Content

10.1 Introduction

Safety valves are used in a large variety of applications and industries. Different operating conditions and industry specific requirements lead to a variety of requested end connections for the safety valve inlet and outlet.

Most commonly flanged or threaded connections are used, but also clamp connections, butt weld ends or three piece union connections.

This chapter shall provide an overview about standard and special connections with reference to applicable codes and standards. Dimensions and pressure/temperature ratings for flanged connections are provided and assistance for the selection of other connections is given.

Product specific information like availability of a connection for a given product can be found in the product catalogs.

10.2 Connections Overview

10.2.1 Pressure/Temperature Rating of Connection versus Safety Valve

The p/t ratings in this chapter refer always to the limits given by relevant codes or standards for the specific connection. This rating will in general be determined by the selected flange rating and material. Maximum set pressure and maximum temperature ratings of safety valves may be different from the p/t ratings of the inlet and outlet connection due to the following potentially limiting factors:

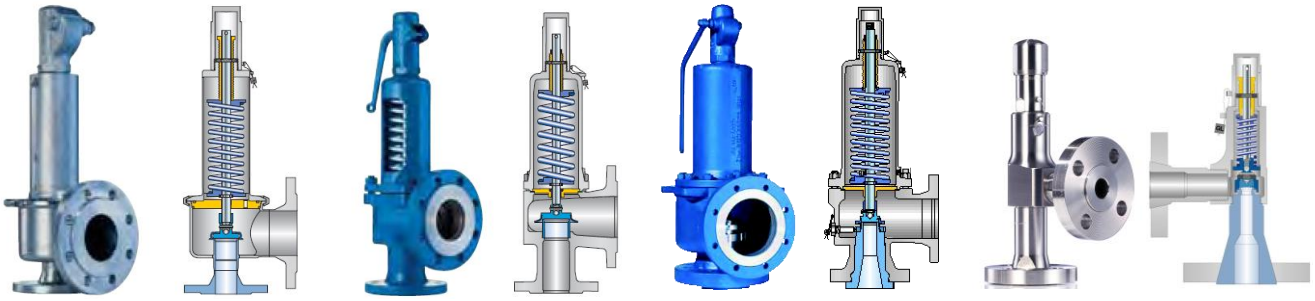
- selected soft good options
- spring chart and spring materials
- approvals
- design

The individual product catalogs will allow the proper selection of the safety valve configuration to meet the requirements.

10.2.2 Flanged Connections

There are four main types of flanged connections:

- welding neck flange
- integrally cast flange
- flange with full nozzle
- lap joint flange



Welding neck flange
LESER type 444

Integrally cast flange
LESER type 441 DIN

Flange with full nozzle
LESER type 526 full nozzle

Lap joint flange
LESER type 437

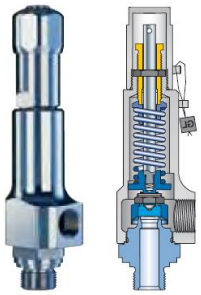
Figure 10.2-1: Four main types of flange connection

10.2.3 Threaded Connections

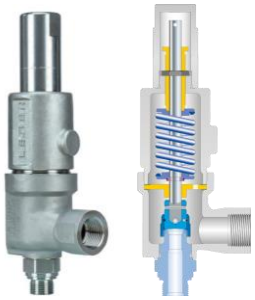
Threaded connections can be selected according to ASME B 1.20.1 (NPT), DIN ISO 228 (G) and other standards.

In addition male and female threads can be combined freely for inlet and outlet.
However male inlets and female outlets are used commonly. In some cases female inlets are preferred, but rarely male outlets.

Examples of threaded connections are shown below.



Threaded connection (inlet male, outlet female)
LESER type 437



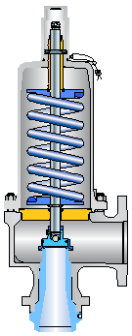
Threaded connection (inlet male, outlet female)
LESER type 459

Figure 10.2.3-1: Examples of threaded valve connections

10.2.4 Welding Ends

Welding ends are used for high pressure / high temperature applications, when it becomes difficult to obtain suitable gasket materials for a flanged connection. Valve repair becomes difficult, because the repair of the valve is in most cases performed in situ.

An example for a welded connection at the inlet is shown below.



Welding end at the inlet
LESER type 457

Figure 10.2.4-1: Example for a welded connection at the inlet

10.2.5 Clean Service Connections

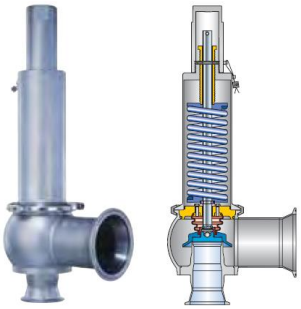
Clean Service safety valves can have different connections:

- threaded connections
- flanged connections
- clamp connections
- welded connections

In most cases these connections will be according to industry specific standards like ASME BPE, DIN 11864 or manufacturer standards.

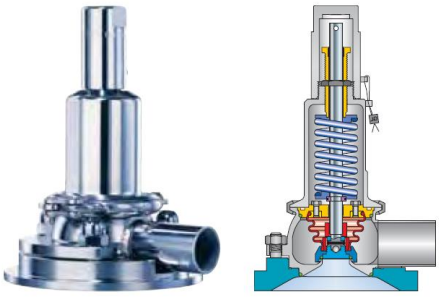
Threaded connection
LESER type 481

Flanged connection
LESER type 483

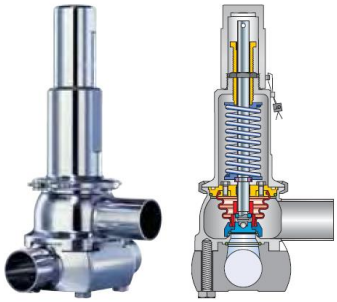


Clamp connection
LESER type 488

Figure 10.2.5-1: Different connections cfor LESER's clean service



Welded connection
LESER type 484



Welded connection
LESER type 485

Figure 10.2.5-2: Different connections for LESER's clean service

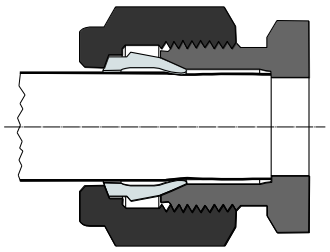
10.2.6 Other Connections

In specific applications further connection types are required.

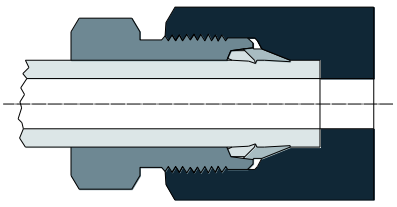
For example:

- High pressure clamp connections
- Compression fitting with locking ring
- Compression fitting with cutting ring

High pressure clamp connection



Compression fitting with locking ring



Compression fitting with cutting ring

Figure 10.2.6-1: Connection types for special application

10.3 Flanged Connections acc. to EN 1092

EN 1092 is split into two sections:

- EN 1092-1 edition 09-2008 for steel flanges
- EN 1092-2 edition 06-1997 for cast iron flanges

EN 1092 contains dimensions as well as pressure temperature ratings.

10.3.1 Pressure/Temperature Ratings acc. to EN 1092

The materials shown in the first column (material) are used generally by LESER. The p/t rating charts on the following pages are organized by material groups. All materials listed in the same group have the same p/t rating.

LESER standard materials		
Material	**Material group**	**Further materials of material group**
0.6025	Cast iron	ISO 1083 grade 200 ISO 1083 grade 250
0.7043	Ductile iron	ISO 1083 grade 350-22 ISO 1083 grade 400-15 ISO 1083 grade 400-18 EN 545 grade 420-5 ISO 1083 grade 500-7 ISO 1083 grade 600-3
1.0425 1.0460 1.0619	3E0	1.0345 1.0348 1.0352 1.0625 ASME SA 105
1.7357	5E0	1.7335 ASME SA 217 WC 6 ASME SA 217 C 5 ASME SA 335 P 12 ASME SA 182 F11 Cl 1/Cl 2/Cl 3 ASME SA 182 F12 Cl 1/Cl 2 ASME SA 387 11 ASME SA 387 12
1.4404	13E0	1.4432 1.4435 1.4458 1.4539 1.4563 1.4918
1.4408	14E0	1.4401 1.4436 ASME SA 351 CF8M ASME SA 312 TP316 ASME SA 312 TP 316 L/H ASME SA 182 F 316 ASME SA 182 F 316 L/H ASME SA 240 316 ASME SA 240 316 L/H
1.4581	15E0	1.4571 1.4580 ASME SA 240 316 Ti
Additional materials		
Material	**Material group**	**Further materials of material group**
1.4462 1.4470	16E0	1.4362 1.4410 1.4469

Table 10.3.1-1: LESER standard materials and material groups acc. to EN 1092

Overview of materials and material groups – further materials

The following materials are typically not used by LESER and pressure-temperature ratings are not listed here, but in EN 1092.
In the case that a material is not listed in EN1092, LESER can provide a proof if this material can be used by a strength calculation or a comparison of mechanical properties with a listed material.

Further materials		
Material group	**Materials of material group**	
Malleable iron	ISO 5922 B 30-06 ISO 5922 B 32-12	ISO 5922 B 35-10
1E0	1.0432	ASME SA 106 B
1E1	1.0038	
3E1	1.0425 1.0426 1.0481 ASME SA 216 WCB ASME SA 216 WCC	ASME SA 333 6 ASME SA 515 70 ASME SA 516 70 ASME SA 537 CL1
4E0	1.5415 1.5419	ASME SA 217 WC 1 ASME SA 182 F1 ASME SA 204 A/B
6E0	1.7375 1.7380 1.7383	ASME SA 217 C 12 ASME SA 335 P5/P9/P22 ASME SA 182 F5/F9/F22 Cl 1/F22 Cl 3 ASME SA 387 5/9/22
6E1	1.7362+NT1 1.7365	1.7366
7E0	1.0488 1.1104	1.1131 1.6220
7E1	1.0566	1.1106
7E2	1.5637 1.5682 1.6212	1.6228 1.6217
7E3	1.5637 1.5638 1.5662 1.5680	1.6217 ASME SA 352 LC 2/LC 3/LC 8 ASME 350 LF 3 ASME SA 203 A/E
8E0	1.0488	1.1104
8E2	1.0477 1.0478	1.0487 ASME SA 350 LF 2 Cl 1/Cl 2
8E3	1.0562 1.0565	1.0571 1.8867
9E0	1.4922	1.4931
9E1	1.4903	
10E0	1.4307 1.4306 1.4335	ASME SA 351 CF 8 ASME SA 312 TP 304 L/TP 304/ TP 304 H ASME SA 182 F 304/F 304 L/F 304 H ASME SA 240 304/304 L/304 H
10E1	1.4311	
11E0	1.4301	1.4948
12E0	1.4541 1.4550 1.4940 1.4941 1.4912	1.4961 ASME SA 312 TP 321/TP 321 H ASME SA 182 F 321/321 H ASME SA 240
13E1	1.4406 1.4429 1.4439	1.4529 1.4547

Table 10.3-2: LESER's materials and material groups

Pressure/temperature ratings acc. to EN 1092

General notes:

(1) Pressure/temperature ratings are generally calculated without considering a creep resistance. The following p/t rating charts contain some values with a gray background. These values are calculated with a creep resistance of 100,000 hours. Please refer to EN 1092-1 G.1.3 or G.2.1 for details.
(2) The following p/t rating charts are simplified versus the EN 1092 charts and list p/t ratings only for limited v_R values as they are used in LESER safety valves. v_R is the reference value for the thickness of a flange. If a chart has such a limit it is noted under the chart. See EN 1092-1 annex G for p/t ratings of flanges with a larger value of v_R and F.2.4 for further information on v_R.
(3) RT stands for reference temperature (-10°C to +50°C).

Material Group: cast iron (0.6025)

	Maximum allowable temperature [°C]							
	-10	120	150	180	200	230	250	300
Class	**Maximum allowable pressure [bar]**							
PN 10	10	10	9	8.4	8	7.4	7	6
PN 16	16	16	14.4	13.4	12.8	11.8	11.2	9.6
PN 25	25	25	22.5	21	20	18.5	17.5	15
PN 40	40	40	36	33.6	32	29.6	28	24

Table 10.3.1-3: pressure/temperature ratings acc. to EN 1092-2 – cast iron

Material Group: ductile iron (0.7043)

	Maximum allowable temperature [°C]						
	-10	120	150	200	250	300	350
Class	**Maximum allowable pressure [bar]**						
PN 10	10	10	9.7	9.2	8.7	8	7
PN 16	16	16	15.5	14.7	13.9	12.8	11.2
PN 25	25	25	24.3	23	21.8	20	17.5
PN 40	40	40	38.8	36.8	34.8	32	28
PN 63	63	63	62	58.8	55.6	51.2	44.8

Table 10.3.1-4: pressure/temperature ratings acc. to EN 1092-2 – ductile iron

Material Group: 3E0 (1.0425; 1.0460; 1.0619)

	Maximum allowable temperature [°C]								
	RT	100	150	200	250	300	350	400	450 (1)
Class	**Maximum allowable pressure [bar]**								
PN 10	10	9,2	8,8	8,3	7,6	6,9	6,4	5,9	3,2
PN 16	16	14,8	14	13,3	12,1	11	10,2	9,5	5,2
PN 25	25	23,2	22	20,8	19	17,2	16	14,8	8,2
PN 40	40	37,1	35,2	33,3	30,4	27,6	25,7	23,8	13,1
PN 63	63	58,5	55,5	52,5	48	43,5	40,5	37,5	20,7
PN 100	100	92,8	88	83,3	76,1	69	64,2	59,5	32,8
PN 160	160	148,5	140,9	133,3	121,9	110,4	102,8	95,2	52,5
PN 250	250	232,1	220,2	208,3	190,4	172,6	160,7	148,8	82,1
PN 320	320	297,1	281,9	266,6	243,8	220,9	205,7	190,4	105,1
PN 400	400	371,4	352,3	333,3	304,7	276,1	257,1	238	131,4

Table 10.3.1-5: Pressure/temperature ratings acc. to EN 1092-1 – 3E0

Notes:

Please note that this table is only valid if v_R is smaller or equal 50 millimeters
(1) see general note (1)

Pressure/temperature ratings acc. to EN 1092

Material Group: 5E0 (1.7357)

	Maximum allowable temperature [°C]									
	RT	100	150	200	250	300	350	400	450	460
Class	**Maximum allowable pressure [bar]**									
PN 10	10	10	10	10	10	10	9,5	9	8,4	8
PN 16	16	16	16	16	16	16	15,2	14,4	13,4	12,8
PN 25	25	25	25	25	25	25	23,8	22,5	21	20
PN 40	40	40	40	40	40	40	38	36	33,7	32
PN 63	63	63	63	63	63	63	60	56,7	53,1	50,5
PN 100	100	100	100	100	100	100	95,2	90	84,2	80,2
PN 160	160	160	160	160	160	160	152,3	144	134,8	128,3
PN 250	250	250	250	250	250	250	238	225	210,7	200,5
PN 320	320	320	320	320	320	320	304,7	288	269,7	256,6
PN 400	400	400	400	400	400	400	380,9	360	337,1	320,8

Table 10.3.1-5: Pressure/temperature ratings acc. to EN 1092-1

	Maximum allowable temperature [°C]									
	470	480	490	500 (1)	510 (1)	520 (1)	530 (1)	540 (1)	550 (1)	560 (1)	570 (1)
Class	**Maximum allowable pressure [bar]**										
PN 10	7,6	7,2	6,8	6,5	5,5	4,4	3,7	2,9	2,3	1,9	1,5
PN 16	12,1	11,5	10,8	10,4	8,8	7,1	5,9	4,6	3,7	3	2,5
PN 25	19	18	17	16,3	13,8	11,1	9,2	7,2	5,8	4,7	3,9
PN 40	30,4	28,8	27,2	26	22	17,9	14,8	11,6	9,3	7,6	6,2
PN 63	47,9	45,4	42,8	41,1	34,8	28,2	23,4	18,3	14,7	12	9,9
PN 100	76,1	72	68	65,2	55,2	44,7	37,1	29	23,3	19	15,7
PN 160	121,8	115,3	108,8	104,3	88,3	71,6	59,4	46,4	37,3	30,4	25,1
PN 250	190,3	180,1	170	163	138	111,9	92,8	72,6	58,3	47,6	39,2
PN 320	243,6	230,6	217,6	208,7	176,7	143,2	118,8	92,9	74,6	60,9	50,2
PN 400	304,5	288,2	272	260,9	220,9	179	148,5	116,1	93,3	76,1	62,8

Table 10.3.1-6: Pressure/temperature ratings acc. to EN 1092-1 – 5E0

Notes:

Please note that this table is only valid if v_R is smaller or equal 60 millimeters

(1) see general note (1)

Material Group: 13E0 (1.4404)

	Maximum allowable temperature [°C]									
	RT	100	150	200	250	300	350	400	450	500
Class	**Maximum allowable pressure [bar]**									
PN 10	10	9,4	8,6	7,9	7,4	6,9	6,6	6,4	6,2	6
PN 16	16	15,1	13,7	12,7	11,9	11	10,5	10,2	10	9,7
PN 25	25	23,6	21,5	19,8	18,6	17,2	16,5	16,0	15,6	15,2
PN 40	40	37,9	34,4	31,8	29,9	27,6	26,4	25,7	25,0	24,3
PN 63	63	59,7	54,3	50,1	47,1	43,5	41,7	40,5	39,4	38,4
PN 100	100	94,7	86,1	79,5	74,7	69,0	66,1	64,2	62,6	60,9
PN 160	160	151,6	137,9	127,2	119,6	110,4	105,9	102,8	100,1	97,5
PN 250	250	236,9	215,4	198,8	186,9	172,6	165,4	160,7	156,5	152,3
PN 320	320	303,2	275,8	254,4	239,2	220,9	211,8	205,7	200,3	195,0
PN 400	400	379,0	344,7	318,0	299,0	276,1	264,7	257,1	250,4	243,8

Table 10.3.1-7: Pressure/temperature ratings acc. to EN 1092-1 – 13E0

Pressure/temperature ratings acc. to EN 1092

Material Group: 14E0 (1.4408)

	Maximum allowable temperature [°C]															
	RT	100	150	200	250	300	350	400	450	500	550	560	570	580	590	600
Class	**Maximum allowable pressure [bar]**															
PN 10	10	10	9	8,4	7,9	7,4	7,1	6,8	6,7	6,6	6,5	6,4	6,3	6,2	6,1	5,6
PN 16	16	16	14,5	13,4	12,7	11,8	11,4	10,9	10,7	10,5	10,4	10,3	10,1	10	9,9	8,9
PN 25	25	25	22,7	21	19,8	18,5	17,8	17,1	16,8	16,5	16,3	16	15,8	15,6	15,4	14
PN 40	40	40	36,3	33,7	31,8	29,7	28,5	27,4	26,9	26,4	26	25,7	25,4	25	24,7	22,4
PN 63	63	63	57,3	53,1	50,1	46,8	45	43,2	42,4	41,7	41,1	40,5	40	39,5	39	35,4
PN 100	100	100	90,9	84,2	79,5	74,2	71,4	68,5	67,3	66,1	65,2	64,3	63,5	62,7	61,9	56,1
PN 160	160	160	145,5	134,8	127,2	118,8	114,2	109,7	107,8	105,9	104,3	103	101,6	100,3	99	89,9
PN 250	250	250	227,3	210,7	198,8	185,7	178,5	171,4	168,4	165,4	163	160,9	158,8	156,7	154,7	140,4
PN 320	320	320	291	269,7	254,4	237,7	228,5	219,4	215,6	211,8	208,7	206	203,3	200,6	198	179,8
PN 400	400	400	363,8	337,1	318	297,1	285,7	274,2	269,5	264,7	260,9	257,5	254,1	250,8	247,6	224,7

Table 10.3.1-8: Pressure/temperature ratings acc. to EN 1092-1 – 14E0

Material Group: 15E0 (1.4581)

	Maximum allowable temperature [°C]															
	RT	100	150	200	250	300	350	400	450	500	550	560	570 (1)	580 (1)	590 (1)	600 (1)
Class	**Maximum allowable pressure [bar]**															
PN 10	10	10	9,8	9,3	8,8	8,3	8	7,8	7,6	7,5	7,4	7,4	7,3	6,7	6	5,5
PN 16	16	16	15,6	14,9	14,1	13,3	12,8	12,4	12,2	12	11,9	11,8	11,7	10,7	9,7	8,8
PN 25	25	25	24,5	23,3	22,1	20,8	20,1	19,5	19,1	18,8	18,6	18,5	18,3	16,7	15,2	13,8
PN 40	40	40	39,2	37,3	35,4	33,3	32,1	31,2	30,6	30	29,9	29,6	29,3	26,8	24,3	22
PN 63	63	63	61,8	58,8	55,8	52,5	50,7	49,2	48,3	47,4	47,1	46,6	46,2	42,3	38,4	34,8
PN 100	100	100	98	93,3	88,5	83,3	80,4	78	76,6	75,2	74,7	74	73,3	67,1	60,9	55,2
PN 160	160	160	156,9	149,3	141,7	133,3	128,7	124,9	122,6	120,3	119,6	118,5	117,3	107,4	97,5	88,3
PN 250	250	250	245,2	233,3	221,4	208,3	201,1	195,2	191,6	188	186,9	185,1	183,3	167,8	152,3	138
PN 320	320	320	313,9	298,6	283,4	266,6	257,5	249,9	245,3	240,7	239,2	237	234,6	214,8	195	176,7
PN 400	400	400	392,3	373,3	354,2	333,3	321,9	312,3	306,6	300,9	299	296,2	293,3	268,5	243,8	220,9

Table 10.3.1-9: Pressure/temperature ratings acc. to EN 1092-1 – 15E0

Notes:

(1) see general note (1)

Material Group: 16E0 (1.4462, 1.4470)

	Maximum allowable temperature [°C]				
	RT	100	150	200	250
Class	**Maximum allowable pressure [bar]**				
PN 10	10,0	10,0	10,0	10,0	10,0
PN 16	16,0	16,0	16,0	16,0	16,0
PN 25	25,0	25,0	25,0	25,0	25,0
PN 40	40,0	40,0	40,0	40,0	40,0
PN 63	63,0	63,0	63,0	63,0	63,0
PN 100	100,0	100,0	100,0	100,0	100,0
PN 160	160,0	160,0	160,0	160,0	160,0
PN 250	250,0	250,0	250,0	250,0	250,0
PN 320	320,0	320,0	320,0	320,0	320,0
PN 400	400,0	400,0	400,0	400,0	400,0

Table 10.3.1-10: Pressure/temperature ratings acc. to EN 1092-1 – 16E0

Pressure/temperature ratings below reference temperature (RT)

Lower temperature limits are described in the standards EN 13445-2 as well as AD-2000 Merkblatt W10. The application of AD-2000 Merkblatt W10 is in compliance with the PED 2014/68/EU and is used to determine pressure/temperature ratings for temperatures below ambient temperature (RT). AD-2000 Merkblatt W10 differentiates between 3 load-cases.

Load-cases

Load case I	No restrictions
Load case II	The operating pressure may not be larger than 75% of the maximum allowable pressure
Load case III	The operating pressure may not be larger than 25% of the maximum allowable pressure

Table 10.3.1-11: Overview of load cases

Minimum temperatures

Material	Load case		
	I	II	III
	Minimum temperature °C		
1.0425 1.0460 1.0619	-10	-60	-85
1.4404 1.4408	-200	-255	-273
1.4462	-40	-60	-60

Table 10.3.1-12: Overview of minimum temperatures for different load cases

10.3.2 Dimensions acc. to EN 1092

Flange dimensions are available from DN 15 to DN 500. The tables are sorted by classes in ascending order. The flange dimensions depend on different flange types.

This is only an extraction of standard EN 1092-1/-2.

Only type 11 and type 21 steel flanges and type 11 cast iron flanges are used by LESER and are listed below. Cast iron flanges in classes PN 2.5, PN 6 and PN63 aren't used at LESER.

Types of flanges:

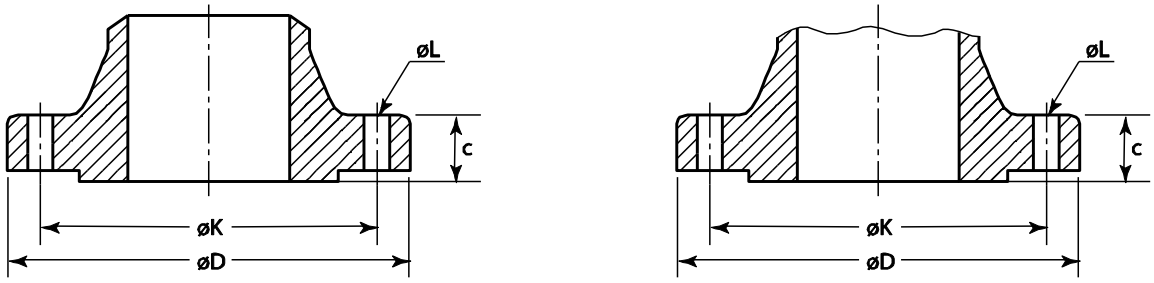


Figure 10.3.2-1: EN1092-1 – types of flanges made of steel

Dimensions acc. to EN 1092

All connection dimensions up to DN 50 in pressure groups PN 10 (table 10.3.2-1) – PN 40 (10.3.2-4) are equal.

Class PN 10

DN	Connection dimensions						Thickness			
	Outside diameter	Bolt circle diameter	Bolt hole diameter		Bolting					
	D	K	L		Number	Size	C_2	C_3	C	C
			Steel	Cast iron			Steel		DG (ductile iron) (1), (3)	GG (cast iron) (1), (4)
	Type of flange									
	11 21						11	21	11	21
15	use nominal pressure of PN40 for this size						16	16	14	14
20							18	18	16	16
25							18	18	16	16
32							18	18	18	18
40							18	18	19	18
50							18	18	19	20
65					4 or 8(5)		18	18	19	20
80							20	20	19	22
100	220	180	18	19	8	M16	20	20	19	24
125	250	210	18	19	8	M16	22	22	19	26
150	285	240	22	23	8	M20	22	22	19	26
200	340	295	22	23	8	M20	24	24	20	26
250	395 (2)	350	22	23	12	M20	26	26	22	28
300	445 (2)	400	22	23	12	M20	26	26	24,5	28
350	505	460	22	23	16	M20	26	26	26.5	30
400	565	515	26	28	16	M24	26	26	28	32
500	670	620	26	28	20	M24	28	28	31.5	34

Table 10.3.2-1: EN1092-1 – dimensions of flanges – class PN 10

Notes:

(1) see table 10.3.2-1 for further information about the material shortcut
(2) for pipes and fittings of ductile iron, the outside diameter have to correspond the dimensions below:
- DN 250: D = 400 mm / - DN 300: D = 455 mm
(3) flanges class PN 10 of ductile iron can be used at sleeve pipes up to a pressure of 15 bar
(4) these flangethicknisses are also valid for flanges of ductile iron type 21-2
(5) flanges of steel acc. to EN 1092-1 shall be delivered with 8 holes,
flanges of cast iron acc. to EN 1092-2 shall be delivered with 4 holes.
Both, EN 1092-1 and EN 1092-2 allow to deviate and supply steel flanges with 4 holes and cast iron flanges with 8 holes, if agreed between purchaser and manufacturer.
Please note that LESER delivers steel and cast iron flanges with 4 holes until further notice. This is to ensure compatibility of flanges made of steel and flanges made of cast iron. LESER will of course supply steel flanges with 8 holes if requested.

Dimensions acc. to EN 1092

Class PN 16

DN	Connection dimensions						Thickness			
	Outside diameter	Bolt circle diameter	Bolt hole diameter		Bolting					
	D	K	L		Number	Size	C_2	C_3	C	C
			Steel	Cast iron			Steel		DG (ductile iron) (1), (2)	GG (cast iron) (1), (3)
	Type of flange									
	11 21						11	21	11	21
15	use nominal pressure of PN40 for this size						16	16	14	14
20							18	18	16	16
25							18	18	16	16
32							18	18	18	18
40							18	18	19	18
50							18	18	19	20
65					4 or 8 (4)		18	18	19	20
80							20	20	19	22
100	220	180	18	19	8	M16	20	20	19	24
125	250	210	18	19	8	M16	22	22	19	26
150	285	240	22	23	8	M20	22	22	19	26
200	340	295	22	23	12	M20	24	24	20	30
250	405 (2)	355	26	28	12	M24	26	26	22	32
300	460 (2)	410	26	28	12	M24	28	28	24.5	32
350	520	470	26	28	16	M24	30	30	26.5	36
400	580	525	30	31	16	M27	32	32	28	38
500	715	650	33	34	20	M30	36	44	31.5	42

Table 10.3.2-2: EN1092-1 – dimensions of flanges – class PN 16

Notes:

(1) see table 10.3.2-1 for further information about the material shortcut

(2) for pipes and fittings of ductile iron, the outside diameter have to correspond the dimensions below:
- DN 250: D = 400 mm / - DN 300: D = 455 mm

(3) these flangethicknisses are also valid for flanges of ductile iron type 21-2

(4) flanges of steel acc. to EN 1092-1 shall be delivered with 8 holes,
flanges of cast iron acc. to EN 1092-2 shall be delivered with 4 holes.
Both, EN 1092-1 and EN 1092-2 allow to deviate and supply steel flanges with 4 holes and cast iron flanges with 8 holes, if agreed between purchaser and manufacturer.
Please note that LESER delivers steel and cast iron flanges with 4 holes until further notice. This is to ensure compatibility of flanges made of steel and flanges made of cast iron. LESER will of course supply steel flanges with 8 holes if requested.

