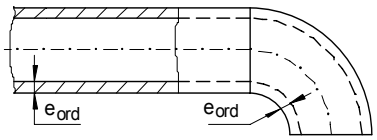
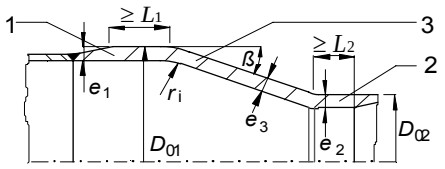
Technical calculation pipe elements : EN 13480-3:2002-05

1	Task	pipe elements : steel 1.4301, DN 500, EN 10220, pc = 22 bar, t = 162 °C				M 1.1
2	field of application	EN 13480-3:2002-8 / Code-Revision until 2007: 6.1 pipe, 6.2 pipe elbow standard method				
3	literature, source	Rohrleitungstechnik, W.W. 9.Auflage Vogel Verlag, TabBuch für Rohrl.Bau,15.Aufl.Vulkan-Verlag				
4	*mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the curser into the cell*					
5	**Pipe calculation.** Strength criteria for all pipe components from non-austenitic (NA) and austenitic (A) steel					
6	**NA** : EN 13480; A < 30%; f = min ($R_{p0,2\,t}$ /1,5 ; R_m /2,4)					
7	**A** : EN 13480; A > 35% (*DB :* A40) : $f = R_{p1,0\,t}$ /1,5					
8	**A** : EN 13480; 30% ≤ A ≤ 35% (*DB :* A35) : f = min ($R_{p1,0\,t}$ /1,5 ; R_m /2,4)					
9	Test: EN 13480; 5.2.1.2 and 5.2.2.2 *note*					
10	**name**	**unit**	**formular / symbol**	**data**		**intern**
11	design pressure internal	N/mm²	$p_c \le PS$, $p_c \ge p_{operat}$	2,20		
12	design temperature in °C	-10 ≤ t ≤ 650 *ending* 0 *or* 5		165		
13	**material selection, pipe**			*correct*		
14	steel name / $R_{p,t}$ / T / N / S / *BI*	–	*data base*	1.4301 / X5CrNi18-10 / Rp1,0 / S		
15	additional - safety factor	–	S_Z =1 *or* S_Z ≥1,2	1,00		
16	strength value, yield point	N/mm²	$R_{m20°}$, $R_{p0,2,t}$, $R_{p1,0,t}$	500,00	0,00	167,50
17	allowed tension	N/mm²	f_s	111,67		
18	**design details**		*note*	*correct*		
19	outer Ø: pipe, cylindrical shell	mm	Ø D_0 ≥10	508,00		
20	welding seam factor longitudinal seam	–	0,7 ≤ z ≤ 1	1,00		
21	*guide value: min. wall thickness*	mm	e_s*	*5,0*		
22	order wall thickness pipe, cylindrical shell	$T > e_s$*,	*recommended* ≥ 2 [mm]	**7,10**		
23	field of application, parameter	mm/mm	T / D_0	0,014		
24		mm/mm	D_0 / D_i	1,029		
25	required thickness minimum	mm	$D_0 / D_i \le 1,7 : e$	4,955		
26	*according Pkt.(6.1-1 / 6.1-3)*	mm	$D_0 / D_i > 1,7 : e$	0,000		
27	*guide value: minus tolerance of pipe according EU-Norm*					
28	*order according code and outer Ø*	mm	C_1 [mm]	*0,892*		
29	*out off code, C1 fixed by user*		*note*			
30	∑C:Corrosion / abrasion (wear), tolerance	mm	$C_{0,1} = (C_0 + C_1) \ge 0$	0,90		
31	min required order thickness	mm	$T = e_{ord,s,min}$	5,855		√
32	available netto strength thickness	mm	$e_a = e_{ord,s} - C_{0,1}$	6,200		
33	allowed internal pressure	N/mm²	p_{allow}	**2,759**		
34	**elbow, standard method section 6.2.3.1**			*correct*		
35	∑C:Corrosion / abrasion (wear), tolerance	mm	$(C_{0,1} + C_2) \ge 0$	0,90		
36	*guide value: radius pipe elbow*	mm	R_{min}	*508,0*	R_{max}	*5.080,0*
37	radius: pipe bend / pipe elbow	mm	$D_0 \le R \le 10 \cdot D_0$	762,00		
38				*correct*		
39	required min thickness straight pipe	mm	e (6.1-1 / 6.1-3)	4,955		
40	parameter	–	R / D_0	1,500		
41	min thickness internal side	mm	e_{int}	6,19		
42	min order wall thickness internal side	mm	$e_{int,ord}$* = $e_{int} + C_{0,1,2}$	7,09		
43	min thickness exterior side	mm	e_{ex}	4,34		
44	min order wall thickness exterior side	mm	$e_{ex,ord}$* = $e_{ex} + C_{0,1,2}$	5,24		
45	name	mm	*elbow ….*	DIN 2605/2 - 3 - 90		
46	order wall thickness internal side	mm	$e_{int,ord} \ge e_{int,ord}$*	**7,90**		
47	order wall thickness exterior side	mm	$e_{ex,ord} \ge e_{ex,ord}$*	**5,60**		√
48	arch - circumferential tension,	N/mm²	$f_{c,int}$	87,20	<	111,67
49	EN1594:2000	N/mm²	$f_{c,ex}$	86,50	<	111,67
50				*correct*		
51	note					
52	date editor					

