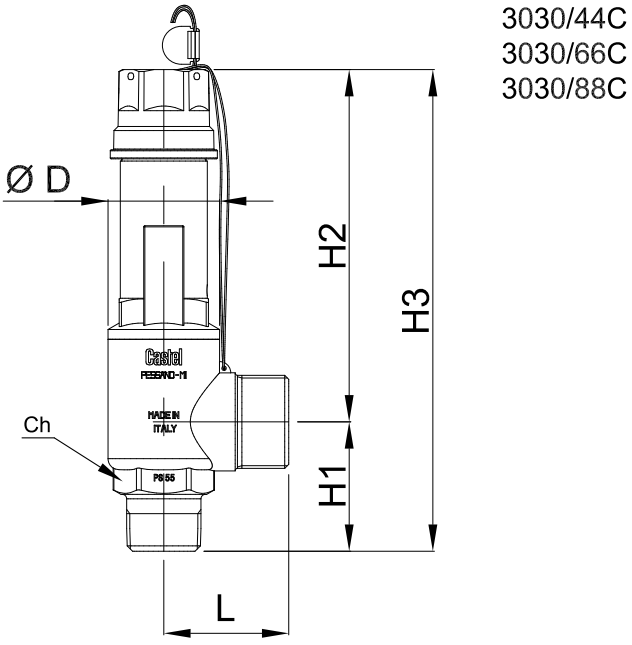

TABLE 3: Maximum discharge capacity of valves 3030/44 ; 3030/66													
Pset [bar]	Po [barsass]	R134a		R22		R404A		R407C		R410A		R448A	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	49,8	1937	33,7	1815	27,0	768	33,9	1811	16,5	1735	31,1	1828
12,0	14,2	53,0	2109	36,9	1972	30,2	837	36,9	1969	19,4	1887	34,1	1986
13,0	15,3	56,0	2284	39,9	2130	33,1	908	39,7	2130	22,1	2041	36,9	2152
14,0	16,4	58,9	2461	42,8	2290	35,9	979	42,4	2292	24,7	2196	39,6	2317
15,0	17,5	61,7	2641	45,5	2452	38,5	1051	44,9	2457	27,2	2352	42,1	2478
16,0	18,6	64,3	2823	48,1	2615	41,0	1125	47,3	2623	29,5	2511	44,6	2652
17,0	19,7	66,8	3009	50,6	2780	43,4	1201	49,6	2792	31,8	2672	46,9	2829
18,0	20,8	69,2	3199	53,0	2947	45,7	1278	51,8	2963	33,9	2834	49,1	2991
19,0	21,9	71,5	3392	55,3	3116	48,0	1357	54,0	3137	36,0	2999	51,2	3180
20,0	23,0	73,7	3589	57,5	3287	50,1	1439	56,0	3313	37,9	3167	53,3	3348
21,0	24,1	75,9	3791	59,7	3461	52,1	1522	58,0	3493	39,9	3336	55,2	3527
22,0	25,2	77,9	3997	61,7	3637	54,1	1608	59,9	3675	41,7	3509	57,1	3717
23,0	26,3	79,9	4209	63,7	3815	56,0	1698	61,7	3861	43,5	3684	58,9	3922
24,0	27,4	81,9	4428	65,7	3997	57,9	1790	63,4	4051	45,2	3863	60,7	4115
25,0	28,5	83,7	4652	67,6	4181	59,7	1887	65,2	4244	46,9	4045	62,4	4320
26,0	29,6	85,6	4885	69,4	4369	61,4	1988	66,8	4442	48,5	4230	64,1	4504
27,0	30,7	87,3	5127	71,2	4561	63,1	2096	68,4	4645	50,1	4419	65,7	4738
28,0	31,8	89,0	5379	72,9	4756	64,7	2211	70,0	4853	51,6	4613	67,2	4947
29,0	32,9	90,7	5644	74,6	4955	66,3	2336	71,5	5067	53,1	4811	68,7	5170
30,0	34,0	92,3	5924	76,2	5159	67,8	2475	72,9	5288	54,6	5014	70,2	5408
31,0	35,1	93,9	6224	77,8	5369	69,3	2637	74,4	5516	56,0	5224	71,6	5606
32,0	36,2	95,4	6550	79,4	5584	70,7	2845	75,7	5753	57,4	5439	73,0	5876
33,0	37,3	96,9	6913	80,9	5805	72,1	3294	77,1	6000	58,7	5662	74,3	6169
34,0	38,4	98,3	7336	82,4	6034			78,4	6259	60,1	5893	75,6	6410
35,0	39,5	99,2	7702	83,9	6271			79,7	6533	61,4	6134	76,9	6753
36,0	40,6	99,5	7897	85,3	6518			80,9	6826	62,6	6386	78,1	7034
37,0	41,7	99,7	8102	86,7	6776			82,1	7142	63,8	6652	79,2	7445
38,0	42,8			88,0	7048			83,2	7493	65,0	6935	80,3	7911
39,0	43,9			89,4	7338			84,3	7896	66,2	7240		
40,0	45,0			90,7	7651			85,3	8399	67,4	7574		
41,0	46,1			92,0	7995			86,1	9227	68,5	7952		
42,0	47,2			93,2	8387					69,6	8404		
43,0	48,3			94,4	8866					70,7	9024		
44,0	49,4			95,6	9584								
45,0	50,5												
46,0	51,6												
47,0	52,7												
48,0	53,8												
49,0	54,9												
50,0	56,0												
51,0	57,1												
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

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TABLE 3: Maximum discharge capacity of valves 3030/44 ; 3030/66

Pset [bar]	Po [barsass]	R449A		R450A		R452A		R507		R1234ze		R744 (CO2)	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	31,0	1838	55,2	1982	28,7	2007	25,8	1990	61,1	1987	-32,5	1465
12,0	14,2	34,0	2000	58,5	2163	31,8	2186	28,9	2169	64,5	2166	-30,2	1588
13,0	15,3	36,9	2164	61,7	2336	34,6	2366	31,9	2351	67,7	2347	-27,9	1713
14,0	16,4	39,5	2330	64,6	2526	37,4	2550	34,7	2536	70,8	2532	-25,8	1837
15,0	17,5	42,1	2498	67,5	2708	39,9	2736	37,3	2724	73,7	2720	-23,8	1962
16,0	18,6	44,5	2668	70,1	2892	42,4	2925	39,8	2916	76,5	2912	-21,8	2088
17,0	19,7	46,8	2841	72,7	3091	44,7	3118	42,2	3112	79,1	3108	-20,0	2215
18,0	20,8	49,1	3016	75,2	3289	47,0	3314	44,5	3313	81,7	3309	-18,2	2342
19,0	21,9	51,2	3195	77,5	3482	49,1	3514	46,8	3518	84,1	3514	-16,5	2470
20,0	23,0	53,2	3376	79,8	3688	51,2	3718	48,9	3729	86,4	3726	-14,9	2599
21,0	24,1	55,2	3561	82,0	3912	53,2	3928	50,9	3946	88,7	3943	-13,3	2729
22,0	25,2	57,1	3749	84,1	4123	55,1	4142	52,9	4171	90,9	4168	-11,7	2860
23,0	26,3	58,9	3941	86,2	4350	57,0	4362	54,8	4403	93,0	4401	-10,2	2991
24,0	27,4	60,7	4137	88,1	4596	58,7	4588	56,7	4644	95,0	4644	-8,8	3123
25,0	28,5	62,4	4338	90,1	4818	60,5	4822	58,5	4896	97,0	4898	-7,4	3257
26,0	29,6	64,1	4544	91,9	5056	62,1	5065	60,2	5162	98,9	5166	-6,0	3391
27,0	30,7	65,7	4756	93,7	5368	63,7	5317	61,9	5443	100,7	5451	-4,7	3527
28,0	31,8	67,2	4974	95,4	5650	65,3	5581	63,5	5746	102,5	5760	-3,4	3663
29,0	32,9	68,7	5199	97,1	5959	66,8	5859	65,1	6076	104,3	6100	-2,2	3801
30,0	34,0	70,2	5430	98,8	6215	68,3	6155	66,6	6448	106,0	6489	-0,9	3940
31,0	35,1	71,6	5672	100,3	6580	69,7	6483	68,1	6889	107,6	6972	0,3	4080
32,0	36,2	73,0	5930	101,9	7100	68,3	16968	69,6	7484	109,2	7821	1,4	4222
33,0	37,3	74,3	6182			72,3	7225					2,6	4365
34,0	38,4	75,6	6490			73,5	7708					3,7	4509
35,0	39,5	76,9	6801									4,8	4655
36,0	40,6	78,1	7140									5,9	4803
37,0	41,7	79,2	7526									6,9	4952
38,0	42,8	80,3	7994									8,0	5103
39,0	43,9	80,7	10047									9,0	5256
40,0	45,0											10,0	5411
41,0	46,1											11,0	5567
42,0	47,2											11,9	5727
43,0	48,3											12,9	5888
44,0	49,4											13,8	6052
45,0	50,5											14,7	6219
46,0	51,6											15,6	6388
47,0	52,7											16,5	6561
48,0	53,8											17,3	6737
49,0	54,9											18,2	6916
50,0	56,0											19,0	7100
51,0	57,1												
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

TABLE 4: Maximum discharge capacity of valves 3030/88													
Pset [bar]	Po [barsass]	R134a		R22		R404A		R407C		R410A		R448A	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	49,8	4712	33,7	4414	27,0	768	33,9	4404	16,5	4221	31,1	4446
12,0	14,2	53,0	5131	36,9	4796	30,2	837	36,9	4790	19,4	4590	34,1	4829
13,0	15,3	56,0	5555	39,9	5181	33,1	908	39,7	5181	22,1	4963	36,9	5233
14,0	16,4	58,9	5985	42,8	5570	35,9	979	42,4	5575	24,7	5340	39,6	5636
15,0	17,5	61,7	6423	45,5	5963	38,5	1051	44,9	5975	27,2	5721	42,1	6028
16,0	18,6	64,3	6867	48,1	6360	41,0	1125	47,3	6380	29,5	6107	44,6	6451
17,0	19,7	66,8	7319	50,6	6762	43,4	1201	49,6	6791	31,8	6498	46,9	6880
18,0	20,8	69,2	7780	53,0	7167	45,7	1278	51,8	7207	33,9	6893	49,1	7275
19,0	21,9	71,5	8250	55,3	7579	48,0	1357	54,0	7630	36,0	7294	51,2	7735
20,0	23,0	73,7	8729	57,5	7995	50,1	1439	56,0	8059	37,9	7701	53,3	8144
21,0	24,1	75,9	9220	59,7	8417	52,1	1522	58,0	8495	39,9	8114	55,2	8578
22,0	25,2	77,9	9722	61,7	8845	54,1	1608	59,9	8939	41,7	8534	57,1	9041
23,0	26,3	79,9	10238	63,7	9279	56,0	1698	61,7	9391	43,5	8961	58,9	9539
24,0	27,4	81,9	10768	65,7	9721	57,9	1790	63,4	9852	45,2	9395	60,7	10007
25,0	28,5	83,7	11316	67,6	10170	59,7	1887	65,2	10323	46,9	9837	62,4	10507
26,0	29,6	85,6	11882	69,4	10627	61,4	1988	66,8	10804	48,5	10288	64,1	10955
27,0	30,7	87,3	12470	71,2	11092	63,1	2096	68,4	11298	50,1	10748	65,7	11523
28,0	31,8	89,0	13083	72,9	11567	64,7	2211	70,0	11804	51,6	11219	67,2	12032
29,0	32,9	90,7	13727	74,6	12052	66,3	2336	71,5	12324	53,1	11702	68,7	12574
30,0	34,0	92,3	14409	76,2	12549	67,8	2475	72,9	12861	54,6	12196	70,2	13153
31,0	35,1	93,9	15138	77,8	13058	69,3	2637	74,4	13416	56,0	12705	71,6	13634
32,0	36,2	95,4	15930	79,4	13581	70,7	2845	75,7	13993	57,4	13229	73,0	14291
33,0	37,3	96,9	16813	80,9	14119	72,1	3294	77,1	14594	58,7	13771	74,3	15004
34,0	38,4	98,3	17843	82,4	14675			78,4	15224	60,1	14333	75,6	15590
35,0	39,5	99,2	18732	83,9	15252			79,7	15890	61,4	14919	76,9	16424
36,0	40,6	99,5	19207	85,3	15852			80,9	16601	62,6	15532	78,1	17107
37,0	41,7	99,7	19706	86,7	16481			82,1	17371	63,8	16179	79,2	18109
38,0	42,8			88,0	17143			83,2	18224	65,0	16867	80,3	19241
39,0	43,9			89,4	17847			84,3	19205	66,2	17608		
40,0	45,0			90,7	18608			85,3	20427	67,4	18422		
41,0	46,1			92,0	19445			86,1	22443	68,5	19341		
42,0	47,2			93,2	20399					69,6	20439		
43,0	48,3			94,4	21562					70,7	21949		
44,0	49,4			95,6	23310								
45,0	50,5												
46,0	51,6												
47,0	52,7												
48,0	53,8												
49,0	54,9												
50,0	56,0												
51,0	57,1												
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

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TABLE 4: Maximum discharge capacity of valves 3030/88

Pset [bar]	Po [barsass]	R449A		R450A		R452A		R507		R1234ze		R744 (CO2)	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	31,0	4471	55,2	4820	28,7	4883	25,8	4841	61,1	4834	-32,5	3563
12,0	14,2	34,0	4865	58,5	5261	31,8	5316	28,9	5275	64,5	5268	-30,2	3863
13,0	15,3	36,9	5263	61,7	5683	34,6	5756	31,9	5718	67,7	5709	-27,9	4165
14,0	16,4	39,5	5667	64,6	6143	37,4	6201	34,7	6167	70,8	6158	-25,8	4468
15,0	17,5	42,1	6075	67,5	6587	39,9	6654	37,3	6625	73,7	6616	-23,8	4773
16,0	18,6	44,5	6489	70,1	7034	42,4	7115	39,8	7092	76,5	7083	-21,8	5079
17,0	19,7	46,8	6910	72,7	7519	44,7	7583	42,2	7569	79,1	7559	-20,0	5387
18,0	20,8	49,1	7336	75,2	8000	47,0	8060	44,5	8057	81,7	8047	-18,2	5697
19,0	21,9	51,2	7770	77,5	8468	49,1	8547	46,8	8557	84,1	8547	-16,5	6009
20,0	23,0	53,2	8211	79,8	8970	51,2	9044	48,9	9070	86,4	9061	-14,9	6322
21,0	24,1	55,2	8660	82,0	9514	53,2	9552	50,9	9598	88,7	9590	-13,3	6637
22,0	25,2	57,1	9118	84,1	10028	55,1	10074	52,9	10143	90,9	10137	-11,7	6955
23,0	26,3	58,9	9585	86,2	10580	57,0	10609	54,8	10708	93,0	10704	-10,2	7275
24,0	27,4	60,7	10063	88,1	11178	58,7	11160	56,7	11295	95,0	11294	-8,8	7597
25,0	28,5	62,4	10551	90,1	11719	60,5	11729	58,5	11908	97,0	11912	-7,4	7921
26,0	29,6	64,1	11052	91,9	12296	62,1	12318	60,2	12554	98,9	12564	-6,0	8248
27,0	30,7	65,7	11567	93,7	13055	63,7	12931	61,9	13239	100,7	13258	-4,7	8578
28,0	31,8	67,2	12098	95,4	13743	65,3	13573	63,5	13974	102,5	14008	-3,4	8910
29,0	32,9	68,7	12644	97,1	14493	66,8	14250	65,1	14778	104,3	14836	-2,2	9245
30,0	34,0	70,2	13207	98,8	15116	68,3	14970	66,6	15682	106,0	15783	-0,9	9583
31,0	35,1	71,6	13795	100,3	16004	69,7	15767	68,1	16755	107,6	16957	0,3	9924
32,0	36,2	73,0	14423	101,9	17269	68,3	41269	69,6	18203	109,2	19023	1,4	10269
33,0	37,3	74,3	15037			72,3	17572					2,6	10616
34,0	38,4	75,6	15784			73,5	18748					3,7	10967
35,0	39,5	76,9	16541									4,8	11322
36,0	40,6	78,1	17367									5,9	11681
37,0	41,7	79,2	18305									6,9	12044
38,0	42,8	80,3	19443									8,0	12411
39,0	43,9	80,7	24436									9,0	12783
40,0	45,0											10,0	13159
41,0	46,1											11,0	13541
42,0	47,2											11,9	13928
43,0	48,3											12,9	14321
44,0	49,4											13,8	14719
45,0	50,5											14,7	15125
46,0	51,6											15,6	15537
47,0	52,7											16,5	15957
48,0	53,8											17,3	16384
49,0	54,9											18,2	16821
50,0	56,0											19,0	17267
51,0	57,1												
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

CHAPTER 2
SAFETY VALVES IN SERIES 3060

GENERAL DESCRIPTION

The valves in series 3060 are unbalanced, conventional direct-loaded safety valves. The valve is opened by the thrust from the fluid under pressure below the shutter, when said thrust exceeds, under the calibrated conditions, the opposing force of the spring acting on the shutter.
Valves are identified by means of:

- a model number formed of an alphanumerical code that includes:
  - the family identity (for ex. 3060/45)
  - the type of connection (C = NPT)
  - the set pressure, expressed in bar, multiplied by 10 (for ex. 300)
- an alphanumerical serial number.