Dimensions acc. to EN 1092

Class PN 25

DN	Connection dimensions						Thickness			
	Outside diameter	Bolt circle diameter	Bolt hole diameter		Bolting					
	D	K	L		Number	Size	C_2	C_3	C	C
			Steel	Cast iron			Steel		DG (ductile iron) (1)	GG (cast iron) (1), (2)
	Type of flange									
	11 21						11	21	11	21
15	use nominal pressure of PN40 for this size								14	
20									16	
25									16	
32									18	
40										
50										
65										
80										
100	235	190	22	23	8	M20	24	24	19	28
125	270	220	26	28	8	M24	26	26	19	30
150	300	250	26	28	8	M24	28	28	20	34
200	360	310	26	28	12	M24	30	30	22	34
250	425	370	30	31	12	M27	32	32	24.5	36
300	485	430	30	31	16	M27	34	34	27.5	40
400	620	550	36	37	16	M33	40	40	32	48

Table 10.3.2-3: EN1092-1 – dimensions of flanges – class PN 25

Notes:

(1) see table 10.3.2-1 for further information about the material shortcut
(2) these flangethicknisses are also valid for flanges of ductile iron type 21-2

Class PN 40

DN	Connection dimensions						Thickness			
	Outside diameter	Bolt circle diameter	Bolt hole diameter		Bolting					
	D	K	L		Number	Size	C_2	C_3	C	C
			Steel	Cast iron			Steel		DG (ductile iron) (1)	GG (cast iron) (1), (2)
	Type of flange									
	11 21						11	21	11	21
15	95	65	14	14	4	M12	16	16	-	16
20	105	75	14	14	4	M12	18	18	-	18
25	115	85	14	14	4	M12	18	18	-	18
32	140	100	18	19	4	M16	18	18	-	20
40	150	110	18	19	4	M16	18	18	19	20
50	165	125	18	19	4	M16	20	20	19	22
65	185	145	18	19	8	M16	22	22	19	24
80	200	160	18	19	8	M16	24	24	19	26
100	235	190	22	23	8	M20	24	24	19	28
125	270	220	26	28	8	M24	26	26	23.5	30
150	300	250	26	28	8	M24	28	28	26	34
200	375	320	30	31	12	M27	34	34	30	40
250	450	385	33	34	12	M30	38	38	34.5	46
300	515	450	33	34	16	M30	42	42	39.5	50

Table 10.3.2-4: EN1092-1 – dimensions of flanges – class PN 40

Notes:

(3) see table 10.3.2-1 for further information about the material shortcut
(4) these flangethickneses are also valid for flanges of ductile iron type 21-2

Dimensions acc. to EN 1092

Class PN 63 (steel flanges)

DN	Connection dimensions					Thickness	
	Outside diameter	Bolt circle diameter	Bolt hole diameter	Bolting			
	D	K	L	Number	Size	C_2	C_3
	Type of flange						
	11 21					11	21
15	105	75	14	4	M12	20	20
20	130	90	18	4	M16	22	22
25	140	100	18	4	M16	24	24
32	155	110	22	4	M20	24	26
40	170	125	22	4	M20	26	28
50	180	135	22	4	M20	26	26
65	205	160	22	8	M20	26	26
80	215	170	22	8	M20	28	28
100	250	200	26	8	M24	30	30
125	295	240	30	8	M27	34	34
150	345	280	33	8	M30	36	36

Table 10.3.2-5: EN1092-1 – dimensions of flanges made of steel – class PN 63

Class PN 100 (steel flanges)

DN	Connection dimensions					Thickness	
	Outside diameter	Bolt circle diameter	Bolt hole diameter	Bolting			
	D	K	L	Number	Size	C_2	C_3
	Type of flange						
	11 21					11	21
15	105	75	14	4	M12	20	20
20	130	90	18	4	M16	22	22
25	140	100	18	4	M16	24	24
32	155	110	22	4	M20	24	26
40	170	125	22	4	M20	26	28
50	195	145	26	4	M24	28	30
65	220	170	26	8	M24	30	34
80	230	180	26	8	M24	32	36
100	265	210	30	8	M27	36	40
125	315	250	33	8	M30	40	40
150	355	290	33	12	M30	44	44

Table 10.3.2-6: EN1092-1 – dimensions of flanges made of steel – class PN 100

Class PN 160 (steel flanges)

DN	Connection dimensions					Thickness	
	Outside diameter	Bolt circle diameter	Bolt hole diameter	Bolting			
	D	K	L	Number	Size	C_2	C_3
	Type of flange						
	11 21					11	21
15	105	75	14	4	M12	20	20
25	140	100	18	4	M16	24	24
40	170	125	22	4	M20	28	28
50	195	145	26	4	M24	30	30
65	220	170	26	8	M24	34	34
80	230	180	26	8	M24	36	36
100	265	210	30	8	M27	40	40
125	315	250	33	8	M30	44	44
150	355	290	33	12	M30	50	50

Table 10.3.2-7 – EN1092-1 – dimensions of flanges made of steel – class PN 160

Dimensions acc. to EN 1092

Class PN 250 (steel flanges)

DN	Connection dimensions					Thickness	
	Outside diameter	Bolt circle diameter	Bolt hole diameter	Bolting			
	D	K	L	Number	Size	C_2	C_3
	Type of flange						
	11 21					11	21
15	130	90	18	4	M16	26	26
25	150	105	22	4	M20	28	28
40	185	135	26	4	M24	34	34
50	200	150	26	8	M24	38	38
65	230	180	26	8	M24	42	42
80	255	200	30	8	M27	46	46
100	300	235	33	8	M30	54	54
125	340	275	33	12	M30	60	60
150	390	320	36	12	M33	68	68

Table 10.3.2-8: EN1092-1 – dimensions of flanges made of steel – class PN 250

Class PN 320 (steel flanges)

DN	Connection dimensions					Thickness	
	Outside diameter	Bolt circle diameter	Bolt hole diameter	Bolting			
	D	K	L	Number	Size	C_2	C_3
	Type of flange						
	11 21					11	21
15	130	90	18	4	M16	26	26
25	160	115	22	4	M20	34	34
40	195	145	26	4	M24	38	38
50	210	160	26	8	M24	42	42
65	255	200	30	8	M27	51	51
80	275	220	30	8	M27	55	55
100	335	265	36	8	M33	65	65
125	380	310	36	12	M33	75	75
150	425	350	39	12	M36	84	84

Table 10.3.2-9: EN1092-1 – dimensions of flanges made of steel – class PN 320

Class PN 400 (steel flanges)

DN	Connection dimensions					Thickness	
	Outside diameter	Bolt circle diameter	Bolt hole diameter	Bolting			
	D	K	L	Number	Size	C_2	C_3
	Type of flange						
	11 21					11	21
15	145	100	22	4	M20	30	30
25	180	130	26	4	M24	38	38
40	220	165	30	4	M27	48	48
50	235	180	30	8	M27	52	52
65	290	225	33	8	M30	64	64
80	305	240	33	8	M30	68	68
100	370	295	39	8	M36	80	80

Table 10.3.2-10: EN1092-1 – dimensions of flanges made of steel – class PN 400

10.3.3 Flange Facings and Finish acc. to EN 1092

Forms of flange facings are shown in Fig. 10.3.3-1 and their dimensions in Tab. 10.3.3-1.

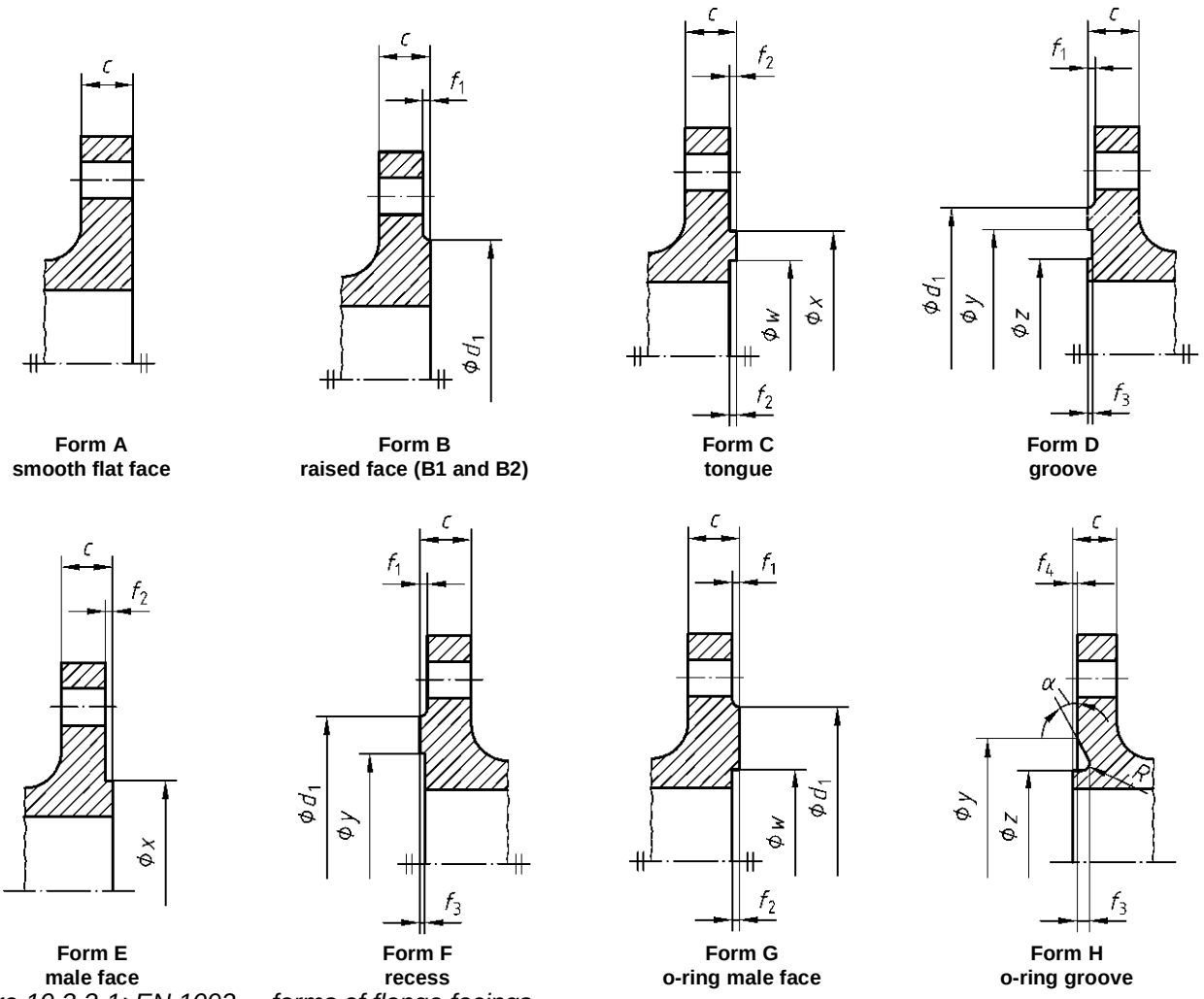


Figure 10.3.3-1: EN 1092 – forms of flange facings

Dimensions of flange facings

This table gives an overview about flange facing dimensions and can be used to select a sealing or to identify an existing sealing surface acc. to EN 1092-1 and parent standards. See chapter 3.2 for flange thickness “C”.

DN	d_1										f_1	f_2	f_3	f_4	w^b	x	y	z^b	α ≈	R
	PN 10	PN 16	PN 25	PN 40	PN 63	PN 100	PN 160	PN 250	PN 320	PN 400										
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm		mm
15	45	45	45	45	45	45	45	45	45	45	2	4,5	4	2	29	39	40	28	-	2,5
20	58	58	58	58	58	58	58	58	58	58					36	50	51	35	-	
25	68	68	68	68	68	68	68	68	68	68					43	57	58	42	41°	
32	78	78	78	78	78	78	78	78	78	78					51	65	66	50		
40	88	88	88	88	88	88	88	88	88	88	3				61	75	76	60		
50	102	102	102	102	102	102	102	102	102	102					73	87	88	72		
65	122	122	122	122	122	122	122	122	122	122					95	109	110	94		
80	138	138	138	138	138	138	138	138	138	138					106	120	121	105		
100	158	158	162	162	162	162	162	162	162	162		5	4,5	2,5	129	149	150	128	32°	3
125	188	188	188	188	188	188	188	188	188	188					155	175	176	154		
150	212	212	218	218	218	218	218	218	218	218					183	203	204	182		
200	268	268	278	285	285	285	285	285	285	285					239	259	260	238		
250	320	320	335	345	345	345	345	345	345	-					292	312	313	291		
300	370	378	395	410	410	410	410	-	-	-	4				343	363	364	342		
350	430	438	450	465	465	465	-	-	-	-		5,5	5	3	395	421	422	394	27°	3,5
400	482	490	505	535	535	535	-	-	-	-					447	473	474	446		
450	532	550	555	560	560	560	-	-	-	-					497	523	524	496		
500	585	610	615	615	615	615	-	-	-	-					549	575	576	548		

Table 10.3.3-1: EN 1092 – dimensions of flange facings

Notes:

(a) Flange sealing surfaces form C, D, E, F, G and H are not used for PN 2,5 and PN 6.
(b) Flange sealing surfaces form G and H are used for PN 10 to PN 40 only.

Surface finish for flange faces

It is not intended that instrument measurements are taken on the faces themselves; the R_a and R_z values as defined in EN ISO 4287 relate to reference specimens. That means an inspection is performed visually by comparing the surface finish of the flange face with the reference specimen.

Flange facings form	Machining operation	Radius of cutting edge mm	R_a[a] µm		R_z[a] µm	
		min.	min.	max.	min.	max.
A, B1[b], E, F	turning[c]	1,0	3,2	12,5	12,5	50
B2[b], C, D, G, H	turning[c]	-	0,8	3,2	3,2	12,5

Table 10.3.3-2: EN 1092 – surface finish for flange faces

Notes:

in some applications (e.g. low temperature casting) it is necessary to define a more detailed quality inspection
(a) Ra and Rz are defined to EN ISO 4287
(b) B1 and B2 are forms of sealing surfaces with raised face (form B) with different surface roughnesses
B1: standard sealing surface for all pressure ratings
B2: an agreement between customer and manufacturer is required
(c) “turning” covers every single machining operation, in which concentrical or spiral grooves are produced

EN 1092 does further contain surface roughness requirements for the outer diameter of the flange. The outer diameter of casted valve bodies is typically not machined (see also section 3.6), because the outer diameter is used to clamp the body during machining.

10.3.4 Comparison of Old DIN Flange Standards and EN 1092-1

Table 10.3.4-1 shows a comparison of old DIN standards for flanges, which were replaced by DIN EN 1092-1 and the application range of EN 1092-1.

See the table below (reference: EN 1092-1, Tab. NA.1)

DIN (old)	Flange type according to EN	Application area	Size according to previous DIN	Size according to EN 1092-1
2512	-	flanges – tongue and groove – sizes, insert rings PN 10 to PN 160	≤ PN 160 DN 4 to DN 1000	≤ PN 100 DN 10 to DN 2000
2513	-	male face und recess	DN 10 to DN 1000	≤ PN 100 DN 10 to DN 2000
2514	-	male face with groove and recess	DN 10 to DN 3000	≤ PN 100 DN 10 to DN 2000
2527	05	blind flange, PN 2.5	not specified	DN 10 to DN 2000
	05	blind flange, PN 6	DN 10 to DN 500	DN 10 to DN 2000
	05	blind flange, PN 10	DN 10 to DN 500	DN 10 to DN 1200
	05	blind flange, PN 16	DN 10 to DN 500	DN 10 to DN 1200
	05	blind flange, PN 25	DN 10 to DN 500	DN 10 to DN 600
	05	blind flange, PN 40	DN 10 to DN 500	DN 10 to DN 600
	05	blind flange, PN 64 (new PN 63)	DN 10 to DN 400	DN 10 to DN 400
	05	blind flange, PN 100	DN 10 to DN 350	DN 10 to DN 350
2528	-	flanges	no sizes, only materials / application temperatures	-
2543	21	cast steel flange, PN 16	DN 10 to DN 2200	DN 10 to DN 2000
2544	21	cast steel flange, PN 25	DN 10 to DN 2000	DN 10 to DN 2000
2545	21	cast steel flange, PN 40	DN 10 to DN 1600	DN 10 to DN 600
2546	21	cast steel flange, PN 64 (new PN 63)	DN 10 to DN 1200	DN 10 to DN 1200
2547	21	cast steel flange, PN 100	DN 125 to DN 700	DN 10 to DN 500
2548	21	cast steel flange, PN 160	DN 10 to DN 300	DN 10 to DN 300
2549	21	cast steel flange, PN 250	DN 10 to DN 300	DN 10 to DN 300
2550	21	cast steel flange, PN 320	DN 10 to DN 250	DN 10 to DN 250
2551	21	cast steel flange, PN 400	DN 10 to DN 200	DN 10 to DN 200
2566	13	threaded flange with socket, PN 10 to PN 16	DN 6 to DN 100	DN 10 to DN 600
2573	1	flanges, blank for brazing and welding, PN 6	DN 10 to DN 500	DN 10 to DN 600
2576	1	flanges, blank for brazing and welding, PN 10	DN 10 to DN 500	DN 10 to DN 600
2627	11	weld neck flanges, PN 400	DN 10 to DN 200	DN 10 to DN 200
2628	11	weld neck flanges, PN 250	DN 10 to DN 250	DN 10 to DN 300
2629	11	weld neck flanges, PN 320	DN 10 to DN 250	DN 10 to DN 250
2630	11	weld neck flange, PN 1 and PN 2.5	DN 10 to DN 4000	DN 10 to DN 4000
2631	11	weld neck flange, PN 6	DN 10 to DN 3600	DN 10 to DN 3600
2632	11	weld neck flange, PN 10	DN 10 to DN 3000	DN 10 to DN 3000
2633	11	weld neck flange, PN 16	DN 10 to DN 2000	DN 10 to DN 2000
2634	11	weld neck flange, PN 25	DN 10 to DN 1000	DN 10 to DN 1000
2635	11	weld neck flange, PN 40	DN 10 to DN 500	DN 10 to DN 600
2636	11	weld neck flange, PN 64 (new PN 63)	DN 10 to DN 400	DN 10 to DN 400
2637[a]	11	weld neck flange, PN 100	DN 10 to DN 350	DN 10 to DN 350
2638[a]	11	weld neck flanges, PN 160	DN 10 to DN 300	DN 10 to DN 300
2641[a]	02, 33, 32	lapped flange; unturned welding flange; plain flange, PN 6	DN 10 to DN 1200	DN 10 to DN 600
2642[a]	02, 33, 32	lapped flange; unturned welding flange; plain flange, PN 10	DN 10 to DN 800	DN 10 to DN 600
2655[a]	02, 33, 32	lapped flange; plain flange, PN 25	DN 10 to DN 500	DN 10 to DN 600
2656[a]	02, 33, 32	lapped flange; plain flange, PN 40	DN 10 to DN 400	DN 10 to DN 600
2673[a]	04, 34	lapped flange with welded flange, PN 10	DN 10 to DN 1200	DN 10 to DN 600

Table 10.3.4-1: EN 1092 – comparison of old DIN standards and EN 1092

Notes

(a) replaced by DIN EN 1092-1

10.3.5 Comparison of Flange Facings Old DIN Standards and EN 1092-1

See the table below (reference: EN 1092-1, Tab. NA.2)

Old designation according to DIN (see table 10.3.4-1)	New designation according to EN 1092-1
form A	form A
form B	
form C	form B1
form D	
form E	form B2[a]
form F	form C
form N	form D
form V 13	form E
form R 13	form F
form V 14	form H
form R 14	form G
[a]) the sealing surface form B2 has to be arranged separately between customer and manufacturer. See EN 1092-1 table 2, note b	

Table 10.3.5-1: EN 1092-1 – comparison of flange facings old DIN standards and EN 1092-1

10.3.6 Flanges according to EN 1759-1

The title of EN 1759-1 is Circular flanges for pipes, valves, fittings and accessories, Class designated.

It contains flanges with ANSI/ASME origin (ASME B16.5) with the dimensions taken from ASME B16.5, hard metricated.

That means that flanges acc. to ASME B16.5 and EN 1759-1 match. If flanges acc. to EN 1759-1 are requested, LESER will confirm and provide flanges acc. to ASME B 16.5.

In addition to ASME B 16.5, EN 1759-1 permits the use of European steels according to EN 1092-1 and contains also pressure temperature ratings for these materials.

10.3.7 Codes and Standards – EN 1092 Flanges

DIN EN 1092-1, *Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part 1: Steel flanges*

DIN EN 1092-2, *Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part 2: Cast iron flanges*

DIN EN 1092-3, *Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part 1: Copper alloy flanges*

EN 1333, *Flanges and their joints - Pipework components - Definition and selection of PN*

EN 1591-1, *Flanges and their joints - Design rules for gasketed circular flange connections - Part 1: Calculation method*

EN ISO 6708, *Pipework components - Definition and selection of DN*

ISO 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 2768-1, *General tolerances — Part 1: tolerances for linear and angular dimensions without individual tolerance indications*

10.4 Flanged Connections acc. to ASME B16.5 / ASME B16.34

Within the ASME Code there are several standards covering pressure-temperature ratings:

Standard	Title	Applies to:
ASME B16.5	Pipe Flanges and Flanged Fittings: NPS 1/2 through 24	Steel flanges
ASME B16.34	Valves Flanged, Threaded and Welding End	Steel valve bodies
ASME B16.42	Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300	Ductile iron flanges

Table 10.4-1: ASME code standards covering pressure-temperature ratings

ASME B16.5 and ASME B16.34 contain material groups and pressure/temperature ratings which are identical. ASME B16.34 however contains some more materials than ASME B16.5. ASME B16.34 does not list the flange class 400, however it contains a class 4500 which applies to butt weld ends only. Only ASME B16.5 contains flange dimensions. Therefore all tables and chapters in this Engineering Handbook are based on ASME B16.5 (edition 2009)

Flanges and pressure-temperature ratings for ductile iron flanges are listed in ASME B16.42 (edition 1998).

Pressure/Temperature Ratings acc. to ASME B16.5:

Pressure-temperature ratings are maximum allowable working gage pressures at the temperatures shown in the following tables for the applicable material and class designation. For intermediate temperatures, linear interpolation is permitted. Interpolation between class designations is not permitted.

Overview of materials and material groups

LESER standard materials			
Material	**Material group**	**Further materials of material group**	**Notes**
SA 105 (1) SA 216 Gr. WCB (1)	1.1	SA 350 Gr. LF2 (1) SA 350 Gr. LF6 Cl. (4) SA 350 Gr. LF3 SA 515 Gr. 70 (1) SA 516 Gr. 70 (1), (2) SA 537 Cl. 1 (3)	(1) Upon prolonged exposure to temperatures above 425°C, the carbide phase of steel may be converted to graphite. Permissible but not recommend for prolonged use above 425°C. (2) Not to be used over 455°C (850°F) (3) Not to be used over 370°C (700°F) (4) Not to be used over 260°C (500°F)
SA 352 LCB (3)	1.3	SA 217 Gr. WC1 (4), (5) SA 352 Gr. LC1 (3) SA 515 Gr. 65 (1) SA 515 Gr. 65 (1), (2) SA 203 Gr. A (1) SA 203 Gr. D (1)	(1) Upon prolonged exposure to temperatures above 425°C (800°F), the carbide phase of steel may be converted to graphite. Permissible but not recommend for prolonged use above 425°C (800°F). (2) Not to be used over 455°C (850°F) (3) Not to be used over 340°C (650°F) (4) Upon prolonged exposure to temperatures above 465°C (875°F), the carbide phase of steel may be converted to graphite. Permissible but not recommend for prolonged use above 465°C (875°F). (5) Use normalized and tempered material only
SA 217 Gr. WC6 (1), (3)	1.9	SA 182 Gr. F11 Cl. 2 (1), (2) SA 387 Gr. 11 Cl. 2 (2)	(1) Use normalized and tempered material only (2) Permissible, but not recommend for prolonged use above 590°C (1100°F) (3) Not to be used over 590°C (1100°F)
SA 351 Gr. CF8M (1)	2.2	SA 182 Gr. F316 (1) SA 182 Gr. F316H SA 182 Gr. F317 (1) SA 351 Gr. CF3M (2) SA 351 Gr. CG8M (3) SA 240 Gr. 316 (1) SA 240 Gr. 316H SA 240 Gr. 317 (1)	(1) At temperatures over 538°C (1000°F), use only when carbon content is 0.04% or higher (2) Not to be used over 455°C (850°F) (3) Not to be used over 538°C (1000°F)
SA 182 Gr. F316L SA 240 Gr. 316L	2.3	SA 182 Gr. 304L (1) SA 240 Gr. 304L (1)	(1) Not to be used over 425°C (800°F)
Additional materials			
Material	**Material group**	**Further materials of material group**	**Notes**
SA 216 Gr. WCC (1) SA 352 Gr. LCC (2)	1.2	SA 350 Gr. LF6 Cl.2 (3) SA 352 Gr. LC2 SA 352 Gr. LC3 SA 203 Gr. B (1) SA 203 Gr. E (1)	(1) Upon prolonged exposure to temperatures above 425°C (800°F), the carbide phase of steel may be converted to graphite. Permissible but not recommend for prolonged use above 425°C (800°F). (2) Not to be used over 340°C (650°F) (3) Not to be used over 260°C (500°F)
SA 217 Gr. WC5 (1)	1.7	SA182 Gr. F2 (2) SA 217 Gr. WC4 (1), (2)	(1) Use normalized and tempered material only. (2) Not to be used over 538° C (1000°F)
SA 217 Gr. WC9 (1), (3)	1.10	SA 182 Gr. F22 Cl. 3 (2) SA 387 Gr. 22 Cl. 2 (2)	(1) Use normalized and tempered material only (2) Permissible, but not recommend for prolonged use above 590°C (1100°F) (3) Not to be used over 590°C (1100°F)
SA 217 Gr C5 (1), (2)	1.13	SA 182 Gr 5Fa	(1) Use normalized and tempered material only (2) The deliberate addition of any element not listed in ASTM A 217, Table 1 is prohibited, except that Ca and Mg may be added for deoxidation
SA 351 Gr. CK3MCuN SA 351 Gr. CE8MN (1) SA 351 Gr. CD4MCu (1) SA 351 Gr. CD3MWCuN (1)	2.8	SA 182 Gr. F44 SA 182 Gr. F51 (1) SA 182 Gr. F53 (1) SA 240 Gr. S31254 SA 240 Gr. S31803 (1) SA 240 Gr. S32750 (1)	(1) This steel may become brittle after service at moderately elevated temperatures. Not to be used over 315° C (600°F)
SA 351 Gr. CF8C (1)	2.11	-	(1) At temperatures over 538° C (1100°F), use only when the carbon content is 0.04% or higher

Table 10.4.-2: ASME B16.5 – materials and their groups

Overview of materials and material groups – further materials

The following materials are typically not used by LESER and pressure-temperature ratings are not listed here, but in ASME B16.5.
Materials for body and bonnet must be listed in ASME VIII and ASME II. In the case that a material is not listed in ASME B16.5, LESER can provide a proof if this material can be used by a strength calculation or a comparison of mechanical properties with a listed material.

Further materials		
Material group	**Materials of material group**	
1.4	SA 515 Gr 60	SA 516 Gr 60
1.5	SA 182 Gr F1	SA 204 Gr A/B
1.11	SA 204 Gr C	
1.14	SA 182 Gr F9	SA 217 Gr C12
1.15	SA 182 Gr F91 SA 217 Gr C12	SA 387 Gr 91 Cl 2
1.17	SA 182 Gr F12 Cl 2	SA 182 Gr F5
2.1	SA 182 Gr F304 SA 182 Gr F304H SA 351 Gr CF3	SA 351 Gr CF8 SA 240 Gr 304 SA 240 Gr 304H
2.4	SA 182 Gr F321 SA 182 Gr F321H	SA 240 Gr 321 SA 240 Gr 241H
2.5	SA 182 Gr F347 SA 182 Gr F347H SA 182 Gr F348 SA 182 Gr F348H	SA 240 Gr 347 SA 240 Gr 347H SA 240 Gr 348 SA 240 Gr 348H
2.6	A 240 Gr 309H	
2.7	SA 182 Gr F310	SA 240 Gr 310H
2.9	SA 240 Gr. 309S	SA 240 Gr. 310S
2.10	SA 351 Gr. CH8	SA 351 Gr. CH20
2.12	SA 351 Gr. CK20	
3.1	SB 462 Gr. N08020	SB 463 Gr. N08020
3.2	SB 160 Gr. N02200	SB 162 Gr. N02200
3.3	SB 160 Gr. N02201	SB 162 Gr. N02201
3.4	SB 564 Gr. N04400 SB 164 Gr. N04405	SB 127 Gr. N04400
3.5	SB 564 Gr. N06600	SB 168 Gr. N06600
3.6	SB 564 Gr. N08800	SB 409 Gr. N08800
3.7	SB 462 Gr. N10665 SB 462 Gr. N10675	SB 333 Gr. N10665 SB 333 Gr. N10675
3.8	SB 462 Gr. N10276 SB 564 Gr. N06625 SB 335 Gr. N10001 SB 573 Gr. N10003 SB 574 Gr. N06455 SB 564 Gr. N08825 SB 462 Gr. N06022 SB 462 Gr. N06200	SB 575 Gr. N10276 SB 443 Gr. N06625 SB 333 Gr. N10001 SB 434 Gr. N10003 SB 575 Gr. N06455 SB 424 Gr. N08825 SB 575 Gr. N06022 SB 575 Gr. N06200
3.9	SB 572 Gr. N06002	SB 435 Gr. N06002
3.10	SB 672 Gr. N08700	SB 599 Gr. N08700
3.11	SB 649 Gr. N08904	B 625 Gr. N08904
3.12	SB 621 Gr. N08320 SB 581 Gr. N06985 SB 462 Gr. N08367 SA 351 Gr. CN3MM	SB 620 Gr. N08320 SB 582 Gr. N06985 SB 688 Gr. N08367
3.13	SB 581 Gr. N06975 SB 564 Gr. N08031	SB 582 Gr. N06975 SB 625 Gr. N08031
3.14	SB 581 Gr. N06007 SB 462 Gr. N06030	SB 582 Gr. N06007 SB 582 Gr. N06030
3.15	SB 564 Gr. N08810	SB 409 Gr. N08810
3.16	SB 511 Gr. N08330	SB 536 Gr. N08330
3.17	SA 351 Gr. CN7M	

Table 10.4 -3: ASME B16.5 – materials and their groups

10.4.1 Pressure/Temperature Ratings acc. to ASME B16.5

Material Group: 1.1 (SA 216 Gr. WCB [1])

Metric units

	Maximum allowable temperature [°C]																
	-29	38	50	100	150	200	250	300	325	350	375	400	425	450	475	500	538
Class	**Maximum allowable pressure [bar]**																
150	19.6	19.6	19.2	17.7	15.8	13.8	12.1	10.2	9.3	8.4	7.4	6.5	5.5	4.6	3.7	2.8	1.4
300	51.1	51.1	50.1	46.6	45.1	43.8	41.9	39.8	38.7	37.6	36.4	34.7	28.8	23.0	17.4	11.8	5.9
600	102.1	102.1	100.2	93.2	90.2	87.6	83.9	79.6	77.4	75.1	72.7	69.4	57.5	46.0	34.9	23.5	11.8
900	153.2	150.4	150.4	139.8	135.2	131.4	125.8	119.5	116.1	112.7	109.1	104.2	86.3	69.0	52.3	35.3	17.7
1500	255.3	255.3	250.6	233.0	225.4	219.0	209.7	199.1	193.6	187.8	181.8	173.6	143.8	115.0	87.2	58.8	29.5
2500	425.5	425.5	417.7	388.3	375.6	365.0	349.5	331.8	322.6	313.0	303.1	289.3	239.7	191.7	145.3	97.9	49.2

Table 10.4.1-1: ASME B16.5 – metric units of material group 1.1 (SA 216 Gr. WCB)

US units

	Maximum allowable temperature [°F]														
	-20	100	200	300	400	500	600	650	700	750	800	850	900	950	1000
Class	**Maximum allowable pressure [psi]**														
150	285	285	260	230	200	170	140	125	110	95	80	65	50	35	20
300	740	740	680	655	635	605	570	550	530	505	410	320	230	135	85
600	1480	1480	1360	1310	1265	1205	1135	1100	1060	1015	825	640	460	275	170
900	2220	2220	2035	1965	1900	1810	1705	1650	1590	1520	1235	955	690	410	255
1500	3705	3705	3395	3270	3170	3015	2840	2745	2655	2535	2055	1595	1150	685	430
2500	6170	6170	5655	5450	5280	5025	4730	4575	4425	4230	3430	2655	1915	1145	715

Table 10.4.1-2: ASME B16.5 – US units of material group 1.1 (SA 216 Gr. WCB)

(1) WCB: Upon prolonged exposure to temperatures above 425°C (800°F), the carbide phase of steel may be converted to graphite. Permissible but not recommend for prolonged use above 425°C (800°F).