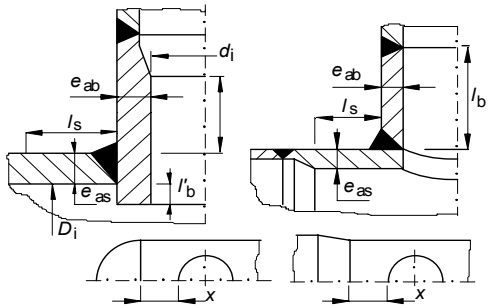


Technical calculation pipe elements : EN 13480-3:2002-05

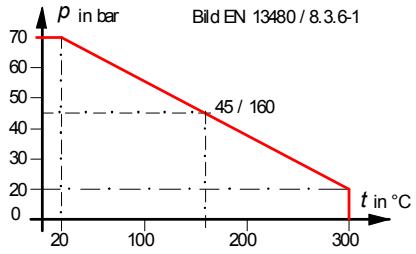
1	Task	data see M 1.1				M 1.3
2	field of application	EN 13480-3:2002-8 / Code-Revision until 2007.				
3	literature, source	Rohrleitungstechnik, W.W. 9.Auflage Vogel Verlag, TabBuch für Rohrl.Bau,15.Aufl.Vulkan-Verlag				
4	*mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the curser into the cell*					
5	**Concentric reducer: rating according design pressure or geomtry**					
6	surface of cone = constant over complete length					
7	e_1; e_2, e_3 = strength thickness without allowance					
8	Note: distance to disturbances 1.4 L1 and 2 L2 respectively					
9	disturbances (endcaps, flanges, armatures etc.)					
10	*note*					
11	**name**	**unit**	**formular / symbol**	**data**		**intern**
12	design pressure internal	N/mm²	$p_c \le PS$, $p_c \ge p_{operat}$	2,200		
13	design temperature in °C	-10 ≤ t ≤ 650 *ending* 0 *or* 5		165		
14	**material selection, part 1 - 3**			*correct*		
15	steel name / $R_{p,t}$ / T / N / S / *Bl*	–	*data base*	1.4301 / X5CrNi18-10 / Rp1,0		
16	additional - safety factor	–	S_Z =1 *or* S_Z ≥1,2	1,00		
17	strength value, yield point	N/mm²	$R_{m20°}$, $R_{p0,2,t}$, $R_{p1,0,t}$	520,00	0,00	167,50
18	allowed tension	N/mm²	f_s	111,67		
19				*correct*		
20	**design details**					
21	outer Ø large cylinder	mm	$D_{01} \ge 20$	508,00		
22	outer Ø small cylinder	mm	10 ≤ D_{02} < D_{01}	273,00		
23	aperture angle of the cone	grd	5 ≤ ß ≤ 60	24		
24	radius of welding seam in mm	0 ≤ r_i ≤ 0,3·D_{cyl},	*welded*: r_i = 0	80,00		√
25	∑C:Corrosion / abrasion (wear), tolerance	mm	*note* $C_{0,1} \ge 0$	0,50		
26	welding seam factor longitudinal seam	–	0,8 ≤ z ≤ 1	0,85		
27	*guide value: thickness of part 1*	mm	e_1*, $C_{0,1}$ = 0	*7,3*		
28	thickness calculation part 1	mm	$e_1 \sim e_1$*	*6,0024*		
29		*note, help*		*correct*		
30	**calculation**		*correct row 29 ? then* →	***click here***		
31	mean cylinder Ø	mm	$D_{c,1}$ =$D_{cyl,1}$ =D_{01} - e_1	502,00		
32	parameter	–	ß* ≥ 0,5 (6.4.6-1)	0,5133	γ (6.4.7-4)	1,2813
33	cone Ø (6.4.4-4 / -7)	mm	D_i =D_K / D_e / D_m	445,54	456,50	451,02
34	cone shell thickness outside of die out length		$e_{con,3}$ (6.4.4-2)		5,725	
35	reinforcement thickness larger cylinder Ø	mm	Max (e_{cyl} ; e_1) (6.4.6-1/-2)		6,002	
36	thickness cone shell	mm	Max ($e_{con,3}$; e_1) (6.4.6-1/-2)		6,002	
37	allowed internal pressure: part 1, 3	N/mm²	p_{allow}	*2,201237084*	$p_{allow} \ge p_c$	2,200 √
38	*guide value: S**	mm / mm	*S** = e_3 / e_2		*1,90*	
39	design value	mm / mm	$S \sim S$*		1,8863823	
40		*note, help*			*correct*	
41	**calculation**		*correct row 40 ? then* →		***click here***	
42	required thickness from part 2	mm	e_2 = e_3 / S		3,182	
43	mean smaller Ø	mm	$D_{c,2}$ =$D_{cyl,2}$ =D_{02} - e_2		269,818	
44	parameter	–	ς (6.4.8-2)	3,169	β_H (6.4.8-4)	1,017
45	allowed internal pressure: part 2, 3	N/mm²	P_{cyl} (6.4.8-5)	*2,200348052*	$p_{allow} \ge p_c$	2,200 √
46	**min required construction dimension,** *including allowance* $C_{0,1}$					
47	large cylinder Ø, part 1	mm	$e_{ord,1} \ge$		**6,50**	
48	small cylinder Ø part 2	mm	$e_{ord,2} \ge$		**6,22**	
49	cone shell thickness, constant part 3	mm	$e_{ord,3} \ge$		**6,50**	
50	die out length	mm	$L_1 \ge 1,4 \cdot l$	76,8	L_2	55,0
51	*For the die out length L1 applies: wall thickness = max (eord,1; eord,3) . For L2 applies: wall thickness = max (eord,2; eord,3)*					
52	distance to disturbance: flange, branch pipe *etc.*		1,4· L_1 [mm]	107,6	1,4· L_2	77,0
53	field of application 6.4.1	ß ≤ 60° ;	e_a·cosß/ D_C ≤ 0,001	0,01092	>	0,0010 √
54	allowed internal pressure: reducer	N/mm²	p_{allow}		**2,2003**	
55	note					
56	date editor					



1	Task	data see M 1.1	M 2.1
2	field of application	EN 13480-3: 2002-05 / 8.3; FDBR-M. 2004: cut out, cut out re-inforcements	
3	*mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the curser into the cell*		
4	**Selected Joints :** Neck or mainpipe reinforced / non reinforced, - with disc		
5	*The figures are not defining the construction, they are only for indication of necessary dimensions of the calculation.*		