CONSTRUCTION

Body: squared, obtained through hot moulding and subsequent machining. It houses the following elements:

- the nozzle with flat sealing seat
- the shutter guide
- the set spring slot
- the threaded seat of the setting adjustment ring nut

In the body, above the shutter guide, a small pressure relief hole is provided through which the spring slot communicates with the exit connection.
Material used: EN 12420-CW617N brass

Shutter: obtained through machining from bar stock and fit with gasket, it ensures the required degree of tightness on the valve seat. The gasket is made from PTFE (Polytetrafluorethylene), a material that, during the valve's estimated service life, maintains good strength and does not cause the shutter to stick on the seat. The shutter is properly guided in the body and the guide action cannot fail. There are no glands or retaining rings that hamper its movement.
Material used: EN 12164-CW614N brass

Spring: it opposes the pressure and the fluid dynamic forces, and always ensures closing of the valve following pressure relief.
Material used: DIN 17223-1 steel for springs.

Calibration system: hex-head threaded ring nut to be screwed inside the upper portion of the body, compressing the spring below. When calibration is complete, the position of the ring nut is maintained unchanged by applying to the threaded coupling a high mechanical strength and low viscosity bonding agent. The low viscosity promotes penetration. The calibration system is protected against subsequent tampering by means of a threaded cap nut, screwed on outside the brass body and blocked in place through re-flanging.

SCOPE

Use: protection against possible overpressure of the apparatuses listed below, with regard to the operating conditions for which they have been designed:

- Refrigeration system or heat pump components, for instance: condensers, liquid receivers, evaporators, liquid accumulators, positive displacement compressor discharge, heat exchangers, oil separators, or piping. (reference standard: EN 378-2:2016)
- Simple pressure vessels (reference Directive: 2009/105/EC)

Fluids: the valves in series 3060 can be used with:

a. Refrigerant fluids in vapour or gaseous state belonging to Group 2:
   - HCFC (R22)
   - HFC (R134a , R404A , R407C , R410A , R507)
   - HFO and HFO/HFC mixtures (R1234ze , R448A , R449A , R450A , and R452A)
   - R744

with reference to Article 13, Para. 1(b) of Directive 2014/68/EU (EC Regulation No. 1272/2008).

b. Air and nitrogen (reference Directive: 2009/105/EC)

For specific applications with refrigerant fluids not listed above, please contact Castel Technical Department.

MARKING

In compliance with the provisions of Article 19 of Directive 2014/68/EC, the following information is reported on the valve body:

- Manufacturer's mark
- Country of manufacturing
- Indication of flow direction
- Maximum allowable pressure
- CE marking
- Identification number of the notified body involved in the production control phase

Again, on the body, the following information is laser marked:

- Valve model
- Serial number
- Set pressure
- Kd discharge coefficient
- Flow section
- Production date

DOCUMENTATION

The safety valves in series 3060 are supplied with the following documentation provided in the packaging:

- operating instructions for the user, containing all information useful for safety in terms of assembly, commissioning, use, and maintenance.
- Compliance Statement for the equipment according to Directive 2014/68/EU, required in Article 17 and issued in compliance with Annex IV of the same directive.
- Calibration certificate for the safety valve, printed on the reverse side of the Compliance Statement.

N.B.: on the website: www.castel.it use the "Certifications" pull-down menu to access the web-page **"Castel Certification Download Center"**. On this page, you can download:

- the Compliance Statement / Calibration Certificate for each valve by entering the 7-digit alphanumeric serial number.
- the general Compliance Statement referring to a specific model of valve 3060 with a specific setting, for ex. 3060/24C250 or 3060/45C420.

VALVE SELECTION

Directive 2014/68/EC requires that pressure equipment, in which permissible limits are reasonably likely to be exceeded, shall be fitted with suitable protection devices, for instance safety devices such as safety valves. Such devices shall prevent pressure from permanently exceeding the maximum allowable pressure (PS) of the equipment they protect. In any case, a short pressure peak limited to 10% of maximum allowable pressure is permitted.

As to the selection and sizing of the suitable protection device, users shall refer to the specific product and sector standards listed below:

- EN ISO 4126-1: 2013: "Safety devices for protection against excessive pressure – Part 1: Safety valves" indicates the general requirements for safety valves regardless of the fluid for which they were designed.
- EN 378-2:2016: "Refrigerating systems and heat pumps – safety and environmental requirements – Part 2: Design, construction, testing, marking and documentation" provides a general outline of the protection devices to be used in refrigerating systems and their characteristics (Para. 6.2.5) and the criteria for the selection of the device suitable for the type and size of the system component to be protected (Para. 6.2.6).
- EN 13136:2013: "Refrigerating systems and heat pumps – Pressure relief devices and their associated piping – Methods for calculation" highlights the possible causes of overpressure in a system and provides users with the tools for sizing pressure relief devices, among which safety valves.

To select the safety valves in series 3060, please see Chapter 5 "Selection Criteria for Safety Valves" in this technical handbook.
Tables 7, 8, 9, 10 and 11 provide the maximum discharge capacities of safety valves, models 3060/23-/24, 3060/33-/34, 3060/45, 3060/36 and 3060/46, as a function of various refrigerants and varying P_{set} for the valve, considering T_o = Steam saturation temperature at discharge pressure, P_o.

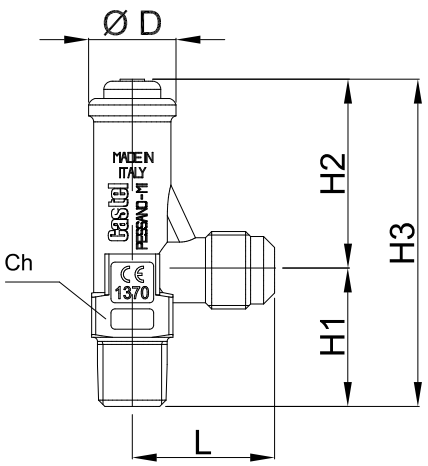
VALVE INSTALLATION

Safety valves type 3060 do NOT guarantee repeatable performance. This means that, after the valves have operated, open/close, the initial setting conditions are NOT maintained.

To calculate the pressure loss in either the upstream line (between vessel and safety valve) or the downstream line (between safety valve and atmosphere) refer to Chapter 5 "Selection Criteria for Safety Valves" in this technical handbook.

TABLE 5: General Characteristics of valves 3060								
Catalogue Number		3060/23C	3060/24C	3060/33C	3060/34C	3060/45C	3060/36C	3060/46C
Connections	Inlet male	1/4" NPT	1/4" NPT	3/8" NPT	3/8" NPT	1/2" NPT	3/8" NPT	1/2" NPT
	Outlet male	3/8" SAE	1/2" SAE	3/8" SAE	1/2" SAE	5/8" SAE	3/4" G	3/4" G
Inlet connection wrench torque (min/max) [Nm]		10/15	10/15	14/20	14/20	21/30	14/20	21/30
Flow Diameter [mm]		7,0				9,5	10,0	
Flow Section [mm2]		38,5				70,9	78,5	
Discharge Coefficient "Kd"		0,63	0,69	0,63	0,69	0,45	0,92	0,93
PS [bar]		55						
TS [°C]		- 50 / + 120						
TA [°C]		- 40 / + 50						
Set Pressure Range at atmospheric back pressure Pset [bar]		9 / 50						
Overpressure		+ 10 % of Pset						
Blowdown		- 50 % of Pset				- 40 % of Pset		
Helium tightness		80 % di Pset (9 bar < Pset < 31 bar)						
		90 % di Pset (31,1 bar < Pset < 50 bar)						
Estimated service life		5 years						
Risk Category according to PED Recast		IV						

TABLE 6: Dimensions and Weights of valves 3060							
Catalogue Number	Dimensions [mm]						Weight [g]
	Ø D	L	Ch	H_1	H_2	H_3	
3060/23C	21,5	35	20	33,5	46,5	80	180
3060/24C	21,5	35	20	33,5	46,5	80	195
3060/33C	21,5	35	20	33,5	46,5	80	195
3060/34C	21,5	35	20	33,5	46,5	80	195
3060/45C	24,5	39,0	23	37	52,5	89	240
3060/36C	30	40	27	37	59,5	96,5	360
3060/46C	30	40	27	40	59,5	99,5	380



3060/23C
3060/24C
3060/33C
3060/34C
3060/45C
3060/36C
3060/46C

TABLE 7: Maximum discharge capacity of valves 3060/23 ; 3060/33

Pset [bar]	Po [barsass]	R134a		R22		R404A		R407C		R410A		R448A	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	49,8	462	33,7	433	27,0	768	33,9	432	16,5	414	31,1	436
12,0	14,2	53,0	503	36,9	470	30,2	837	36,9	470	19,4	450	34,1	474
13,0	15,3	56,0	545	39,9	508	33,1	908	39,7	508	22,1	487	36,9	513
14,0	16,4	58,9	587	42,8	546	35,9	979	42,4	547	24,7	524	39,6	553
15,0	17,5	61,7	630	45,5	585	38,5	1051	44,9	586	27,2	561	42,1	591
16,0	18,6	64,3	673	48,1	624	41,0	1125	47,3	626	29,5	599	44,6	632
17,0	19,7	66,8	718	50,6	663	43,4	1201	49,6	666	31,8	637	46,9	675
18,0	20,8	69,2	763	53,0	703	45,7	1278	51,8	707	33,9	676	49,1	713
19,0	21,9	71,5	809	55,3	743	48,0	1357	54,0	748	36,0	715	51,2	758
20,0	23,0	73,7	856	57,5	784	50,1	1439	56,0	790	37,9	755	53,3	798
21,0	24,1	75,9	904	59,7	825	52,1	1522	58,0	833	39,9	796	55,2	841
22,0	25,2	77,9	953	61,7	867	54,1	1608	59,9	876	41,7	837	57,1	887
23,0	26,3	79,9	1004	63,7	910	56,0	1698	61,7	921	43,5	879	58,9	935
24,0	27,4	81,9	1056	65,7	953	57,9	1790	63,4	966	45,2	921	60,7	981
25,0	28,5	83,7	1110	67,6	997	59,7	1887	65,2	1012	46,9	965	62,4	1030
26,0	29,6	85,6	1165	69,4	1042	61,4	1988	66,8	1059	48,5	1009	64,1	1074
27,0	30,7	87,3	1223	71,2	1088	63,1	2096	68,4	1108	50,1	1054	65,7	1130
28,0	31,8	89,0	1283	72,9	1134	64,7	2211	70,0	1157	51,6	1100	67,2	1180
29,0	32,9	90,7	1346	74,6	1182	66,3	2336	71,5	1208	53,1	1147	68,7	1233
30,0	34,0	92,3	1413	76,2	1230	67,8	2475	72,9	1261	54,6	1196	70,2	1290
31,0	35,1	93,9	1484	77,8	1280	69,3	2637	74,4	1315	56,0	1246	71,6	1337
32,0	36,2	95,4	1562	79,4	1332	70,7	2845	75,7	1372	57,4	1297	73,0	1401
33,0	37,3	96,9	1649	80,9	1384	72,1	3294	77,1	1431	58,7	1350	74,3	1471
34,0	38,4	98,3	1750	82,4	1439			78,4	1493	60,1	1405	75,6	1529
35,0	39,5	99,2	1837	83,9	1495			79,7	1558	61,4	1463	76,9	1610
36,0	40,6	99,5	1883	85,3	1554			80,9	1628	62,6	1523	78,1	1677
37,0	41,7	99,7	1932	86,7	1616			82,1	1703	63,8	1586	79,2	1776
38,0	42,8			88,0	1681			83,2	1787	65,0	1654	80,3	1887
39,0	43,9			89,4	1750			84,3	1883	66,2	1727		
40,0	45,0			90,7	1825			85,3	2003	67,4	1806		
41,0	46,1			92,0	1907			86,1	2201	68,5	1896		
42,0	47,2			93,2	2000					69,6	2004		
43,0	48,3			94,4	2114					70,7	2152		
44,0	49,4			95,6	2286								
45,0	50,5												
46,0	51,6												
47,0	52,7												
48,0	53,8												
49,0	54,9												
50,0	56,0												
51,0	57,1												
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

Continued

TABLE 7: Maximum discharge capacity of valves 3060/23 ; 3060/33

Pset [bar]	Po [barsass]	R449A		R450A		R452A		R507		R1234ze		R744 (CO2)	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	31,0	438	55,2	473	28,7	479	25,8	475	61,1	474	-32,5	349
12,0	14,2	34,0	477	58,5	516	31,8	521	28,9	517	64,5	517	-30,2	379
13,0	15,3	36,9	516	61,7	557	34,6	564	31,9	561	67,7	560	-27,9	408
14,0	16,4	39,5	556	64,6	602	37,4	608	34,7	605	70,8	604	-25,8	438
15,0	17,5	42,1	596	67,5	646	39,9	652	37,3	650	73,7	649	-23,8	468
16,0	18,6	44,5	636	70,1	690	42,4	698	39,8	695	76,5	694	-21,8	498
17,0	19,7	46,8	678	72,7	737	44,7	744	42,2	742	79,1	741	-20,0	528
18,0	20,8	49,1	719	75,2	784	47,0	790	44,5	790	81,7	789	-18,2	559
19,0	21,9	51,2	762	77,5	830	49,1	838	46,8	839	84,1	838	-16,5	589
20,0	23,0	53,2	805	79,8	880	51,2	887	48,9	889	86,4	888	-14,9	620
21,0	24,1	55,2	849	82,0	933	53,2	937	50,9	941	88,7	940	-13,3	651
22,0	25,2	57,1	894	84,1	983	55,1	988	52,9	995	90,9	994	-11,7	682
23,0	26,3	58,9	940	86,2	1037	57,0	1040	54,8	1050	93,0	1050	-10,2	713
24,0	27,4	60,7	987	88,1	1096	58,7	1094	56,7	1108	95,0	1107	-8,8	745
25,0	28,5	62,4	1035	90,1	1149	60,5	1150	58,5	1168	97,0	1168	-7,4	777
26,0	29,6	64,1	1084	91,9	1206	62,1	1208	60,2	1231	98,9	1232	-6,0	809
27,0	30,7	65,7	1134	93,7	1280	63,7	1268	61,9	1298	100,7	1300	-4,7	841
28,0	31,8	67,2	1186	95,4	1348	65,3	1331	63,5	1370	102,5	1374	-3,4	874
29,0	32,9	68,7	1240	97,1	1421	66,8	1397	65,1	1449	104,3	1455	-2,2	906
30,0	34,0	70,2	1295	98,8	1482	68,3	1468	66,6	1538	106,0	1548	-0,9	940
31,0	35,1	71,6	1353	100,3	1569	69,7	1546	68,1	1643	107,6	1663	0,3	973
32,0	36,2	73,0	1414	101,9	1693	68,3	4047	69,6	1785	109,2	1865	1,4	1007
33,0	37,3	74,3	1474			72,3	1723					2,6	1041
34,0	38,4	75,6	1548			73,5	1838					3,7	1075
35,0	39,5	76,9	1622									4,8	1110
36,0	40,6	78,1	1703									5,9	1145
37,0	41,7	79,2	1795									6,9	1181
38,0	42,8	80,3	1906									8,0	1217
39,0	43,9	80,7	2396									9,0	1253
40,0	45,0											10,0	1290
41,0	46,1											11,0	1328
42,0	47,2											11,9	1366
43,0	48,3											12,9	1404
44,0	49,4											13,8	1443
45,0	50,5											14,7	1483
46,0	51,6											15,6	1523
47,0	52,7											16,5	1565
48,0	53,8											17,3	1607
49,0	54,9											18,2	1649
50,0	56,0											19,0	1693
51,0	57,1												
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