Material Group: 1.2 (SA 216 Gr. WCC [1], SA 352 Gr. LCC [2])

Metric units

	Maximum allowable temperature [°C]																
	-29	38	50	100	150	200	250	300	325	350	375	400	425	450	475	500	538
Class	**Maximum allowable pressure [bar]**																
150	19.8	19.8	19.5	17.7	15.8	13.8	12.1	10.2	9.3	8.4	7.4	6.5	5.5	4.6	3.7	2.8	1.4
300	51.7	51.7	51.7	51.5	50.2	48.6	46.3	42.9	41.4	40.0	37.8	34.7	28.8	23.0	17.1	11.6	5.9
600	103.4	103.4	103.4	103.0	100.3	97.2	92.7	85.7	82.6	80.0	75.7	69.4	57.5	46.0	34.2	23.2	11.8
900	155.1	155.1	155.1	154.6	150.5	145.8	139.0	128.6	124.0	120.1	113.5	104.2	86.3	69.0	51.3	34.7	17.7
1500	258.6	258.6	258.6	257.6	250.8	243.2	231.8	214.4	206.6	200.1	189.2	173.6	143.8	115.0	85.4	57.9	29.5
2500	430.9	430.9	430.9	429.4	418.1	405.4	386.2	357.1	344.3	333.5	315.3	289.3	239.7	191.7	142.4	96.5	49.2

Table 10.4.1-3: ASME B16.5 – metric units of material group 1.2 (SA 216 Gr. WCC (1), SA 352 Gr. LCC (2))

US units

	Maximum allowable temperature [°F]														
	-20	100	200	300	400	500	600	650	700	750	800	850	900	950	1000
Class	**Maximum allowable pressure [psi]**														
150	290	290	260	230	200	170	140	125	110	95	80	65	50	35	20
300	750	750	750	730	705	665	605	590	555	505	410	320	225	135	85
600	1500	1500	1500	1455	1405	1330	1210	1175	1110	1015	825	640	445	275	170
900	2250	2250	2250	2185	2110	1995	1815	1765	1665	1520	1235	955	670	410	255
1500	3750	3750	3750	3640	3520	3325	3025	2940	2775	2535	2055	1595	1115	685	430
2500	6250	6250	6250	6070	5865	5540	5040	4905	4630	4230	3430	2655	1855	1145	715

Table 10.4.1-4: ASME B16.5 – US units of material group 1.2 (SA 216 Gr. WCC (1), SA 352 Gr. LCC (2))

(1) WCC: Upon prolonged exposure to temperatures above 425°C (800°F), the carbide phase of steel may be converted to graphite. Permissible but not recommend for prolonged use above 425°C (800°F).
(2) LCC: Not to be used over 340°C (650°F).

Pressure/temperature ratings acc. to ASME B16.5

Material Group: 1.3 (SA 352 LCB [(1)])

Metric units

	Maximum allowable temperature [°C]																
	-29	38	50	100	150	200	250	300	325	350	375	400	425	450	475	500	538
Class	**Maximum allowable pressure [bar]**																
150	18.4	18.4	18.2	17.4	15.8	13.8	12.1	10.2	9.3	8.4	7.4	6.5	5.5	4.6	3.7	2.8	1.4
300	48.0	48.0	47.5	45.3	43.9	42.5	40.8	38.7	37.6	36.4	35.0	32.6	27.3	21.6	15.7	11.1	5.9
600	96.0	96.0	94.9	90.7	87.9	85.1	81.6	77.4	75.2	72.8	69.9	65.2	54.6	43.2	31.3	22.1	11.8
900	144.1	144.1	142.4	136.0	131.8	127.6	122.3	116.1	112.7	109.2	104.9	97.9	81.9	64.8	47.0	33.2	17.7
1500	240.1	240.1	237.3	226.7	219.7	212.7	203.9	193.4	187.9	182.0	174.9	163.1	136.5	107.9	78.3	55.4	29.5
2500	400.1	400.1	395.6	377.8	366.1	354.4	339.8	322.4	313.1	303.3	291.4	271.9	227.5	179.9	130.6	92.3	49.2

Table 10.4.1-5: ASME B16.5 – metric units of material group 1.3 (SA 352 Gr. LCB)

US units

	Maximum allowable temperature [°F]														
	-20	100	200	300	400	500	600	650	700	750	800	850	900	950	1000
Class	**Maximum allowable pressure [psi]**														
150	265	265	255	230	200	170	140	125	110	95	80	65	50	35	20
300	695	695	660	640	615	585	550	535	510	475	390	300	200	135	85
600	1395	1395	1320	1275	1230	1175	1105	1065	1025	955	780	595	405	275	170
900	2090	2090	1980	1915	1845	1760	1655	1600	1535	1430	1175	895	605	410	255
1500	3480	3480	3300	3190	3075	2930	2755	2665	2560	2385	1955	1490	1010	685	430
2500	5805	5805	5505	5315	5125	4885	4595	4440	4270	3970	3255	2485	1685	1145	715

Table 10.4.1-6: ASME B16.5 – US units of material group 1.3 (SA 352 Gr. LCB)

(1) LCB: Acc. to ASME 16.5 LCB is not to be used over 340°C(650°F). LESER supplies LCB material with a fivefold material certificate that includes WCB. That means in a critical case where LCB must be used at temperature above 340°C (650°F) the pressure temperature rating of WCB can be applied.

Pressure/temperature ratings acc. to ASME B16.5

Material Group: 1.7 (SA 217 Gr. WC5)

Metric units

	Maximum allowable temperature [°C]									
	-29	38	50	100	150	200	250	300	325	350
Class	**Maximum allowable pressure [bar]**									
150	19.8	19.8	19.5	17.7	15.8	13.8	12.1	10.2	9.3	8.4
300	51.7	51.7	51.7	51.5	50.3	48.6	46.3	42.9	41.4	40.3
600	103.4	103.4	103.4	103.0	100.3	97.2	92.7	85.7	82.6	80.4
900	155.1	155.1	155.1	154.6	150.6	145.8	139.0	128.6	124.0	120.7
1500	258.6	258.6	258.6	257.6	250.8	243.4	231.8	214.4	206.6	201.1
2500	430.9	430.9	430.9	429.4	418.2	405.4	386.2	357.1	344.3	335.3

Table 10.4.1-7: ASME B16.5 – metric units of material group 1.7 (SA 217 Gr. WC5)

Metric units

	Maximum allowable temperature [°C]								
	375	400	425	450	475	500	538	550	575
Class	**Maximum allowable pressure [bar]**								
150	7.4	6.5	5.5	4.6	3.7	2.8	1.4	-	-
300	38.9	36.5	35.2	33.7	31.7	26.7	13.9	12.6	7.2
600	77.6	73.3	70.0	67.7	63.4	53.4	27.9	25.2	14.4
900	116.5	109.8	105.1	101.4	95.1	80.1	41.8	37.8	21.5
1500	194.1	183.1	175.1	169.0	158.2	133.4	69.7	63.0	35.9
2500	323.2	304.9	291.6	281.8	263.9	222.4	116.2	105.0	59.8

Table 10.4.1-8: ASME B16.5 – metric units of material group 1.7 (SA 217 Gr. WC5)

US units

	Maximum allowable temperature [°F]									
	-20	100	200	300	400	500	600	650	700	750
Class	**Maximum allowable pressure [psi]**									
150	290	290	260	230	200	170	140	125	110	95
300	750	750	750	730	705	665	605	590	570	530
600	1500	1500	1500	1455	1410	1330	1210	1175	1135	1065
900	2250	2250	2250	2185	2115	1995	1815	1765	1705	1595
1500	3750	3750	3750	3640	3530	3325	3025	2940	2840	2660
2500	6250	6250	6250	6070	5880	5540	5040	4905	4730	4430

Table 10.4.1-9 : ASME B16.5 – US units of material group 1.7 (SA 217 Gr. WC5)

US units

	Maximum allowable temperature [°F]					
	800	850	900	950	1000	1050
Class	**Maximum allowable pressure [psi]**					
150	80	65	50	35	20	-
300	510	485	450	315	200	160
600	1015	975	900	630	405	315
900	1525	1460	1350	945	605	475
1500	2540	2435	2245	1575	1010	790
2500	4230	4060	3745	2630	1685	1315

Table 10.4.1-10: ASME B16.5 – US units of material group 1.7 (SA 217 Gr. WC5)

Pressure/temperature ratings acc. to ASME B16.5

Material Group: 1.9 (SA 217 Gr. WC6 (1))

Metric units

	Maximum allowable temperature [°C]											
	-29	38	50	100	150	200	250	300	325	350	375	400
Class	**Maximum allowable pressure [bar]**											
150	19.8	19.8	19.5	17.7	15.8	13.8	12.1	10.2	9.3	8.4	7.4	6.5
300	51.7	51.7	51.7	51.5	49.7	48.0	46.3	42.9	41.4	40.3	38.9	36.5
600	103.4	103.4	103.4	103.0	99.5	95.9	92.7	85.7	82.6	80.4	77.6	73.3
900	155.1	155.1	155.1	154.4	149.2	143.9	139.0	128.6	124.0	120.7	116.5	109.8
1500	258.6	258.6	258.6	257.4	248.7	239.8	231.8	214.4	206.6	201.1	194.1	183.1
2500	430.9	430.9	430.9	429.0	414.5	399.6	386.2	357.1	344.3	335.3	323.2	304.9

Table 10.4.1-11: ASME B16.5 – metric units of material group 1.9 (SA 217 Gr. WC6)

Metric units

	Maximum allowable temperature [°C]									
	425	450	475	500	538	550	575	600	625	650
Class	**Maximum allowable pressure [bar]**									
150	5.5	4.6	3.7	2.8	1.4	-	-	-	-	-
300	35.2	33.7	31.7	25.7	14.9	12.7	8.8	6.1	4.3	2.8
600	70.0	67.7	63.4	51.5	29.8	25.4	17.6	12.2	8.5	5.7
900	105.1	101.4	95.1	77.2	44.7	38.1	26.4	18.3	12.8	8.5
1500	175.1	169.0	158.2	128.6	74.5	63.5	44.0	30.5	21.3	14.2
2500	291.6	281.8	263.9	214.4	124.1	105.9	73.4	50.9	35.5	23.6

Table 10.4.1-12: ASME B16.5 – metric units of material group 1.9 (SA 217 Gr. WC6)

US units

	Maximum allowable temperature [°F]											
	-20	100	200	300	400	500	600	650	700	750	800	850
Class	**Maximum allowable pressure [psi]**											
150	290	290	260	230	200	170	140	125	110	95	80	65
300	750	750	750	720	695	665	605	590	570	530	510	485
600	1500	1500	1500	1445	1385	1330	1210	1175	1135	1065	1015	975
900	2250	2250	2250	2165	2080	1995	1815	1765	1705	1595	1525	1460
1500	3750	3750	3750	3610	3465	3325	3025	2940	2840	2660	2540	2435
2500	6250	6250	6250	6015	5775	5540	5040	4905	4730	4430	4230	4060

Table 10.4.1-13: ASME B16.5 – US units of material group 1.9 (SA 217 Gr. WC6)

US units

	Maximum allowable temperature [°F]						
	900	950	1000	1050	1100	1150	1200
Class	**Maximum allowable pressure [psi]**						
150	50	35	20	-	-	-	-
300	450	320	215	145	95	65	40
600	900	640	430	290	190	130	80
900	1350	955	650	430	290	195	125
1500	2245	1595	1080	720	480	325	205
2500	3745	2655	1800	1200	800	545	345

Table 10.4.1-14 : ASME B16.5 – US units of material group 1.9 (SA 217 Gr. WC6)

(1) WC6: Not to be used over 590°C.

Pressure/temperature ratings acc. to ASME B16.5

Material Group: 1.10 (SA 217 Gr. WC9 [1])

Metric units

	Maximum allowable temperature [°C]										
	-29	38	50	100	150	200	250	300	325	350	375
Class	**Maximum allowable pressure [bar]**										
150	19.8	19.8	19.5	17.7	15.8	13.8	12.1	10.2	9.3	8.4	7.4
300	51.7	51.7	51.7	51.5	50.3	48.6	46.3	42.9	41.4	40.3	38.9
600	103.4	103.4	103.4	103.0	100.3	97.2	92.7	85.7	82.6	80.4	77.6
900	155.1	155.1	155.1	154.6	150.6	145.8	139.0	128.6	124.0	120.7	116.5
1500	258.6	258.6	258.6	257.6	250.8	243.4	231.8	214.4	206.6	201.1	194.1
2500	430.9	430.9	430.9	429.4	418.2	405.4	386.2	357.1	344.3	335.3	323.2

Table 10.4.1-15: ASME B16.5 –metric units of material group 1.10 (SA 217 Gr. WC9)

Metric units

	Maximum allowable temperature [°C]										
	400	425	450	475	500	538	550	575	600	625	650
Class	**Maximum allowable pressure [bar]**										
150	6.5	5.5	4.6	3.7	2.8	1.4	-	-	-	-	-
300	36.5	35.2	33.7	31.7	28.2	18.4	15.6	10.5	6.9	4.5	2.8
600	73.3	70.0	67.7	63.4	56.5	36.9	31.3	21.1	13.8	8.9	5.7
900	109.8	105.1	101.4	95.1	84.7	55.3	46.9	31.6	20.7	13.4	8.5
1500	183.1	175.1	169.0	158.2	140.9	92.2	78.2	52.6	34.4	22.3	14.2
2500	304.9	291.6	281.8	263.9	235.0	153.7	130.3	87.7	57.4	37.2	23.6

Table 10.4.1-16: ASME B16.5 –metric units of material group 1.10 (SA 217 Gr. WC9)

US units

	Maximum allowable temperature [°F]										
	-20	100	200	300	400	500	600	650	700	750	800
Class	**Maximum allowable pressure [psi]**										
150	290	290	260	230	200	170	140	125	110	95	80
300	750	750	750	730	705	665	605	590	570	530	510
600	1500	1500	1500	1455	1410	1330	1210	1175	1135	1065	1015
900	2250	2250	2250	2185	2115	1995	1815	1765	1705	1595	1525
1500	3750	3750	3750	3640	3530	3325	3025	2940	2840	2660	2540
2500	6250	6250	6250	6070	5880	5540	5040	4905	4730	4430	4230

Table 10.4.1-17: ASME B16.5 – US units of material group 1.10 (SA 217 Gr. WC9)

US units

	Maximum allowable temperature [°F]							
	850	900	950	1000	1050	1100	1150	1200
Class	**Maximum allowable pressure [psi]**							
150	65	50	35	20	-	-	-	-
300	485	450	385	265	175	110	70	40
600	975	900	775	535	350	220	135	80
900	1460	1350	1160	800	525	330	205	125
1500	2435	2245	1930	1335	875	550	345	205
2500	4060	3745	3220	2230	1455	915	570	345

Table 10.4.1-18: ASME B16.5 – US units of material group 1.10 (SA 217 Gr. WC9)

(1) WC9: Not to be used over 590°C.

Pressure/temperature ratings acc. to ASME B16.5

Material Group: 1.13 (A 217 Gr. C5)

Metric units

	Maximum allowable temperature [°C]										
	-29	38	50	100	150	200	250	300	325	350	375
Class	**Maximum allowable pressure [bar]**										
150	20.0	20.0	19.5	17.7	15.8	13.8	12.1	10.2	9.3	8.4	7.4
300	51.7	51.7	51.7	51.5	50.3	48.6	46.3	42.9	41.4	40.3	38.9
600	103.4	103.4	103.4	103.0	100.3	97.2	92.7	85.7	82.6	80.4	77.6
900	155.1	155.1	155.1	154.6	150.6	145.8	139.0	128.6	124.0	120.7	116.5
1500	258.6	258.6	258.6	257.6	250.8	243.4	231.8	214.4	206.6	201.1	194.1
2500	430.9	430.9	430.9	429.4	418.2	405.4	386.2	357.1	344.3	335.3	323.2

Table 10.4.1-19: ASME B16.5 –metric units of material group 1.13 (A 217 Gr. C5)

Metric units

	Maximum allowable temperature [°C]										
	400	425	450	475	500	538	550	575	600	625	650
Class	**Maximum allowable pressure [bar]**										
150	6.5	5.5	4.6	3.7	2.8	1.4	-	-	-	-	-
300	36.5	35.2	33.7	27.9	21.4	13.7	12.0	8.9	6.2	4.0	2.4
600	73.3	70.0	67.7	55.7	42.8	27.4	24.1	17.8	12.5	8.0	4.7
900	109.8	105.1	101.4	83.6	64.1	41.1	36.1	26.7	18.7	12.0	7.1
1500	183.1	175.1	169.0	139.3	106.9	68.6	60.2	44.4	31.2	20.0	11.8
2500	304.9	291.6	281.8	232.1	178.2	114.3	100.4	74.0	51.9	33.3	19.7

Table 10.4.1-20: ASME B16.5 –metric units of material group 1.13 (A 217 Gr. C5)

US units

	Maximum allowable temperature [°F]										
	-20	100	200	300	400	500	600	650	700	750	800
Class	**Maximum allowable pressure [psi]**										
150	290	290	260	230	200	170	140	125	110	95	80
300	750	750	750	730	705	665	605	590	570	530	510
600	1500	1500	1500	1455	1410	1330	1210	1175	1135	1065	1015
900	2250	2250	2250	2185	2115	1995	1815	1765	1705	1595	1525
1500	3750	3750	3750	3640	3530	3325	3025	2940	2840	2660	2540
2500	6250	6250	6250	6070	5880	5540	5040	4905	4730	4430	4230

Table 10.4.1-21: ASME B16.5 – US units of material group 1.13 (A 217 Gr. C5)

US units

	Maximum allowable temperature [°F]							
	850	900	950	1000	1050	1100	1150	1200
Class	**Maximum allowable pressure [psi]**							
150	65	50	35	20	-	-	-	-
300	485	375	275	200	145	100	60	35
600	975	745	550	400	290	200	125	70
900	1460	1120	825	595	430	300	185	105
1500	2435	1870	1370	995	720	495	310	170
2500	4060	3115	2285	1655	1200	830	515	285

Table 10.4.1-22: ASME B16.5 – US units of material group 1.13 (A 217 Gr. C5)

Pressure/temperature ratings acc. to ASME B16.5

Material Group: 2.2 (SA 351 Gr. CF8M [1])

Metric units

	Maximum allowable temperature [°C]														
	-29	38	50	100	150	200	250	300	325	350	375	400	425	450	475
Class	**Maximum allowable pressure [bar]**														
150	19.0	19.0	18.4	16.2	14.8	13.7	12.1	10.2	9.3	8.4	7.4	6.5	5.5	4.6	3.7
300	49.6	49.6	48.1	42.2	38.5	35.7	33.4	31.6	30.9	30.3	29.9	29.4	29.1	28.8	28.7
600	99.3	99.3	96.2	84.4	77.0	71.3	66.8	63.2	61.8	60.7	59.8	58.9	58.3	57.7	57.3
900	148.9	148.9	144.3	126.6	115.5	107.0	100.1	94.9	92.7	91.0	89.6	88.3	87.4	86.5	86.0
1500	248.2	248.2	240.6	211.0	192.5	178.3	166.9	158.1	154.4	151.6	149.4	147.2	145.7	144.2	143.4
2500	413.7	413.7	400.9	351.6	320.8	297.2	278.1	263.5	257.4	252.7	249.0	245.3	242.9	240.4	238.9

Table 10.4.1-23: ASME B16.5 – metric units of material group 2.2 (SA 351 Gr. CF8M)

Metric units

	Maximum allowable temperature [°C]													
	500	538	550	575	600	625	650	675	700	725	750	775	800	816
Class	**Maximum allowable pressure [bar]**													
150	2.8	1.4	-	-	-	-	-	-	-	-	-	-	-	-
300	28.2	25.2	25.0	24.0	19.9	15.8	12.7	10.3	8.4	7.0	5.9	4.6	3.5	2.8
600	56.5	50.0	49.8	47.9	39.8	31.6	25.3	20.6	16.8	14.0	11.7	9.0	7.0	5.9
900	84.7	75.2	74.8	71.8	59.7	47.4	38.0	31.0	25.1	21.0	17.6	13.7	10.5	8.6
1500	140.9	125.5	124.9	119.7	99.5	79.1	63.3	51.6	41.9	34.9	29.3	22.8	17.4	14.1
2500	235.0	208.9	208.0	199.5	165.9	131.8	105.5	86.0	69.8	58.2	48.9	38.0	29.2	23.8

Table 10.4.1-24: ASME B16.5 – metric units of material group 2.2 (SA 351 Gr. CF8M)

US units

	Maximum allowable temperature [°F]														
	-20	100	200	300	400	500	600	650	700	750	800	850	900	950	1000
Class	**Maximum allowable pressure [psi]**														
150	275	275	235	215	195	170	140	125	110	95	80	65	50	35	20
300	720	720	620	560	515	480	450	440	435	425	420	420	415	385	365
600	1440	1440	1240	1120	1025	955	900	885	870	855	845	835	830	775	725
900	2160	2160	1860	1680	1540	1435	1355	1325	1305	1280	1265	1255	1245	1160	1090
1500	3600	3600	3095	2795	2570	2390	2255	2210	2170	2135	2110	2090	2075	1930	1820
2500	6000	6000	5160	4660	4280	3980	3760	3680	3620	3560	3520	3480	3460	3220	3030

Table 10.4.1-25: ASME B16.5 – US units material group 2.2 (SA 351 Gr. CF8M)

US units

	Maximum allowable temperature [°F]									
	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500
Class	**Maximum allowable pressure [psi]**									
150	-	-	-	-	-	-	-	-	-	-
300	360	305	235	185	145	115	95	75	60	40
600	720	610	475	370	295	235	190	150	115	85
900	1080	915	710	555	440	350	290	225	175	125
1500	1800	1525	1185	925	735	585	480	380	290	205
2500	3000	2545	1970	1545	1230	970	800	630	485	345

Table 10.4.1-26: ASME B16.5 – US units of material group 2.2 (SA 351 Gr. CF8M)

(1) At temperatures over 538°C (1000°F), use only when carbon content is 0.04% or higher
LESER does not specify a minimum carbon content for standard CF8M stock material, therefore the carbon content must be verified respectively specified, if an application at temperatures over 538°C (1000°F) is intended.

Pressure/temperature ratings acc. to ASME B16.5

Material Group: 2.3 (SA 182 Gr. F316L, SA 240 Gr. 316L)

Metric units

	Maximum allowable temperature [°C]													
	-29	38	50	100	150	200	250	300	325	350	375	400	425	450
Class	Maximum pressure [bar]													
150	15.9	15.9	15.3	13.3	12.0	11.2	10.5	10.0	9.3	8.4	7.4	6.5	5.5	4.6
300	41.4	41.4	40.0	34.8	31.4	29.2	27.5	26.1	25.5	25.1	24.8	24.3	23.9	23.4
600	82.7	82.7	80.0	69.6	62.8	58.3	54.9	52.1	51.0	50.1	49.5	48.6	47.7	46.8
900	124.1	124.1	120.1	104.4	94.2	87.5	82.4	78.2	76.4	75.2	74.3	72.9	71.6	70.2
1500	206.8	206.8	200.1	173.9	157.0	145.8	137.3	130.3	127.4	125.4	123.8	121.5	119.3	117.1
2500	344.7	344.7	333.5	289.9	261.6	243.0	228.9	217.2	212.3	208.9	206.3	202.5	198.8	195.1

Table 10.4.1-27: ASME B16.5 – metric units of material group 2.3 (SA 182 Gr. F316L, SA 240 Gr. 316L)

US units

	Maximum allowable temperature [°F]													
	-20	100	200	300	400	500	600	650	700	750	800	850		
Class	Maximum allowable pressure [psi]													
150	230	230	195	175	160	150	140	125	110	95	80	65		
300	600	600	510	455	420	395	370	365	360	355	345	340		
600	1200	1200	1020	910	840	785	745	730	720	705	690	675		
900	1800	1800	1535	1370	1260	1180	1115	1095	1080	1060	1035	1015		
1500	3000	3000	2555	2280	2100	1970	1860	1825	1800	1765	1730	1690		
2500	5000	5000	4260	3800	3500	3280	3100	3040	3000	2940	2880	2820		

Table 10.4.1-28: ASME B16.5 – US units of material group 2.3 (SA 182 Gr. F316L, SA 240 Gr. 316L)

Material Group: 2.8 (SA 351 Gr. CK3MCuN, SA 351 Gr. CE8MN (1), SA 351 Gr. CD4Mcu (1), SA 351 Gr. CD3MWCuN)

Metric units

	Maximum allowable temperature [°C]											
	-29	38	50	100	150	200	250	300	325	350	375	400
Class	Maximum allowable pressure [bar]											
150	20.0	20.0	19.5	17.7	15.8	13.8	12.1	10.2	9.3	8.4	7.4	6.5
300	51.7	51.7	51.7	50.7	45.9	42.7	40.5	38.9	38.2	37.6	37.4	36.5
600	103.4	103.4	103.4	101.3	91.9	85.3	80.9	77.7	76.3	75.3	74.7	73.3
900	155.1	155.1	155.1	152.0	137.8	128.0	121.4	116.6	114.5	112.9	112.1	109.8
1500	258.6	258.6	258.6	253.3	229.6	213.3	202.3	194.3	190.8	188.2	186.8	183.1
2500	430.9	430.9	430.9	422.2	382.7	355.4	337.2	323.8	318.0	313.7	311.3	304.9

Table 10.4.1-29: ASME B16.5 – metric units of material group 2.3 (SA 182 Gr. F316L, SA 240 Gr. 316L)

US units

	Maximum allowable temperature [°F]											
		100	200	300	400	500	600	650	700	750		
Class	Maximum allowable pressure [psi]											
150		290	260	230	200	170	140	125	110	95		
300		750	745	665	615	580	555	545	540	530		
600		1500	1490	1335	1230	1160	1115	1095	1085	1065		
900		2250	2230	2000	1845	1740	1670	1640	1625	1595		
1500		3750	3720	3335	3070	2905	2785	2735	2710	2660		
2500		6250	6200	5560	5120	4840	4640	4560	4520	4430		

Table 10.4.1-30: ASME B16.5 – US units of material group 2.3 (SA 182 Gr. F316L, SA 240 Gr. 316L)

(1) This steel may become brittle after service at moderately elevated temperatures. Not to be used over 315° C (600°F)

Pressure/temperature ratings acc. to ASME B16.5

Material Group: 2.11 (SA 351 Gr. CF8C)

Metric units

	MNaximum allowable temperature [°C]														
	-29	38	50	100	150	200	250	300	325	350	375	400	425	450	475
Class	**Maximum allowable pressure [bar]**														
150	19.0	19.0	18.7	17.4	15.8	13.8	12.1	10.2	9.3	8.4	7.4	6.5	5.5	4.6	3.7
300	49.6	49.6	48.8	45.3	42.5	39.9	37.8	36.1	35.4	34.8	34.2	33.9	33.6	33.5	31.7
600	99.3	99.3	97.5	90.6	84.9	79.9	75.6	72.2	70.7	69.5	68.4	67.8	67.2	66.9	63.4
900	148.9	148.9	146.3	135.9	127.4	119.8	113.4	108.3	106.1	104.3	102.6	101.7	100.8	100.4	95.1
1500	248.2	248.2	243.8	226.5	212.4	199.7	189.1	180.4	176.8	173.8	171.0	169.5	168.1	167.3	158.2
2500	413.7	413.7	406.4	377.4	353.9	332.8	315.1	300.7	294.6	289.6	285.1	282.6	280.1	278.8	263.9

Table 10.4.1-31: ASME B16.5 – metric units of material group 2.11 (SA 351 Gr. CF8C)

Metric units

	Maximum allowable temperature [°C]													
	500	538	550	575	600	625	650	675	700	725	750	775	800	816
Class	**Maximum allowable pressure [bar]**													
150	2.8	1.4	-	-	-	-	-	-	-	-	-	-	-	-
300	28.2	25.2	25.0	24.0	19.8	13.9	10.3	8.0	5.6	4.0	3.1	2.5	2.0	1.9
600	56.5	50.0	49.8	47.9	39.6	27.7	20.6	15.9	11.2	8.0	6.2	4.9	4.0	3.8
900	84.7	75.2	74.8	71.8	59.4	41.6	30.9	23.9	16.8	11.9	9.3	7.4	6.1	5.7
1500	140.9	125.5	124.9	119.7	99.0	69.3	51.5	39.8	28.1	19.9	15.5	12.3	10.1	9.5
2500	235.0	208.9	208.0	199.5	165.1	115.5	85.8	66.3	46.8	33.1	25.8	20.4	16.9	15.8

Table 10.4.1-32 – ASME B16.5 – metric units of material group 2.11 (SA 351 Gr. CF8C)

US units

	Maximum allowable temperature [°F]														
	-20	100	200	300	400	500	600	650	700	750	800	850	900	950	1000
Class	**Maximum allowable pressure [psi]**														
150	275	275	255	230	200	170	140	125	110	95	80	65	50	35	20
300	720	720	660	615	575	540	515	505	495	490	485	485	450	385	365
600	1440	1440	1325	1235	1150	1085	1030	1015	995	985	975	970	900	775	725
900	2160	2160	1985	1850	1730	1625	1550	1520	1490	1475	1460	1455	1350	1160	1090
1500	3600	3600	3310	3085	2880	2710	2580	2530	2485	2460	2435	2425	2245	1930	1820
2500	6000	6000	5520	5140	4800	4520	4300	4220	4140	4100	4060	4040	3745	3220	3030

Table 10.4.1-33: ASME B16.5 – US units of material group 2.11 (SA 351 Gr. CF8C)

US units

	Maximum allowable temperature [°F]									
	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500
Class	**Maximum allowable pressure [psi]**									
150	-	-	-	-	-	-	-	-	-	-
300	360	310	210	150	115	75	50	40	30	25
600	720	625	420	300	225	150	105	80	60	55
900	1080	935	625	455	340	225	155	125	95	80
1500	1800	1560	1045	755	565	375	255	205	155	135
2500	3000	2600	1745	1255	945	630	430	345	255	230

Table 10.4.1-34: ASME B16.5 – US units of material group 2.11 (SA 351 Gr. CF8C)

(1) At temperatures over 538°C (1000°F), use only when carbon content is 0.04% or higher
LESER does not stock CF8C material. If an application at temperatures over 538°C (1000°F) is intended this should be specified, so LESER can specify the minimum carbon content for the material.

10.4.2 Pressure/Temperature Ratings acc. to ASME B16.42

ASME B16.42 covers ductile iron pipe flanges.

Overview of materials and their groups

LESER standard material	Material group	Other materials of material group
Ductile Gr. 60-40-18	ductile iron	Ductile Gr. 65-45-15

Table 10.4.2-1: ASME B16.42 – pressure/temperature ratings acc. to B16.42

Material Group: ductile iron (ductile 60-40-18)

Metric units

	Maximum temperature [°C]							
	-28.9	37.8	93.3	148.9	204.4	260	315.6	343.3
Class	**Maximum pressure [bar]**							
150	19.6	19.6	19.2	17.7	15.8	13.8	12.1	10.2
300	51.1	51.1	50.1	46.6	45.1	43.8	41.9	39.8

Table 10.4.2-2 – ASME B16.42 – US units of material group: ductile iron (ductile 60-40-18)

US units

	Maximum allowable temperature [°F]							
	-20	100	200	300	400	500	600	650
Class	**Maximum allowable pressure [psi]**							
150	284	284	278	257	229	200	175	148
300	741	741	727	676	654	635	608	577

Table 10.4.2-3: ASME B16.42 – US units of material group: ductile iron (ductile 60-40-18)–

10.4.3 Dimensions acc. to ASME B16.5

Flange dimensions are available from ½" to 20". The tables below are sorted by classes in ascending order, showing the type "welding neck". Sizes of l and b were in all tables with metric units calculated (1 inch = 25.4 mm).