Close-by disturbance, allowed distance X

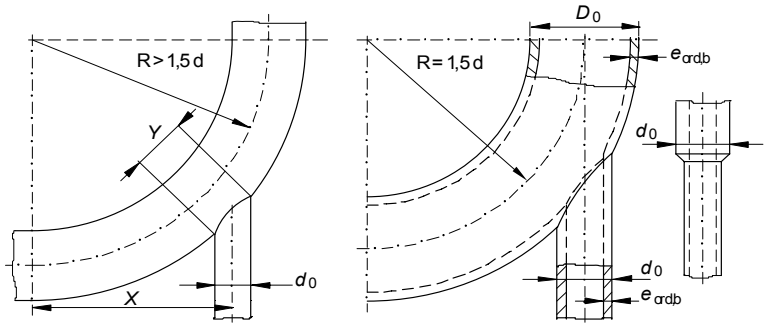


Allowed patch plate reinforcement
Ø d_i / D_i ≤ 0,8

	name	unit	formular / symbol	data			intern
17							
19	design pressure internal	N/mm²	$p_c \le PS$, $p_c \ge p_{operat}$	2,20			
20	design temperature in °C		-10 ≤ t ≤ 650 *ending* 0 *or* 5	165			
21	**reinforment construction**			*correct*			
22	area of disturbance, see distance X	–	*select*	cap, head, reducer, flange, armature			
23	construction: reinforcement	–	*select*	cut out with reinforment pad			
24	welded in neck	–	*select*	inserted through internal flush			
25	**material selection: pipe**			*correct*			
26	steel name /$R_{p,t}$ / T / N / S / *Bl*	–	*data base*	1.4301 / X5CrNi18-10 / Rp1,0 / S			
27	additional - safety factor	–	S_Z =1 *or* S_Z ≥1,2	1,00			
28	strength value, yield point	N/mm²	$R_{m20°}$, $R_{p0,2,t}$, $R_{p1,0,t}$	500,00	0,00	167,50	
29	allowed tension	N/mm²	f_s		111,67		
30	**material selection: neck or branch**			*correct*			
31	steel name /$R_{p,t}$ / T / N / S / *Bl*	–	*data base*	1.4301 / X5CrNi18-10 / Rp1,0 / N			
32	additional - safety factor	–	S_Z =1 *or* S_Z ≥1,2	1,00			
33	strength value, yield point	N/mm²	$R_{m20°}$, $R_{p0,2,t}$, $R_{p1,0,t}$	500,00	0,00	165,50	
34	allowed tension	N/mm²	f_b		110,33		
35	**material selection: plate**			*correct*			
36	steel name /$R_{p,t}$ / T / N / S / *Bl*	–	*data base*	1.4301 / X5CrNi18-10 / Rp1,0			
37	additional - safety factor	–	S_Z =1 *or* S_Z ≥1,2	1,00			
38	strength value, yield point	N/mm²	$R_{m20°}$, $R_{p0,2,t}$, $R_{p1,0,t}$	520,00	0,00	167,50	
39	allowed tension	N/mm²	f_{Pl}		111,67		
40	**design details**			*correct*			
41	outer Ø: pipe, cylindrical shell	mm	Ø D_0	508,0			
42	∑C:Corrosion /abrasion (wear),tolerance	mm	$C_{0,1}$ ≥ 0	0,90			
43	welding seam factor longitudinal seam	–	0,7 ≤ z ≤ 1	1,00			
44	*guide value: min order wall thickness*	mm	$e_{ord,s}$	*5,86*			
45	order wall thickness: pipe, cylindrical shell	mm	*recommended* $e_{ord,s}$ ≥ 2	**7,10**			√
46	outer Ø: neck	mm	Ø d_0 < Ø D_0	323,90			
47	∑C:Corrosion /abrasion (wear),tolerance	mm	$C_{0,1}$ ≥ 0	0,80			
48	welding seam factor longitudinal seam	–	0,7 ≤ z ≤ 1	1,00			
49	*guide value: min order wall thickness*	mm	$e_{ord,b}$	*4,00*			
50	order wall thickness neck	mm	*recommended* $e_{ord,b}$ ≥ 2	**11,00**			√
51	*guide value: effective, undisturbed length around the neck*		l_s	*55,78*			
52	dimension: length around the neck	mm	*recommended* $L_s \ge l_s$	100,00			
53	*guide value: effective length of neck*	mm	l_b	*56,57*			
54	dimension: effective length of neck	mm	$L_B \ge l_b$	100,00			
55	inserted through length	mm	$l_b^* \ge 0$, *if plate* $l_b^* = 0$	0,00			√
56				*correct*			
57							

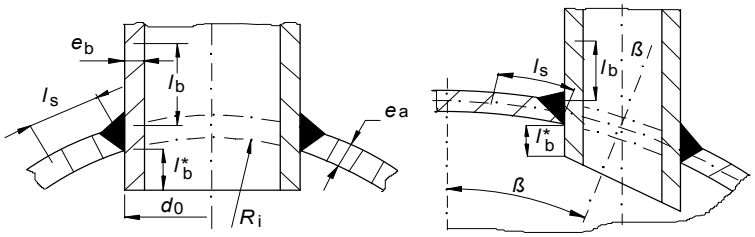
	name	unit	formular / symbol	data			intern
59	**construction, reinforcement plate**						
60	thickness of stiffening plate	mm	$e_{pl} > 0$	**8,00**			
61	*guide value: plate width*	mm	L_{pl} * ≥	*55,8*			
62	selected: plate width	mm	L_{pl}	60,00			
63				*correct*			
64	**field of application, data**						
65	strength thickness: shell, neck, plate	mm	e_{as} e_{ab} e_{apl}	6,20	10,20	6,20	
66	factor Ø, factor thickness	mm / mm	d_i /D_i	0,611	e_{ab} /e_{as}	1,645	
67	allowed tension: pipe,neck, plate	mm^2	f_s f_b f_{Pl}	111,67	110,33	111,67	
68					*correct*		
69	***check area of application, allowed conditions according EN 13480 / section 8.3.1-1***						
70							
71							
72							
73							
74							
75							
76							
77							
78							
79							
80							
81	steel: $f_s \le 250$ N/mm^2			steel: $f_s > 250$ Nmm^2			
82			***click here*** >	*conditions checked and in limits*			
83	**calculation section 8.3**						
84	reinforcements length: pipe, neck, plate	mm	l_s l_b l_b* l_{pl} (8.4.3-1/2)	55,78	56,57	0,00	55,78
85	pressure imposed area	mm^2	A_p		63.478		
86	pressure supporting area	mm^2	$A_{f,s}$ $A_{f,b}$ $A_{f,pl}$	346	640	346	
87	condition :	*term* (8.4.3-3 ; 8.4.3-6 ; 8.4.3-7)	≥ $p_c \cdot A_p$	146.405,7	>	139.651,0	
88	allowed internal pressure	N/mm^2	$p_{allow.}$		**2,305**		
89					*correct*		
90	**further required construction dimensions**						
91	min required plate Ø	mm	Ø D_{pl} ≥		447,9		
92	min distance to disturbance	mm	X_{min} ≥ (8.3.2-1/ 2)		56		
93	section 8.3 / 8.4, see figure row 14-15						
94	note						
95							
96	date editor						