TABLE 8: Maximum discharge capacity of valves 3060/24 ; 3060/34

Pset [bar]	Po [barsass]	R134a		R22		R404A		R407C		R410A		R448A	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	49,8	506	33,7	474	27,0	768	33,9	473	16,5	453	31,1	477
12,0	14,2	53,0	551	36,9	515	30,2	837	36,9	514	19,4	493	34,1	519
13,0	15,3	56,0	597	39,9	556	33,1	908	39,7	556	22,1	533	36,9	562
14,0	16,4	58,9	643	42,8	598	35,9	979	42,4	599	24,7	573	39,6	605
15,0	17,5	61,7	690	45,5	640	38,5	1051	44,9	642	27,2	614	42,1	647
16,0	18,6	64,3	737	48,1	683	41,0	1125	47,3	685	29,5	656	44,6	693
17,0	19,7	66,8	786	50,6	726	43,4	1201	49,6	729	31,8	698	46,9	739
18,0	20,8	69,2	835	53,0	770	45,7	1278	51,8	774	33,9	740	49,1	781
19,0	21,9	71,5	886	55,3	814	48,0	1357	54,0	819	36,0	783	51,2	831
20,0	23,0	73,7	937	57,5	859	50,1	1439	56,0	865	37,9	827	53,3	875
21,0	24,1	75,9	990	59,7	904	52,1	1522	58,0	912	39,9	871	55,2	921
22,0	25,2	77,9	1044	61,7	950	54,1	1608	59,9	960	41,7	916	57,1	971
23,0	26,3	79,9	1099	63,7	996	56,0	1698	61,7	1008	43,5	962	58,9	1024
24,0	27,4	81,9	1156	65,7	1044	57,9	1790	63,4	1058	45,2	1009	60,7	1075
25,0	28,5	83,7	1215	67,6	1092	59,7	1887	65,2	1109	46,9	1056	62,4	1128
26,0	29,6	85,6	1276	69,4	1141	61,4	1988	66,8	1160	48,5	1105	64,1	1176
27,0	30,7	87,3	1339	71,2	1191	63,1	2096	68,4	1213	50,1	1154	65,7	1237
28,0	31,8	89,0	1405	72,9	1242	64,7	2211	70,0	1268	51,6	1205	67,2	1292
29,0	32,9	90,7	1474	74,6	1294	66,3	2336	71,5	1323	53,1	1257	68,7	1350
30,0	34,0	92,3	1547	76,2	1348	67,8	2475	72,9	1381	54,6	1310	70,2	1412
31,0	35,1	93,9	1626	77,8	1402	69,3	2637	74,4	1441	56,0	1364	71,6	1464
32,0	36,2	95,4	1711	79,4	1458	70,7	2845	75,7	1503	57,4	1421	73,0	1535
33,0	37,3	96,9	1806	80,9	1516	72,1	3294	77,1	1567	58,7	1479	74,3	1611
34,0	38,4	98,3	1916	82,4	1576			78,4	1635	60,1	1539	75,6	1674
35,0	39,5	99,2	2011	83,9	1638			79,7	1706	61,4	1602	76,9	1764
36,0	40,6	99,5	2063	85,3	1702			80,9	1783	62,6	1668	78,1	1837
37,0	41,7	99,7	2116	86,7	1770			82,1	1865	63,8	1737	79,2	1945
38,0	42,8			88,0	1841			83,2	1957	65,0	1811	80,3	2066
39,0	43,9			89,4	1917			84,3	2062	66,2	1891		
40,0	45,0			90,7	1998			85,3	2194	67,4	1978		
41,0	46,1			92,0	2088			86,1	2410	68,5	2077		
42,0	47,2			93,2	2191					69,6	2195		
43,0	48,3			94,4	2315					70,7	2357		
44,0	49,4			95,6	2503								
45,0	50,5												
46,0	51,6												
47,0	52,7												
48,0	53,8												
49,0	54,9												
50,0	56,0												
51,0	57,1												
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

Continued

TABLE 8: Maximum discharge capacity of valves 3060/24 ; 3060/34

Pset [bar]	Po [barsass]	R449A		R450A		R452A		R507		R1234ze		R744 (CO2)	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	31,0	480	55,2	518	28,7	524	25,8	520	61,1	519	-32,5	383
12,0	14,2	34,0	522	58,5	565	31,8	571	28,9	567	64,5	566	-30,2	415
13,0	15,3	36,9	565	61,7	610	34,6	618	31,9	614	67,7	613	-27,9	447
14,0	16,4	39,5	609	64,6	660	37,4	666	34,7	662	70,8	661	-25,8	480
15,0	17,5	42,1	652	67,5	707	39,9	715	37,3	711	73,7	710	-23,8	513
16,0	18,6	44,5	697	70,1	755	42,4	764	39,8	762	76,5	761	-21,8	545
17,0	19,7	46,8	742	72,7	807	44,7	814	42,2	813	79,1	812	-20,0	579
18,0	20,8	49,1	788	75,2	859	47,0	866	44,5	865	81,7	864	-18,2	612
19,0	21,9	51,2	834	77,5	909	49,1	918	46,8	919	84,1	918	-16,5	645
20,0	23,0	53,2	882	79,8	963	51,2	971	48,9	974	86,4	973	-14,9	679
21,0	24,1	55,2	930	82,0	1022	53,2	1026	50,9	1031	88,7	1030	-13,3	713
22,0	25,2	57,1	979	84,1	1077	55,1	1082	52,9	1089	90,9	1089	-11,7	747
23,0	26,3	58,9	1029	86,2	1136	57,0	1139	54,8	1150	93,0	1149	-10,2	781
24,0	27,4	60,7	1081	88,1	1200	58,7	1198	56,7	1213	95,0	1213	-8,8	816
25,0	28,5	62,4	1133	90,1	1258	60,5	1259	58,5	1279	97,0	1279	-7,4	851
26,0	29,6	64,1	1187	91,9	1320	62,1	1323	60,2	1348	98,9	1349	-6,0	886
27,0	30,7	65,7	1242	93,7	1402	63,7	1389	61,9	1422	100,7	1424	-4,7	921
28,0	31,8	67,2	1299	95,4	1476	65,3	1458	63,5	1501	102,5	1504	-3,4	957
29,0	32,9	68,7	1358	97,1	1556	66,8	1530	65,1	1587	104,3	1593	-2,2	993
30,0	34,0	70,2	1418	98,8	1623	68,3	1608	66,6	1684	106,0	1695	-0,9	1029
31,0	35,1	71,6	1481	100,3	1719	69,7	1693	68,1	1799	107,6	1821	0,3	1066
32,0	36,2	73,0	1549	101,9	1854	68,3	4432	69,6	1955	109,2	2043	1,4	1103
33,0	37,3	74,3	1615			72,3	1887					2,6	1140
34,0	38,4	75,6	1695			73,5	2013					3,7	1178
35,0	39,5	76,9	1776									4,8	1216
36,0	40,6	78,1	1865									5,9	1254
37,0	41,7	79,2	1966									6,9	1293
38,0	42,8	80,3	2088									8,0	1333
39,0	43,9	80,7	2624									9,0	1373
40,0	45,0											10,0	1413
41,0	46,1											11,0	1454
42,0	47,2											11,9	1496
43,0	48,3											12,9	1538
44,0	49,4											13,8	1581
45,0	50,5											14,7	1624
46,0	51,6											15,6	1668
47,0	52,7											16,5	1714
48,0	53,8											17,3	1759
49,0	54,9											18,2	1806
50,0	56,0											19,0	1854
51,0	57,1												
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

TABLE 9: Maximum discharge capacity of valves 3060/45

Pset [bar]	Po [barsass]	R134a		R22		R404A		R407C		R410A		R448A	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	49,8	607	33,7	569	27,0	768	33,9	567	16,5	544	31,1	573
12,0	14,2	53,0	661	36,9	618	30,2	837	36,9	617	19,4	591	34,1	622
13,0	15,3	56,0	716	39,9	667	33,1	908	39,7	667	22,1	639	36,9	674
14,0	16,4	58,9	771	42,8	718	35,9	979	42,4	718	24,7	688	39,6	726
15,0	17,5	61,7	827	45,5	768	38,5	1051	44,9	770	27,2	737	42,1	776
16,0	18,6	64,3	885	48,1	819	41,0	1125	47,3	822	29,5	787	44,6	831
17,0	19,7	66,8	943	50,6	871	43,4	1201	49,6	875	31,8	837	46,9	886
18,0	20,8	69,2	1002	53,0	923	45,7	1278	51,8	928	33,9	888	49,1	937
19,0	21,9	71,5	1063	55,3	976	48,0	1357	54,0	983	36,0	940	51,2	996
20,0	23,0	73,7	1124	57,5	1030	50,1	1439	56,0	1038	37,9	992	53,3	1049
21,0	24,1	75,9	1188	59,7	1084	52,1	1522	58,0	1094	39,9	1045	55,2	1105
22,0	25,2	77,9	1252	61,7	1139	54,1	1608	59,9	1151	41,7	1099	57,1	1165
23,0	26,3	79,9	1319	63,7	1195	56,0	1698	61,7	1210	43,5	1154	58,9	1229
24,0	27,4	81,9	1387	65,7	1252	57,9	1790	63,4	1269	45,2	1210	60,7	1289
25,0	28,5	83,7	1458	67,6	1310	59,7	1887	65,2	1330	46,9	1267	62,4	1353
26,0	29,6	85,6	1530	69,4	1369	61,4	1988	66,8	1392	48,5	1325	64,1	1411
27,0	30,7	87,3	1606	71,2	1429	63,1	2096	68,4	1455	50,1	1384	65,7	1484
28,0	31,8	89,0	1685	72,9	1490	64,7	2211	70,0	1520	51,6	1445	67,2	1550
29,0	32,9	90,7	1768	74,6	1552	66,3	2336	71,5	1587	53,1	1507	68,7	1620
30,0	34,0	92,3	1856	76,2	1616	67,8	2475	72,9	1657	54,6	1571	70,2	1694
31,0	35,1	93,9	1950	77,8	1682	69,3	2637	74,4	1728	56,0	1636	71,6	1756
32,0	36,2	95,4	2052	79,4	1749	70,7	2845	75,7	1802	57,4	1704	73,0	1841
33,0	37,3	96,9	2166	80,9	1819	72,1	3294	77,1	1880	58,7	1774	74,3	1933
34,0	38,4	98,3	2298	82,4	1890			78,4	1961	60,1	1846	75,6	2008
35,0	39,5	99,2	2413	83,9	1965			79,7	2047	61,4	1922	76,9	2116
36,0	40,6	99,5	2474	85,3	2042			80,9	2138	62,6	2001	78,1	2204
37,0	41,7	99,7	2538	86,7	2123			82,1	2238	63,8	2084	79,2	2333
38,0	42,8			88,0	2208			83,2	2347	65,0	2173	80,3	2478
39,0	43,9			89,4	2299			84,3	2474	66,2	2268		
40,0	45,0			90,7	2397			85,3	2631	67,4	2373		
41,0	46,1			92,0	2505			86,1	2891	68,5	2491		
42,0	47,2			93,2	2628					69,6	2633		
43,0	48,3			94,4	2777					70,7	2827		
44,0	49,4			95,6	3003								
45,0	50,5												
46,0	51,6												
47,0	52,7												
48,0	53,8												
49,0	54,9												
50,0	56,0												
51,0	57,1												
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

Continued

TABLE 9: Maximum discharge capacity of valves 3060/45

Pset [bar]	Po [barsass]	R449A		R450A		R452A		R507		R1234ze		R744 (CO2)	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	31,0	576	55,2	621	28,7	629	25,8	624	61,1	623	-32,5	459
12,0	14,2	34,0	627	58,5	678	31,8	685	28,9	680	64,5	679	-30,2	498
13,0	15,3	36,9	678	61,7	732	34,6	741	31,9	736	67,7	735	-27,9	537
14,0	16,4	39,5	730	64,6	791	37,4	799	34,7	794	70,8	793	-25,8	576
15,0	17,5	42,1	783	67,5	848	39,9	857	37,3	853	73,7	852	-23,8	615
16,0	18,6	44,5	836	70,1	906	42,4	916	39,8	914	76,5	912	-21,8	654
17,0	19,7	46,8	890	72,7	968	44,7	977	42,2	975	79,1	974	-20,0	694
18,0	20,8	49,1	945	75,2	1030	47,0	1038	44,5	1038	81,7	1037	-18,2	734
19,0	21,9	51,2	1001	77,5	1091	49,1	1101	46,8	1102	84,1	1101	-16,5	774
20,0	23,0	53,2	1058	79,8	1155	51,2	1165	48,9	1168	86,4	1167	-14,9	814
21,0	24,1	55,2	1116	82,0	1225	53,2	1230	50,9	1236	88,7	1235	-13,3	855
22,0	25,2	57,1	1174	84,1	1292	55,1	1298	52,9	1307	90,9	1306	-11,7	896
23,0	26,3	58,9	1235	86,2	1363	57,0	1367	54,8	1379	93,0	1379	-10,2	937
24,0	27,4	60,7	1296	88,1	1440	58,7	1437	56,7	1455	95,0	1455	-8,8	979
25,0	28,5	62,4	1359	90,1	1509	60,5	1511	58,5	1534	97,0	1534	-7,4	1020
26,0	29,6	64,1	1424	91,9	1584	62,1	1587	60,2	1617	98,9	1618	-6,0	1062
27,0	30,7	65,7	1490	93,7	1682	63,7	1666	61,9	1705	100,7	1708	-4,7	1105
28,0	31,8	67,2	1558	95,4	1770	65,3	1748	63,5	1800	102,5	1804	-3,4	1148
29,0	32,9	68,7	1629	97,1	1867	66,8	1835	65,1	1904	104,3	1911	-2,2	1191
30,0	34,0	70,2	1701	98,8	1947	68,3	1928	66,6	2020	106,0	2033	-0,9	1234
31,0	35,1	71,6	1777	100,3	2061	69,7	2031	68,1	2158	107,6	2184	0,3	1278
32,0	36,2	73,0	1858	101,9	2224	68,3	5316	69,6	2345	109,2	2450	1,4	1323
33,0	37,3	74,3	1937			72,3	2263					2,6	1367
34,0	38,4	75,6	2033			73,5	2415					3,7	1413
35,0	39,5	76,9	2131									4,8	1458
36,0	40,6	78,1	2237									5,9	1505
37,0	41,7	79,2	2358									6,9	1551
38,0	42,8	80,3	2504									8,0	1599
39,0	43,9	80,7	3148									9,0	1647
40,0	45,0											10,0	1695
41,0	46,1											11,0	1744
42,0	47,2											11,9	1794
43,0	48,3											12,9	1845
44,0	49,4											13,8	1896
45,0	50,5											14,7	1948
46,0	51,6											15,6	2001
47,0	52,7											16,5	2055
48,0	53,8											17,3	2110
49,0	54,9											18,2	2167
50,0	56,0											19,0	2224
51,0	57,1												
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