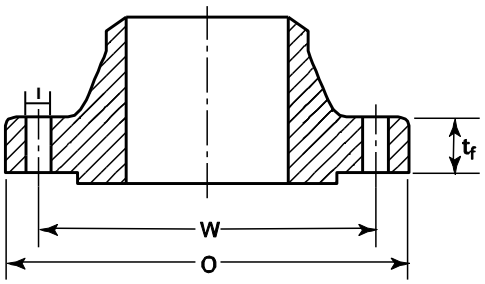


Figure 10.4.3-1: Welding neck flange

Dimensions acc. to ASME B16.5

Class 150

US units [inch]

Nominal Pipe Size	Connection dimensions					Thickness min. (2) - (4)
	Outside diameter	Bolt circle diameter (1), (5)	Bolt hole diameter (1), (5)	Bolting (1), (5)		
	O	W	l	Number	b	t_f
½	3.50	2.38	5/8	4	1/2	0.38
¾	3.88	2.75	5/8	4	1/2	0.44
1	4.25	3.12	5/8	4	1/2	0.50
1¼	4.62	3.50	5/8	4	1/2	0.56
1½	5.00	3.88	5/8	4	1/2	0.62
2	6.00	4.75	3/4	4	5/8	0.69
2½	7.00	5.50	3/4	4	5/8	0.81
3	7.50	6.00	3/4	4	5/8	0.88
4	9.00	7.50	3/4	8	5/8	0.88
5	10.00	8.50	7/8	8	3/4	0.88
6	11.00	9.50	7/8	8	3/4	0.94
8	13.50	11.75	7/8	8	3/4	1.06
10	16.00	14.25	1	12	7/8	1.12
12	19.00	17.00	1	12	7/8	1.19
14	21.00	18.75	1 1/8	12	1	1.31
16	23.50	21.25	1 1/8	16	1	1.38
18	25.00	22.75	1 ¼	16	1 1/8	1.50
20	27.50	25.00	1 ¼	20	1 1/8	1.62
24	32.00	29.50	1 3/8	20	1 1/4	1.81

Table 10.4.3-1: ASME B16.5 – dimensions of flanges [inch] – class 150

Metric units [mm]

Nominal Pipe Size	Connection dimensions					Thickness min. (2) - (4)
	Outside diameter	Bolt circle diameter (1), (5)	Bolt hole diameter (1), (5)	Bolting (1), (5)		
	O	W	l	Number	b	t_f
½	90	60.5	15,9	4	12,70	9.6
¾	100	69.9	15,9	4	12,70	11.2
1	110	79.2	15,9	4	12,70	12.7
1¼	115	88.9	15,9	4	12,70	14.3
1½	125	98.6	15,9	4	12,70	15.9
2	150	120.7	19,1	4	15,88	17.5
2½	180	139.7	19,1	4	15,88	20.7
3	190	152.4	19,1	4	15,88	22.3
4	230	190.5	19,1	8	15,88	22.3
5	255	215.9	22,2	8	19,05	22.3
6	280	241.3	22,2	8	19,05	23.9
8	345	298.5	22,2	8	19,05	27.0
10	405	362.0	25,4	12	22,23	28.6
12	485	431.8	25,4	12	22,23	30.2
14	535	476.3	28,6	12	25,4	33.4
16	595	539.8	28,6	16	25,4	35.0
18	635	577.9	31,8	16	28,58	38.1
20	700	635.0	31,8	20	28,58	41.3
24	815	749.3	34,93	20	31,75	46.1

Table 10.4.3-2: ASME B16.5 – dimensions of flanges [mm] – class 150

Notes:

(1) For flange bolt holes, see ASME B16.5 para 6.5
(2) The minimum thickness of these loose flanges, in sizes NPS 3½ and smaller, is slightly greater than the thickness of flanges on fittings, table ASME B16.5 F9, which are reinforced by cast integral with the body of the fitting.
(3) When these flanges are required with flat face, the flat face may be either the full tf-dimension thickness plus 0.06 inch/2 mm., or the tf dimension thickness without the raised face height. See para. ASME B16.5 6.3.2 for additional restrictions.
(4) The flange dimensions illustrated are for regularly furnished 0.06 inch/2 mm raised face (except lapped); for requirements of other facings, see ASME B16.5 figure F7
(5) For spot facing, see ASME B16.5 para 6.6

Dimensions acc. to ASME B16.5

Class 300

US units [inch]

Nominal Pipe Size	Connection dimensions					Thickness min. (2) - (4)
	Outside diameter	Bolt circle diameter (1), (5)	Bolt hole diameter (1), (5)	Bolting (1), (5)		
	O	W	I	Number	b	t_f
½	3.75	2.62	5/8	4	1/2	0.50
¾	4.62	3.25	3/4	4	5/8	0.56
1	4.88	3.50	3/4	4	5/8	0.62
1¼	5.25	3.88	3/4	4	5/8	0.69
1½	6.12	4.50	7/8	4	3/4	0.75
2	6.50	5.00	3/4	8	5/8	0.81
2½	7.50	5.88	7/8	8	3/4	0.94
3	8.25	6.62	7/8	8	3/4	1.06
4	10.00	7.88	7/8	8	3/4	1.19
5	11.00	9.25	7/8	8	3/4	1.31
6	12.50	10.62	7/8	12	3/4	1.38
8	15.00	13.00	1	12	7/8	1.56
10	17.50	15.25	1 1/8	16	1	1.81
12	20.50	17.75	1 1/4	16	1 1/8	1.94
14	23.00	20.25	1 1/4	20	1 1/8	2.06
16	25.50	22.50	1 3/8	20	1 1/4	2.19
18	28.00	24.75	1 3/8	24	1 1/4	2.31
20	30.50	27.00	1 3/8	24	1 1/4	2.44
24	36.00	32.00	1 5/8	24	1 1/2	2.69

Table 10.4.3-3: ASME B16.5 – dimensions of flanges [inch] – class 300

Metric units [mm]

Nominal Pipe Size	Connection dimensions					Thickness min. (2), (3)
	Outside diameter	Bolt circle diameter (1), (5)	Bolt hole diameter (1), (5)	Bolting (1), (5)		
	O	W	I	Number	b	t_f
½	95	66.7	15,9	4	12,70	12.7
¾	115	82.6	19,1	4	15,88	14.3
1	125	88.9	19,1	4	15,88	15.9
1¼	135	98.4	19,1	4	15,88	17.5
1½	155	114.3	22,2	4	19,05	19.1
2	165	127.0	19,1	8	15,88	20.7
2½	190	149.2	22,2	8	19,05	23.9
3	210	168.3	22,2	8	19,05	27.0
4	255	200.0	22,2	8	19,05	30.2
5	280	235.0	22,2	8	19,05	33.4
6	320	269.9	22,2	12	19,05	35.0
8	380	330.2	25,4	12	22,23	39.7
10	445	387.4	28,6	16	25,4	46.1
12	520	450.8	31,8	16	28,58	49.3
14	585	514.4	31,8	20	28,58	52.4
16	650	571.5	34,9	20	31,75	55.6
18	710	628.6	34,9	24	31,75	58.8
20	775	685.8	34,9	24	31,75	62.0
24	915	812.8	41,3	24	38,10	68.3

Table 10.4.3-4: ASME B16.5 – dimensions of flanges [mm] – class 300

Notes:

(1) For flange bolt holes, see ASME B16.5 para 6.5
(2) These flanges may be supplied with a flat face. The flat face may be either the full tf dimension thickness plus 0.06 inch/2 mm or the tf dimension thickness without the raised face height. See para. ASME B16.5 6.3.2 for additional restrictions.
(3) The flange dimensions illustrated are for regularly furnished 0.06 inch/2 mm raised face (except lapped); for requirements of other facings, see ASME B16.5 fig. F-7.
(4) For welding end bevel, see AMSE B 16.5 para. 6.7.
(5) For spot facing, see ASME B16.5 para 6.6

Dimensions acc. to ASME B16.5

Class 600

US units [inch]

Nominal Pipe Size	Connection dimensions					Thickness min.
	Outside diameter	Bolt circle diameter (2), (3)	Bolt hole diameter (2), (3)	Bolting (2), (3)		
	O	W	I	Number	b	t_f
½	3.75	2.62	5/8	4	1/2	0.56
¾	4.62	3.25	3/4	4	5/8	0.62
1	4.88	3.50	3/4	4	5/8	0.69
1¼	5.25	3.88	3/4	4	5/8	0.81
1½	6.12	4.50	7/8	4	3/4	0.88
2	6.50	5.00	3/4	8	5/8	1.00
2½	7.50	5.88	7/8	8	3/4	1.12
3	8.25	6.62	7/8	8	3/4	1.25
4	10.75	8.50	1	8	7/8	1.50
5	13.00	10.50	1 1/8	8	1	1.75
6	14.00	11.50	1 1/8	12	1	1.88

Table 10.4.3-5: ASME B16.5 – dimensions of flanges [inch] – class 600

Metric units [mm]

Nominal Pipe Size	Connection dimensions					Thickness min.
	Outside diameter	Bolt circle diameter (2), (3)	Bolt hole diameter (2), (3)	Bolting (2), (3)		
	O	W	I	Number	b	t_f
½	95	66.7	15,9	4	12,70	14.3
¾	115	82.6	19,1	4	15,88	15.9
1	125	88.9	19,1	4	15,88	17.5
1¼	135	98.4	19,1	4	15,88	20.7
1½	155	114.3	22,2	4	19,05	22.3
2	165	127.0	19,1	8	15,88	25.4
2½	190	149.2	22,2	8	19,05	28.6
3	210	168.3	22,2	8	19,05	31.8
4	275	215.9	25,4	8	22,23	38.1
5	330	266.7	28,6	8	25,4	44.5
6	355	292.1	28,6	12	25,4	47.7

Table 10.4.3-6: ASME B16.5 – dimensions of flanges [mm] – class 600

Notes:

(2) For flange bolt holes, see ASME B16.5 para 6.5
(3) For spot facing, see ASME para 6.6

Dimensions acc. to ASME B16.5

Class 900

US units [inch]

Nominal Pipe Size	Connection dimensions					Thickness min.
	Outside diameter	Bolt circle diameter (2), (3)	Bolt hole diameter (2), (3)	Bolting (2), (3)		
	O	W	l	Number	b	t_f
½ ¾ 1 1¼ 1½ 2 2½	Use class 1500 dimensions in these sizes					
3	9.50	7.50	1	8	7/8	1.50
4	11.50	9.25	1 1/4	8	1 1/8	1.75

Table 10.4.3-7: ASME B16.5 – dimensions of flanges [inch] – class 900

Metric units [mm]

Nominal Pipe Size	Connection dimensions					Thickness min.
	Outside diameter	Bolt circle diameter (2), (3)	Bolt hole diameter (2), (3)	Bolting (2), (3)		
	O	W	l	Number	b	t_f
½ ¾ 1 1¼ 1½ 2 2½	Use class 1500 dimensions in these sizes					
3	240	190.5	25,4	8	22,23	38.1
4	290	235.0	31,8	8	28,58	44.5

Table 10.4.3-8: ASME B16.5 – dimensions of flanges [mm] – class 900

Notes:

(2) For flange bolt holes, see ASME B16.5 para 6.5
(3) For spot facing, see ASME para 6.6

Dimensions acc. to ASME B16.5

Class 1500

US units [inch]

Nominal Pipe Size	Connection dimensions					Thickness min.
	Outside diameter	Bolt circle diameter (2), (3)	Bolt hole diameter (2), (3)	Bolting (2), (3)		
	O	W	I	Number	b	t_f
½	4.75	3.25	7/8	4	3/4	0.88
¾	5.12	3.50	7/8	4	3/4	1.00
1	5.88	4.00	1	4	7/8	1.12
1¼	6.25	4.38	1	4	7/8	1.12
1½	7.00	4.88	1 1/8	4	1	1.25
2	8.50	6.50	1	8	7/8	1.50
2½	9.62	7.50	1 1/8	8	1	1.62
3	10.50	8.00	1 1/4	8	1 1/8	1.88
4	12.25	9.50	1 3/8	8	1 1/4	2.12

Table 10.4.3-9: ASME B16.5 – dimensions of flanges [inch] – class 1500

Metric units [mm]

Nominal Pipe Size	Connection dimensions					Thickness min.
	Outside diameter	Bolt circle diameter (2), (3)	Bolt hole diameter (2), (3)	Bolting (2), (3)		
	O	W	I	Number	b	t_f
½	120	82.6	22,2	4	19,05	22.3
¾	130	88.9	22,2	4	19,05	25.4
1	150	101.6	25,4	4	22,23	28.6
1¼	160	111.1	25,4	4	22,23	28.6
1½	180	123.8	28,6	4	25,4	31.8
2	215	165.1	25,4	8	22,23	38.1
2½	245	190.5	28,6	8	25,4	41.3
3	265	203.2	31,8	8	28,58	47.7
4	310	241.3	34,9	8	31,75	54.0

Table 10.4.3-10: ASME B16.5 – dimensions of flanges [mm] – class 1500

Notes:

(2) For flange bolt holes, see ASME B16.5 para 6.5
(3) For spot facing, see ASME para 6.6

Dimensions acc. to ASME B16.5

Class 2500

US units [inch]

Nominal Pipe Size	Connection dimensions					Thickness min.
	Outside diameter	Bolt circle diameter (2), (3)	Bolt hole diameter (2), (3)	Bolting (2), (3)		
	O	W	l	Number	b	t_f
½	5.25	3.50	7/8	4	3/4	1.19
¾	5.50	3.75	7/8	4	3/4	1.25
1	6.25	4.25	1	4	7/8	1.38
1¼	7.25	5.12	1 1/8	4	1	1.50
1½	8.00	5.75	1 1/4	4	1 1/8	1.75
2	9.25	6.75	1 1/8	8	1	2.00
2½	10.50	7.75	1 1/4	8	1 1/8	2.25
3	12.00	9.00	1 3/8	8	1 1/4	2.62
4	14.00	10.75	1 5/8	8	1 1/2	3.00

Table 10.4.3-11: ASME B16.5 – dimensions of flanges [inch] – class 2500

Metric units [mm]

Nominal Pipe Size	Connection dimensions					Thickness min.
	Outside diameter	Bolt circle diameter (2), (3)	Bolt hole diameter (2), (3)	Bolting (2), (3)		
	O	W	l	Number	b	t_f
½	135	88.9	22,2	4	19,05	30.2
¾	140	95.2	22,2	4	19,05	31.8
1	160	108.0	25,4	4	22,23	35.0
1¼	185	130.2	28,6	4	25,4	38.1
1½	205	146.0	31,8	4	28,58	44.5
2	235	171.4	28,6	8	25,4	50.9
2½	265	196.8	31,8	8	28,58	57.2
3	305	228.6	34,9	8	31,75	66.7
4	355	273.0	41,3	8	38,10	76.2

Table 10.4.3-12: ASME B16.5 – dimensions of flanges [mm] – class 2500

Notes:

(2) For flange bolt holes, see ASME B16.5 para 6.5
(3) For spot facing, see ASME para 6.6

10.4.4 Flange Facings and Finish acc. to ASME B16.5

Forms of flange facings are shown in Fig. 10.4.4-1 and their dimensions in Tab. 10.4.4-1.
For flat face (FF) flange facings see section 4.6.

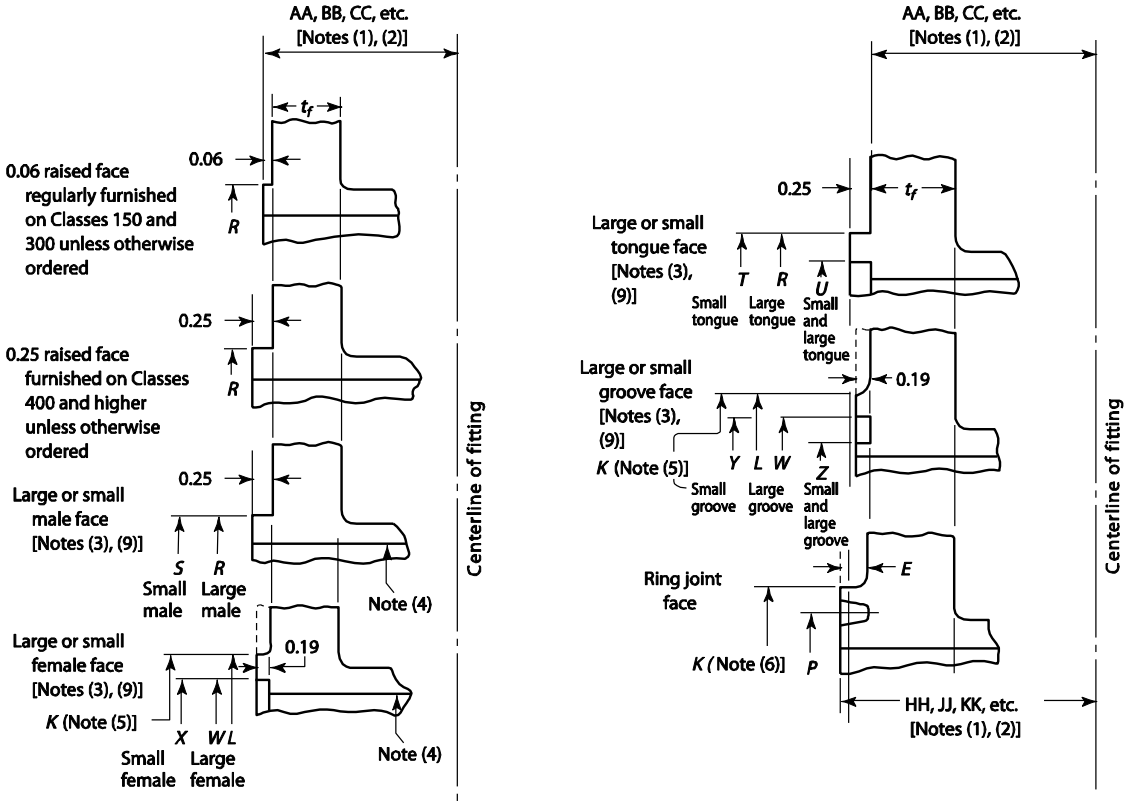


Figure 10.4.4-1: ASME B16.5 – End flange facings [inch] and their relationship to flange thickness and Center-To-End and End-To-End dimensions

Dimensions of facings other than ring joints [inch]

Nominal pipe size	Outside diameter			Inside diameter of LTF and STF	Inside diameter of SMF (4), (10)	Outside diameter			Inside Diameter of LGF and SGF	Height		Depth of groove or female (11), (14)	Minimum outside diameter of raised portion (15), (9)	
	RF, LMF and LTF	SMF (4), (10)	STF			LFF and LGF	SFF (4), (10)	SGF		RF (11), (12)	SMF, LMF, STF and LTF (11), (13)		SFF and SGF	LFF and LGF
	R	S	T	U		W	X	Y	Z				K	L
½	1.38	0.72	1.38	1.00	-	1.44	0.78	1.44	0.94	-	-	-	1.75	1.81
¾	1.69	0.94	1.69	1.31	-	1.75	1.00	1.75	1.25	-	-	-	2.06	2.12
1	2.00	1.19	1.88	1.50	-	2.06	1.25	1.94	1.44	-	-	-	2.25	2.44
1¼	2.50	1.50	2.25	1.88	-	2.56	1.56	2.31	1.81	-	-	-	2.62	2.94
1½	2.88	1.75	2.50	2.12	-	2.94	1.81	2.56	2.06	-	-	-	2.88	3.31
2	3.62	2.25	3.25	2.88	-	3.69	2.31	3.31	2.81	-	-	-	3.62	4.06
2½	4.12	2.69	3.75	3.38	-	4.19	2.75	3.81	3.31	-	-	-	4.12	4.56
3	5.00	3.31	4.62	4.25	-	5.06	3.38	4.69	4.19	-	-	-	5.00	5.44
3½	5.50	3.81	5.12	4.75	-	5.56	3.88	5.19	4.69	-	-	-	5.50	5.94
4	6.19	4.31	5.69	5.19	-	6.25	4.38	5.75	5.12	-	-	-	6.19	6.62
5	7.31	5.38	6.81	6.31	-	7.38	5.44	6.88	6.25	-	-	-	7.31	7.75
6	8.50	6.38	8.00	7.50	-	8.56	6.44	8.06	7.44	-	-	-	8.50	8.94
8	10.62	8.38	10.00	9.38	-	10.69	8.44	10.06	9.31	-	-	-	10.62	11.06
10	12.75	10.50	12.00	11.25	-	12.81	10.56	12.06	11.19	-	-	-	12.75	13.19
12	15.00	12.50	14.25	13.50	-	15.06	12.56	14.31	13.44	-	-	-	15.00	15.44
14	16.25	13.75	15.50	14.75	-	16.31	13.81	15.56	14.69	-	-	-	16.25	16.69
16	18.50	15.75	17.62	16.75	-	18.56	15.81	17.69	16.69	-	-	-	18.50	18.94
18	21.00	17.75	20.12	19.25	-	21.06	17.81	20.19	19.19	-	-	-	21.00	21.44
20	23.00	19.75	22.00	21.00	-	23.06	19.81	22.06	20.94	-	-	-	23.00	23.44
24	27.25	23.75	26.25	25.25	-	27.31	23.81	26.31	25.19	-	-	-	27.25	27.69

Table 10.4.4-1: ASME B16.5 – Dimensions other than ring joints [inch]

Shortcuts:

RF	raised face
SMF	small male facing
LMF	large male facing
SFF	small female facing
LFF	large female facing
STF	small tongue facing
LTF	large tongue facing
SGF	small groove facing
LGF	large groove facing

General Notes table 10.4.4-1:

(a) For facing requirements for flanges end flanged fittings, see paras. 6.3 and 6.4 and Fig. F7.
(b) For facing requirements for lapped joints, see para. 6.4.3 and Fig. F7
(c) For facing tolerances, see para 7.3

Notes:

(1) See ASME B16.5 paras. 6.2 and 6.4
(2) See tables below
(3) See table 10.4.4-1 for dimensions of facings (other than ring joint) and table 10.4.4-2
(4) For small male and female joints, care should be taken in the use of these dimensions to insure that the inside diameter of fitting pipe is small enough to permit sufficient bearing surface to prevent crushing of the gasket (see ASME B16.5 table F4). This applies particularly on lines where the joint is made on the end of the pipe. Threaded companion flanges for small male and female joints are furnished with plain face and are threaded with American Standard Locknut Thread (NPSL).
(5) See ASME B16.5 table F4
(6) See section 4.3 or ASME B16.5 table F5
(7) See ASME B16.5 para. 6.4.3
(8) See ASME B16.5 para. 6.4.3.5 and table F5
(9) Large male and female faces and large tongue and groove are not applicable to class 150 because of potential dimensional conflicts
(10) Inside diameter of fitting should match inside diameter of pipe as specified by purchaser.
(11) See para. 6.4.3 and Fig. F7 for thickness and outside diameter of laps.
(12) Height of raised face either 0.06 in. of 0.25 in.
(13) Height of large and small male and tongue is 0.25 in.
(14) Depth of groove or female is 0.19 in.
(15) Raised portion of full face may be furnished unless otherwise specified an order.

Dimensions of Ring-Joint Facings [inch]

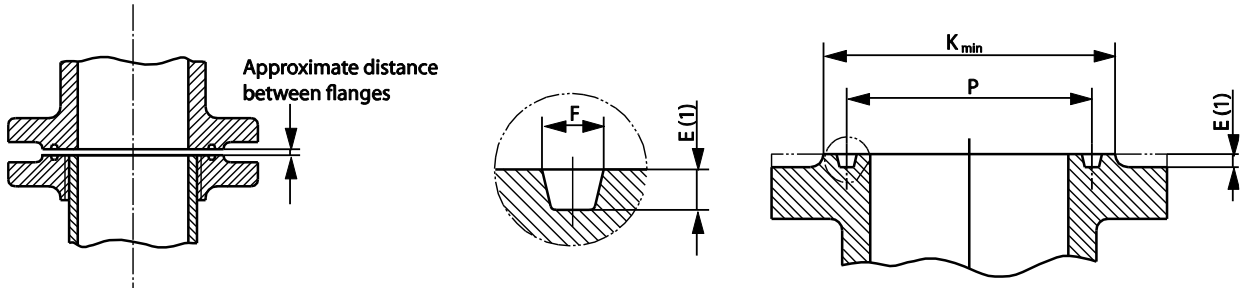


Figure 10.4.4-2: ASME B16.5 – ring joint facings

Nominal Pipe Size						Groove Number	Groove Dimensions				Diameter of Raised Portion, K					Approximate Distance Between Flanges					
Class 150	Class 300	Class 600	Class 900 [note (3)]	Class 1500	Class 2500		Pitch Diameter	Depth [note (1)]	Width	Radius at Bottom	Class 150	Class 300, 600	Class 900	Class 1500	Class 2500	Class 150	Class 300	Class 600	Class 900	Class 1500	Class 2500
							P	E	F	R											
…	½	½	…	…	…	R11	1.344	0.219	0.281	0.03	…	2.00	…	…	…	…	0.12	0.12	…	…	…
…	…	…	…	½	…	12	1.562	0.250	0.344	0.03	…	…	…	2.38	…	…	…	…	…	0.16	…
…	¾	¾	…	…	½	13	1.688	0.250	0.344	0.03	…	2.50	…	…	2.56	…	0.16	0.16	…	…	0.16
…	…	…	…	¾	…	14	1.750	0.250	0.344	0.03	…	…	…	2.62	…	…	…	…	…	0.16	…
1	…	…	…	…	…	15	1.875	0.250	0.344	0.03	2.50	…	…	…	…	0.16	…	…	…	…	…
…	1	1	…	1	¾	16	2.000	0.250	0.344	0.03	…	2.75	…	2.81	2.88	…	0.16	0.16	…	0.16	0.16
1¼	…	…	…	…	…	17	2.250	0.250	0.344	0.03	2.88	…	…	…	…	0.16	…	…	…	…	…
…	1¼	1¼	…	1¼	1	18	2.375	0.250	0.344	0.03	…	3.12	…	3.19	3.25	…	0.16	0.16	…	0.16	0.16
1½	…	…	…	…	…	19	2.562	0.250	0.344	0.03	3.25	…	…	…	…	0.16	…	…	…	…	…
…	1½	1½	…	1½	…	20	2.688	0.250	0.344	0.03	…	3.56	…	3.62	…	…	0.16	0.16	…	0.16	…
…	…	…	…	…	1¼	21	2.844	0.312	0.469	0.03	…	…	…	…	4.00	…	…	…	…	…	0.12
2	…	…	…	…	…	22	3.250	0.250	0.344	0.03	4.00	…	…	…	…	0.16	…	…	…	…	…
…	2	2	…	…	1½	23	3.250	0.312	0.469	0.03	…	4.25	…	…	4.50	…	0.22	0.19	…	…	0.12
…	…	…	…	2	…	24	3.750	0.312	0.469	0.03	…	…	…	4.88	…	…	…	…	…	0.12	…
2½	…	…	…	…	…	25	4.000	0.250	0.344	0.03	4.75	…	…	…	…	0.16	…	…	…	…	…
…	2½	2½	…	…	2	26	4.000	0.312	0.469	0.03	…	5.00	…	…	5.25	…	0.22	0.19	…	…	0.12
…	…	…	…	2½	…	27	4.250	0.312	0.469	0.03	…	…	…	5.38	…	…	…	…	…	0.12	…
…	…	…	…	…	2½	28	4.375	0.375	0.531	0.06	…	…	…	…	5.88	…	…	…	…	…	0.12
3	…	…	…	…	…	29	4.500	0.250	0.344	0.03	5.25	…	…	…	…	0.16	…	…	…	…	…
…	(4)	(4)	…	…	…	30	4.625	0.312	0.469	0.03	…	…	…	…	…	…	…	…	…	…	…
…	3 (4)	3 (4)	3	…	…	31	4.875	0.312	0.469	0.03	…	5.75	6.12	…	…	…	0.22	0.19	0.16	…	…
…	…	…	…	…	3	32	5.000	0.375	0.531	0.06	…	…	…	…	6.62	…	…	…	…	…	0.12
3½	…	…	…	…	…	33	5.188	0.250	0.344	0.03	6.06	…	…	…	…	0.16	…	…	…	…	…
…	3½	3½	…	…	…	34	5.188	0.312	0.469	0.03	…	6.25	…	…	…	…	0.22	0.19	…	…	…
…	…	…	…	3	…	35	5.375	0.312	0.469	0.03	…	…	…	6.62	…	…	…	…	…	0.12	…
4	…	…	…	…	…	36	5.875	0.250	0.344	0.03	6.75	…	…	…	…	0.16	…	…	…	…	…
…	4	4	4	…	…	37	5.875	0.312	0.469	0.03	…	6.88	7.12	…	…	…	0.22	0.19	0.16	…	…
…	…	…	…	…	4	38	6.188	0.438	0.656	0.06	…	…	…	…	8.00	…	…	…	…	…	0.16
…	…	…	…	4	…	39	6.375	0.312	0.469	0.03	…	…	…	7.62	…	…	…	…	…	0.12	…
5	…	…	…	…	…	40	6.750	0.250	0.344	0.03	7.62	…	…	…	…	0.16	…	…	…	…	…
…	5	5	5	…	…	41	7.125	0.312	0.469	0.03	…	8.25	8.50	…	…	…	0.22	0.19	0.16	…	…
…	…	…	…	…	5	42	7.500	0.500	0.781	0.06	…	…	…	…	9.50	…	…	…	…	…	0.16
6	…	…	…	…	…	43	7.625	0.250	0.344	0.03	8.62	…	…	…	…	0.16	…	…	…	…	…
…	…	…	…	5	…	44	7.625	0.312	0.469	0.03	…	…	…	9.00	…	…	…	…	…	0.12	…
…	6	6	6	…	…	45	8.312	0.312	0.469	0.03	…	9.50	9.50	…	…	…	0.22	0.19	0.16	…	…
…	…	…	…	6	…	46	8.312	0.375	0.531	0.06	…	…	…	9.75	…	…	…	…	…	0.12	…
…	…	…	…	…	6	47	9.000	0.500	0.781	0.06	…	…	…	…	11.00	…	…	…	…	…	0.16
8	…	…	…	…	…	48	9.750	0.250	0.344	0.03	10.75	…	…	…	…	0.16	…	…	…	…	…
…	8	8	8	…	…	49	10.625	0.312	0.469	0.03	…	11.88	12.12	…	…	…	0.22	0.19	0.16	…	…
…	…	…	…	8	…	50	10.625	0.438	0.656	0.06	…	…	…	12.50	…	…	…	…	…	0.16	…

Table 10.4.4-2: ASME B16.5 – dimension of ring joint facings

Dimensions of Ring-Joint Facings (continued) [inch]

Nominal Pipe Size						Groove Number	Groove Dimensions				Diameter of Raised Portion, K					Approximate Distance Between Flanges					
Class 150	Class 300	Class 600	Class 900 [note (3)]	Class 1500	Class 2500		Pitch Diameter	Depth [note (1)]	Width	Radius at Bottom	Class 150	Class 300, 600	Class 900	Class 1500	Class 2500	Class 150	Class 300	Class 600	Class 900	Class 1500	Class 2500
							P	E	F	R											
…	…	…	…	…	8	51	11.000	0.562	0.906	0.06	…	…	…	…	13.38	…	…	…	…	…	0.19
10	…	…	…	…	…	52	12.000	0.250	0.344	0.03	13.00	…	…	…	…	0.16	…	…	…	…	…
…	10	10	10	…	…	53	12.750	0.312	0.469	0.03	…	14.00	14.25	…	…	…	0.22	0.19	0.16	…	…
…	…	…	…	10	…	54	12.750	0.438	0.656	0.06	…	…	…	14.62	…	…	…	…	…	0.16	…
…	…	…	…	…	10	55	13.500	0.688	1.188	0.09	…	…	…	…	16.75	…	…	…	…	…	0.25
12	…	…	…	…	…	56	15.000	0.250	0.344	0.03	16.00	…	…	…	…	0.16	…	…	…	…	…
…	12	12	12	…	…	57	15.000	0.312	0.469	0.03	…	16.25	16.50	…	…	…	0.22	0.19	0.16	…	…
…	…	…	…	12	…	58	15.000	0.562	0.906	0.06	…	…	…	17.25	…	…	…	…	…	0.19	…
14	…	…	…	…	12	59	15.625	0.250	0.344	0.03	16.75	…	…	…	…	0.12	…	…	…	…	…
…	…	…	…	…	…	60	16.000	0.688	1.312	0.09	…	…	…	…	19.50	…	…	…	…	…	0.31
…	14	14	14	…	…	61	16.500	0.312	0.469	0.03	…	18.00	…	…	…	…	0.22	0.19	…	…	…
…	…	…	…	14	…	62	16.500	0.438	0.656	0.06	…	…	18.38	…	…	…	…	…	0.16	…	…
…	…	…	…	…	…	63	16.500	0.625	1.062	0.09	…	…	…	19.25	…	…	…	…	…	0.22	…
16	…	…	…	…	…	64	17.875	0.250	0.344	0.03	19.00	…	…	…	…	0.12	…	…	…	…	…
…	16	16	16	…	…	65	18.500	0.312	0.469	0.03	…	20.00	…	…	…	…	0.22	0.19	…	…	…
…	…	…	…	16	…	66	18.500	0.438	0.656	0.06	…	…	20.62	…	…	…	…	…	0.16	…	…
…	…	…	…	…	…	67	18.500	0.688	1.188	0.09	…	…	…	21.50	…	…	…	…	…	0.31	…
18	…	…	…	…	…	68	20.375	0.250	0.344	0.03	21.50	…	…	…	…	0.12	…	…	…	…	…
…	18	18	18	…	…	69	21.000	0.312	0.469	0.03	…	22.62	…	…	…	…	0.22	0.19	…	…	…
…	…	…	…	18	…	70	21.000	0.500	0.781	0.06	…	…	23.38	…	…	…	…	…	0.19	…	…
…	…	…	…	…	…	71	21.000	0.688	1.188	0.09	…	…	…	24.12	…	…	…	…	…	0.31	…
20	…	…	…	…	…	72	22.000	0.250	0.344	0.03	23.50	…	…	…	…	0.12	…	…	…	…	…
…	20	20	20	…	…	73	23.000	0.375	0.531	0.06	…	25.00	…	…	…	…	0.22	0.19	…	…	…
…	…	…	…	20	…	74	23.000	0.500	0..781	0.06	…	…	25.50	…	…	…	…	…	0.19	…	…
…	…	…	…	…	…	75	23.000	0.688	1.312	0.09	…	…	…	26.50	…	…	…	…	…	0.38	…
24	…	…	…	…	…	76	26.500	0.250	0.344	0.03	28.00	…	…	…	…	0.12	…	…	…	…	…
…	24	24	24	…	…	77	27.250	0.438	0.656	0.06	…	29.50	…	…	…	…	0.25	0.22	…	…	…
…	…	…	…	24	…	78	27.250	0.625	1.062	0.09	…	…	30.38	…	…	…	…	…	0.22	…	…
…	…	…	…	…	…	79	27.250	0.812	1.438	0.09	…	…	…	31.25	…	…	…	…	…	0.44	…

Table 10.4.4-3: ASME B16.5 – dimension of ring joint facings (continued)

General notes:

(1) Dimensions are in inches
(2) For facing requirements for flanges and flanged fittings, see para. 6.4.1 and Fig. F7
(3) For facing requirements for lapped joints, see para. 6.4.3 and Fig. F7.
(4) See para. 4.2.7 for marking requirements

Notes:

(1) Height of full raised portion is equal to the depth of groove dimension E, but is not subjected to the tolerances for E. Former full-face contour may be used.
(2) Use class 600 in sizes NPS ½ to NPS 3½ for class 400.
(3) Use class 1500 in sizes NPS ½ to NPS 2½ for class 900.
(4) For ring joints with lapped joint flanges in classes 300 and 600, ring and groove number R30 are used instead of R31.