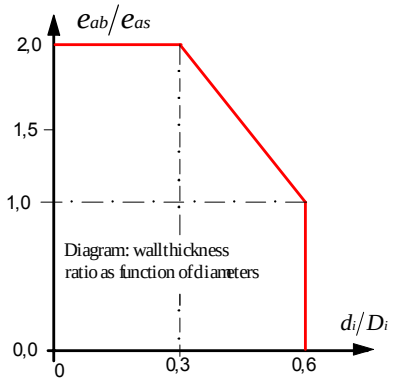
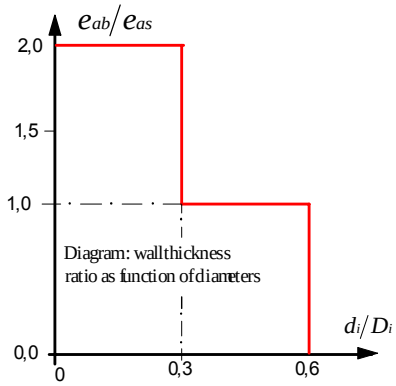
1	Task	data see M 1.1	M 2.4
2	field of application	EN 13480-3: 2002-05 / E ; cut out, cut out reinforcements	
3	*mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the curser into the cell*		
4	**Branch pipe joint: put on neck in elbow**		
5	*The figures are defining the design arrangement, the indicated construction dimensions must be maintained*		
6			
7	Application range, Conditions		
8	- seamless 3d (1,5 R) - and 5d (2,5 R) elbows		
9	- seamless / welded (non spiral), pipe bend		
10	- Load alterations n≤ 1000		
11	- not for creep strength		
12	- cut out Y ≤ D_0		
13	*note*		
14			
15			



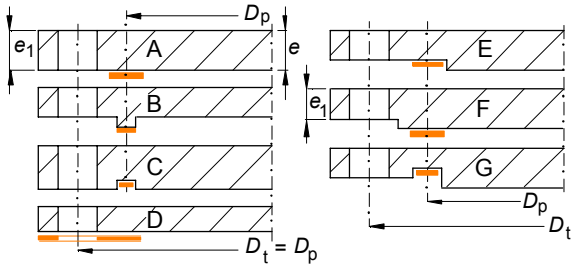
	name	unit	formular / symbol	data			intern
16							
17	design pressure internal	N/mm²	$p_c \le 4$, $p_c \ge p_{operat}$		2,20		
18	design temperature in °C		-10 ≤ t ≤ 200 (350) *ending* 0 *or* 5		165		
19	construction	–	*select*		pipe elbow insulated, tmax = 350°		
20	**material selection: pipe elbow**				*correct*		
21	steel name / $R_{p,t}$ / T / N / S / *Bl*	–	*data base*		1.4301 / X5CrNi18-10 / Rp1,0 / S		
22	additional - safety factor	–	S_Z =1 *or* S_Z ≥1,2		1,00		
23	strength value, yield point	N/mm²	$R_{m20°}$, $R_{p0,2,t}$, $R_{p1,0,t}$	500,00	0,00	167,50	
24	allowed tension	N/mm²	f_s		111,67		
25	**material selection: neck or branch**				*correct*		
26	steel name / $R_{p,t}$ / T / N / S / *Bl*	–	*data base*		1.4301 / X5CrNi18-10 / Rp1,0 / N		
27	additional - safety factor	–	S_Z =1 *or* S_Z ≥1,2		1,00		
28	strength value, yield point	N/mm²	$R_{m20°}$, $R_{p0,2,t}$, $R_{p1,0,t}$	500,00	0,00	165,50	
29	allowed tension	N/mm²	f_b		110,33		
30	**design details**				*correct*		
31	outer Ø elbow, allowable :	mm	168,3 ≤ D_0 ≤ 609,6		508,00		
32	construction	mm	*select*		seamless pipe elbow R = 1,5 Do		
33	bending radius, dimension	mm	$R \ge 1,5 \cdot D_0$, *toler* =± 10%		762,00		√
34	∑C:Corrosion/abrasion (wear), tolerance	mm	$C_{0,1} \ge 0$		1,00		
35	welding seam factor longitudinal seam	–	0,7 ≤ z ≤ 1		1,00		
36	*guide value: min. order wall thickness pipie elbow*		$e_{ord,int}$*	*7,19*	$e_{ord,ex}$*	*5,34*	
37	thickenss: internal arch side	mm	$e_{ord,int} \ge e_{ord,int}$*		**11,00**		
38	thickness: external arch side	mm	$e_{ord,ex} \ge e_{ord,ex}$*		**11,00**		
39					*correct*		
40	Tab.EN 13480-3 / E.1.1-2 and -3	pressure N/mm²			recommended combination		
41	bending radius R = 1,5·D	p ≤ 0,5	*select*				
42		0,5 < p ≤ 1	*select*				
43		1 < p ≤ 4	*select*		pipe elbow Ø 508 max neck Ø 114,3		√
44	bending radius R >1,5·D	0 < p ≤ 4	*select*				
45	**neck or branch**				*correct*		
46	external Ø	mm	d_0 *Tab.E.1.1-2 und 3*		88,90		
47	∑C:Corrosion/abrasion (wear), tolerance	mm	$C_{0,1} \ge 0$		0,35		
48	welding seam factor longitudinal seam	–	0,7 ≤ z ≤ 1		1,00		
49	*guide value: min. wall thickness neck*	mm	$e_{ord,b}$		*1,23*		
50	order wall thickness: neck	mm	$e_{ord,b}$ ≥2		**3,60**		
51	*guide value: allowed built in distance*	mm	X_{min} X_{max}	*762,00*		*762,00*	
52	built in distance, see figure	mm	X		762,00		
53					*correct*		