TABLE 10: Maximum discharge capacity of valves 3060/36

Pset [bar]	Po [barsass]	R134a		R22		R404A		R407C		R410A		R448A	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	49,8	1376	33,7	1289	27,0	768	33,9	1286	16,5	1232	31,1	1298
12,0	14,2	53,0	1498	36,9	1400	30,2	837	36,9	1398	19,4	1340	34,1	1410
13,0	15,3	56,0	1622	39,9	1513	33,1	908	39,7	1513	22,1	1449	36,9	1528
14,0	16,4	58,9	1748	42,8	1626	35,9	979	42,4	1628	24,7	1559	39,6	1645
15,0	17,5	61,7	1875	45,5	1741	38,5	1051	44,9	1745	27,2	1670	42,1	1760
16,0	18,6	64,3	2005	48,1	1857	41,0	1125	47,3	1863	29,5	1783	44,6	1883
17,0	19,7	66,8	2137	50,6	1974	43,4	1201	49,6	1983	31,8	1897	46,9	2009
18,0	20,8	69,2	2271	53,0	2093	45,7	1278	51,8	2104	33,9	2013	49,1	2124
19,0	21,9	71,5	2409	55,3	2213	48,0	1357	54,0	2228	36,0	2130	51,2	2258
20,0	23,0	73,7	2549	57,5	2334	50,1	1439	56,0	2353	37,9	2249	53,3	2378
21,0	24,1	75,9	2692	59,7	2457	52,1	1522	58,0	2480	39,9	2369	55,2	2504
22,0	25,2	77,9	2838	61,7	2582	54,1	1608	59,9	2610	41,7	2492	57,1	2640
23,0	26,3	79,9	2989	63,7	2709	56,0	1698	61,7	2742	43,5	2616	58,9	2785
24,0	27,4	81,9	3144	65,7	2838	57,9	1790	63,4	2876	45,2	2743	60,7	2922
25,0	28,5	83,7	3304	67,6	2969	59,7	1887	65,2	3014	46,9	2872	62,4	3067
26,0	29,6	85,6	3469	69,4	3103	61,4	1988	66,8	3154	48,5	3004	64,1	3199
27,0	30,7	87,3	3641	71,2	3238	63,1	2096	68,4	3298	50,1	3138	65,7	3364
28,0	31,8	89,0	3820	72,9	3377	64,7	2211	70,0	3446	51,6	3276	67,2	3513
29,0	32,9	90,7	4008	74,6	3519	66,3	2336	71,5	3598	53,1	3417	68,7	3671
30,0	34,0	92,3	4207	76,2	3664	67,8	2475	72,9	3755	54,6	3561	70,2	3840
31,0	35,1	93,9	4420	77,8	3812	69,3	2637	74,4	3917	56,0	3709	71,6	3981
32,0	36,2	95,4	4651	79,4	3965	70,7	2845	75,7	4085	57,4	3862	73,0	4172
33,0	37,3	96,9	4909	80,9	4122	72,1	3294	77,1	4261	58,7	4021	74,3	4380
34,0	38,4	98,3	5210	82,4	4285			78,4	4445	60,1	4185	75,6	4552
35,0	39,5	99,2	5469	83,9	4453			79,7	4639	61,4	4356	76,9	4795
36,0	40,6	99,5	5608	85,3	4628			80,9	4847	62,6	4535	78,1	4995
37,0	41,7	99,7	5753	86,7	4812			82,1	5072	63,8	4724	79,2	5287
38,0	42,8			88,0	5005			83,2	5321	65,0	4925	80,3	5618
39,0	43,9			89,4	5211			84,3	5607	66,2	5141		
40,0	45,0			90,7	5433			85,3	5964	67,4	5378		
41,0	46,1			92,0	5677			86,1	6552	68,5	5647		
42,0	47,2			93,2	5956					69,6	5967		
43,0	48,3			94,4	6295					70,7	6408		
44,0	49,4			95,6	6806								
45,0	50,5												
46,0	51,6												
47,0	52,7												
48,0	53,8												
49,0	54,9												
50,0	56,0												
51,0	57,1												
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

Continued

TABLE 10: Maximum discharge capacity of valves 3060/36

Pset [bar]	Po [barsass]	R449A		R450A		R452A		R507		R1234ze		R744 (CO2)	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	31,0	1305	55,2	1407	28,7	1426	25,8	1413	61,1	1411	-32,5	1040
12,0	14,2	34,0	1420	58,5	1536	31,8	1552	28,9	1540	64,5	1538	-30,2	1128
13,0	15,3	36,9	1537	61,7	1659	34,6	1680	31,9	1669	67,7	1667	-27,9	1216
14,0	16,4	39,5	1654	64,6	1793	37,4	1811	34,7	1801	70,8	1798	-25,8	1305
15,0	17,5	42,1	1774	67,5	1923	39,9	1943	37,3	1934	73,7	1932	-23,8	1394
16,0	18,6	44,5	1895	70,1	2054	42,4	2077	39,8	2071	76,5	2068	-21,8	1483
17,0	19,7	46,8	2017	72,7	2195	44,7	2214	42,2	2210	79,1	2207	-20,0	1573
18,0	20,8	49,1	2142	75,2	2336	47,0	2353	44,5	2352	81,7	2349	-18,2	1663
19,0	21,9	51,2	2269	77,5	2472	49,1	2495	46,8	2498	84,1	2495	-16,5	1754
20,0	23,0	53,2	2397	79,8	2619	51,2	2640	48,9	2648	86,4	2645	-14,9	1846
21,0	24,1	55,2	2528	82,0	2778	53,2	2789	50,9	2802	88,7	2800	-13,3	1938
22,0	25,2	57,1	2662	84,1	2928	55,1	2941	52,9	2961	90,9	2960	-11,7	2031
23,0	26,3	58,9	2798	86,2	3089	57,0	3097	54,8	3126	93,0	3125	-10,2	2124
24,0	27,4	60,7	2938	88,1	3264	58,7	3258	56,7	3298	95,0	3297	-8,8	2218
25,0	28,5	62,4	3081	90,1	3421	60,5	3424	58,5	3477	97,0	3478	-7,4	2313
26,0	29,6	64,1	3227	91,9	3590	62,1	3596	60,2	3665	98,9	3668	-6,0	2408
27,0	30,7	65,7	3377	93,7	3812	63,7	3775	61,9	3865	100,7	3871	-4,7	2504
28,0	31,8	67,2	3532	95,4	4012	65,3	3963	63,5	4080	102,5	4090	-3,4	2601
29,0	32,9	68,7	3691	97,1	4231	66,8	4160	65,1	4315	104,3	4331	-2,2	2699
30,0	34,0	70,2	3856	98,8	4413	68,3	4371	66,6	4579	106,0	4608	-0,9	2798
31,0	35,1	71,6	4028	100,3	4672	69,7	4603	68,1	4892	107,6	4951	0,3	2897
32,0	36,2	73,0	4211	101,9	5042	68,3	12049	69,6	5315	109,2	5554	1,4	2998
33,0	37,3	74,3	4390			72,3	5130					2,6	3099
34,0	38,4	75,6	4608			73,5	5474					3,7	3202
35,0	39,5	76,9	4829									4,8	3306
36,0	40,6	78,1	5070									5,9	3410
37,0	41,7	79,2	5344									6,9	3516
38,0	42,8	80,3	5677									8,0	3624
39,0	43,9	80,7	7134									9,0	3732
40,0	45,0											10,0	3842
41,0	46,1											11,0	3953
42,0	47,2											11,9	4066
43,0	48,3											12,9	4181
44,0	49,4											13,8	4297
45,0	50,5											14,7	4416
46,0	51,6											15,6	4536
47,0	52,7											16,5	4659
48,0	53,8											17,3	4784
49,0	54,9											18,2	4911
50,0	56,0											19,0	5041
51,0	57,1												
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

TABLE 11: Maximum discharge capacity of valves 3060/46

Pset [bar]	Po [barsass]	R134a		R22		R404A		R407C		R410A		R448A	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	49,8	1391	33,7	1303	27,0	768	33,9	1300	16,5	1246	31,1	1312
12,0	14,2	53,0	1514	36,9	1415	30,2	837	36,9	1414	19,4	1355	34,1	1425
13,0	15,3	56,0	1639	39,9	1529	33,1	908	39,7	1529	22,1	1465	36,9	1544
14,0	16,4	58,9	1767	42,8	1644	35,9	979	42,4	1646	24,7	1576	39,6	1663
15,0	17,5	61,7	1896	45,5	1760	38,5	1051	44,9	1764	27,2	1689	42,1	1779
16,0	18,6	64,3	2027	48,1	1877	41,0	1125	47,3	1883	29,5	1802	44,6	1904
17,0	19,7	66,8	2160	50,6	1996	43,4	1201	49,6	2004	31,8	1918	46,9	2031
18,0	20,8	69,2	2296	53,0	2115	45,7	1278	51,8	2127	33,9	2035	49,1	2147
19,0	21,9	71,5	2435	55,3	2237	48,0	1357	54,0	2252	36,0	2153	51,2	2283
20,0	23,0	73,7	2576	57,5	2360	50,1	1439	56,0	2378	37,9	2273	53,3	2403
21,0	24,1	75,9	2721	59,7	2484	52,1	1522	58,0	2507	39,9	2395	55,2	2532
22,0	25,2	77,9	2869	61,7	2610	54,1	1608	59,9	2638	41,7	2519	57,1	2668
23,0	26,3	79,9	3022	63,7	2739	56,0	1698	61,7	2772	43,5	2645	58,9	2815
24,0	27,4	81,9	3178	65,7	2869	57,9	1790	63,4	2908	45,2	2773	60,7	2954
25,0	28,5	83,7	3340	67,6	3001	59,7	1887	65,2	3047	46,9	2903	62,4	3101
26,0	29,6	85,6	3507	69,4	3136	61,4	1988	66,8	3189	48,5	3036	64,1	3233
27,0	30,7	87,3	3680	71,2	3274	63,1	2096	68,4	3334	50,1	3172	65,7	3401
28,0	31,8	89,0	3861	72,9	3414	64,7	2211	70,0	3484	51,6	3311	67,2	3551
29,0	32,9	90,7	4051	74,6	3557	66,3	2336	71,5	3637	53,1	3454	68,7	3711
30,0	34,0	92,3	4253	76,2	3704	67,8	2475	72,9	3796	54,6	3599	70,2	3882
31,0	35,1	93,9	4468	77,8	3854	69,3	2637	74,4	3960	56,0	3750	71,6	4024
32,0	36,2	95,4	4702	79,4	4008	70,7	2845	75,7	4130	57,4	3904	73,0	4218
33,0	37,3	96,9	4962	80,9	4167	72,1	3294	77,1	4307	58,7	4064	74,3	4428
34,0	38,4	98,3	5266	82,4	4331			78,4	4493	60,1	4230	75,6	4601
35,0	39,5	99,2	5528	83,9	4501			79,7	4690	61,4	4403	76,9	4847
36,0	40,6	99,5	5669	85,3	4679			80,9	4900	62,6	4584	78,1	5049
37,0	41,7	99,7	5816	86,7	4864			82,1	5127	63,8	4775	79,2	5345
38,0	42,8			88,0	5059			83,2	5379	65,0	4978	80,3	5679
39,0	43,9			89,4	5267			84,3	5668	66,2	5197		
40,0	45,0			90,7	5492			85,3	6029	67,4	5437		
41,0	46,1			92,0	5739			86,1	6624	68,5	5708		
42,0	47,2			93,2	6020					69,6	6032		
43,0	48,3			94,4	6364					70,7	6478		
44,0	49,4			95,6	6880								
45,0	50,5												
46,0	51,6												
47,0	52,7												
48,0	53,8												
49,0	54,9												
50,0	56,0												
51,0	57,1												
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

Continued

TABLE 11: Maximum discharge capacity of valves 3060/46

Pset [bar]	Po [barsass]	R449A		R450A		R452A		R507		R1234ze		R744 (CO2)	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	31,0	1320	55,2	1423	28,7	1441	25,8	1429	61,1	1427	-32,5	1052
12,0	14,2	34,0	1436	58,5	1553	31,8	1569	28,9	1557	64,5	1555	-30,2	1140
13,0	15,3	36,9	1553	61,7	1677	34,6	1699	31,9	1687	67,7	1685	-27,9	1229
14,0	16,4	39,5	1672	64,6	1813	37,4	1830	34,7	1820	70,8	1818	-25,8	1319
15,0	17,5	42,1	1793	67,5	1944	39,9	1964	37,3	1955	73,7	1953	-23,8	1409
16,0	18,6	44,5	1915	70,1	2076	42,4	2100	39,8	2093	76,5	2090	-21,8	1499
17,0	19,7	46,8	2039	72,7	2219	44,7	2238	42,2	2234	79,1	2231	-20,0	1590
18,0	20,8	49,1	2165	75,2	2361	47,0	2379	44,5	2378	81,7	2375	-18,2	1681
19,0	21,9	51,2	2293	77,5	2499	49,1	2523	46,8	2525	84,1	2523	-16,5	1773
20,0	23,0	53,2	2423	79,8	2647	51,2	2669	48,9	2677	86,4	2674	-14,9	1866
21,0	24,1	55,2	2556	82,0	2808	53,2	2819	50,9	2833	88,7	2830	-13,3	1959
22,0	25,2	57,1	2691	84,1	2960	55,1	2973	52,9	2994	90,9	2992	-11,7	2053
23,0	26,3	58,9	2829	86,2	3123	57,0	3131	54,8	3160	93,0	3159	-10,2	2147
24,0	27,4	60,7	2970	88,1	3299	58,7	3294	56,7	3334	95,0	3333	-8,8	2242
25,0	28,5	62,4	3114	90,1	3459	60,5	3462	58,5	3515	97,0	3516	-7,4	2338
26,0	29,6	64,1	3262	91,9	3629	62,1	3636	60,2	3705	98,9	3708	-6,0	2434
27,0	30,7	65,7	3414	93,7	3853	63,7	3817	61,9	3907	100,7	3913	-4,7	2532
28,0	31,8	67,2	3570	95,4	4056	65,3	4006	63,5	4124	102,5	4134	-3,4	2630
29,0	32,9	68,7	3732	97,1	4278	66,8	4206	65,1	4362	104,3	4379	-2,2	2729
30,0	34,0	70,2	3898	98,8	4461	68,3	4418	66,6	4629	106,0	4658	-0,9	2828
31,0	35,1	71,6	4072	100,3	4723	69,7	4654	68,1	4945	107,6	5005	0,3	2929
32,0	36,2	73,0	4257	101,9	5097	68,3	12180	69,6	5373	109,2	5614	1,4	3031
33,0	37,3	74,3	4438			72,3	5186					2,6	3133
34,0	38,4	75,6	4658			73,5	5533					3,7	3237
35,0	39,5	76,9	4882									4,8	3342
36,0	40,6	78,1	5126									5,9	3448
37,0	41,7	79,2	5403									6,9	3555
38,0	42,8	80,3	5738									8,0	3663
39,0	43,9	80,7	7212									9,0	3773
40,0	45,0											10,0	3884
41,0	46,1											11,0	3996
42,0	47,2											11,9	4111
43,0	48,3											12,9	4227
44,0	49,4											13,8	4344
45,0	50,5											14,7	4464
46,0	51,6											15,6	4586
47,0	52,7											16,5	4709
48,0	53,8											17,3	4836
49,0	54,9											18,2	4965
50,0	56,0											19,0	5096
51,0	57,1												
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

CHAPTER 3
SAFETY VALVES IN SERIES 3061

GENERAL DESCRIPTION

The valves in series 3061 are unbalanced, conventional direct-loaded safety valves. The valve is opened by the thrust from the fluid under pressure below the shutter, when said thrust exceeds, under the calibrated conditions, the opposing force of the spring acting on the shutter.
Valves are identified by means of:

- a model number formed of an alphanumerical code that includes:
  - the family identity (for ex. 3061/3)
  - the type of inlet connection (for ex. C = NPT)
  - the set pressure, expressed in bar, multiplied by 10 (for ex. 200)
- an alphanumerical serial number.