Tolerances:

E	(depth) + 0.016, - 0.0
F	(width) ± 0.008
P	(pitch diameter) ± 0.005
R	(radius at bottom)
	R ≤ 0.06 + 0.03, - 0.0
	R > 0.06 ± 0.03
23 deg	(angle) ± ½ deg

Flange facing finish

All sealing surfaces are machined and have a surface finish which corresponds to the values in Tab. 10.4.4-4 when compared to test specimens by look and feel inspection. See ASME B16.5, 6.4.5 for more information.
ASME B16.5 defines the requirements of sealing surfaces. „Flange facing finishes“ are commmented in chapter 6.4.5 in this standard. Furthermore, the forms of sealing surfaces are described in MSS SP-6.

In this context called finishes are:

- Serrated spiral finish

  Continuos spiral rill, which can be produced by face turning with radial feed

- Serrrated concentric finish

  concentric rills, which can be produced by a cog tool with axial traverse speed. The types „serrated spiral finish“ and „serrated concentric finish“ are equal and can be engineered alternatively.

- Smooth oder non serrated finish

  The effective MSS SP-6 (Edition 2001) does not mention “smooth finish” anymore. In MSS SP-6 (Edition 1980) “Smooth finish” is defined for finishes of contact flanges as “250 µinch (6,3 µm) AARH max.”.

  LESER supplies flange facings according to ASME B16.5 – 1996, paragraph 6.4.4.3: “Either a serrated concentric or serrated spiral finish resulting in service finish from 125 µinch to 250 µinch average roughness shall be furnished.” This finish meets the requirements of MSS SP-6 (Edition 1980), which is not valid anymore!

- Stock finish

  Stock finish is not defined in any technical standard. If purchase orders show “Stock finish” LESER supplies standard facing according to DIN or ASME (marked with * in table “Flange facings” of each valve series).

The finish of the gasket contact faces shall be judged by visual comparison with R_a standards (see ASME B46.1) and not by instruments having stylus tracers and electronic amplification.

The following table shows the allowed surface roughness in combination with the forms of sealing surfaces:

Form of surface finish	AARH, R_a		R_z [µm]		$Radius_{tool}$	Roughness	Standard
	[µm]	[µinch]	[µm]	[µinch]	[mm]	[mm/rotation]	
FF, RF – serrated finish (1) LMF, LFF – serrated finish (1)	3.2 – 6.3	125 – 250	12.5 - 25	500 – 1000	> 1.52 (2)	0.462 – 0.556 (2)	ASME B16.5
RTJ	max 1.6	max 63	n/a	n/a	n/a	n/a	ASME B16.5
SGF, STF, SMF, SFF, LGF, LTF	max 3.2	max 125					
Smooth finish (non serrated)	max 6.3	max 250	max. 25	1000	n/a	n/a	MSS SP-6

Table 10.4.4-4: ASME B16.5 – allowed surface roughness

Notes:
(1) serrated spiral oder serrated concentric finish
(2) LESER: R_{tool} > 1.6 mm, roughness 0.46 – 0.56

AARH: Arithmetic average roughness height R_a
Maximum roughness height R_z

10.4.5 Flange Ratings acc. to API 526

Besides ASME B16.5 / B16.34 also API 526 lists pressure-temperature ratings for flanges. This section explains the differences between these standards.

Related to the pressure/temperature limits the standards ASME B16.5 / B16.34 and API 526 are identical to a certain extent.

The differences are:

- acc. to API 526 the pressure/temperature limit of the highest flange class in all orifices is lower than the limit in ASME B16.5 / B16.34
- for API orifices L through T the pressure / temperature limits also for lower flange classes deviate from the values of ASME B16.5 / B16.34
- there are less intermediate temperature steps in the API 526.

See chapter 4.1 for ASME and LESER catalogue for API limits.

In case the pressure/temperature limit acc. to API 526 is lower than the limit acc. to ASME B16.5 / B16.34, the LESER type 526 can usually be supplied with a set pressure in accordance with the ASME B16.5 / B16.34 flange rating. The limiting factor however may be the spring chart (LGS 3630).

Class 300L according to API 526

A Class 300L flange is dimensionally identical to a Class 300 flange. The maximum set pressure of an API valve with a Class 300L inlet flange however is the same as for a Class 150 flange at ambient temperatures. The difference to a Class 150 inlet flange is that the maximum set pressure is extended to a temperature of 800°F/427°C.

The application area for #300L inlet flanges is shown in the following chart.

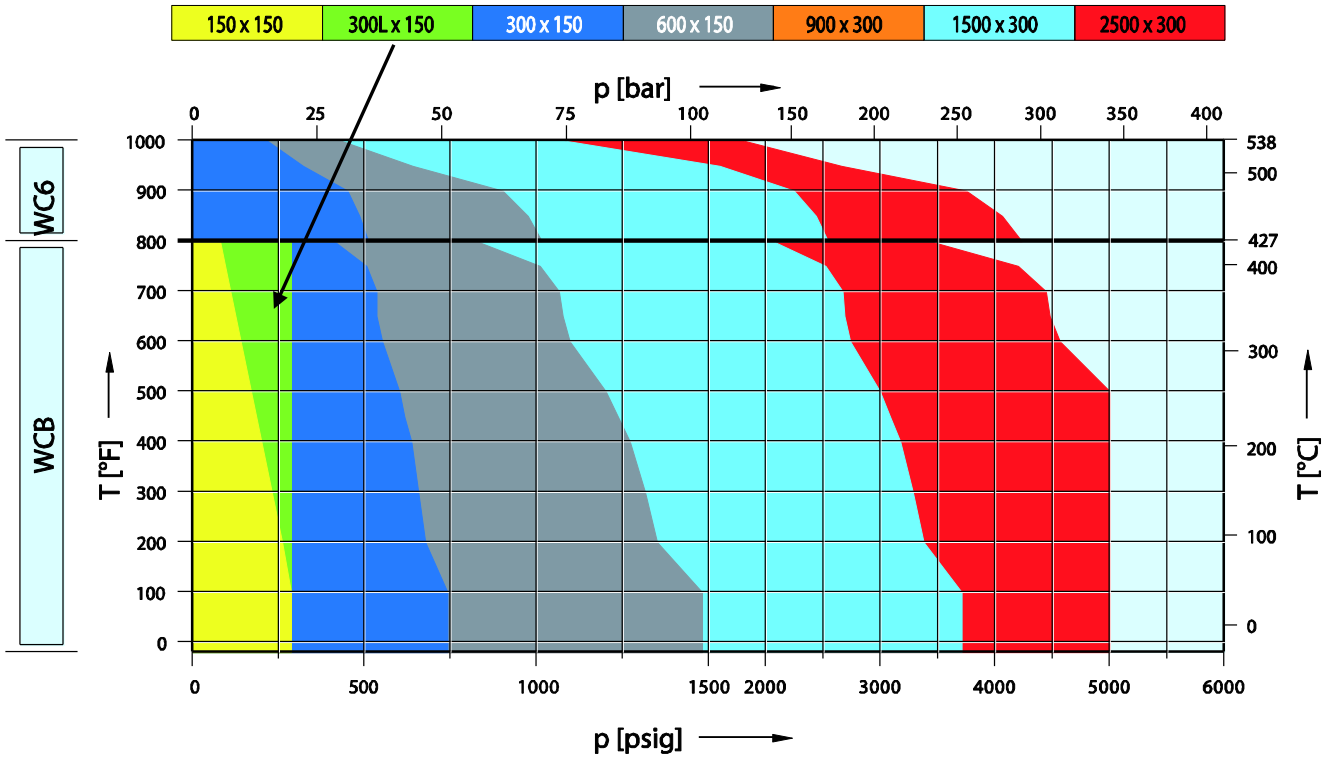


Figure 10.4.5-1: Application area for #300L inlet flanges

10.4.6 Cast Iron and Ductile Iron Flanges acc. to ASME B 16.1 and ASME B 16.42

Cast Iron

According to ASME B16.1 cast iron equates to class 125 and class 250.
In general flat face flange facing (FF) is required. Cast iron castings for LESER valves generally don't allow to machine a flat face without falling below the minimum thickness of the flange. Therefore class 125 and 250 are not offered by LESER.
Connecting dimensions of class 125 and 250 are equal to class 150 respectively class 300 for steel flanges.

Following connection dimensions of flanges are equal:

Iron	Steel
#125	#150
#250	#300

Table 10.4.6-1: Equal connection dimensions of flanges

Note: A flat face flange facing for a carbon steel or stainless steel safety valve can be supplied only after verification and confirmation by LESER.
Flat face flange facing is not possible for

- all full nozzle design, like Type 526 or 458 or Type 488
- Critical Service safety valves Type 447 and 546
- Compact Performance safety valves equipped with flanges

Ductile Iron

According to ASME B16.42 ductile Iron equates to class 150 and class 300.

Class 150: Flat Face (FF) or Raised Face (RF)
Class 300: Raised Face (RF)

LESER can supply ductile iron valves, e.g. type 4415 or 4335 with raised face in class 150.

10.4.7 LCB, WCB and European Codes & Standards

LESER sources LCB with a fivefold material certificate for WCB, WCC, LCB, LCC and 1.0619. That means chemical composition and mechanical properties of the material fulfill the requirements of all five materials designations.

The applicability of WCB and LCB according to European Standards can be taken from the following EN standards:

1. EN 1503-2: „Valves - Materials for bodies, bonnets and covers“

   Part 2 of this standard contains steels for pressure retaining valve bodies, bonnets and covers which are not part of European material standards. WCB and LCB can be found in table 1, page 5.

2. EN 12516-1: „Industrial valves – shell designs strength – part 1: Calculation method for steel valve shells”

   This part of the EN12516 contains a method to determine the wall thickness of pressure retaining bodies of valves and includes pressure temperature ratings similar to EN 1092-1. 1.0619, WCB and LCB are grouped into different material groups:

material	material group
1.0619	3E0
WCB	1C1
LCB	1C3

Table 10.4.7-1: Different matrial groups for wall thickness determination

   This means also pressure temperature ratings for the materials are different.

Customer benefit:

In combination with LESER’s fivefold material certification this results in the following benefit for the customer: in borderline applications where the p/t limits of one material, e.g. 1.0619 are exceeded, the customer may select to use the p/t ratings of a material that meets the requirements due to its higher ratings, e.g. WCB. This may require to change the material designation within the customer’s specification, but does not require any changes of LESER’s products or documentation.

10.4.8 Class 400 and Class 4500

Class 400

Class 400 is not offered by LESER as a standard, only on request for replacement purposes. It is not available in ASME B16.34. Furthermore the class is not commonly used.

Class 4500

Class 4500 is not a flange rating. The class is used for butt weld ends only (see ASME B16.34 for additional information).

The connecting dimensions for butt welded end can be supplied, but not the Class 4500 pressure rating.

10.4.9 Codes and Standards – ASME Flanges

The following is a list of standards and specifications referenced in ASME B16.5.

ASME Publications

ASME B16.5, *Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 metric / inch Standard*

ASME B16.20, *Metallic Gaskets for Pipe Flanges – Ring Joint, Spiral-Wound and Jacketed*

ASME B16.21, *Nonmetallic Flat Gaskets for Pipe Flanges*

ASME B16.34, *Valves – Flanged, threaded and welding end*

ASME PCC-1, *Guidelines for Pressure Boundary Bolted Flange Joint Assembly*

MSS Publications

MSS SP-6-2001, *Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings*

MSS SP-9-2001, *Spot Facing for Bronze, Iron and Steel Flanges*

MSS SP-25-1998, *Standard Marking System for Valves, Fittings, Flanges and Unions*

MSS SP-44-R2001, *Steel Pipeline Flanges*

MSS SP-45-1998, *Bypass and Drain Connections*

MSS SP-55-2001, *Quality Standard for Steel Casting for Valves, Flanges and Fittings*

MSS SP-61-1999, *Pressure Testing of Steel Valves*

10.5 Flanged Connections acc. to JIS B 2220/2239

There are two main standards covering flanges according to Japanese JIS (Japanese Industrial Standard) standards:

JIS B 2220 edition 2004: steel flanges
JIS B 2239 edition 2004: cast iron flanges

JIS B 2220 and JIS B 2239 contain dimensions as well as pressure temperature ratings.

Please note that the Korean Standard (KS) is identical to JIS.

10.5.1 Pressure/Temperature Ratings acc. to JIS B 2220/2239

Overview of materials and their groups

LESER standard materials			
Material	**Material group**	**Further materials of material group**	
SA 395	D1	JIS B 8270 FCD-S (1) JIS G 5502 FCD 350 JIS G 5502 FCD 400 JIS G 5502 FCD 450	ISO 1083 350-22 ISO 1083 400-15 ISO 1083 450-10
SA 105 SA 216 Gr. WCB	1.1	JIS G 3101 SS 400 JIS G 4051 S 20 C JIS G 4051 S 25 C JIS G 3201 SF 390A JIS G 3202 SFVC 1 JIS G 3201 SF 440A JIS G 3202 SFVC 2A JIS G 5101 SC410 JIS G 5151 SCPH 1 JIS G 5101 SC 480 JIS G 5151 SCPH 11	ISO 9328-2 PH 290 ISO 9328-2 PH 315 ISO 9328-2 PH 355 ISO 2604-1 F13 ISO 2604-1 F18 ISO 2604-1 F72 ISO 4991 C26-52H SA 515 70 SA 516 70 SA 537 CL1 SA 350 LF2
SA 217 Gr. WC6	1.9	ISO 4991 C32H A 387 11 CL2	SA 182 F11 CL2 SA 182 F12 CL2
SA 351 Gr. CF8M	2.2	JIS G 4304 SUS 316 JIS G 4305 SUS 316 JIS G 3214 SUS F316 JIS G 5121 SCS 14A JIS G 5121 SCS 16A ISO 9328-5 X 5 CrNiMo 17 12 ISO 9328-5 X 7 CrNiMo 17 12 ISO 2604-1 F62 ISO 2604-1 F64	ISO 4991 C57 ISO 4991 C60 ISO 4991 C61 ISO 4991 C61LC SA 240 316 SA 240 316H SA 20 317 SA 182 F316 SA 182 F316H
SA 479 Gr. 316L	2.3	JIS G 4304 SUS304L JIS G 4305 SUS304L JIS G 3214 SUS F304L JIS G 4304 SUS316L JIS G 4305 SUS316L JIS G 3214 SUS F316L	ISO 9328-5 X 2 CrNi 18 10 ISO 9328-5 X 2 CrNiMo 17 12 ISO 9328-5 X 2 CrNiMo 17 13 ISO 2604-1 F46 ISO 2604-1 F59 SA 240 304L SA 182 F304L

Table 10.5.1-1: JIS – material groups

Overview of materials and their groups

Further materials in standard which are not used by LESER generally		
Material group	**Further materials of material group**	
G1 (2)		SA 126 A
G2	JIS G 5501 FC 200	ISO 185 200 SA 126 B
G3	JIS G 5501 FC 250	ISO 185 250
D2 (2)		ISO 2531 400-5 ISO 1083 600-3
M1	JIS G 5705 FCMB 27-05	ISO/DIS 5922 BF 27-05 ISO/DIS 5922 BF 30-06
M2	JIS G 5705 FCMB 35-10 JIS G 5705 FCMB 35-10S (1)	SA 47 32510 ISO/DIS 5922 BF 35-10
1.3	JIS G 3203 SFVA F1	JIS G 5151 SCPH 11
1.5	JIS G 3203 SFVA F11A JIS G 5151 SCPH 21	A 204 A A 204 B A 182 F1 A 217 WC1 A 352 LC1 ISO 9328-2 16 Mo 3 ISO 2604-1 F28 ISO 4991 C28H

Table 10.5.1-2: JIS – material groups (continued)

Notes:

(1) Impact values need not to be considered unless the impact value specified in the material standard requires to be satisfied by the regulation applied

(2) The material group symbols G1 and D2 are shown as information to indicate the configuration of the material group. The numerals of the mechanical properties indicates in ( ) are based on the corresponding standard.

Divisions

JIS B 2220 distinguishes between Division I, II and III depending on the type and size of flange. Division II is the rating with some limitations put on that of Division I, while Divisions III is the rating with further limitations put on that of Division II.
For flange type WN (welding neck) and IT (integral) generally Division I applies. Therefore only pressure/temperature ratings for Division I are listed in this section of ENGINEERING. The only exemption in the scope of this section is material group: 2.3 (SA 479 Gr. 316L) where Division II applies for JIS 16K and flanges sizes > DN 200, see Table 10.5.1-8.

Pressure/temperature ratings acc. to JIS B 2220/2239

Material group: D1 (SA 395)

	Maximum temperature [°C]				
	-10	120	220	300	350
Class	**Maximum pressure [bar]**				
10K	14	14	12	10	-
16K	22	22	20	18	16
20K	28	28	25	23	20

Table 10.5.1-3: Pressure/temperature ratings acc. to JIS B 2239 – D1

Material group: 1.1 (SA 216 Gr. WCB)

	Maximum temperature [°C]									
	T_L to 120	120	220	300	350	400	425	450	475	490
Class	**Maximum pressure [bar]**									
10K	14	14	12	10	-	-	-	-	-	-
16K	27	27	25	23	21	18 (9)	16 (9)	-	-	-
20K	34	34	31	29	26	23 (9)	20 (9)	-	-	-
30K	51	51	46	43	39	34 (9)	30 (9)	-	-	-

Table 10.5.1-4: Pressure/temperature ratings acc. to JIS B 2220 – 1.1

Material group: 1.1 (SA 216 Gr. WCB)

	Maximum temperature [°C]											
	T_A to 120	120	220	300	350	400	425	450	475	490	500	510
Class	**Maximum pressure [bar]**											
40K	68	68	62	57	52	46 (14)	40 (14)	-	-	-	-	-
63K	107	107	97	90	81	72 (14)	63 (14)	-	-	-	-	-

Table 10.5.1-5: Pressure/temperature ratings acc. to JIS B 2220 Annex 6 – 1.1

Material group: 2.2 (SA 351 Gr. CF8M)

	Maximum temperature [°C]									
	T_L to 120	120	220	300	350	400	425	450	475	490
Class	**Maximum pressure [bar]**									
10K	14	14	12	10	-	-	-	-	-	-
16K	27	27	25	23	21	18	16	-	-	-
20K	34	34	31	29	26	23	20	-	-	-
30K	51	51	46	43	39	38	36	34 (11)	32 (11) (12)	30 (11) (12)

Table 10.5.1-6: Pressure/temperature ratings acc. to JIS B 2220 – 2.2

Material group: 2.3 (SA 479 Gr. 316L) – Division I (≤ DN 200)

	Maximum temperature [°C]									
	T_L to 120	120	220	300	350	400	425	450	475	490
Class	**Maximum pressure [bar]**									
10K	14	14	12	10	-	-	-	-	-	-
16K	27	27	25	23	21	18	16	-	-	-
20K	34	34	31	29	26	23	20	-	-	-
30K	51	51	46	43	39	38	36	34(13)	-	-

Table 10.5.1-7: Pressure/temperature ratings acc. to JIS B 2220 – 2.3

Material group: 2.3 (SA 479 Gr. 316L) – Division II (> DN 200)

	Maximum temperature [°C]									
	T_L to 120	120	220	300	350	400	425	450	475	490
Class	**Maximum pressure [bar]**									
16K	16	16	16	15	14	13	13	-	-	-

Table 10.5.1-8: Pressure/temperature ratings acc. to JIS B 2220 – 2.3

General notes:

(1) T_L is a minimum working temperature which is the normal temperature or below. The minimum working temperature lower than the normal temperature shall be subjected to the agreement between the parties concerned.
T_A is the normal temperature.

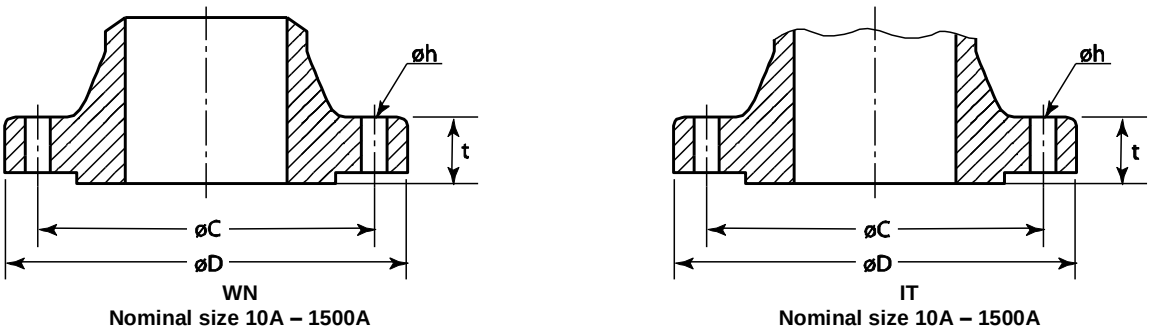
Notes:

(9) Not applicable to JIS G 5101 SC 480 of material group 002 and ASTM SA 537 CLI and ISO 9328-2 PH355 of material group 1.1
(11) Not applicable to ASTM SA 351 CF3 and ISO 4991 C46 of material group 021b and 2.1
(12) Not applicable to ASTM SA 351 CF3M of material group 022b and 2.2, ISO 4991 C57, ISO 4991 C60, ISO 4991 C61 and ISO 4991 C61LC
(13) Not applicable to ASTM SA 240 304L of material group 023a and 2.3, ASTM A 182 F304L and ISO 9328-5 X 2CrNi 1810
(14) Not to be applied to SC 480 of material group 002

10.5.2 Dimensions acc. to JIS B 2220/JIS 2239

The standards JIS B 2220/JIS B 2239 contain several types of flanges. The flange dimensions depend on different flange types.
Only IT (integral) and WN (welding neck) steel flanges and IT (integral) cast iron flanges in sizes of DN 15 to DN 500 are used by LESER and are listed in the tables below.
The tables are sorted by pressure classes in ascending order. Flanges are generally offered up to nominal pressure of 30K.

Types of flanges:



WN
Nominal size 10A – 1500A

IT
Nominal size 10A – 1500A

Figure 10.5.2-1: JIS B 2220 – types of flanges made of steel

Dimensions acc. to JIS B 2220/JIS B 2239

Nominal pressure 10K [mm]

Nominal size	Connection dimensions					Thickness of flange	
	Outside diameter	Bolt circle diameter	Bolt hole diameter	Bolting			
	D	C	h	Number	Size	t	
	Steel cast iron					Steel	Cast iron
	Type of flange						
	WN IT						IT D1
15	95	70	15	4	M12	12	16
20	100	75	15	4	M12	14	18
25	125	90	19	4	M16	14	18
32	135	100	19	4	M16	16	20
40	140	105	19	4	M16	16	20
50	155	120	19	4	M16	16	20
65	175	140	19	4	M16	18	22
80	185	150	19	8	M16	18	22
100	210	175	19	8	M16	18	24
125	250	210	23	8	M20	20	24
150	280	240	23	8	M20	22	26
200	330	290	23	12	M20	22	26
250	400	355	25	12	M22	24	30
300	445	400	25	16	M22	24	32
350	490	445	25	16	M22	26	34
400	560	510	27	16	M24	28	36
450	620	565	27	20	M24	30	38
500	675	620	27	20	M24	30	40

Table 10.5.2-1: JIS B 2220/JIS B 2239 – dimensions of flanges – pressure class 10K [mm]

Nominal pressure 16K [mm]

Nominal size	Connection dimensions					Thickness of flange	
	Outside diameter	Bolt circle diameter	Bolt hole diameter	Bolting			
	D	C	h	Number	Size	t	
	Steel cast iron					Steel	Cast iron
	Type of flange						
	WN IT						IT D1
15	95	70	15	4	M12	12	16
20	100	75	15	4	M12	14	18
25	125	90	19	4	M16	14	18
32	135	100	19	4	M16	16	20
40	140	105	19	4	M16	16	20
50	155	120	19	8	M16	16	20
65	175	140	19	8	M16	18	22
80	200	160	23	8	M20	20	24
100	225	185	23	8	M20	22	26
125	270	225	25	8	M22	22	26
150	305	260	25	12	M22	24	28
200	350	305	25	12	M22	26	30
250	430	380	27	12	M24	28	34
300	480	430	27	16	M24	30	36
350	540	480	33	16	M30x3	34	38
400	605	540	33	16	M30x3	38	42
450	675	605	33	20	M30x3	40	46
500	730	660	33	20	M30x3	42	50

Table 10.5.2-2: JIS 2220/JIS 2239 – dimensions of flanges – pressure class 16K [mm]

Dimensions acc. to JIS B 2220/JIS B 2239

Nominal pressure 20K [mm]

Nominal size	Connection dimensions					Thickness of flange	
	Outside diameter	Bolt circle diameter	Bolt hole diameter	Bolting			
	D	C	h	Number	Size	t	
	Steel cast iron					Steel	Cast iron
	Type of flange						
	WN IT						IT D1
15	95	70	15	4	M12	14	16
20	100	75	15	4	M12	16	18
25	125	90	19	4	M16	16	20
32	135	100	19	4	M16	18	20
40	140	105	19	4	M16	18	22
50	155	120	19	8	M16	18	22
65	175	140	19	8	M16	20	24
80	200	160	23	8	M20	22	26
100	225	185	23	8	M20	24	28
125	270	225	25	8	M22	26	30
150	305	260	25	12	M22	28	32
200	350	305	25	12	M22	30	34
250	430	380	27	12	M24	34	38
300	480	430	27	16	M24	36	40
350	540	480	33	16	M30x3	40	44
400	605	540	33	16	M30x3	46	50
450	675	605	33	20	M30x3	48	54
500	730	660	33	20	M30x3	50	58

Table 10.5.2-3: JIS 2220/JIS 2239 – dimensions of flanges– pressure class 20K [mm]

Nominal pressure 30K (steel flanges) [mm]

Nominal size	Connection dimensions					Thickness of flange
	Outside diameter	Bolt circle diameter	Bolt hole diameter	Bolting		
	D	C	h	Number	Size	t
	Type of flange					
	WN IT					
15	115	80	19	4	M16	18
20	120	85	19	4	M16	18
25	130	95	19	4	M16	20
32	140	105	19	4	M16	22
40	160	120	23	4	M20	22
50	165	130	19	8	M16	22
65	200	160	23	8	M20	26
80	210	170	23	8	M20	28
90	230	185	25	8	M22	30
100	240	195	25	8	M22	32
125	275	230	25	8	M22	36
150	325	275	27	12	M24	38
200	370	320	27	12	M24	42
250	450	390	33	12	M30x3	48
300	515	450	33	16	M30x3	52
350	560	495	33	16	M30x3	54
400	630	560	39	16	M36x3	60

Table 10.5.2-4: JIS 2220 – dimensions of flanges made of steel – pressure class 30K [mm]

Compatibility of JIS B 2220/JIS B 2239 and ASME B16.5

Its possible to connect JIS flanges with flanges according to ASME B16.5, see the compatibility list below for more information.

JIS B 2220/JIS B 2239	ASME B16.5	Compatibility of drilling template and raised face	Compatibility of outer diameter of flange
DN 50, 10K	NPS 2”, CL 150	x	
DN 50, 16K	NPS 2”, CL 150	x	
DN 65, 10K	NPS 2½”, CL 150	x	x
DN 65, 16K	NPS 2½”, CL 150	x	x
DN 65, 20K	NPS 2½”, CL 150	x	x
DN 80, 10K	NPS 3”, CL 150	x	x
DN 80, 16K	NPS 3”, CL 150	x	
DN 80, 20K	NPS 3”, CL 150	x	
DN 100, 10K	NPS 4”, CL 150	x	x
DN 100, 16K	NPS 4”, CL 150	x	x
DN 125, 10K	NPS 5”, CL 150	x	x
DN 125, 16K	NPS 5”, CL 150	x	
DN 150, 10K	NPS 6”, CL 150	x	
DN 200, 10K	NPS 8”, CL 150	x	x
DN 250, 10K	NPS 10”, CL 150	x	x

Table 10.5.2-5: Compability list for JIS flanges with flanges acc. to ASME B16.5

10.5.3 Codes and Standards – JIS Flanges

JIS B 2001, *Nominal size and bore of valves*

ISO 2531, Ductile *iron pipes, fittings, accessories and their joints for water or gas application*

JIS G 3468, *Large diameter welded stainless steel pipes*

JIS B 2220, *Steel pipe flanges*

JIS B 2239, *Cast iron pipe flanges*

JIS B 2240 *Copper alloy pipe flanges*

JIS B 2241 *Aluminium pipe flanges*

10.6 Threaded Connections

This section shall provide an overview about different international thread standards and how they are linked with each other. For more information about available threaded connections and option codes for LESER Compact Performance safety valves see LESERs catalog and price lists.