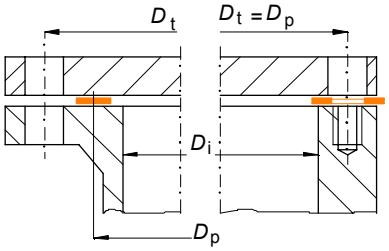
54	name	unit	formular / symbol	data			intern
55	**calculation, - E.1, Pkt. 8.4**						
56	factor: radius / arch Ø	mm/mm	R / D_0		1,500		
57	factor pipe elbow	–	*internal / external*	1,250		0,875	
58	available netto strength thickness	mm	e_{int} e_{ext} e_b	10,00	10,00	3,25	
59	effective length elbow, neck	mm	L_s l_b	70,57		16,68	
60	parameter E.2.1.1	grd	α $ß$ γ	41,410	45,069	37,463	
61		grd	τ A^* B^*	4,000	40,930	33,463	
62	sector area, max pressure area	mm^2	Ω G_2 E.2.1-6 / -7	3.852,61		30.874,07	
63	tension strained area	mm^2	$S_2 = S_B + S_S$		759,9		
64	allowed internal pressure without neck	N/mm^2	p_{allow}		*3,573*		
65	with neck bordered to the external side	N/mm^2	$p_c \le S_2 \cdot f / G_2$		*2,748*		
66	allowed internal pressure	N/mm^2	p_{allow}		**2,748**		
67					*correct*		
68	**required further construction dimensions**						
69	min neck length / reinforcement	mm	l_b thickenss = const.		17,0		
70	built in distance	mm	X		762,0		
71	note						
72	date editor						

1	Task	data see M 1.1				M 3.2
2	field of application	EN 13480-3 / 7.1.3; EN 13445-3 / 2003-07:Torospherical head, Dished head, Basket arch head				
3	literature, source	Rohrleitungstechnik, W.W. 9.Auflage Vogel Verlag, TabBuch für Rohrl.Bau,15.Aufl.Vulkan-Verlag				
4	*mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the curser into the cell*					
5	**Selected Joints :** Neck in bottom axis or neck with offset axis					
6	*The figures are not defining the construction, they are only for indication of necessary dimensions of the calculation.*					
7	Conditions :					
8	1. Neck does not touch the brim					
9	2. Wall thickness ratio $d_i/D_i > 0,3$					
10	always cut out reinforcement by					
11	increasing of wall thickness according section 8.4.3					
12	3. Recommended : $L_s \geq l_s$ (computation value)					
13						
14	**name**	**unit**	**formular / symbol**	**data**		**intern**
15	head shape	–	*select*	dished head, neck in shell		
16	welded in neck	–	*select*	welded on		
18	design pressure internal	N/mm²	$p_c \leq PS$, $p_c \geq p_{operat}$	2,20		
19	design temperature in °C		$-10 \leq t \leq 650$ *ending* 0 *or* 5	165		
20	**material selection: head**			*correct*		
21	steel name / $R_{p,t}$ / T / N / S / *Bl*	–	*data base*	1.4301 / X5CrNi18-10 / Rp1,0		
22	additional - safety factor	–	$S_Z = 1$ *oder* $S_Z \geq 1,2$	1,00		
23	factor of cold hardening against buckling	–	1,0 *or* 1,6 *note*	1,00		
24	strength value, yield point	N/mm²	$R_{m20°}$, $R_{p0,2,t}$, $R_{p1,0,t}$	520,00	0,00	167,50
25	allowed tension / - buckling tension	N/mm²	f_c	111,67	f_{buck}	111,67
26	**material selection: neck**			*correct*		
27	steel name / $R_{p,t}$ / T / N / S / *Bl*	–	*data base*	1.4301 / X5CrNi18-10 / Rp1,0 / N		
28	additional - safety factor	–	$S_Z = 1$ *or* $S_Z \geq 1,2$	1,00		
29	strength value, yield point	N/mm²	$R_{m20°}$, $R_{p0,2,t}$, $R_{p1,0,t}$	500,00	0,00	165,50
30	allowed tension	N/mm²	f_b	110,33		
31	**design details**			*correct*		
32	outer Ø: dished head	mm	D_0	508,0		
33	welding seam efficiency rating segments	–	$0,85 \leq z \leq 1$	1,00		
34	∑C: Corrosion/abrasion (wear), tolerance	mm	$C_{0,1} \geq 0$	0,90		
35	*guide value: min thickness brim*	mm	e^*_{kn}	*6,26*		
36	order wall thickness:spherical shell	mm	$e_{ord,s}$	**8,00**		
37	order wall thickness:brim	mm	$e_{ord,kn} \geq e^*_{kn} + C_{0,1}$	**8,00**		√
38	*guide value: allowed brim radius*	mm	$r_{i,min}$	*50,800*	$r_{i,max}$	*50,800*
39	internal radius of brim	mm	min $\leq r_i \leq$ max	50,80		
40	*guide value: radius spherical shell*	mm	R_i	*508,00*		
41	radius spherical shell	mm	R_i	508,00		√
42	outer Ø: neck	mm	Ø d_0	168,30		
43	∑C: Corrosion /abrasion (wear),tolerance	mm	$C_{0,1} \geq 0$	0,40		
44	welding seam factor longitudinal seam	–	$0,7 \leq z \leq 1$	1,00		
45	*guide value: min. oder wall thickness*	mm	$e_{ord,b}$	*2,06*		
46	order wall thickness neck	mm	$e_{ord,b} \geq 1$	**8,00**		
47	angle, neck position	°, grd	$0 \leq ß° \leq 50$	0,00		√
48	*guide value: effective, undisturbed length around the neck*		l_s	*86,0*		
49	dimension: length around the neck	mm	*recommended* $L_s \geq l_s$	90,00		
50	*guide value: effective length branch neck*	mm	l_b	*34,95*		
51	dimension: effective neck length	mm	$L_B \geq l_b$	80,00		
52	inserted through length	mm	$l_b^* \geq 0$	0,00		
53				*correct*		