CONSTRUCTION

Body: squared, obtained through hot moulding and subsequent machining. It houses the following elements:

- the nozzle with flat sealing seat
- the shutter guide
- the set spring slot
- the threaded seat of the setting adjustment ring nut

In the body, above the shutter guide, a small pressure relief hole is provided through which the spring slot communicates with the exit connection. For this reason, during relief, there is a no gas leak through this orifice.
Material used: EN 12420-CW617N brass

Shutter: obtained through machining from bar stock and fit with gasket, it ensures the required degree of tightness on the valve seat. The gasket is made from modified PTFE (Polytetrafluorethylene), a material that, during the valve's estimated service life, maintains good strength and does not cause the shutter to stick on the seat. The shutter is properly guided in the body and the guide action cannot fail. There are no glands or retaining rings that hamper its movement.
Material used: EN 12164-CW614N brass

Spring: it opposes the pressure and the fluid dynamic forces, and always ensures closing of the valve following pressure relief. When the shutter has reached the maximum height determined by the mechanical stop, the spring compression does not exceed 80% of the total compression. All the springs are compliant with the compression helical spring requirements defined in EN ISO 4126-7:2013.
Material used: EN 10270-2 - FD steel for springs.

Calibration system: hex-head threaded ring nut to be screwed inside the upper portion of the head, compressing the spring below. When calibration is complete, the position of the ring nut is maintained unchanged by applying to the threaded coupling a high mechanical strength and low viscosity bonding agent. The low viscosity promotes penetration. The calibration system is protected against subsequent tampering by means of a threaded cap nut, screwed on outside the brass body and blocked in place through re-flanging.

SCOPE

Use: protection against possible overpressure of the apparatuses listed below, with regard to the operating conditions for which they have been designed:

- Refrigeration system or heat pump components, for instance: condensers, liquid receivers, evaporators, liquid accumulators, positive displacement compressor discharge, heat exchangers, oil separators, or piping. (reference standard: EN 378-2:2016)
- Simple pressure vessels (reference Directive: 2009/105/EC)

Fluids: the valves in series 3061 can be used with:

a. Refrigerant fluids in vapour or gaseous state belonging to Group 2:
   - HCFC (R22)
   - HFC (R134a , R404A , R407C , R410A , R507)
   - HFO and HFO/HFC mixtures (R1234ze , R448A , R449A , R450A , and R452A)
   - R744

with reference to Article 13, Para. 1(b) of Directive 2014/68/EU (EC Regulation No. 1272/2008).

b. Refrigerant fluids in vapour or gaseous state belonging to Group 1:
- HFO (R1234yf)
- HC (R290 , R600 , R600a)

with reference to Article 13, Para. 1(a) of Directive 2014/68/EU (EC Regulation No. 1272/2008).

c. Air and nitrogen (reference Directive: 2009/105/EC)

For specific applications with refrigerant fluids not listed above, please contact Castel Technical Department.

MARKING

In compliance with the provisions of Article 19 of Directive 2014/68/EC, the following information is cast on the valve body:
- Manufacturer's mark
- Country of manufacturing
- Indication of flow direction
- Maximum allowable pressure

Again, on the body, the following information is laser marked:
- Valve model
- Serial number
- Set pressure
- Allowable temperature range
- Kd discharge coefficient
- Flow section
- Production date
- CE marking
- Identification number of the notified body involved in the production control phase

DOCUMENTATION

The safety valves in series 3061 are supplied with the following documentation provided in the packaging:
- operating instructions for the user, containing all information useful for safety in terms of assembly, commissioning, use, and maintenance.
- Compliance Statement for the equipment according to Directive 2014/68/EU, required in Article 17 and issued in compliance with Annex IV of the same directive.
- Calibration certificate for the safety valve, printed on the reverse side of the Compliance Statement.

N.B.: on the website: www.castel.it use the "Certifications" pull-down menu to access the web-page **"Castel Certification Download Center"**. On this page, you can download:
- the Compliance Statement / Calibration Certificate for each valve by entering the 7-digit alphanumeric serial number.
- the general Compliance Statement referring to a specific model of valve 3061 with a specific setting, for ex. 3061/2C250 or 3061/4C420.

VALVE SELECTION

Directive 2014/68/EC requires that pressure equipment, in which permissible limits are reasonably likely to be exceeded, shall be fitted with suitable protection devices, for instance safety devices such as safety valves. Such devices shall prevent pressure from permanently exceeding the maximum allowable pressure (PS) of the equipment they protect. In any case, a short pressure peak limited to 10% of maximum allowable pressure is permitted.
As to the selection and sizing of the suitable protection device, users shall refer to the specific product and sector standards listed below:

- EN ISO 4126-1: 2013: "Safety devices for protection against excessive pressure – Part 1: Safety valves" indicates the general requirements for safety valves regardless of the fluid for which they were designed.
- EN 378-2:2016 "Refrigerating systems and heat pumps – Safety and environmental requirements – Part 2: Design, construction, testing, marking and documentation" provides a general outline of the protection devices to be used in refrigerating systems and their characteristics (Para. 6.2.5) and the criteria for the selection of the device suitable for the type and size of the system component to be protected (Para. 6.2.6).
- EN 13136:2013: "Refrigerating systems and heat pumps – Pressure relief devices and their associated piping – Methods for calculation" highlights the possible causes of overpressure in a system and provides users with the tools for sizing pressure relief devices, among which safety valves.

To select the safety valves in series 3061, please see Chapter 5 "Selection Criteria for Safety Valves" in this technical handbook.
Table 14 provides the maximum discharge capacities of safety valves, models 3061/2, 3061/3 and 3061/4, as a function of various refrigerants and varying P_{set} for the valve, considering T_o = Steam saturation temperature at discharge pressure, P_o.

VALVE INSTALLATION

Safety valves type 3061 guarantee repeatable performance. This means that, after the valves have operated, open/close, the initial setting conditions are maintained. PNevertheless, it is advisable to replace a 3061 valve once it has discharged as during release debris, such as metal shavings or solder impurities, can deposit on the valve gasket. This can inhibit the safety valve from returning to its original conditions.

To calculate the pressure loss in either the upstream line (between vessel and safety valve) or the downstream line (between safety valve and atmosphere) refer to Chapter 5 "Selection Criteria for Safety Valves" in this technical handbook.

TABLE 12 : General Characteristics of valves 3061				
Catalogue Number		3061/2C	3061/3C	3061/4C
Connections	Inlet male	1/4" NPT	3/8" NPT	1/2" NPT
	Outlet male	3/8" G	1/2" G	1/2" G
Inlet connection wrench torque (min/max) [Nm]		10/15	14/20	21/30
Flow Diameter [mm]		7,5	7,5	7,5
Flow Section [mm2]		44,2	44,2	44,2
Lift [mm]		-	-	-
Discharge Coefficient "Kd"		0,89	0,89	0,89
PS [bar]		70		
TS [°C]		- 50 / + 150		
TA [°C]		- 40 / + 50		
Set Pressure Range at atmospheric back pressure Pset [bar]		11 / 60		
Overpressure		+ 10 % of Pset		
Blowdown		- 15 % of Pset		
Helium tightness		- 20 % of Pset (11 bar < Pset < 14 bar)		
		- 15 % of Pset (14,1 bar < Pset < 24 bar)		
		- 10 % of Pset (24,1 bar < Pset < 60 bar)		
Estimated service life		9 years		
Risk Category according to PED Recast		IV		

TABLE 13: Dimensions and Weights of valves 3061							
Catalogue Number	Dimensions [mm]						Weight [g]
	Ø D	L	Ch	H_1	H_2	H_3	
3061/2C	28,5	33,5	23	30	61	91	200
3061/3C	28,5	33,5	23	30	61	91	230
3061/4C	28,5	33,5	23	35	61	96	260

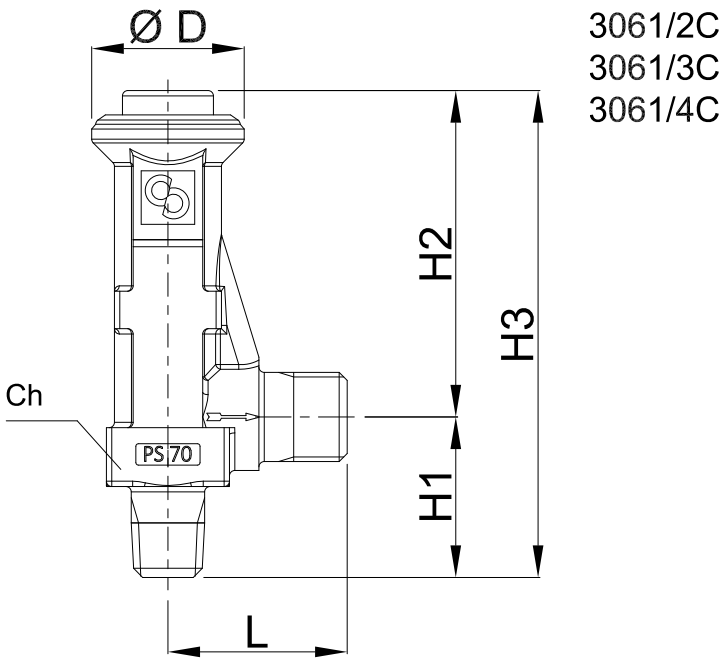


TABLE 14: Maximum discharge capacity of valves 3061

Pset [bar]	Po [barsass]	R134a		R22		R32		R404A		R407C		R410A	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	49,8	749	33,7	702	15,8	574	27,0	768	33,9	700	16,5	671
12,0	14,2	53,0	815	36,9	762	18,6	624	30,2	837	36,9	761	19,4	729
13,0	15,3	56,0	883	39,9	823	21,3	674	33,1	908	39,7	823	22,1	789
14,0	16,4	58,9	951	42,8	885	23,9	724	35,9	979	42,4	886	24,7	849
15,0	17,5	61,7	1021	45,5	948	26,3	775	38,5	1051	44,9	950	27,2	909
16,0	18,6	64,3	1091	48,1	1011	28,6	827	41,0	1125	47,3	1014	29,5	971
17,0	19,7	66,8	1163	50,6	1075	30,8	879	43,4	1201	49,6	1079	31,8	1033
18,0	20,8	69,2	1236	53,0	1139	33,0	931	45,7	1278	51,8	1145	33,9	1096
19,0	21,9	71,5	1311	55,3	1204	35,0	984	48,0	1357	54,0	1213	36,0	1159
20,0	23,0	73,7	1387	57,5	1271	37,0	1038	50,1	1439	56,0	1281	37,9	1224
21,0	24,1	75,9	1465	59,7	1338	38,9	1092	52,1	1522	58,0	1350	39,9	1290
22,0	25,2	77,9	1545	61,7	1406	40,7	1147	54,1	1608	59,9	1421	41,7	1356
23,0	26,3	79,9	1627	63,7	1475	42,5	1202	56,0	1698	61,7	1492	43,5	1424
24,0	27,4	81,9	1711	65,7	1545	44,2	1258	57,9	1790	63,4	1566	45,2	1493
25,0	28,5	83,7	1798	67,6	1616	45,8	1315	59,7	1887	65,2	1641	46,9	1563
26,0	29,6	85,6	1888	69,4	1689	47,4	1373	61,4	1988	66,8	1717	48,5	1635
27,0	30,7	87,3	1982	71,2	1763	49,0	1431	63,1	2096	68,4	1796	50,1	1708
28,0	31,8	89,0	2079	72,9	1838	50,5	1491	64,7	2211	70,0	1876	51,6	1783
29,0	32,9	90,7	2182	74,6	1915	52,0	1551	66,3	2336	71,5	1959	53,1	1860
30,0	34,0	92,3	2290	76,2	1994	53,5	1613	67,8	2475	72,9	2044	54,6	1938
31,0	35,1	93,9	2406	77,8	2075	54,9	1675	69,3	2637	74,4	2132	56,0	2019
32,0	36,2	95,4	2532	79,4	2158	56,3	1739	70,7	2845	75,7	2224	57,4	2102
33,0	37,3	96,9	2672	80,9	2244	57,6	1803	72,1	3294	77,1	2319	58,7	2189
34,0	38,4	98,3	2836	82,4	2332	58,9	1869			78,4	2419	60,1	2278
35,0	39,5	99,2	2977	83,9	2424	60,2	1937			79,7	2525	61,4	2371
36,0	40,6	99,5	3052	85,3	2519	61,5	2006			80,9	2638	62,6	2468
37,0	41,7	99,7	3132	86,7	2619	62,7	2077			82,1	2761	63,8	2571
38,0	42,8			88,0	2724	63,9	2149			83,2	2896	65,0	2681
39,0	43,9			89,4	2836	65,1	2224			84,3	3052	66,2	2798
40,0	45,0			90,7	2957	66,2	2301			85,3	3246	67,4	2928
41,0	46,1			92,0	3090	67,3	2381			86,1	3567	68,5	3074
42,0	47,2			93,2	3242	68,5	2463					69,6	3248
43,0	48,3			94,4	3427	69,5	2550					70,7	3488
44,0	49,4			95,6	3705	70,6	2640						
45,0	50,5					71,7	2735						
46,0	51,6					72,7	2836						
47,0	52,7					73,7	2945						
48,0	53,8					74,7	3065						
49,0	54,9					75,6	3201						
50,0	56,0					76,6	3364						
51,0	57,1					77,5	3593						
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