Pressure / temperature ratings

Unlike for flanged connections there are no standards which provide information about pressure-temperature ratings of threaded connections.
On the side of the protected system the wall thickness of the pipe respectively the pipe schedule determines the pressure rating of the pipe.
For the inlet and outlet bodies of the Compact Performance safety valves LESER has performed design strength calculations based on the wall thickness of the body. These calculations are verified during the certification of the safety valves according to PED Directive and ASME Code by the notified bodies TUEV and National Board.
The pressure-temperature ratings for the individual valve types and connections are documented in the Compact Performance catalog and are marked on every inlet body in PN and Class designations.

Male and female connections

Generally it can be distinguished between so called male and female connections. The most commonly used combination for safety valves is a male inlet and a female outlet.

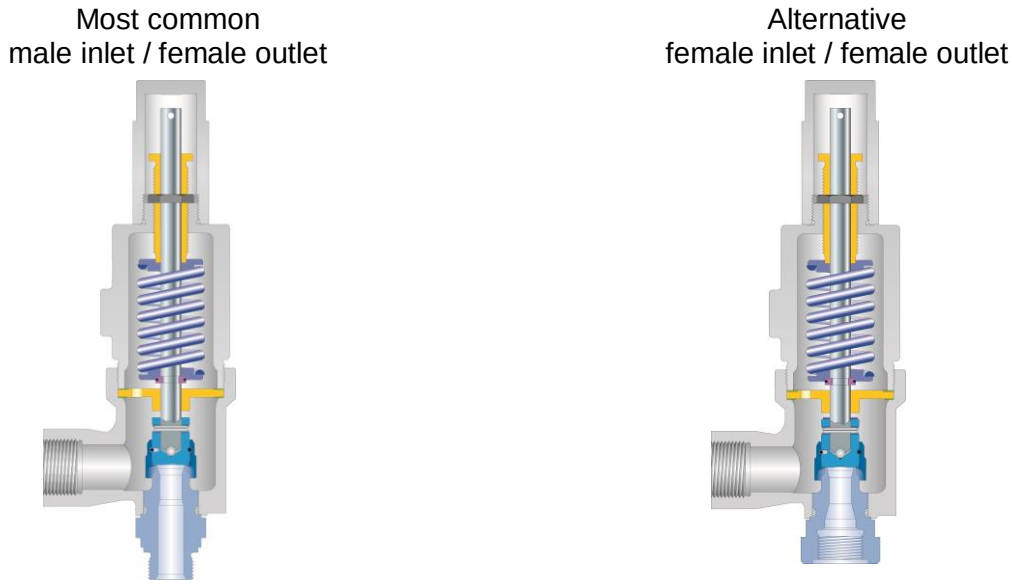


Figure 10.6.-1: General view of a safety valve with threaded connections

Overview about international thread standards

A major differentiation between threads is the point of sealing, which can be on the thread or not on the thread by e.g. a sealing ring between the two components.

There are two basic international standards for threaded connections in which a sealed joint is obtained between the flanks of the screw threads.

1. ANSI/ASME B1.20.1 (thread abbreviation “NPT”)
2. International standard ISO 7-1 third edition from 1994 (thread abbreviation “R”)

Threaded connections - sealing on thread

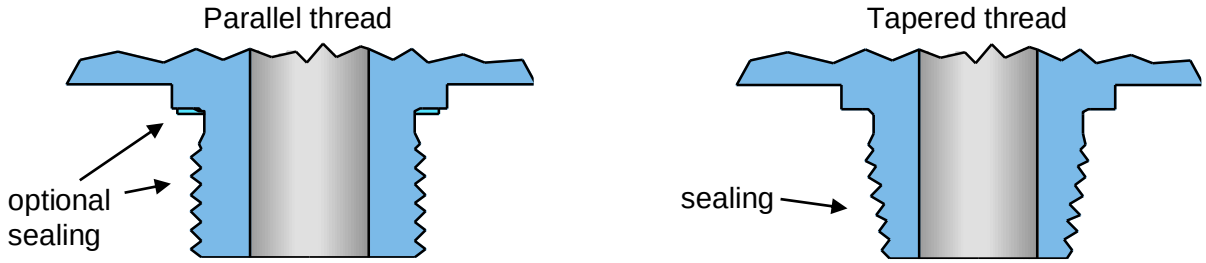


Figure 10.6-2: Parallel and tapered thread

Main standard	Symbol	Form	Thread		National standards					
			Female	Male	DE	GB	US	BR	ZA	JP
ANSI / ASME B1.20.1	NPT	Tapered	x	x	-	-	ANSI / ASME B1.20.1	NBR 12912	-	-
ANSI / ASME B1.20.3	NPTF	Tapered	x	x	-	-	ANSI / ASME B1.20.3	-	-	-
	PS	Parallel	x		-	-	-	-	-	JIS B 0203 (Annex 1)
	PT	Tapered	x	x	-	-	-	-	-	JIS B 0203 (Annex 1)
ISO 7-1	R	Tapered		x	DIN 2999-1	BS 21 [BSP(T)]	-	NBR 8133	SABS 1109	JIS B 0203
ISO 7-1	Rc	Tapered	x		-	BS 21 [BSP(T)]	-	NBR 8133	SABS 1109	JIS B 0203
ISO 7-1	Rp	Parallel	x		DIN 2999-1	BS 21 [BSP(P)]	-	NBR 8133	SABS 1109	JIS B 0203
	Rs (1)	Parallel		x	-	BS 21 (Annex C)	-	-	-	-

Table 10.6-1: Threaded connections sealing on thread

Notes:

(1) a sealing strip is required

Threaded connections - not sealing on thread

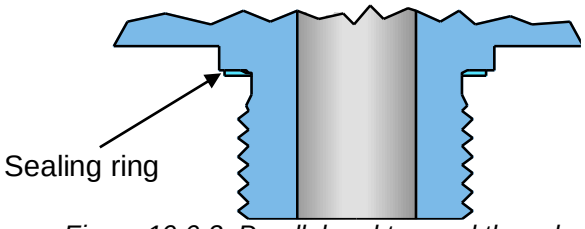


Figure 10.6-3: Parallel and tapered thread

Main standard	Symbol	Form	Thread		National standards					
			Female	Male	DE	GB	US	BR	ZA	JP
ISO 228-1	G	Parallel	x	x	DIN ISO 228-1	BS 2779	-	NBR 6414	SABS 1306	JIS B 0202
	PS	Parallel	x	x	-	-	-	-	-	JIS B 0202 Appendix

Table 10.6-2: Threaded connections not sealing on thread

10.6.1 Threaded Connections acc. to ISO 7-1

Pipe thread for connections sealing on the thread

In the case of threaded connections in accordance with ISO 7-1, the male thread is always a tapered thread whereas the female thread may be either parallel or tapered. The thread geometry is historically based on the Whitworth thread (55° thread angle). If one of the listed national standards is needed LESER supplies and certifies the standard ISO 7-1.

The following abbreviations are used:

- R tapered male thread
- R_c tapered female thread
- R_p parallel female thread

National standards

- Federal Republic of Germany – DIN 2999
  DIN 2999 “Pipe threads” for tubes and fittings.
  Special feature: only the parallel female thread is shown in DIN 2999, because tapered female threads are not in standard use in Germany and do not therefore need to be standardized. This is the reason why ISO 7-1 was not published as DIN ISO 7-1 but as national DIN standard
- United Kingdom – BS 21
  BS 21 Pipe threads for tubes and fittings where pressure tight joins are made on threads (metric dimensions)
  BS 21 refers to ISO 7-1 with regard of tolerances. The thread designations have been included unchanged. The types of thread gauges have mainly been defined including – and this is a special British feature – those for testing “long screwed threads” for gas applications. Long screwed threads are extended male threads which can be given the abbreviation RL. The following designations are frequently found: BSP(T) for taper or BSP(P) for parallel threads.
  Rs
  In addition, a parallel male thread with the designation Rs is defined for gas applications in Appendix C of BS 21. An additional gasket is required here for sealing at the end face or at the end of thread. The nominal dimensions of this thread correspond to those of ISO 228-1, but a greater thread clearance results from the tolerance values
- Brazil – NBR 8133
  ISO 7-1 is used in Brazil under the number NBR 8133.
  Both the taper and parallel threads are defined in this standard. The designations correspond to the ISO designations.
- South Africa – SABS 1109
  ISO 7-1 is used in South Africa under the number SABS 1109.
  Both the taper and parallel threads are defined in this standard. The designations correspond to the ISO designations.
- Japan – JIS B 0203
  ISO 7-1 is used in Japan under the number JIS B 0203.
  Both the taper and parallel threads are defined in this standard. The designations correspond to the ISO designations.
  PT, PS
  In Annex 1 of JIS B 0203 the designations PT and PS are mentioned. PT describes external and internal taper threads. PS describes parallel female thread fitting to taper male threads. Threads up to 6” are exactly the same as mentioned in ISO 7-1. The difference is that ISO 7-1 specifies threads only up to 6” while the annex 1 of JIS B 0203 goes up to 12” threads

Pipe thread for connections not sealing on the thread in accordance with ISO 228-1 (“G” designation)

The threads described in ISO 228-1 are parallel threads which correspond to the threads of ISO 7-1 in terms of their thread pitch and thread angle. The essential difference is the parallel male thread of the connection which prevents sealant from being introduced into the thread. Threads in accordance with ISO 228-1 are sealed by gaskets on the end face or on the top end of thread.
ISO 228-1 and ISO 7-1 differ from one another in the tolerance values for the thread. However, in theory an male G thread in accordance with ISO 228-1 can be screwed into an femalel Rp thread in accordance with ISO 7-1.

ISO 228-1 National Standards

Germany	DIN ISO 228-1
United Kingdom	BS 2779
Brazil	NBR 6414
South Africa	NBR 1306
Japan	JIS B 0202

10.6.2 Threaded Connections acc. to ASME B1.20.1/B1.20.3

Pipe thread for connections sealing on the thread

ANSI/ASME B1.20.1 thread abbreviation "NPT"

In US-influenced markets NPT threads in accordance with ANSI/ASME B1.20.1 are standard. These threads differ from the ISO 7-1 threads in the thread angle (60°) and to some extent in the thread pitch. The male and female threads of NPT threads have a tapered form.

National standards based on ANSI/ASME B1.20.1

Brazil	NBR 12912

ANSI / ASME B1.20.3, thread abbreviation “NPTF”

In rare cases a metallic sealing thread is used acc. to ANSI / ASME B1.20.3 as a so called NPTF thread. To accomplish this some modifications of thread form and greater accuracy in manufacture is required.
Nevertheless, according to ANSI / ASME B1.20.3 it is advised to use sealing band. Even the refrigeration industry, where metallic sealings are favoured, accepts usage of additional sealing material (see ANSI B1.20.3, Chapter 1.1 footnote for more information).

Commonly used shortcuts

FNPT	female NPT
MNPT	male NPT

10.6.3 Minimum Inside Diameters for Compact Performance Safety Valves

Compact Performance safety valves can be supplied with a large variety of connections at the inlet and outlet.

When type and size of a connection are selected it must be considered that specific minimum inside diameters at inlet and outlet of the safety valve are required. This applies to all types of connections like threaded, welded of flanged connections.

This means that at no part of the inlet or outlet piping the inside diameter should fall below the listed minimum diameters. Otherwise the flow path would be restricted and the safety valve cannot discharge its full rated capacity or may chatter. Further the minimum wall thickness of an inlet male connection is 2 mm.

Type	Orifice diameter d_0 [mm]	Minimum inside diameter [mm]	
		Inlet	Outlet
437/438/439	6	8	16
	10	12.5	
459/462	6	10	26.4
	9	12.5	
	13	15	
	17.5	21	34

Table 10.6.3-1: Minimum inside diameters for Compact Performance safety valves

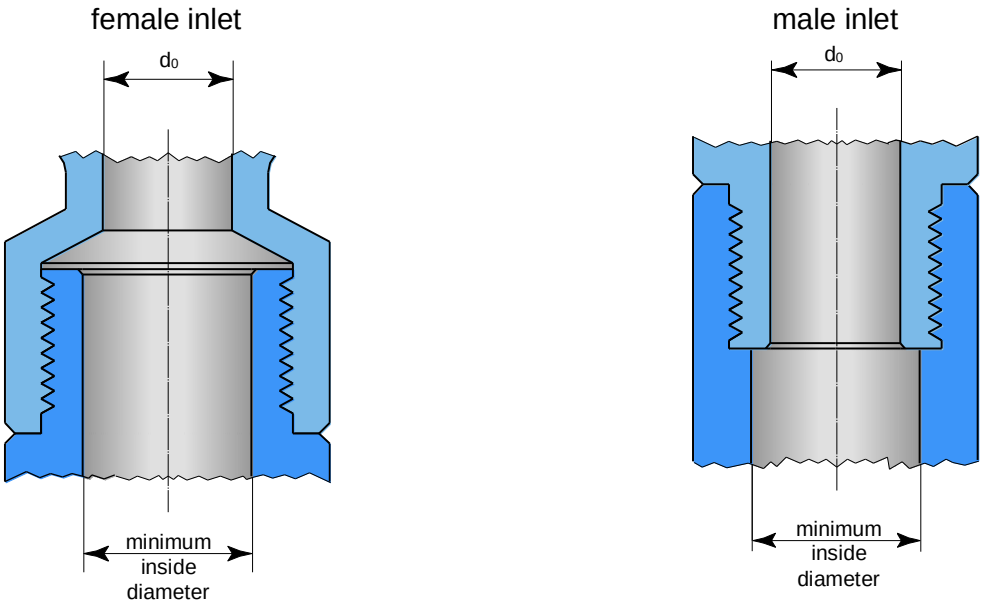


Figure 10.6.3-1: Minimum inside diameters for female and male inlets

10.6.4 Codes and Standards – Threaded Connections

ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads – part 1: dimensions, tolerances and designation*

ANSI B1.2, *Gages and Gaging for Unified Screw Threads*

ANSI B1.7, *Screw Threads: Nomenclature, Definitions, and Letter Symbols*

ANSI B1.20.3, *Dryseal pipe threads [inch]*

ANSI B1.20.4, *Dryseal pipe threads (Metric Translation)*

ANSI B1.20.5, *Gaging for Dryseal pipe threads [inch]*

ANSI B1.20.6M, *Gaging for Dryseal pipe threads (Metric Translation)*

ANSI B2.2, *Brazing procedure and performance Qualification*

ANSI B2.4, *Specification for Welding Procedure and Performance Qualification for Thermoplastics*

ANSI B47.1, *Gage Blanks*

10.7 Welding Ends

Welding ends are used for high pressure / high temperature applications, when it becomes difficult to obtain suitable gasket materials for a flanged connection. Valve repair also becomes an issue, because the repair of the valve is in most cases performed in situ.

Recommendation

LESER recommends a savety valve with full nozzle if a welding end is requested. On the one hand the pressure classes are maintained, on the other hand the dimensions of the welding end can be arranged more flexible. Therefore this section is focused on full nozzle valves.

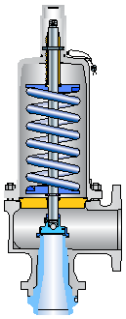


Figure 10.7-1:LESER type 457
With full nozzle and welding end at the inlet

The following information are necessary to determine the welding end at the safety valve:

- requested material of nozzle (must be weldable to the pipe)
- pipe standard
- wall thickness of pipe
- inner diameter of pipe

General information

Following drawing shows the design of an inlet welding end for a full nozzle type safety valve:

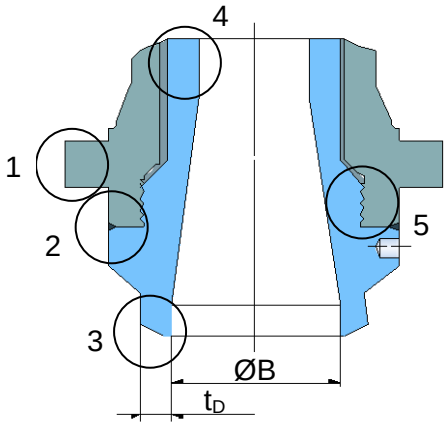


Figure 10.7.0-2: Inlet welding end

Notes:

(1) collar - necessary to clamp the valve on the test bench
(2) seal weld
(3) welding end acc. to
- EN
- ASME

(4) Material
(5) thread

10.7.1 Materials for Welding Ends

The nozzle of the safety valve is typically 316L or CF8M. Other materials may be used, but the seat of the safety valve should be corrosion resistant stainless steel. If a carbon steel nozzle is required a stellited seat must be foreseen.

10.7.2 Welding Ends acc. to EN 12627

The standard EN 12627 differentiates between two welded joints. Up to a wall thickness of 4 mm a butt joint with square weld can be used. Up to a wall thickness of 22 mm a v-single weld has to be used.

At LESER all connections are welded with a v-single weld up a wall thickness of 22 mm. At higher wallthicknesses multiple welding layers are used.

Exception: Clean Service safety valves Series 48X, which are supplied with a square weld end.

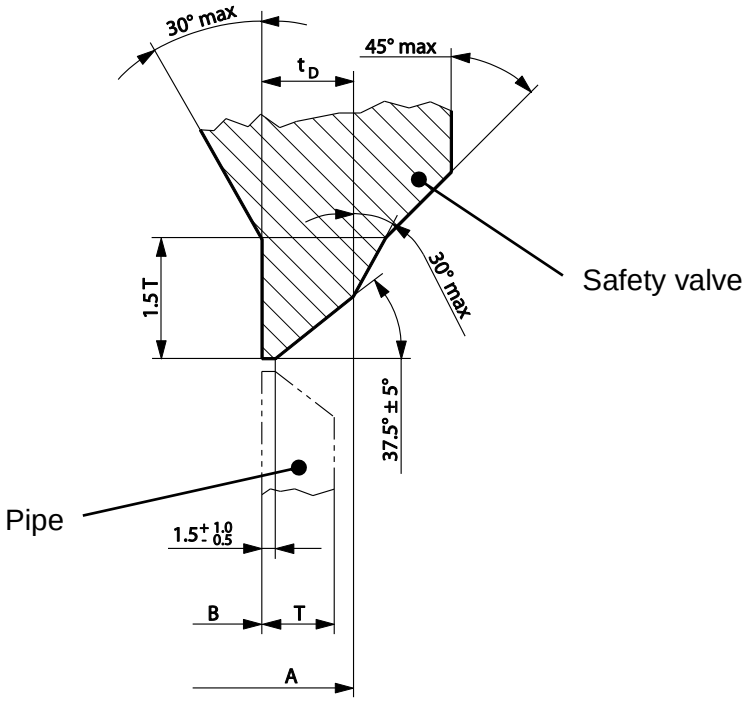


Figure 10.7.2-1: Welding end with single v weld for connection of pipe with wall thickness up to 22 mm

Following tables are an extraction of EN 12627. Welding dimensions are available from DN 15 to DN 500.

Nominal size of valve	ØA	Tolerance
DN 15	22	+2.5 -1
DN 20	28	+2,5 -1,5
DN 25	35	
DN 32	44	+2,5 -2
DN 40	50	
DN 50	62	
DN 65	77	+2,5 -2,5
DN 80	91	
DN 100	117	

Nominal size of valve	ØA	Tolerance
DN 125	144	+4 -2,5
DN 150	172	
DN 200	223	
DN 250	278	
DN 300	329	
DN 350	362	
DN 400	413	
DN 450	464	
DN 500	516	

Table 10.7.2-1: Dimensions and tolerances of outside diameter ØA of welding end [mm]

Nominal size of valve	DN 8 - DN 250	DN 300 - DN 450	DN 500 – DN 1400
Tolerance of ØB	+1 -1	+2 -2	+3 -2

Table 10.7.2-2: Tolerance of inside diameter B of welding end [mm]

Inside Diameter

The inside diameter B of the welding end has to be equal to the nominal inside diameter of the pipe acc. to ISO 4200, on which it has to be welded.

The standard ISO 4200 provides the basis for the standard EN ISO 1127. Pipe dimensions are equal in both standards.

For pipe dimensions see the following table acc. to ISO 4200.

Preferenced wall-thickness according to ISO 4200 [mm]

Outside diameter of pipe	Preferenced wall-thickness						
	Category						
	A	B	C	D	E (1)	F	G
	Stainless			Alloyed, non-alloyed	Stainless, alloyed, non-alloyed		
10.2	1.6	-	-		1.6	-	-
13.5	1.6	-	-	1.6	2	-	-
17.2	1.6	-	-	1.6	2	-	-
21.3	1.6	-	-	1.8	2	3.2	4
26.9	1.6	-	-	1.8	2	3.2	4
33.7	1.6	2	-	2	2.3	3.2	4.5
42.4	1.6	2	-	2.3	2.6	3.6	5
48.3	1.6	2	-	2.3	2.6	3.6	5
60.3	1.6	2	2.3	2.3	2.9	4	5.6
76.1	1.6	2.3	2.6	2.6	2.9	5	7.1
88.9	2	2.3	2.9	2.9	3.2	5.6	8
114.3	2	2.6	2.9	3.2	3.6	6.3	8.8
139.7	2	2.6	3.2	3.6	4	6.3	10
168.3	2	2.6	3.2	4	4.5	7.1	11
219.1	2	2.6	3.6	4.5	6.3	8	12.5
273	2	3.6	4	5	6.3	10	-
323.9	2.6	4	4.5	5.6	7.1	10	-
355.6	2.6	4	5	5.6	8	11	-
406.4	2.6	4	5	6.3	8.8	12.5	-
457	3.2	4	5	6.3	10	-	-
508	3.2	5	5.6	6.3	11	-	-

Table 10.7.2 -3: Preferenced wall thickness acc. to ISO 4200

Notes:

(3) Selection of wall-thickness acc. to prior ISO 134

To define the correct welding end, the following information are required:

- pipe dimensions
- material

10.7.3 Welding Ends (Butt welded) acc. to ASME B16.25 and ASME B16.9

Only welding ends for wall thicknesses up to 22 mm are described in this chapter.

There are two used standards at LESER:
ASME B16.25 (2003) for a wall thickness from 3 mm up to 10 mm (see figure 10.7.3-1)
ASME B16.9 (2003) for a wall thickness larger than 10 mm (see figure 10.7.3-2).

In most case ASME B16.25is applied.

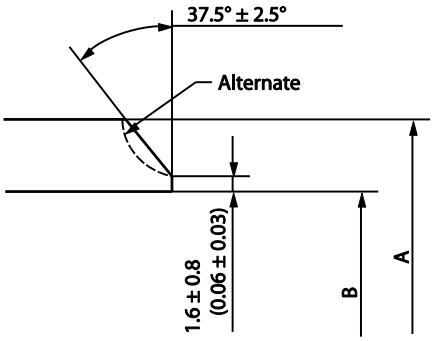


Figure 10.7.3-1: ASME B16.25 – weld bevel details for GTAW Root Pass with wall thickness from 3 mm up to 10 mm

General Notes:

(a) This detail applies for gas tungsten arc welding (GTAW) of the root pass where nominal wall thickness is over 3 mm (0.12 inch) to 10 mm (0.38 inch) inclusive
(b) Linear dimensions are in millimeters with inch values in parentheses

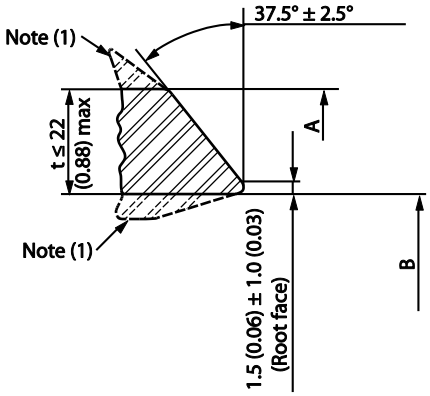


Figure 10.7.3-2: ASME B16.9 – Plain bevel From x (2) mm up to 22 mm

General notes:

a. Dimensions in parentheses are in inches
b. Other dimensions are in millimeters

Notes:

(1) see ASME B16.9 chapter 8 and fig. 1 for transition contours
(2) x = 5 (0.19) for carbon steel or ferritic alloy steel and 3 (0.12) for austenitic alloy steel

Dimensions of welding ends [mm]

The standard ASME B16.25 describes welding ends from a nominal size of 2½“ up to 36”. This extraction deals only with sizes from 2 ½” up to 16”.
The schedule number is a designation system that combines sizes and wall thicknesses for ordering pipes.

	O.D. at welding ends			
Nominal pipe size	Schedule no. (1)	Wrought or fabricated components (1) A	Cast components A	B
2½”	40	73.0	75	62.5
	80	73.0	75	59
	160	73.0	75	54
	XXS	73.0	75	45
3”	40	88.9	91	78
	80	88.9	91	73.5
	160	88.9	91	66.5
	XXS	88.9	91	58.5
3½”	40	101.6	105	90
	80	101.6	105	85.5
4”	40	114.3	117	102
	80	114.3	117	97
	120	114.3	117	92
	160	114.3	117	87.5
	XXS	114.3	117	80
5”	40	141.3	144	128
	80	141.3	144	122
	210	141.3	144	116
	160	141.3	144	109-5
	XXS	141.3	144	103
6”	40	168.3	172	154
	80	168.3	172	146-5
	120	168.3	172	140
	160	168.3	172	132
	XXS	168.3	172	124.5
8”	40	219.1	223	203
	60	219.1	223	198.5
	80	219.1	223	193.5
	100	219.1	223	189
	120	219.1	223	182.5
	140	219.1	223	178
10”	40	273.0	278	254.5
	60	273.0	278	247.5
	80	273.0	278	243
	100	273.0	278	236.5
	120	273.0	278	230
12”	STD	323.8	329	305
	40	323.8	329	303
	XS	323.8	329	298.5
	60	323.8	329	295
	80	323.8	329	289
	100	323.8	329	281
14”	STD	355.6	362	336.5
	4XS0	355.6	362	333.5
	60	355.6	362	330
	80	355.6	362	325.5
16”	STD	406.4	413	387.5
	40	406.4	413	381
	60	406.4	413	373
	80	406.4	413	363.5

Table 10.7.3-1: ASME B16.25 – dimensions of welding ends [mm]

Notes:

(1) Data is from ASME B36.10M or a more precise rounding of the inch dimensions from table I-1. Letter designations signify:
- (a) STD = standard wall thickness
- (b) XS = extra-strong wall thickness
- (c) XXS = double extra-strong wall thickness

10.7.4 Welding Ends acc. to ASME B16.11 (Socket welded)

For welding ends acc. to ASME Code in sizes 2" and smaller the socket weld connection is preferred over the butt weld end connection which is standardized for sizes 2 ½" and larger. Socket weld connections apply to Compact Performance Series safety valves, where the socket is formed by the safety valve inlet body as shown below.

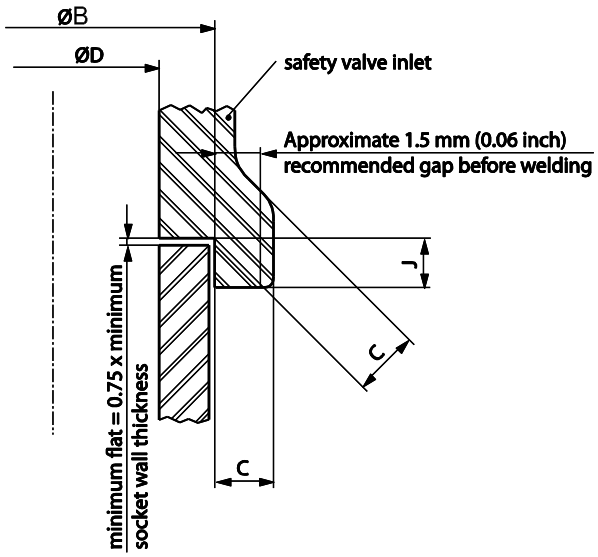


Figure 10.7.4-1: ASME B16.11 – welding gap and minimum flat dimensions for socket-welding fittings

Dimensions of socket-welding fittings

Table 10.7.4-1 shows the most common sizes of socket-welding fittings as an extract of ASME B16.11. Upper and lower values (see note (1)) are perceived as tolerances.

DN	Nominal pipe size	Socket bore diameter (1) B	Bore diameter of fittings D (1), (3) Class designation			Socket wall thickness (2), C Class designation						Min. depth of socket J
			3000	6000	9000	3000		6000		9000		
						Avg.	Min.	Avg.	Min.	Avg.	Min.	
15	½"	22.2	16.6	12.5	7.2	4.67	4.09	5.97	5.18	9.35	8.18	9.5
		21.8	15.0	11.0	5.6							
20	¾"	27.6	21.7	16.3	11.8	4.90	4.27	6.96	6.04	9.78	8.56	12.5
		27.2	20.2	14.8	10.3							
25	1"	34.3	27.4	21.5	16.0	5.69	4.98	7.92	6.93	11.38	9.96	12.5
		33.9	25.9	19.9	14.4							
32	1¼"	43.1	35.8	30.2	23.5	6.07	5.28	7.92	6.93	12.14	10.62	12.5
		42.7	34.3	28.7	22.0							
40	1½"	49.2	41.6	34.7	28.7	6.35	5.54	8.92	7.80	12.70	11.12	12.5
		48.8	40.1	33.2	27.2							
50	2"	61.7	53.3	43.6	38.9	6.93	6.04	10.92	9.50	13.84	12.12	16.0
		61.2	51.7	42.1	37.4							

Table 10.7.4-1: ASME B16.11 – dimensions of socket-welding fittings [mm]

General notes:

Dimensions are in millimeters

Notes:

(1) upper and lower values for each size are the respective maximum and minimum dimensions
(2) average of socket wall thickness around periphery shall be no less than listed values. The minimum values are permitted in localized areas
(3) see 6.3 for minimum dimensions of Compact Performance valves

Correlation of fittings class with schedule number or wall designation of pipe

Table 10.7.4-2 shows the correlation of the class designation of socket-welding fittings acc. to ASME B16.11 and the schedule number or wall designation of pipes (cp. ASME B36.10M). Nominal wall thickness of schedule 160 and double extra strong pipes of small sizes (⅛", ¼", ⅜") are not defined in ASME B36.10M; for these cases, ASME B16.11 gives a definition.

Class Designation of Fitting	Type of Fitting	Pipe Used for Rating Basis [Note (1)]	
		Schedule No.	Wall Designation
3000	Socket-welding	80	XS
6000	Socket-welding	160	…
9000	Socket-welding	…	XXS

Table 10.7.4-2: ASME B16.11 – Correlation of fittings class with schedule number or wall designation of pipe for calculation of ratings [mm]

Notes:

(1) This table is not intended to restrict the use of pipe of thinner or thicker wall with fittings. Pipe actually used may be thinner or thicker in nominal wall than that shown in Table 10.7.4-2. When thinner pipe is used, its strength may govern the rating. When thicker pipe is used (e.g., for mechanical strength), the strength of the fitting governs the rating.

10.7.5 Codes and Standards – welding ends

LDeS 3288.20-EN_Specification for butt welding ends-Compact Performance

EN 29692, *preparation of welded joints*

ASME B1.20.1, *Pipe Threads, General Purpose*

ASME B16.5, *Pipe Flanges and Flanged Fittings*

ASME B16.9, *Factory-Made Wrought Butt welding Fittings*

ASME B16.11, *Forged Fittings, Socket-welding and Threaded*

ASME B16.34M, *Valves – Flanged, Threaded and Welding End*

ASME B36.10M, *Welded and Seamless Wrought Steel Pipe*

10.8 Clean Service Connections

This chapter gives an overview about the variety of clean service connections, the allowable pressures and the temperature ranges. There are no pressure/temperature ratings like for EN or ASME flanges, because all connections use elastomer sealing elements, where the type/grade of the elastomer determines the maximum temperature.

LESER does not recommend a certain type of connection. The selection of a connection is up to the user. Please note that the inner diameter is controlling not the outer diameter by reason of cleaning the connection and the pipe. Pipe standards often describe the outer diameter and the wall thickness.