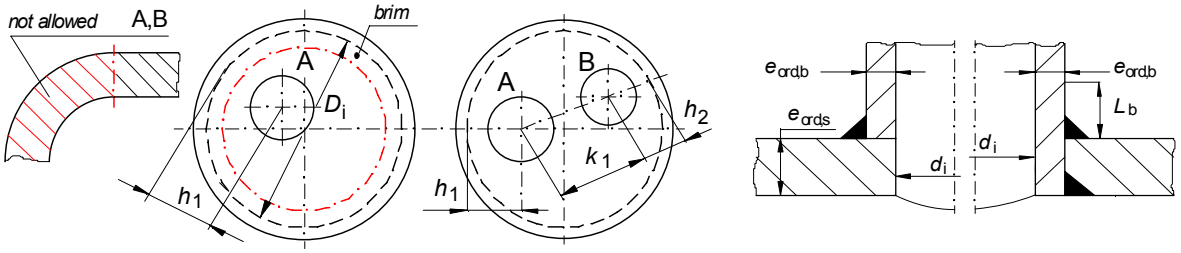
	name	unit	formular / symbol	data			intern
55	**field of application**						
56	strength thickness: spherical shell, neck	mm	e_{as}, e_{kn}, e_{ab}	7,10	7,10	7,60	
57	factor Ø, thickness ratio	mm / mm	$d_i / D_i \le 0,6$	0,310	$e_{ab} / e_{as} \le 2$	1,070	
58 59	allowed tension: head, neck	N/mm²	f_s	111,67	f_b	110,33	
60					*correct*		
61	***check area of application, allowed conditions according EN 13480 / section 8.3.1-2***						
62 63 64 65 66 67 68 69 70 71 72 73	 steel: $f_s \le 250$ N/mm²			 steel: $f_s > 250$ N/mm²			
74							
75			***click here >***	*conditions checked and in limits*			
76	**calculation Pt. 8.3**						
77	coeffcient: Y ; Z	–	Y (7.1.5-1 bis 7.1.5-8)	0,01398	*Z*	1,85461	
78	coeffcient : X ; N	–	$0,06 \le X = r_i / D_i \le 0,2$	0,1033	*N*	0,8911	
79	coeffcient : $ß_{0,06}$; $ß_{0,1}$; $ß_{0,2}$	–	$ß_{0,06}$; $ß_{0,1}$; $ß_{0,2}$	0,9532	0,7473	0,5000	
80	coeffcient, field of application	–	$0,4 \le ß \le 1,6$		*0,7392*		
81	**head without neck**						
82	allowed pressure spherical shell	N/mm²	p_s (7.1.3-6)		3,100		
83	allow. pressure of brim against yielding	N/mm²	p_{kny} (7.1.3-7)		2,235		
84	allow. pressure of brim against buckling	N/mm²	p_{knb} (7.1.3-8)		3,418		
85	allowed internal pressure	N/mm²	p_{allow}		**2,235**		
86	**head with neck**						
87	reinforcements length: head, neck	mm	l_s l_b l^*_b (8.4.3-1/2)	85,23	34,95	0,00	
88	pressure imposed area	mm²	A_p		46.241,0		
89	pressure supporting area	mm²	A_f		924,7		
90	condition :	*term* (8.4.3-3 ; 8.4.3-6 ; 8.4.3-7)	$\ge p_c \cdot A_p$	101.885,4	>	101.730,3	
91 92	allowed internal pressure with neck to spherical shell	N/mm²	$p_{allow} \ge p_c$	**2,220**	>	2,200	
93					*correct*		
94	note						
95	date editor						

1	Task	data see M 1.1 : head DN 500, neck A = DN 100, neck B = DN 80	M 4.2
2	field of application	EN 13480-3 / 7.2.4	
3	literature, source	EN 10216-1,- 2, -3,- 5, EN 10217- 1,-2,-3 ,-5, prEN 10217-7 ; EN 10028-2,-3, EN 10222-2,-4,-5	
4	*mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the curser into the cell*		
5	**Non fixed, flat heads (cover, blind flange) section. 7.2.4**		
6	*The figures are not defining the construction, they are only for indication of necessary dimensions of the calculation.*		





	name	unit	formular / symbol	data			intern
17	design pressure internal	N/mm²	$p_c \le PS$, $p_c \ge p_{operat}$	2,20			
18	design temperature in °C		-10 ≤ *t* ≤ 650 *ending* 0 *or* 5	165			
				correct			
19	**material selection: flat head**						
20	steel name / $R_{p,t}$ / T / N / S / *Bl*	–	*data base*	1.4301 / X5CrNi18-10 / Rp1,0			
21	additional - safety factor Pt. 5.2.5.2	–	S_Z =1 *or* S_Z ≥1,2	1,00			
22	strength value, yield point	N/mm²	$R_{m20°}$, $R_{p0,2,t}$, $R_{p1,0,t}$	520,00	0,00	167,50	
23	allowed tension	N/mm²	$f_{A,20°}$ f_1	166,67	f_1	111,67	
				correct			
24	**design details**						
25	kind of joint	mm	*select*	head with end-to-end gasket, figure D			
26	internal Ø of the head	mm	D_i	488,0			
27	∑C: Corros./abrasion (wear), tolerance	mm	$C_{0,1}$ ≥ 0	0,0			
28	pitch Ø	mm	D_t	660,0			
29	bore diameterØ	mm	d_L	36,00			
30	outer Ø: gasket	mm	*internal*: $d_{aG} < (D_t - d_L)$ *end-to-end*: $d_{aG} > (D_t + d_L)$	720,0			
31	internal Ø: gasket	mm	d_{iG}	600,0			√
32	gasket width, real contact face width	mm	*w*	60,0			
33	middle Ø: gasket	mm	D_p	660,0			
34	design $Ø_{gasket}$ / effective gasket width	mm	D_p	660,00	*b*	30,00	
35	select: gasket	–	*data base*	spiral carbon steel, asbestos filling			
36	specific gasket value m / y	– , N/mm²	*m* *table 7.2.4-1*	2,50	*y*	20,00	
				correct			
37	**head with inboard gasket**						
38	bolt tensile force at pre-deformation	N	F_A (7.2.4-3)	*result see row 48*			
39	min.head thickness for pre-deformation	mm	e_A (7.2.4-2)				
40	min.head thickness in state of operatio.	mm	e_p (7.2.4-4)				
41	min. head thickness at border area	mm	e_1 (7.2.4-5)				
42	strength thickness of the head	mm	e = max (e_A ; e_p)				
43	head thickness in border area	mm	e_1 = max (e_A ; e_1)				
44	**head with end-to-end gasket, no bending moment**						
45	strength thickness of the head	mm	e (7.2.4-6)	37,98			
46	min. head thickness in border area	mm	e_1 (7.2.4-7)	30,39			
47	**result**						
48	min order thickness of the head	mm	$e_{ord,heat} \ge e + C_{0,1}$	37,98			
49	order thickness: flat head	mm	$e_{ord,heat}$	**38,00**			
				correct			
51	note			weiter siehe : fitted neck			
52	date editor						