Continued

TABLE 14: Maximum discharge capacity of valves 3061

Pset [bar]	Po [barsass]	R448A		R449A		R450A		R452A		R507		R1234yf	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	31,1	707	31,0	711	55,2	766	28,7	776	25,8	769	50,2	791
12,0	14,2	34,1	768	34,0	773	58,5	836	31,8	845	28,9	838	53,7	862
13,0	15,3	36,9	832	36,9	836	61,7	903	34,6	915	31,9	909	56,9	935
14,0	16,4	39,6	896	39,5	901	64,6	976	37,4	986	34,7	980	59,9	1010
15,0	17,5	42,1	958	42,1	966	67,5	1047	39,9	1058	37,3	1053	62,9	1086
16,0	18,6	44,6	1025	44,5	1031	70,1	1118	42,4	1131	39,8	1127	65,6	1164
17,0	19,7	46,9	1093	46,8	1098	72,7	1195	44,7	1205	42,2	1203	68,3	1244
18,0	20,8	49,1	1156	49,1	1166	75,2	1271	47,0	1281	44,5	1280	70,8	1327
19,0	21,9	51,2	1229	51,2	1235	77,5	1346	49,1	1358	46,8	1360	73,2	1411
20,0	23,0	53,3	1294	53,2	1305	79,8	1426	51,2	1437	48,9	1441	75,6	1499
21,0	24,1	55,2	1363	55,2	1376	82,0	1512	53,2	1518	50,9	1525	77,8	1590
22,0	25,2	57,1	1437	57,1	1449	84,1	1594	55,1	1601	52,9	1612	80,0	1685
23,0	26,3	58,9	1516	58,9	1523	86,2	1682	57,0	1686	54,8	1702	82,1	1784
24,0	27,4	60,7	1590	60,7	1599	88,1	1777	58,7	1774	56,7	1795	84,1	1890
25,0	28,5	62,4	1670	62,4	1677	90,1	1862	60,5	1864	58,5	1893	86,1	2002
26,0	29,6	64,1	1741	64,1	1757	91,9	1954	62,1	1958	60,2	1995	88,0	2125
27,0	30,7	65,7	1831	65,7	1838	93,7	2075	63,7	2055	61,9	2104	89,8	2261
28,0	31,8	67,2	1912	67,2	1923	95,4	2184	65,3	2157	63,5	2221	91,6	2421
29,0	32,9	68,7	1998	68,7	2009	97,1	2303	66,8	2265	65,1	2349	93,3	2631
30,0	34,0	70,2	2090	70,2	2099	98,8	2402	68,3	2379	66,6	2492		
31,0	35,1	71,6	2167	71,6	2192	100,3	2543	69,7	2506	68,1	2663		
32,0	36,2	73,0	2271	73,0	2292	101,9	2745	68,3	6559	69,6	2893		
33,0	37,3	74,3	2384	74,3	2390			72,3	2793				
34,0	38,4	75,6	2478	75,6	2508			73,5	2980				
35,0	39,5	76,9	2610	76,9	2629								
36,0	40,6	78,1	2719	78,1	2760								
37,0	41,7	79,2	2878	79,2	2909								
38,0	42,8	80,3	3058	80,3	3090								
39,0	43,9			80,7	3884								
40,0	45,0												
41,0	46,1												
42,0	47,2												
43,0	48,3												
44,0	49,4												
45,0	50,5												
46,0	51,6												
47,0	52,7												
48,0	53,8												
49,0	54,9												
50,0	56,0												
51,0	57,1												
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

TABLE 14: Maximum discharge capacity of valves 3061

Pset [bar]	Po [barsass]	R1234ze		R290		R600		R600a		R744 (CO2)	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	61,1	768	38,1	505	92,3	527	78,8	540	-32,5	566
12,0	14,2	64,5	837	41,6	549	96,3	574	82,7	588	-30,2	614
13,0	15,3	67,7	907	44,9	594	100,1	622	86,4	636	-27,9	662
14,0	16,4	70,8	979	48,0	639	103,7	670	89,9	686	-25,8	710
15,0	17,5	73,7	1051	51,0	684	107,2	719	93,3	737	-23,8	759
16,0	18,6	76,5	1126	53,8	731	110,4	769	96,5	788	-21,8	807
17,0	19,7	79,1	1201	56,5	778	113,5	820	99,6	841	-20,0	856
18,0	20,8	81,7	1279	59,2	826	116,5	872	102,5	895	-18,2	905
19,0	21,9	84,1	1358	61,7	874	119,4	925	105,3	950	-16,5	955
20,0	23,0	86,4	1440	64,1	924			108,0	1007	-14,9	1005
21,0	24,1	88,7	1524	66,4	974			110,6	1065	-13,3	1055
22,0	25,2	90,9	1611	68,7	1026			113,2	1125	-11,7	1105
23,0	26,3	93,0	1701	70,8	1078			115,6	1187	-10,2	1156
24,0	27,4	95,0	1795	73,0	1132			118,0	1252	-8,8	1207
25,0	28,5	97,0	1893	75,0	1188			120,3	1320	-7,4	1259
26,0	29,6	98,9	1997	77,0	1245			122,5	1391	-6,0	1311
27,0	30,7	100,7	2107	78,9	1303			124,7	1467	-4,7	1363
28,0	31,8	102,5	2226	80,8	1364			126,8	1549	-3,4	1416
29,0	32,9	104,3	2358	82,6	1427			128,8	1640	-2,2	1469
30,0	34,0	106,0	2508	84,4	1493			130,8	1743	-0,9	1523
31,0	35,1	107,6	2695	86,2	1563			132,7	1873	0,3	1577
32,0	36,2	109,2	3023	87,9	1636			134,5	2129	1,4	1632
33,0	37,3			89,5	1715					2,6	1687
34,0	38,4			91,1	1801					3,7	1743
35,0	39,5			92,7	1898					4,8	1799
36,0	40,6			94,2	2012					5,9	1856
37,0	41,7			95,7	2166					6,9	1914
38,0	42,8									8,0	1972
39,0	43,9									9,0	2032
40,0	45,0									10,0	2091
41,0	46,1									11,0	2152
42,0	47,2									11,9	2214
43,0	48,3									12,9	2276
44,0	49,4									13,8	2339
45,0	50,5									14,7	2404
46,0	51,6									15,6	2469
47,0	52,7									16,5	2536
48,0	53,8									17,3	2604
49,0	54,9									18,2	2673
50,0	56,0									19,0	2744
51,0	57,1									19,9	2817
52,0	58,2									20,7	2891
53,0	59,3									21,5	2968
54,0	60,4									22,3	3046
55,0	61,5									23,0	3128
56,0	62,6									23,8	3212
57,0	63,7									24,6	3300
58,0	64,8									25,3	3391
59,0	65,9									26,0	3487
60,0	67,0									26,8	3590

CHAPTER 4
SAFETY VALVES IN SERIES 3065

GENERAL DESCRIPTION

The valves in series 3065 are unbalanced, conventional direct-loaded safety valves. The valve is opened by the thrust from the fluid under pressure below the shutter, when said thrust exceeds, under the calibrated conditions, the opposing force of the spring acting on the shutter.
Valves are identified by means of:

- a model number formed of an alphanumerical code that includes:
  - the family identity (for ex. 3065/4)
  - the type of inlet connection (for ex. C = NPT)
  - the set pressure, expressed in bar, multiplied by 10 (for ex. 140)
- an alphanumerical serial number

CONSTRUCTION

Body: squared, obtained through hot moulding and subsequent machining. It houses the following elements:

- the nozzle with flat sealing seat
- the shutter guide
- the set spring slot
- the threaded seat of the setting adjustment ring nut

In the body, above the shutter guide, a small pressure relief hole is provided through which the spring slot communicates with the exit connection. For this reason, during relief, there is a no gas leak through this orifice.
Material used: EN 12420-CW617N brass

Shutter: obtained through machining from bar stock and fit with gasket, it ensures the required degree of tightness on the valve seat. The gasket is made from modified PTFE (Polytetrafluorethylene), a material that, during the valve's estimated service life, maintains good strength and does not cause the shutter to stick on the seat. The shutter is properly guided in the body and the guide action cannot fail. There are no glands or retaining rings that hamper its movement.
Material used: EN 12164-CW614N brass

Spring: it opposes the pressure and the fluid dynamic forces, and always ensures closing of the valve following pressure relief. When the shutter has reached the maximum height determined by the mechanical stop, the spring compression does not exceed 80% of the total compression. All the springs are compliant with the compression helical spring requirements defined in EN ISO 4126-7:2013.
Material used: EN 10270-2 - FD steel for springs.

Calibration system: hex-head threaded ring nut to be screwed inside the upper portion of the head, compressing the spring below. When calibration is complete, the position of the ring nut is maintained unchanged by applying to the threaded coupling a high mechanical strength and low viscosity bonding agent. The low viscosity promotes penetration. The calibration system is protected against subsequent tampering by means of a threaded cap nut, screwed on outside the brass body and blocked in place through re-flanging.

SCOPE

Use: protection against possible overpressure of the apparatuses listed below, with regard to the operating conditions for which they have been designed:

- Refrigeration system or heat pump components, for instance: condensers, liquid receivers, evaporators, liquid accumulators, positive displacement compressor discharge, heat exchangers, oil separators, or piping (reference standard: EN 378-2:2016)
- Simple pressure vessels (reference Directive: 2009/105/EC)

Fluids: the valves in series 3065 can be used with:

a. Refrigerant fluids in vapour or gaseous state belonging to Group 2:
   - HCFC (R22)
   - HFC (R134a , R404A , R407C , R410A , R507)
   - HFO and HFO/HFC mixtures (R1234ze , R448A , R449A , R450A , and R452A)
   - R744

with reference to Article 13, Para. 1(b) of Directive 2014/68/EU (EC Regulation No. 1272/2008).

b. Refrigerant fluids in vapour or gaseous state belonging to Group 1:
- HFC (R32)
- HFO (R1234yf)
- HC (R290 , R600 , R600a)

with reference to Article 13, Para. 1(a) of Directive 2014/68/EU (EC Regulation No. 1272/2008).

c. Air and nitrogen (reference Directive: 2009/105/EC)

For specific applications with refrigerant fluids not listed above, please contact Castel Technical Department.

MARKING

In compliance with the provisions of Article 19 of Directive 2014/68/EC, the following information is cast on the valve body:
- Manufacturer's mark
- Country of manufacturing
- Indication of flow direction
- Maximum allowable pressure

Again, on the body, the following information is laser marked:
- Valve model
- Serial number
- Set pressure
- Allowable temperature range
- Kd discharge coefficient
- Flow section
- Production date
- CE marking
- Identification number of the notified body involved in the production control phase

DOCUMENTATION

The safety valves in series 3065 are supplied with the following documentation provided in the packaging:
- operating instructions for the user, containing all information useful for safety in terms of assembly, commissioning, use, and maintenance.
- Compliance Statement for the equipment according to Directive 2014/68/EU, required in Article 17 and issued in compliance with Annex IV of the same directive.
- Calibration certificate for the safety valve, printed on the reverse side of the Compliance Statement.

N.B.: on the website: www.castel.it use the "Certifications" pull-down menu to access the web-page **"Castel Certification Download Center"**. On this page, you can download:
- the Compliance Statement / Calibration Certificate for each valve by entering the 7-digit alphanumeric serial number.
- the general Compliance Statement referring to a specific model of valve 3065 with a specific setting, for ex. 3065/4C250 or 3065/6C420.

VALVE SELECTION

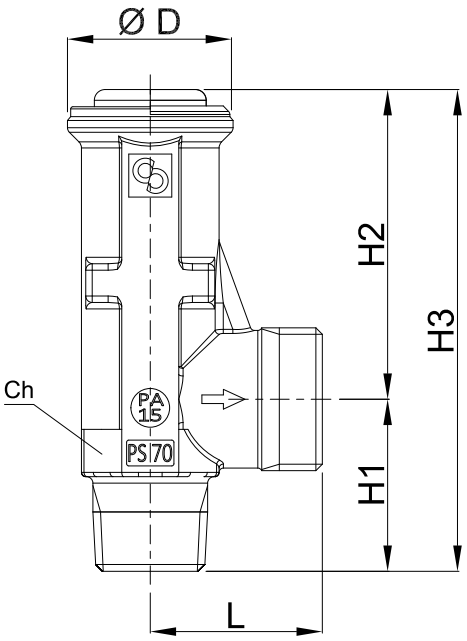
Directive 2014/68/EC requires that pressure equipment, in which permissible limits are reasonably likely to be exceeded, shall be fitted with suitable protection devices, for instance safety devices such as safety valves. Such devices shall prevent pressure from permanently exceeding the maximum allowable pressure (PS) of the equipment they protect. In any case, a short pressure peak limited to 10% of maximum allowable pressure is permitted.
As to the selection and sizing of the suitable protection device, users shall refer to the specific product and sector standards listed below:

- EN ISO 4126-1: 2013: "Safety devices for protection against excessive pressure – Part 1: Safety valves" indicates the general requirements for safety valves regardless of the fluid for which they were designed.
- EN 378-2:2016 "Refrigerating systems and heat pumps – Safety and environmental requirements – Part 2: Design, construction, testing, marking and documentation" provides a general outline of the protection devices to be used in refrigerating systems and their characteristics (Para. 6.2.5) and the criteria for the selection of the device suitable for the type and size of the system component to be protected (Para. 6.2.6).
- EN 13136:2013: "Refrigerating systems and heat pumps – Pressure relief devices and their associated piping – Methods for calculation" highlights the possible causes of overpressure in a system and provides users with the tools for sizing pressure relief devices, among which safety valves.

For sizing of the safety valves in series 3065, please see Chapter 5 "Selection Criteria for Safety Valves" in this technical handbook.
Table 17 provides the maximum discharge capacities of safety valves, models 3065/4 and 3065/6, as a function of various refrigerants and varying P_{set} for the valve, considering T_o = Steam saturation temperature at discharge pressure, P_o.

TABLE 15 : General Characteristics of valves 3065			
Catalogue Number		3065/4C	3065/6C
Connections	Inlet male	1/2" NPT	3/4" NPT
	Outlet male	1" G	1" G
Inlet connection wrench torque (min/max) [Nm]		21/30	32/45
Flow Diameter [mm]		13,0	13,0
Flow Section [mm2]		132,7	132,7
Lift [mm]		6,3	6,3
Discharge Coefficient "Kd"		0,87	0,87
PS [bar]		70	
TS [°C]		- 50 / + 150	
TA [°C]		- 40 / + 50	
Set Pressure Range at atmospheric back pressure Pset [bar]		11 / 60	
Overpressure		+ 10 % of Pset	
Blowdown		- 15 % of Pset	
Helium tightness		- 20 % of Pset (11 bar < Pset < 14 bar)	
		- 15 % of Pset (14,1 bar < Pset < 24 bar)	
		- 10 % of Pset (24,1 bar < Pset < 60 bar)	
Estimated service life		9 years	
Risk Category according to PED Recast		IV	

TABLE 16: Dimensions and Weights of valves 3065							
Catalogue Number	Dimensions [mm]						Weight [g]
	Ø D	L	Ch	H_1	H_2	H_3	
3065/4C	38,5	40	32	40	72	112	520
3065/6C	38,5	40	32	40	72	112	520