Please refer to the LESER product catalogue for further information about:
- finishing surface of clean service connections
- detailed overview of available connections for individual products.

10.8.1 Piping and Connection Standards

The dimensions of the connections are a result of the combination of the different pipe- and connection standards.

Following pipe standards are used in clean service applications:

- BS 4825-1
- DIN 11850
- DIN EN 1127
- ISO 2037

Pipe dimensions

Outside diameter of pipe x wall thickness

	DIN		ISO		OD
Nominal size DN	DIN 11850	Row	DIN EN 1127	Nominal size NPS	ISO 2037 (BS 4825/Part 1)
15	20 x 2.0	3	21.3 x 1.6	-	-
25	30 x 2.0	3	33.7 x 2.0	1”	25.4 x 1.6
40	42 x 2.0	3	48.3 x 2.0	1½“	38 x 1.6
50	54 x 2.0	3	60.3 x 2.0	2”	51 x 1.6
65	70 x 2.0	2	76.1 x 2.0	2½“	63.5 x 1.6
80	85 x 2.0	2	88.9 x 2.3	3”	88.9 x 2.0
100	104 x 2.0	2	114.3 x 2.6	4”	101.6 x 2.0
125	129 x 2.0	2	139.7 x 2.6	5”	139.7 x 2.0
150	154 x 2.0	2	168.3 x 2.6	6”	168.3 x 2.6

Table 10.8.1-1: Dimensions of pipes

Following connection standards are used:

- DIN 11864-1
- DIN 11864-2
- DIN 11851
- ASME BPE
- Manufacturer standards: APV, NEUMO, Tuchenhagen

Within this section the following shortcuts are used:

- OD tube (outside diameter of tube)
- ID tube (inner diameter of tube)
- WT (wall thickness)

10.8.2 Aseptic Flange Connections

Aseptic flange acc. to DIN 11864 form A

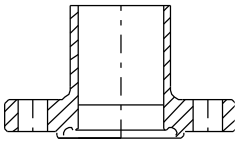
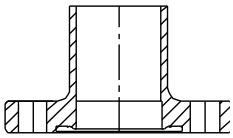
	Aseptic flange groove			**Aseptic flange tongue**		
						
***LESER** Code*	NF			BF		
Acc. to	DIN 11864 T2 Form A					
Piping standard	DIN 11850 DIN EN ISO 1127 BS 4825-1					
OD of tube [mm]	12,7 – 41	42,4 – 104	114,3 – 154	12,7 – 41	42,4 – 104	114,3 – 154
Allowable pressure depending on OD [bar]	25	16	10	25	16	10

Table 10.8.2-1: Aseptic flange connections – DIN 11864 form A

Aseptic flange acc. to DIN 11864 form B

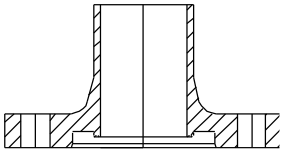
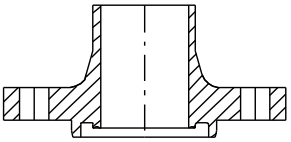
	Aseptic flange groove			**Aseptic flange tongue**		
						
***LESER** Code*	NG			BG		
Acc. to	DIN 11864 T2 Form B					
Piping standard	DIN 11850 DIN EN ISO 1127 BS 4825-1					
OD of tube [mm]	12,7 – 41	42,4 – 104	114,3 – 154	12,7 – 41	42,4 – 104	114,3 – 154
Allowable pressure depending on OD [bar]	25	16	10	25	16	10

Table 10.8.2-2: Aseptic flange connections – DIN 11864 form B

10.8.3 Flanged Connections (APV, Tuchenhagen)

Flange connections acc. to APV, Tuchenhagen

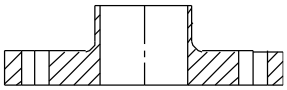
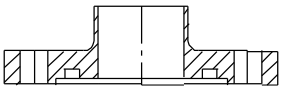
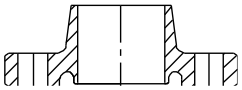
	APV-FG1- flange flat face		APV-FN1 flange groove		Varivent flange groove	
						
***LESER** Code*	AF		AN		TN	
Acc. to	APV				Tuchenhagen	
Piping standard	DIN 11850				DIN 11850	
Nominal size	DN 25 – DN 50	DN 65 – DN 250	DN 25 – DN 50	DN 65 – DN 250	DN 25 - DN 65	DN 80 - DN 150
Allowable pressure depending on OD [bar]	40	25	40	25	16	10

Table 10.8.3-1: Flange connections acc. to APV, Tuchenhagen

10.8.4 Threaded Connections

Threaded connections acc. to DIN 11864 form A

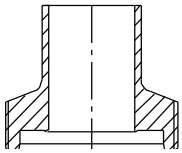
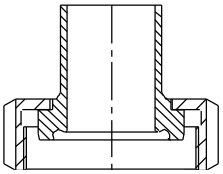
	Aseptic thread		Aseptic clamp and nut		
					
***LESER** Code*	GS		BS		
Acc. to	DIN 11864 T1 Form A				
Piping standard	DIN 11850 DIN EN ISO 1127 BS 4825-1				
Nominal size	DN 10 – DN 40 OD 13,5 – OD 33,7 ½" - 1½"	DN 50 –DN 100 OD 42,4 – OD 88,9 2" – 4"	DN 10 – DN 40 OD 13,5 – OD 33,7 ½“ – 1½“	DN 50 – DN 65 OD 42,4 – OD 60,3 2" – 2½“	DN 80 – DN 100 OD 76,1 – OD 88,9 3" – 4"
Allowable pressure depending on OD [bar]	40	25	40	25	16

Table 10.8.4-1: Aseptic thread, aseptic clamp and nut – DIN 11864 form A

Threaded connections acc. to DIN 11864 form B

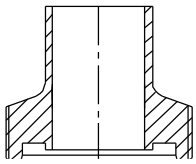
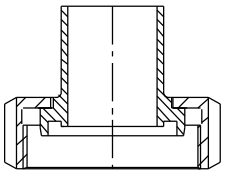
	Aseptic thread		Aseptic clamp and nut		
					
***LESER** Code*	GT		BT		
Acc. to	DIN 11864 T1 Form B				
Piping standard	DIN 11850 DIN EN ISO 1127 BS 4825-1				
Nominal size	DN 10 – DN 40 OD 13,5 – OD 33,7 ½" - 1½"	DN 50 –DN 100 OD 42,4 – OD 88,9 2" – 4"	DN 10 – DN 40 OD 13,5 – OD 33,7 ½“ – 1½“	DN 50 – DN 65 OD 42,4 – OD 60,3 2" – 2½“	DN 80 – DN 100 OD 76,1 – OD 88,9 3" – 4"
Allowable pressure depending on OD [bar]	40	25	40	25	16

Table 10.8.4-2: Aseptic thread, aseptic clamp and nut – DIN 11864 form B

Threaded connections acc. to DIN 11851

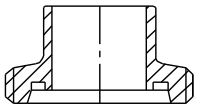
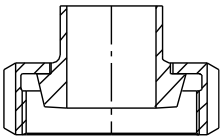
	Aseptic thread			Aseptic clamp and nut		
						
***LESER** Code*	GO			KO		
Acc. to	DIN 11851					
Piping standard	DIN 11850					
Nominal size	DN 10 – DN 40	DN 50 – DN 100	DN 125 – DN 150	DN 10 – DN 40	DN 50 – DN 100	DN 125 – DN 150
Allowable pressure depending on OD [bar]	40	25	16	40	25	16

Table 10.8.4-3: Aseptic thread, aseptic clamp and nut – DIN 11851

10.8.5 Sterile Threaded Connections

Sterile threaded connections acc. to NEUMO

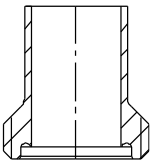
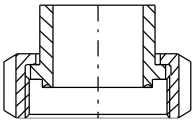
	Sterile thread	Sterile clamp and nut
		
***LESER** Code*	GD	BD
Acc. to	Neumo	
Piping standard	DIN 11850 DIN EN ISO 1127	
Allowable pressure depending on OD [bar]	70	

Table 10.8.5-1: Sterile threaded connections

10.8.6 Clamp Fittings

The following table shows the combination of pipe- and clamp standard, allowable pressure grouped by the LESER clamp code.

	SO		DO		BO		CO	
Clamp standard	DIN 32676		ISO 2852		ASME BPE		ISO 2852	
Piping standard	DIN 11850		DIN EN ISO 1127		BS 4825-1		ISO 2037	
Allowable pressure [bar]	DN 15 – DN 50	DN 65 – DN 100	DN 15 – DN 50	DN 65 – DN 100	1.5” – 2.5”	3” – 4”	DN 25 – DN 50	DN 65 – DN 150
	16	10	16	10	16	10	16[1)]	10

Table 10.8.6-1: Clamp fitting standards

1): 16 bar can be exceeded for LESER Type 481, when heavy duty clamps for the connection of the two fittings are used.

Please mind the size of the inner diameter when combining a welding end and a clamp for type 488. The inner diameter of the clamp has to be bigger than the inner diameter of the welding end of the clamp.

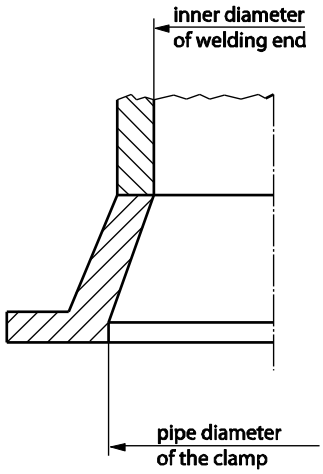


Figure 10.8.6-1: Prinziple of inner diameter for clamp and welding

The dimensions are listed in the following subsections.

Dimensions acc. to DIN 32676 - SO [mm]

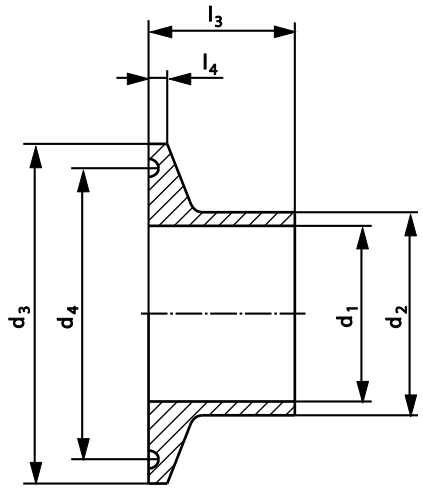


Figure 10.8.6-2: Sectional drawing of clamp fitting

Nominal size (DN)	d1	d2	d3	d4	l3	l4
10	10	13 14	34	27.5	18	2.85
15	16	19 20	34	27.5	18	2.85
20	20	23 24	34	27.5	18	2.85
25	26	29 30	50.5	43.5	21.5	2.85
32	32	35 36	50.5	43.5	21.5	2.85
40	38	41 42	50.5	43.5	21.5	2.85
50	50	53 54	64	56.5	21.5	2.85
65	66	70	91	83.5	28	2.85
80	81	85	106	97	28	2.85
100	100	104	119	110	28	2.85
125	125	129	155	146	28	5.6
150	150	154	183	174	28	5.6
200	200	204	233.5	225	28	5.6

Table 10.8.6-2: Clamp dimensions acc. to DIN 32676 - SO

Notes:

See DIN 32676 table 2 and table 3 for tolerances

Dimensions acc. to ISO 2852 – Welded-type clamp liner – DO [mm]

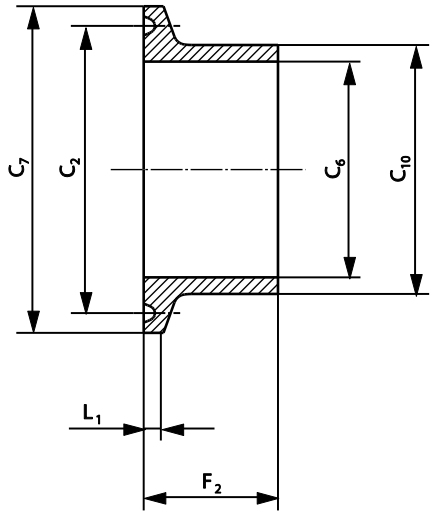


Figure 10.8.6-3: Sectional drawing of a clamp fitting acc. to ISO 2852 - DO

Nominal size	C6	C10	C7	F2	C2	L1
25	22.6	25.6	50.5	21.5	43.5	2.85
33.7	31.3	34.3	50.5	21.5	43.5	2.85
38	35.6	38.6	50.5	21.5	43.5	2.85
40	37.6	40.6	64	21.5	56.5	2.85
51	48.6	51.6	64	21.5	56.5	2.85
63.5	60.3	64.1	77.5	21.5	70.5	2.85
70	66.8	70.6	91	21.5	83.5	2.85
76.1	72.9	76.7	91	21.5	83.5	2.85
88.9	84.9	89.8	106	21.5	97	2.85
101.6	97.6	102.5	119	21.5	110	2.85
114.3	110.3	115.6	130	28	122	2.85
139.7	135.7	141.2	155	28	146	5.6
168.3	163.1	170	183	28	174	5.6
219.1	213.9	221.2	233.5	28	225	5.6

Table 10.8.6-3: Camp dimensions acc. to ISO 2852 - DO

Notes:

See ISO 2852 table 1 for tolerances

Dimensions acc. to ASME BPE – BO [inch]

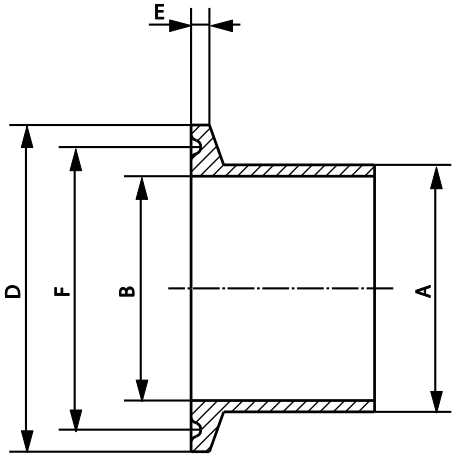


Figure 10.8.6-4: Sectional drawing of a clamp fitting acc. to ASME BPE -BO

Nominal size	tube diameter	ID Bore	Flange diameter	flange thickness	Groove diameter
	A	B	D	E	F
¼	0.250	0.180	0.984	0.143	0.800
3/8	0.375	0.305	0.984	0.143	0.800
½	0.500	0.370	0.984	0.143	0.800
¾	0.750	0.620	0.984	0.143	0.800
1	1.000	0.870	1.984	0.112	1.718
1½	1.500	1.370	1.984	0.112	1.718
2	2.000	1.870	2.516	0.112	2.218
2½	2.500	2.370	3.047	0.112	2.781
3	3.000	2.870	3.579	0.112	3.281
4	4.000	3.834	4.682	0.112	4.344
6	6.000	5.782	6.570	0.220	6.176

Table 10.8.6-4: Clamp dimensions acc. to ASME BPE - BO

Notes:

See ASME BPE Table DT-5.1 for tolerances

Dimensions acc. to ISO 2852 – Expanded-type clamp liner – CO [mm]

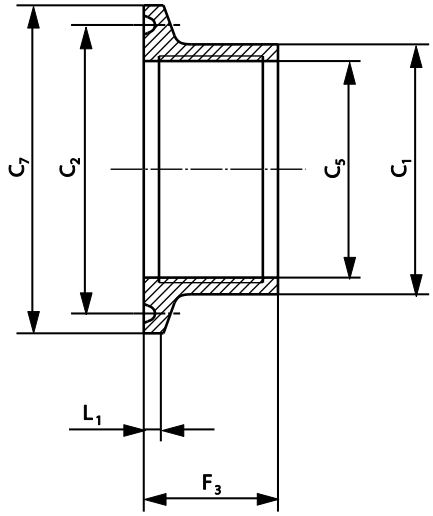


Figure 10.8.6-5: Sectional drawing of a clamp fitting acc. to ISO 2852 - CO

Nominal size	C5	C1	C7	C2	L1	F3
12	12	16	34	27.5	2,85	16
12.7	12.7	16.7	34	27.5	2,85	16
17.2	17.2	21.2	34	27.5	2,85	18
21.3	21.3	25.3	34	27.5	2,85	20
25	25	29	50.5	43.5	2,85	20
33.7	33.7	38.1	50.5	43.5	2,85	20
38	38	42.4	50.5	43.5	2,85	20
40	40	44.8	64	56.5	2,85	20
51	51	55.8	64	56.5	2,85	25
63.5	63.5	68.9	77.5	70.5	2,85	30
70	70	75.8	91	83.5	2,85	30
76.1	76.1	81.9	91	83.5	2,85	30

Table 10.8.6-5: Clamp dimensions acc. to ISO 2852 - CO

Notes:

See ISO 2852 table 2 for tolerances

Gasket materials

	Buna-N (U)	EPDM (E)	Fluoro-elastomer (FPM)	Silicone (X)	PTFE (G)
Hardness, Shore A	70	70	70	70	-
Tensile strength [bar]	129.3	113.8	83.6	92.4	-
Elongation [%]	340	317	272	260	-
temperature range [°C]	-53.9 - +93.3	-51.1 - +140	-28.9 - +176.7	-40 - 232.2	-40 - +93.3

Table 10.8.6-6: Gasket materials acc. Alfa Laval

Definition „Tri-Clamps“

Tri-Clover Tri-Clamp® and Tri-Weld® Fittings are part of Alfa Laval's product line. They are manufactured in compliance with the actual ASME BPE.

LESER offers CO Clamps which are compatible to Tri-Clamps®. See tables 10.8.6-1 and 10.8.6-7 for differences in dimensions.

Tri-Clamp dimensions

OD	**ID**		**WT**		**A ferrule face**	
[inch]	[inch]	[mm]	[inch] / [gauge]	[mm] / [gauge]	[inch]	[mm]
½	0.37	9.4	0.065 / 16	1.7 / 16	0.984	25.0
¾	0.62	15.7	0.065 / 16	1.7 / 16	0.984	25.0
1	0.87	22.1	0.065 / 16	1.7 / 16	1.984	50.4
1½	1.37	34.8	0.065 / 16	1.7 / 16	1.984	50.4
2	1.87	47.5	0.065 / 16	1.7 / 16	2.516	63.9
2½	2.37	60.2	0.065 / 16	1.7 / 16	3.047	77.4
3	2.87	72.9	0.065 / 16	1.7 / 16	3.579	90.9
4	3.87	98.3	0.083 / 14	2.1 / 14	4.682	118.9

Table 10.8.6-7: Tri-Clamp dimensions

10.8.7 Connections acc. to EN 1092 and ASME B16.5

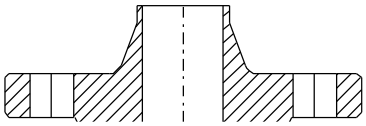
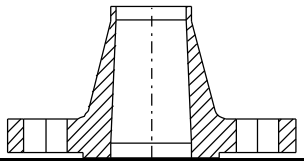
	Flange PN 16 Range B1 EN 1092	**Flange ANSI CL150 RF ASME B16.5**
		
***LESER** Code*	FD	FA

Figure 10.8.7-1: Connections acc. to EN 1092 and ASME B16.5

Clean Service Safety valves can be delivered with flanges according to EN 1092 and ASME B16.5, however these connections are not considered as Clean Service connections.
For further information see EN 1092 and ASME B16.5.

10.8.8 Codes and Standards – Clean Service Connections

ISO 2037, *stainless steel tubes for the industry*

ISO 2852, *stainless steel clamp pipe couplings for the food industry*

DIN 405-1, General *purpose knuckle threads - Part 1: Profiles, nominal sizes*

DIN 405-2, *Rundgewinde allgemeiner Anwendung - Teil 2: Abmaße und Toleranzen*

DIN EN ISO 1127, *stainless steel tubes – dimensions, tolerances and conventional masses per unit length*

DIN EN ISO 4288, *Geometrical Product Specifications (GPS) - Surface texture: Profile method - Rules and procedures for the assessment of surface texture*

DIN 11850, *stainless steel tubes for the food and chemical industries – dimensions, materials*

DIN 11851, *Fittings for food, chemical and pharmaceutical industry - Stainless steel screwed pipe connections - Design for rolling in and welding-on*

DIN 11864-1, *Fittings of stainless steel for the aseptic, chemical and pharmaceutical industry - Part 1: Aseptic screwed pipe connection, standard type*

DIN 11864-2, *Stainless steel fittings for the aseptic, chemical and pharmaceutical industries - Part 2: Aseptic flanged pipe connection, standard type*

DIN 11887, *Fittings for food, chemical and pharmaceutical industry - Round thread connections - Design of threaded and conical connection pieces*

DIN 32676, *Fittings for the food, chemical and pharmaceutical industries - Clamp connections for stainless steel tubes - Weld-on type*

ASME-BPE, *Bio processing equipment. The ASME BPE Standard standardizes specifications for the design, manufacture, installation, inspection and acceptance of equipment used in the pharmaceutical and biologic products industries.*

ASTM A 182 / A 182M, Specifications *for forged or rolled alloy and stainless steel pipe flanges, forged fittings, and valves and Parts for High-Temperature Service*

ASTM A 380, *Practice for cleaning, descaling, and passivation of stainless steel parts, equipment and systems*

BS 4825-1, Stainless steel tubes and fittings for the food industry and other hygienic applications - Specification for tubes

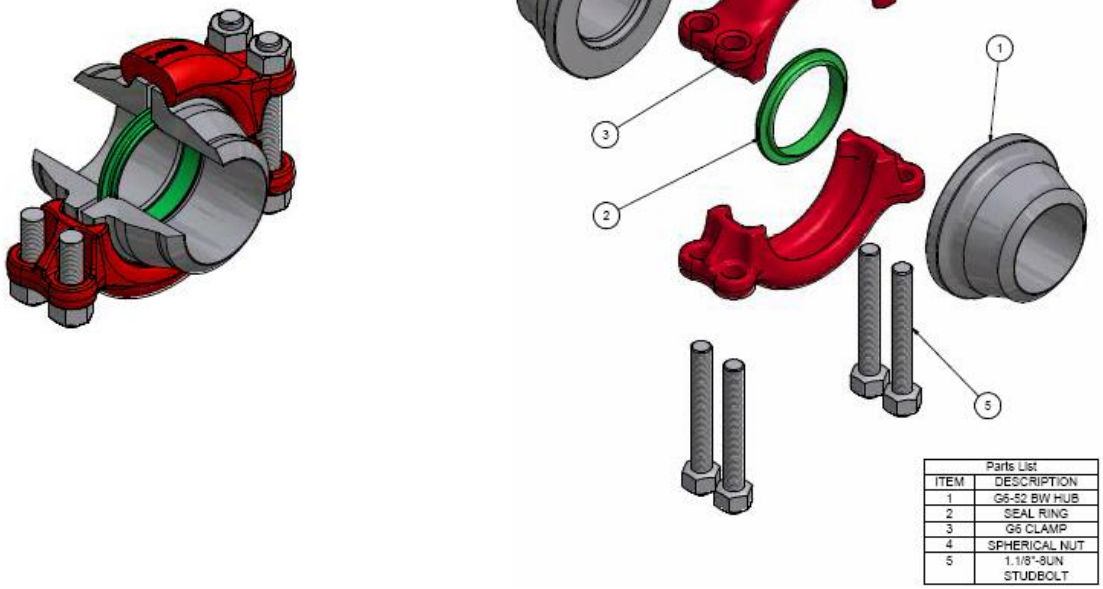
10.9 High Pressure Clamp Connections - Grayloc/Destec

General

This chapter specifies the assembly of the API-safety valves with a clamp connector on the hub. It describes the design feature of the clamp connector as well as the sealing ring, hub and the pipe dimensions (see Figure 10.9.1-2 for a detailed drawing).

The tables describe the allocation of the clamp to the API-526 Safety Valve. This allocation allows to select the suitable clamp for an existing safety valve or the suitable safety valve for an already existing clamp dimension.

Generally LESER delivers a hub welded to the nozzle. If hub dimensions are available, LESER prefers to machine the hub dimensiond directly to the nozzle.



Parts List	
ITEM	DESCRIPTION
1	G6-52 BW HUB
2	SEAL RING
3	G6 CLAMP
4	SPHERICAL NUT
5	1.1/8"-8UN STUDBOLT

Figure 10.9-1: GRAYLOC connector

Notes:

LESER supplies only the hub (no.1). It must be welded to the nozzle of the safety valve.
All other components are not scope of supply unless it is specified.

Background of high pressure clamps

Compared to conventional ANSI or API ring joint flanges, the clamp connector is significantly lighter and smaller. In addition there is a freedom to rotate the clamp with no bolt hole alignment.

Field of application

The simplicity, sealing efficiency and economy of the clamp connector benefit a wide range of industries in various applications:

- Oil and gas production
- Petroleum refining
- Chemical, synthetic fuels and food processing
- Fossil and nuclear power generation
- Aerospace and industrial gas manufacturing
- Coal gasification and liquefaction

Design

General design aspects

- LESER welds the hub of the clamp to the nozzle of the safety valve
- Nozzle material, hub material and welding filler have to fit to each other according to the welding standards
- The nozzle end of the API safety valve can be machined in hub dimensions if LESER gets a technical drawing of the specified hub
- Further components like clamps, bolts or sealings have to be purchased by the clamp manufacturer or could be attached to the delivery
- The pressure temperature ratings given at the end of this chapter are based on the allowable stress from ASME B31.3-1993 Edition.

Ordering

The customer has to supply the following characteristics to define the correct clamp connection:

- Schedule number
- Orifice
- Outer diameter

Design Predefinitions

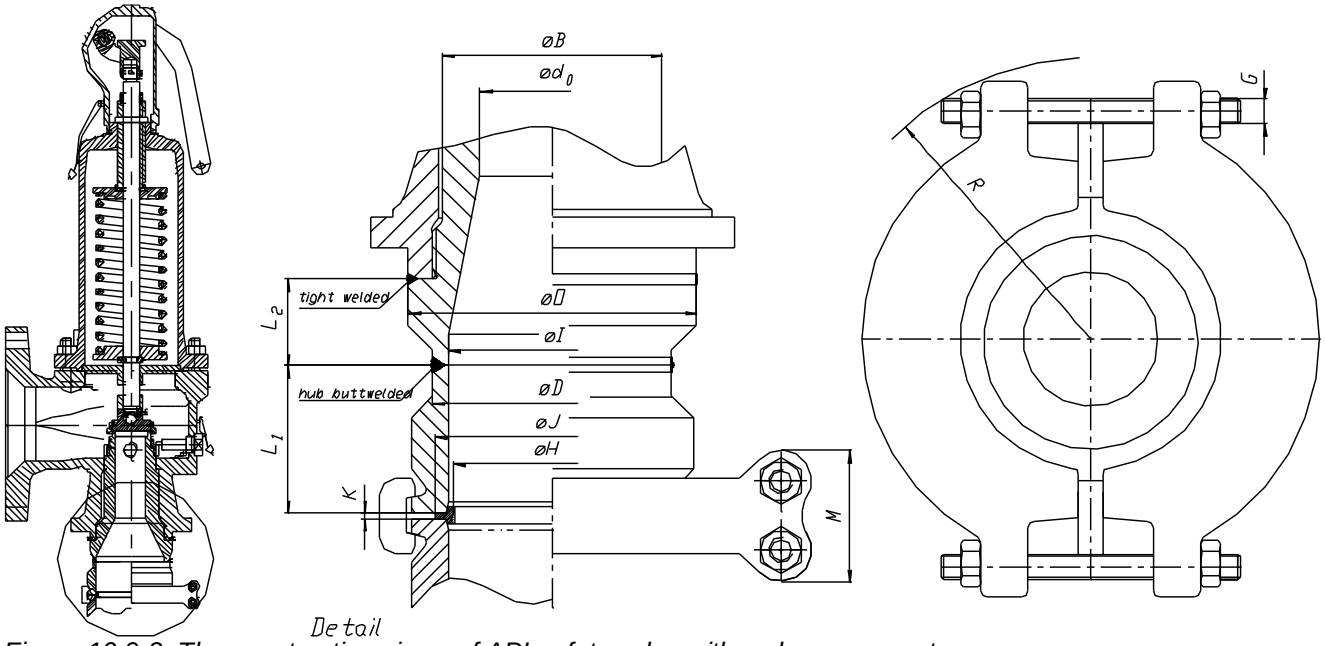


Figure 10.9-2: The construction views of API-safety valve with a clamp connector

Indices:

Pipe		Clamp		Nozzle	
ØD	outer diameter	ØR	clamp clearance	Ødo	orifice diameter
ØI	inner diameter	M	clamp width	ØB	outer diameter cylinder
		ØG	bolt diameter	ØI	inner diameter (clamp side)
		ØH	inner diameter of seal ring	ØO	outer diameter
		ØJ	outer diameter of seal ring	L2	length of butt welded end
		K	rib of seal ring		
		L1	length of the hub		

Possible schedules

A selection of possible pipe schedules used for the API 526 safety valve is a prerequisite to establish a selection of clamps for LESER safety valves. Table 10.9.1-1 shows the possible schedules.
The selection of clamps of the manufacturers DESTEC and GRAYLOC are described in Table 10.9-2.

Table 10.9-3 shows the selection of LESER nozzles. Main dimensions are listed in order to align the welding end of the nozzle with the welding end of the hub. Basic principle is the consideration of the pipe dimensions and schedules of the ASME B36.10M.

The schedule number is a system to combine sizes and wall thicknesses which would have an approximately relationship. The schedule numbers are a convenient designation system for use in ordering pipes.