1	Task	data see M 4.2					M 4.3
2	field of application	EN 13480-3 / 7.2.5					
3	literature, source	EN 10216-1,- 2, -3,- 5, EN 10217- 1,-2,-3 ,-5, prEN 10217-7 ; EN 10028-2,-3, EN 10222-2,-4,-5					
4	*mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the curser into the cell*						
5	**Brimmed or flat head with 1-2 fitted necks**						
6	*The figures are not defining the construction, they are only for indication of necessary dimensions of the calculation.*						
7							
14	Distance : $h_1 \geq 0{,}5 \cdot d_i + r_i$ cut out out of brim area						
15	*The proof with cut out and neck is only allowed after completed head calculation (w/o cut outs)*						
16	**name**	**unit**	**formular / symbol**	**data**			**intern**
17	selected: head with neck	–	*data base*	bolted head / blind flange, 2 neck			
18	**data full head** (complete uniform wall thickness)			*correct*			
19	design pressure internal	N/mm²	$p_c \leq PS$, $p_c \geq p_{operat}$	2,20			
20	design temperature in °C		$-10 \leq t \leq 650$ *ending* 0 *or* 5	165			
21	material of the head	–	*data base*	1.4301 / X5CrNi18-10 / Rp1,0			
22	allowed tension	N/mm²	f_1	111,67			
23	head inner Ø; gasket Ø	mm	D_i	488,00	D_p	660,00	
24	∑C:Corros./abrasion (wear), toleranc	mm	$C_{0,1} \geq 0$	0,00			
25	thickness of head, no cut out	mm	$e_{op,Bo}$	37,98			
26	*guide value C_1 of the brimmed head*	mm	C_1*	*0,0000*			
27	*C^*_1 confirmed or other value*	mm	$C_1 \geq C_1$*	0,00			
28	**material selection: neck (if 2 necks then same steel type)**			*correct*			
29	steel name / $R_{p,t}$ / T / N / S / *Bl*	–	*data base*	1.4301 / X5CrNi18-10 / Rp1,0 / N			
30	additional - safety factor Pt. 5.2.5.2	–	S_Z =1 *or* $S_Z \geq$1,2	1,00			
31	strength value, yield point	N/mm²	$R_{m20°}$, $R_{p0,2,t}$, $R_{p1,0,t}$	500,00	0,00	165,50	
32	allowed tension	N/mm²	f_2	110,33			
33				*correct*			
34	**design details**			**A**		**B**	
35	welded in neck	–	*Datei A*	internal flush	*Datei B*	internal flush	
36	cut out Ø respectively neck inner Ø	mm	$\sum d_{i,A} + d_{i,B} \leq 0{,}5 \cdot D_i$	108,00	√	88,90	√
37	∑C: Corros./abrasion (wear), toleranc	mm	$C_{0,1} \geq 0$	0,35		0,30	
38	welding seam factor	–	$0{,}7 \leq z \leq 1$	1,0		1,0	
39	*guide value: min. order wall tickness neck*	mm	$e_{ord,b}$*	*1,55*		*1,28*	
40	order wall thickness: neck	mm	$e_{ord,b} \geq e_{ord,b}$*	**3,60**		**3,20**	
41	strength thickness: neck	mm	$e_{a,b}$	3,25	√	2,90	√
42	*guide value: min.distance of outer edge*	mm	h_{1min}	*64,0*	h_{2min}	*54,5*	
43	distance dimensions h_1, h_2	mm	$h_1 \geq h_{1min}$ / $h_2 \geq h_{2min}$	120,0	√	95,0	√
44	*guide value: allowed distance A – B*	mm	$K_{min} \geq e_{op,Bo} + (d_A + d_B)/2$	*136,5*			
45	distance dimension K_1	mm	$K_1 \geq K_{min}$ *or* K_1=0	200,0			√
46				*correct*			
47			***click here***	*conditions checked and in limits*			
48	**neck reinforcement**						
49	min required neck thickness	mm	e_{rb}	1,088		0,895	
50	residual thickness of the pipe reinforcement		*required* : $e_{r,v} \geq 1$	2,162	√	2,005	√
51	reinforcement length, thickness = constant		L_b (8.4.3-1)	15,1		13,2	
52	factor head / neck	–	*min* $(1; f_1 / f_2)$	1,00		1,00	
53				*correct*		*correct*	

54	name	unit	formular / symbol	data			intern
55	**proof: single cut out**			**A**		**B**	
56	reinforcement area	mm^2	$A_r \cdot f_1 / f_2$	156,16	$A_r \cdot f_1 / f_2$	136,61	
57	equivalent Ø	mm	d_1	106,98	d_2	88,11	
58	distance cut out	mm	$K = 2 \cdot h$ (7.2.5-3)	240,00		190,00	
59	calculation distance cut out	mm	$K = D_i$ (7.2.5-3)	488,00	K (7.2.5-4)	488,00	
60	coefficient brimmed head	–	Y_1 (7.2.5-3)	1,2174	Y_1	1,2308	
61	bolted / brimmed head	–	Y_2 (7.2.5-4)	1,1317	Y_2	1,1047	
62				*correct*		*correct*	
63	required head thickness Ø A *or* max Ø (A; B)		e_{op} [mm]		**42,98**		
64	**proof: with 2 cut outs / necks**						
65	average: Ød_1 / Ø d_2	mm	$d_m = (d_1 + d_2) / 2$	97,54			
66	distance		K_1	200,00			
67	coefficient Y	–	Y_1 (7.2.5-3)	0,00			
68		–	Y_2 (7.2.5-4)	1,40			
69	required head thickness	mm	e_{op}	53,07			
70							
71	min. order thickness of the head	mm	$e_{ord,Bo}{}^* + C_{0,1}$	53,07			
72	order thickness: flat head	mm	$e_{ord,s} \geq e_{ord,Bo}{}^* + C_{0,1}$	**54,0**			
73	min. thickness at border area	mm	$e_1 \geq 0{,}8 \cdot e_{ord,s}$	43,2			
74					*correct*		
75	note						
76	date editor						

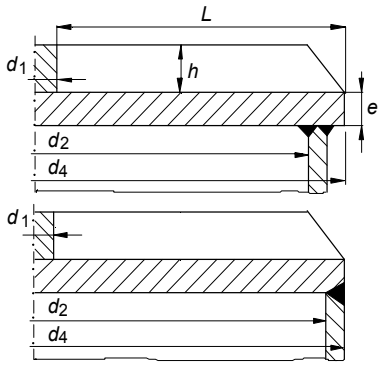
Task	data see M 4.2, no leak-tightness required		M 4.4
field of application	EN 13480-3; EN 13445-3 / 2002/prA16:2006 ;RKF-Festigkeitsberechnungen BR-A9 / 1973		