3065/4C
3065/6C

TABLE 17: Maximum discharge capacity of valves 3065

Pset [bar]	Po [barsass]	R134a		R22		R32		R404A		R407C		R410A	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	49,8	2200	33,7	2061	15,8	1686	27,0	2257	33,9	2056	16,5	1970
12,0	14,2	53,0	2395	36,9	2239	18,6	1832	30,2	2460	36,9	2236	19,4	2143
13,0	15,3	56,0	2593	39,9	2419	21,3	1979	33,1	2666	39,7	2418	22,1	2317
14,0	16,4	58,9	2794	42,8	2600	23,9	2127	35,9	2875	42,4	2603	24,7	2493
15,0	17,5	61,7	2998	45,5	2784	26,3	2277	38,5	3088	44,9	2789	27,2	2671
16,0	18,6	64,3	3206	48,1	2969	28,6	2428	41,0	3306	47,3	2978	29,5	2851
17,0	19,7	66,8	3417	50,6	3156	30,8	2580	43,4	3528	49,6	3170	31,8	3033
18,0	20,8	69,2	3632	53,0	3346	33,0	2735	45,7	3755	51,8	3364	33,9	3218
19,0	21,9	71,5	3851	55,3	3538	35,0	2890	48,0	3987	54,0	3562	36,0	3405
20,0	23,0	73,7	4075	57,5	3732	37,0	3048	50,1	4226	56,0	3762	37,9	3595
21,0	24,1	75,9	4304	59,7	3929	38,9	3207	52,1	4471	58,0	3966	39,9	3788
22,0	25,2	77,9	4538	61,7	4129	40,7	3368	54,1	4724	59,9	4173	41,7	3984
23,0	26,3	79,9	4779	63,7	4332	42,5	3531	56,0	4986	61,7	4384	43,5	4183
24,0	27,4	81,9	5027	65,7	4538	44,2	3696	57,9	5258	63,4	4599	45,2	4386
25,0	28,5	83,7	5282	67,6	4747	45,8	3863	59,7	5542	65,2	4819	46,9	4592
26,0	29,6	85,6	5547	69,4	4961	47,4	4033	61,4	5840	66,8	5044	48,5	4803
27,0	30,7	87,3	5821	71,2	5178	49,0	4205	63,1	6156	68,4	5274	50,1	5017
28,0	31,8	89,0	6107	72,9	5400	50,5	4379	64,7	6494	70,0	5510	51,6	5237
29,0	32,9	90,7	6408	74,6	5626	52,0	4556	66,3	6861	71,5	5753	53,1	5463
30,0	34,0	92,3	6726	76,2	5858	53,5	4737	67,8	7270	72,9	6004	54,6	5693
31,0	35,1	93,9	7067	77,8	6096	54,9	4920	69,3	7747	74,4	6263	56,0	5931
32,0	36,2	95,4	7436	79,4	6340	56,3	5107	70,7	8358	75,7	6532	57,4	6175
33,0	37,3	96,9	7849	80,9	6591	57,6	5297	72,1	9674	77,1	6812	58,7	6428
34,0	38,4	98,3	8329	82,4	6851	58,9	5491			78,4	7107	60,1	6691
35,0	39,5	99,2	8744	83,9	7120	60,2	5689			79,7	7418	61,4	6964
36,0	40,6	99,5	8966	85,3	7400	61,5	5892			80,9	7749	62,6	7251
37,0	41,7	99,7	9199	86,7	7693	62,7	6100			82,1	8109	63,8	7552
38,0	42,8			88,0	8002	63,9	6313			83,2	8507	65,0	7874
39,0	43,9			89,4	8331	65,1	6533			84,3	8965	66,2	8220
40,0	45,0			90,7	8686	66,2	6759			85,3	9536	67,4	8600
41,0	46,1			92,0	9077	67,3	6993			86,1	10476	68,5	9029
42,0	47,2			93,2	9522	68,5	7236					69,6	9541
43,0	48,3			94,4	10066	69,5	7489					70,7	10246
44,0	49,4			95,6	10882	70,6	7754						
45,0	50,5					71,7	8033						
46,0	51,6					72,7	8330						
47,0	52,7					73,7	8651						
48,0	53,8					74,7	9003						
49,0	54,9					75,6	9402						
50,0	56,0					76,6	9881						
51,0	57,1					77,5	10554						
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

Continued

TABLE 17: Maximum discharge capacity of valves 3065

Pset [bar]	Po [barsass]	R448A		R449A		R450A		R452A		R507		R1234yf	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	31,1	2075	31,0	2087	55,2	2250	28,7	2279	25,8	2260	50,2	2322
12,0	14,2	34,1	2254	34,0	2271	58,5	2456	31,8	2482	28,9	2463	53,7	2533
13,0	15,3	36,9	2443	36,9	2457	61,7	2653	34,6	2687	31,9	2669	56,9	2748
14,0	16,4	39,6	2631	39,5	2645	64,6	2867	37,4	2895	34,7	2879	59,9	2967
15,0	17,5	42,1	2814	42,1	2836	67,5	3075	39,9	3106	37,3	3093	62,9	3191
16,0	18,6	44,6	3011	44,5	3029	70,1	3284	42,4	3321	39,8	3311	65,6	3420
17,0	19,7	46,9	3212	46,8	3226	72,7	3510	44,7	3540	42,2	3533	68,3	3655
18,0	20,8	49,1	3396	49,1	3425	75,2	3735	47,0	3763	44,5	3761	70,8	3897
19,0	21,9	51,2	3611	51,2	3627	77,5	3953	49,1	3990	46,8	3994	73,2	4146
20,0	23,0	53,3	3802	53,2	3833	79,8	4187	51,2	4222	48,9	4234	75,6	4403
21,0	24,1	55,2	4004	55,2	4043	82,0	4441	53,2	4459	50,9	4481	77,8	4670
22,0	25,2	57,1	4221	57,1	4256	84,1	4681	55,1	4702	52,9	4735	80,0	4949
23,0	26,3	58,9	4453	58,9	4474	86,2	4939	57,0	4952	54,8	4999	82,1	5241
24,0	27,4	60,7	4672	60,7	4697	88,1	5218	58,7	5210	56,7	5273	84,1	5551
25,0	28,5	62,4	4905	62,4	4925	90,1	5470	60,5	5475	58,5	5559	86,1	5881
26,0	29,6	64,1	5114	64,1	5159	91,9	5740	62,1	5750	60,2	5860	88,0	6241
27,0	30,7	65,7	5379	65,7	5400	93,7	6094	63,7	6037	61,9	6180	89,8	6642
28,0	31,8	67,2	5617	67,2	5647	95,4	6415	65,3	6336	63,5	6523	91,6	7112
29,0	32,9	68,7	5870	68,7	5902	97,1	6766	66,8	6652	65,1	6899	93,3	7729
30,0	34,0	70,2	6140	70,2	6165	98,8	7056	68,3	6988	66,6	7321		
31,0	35,1	71,6	6365	71,6	6440	100,3	7471	69,7	7360	68,1	7821		
32,0	36,2	73,0	6671	73,0	6733	101,9	8061	68,3	19265	69,6	8498		
33,0	37,3	74,3	7004	74,3	7019			72,3	8203				
34,0	38,4	75,6	7278	75,6	7368			73,5	8752				
35,0	39,5	76,9	7667	76,9	7721								
36,0	40,6	78,1	7986	78,1	8107								
37,0	41,7	79,2	8453	79,2	8545								
38,0	42,8	80,3	8982	80,3	9076								
39,0	43,9			80,7	11407								
40,0	45,0												
41,0	46,1												
42,0	47,2												
43,0	48,3												
44,0	49,4												
45,0	50,5												
46,0	51,6												
47,0	52,7												
48,0	53,8												
49,0	54,9												
50,0	56,0												
51,0	57,1												
52,0	58,2												
53,0	59,3												
54,0	60,4												
55,0	61,5												
56,0	62,6												
57,0	63,7												
58,0	64,8												
59,0	65,9												
60,0	67,0												

Continued

TABLE 17: Maximum discharge capacity of valves 3065											
Pset [bar]	Po [barsass]	R1234ze		R290		R600		R600a		R744 (CO2)	
		To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]	To [°C]	Qm [kg/h]
11,0	13,1	61,1	2256	38,1	1483	92,3	1549	78,8	1585	-32,5	1663
12,0	14,2	64,5	2459	41,6	1612	96,3	1686	82,7	1726	-30,2	1804
13,0	15,3	67,7	2665	44,9	1744	100,1	1826	86,4	1869	-27,9	1944
14,0	16,4	70,8	2875	48,0	1876	103,7	1968	89,9	2015	-25,8	2086
15,0	17,5	73,7	3088	51,0	2010	107,2	2112	93,3	2164	-23,8	2228
16,0	18,6	76,5	3306	53,8	2147	110,4	2259	96,5	2315	-21,8	2371
17,0	19,7	79,1	3529	56,5	2285	113,5	2408	99,6	2470	-20,0	2515
18,0	20,8	81,7	3757	59,2	2425	116,5	2561	102,5	2628	-18,2	2659
19,0	21,9	84,1	3990	61,7	2568	119,4	2718	105,3	2790	-16,5	2805
20,0	23,0	86,4	4230	64,1	2714			108,0	2956	-14,9	2951
21,0	24,1	88,7	4477	66,4	2862			110,6	3128	-13,3	3098
22,0	25,2	90,9	4732	68,7	3013			113,2	3304	-11,7	3247
23,0	26,3	93,0	4997	70,8	3168			115,6	3487	-10,2	3396
24,0	27,4	95,0	5272	73,0	3326			118,0	3677	-8,8	3546
25,0	28,5	97,0	5561	75,0	3489			120,3	3877	-7,4	3698
26,0	29,6	98,9	5865	77,0	3656			122,5	4086	-6,0	3850
27,0	30,7	100,7	6189	78,9	3828			124,7	4309	-4,7	4004
28,0	31,8	102,5	6539	80,8	4007			126,8	4550	-3,4	4159
29,0	32,9	104,3	6926	82,6	4192			128,8	4816	-2,2	4316
30,0	34,0	106,0	7368	84,4	4386			130,8	5120	-0,9	4474
31,0	35,1	107,6	7916	86,2	4590			132,7	5502	0,3	4633
32,0	36,2	109,2	8880	87,9	4806			134,5	6255	1,4	4793
33,0	37,3			89,5	5037					2,6	4956
34,0	38,4			91,1	5290					3,7	5120
35,0	39,5			92,7	5574					4,8	5285
36,0	40,6			94,2	5910					5,9	5453
37,0	41,7			95,7	6363					6,9	5622
38,0	42,8									8,0	5794
39,0	43,9									9,0	5967
40,0	45,0									10,0	6143
41,0	46,1									11,0	6321
42,0	47,2									11,9	6502
43,0	48,3									12,9	6685
44,0	49,4									13,8	6871
45,0	50,5									14,7	7060
46,0	51,6									15,6	7253
47,0	52,7									16,5	7449
48,0	53,8									17,3	7648
49,0	54,9									18,2	7852
50,0	56,0									19,0	8061
51,0	57,1									19,9	8274
52,0	58,2									20,7	8492
53,0	59,3									21,5	8717
54,0	60,4									22,3	8948
55,0	61,5									23,0	9187
56,0	62,6									23,8	9434
57,0	63,7									24,6	9692
58,0	64,8									25,3	9961
59,0	65,9									26,0	10243
60,0	67,0									26,8	10543

VALVE INSTALLATION

Safety valves type 3065 guarantee repeatable performance. This means that, after the valves have operated, open/close, the initial setting conditions are maintained. Nevertheless, it is advisable to replace a 3065 valve once it has discharged as during release debris, such as metal shavings or solder impurities, can deposit on the valve gasket. This can inhibit the safety valve from returning to its original conditions.

To calculate the pressure loss in either the upstream line (between vessel and safety valve) or the downstream line (between safety valve and atmosphere) refer to Chapter 5 “Selection Criteria for Safety Valves” in this technical handbook.

CHAPTER 5
SELECTION CRITERIA FOR SAFETY VALVES

CALCULATION OF THE DISCHARGE CAPACITY (REF. EN 13136:2013)

The evaluation of the minimum required discharge capacity of safety valves is closely linked to the type of system where the equipment protected by the valve is installed, with the causes that may cause the safety valve to open, i.e.:

- **External heat sources** (Para. 6.2.1 - EN 13136:2013). The minimum required discharge capacity is determined by the following formula:

$$Q_{md} = \frac{3600 \times \varphi \times A_{surf}}{h_{vap}} \text{ [kg/h]}$$

where:
- φ = density of heat flow rate, assumed to be 10 [kW/m^2]
- A_{surf} = external surface area of the vessel [m^2]
- h_{vap} = latent heat of vaporization of liquid at p_o [kJ/kg]

- **Internal heat sources** (Para. 6.2.2 - EN 13136:2013). The minimum required discharge capacity is determined by the following formula:

$$Q_{md} = \frac{3600 \times Q_h}{h_{vap}} \text{ [kg/h]}$$

where Q_h = rate of heat production [KW]

- **Increased pressure caused by a positive displacement compressor** (Para. 6.3 - EN 13136:2013). The minimum required discharge capacity is determined by the following formula:

$$Q_{md} = 60 \times V \times n \times \rho_{10} \times \eta_v \text{ [kg/h]}$$

where:
- V = theoretical displacement of compressor [m^3]
- n = rotational frequency of compressor [min^{-1}]
- ρ_{10} = vapour density of refrigerant, from the saturation curve at a temperature of 10 °C [kg/m^3].
- Table 18 provides the values of ρ_{10} for:
  - traditional HCFC and HFC refrigerants most commonly used
  - new HFO and HFC/HFO blend refrigerants
  - natural HC fluids

(for R744, the ρ_{-40} vapour density value for CO_2 is indicated, from the saturation curve at a temperature of -40 °C [kg/m^3]).
- η_v = volumetric efficiency of the compressor, estimated at suction pressure and discharge pressure equivalent to the safety valve setting.

SIZING OF SAFETY VALVES DESIGNED TO DISCHARGE GAS OR VAPOUR AT CRITICAL FLOW (Ref. EN ISO 4126-1: 2013 and EN 13136 :2013)

Critical flow occurs when the back-pressure p_b (the pressure existing immediately at the outlet of the valve) is lower than or equal to the critical pressure:

$$p_b \leq p_o \left| \frac{2}{k+1} \right|^{\frac{k}{k-1}} \text{ [bar abs]}$$

where:
- p_o = actual relieving pressure, upstream the valve. It's equal to the set pressure plus overpressure; that is, the pressure increase over the set pressure at which the shutter has its total lift [bar abs]
- k = isentropic exponent of gas or vapour, based on the actual temperature and pressure conditions upstream of the valve during the discharge phase under full glow.

If k is unknown or difficult to determine, it is possible to assume:

$$p_{critica} = 0{,}5 \times p_o \text{ [bar abs]}$$

A valve that discharges to the atmosphere, is under in critical flow conditions.
The safety valves designed to discharge gas or vapour at critical flow must be sized using the following calculation, shown in Paragraph 7.2.5.2 of the EN 13136:2013 standard.

$$A_c = 3{,}469 \times \frac{Q_{md}}{C \times 0{,}9 \times K_d} \times \sqrt{\frac{v_o}{p_o}} \text{ [mm}^2\text{]}$$

where:
- A_c = minimum net cross-section area of the valve orifice [mm^2]
- Q_{md} = minimum required discharge capacity of safety valve [kg/h]
- K_d = certified discharge ratio of safety valve
- p_o = actual pressure upstream of the safety valve during discharge of the entire flow, see definition above. [bar abs]
- v_o = specific volume of gas or vapour at discharge conditions p_o and T_o, where T_o is the fluid temperature at valve inlet, defined by the user or by the designer [m^3/kg]
- C = expansion rate as a function of the k coefficient in the isentropic equation calculated with the following formula:

$$C = 3{,}948 \times \sqrt{k \times \left| \frac{2}{k+1} \right|^{\frac{(k+1)}{(k-1)}}}$$

for this calculation, the value of k refers to a temperature of 25 °C. (Para. 7.2.3, EN 13136:2013 standard).
Table 18 provides the k and C values for:

- traditional HCFC and HFC refrigerants most commonly used
- new HFO and HFC/HFO blend refrigerants
- natural HC fluids and R744

To calculate the flow rate of a safety valve, under specific operating conditions, use the following formula, provided in Para. 7.2.5.2 of EN 13136:2013.

$$Q_m = 0{,}2883 \times C \times A \times 0{,}9 \times K_d \times \sqrt{\frac{p_o}{v_o}}$$

where:

- Q_m = maximum discharge capacity of safety valve [kg/h]
- A = net cross-section area of the valve orifice [mm^2]

This formula was used to calculate the maximum discharge flow of the safety valve shown in:

- Table 3 and 4 for valves in series 3030
- Table 7, 8, 9, 10 and 11 for valves in series 3060
- Table 14 for valves in series 3061
- Table 17 for valves in series 3065

INSTALLATION OF A SAFETY VALVE (Ref. EN 13136:2013)

As far as the installation of safety valves is concerned, remember these basic points:

- Safety valves must be installed near an area of the system where vapours or gases are present and where there is no fluid turbulence. They must be placed in as close to an upright position as possible, with the inlet connector turned downwards.