<table>
<tr><th colspan="2">Safety Valve</th><th colspan="6">ASME B36.10M</th></tr>
<tr><th>NPS</th><th>Orifice</th><th>Outer diameter (ØD)</th><th>Max. wall thickness</th><th colspan="4">Possible schedules</th></tr>
<tr><td>1x2</td><td rowspan="2">E</td><td>33.4</td><td>6.4</td><td>-</td><td rowspan="15">160</td><td rowspan="20">80</td><td rowspan="20">40</td></tr>
<tr><td>1½x2</td><td rowspan="3">48.3</td><td rowspan="3">10.2</td><td rowspan="11">XXS</td></tr>
<tr><td>1½x2/3</td><td>F</td></tr>
<tr><td>1½x2/3</td><td rowspan="2">G</td></tr>
<tr><td>2x3</td><td>60.3</td><td>11.1</td></tr>
<tr><td>1½x2/3</td><td rowspan="2">H</td><td>48.3</td><td>10.2</td></tr>
<tr><td>2x3</td><td rowspan="2">60.3</td><td rowspan="2">11.1</td></tr>
<tr><td>2x3</td><td rowspan="2">J</td></tr>
<tr><td>3x4</td><td rowspan="9">114.0</td><td rowspan="5">18.9</td></tr>
<tr><td>3x4</td><td rowspan="2">K</td></tr>
<tr><td>4x6</td></tr>
<tr><td>3x4</td><td rowspan="2">L</td></tr>
<tr><td>4x6</td><td rowspan="8">11.0</td><td rowspan="7">-</td><td rowspan="3">120</td></tr>
<tr><td>4x6</td><td>M</td></tr>
<tr><td>4x6</td><td>N</td></tr>
<tr><td>4x6</td><td>P</td></tr>
<tr><td>6x8</td><td>Q</td><td rowspan="3">168.3</td><td rowspan="4">-</td></tr>
<tr><td>6x8</td><td rowspan="2">R</td></tr>
<tr><td>6x10</td></tr>
<tr><td>8x10</td><td>T</td><td>219.1</td><td>12.7</td></tr>
</table>

Table 10.9-1: ASME B36.10M pipe schedules for API 526 safety valves

Selection of clamps in consideration of the API 526 orifice and NPS

Safety valve		Type of clamp connection								
NPS	Orifice	Destec Types				Grayloc Types				
		Schedule								
		xxs	160	80	40	xxs	160	120	80	40
1x2	E	G1½-11	G1-7	G1-11		1GR5	1GR7	-	1GR11	
1½x2			G1½-14			1½GR11			1½GR14	
1½x2/3	F									
1½x2/3	G									
2x3		G2-14	G2-16 or G2-20			2GR14			2GR20	
1½x2/3	H	G1½-11	G1½-14			1½GR11			1½GR14	
2x3		G2-14	G2-16 or G2-20			2GR14			2GR20	
2x3	J									
3x4		G4-31	G4 - 34	G4-40		4GR31		4GR34	4GR40	
3x4	K									
4x6										
3x4	L									
4x6		-				-				
4x6	M									
4x6	N									
4x6	P									
6x8	Q			G6-62 G6-54 (schedule 120)				-	6GR62	
6x8	R									
6x10										
8x10	T			G8-76	G8-82				8GR76	8GR82

Table 10.9-2: Selection of clamps in consideration of the API 526 orifice and NPS

Notes:

Hub size allocation must be limited in order to avoid that the inner diameter of the pipe run-under the diameter of the orifice of the safety valve

Safety valve			Nozzle				Pipe (ASME B36.10M)					
NPS	Orifice	Nozzle part number	Ød0	ØB	ØO	L2	ØD	Øl of hub and nozzle end				
								XXS	160	120	80	40
1x2	D/E	207.20xx.9xxx 207.22xx.9xxx 207.27xx.9xxx	14.0	42.0	48.0	38.0	33.4	-	20.7	do not exist at the clamp supplier	23.4	26.6
1½x2				56.0	62.0	43.0	48.3	27.9	33.99		38.1	41.0
1½x2/3	F	207.23xx.9xxx	18.0									
		207.28xx.9xxx										
1½x2/3	G	207.24xx.9xxx	22.5			53.0						
2x3		207.32xx.9xxx		70.0	76.0	43.0	60.3	38.2	42.85		49.2	52.4
1½x2/3	H	207.25xx.9xxx	28.3	56.0	62.0	53.0	48.3	27.9	33.99		38.1	41.0
2x3		207.29xx.9xxx		72.0	78.0		60.3	38.2	42.85		49.2	52.4
		207.31xx.9xxx		70.0	76.0				42.85			
2x3	J	207.30xx.9xxx	36.0	72.0	78.0				42.85			
3x4		207.35xx.9xxx		110.0	116.0		114.0	80.1	87.3		97.2	102.0
3x4	K	207.33xx.9xxx	43.0									
		207.33xx.9xxx										
4x6		207.41xx.9xxx										
		207.42xx.9xxx										
3x4	L	207.34xx.9xxx	53.5									
4x6		207.37xx.9xxx										
		207.39xx.9xxx										
		207.43xx.9xxx										
4x6	M	207.38xx.9xxx	60.3	136.0	142.0			-	-	92.05	97.18	102.26
		207.44xx.9xxx										
4x6	N	207.40xx.9xxx	66.0									
4x6	P	207.45xx.9xxx	80.0									
		207.46xx.9xxx										
6x8	Q	207.47xx.9xxx	105.5	180.0	187.0	70.0	168.3			-	146.3	154.1
6x8	R	207.48xx.9xxx	126.0									
6x10		207.57xx.9xxx										
8x10	T	207.59xx.9xxx	161.5	234.1	241.1		219.1				193.7	202.7

Table 10.9-3: Selection of API 526 nozzles and predefinition of inlet diameter

Notes:

Min. inner diameter of the pipe must be limited in order to avoid that this diameter under-runs the orifice of the safety valve

Dimensions – DESTEC clamp

Safety valve		DESTEC clamp												
NPS	Orifice	Type of connection	Connection assembly											
		Dimensions	ØR (mm)					M (mm)					ØG	L1 (mm)
		G-Range	XXS	160	120	80	40	XXS	160	120	80	40	all	
1x2	D/E	G1-11(80,40) G1-7 (160)	-	66.7		66.7		-	58.7		58.7		1/2”	44.4
1½ x2		G1½-11 (XXS) G1½-14 (160, 80, 40)	102			102		79.4			79.4		5/8”	60.3
1 ½ x 2/3	F													
1 ½ x 2/3	G													
2x3		G2-14 (XXS) G2-16 (160) G2-20 (80, 40)	114			114		89			89		3/4”	69.8
1 ½ x2/3	H	G1½-11 (XXS) G1 ½ -14 (160, 80, 40)	102			102		79.4			79.4		5/8”	60.3
2x3		G2-14 (XXS) G2-16 (160) G2-20 (80, 40)	114			114		89			89		3/4”	69.8
2x3	J				-					-				
3x4		G4-31 (XXS) G4-34 (160) G4-40 (80, 40)	152.4			152.4		96.9			96.9		7/8”	92.1
3x4	K													
4x6														
3x4	L			-				-						
4x6		G4-40 (80, 40)												
4x6	M													
4x6	N													
4x6	P													
6x8	Q	G6-62 (80, 40)				222.2					122.3		1 1/8”	117.5
6x8	R													
6x10														
8x10	T	G8-76 (80) G8-82 (40)				250.8					149.2		1 1/4”	136.5

Table 10.9-4: Dimensions of DESTEC clamps – connection assembly

Safety valve		DESTEC clamp											
NPS	Orifice	Connection dimensions	seal ring										K (mm)
			ØH (mm)					ØJ (mm)					
		G-Range	XXS	160	120	80	40	XXS	160	120	80	40	all
1x2	D/E	G1-11(80,40) G1-7 (160)	-	23		28.6		-	34.9		44.4		3.18
1½ x2		G1½-11 (XXS) G1½-14 (160, 80, 40)	40.9			40.9		66.7			66.7		6.3
1 ½ x 2/3	F												
1 ½ x 2/3	G												
2x3		G2-14 (XXS) G2-16 (160) G2-20 (80, 40)		47.5		52.4			68.3		82.5		
1 ½ x2/3	H	G1½-11 (XXS) G1 ½ -14 (160, 80, 40)	40.9	40.9		40.9		66.7	66.7		66.7		
2x3		G2-14 (XXS) G2-16 (160) G2-20 (80, 40)		47.5		52.4			68.3		82.5		
2x3	J				-					-			
3x4		G4-31 (XXS) G4-34 (160) G4-40 (80, 40)	82.5	93.7		103		114.3	127		139.7		
3x4	K												
4x6													
3x4	L			-				-					
4x6		G4-40 (80, 40)											
4x6	M												
4x6	N												
4x6	P												
6x8	Q	G6-62 (80, 40)				154					200		9.5
6x8	R												
6x10													
8x10	T	G8-76 (80) G8-82 (40)				196.7	209.6				254	257	

Table 10.9-5: Dimensions of DESTEC clamp – ring seal

Dimensions – GRAYLOC clamp

Safety valve		GRAYLOC clamp												
NPS	Orifice	Type of connection	Connection assembly											
		dimensions	ØR (mm)					M (mm)					ØG	L1 (mm)
		G-Range	XXS	160	120	80	40	XXS	160	120	80	40	all	
1x2	D/E	1GR7 (160) 1GR5 (80,40)	-	66.68		66.68		-	58.75		58.7		1/2”	44.45
1½ x2		1½GR14 (XX, 160, 80, 40)	101.6			101.6		79.38			79.38		5/8”	60.33
1 ½ x 2/3	F													
1 ½ x 2/3	G													
2x3		2GR14 (XX) 2GR20 (160, 80, 40)	114.3			114.3		88.9			88.9		3/4"	69.85
1 ½ x2/3	H	1½GR14 (XX, 160, 80, 40)	101.6			101.6		79.38		-	79.38		5/8”	60.33
2x3		2GR14 (XX) 2GR20 (160, 80, 40)	114.3			114.3		88.9			88.9		3/4”	69.85
2x3	J													
3x4		4GR31 (XX) 4GR34 (160) 4GR40 (80, 40)	152.4			152.4		103.2			103.2		7/8”	92.08
3x4	K													
4x6														
3x4	L													
4x6														
4x6	M	4GR34 (120) 4GR40 (80, 40)	-		152.4			-		103.2				
4x6	N													
4x6	P													
6x8	Q	6GR62			-	222.25				103.2	122.25		1 1/8”	117.48
6x8	R													
6x10														
8x10	T	8GR76 (80) 8GR82 (40)				250.83					149.22		1 1/4"	136.53

Table 10.9-6: Dimensions of GRAYLOC connection – clamp assembly

Safety valve		GRAYLOC clamp												
NPS	Orifice	Connection dimensions	Seal ring										K (mm)	
			ØH (mm)					ØJ (mm)						
		G-Range	XXS	160	120	80	40	XXS	160	120	80	40	all	
1x2	D/E	1GR7 (160) 1GR5 (80,40)	-	23.01		28.58		-	34.93		44.04		3.18	
1½ x2		1½GR14 (XX, 160, 80, 40)	40.89			40.89		66.68			66.68		6.35	
1 ½ x 2/3	F													
1 ½ x 2/3	G													
2x3		2GR14 (XX) 2GR20 (160, 80, 40)	40.89	52.4		52.4		66.68	82.55		82.55			
1 ½ x2/3	H	1½GR14 (XX, 160, 80, 40)	40.89		-	40.89		66.68		-	66.68			
2x3		2GR14 (XX) 2GR20 (160, 80, 40)	40.89	52.4		52.4		66.68	82.55		82.55			
2x3	J													
3x4		4GR31 (XX) 4GR34 (160) 4GR40 (80, 40)	82.55	93.68		103.2		114.3	127		139.7			
3x4	K													
4x6														
3x4	L													
4x6														
4x6	M	4GR34 (120) 4GR40 (80, 40)	-		93.7			-		127				
4x6	N													
4x6	P													
6x8	Q	6GR62			-	154.05				-	200.03		9.525	
6x8	R													
6x10														
8x10	T	8GR76 (80) 8GR82 (40)				197	210				254	257		

Table 10.9-7: Dimensions of GRAYLOC clamps – seal ring

Materials

The material of clamp and nozzle varies between

- Stainless Steel SA182-F316/F316L/F316H and
- Carbon Steel SA350 LF2

Pressure temperature ratings

The following tables contain the pressure temperature ratings for the Destec and Grayloc clamp connector respectively. These ratings are applied for stainless steel A182-F316 and have been calculated using the following preconditions:

- Allowable stresses taken from ANSI B31.3
- Zero corrosion allowance
- Maximum bore through the hub
- Stress analysis to ASME VIII Appendix 24

DESTEC connector (SA 182 Gr. F316)

	Maximum allowable temperature [°C]									
	-46 - 20	100	200	250	300	350	400	450	500	550
Size	**Maximum allowable pressure [bar]**									
G 1-5	943	943	886	835	788	762	735	705	682	618
G 1-7	518	518	487	459	433	418	404	387	375	339
G 1½-14	372	372	360	338	321	309	298	293	287	264
G 2-14	1013	1013	980	919	874	841	815	797	782	757
G 2-20	257	257	249	234	222	214	207	202	199	189
G 4-31	460	460	433	408	385	372	359	344	333	302
G 4-34	275	275	266	249	237	228	221	216	212	205
G 4-40	137	137	132	124	118	113	110	108	106	102
G 6-62	199	199	192	180	171	165	160	156	153	144
G 8-76	216	216	203	191	180	174	168	161	156	141

Table 10.9-8: Pressure temperature ratings for DESTEC connectors

GRAYLOC connector (SA 182 Gr. F316)

	Maximum allowable temperature [°C]													
	38	93	149	205	260	316	343	371	400	427	454	482	510	538
Size	**Maximum allowable pressure [bar]**													
1 GR 5	1112	1112	1088	999	975	952	932	935	917	902	892	882	872	862
1½ GR 11	1032	1032	1032	1010	960	905	884	868	851	837	828	818	809	800
2 GR 14	705	705	705	690	656	618	604	593	582	572	565	559	553	546
4 GR 31	490	490	490	480	456	430	420	412	404	398	393	389	384	380

Table 10.9-9: Pressure temperature ratings for GRAYLOC connectors

Notes:

These ratings represent the allocation to the clamp components.

10.10 Compression Fittings

10.10.1 Compression Fittings with Cutting Ring acc. to DIN 2353

Background

The compression fitting with cutting ring uses the cutted profile of the pipe to seal. It's a metallic sealing without a joint sealer. This sealing is removable, but should not be reattached at the same position of the pipe, because of potential leakage.

A compression fitting with cutting ring is temperature and medium independent, and saves space.

LESER offers this type of connection for Compact Performance safety valves only.

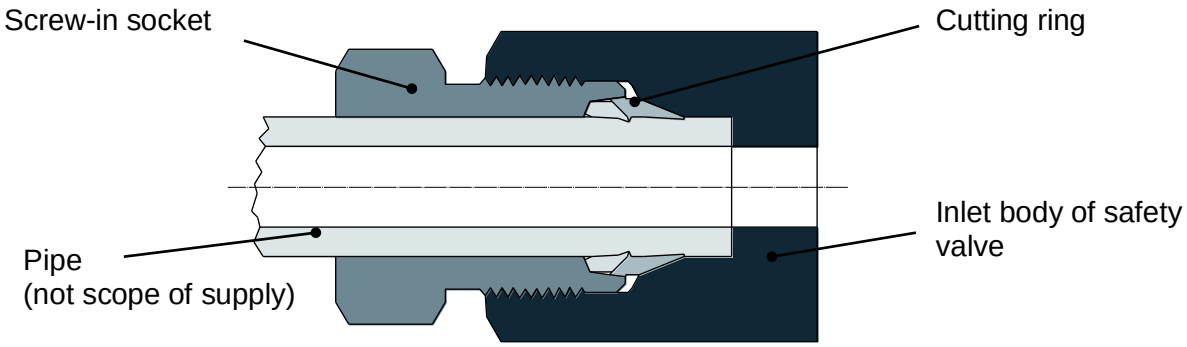


Figure 10.10.1-1: Exemplary sketch of a compression fitting with cutting ring

Compression fittings with cutting ring for LESER Compact Performance safety valves

The following connections are standardized for LESER Compact Performance safety valves. Other sizes are available on request.

Series	Rated for a nominal pressure in bar of (1)	Pipe dimensions	Series 437		Series 459			
		Outside diameter x wall thickness	d_0 6 mm		d_0 13 mm		d_0 17.5 mm	
		mm	Option Code		Option Code		Option Code	
			Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
-	-	16 x 2.0	V25	-	-	-	-	-
L	160	22 x 1.5	-	V26	-	-	-	-
S	400	25 x 2.5	-	-	V46	-	-	-
L	100	28 x 2.0	-	-	-	-	V47	-

Table 10.10.1-1: Possible connections for LESER Compact Performance safety valves

Notes:

(1) applies only to steel couplings (cf. DIN 3859-1 for technical delivery conditions)

A progressive – Cutting ring – connection acc. to DIN 2353 / DIN EN ISO 8434-1 is the standard connection LESER uses.

Materials

The standard material of compression fittings and couplings shall be stainless steel. Other materials specified in DIN 3859-1 shall be the subject of agreement.

10.10.2 Compression Fitting with Locking Ring (e.g. Parker A-Lok)

Background

The fitting uses the area contact pressure to seal. Tubing and fitting materials should be selected to be compatible with the fluid media. Due to thermal expansion characteristics and chemical stability, the tubing should be of the same material as the fitting.

LESER offers this type of connection for threaded valves only. See at the end of this chapter (Swagelok) for information.

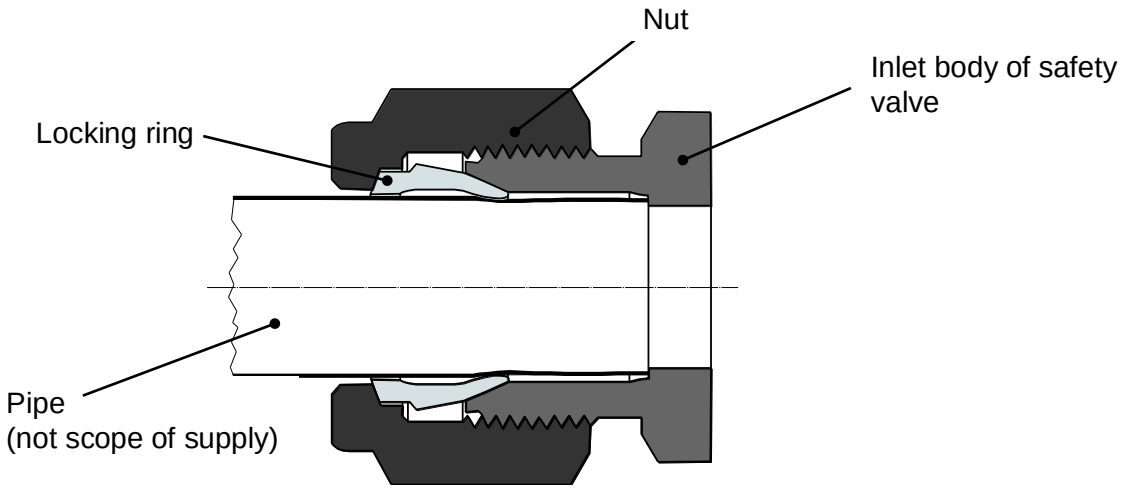


Figure 10.10.2-1: Exemplary sketch of a compression fitting with locking ring

Torque

The Tube fittings do not twist the tubing during installation. The ferrule designs assure that all make and remake motion is transmitted axially to the tubing. Since no radial movement of the tubing occurs, the tubing is not stressed. The mechanical integrity of the tubing is maintained.

No Distortion

In make-up, there is no undue force in an outward direction to distort the fitting body or ferrules to cause interference between the ferrules and nut. This assures that the nut will back-off freely for disassembly and permits a greater number of easy remakes.

Swagelok

Swagelok is a manufacturer of different pipe connections. Such as compression fittings and VCO (soft sealing), VCR (metallically sealing) connections.

A compression fitting with double locking ring designed by Swagelok is the standard connection LESER uses. It's also called a Mechanical Grip-Type Tube Fitting.

Pipe dimensions	**Series 437**	
Outside diameter x wall thickness	d_0 10 mm	
mm	inlet	outlet
18 x 1.5	V44	-

Table 10.10.2-1: Possible Swagelok connections at LESER

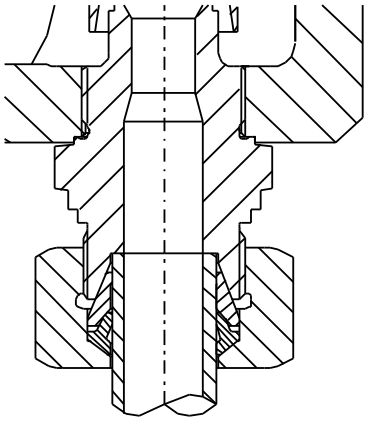


Figure 10.10.2-2: Swagelok compression fitting with double locking ring

10.11 IG-Flanges

IG Flanges are special types of high pressure flanges according to the High Pressure Engineering Standard of the BASF Group. LESER uses this type of connection in the Compact Performance series.

Class	Nominal size	Series 437				Series 459							
		d_0 6 mm		d_0 10 mm		d_0 6 mm		d_0 9 mm		d_0 13 mm		d_0 17.5 mm	
		Option code		Option code		Option code		Option code		Option code		Option code	
PN	DN	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
325	10	W01	-	-	-	-	-	-	-	-	-	-	-
	16	W02	W17	W02	W17	-	-	W02	-	-	-	-	-
	24	-	W18	-	-	W03	W18	W03	W18	-	-	W03	-
	30	-	-	-	-	-	-	-	W19	-	-	-	-
	45	-	W20	-	-	-	-	W05	W20	-	-	-	-
500	10	-	-	-	-	W06	W21	-	-	-	-	-	-
	16	-	-	W12	-	-	-	-	-	-	-	-	-
	24	-	-	-	-	W08	-	W08	-	-	-	-	-
	30	-	-	-	-	-	-	-	-	-	-	-	-
700	10	W26	-	-	-	W26	-	-	-	-	-	-	-
	16	-	-	-	-	-	-	-	-	-	-	-	-
	24	-	-	-	-	-	-	-	-	-	-	-	-
	30	-	-	-	-	-	-	-	-	-	-	-	-

Table 10.11 – 1: Possible IG flange connections at LESER

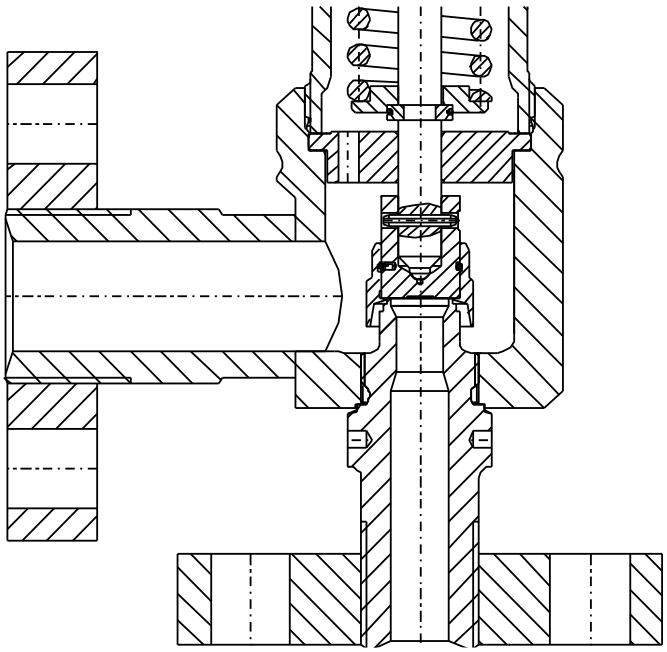


Figure 10.11 -1: IG-Flange connection

10.12 LESER Specific Details

10.12.1 Lap joint flanges

For Compact Performance safety valves LESER provides lap joint flanges, which are not specifed in a standard, but are dimensioned sufficiently in all possible nominal pressure ratings.

The design strength of the socket is calculated according to AD-2000. The flange-thickness is calculated according to AD-2000 B7 and ASME section II with a safety factoraddition of 2 mm.

Figure 10.12.1-1: Lap joint flanges

10.12.2 Machining of outer flange diameter and flange thickness for cast bodies

LESER is stocking cast bodies for all safety valves. Flange connections for different flange classes (acc. to EN or ASME) can be machined from one cast body, which means that e.g. the flange of the raw casting is designed for ASME Class 600. Depending on the valve size from this casting the flange Class 600, 300 as well as Class 150 may be machined.

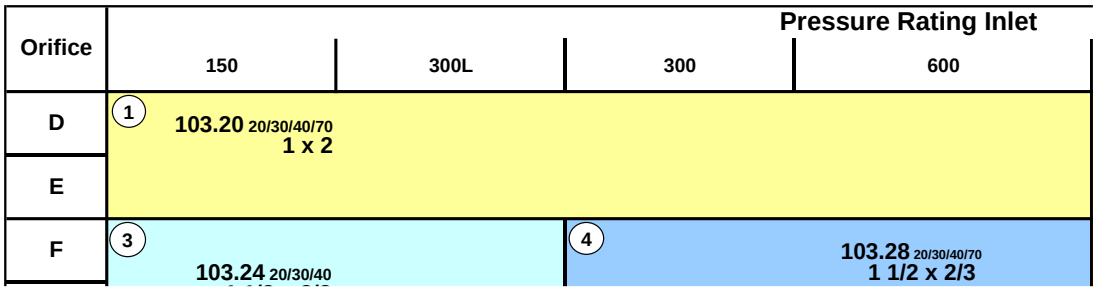


Figure 10.12.2-1: Illustration of body patterns versus flange ratings

ASME B16.34 defines all requirements regarding valves with flanged, threaded, and welding ends. For flanged end dimensions ASME B16.34 references to ASME B16.5 (or 16.47 for large diameters).
ASME B16.5 includes all nominal dimensions to design a flange. For functionally important dimensions tolerances are defined too.
For the outer flange diameter “O” no specific tolerances are defined within the ASME standards.

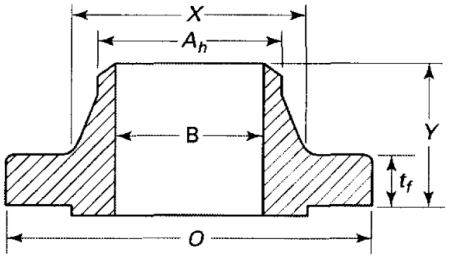


Figure 10.12.2-2: Flange dimensions

Therefore the **outer flange diameter** of the cast flanges is left unmachined and can in some cases be larger than the nominal dimensions listed in the applicable standard for welding neck flanges.In addition the outer diameter is used to clamp the body in the CNC machine for a most rigid clamping. This procedure is common industry practice.
The advantages are:

- short lead times from LESER stock, because the number of required raw material items is reduced, increasing the availability of the individual casting
- valve body for smaller flange classes is more solid than required
- centre to face dimensions are always the same independent from the flange standard

The connecting dimensions (bolt holes and raised face) always fulfil the requirements of the applicable standard (EN 1092 or ASME B16.34 / ASME B16.5).
Therefore the assembly of the safety valve with the connecting flanges of the pipework is not affected.

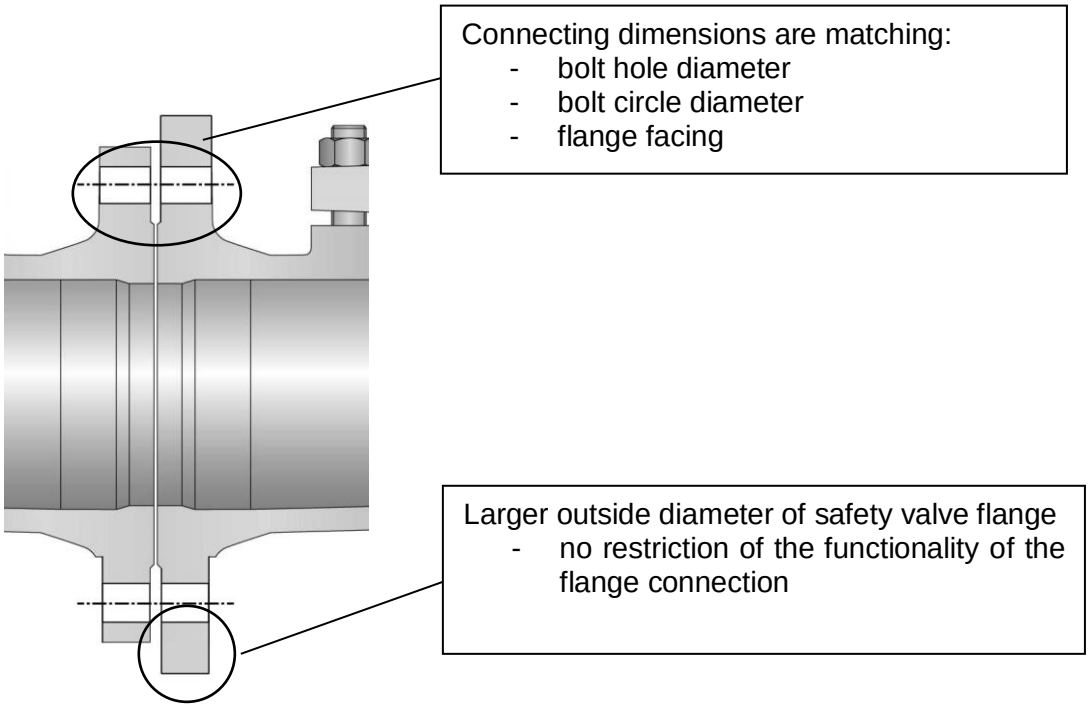


Figure 10.12.2-3: Illustration safety valve flange and pipe flange

In case the larger outer diameter is not accepted from an optical standpoint, it can be machined on request and at additional cost. For details on actual flange outer diameters of LESER Type 526 please contact LESER technical sales.

The **flange thickness** of LESER designs according to API standard 526 like Type 526 may exceed the flange thickness as mentioned in ASME / ANSI B16.5. This is fully in accordance with API standard 526, section 2.4. Dimensions, which states that:

“For some valve designs, the inlet raised face height may substantially exceed the nominal dimension specified in ASME. Consult the manufacturer for exact dimensions.”

This statement is valid for all valve types acc. to API 526 (spring loaded and POSV) as well as for all further full nozzle types like 457/458 and 441FN.

The total height of flange thickness plus raised face height (dimension S) can be found in the LESER catalog and in VALVESTAR documentations.

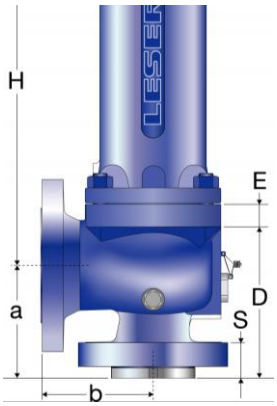


Figure 10.12.2-4: Flange thickness dimension “S”

Full nozzle safety valves like LESER API Series 526 exceed the flange thickness stated in ASME B16.5 of the inlet flange due to:

- Height of nozzle sealing face installed in the valve inlet
- The outer diameter of the nozzle thread, screwed into the body inlet, requires a flange thickness larger than specified in ASME / ANSI B16.5 to achieve the required pressure rating.

This results in:

- Valve body is more rigid and therefore less prone to distortion caused by stresses induced by piping loads during installation, this preserves factory seat tightness acc. to API 527
- During installation, bolting requirements should be calculated using the “S” dimension stated in the LESER API catalogue, please do not hesitate to contact us if you need any assistance

Major safety valve manufactures follow the same design philosophy. LESER’s design approval, certified by third party inspection bodies including ASME, National Board and TUEV, have approved the design.

When customers or inspectors insist on having the inlet flange thickness strictly in accordance with ASME tolerances LESER can perform a machining of the flange front side at request and at additional cost. This machining will decrease the “t_f” dimension acc. to figure 10.12.2-2, but not change the “S” dimension.

10.12.3 Flattened outlet diameter

Very few outlet flanges in LESER designs are supplied with flattened outlet flanges as shown in the figure below. This is due to the short inlet center to face dimension of the inlet flange. The flattened outlet flange allows:

- backside machining of the inlet flange
- easier fitting of bolts and nuts at the inlet flange

The flattened flange design is not stipulated in the EN 1092 or ASME B16.5 standards, but it causes no decrease of strength in respect to operating pressure and temperature limits compared to standard flanges.

Flanges of all possible nominal pressure ratings are dimensioned sufficiently. This is possible with an increase of the outer diameter and the flange thickness. The design was calculated according to ASME Section VIII Div 1 Appendix 2 (e.g. LESER type 458). All body designs of this series are type tested and approved by TUEV and ASME.

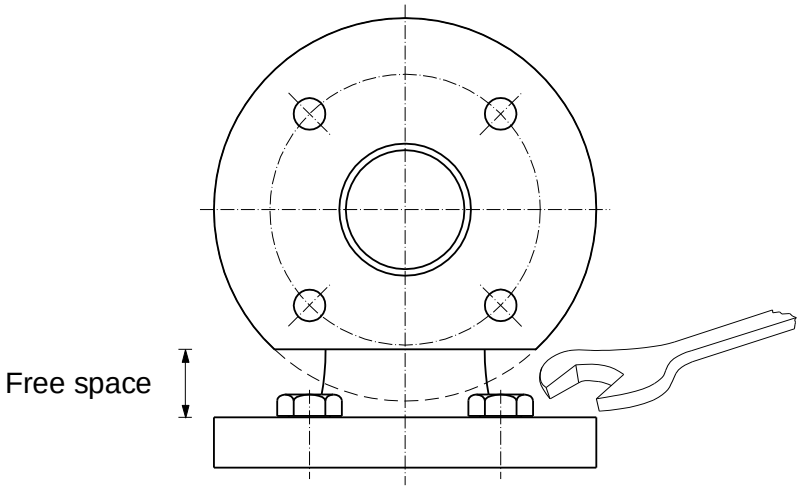


Figure 10.12.3 -1: Flattered outlet fange design