- Vessels joined by piping, of a diameter deemed by the manufacturer and the user to be adequate, without any stop valves between them, may be considered as a single vessel for the installation of a safety valve.

- The fitting between the valve and the equipment to be protected must be as short as possible. Furthermore, the cross-section of the piping must not be smaller than the valve inlet. In any case, EN 13136:2013 states that the pressure drop between the protected vessel and the safety valve, at discharge capacity, shall not exceed 3% of the setting value, po, including any accessory on the line.

- The location selected for installation of the safety valve must consider that valve operation involves the discharge of the refrigerant fluid under pressure, sometimes at high temperature. Where there is the risk of causing injuries to people nearby, exhaust piping must be provided, sized so as to not compromise valve operation. EN 13136:2013 states that this piping must not generate, at discharge capacity, a back-pressure exceeding 10% of pressure po , for unbalanced, conventional valves. In the event of multiple valves installed in parallel, it is highly recommended that each valve be fit with a dedicated exhaust line rather than a single manifold for all of the valves. The risk of the latter solution is to create an overpressure in the manifold determined when a valve discharges. This overpressure can modify the operating characteristics of all the other valves installed in parallel.

Pressure losses in the upstream line

To calculate the pressure losses in the upstream line (between vessel and safety valve) refer to Section 7.4 of EN 13136:2013.
The upstream pressure loss is given by:

$$\frac{\Delta p_{in}}{p_o} = 0{,}032 \times \left[\frac{A_c}{A_{in}} \times C \times K_{dr} \right]^2 \times \zeta$$

where:

- A_c = minimum calculated flow cross-section area [mm^2]
- A_{in} = cross-section area of inlet tube to valve [mm^2]
- $K_{dr} = K_d \times 0.9$, reduced discharge coefficient
- C = expansion rate as a function of the k coefficient in the isentropic equation for the refrigerant fluid
- ξ = sum of the of pressure loss coefficients ξ_n of the individual components and piping.
  The coefficients ξ_n refer to:
  - pipe element losses, such as fittings and elbows
  - valve losses
  - losses along the piping

  and are listed in standard EN 13136:2013, Table A.4.

Pressure losses in the downstream line

To calculate the pressure losses in the downstream line (between safety valve and atmosphere) refer to Section 7.4 of EN 13136:2013.
The downstream pressure loss is given by:

$$p_1 = \sqrt{0{,}064 \times \zeta \times \left(\frac{A_c}{A_{out}} \times C \times K_{dr} \times p_o \right)^2 + p_2^{\,2}}$$

where:

- P_1 = inlet pressure to discharge line [bar abs]
- P_2 = outlet pressure to discharge line, equal to atmospheric pressure [bar abs]
- A_c = minimum calculated flow cross-section area [mm^2]
- A_{out} = cross-section area of valve outlet pipe [mm^2]
- $K_{dr} = K_d \times 0.9$, reduced discharge coefficient

- C = expansion rate as a function of the k coefficient in the isentropic equation for the refrigerant fluid
- p_o = actual pressure downstream of the safety valve during discharge of the entire flow [bar abs]
- ξ = sum of the of pressure loss coefficients ξ_n of the piping
  The coefficients ξ_n refer to:
  - pipe element losses, bends
  - losses along the piping

  e sono elencati nella Tabella A.4 della norma EN 13136:2013.

EXAMPLE 1: Calculation of the flow rate (Q_{md}) and selection of the safety valve
(Increased pressure caused by a positive displacement compressor)

Compressor data

• Bore:	82.5 mm
• Stroke:	69.8 mm
• Number of cylinders	4
• Rotational frequency	1450 rpm
• Clearance	4%
• Refrigerant fluid	R407C

The theoretical displacement of the compressor is:

$$V = \frac{\pi}{4} \times 0{,}0825^2 \times 0{,}0698 \times 4 = 0{,}00149 \text{ [m}^3\text{]}$$

Maximum allowable pressure of the liquid condenser / receiver: PS = 25 bar Set pressure of the safety valve installed on the upper crown of the condenser housing: p_{set} = 25 bar

Calculation of the valve discharge pressure under full flow exhaust conditions: using a safety valve in series 3065 with an overpressure of 10%:

$$p_0 = p_{set} \times \left(1 + \frac{10}{100}\right) + 1 = 28{,}5 \text{ [bar abs]}$$

Operating conditions of compressor at the safety valve discharge:
Condensation temperature: +65.2 °C (28.5 bar abs)
Evaporation temperature: +10 °C (6.33 bar abs)
These conditions, defined by the designer, are assumed to be the most unfavourable for the safety valve due to operating faults such as:
- Movement errors
- Non-operation of automatic safety devices that should have been triggered prior to the safety valve due to failures or other reasons

Calculation of minimum full discharge capacity
For cautionary reasons, ignoring the vapour overheating at the outlet of the evaporator, the volumetric efficiency of compressor is:

$$\eta_v = 1 - 0{,}04 \times \frac{p_{mandata}}{p_{aspirazione}} = 1 - 0{,}04 \times \frac{28{,}5}{6{,}33} = 0{,}82$$

and so the minimum required full discharge capacity:

$$Q_{md} = 60 \times V \times n \times \rho_{10} \times \eta_v =$$
$$60 \times 0{,}00149 \times 1450 \times 27{,}45 \times 0{,}82 = 2918 \text{ [kg/h]}$$

where ρ_{10} = 27.45 [kg/m³] , saturated vapour density of R407C at a temperature of 10 °C

Sizing of minimum flow cross-section area of the safety valve

$$A_c = 3{,}469 \times \frac{Q_{md}}{C \times 0{,}9 \times K_d} \times \sqrt{\frac{v_o}{p_o}} =$$
$$3{,}469 \times \frac{2918}{2{,}51 \times 0{,}9 \times 0{,}87} \times \sqrt{\frac{0{,}0069}{28{,}5}} = 80{,}3 \text{ [mm}^2\text{]}$$

where:
- C = 2.51, corresponding to k exponent for R407C, equal to 1.14, according to Table 1
- K_d = 0.87, certified discharge ratio of safety valve 3065/4
- v_o = 0.0069 [m³/kg] , specific volume of the saturated vapour upstream of the safety valve during operation. This value refers to the following operating conditions upstream of the valve:
  - Pressure p_o = 28.5 [bar abs]
  - Temperature T_o = 65.2 [°C]

Conclusion: the selected safety valve is model 3065/4 with the following characteristics:
- certified discharge ratio, K_d = 0.87
- nozzle cross-section area, A = 132.73 [mm²]
- set pressure, p_{set} = 25 bar

Verification of the system upstream the safety valve
Assuming the valve installed is 3065/4C250, using a steel fitting with the following characteristics:
- d_{in} = 17 [mm] , fitting inside diameter
- A_{in} = 227 [mm²] , fitting inside cross-section area
- L = 60 [mm] , fitting length
- Condenser connection: Flush with the housing and with a sharp edge

The following information is taken from Table A.4 in standard EN 13136:2013:
- $\xi_{1\ (inlet)}$ = 0.25
- $\xi_{2\ (length)}$ = λ x L/ din = 0.02 x 60/17 = 0.07
  with λ = 0.02 for steel pipe
- $\xi_T = \xi_1 + \xi_2$ = 0.25 + 0.07 = 0.32

Between the safety valve and the steel fitting, a shut-off valve type 3064/44 is installed.
The main characteristics of this valve are:
- d_R = 13 [mm] , inside valve diameter
- A_R = 132.7 [mm²] , inside valve cross-section area
- kv = 10 [m³/h] , valve kv coefficient

The pressure loss coefficient ξ_R of the shut-off valve is given by:

$$\xi_R = 2{,}592 \times \left[\frac{132{,}7}{10}\right]^2 \times 10^{-3} = 0{,}45$$

Total loss coefficient: $\xi_T + \xi_R$ = 0.77

Recalling the previously calculated cross-section, the characteristics of safety valve 3065/4 and refrigerant fluid R407C:

- A_c = 80.3 [mm²]
- K_{dr} = 0.87 x 0.9 =0.783
- C = 2.51

The pressure loss is given by:

$$\frac{\Delta p_{in}}{p_o} = 0{,}032 \times \left[\frac{80{,}3}{227} \times 2{,}51 \times 0{,}783\right]^2 \times 0{,}77 = 0{,}012$$

The pressure loss value obtained is admissible because it is lower than the value of 0.03 indicated in standard EN 13136:2013.

Verification of system downstream the safety valve

Suppose it is necessary to construct a discharge pipe on safety valve 3065/4C250, using 1" gas pipe with the following characteristics:

- d_{out} = 30 [mm] , inside pipe diameter
- A_{out} = 707 [mm²] , inside pipe cross-section area
- L = 3000 [mm] , pipe length
- 90° elbow with bending radius, R, equal to three times external diameter of pipe

The following information is taken from Table A.4 in standard EN 13136:2013:

- $\xi_{1\ (elbow)}$ = 0.25
- $\xi_{2\ (length)}$ = λ x L/ d_{out} = 0.02 x 3000/30 = 2 where λ = 0.02 for steel pipe
- $\xi_T = \xi_1 + \xi_2$ = 0.25 + 2 = 2.25

The pressure loss is given by:

$$p_1 = \sqrt{0{,}064 \times 2{,}25 \times \left(\frac{80{,}3}{707} \times 2{,}51 \times 0{,}783 \times 28{,}5\right)^2 + 1^2} = 2{,}61$$

$$= \frac{\Delta p_{out}}{p_o} = \frac{2{,}61 - 1}{28{,}5} = 0{,}056 \text{ [bar]}$$

The pressure loss value obtained is admissible because it is lower than the value of 0.10 indicated in standard EN 13136:2013.

N.B.: All steps performed in the previous example, that is:

- calculation of minimum discharge capacity
- sizing of minimum cross-sectional area of the valve orifice
- calculation of the load loss in the upstream system
- calculation of the load loss in the downstream system

can be performed using the selection software available on the Castel website.

EXAMPLE 2: Calculation of the flow rate (Q_{md}) and selection of the safety valve
(Increase in pressure caused by internal heat source)

Data for the liquid receiver

- Refrigerant fluid R404A
- Pressure equipment 300 l liquid receiver
- External surface area of the vessel 3.2 m²
- PS of the vessel 28 bar

Calculation of the valve discharge pressure under full flow exhaust conditions: using a safety valve in series 3061 with an overpressure of 10%:

$$p_0 = (p_{set} \times 1{,}1) + 1 = (28 \times 1{,}1) + 1 = 31{,}8 \text{ [bar abs]}$$

Calculation of minimum discharge capacity

Calculation of the flow rate for the external heat source considering that there are flammable substances in such quantities as to feed a fire near the vessel to be protected.

$$Q_{md} = \frac{3600 \times \varphi \times A_{surf}}{h_{vap}} = \frac{3600 \times 10 \times 3{,}2}{67{,}28} = 1712 \text{ [kg/h]}$$

where:

- φ = density of heat flow rate, assumed to be 10 [kW/m²]
- A_{surf} = external surface area of the vessel [m²]
- h_{vap} = latent heat of vaporization of R404A at pressure p_0 [kJ/kg]

Sizing of minimum flow cross-section area of the safety valve

The safety valves to discharge gas or vapour at critical flow must be sized using the following formula.

$$A_c = 3{,}469 \times \frac{Q_{md}}{C \times 0{,}9 \times K_d} \times \sqrt{\frac{v_o}{p_o}} =$$

$$3{,}469 \times \frac{1712}{2{,}5 \times 0{,}9 \times 0{,}89} \sqrt{\frac{0{,}004231}{31{,}8}} = 34{,}2 \text{ [mm²]}$$

where:

- A_c = minimum net cross-section area of the valve orifice [mm²]
- Q_{md} = minimum required discharge capacity of safety valve [kg/h]
- C = expansion rate as a function of the k coefficient in the isentropic equation for the R404A refrigerant fluid
- K_d = certified discharge ratio of safety valve 3061/4
- p_0 = pressure downstream of the valve during operation [bar abs]
- v_0 = specific volume of the saturated vapour upstream of the safety valve during operation.
  This value refers to the following operating conditions upstream of the valve:
  - Pressure p_0 = 31.8 [bar abs]
  - Temperature T_0 = 64.7 [°C] (saturation temperature)

Conclusion: the selected safety valve is model 3061/4 with the following characteristics:

- certified discharge ratio, K_d = 0.89
- nozzle cross-section area, A = 44.2 [mm²]
- set pressure, p_{set} = 28 bar

of standard EN 13136:2013.

Verification of the system upstream the safety valve

Assuming the valve installed is 3061/4C280, using a steel fitting with the following characteristics:

- d_{in} = 17 [mm] , fitting inside diameter
- A_{in} = 227 [mm^2] , fitting inside cross-section area
- L = 60 [mm] , fitting length
- Receiver connection: Flush with the housing and with a sharp edge

The following data is taken from Table A.4:
- $\xi_{1\ (inlet)}$ = 0.25
- $\xi_{2\ (length)} = \lambda \times L / d_{in} = 0.02 \times 60/17 = 0.07$ with λ = 0.02 for steel pipe
- $\xi_T = \xi_1 + \xi_2 = 0.25 + 0.07 = 0.32$

Between the valve and the fitting, an exchange valve (type 3032/44) has been installed.
The main characteristics of this valve are:
- d_R = 13 [mm] , inside valve diameter
- A_R = 132.7 [mm^2] , inside valve cross-section area
- kv = 3.3 [m^3/h] , valve kv coefficient

The pressure loss coefficient ξ_R of the exchange valve is given by:

$$\xi_R = 2{,}592 \times \left[\frac{132{,}7}{3{,}3}\right]^2 \times 10^{-3} = 4{,}19$$

Total loss coefficient: $\xi_T + \xi_R = 4.51$

Recalling the previously calculated cross-section, the characteristics of safety valve 3061/4 and refrigerant fluid R404A:
- A_c = 34.2 [mm^2]
- $K_{dr} = 0.89 \times 0.9 = 0.801$
- C = 2.50

The pressure loss is given by:

$$\frac{\Delta p_{in}}{p_o} = 0{,}032 \times \left[\frac{34{,}2}{227} \times 2{,}50 \times 0{,}801\right]^2 \times 4{,}51 = 0{,}013$$

The pressure loss value obtained is admissible because it is lower than the value of 0.03 indicated in standard EN 13136:2013.

TABLE 18 : Exponent K of the isoentropic equation. Expansion coefficient C. Vapour density ϱ

	R134a	R22	R32	R404A	R407C	R410A	R448A	R449A	R450A	R452A	R507	R1234yf	R1234ze	R290	R600	R600a	R744
Group PED	2	2	1	2	2	2	2	2	2	2	2	1	2	1	1	1	2
k	1,12	1,17	1,24	1,12	1,14	1,17	1,14	1,14	1,11	1,11	1,10	1,07	1,07	1,19	1,10	1,10	1,30
C	2,50	2,54	2,59	2,50	2,51	2,54	2,51	2,51	2,49	2,49	2,48	2,45	2,45	2,55	2,48	2,48	2,63
ϱ [kg/m^3] (1)	20,23	28,82	30,23	41,66	27,45	41,92	30,63	31,11	18,49	40,62	44,03	24,27	16,45	13,78	3,87	5,87	26,12

(1) ϱ_{10} [kg/m^3] for all refrigerant, excluded R744
ϱ_{-40} [kg/m^3] for R744

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