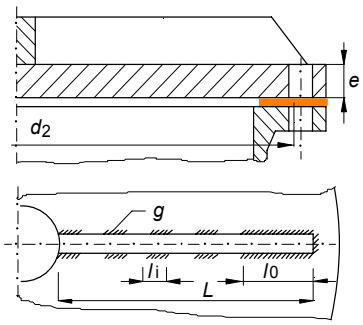
mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the curser into the cell

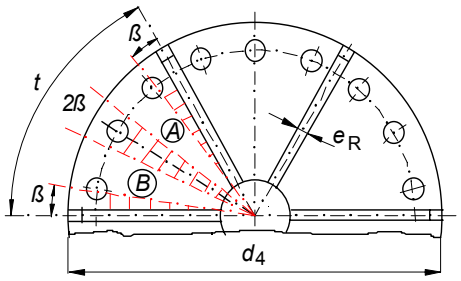
Circular flat head with stiffening ribs, welded or bolted with end to end gasket

The figures are not defining the construction, they are only for indication of necessary dimensions of the calculation.

to screw, leak-proof : recommended ≤ 6 bar







Distance of ribs related to diameter d_2

name	unit	formular / symbol	data			intern
design pressure internal	N/mm²	$p_c \le PS$, $p_c \ge p_{operat}$		2,20		
design temperature in °C		-10 ≤ t ≤ 650 *ending* 0 *or* 5		165		
material selection: flat head				*correct*		
steel name / $R_{p,t}$ / T / N / S / *Bl*	–	*data base*		1.4301 / X5CrNi18-10 / Rp1,0		
additional - safety factor	–	S_Z =1 *or* S_Z ≥1,2		1,00		
strength value, yield point	N/mm²	$R_{m20°}$, $R_{p0,2,t}$, $R_{p1,0,t}$	520,00	0,00	167,50	
allowed tension	N/mm²	f_B		111,67		
material selection: reinforcement ribs, centring ring				*correct*		
steel name / $R_{p,t}$ / T / N / S / *Bl*	–	*data base*		1.0036 / S235JRG1 / ≤ 16		
additional - safety factor	–	S_Z =1 *or* S_Z ≥1,2		1,00		
strength value, yield point	N/mm²	$R_{m20°}$, $R_{p0,2,t}$, $R_{p1,0,t}$	340,00	170,10	0,00	
allowed tension	N/mm²	f_R		113,40		
design details				*correct*		
pressure imposed Ø *bolting: d2 ≤ pitch Ø, see figure*	mm	d_2		488,0		
outer Ø: head / flange	mm	d_4		720,0		
welding seam factor head	–	0,7 ≤ z ≤ 1		1,0		
∑C: Corros./abrasion (wear), tolerance	mm	*head :* $C_{0,1}$ ≥ 0		0,5		
guide value: max / min thickness of heat	mm	e^*_{min}	*6,0*	e^*_{max}	*13,5*	
selected : head thickness incl. $C_{0,1}$	mm	$e \ge e^*_{min}$ (*recomm.* = 8)		**10,0**		√
guide value: number of ribs	–	*calculation* (22.4-1) : $n_{V,min}$	*6*	$n_{V,max}$	*24*	
selected: number of ribs		*recommended* n_V ≥ 4, 6, 8, 10, 12 ---		**8,0**		√
guide value: rib thickness	mm	e_R^*		*8,0*		
selected: rib thickness	mm	*recommended* $e_R \ge e_R^*$		**10,0**		√
guide value: outer Ø centring	mm	$d_{1,min}^*$		*50,9*		
outer Ø: centring	mm	$d_1 \ge d_{1,min}^*$		55,0		
guide value: length of ribs, see figure	mm	L^*_{min}	*216,5*	L^*_{max}	*332,5*	
length of ribs	mm	$L \ge L^*_{min}$		320,0		√
guide value: height of ribs	mm	h^*_{min}	*50,0*	h_{max}	*113,3*	
selected: height of ribs	mm	$h \ge h^*_{min}$		**100**		
welding seam: head with rib	–	*select*		stitched seams, not fully welded		
length of stitchweld, l = *const*	mm	$l_1 = l_i$; no stitchweld = 0		50,0		√
number of stitch weldings without end lag seam l_0		$n_{g,i} \ge 0$		4,0		
length of lag seam, ∑ l_0	mm	$l_0 \ge 0{,}2 \cdot L$ *or* $l_0 = 0$		100,0		
welding seam factor all joints	–	0,7 ≤ z ≤ 1		0,80		√
guide value: fillet weld thickness	mm	g_0		*5,33*		
fillet weld thickness rib, centring ring	mm	$g_1 \ge g_0$ (≥ 3)		**6,0**		
				correct		

	name	unit	formular / symbol	data			intern
58	faktor	–	C *figure (22.5-1)*	0,130	K (22.5-2)	0,124	
59	faktor welding joint	–	u (22.5-3)	0,5875	Z (22.5-6)	0,2348	
62					*correct*		
63	check: thickness of welding seam	mm	g_0 (22.8-1)	5,33	<	6,00	√
64	conditions for interrupted seam	mm^2	$2 \cdot l_0 \cdot g_0 \le \sum (l_i \cdot g_1)$	1.066,1	<	1.200,0	√
65		mm	$l_0 \le \sum l_i \le 0{,}8 \cdot l$	100,0	200,0	256,0	√
66					*correct*		
67	critical pressure	N/mm^2	p_{A1} (22.5-1)	2,504	p_{A2} (22.5-2)	2,671	
68	allowed internal pressure	N/mm^2	$P_A = \min (p_{A1}; p_{A2})$		**2,504**		
69			*note*		*correct*		
70	within the sector 2ß (red) …..	grd	*critical angle ß*		5,6		
71	no cut out allowed						
72	**field of application, section 22.4**		*recommended limits*				
73	pitch distance relating to $Ød_2$	mm	$t \le (20 .. 28) \cdot e_a$	191,6	<	280,0	
74	rib height	mm	$5 \cdot e_R \le h \le 15 \cdot e_R$	50,0	100,0	150,0	
75	rib thickness	mm	$0{,}5 \cdot e \le e_R \le 1{,}5 \cdot e$	5,0	10,0	15,0	
76							
77	note						
78	date editor						

Technical calculation pipe elements : EN 13480-3:2002-05

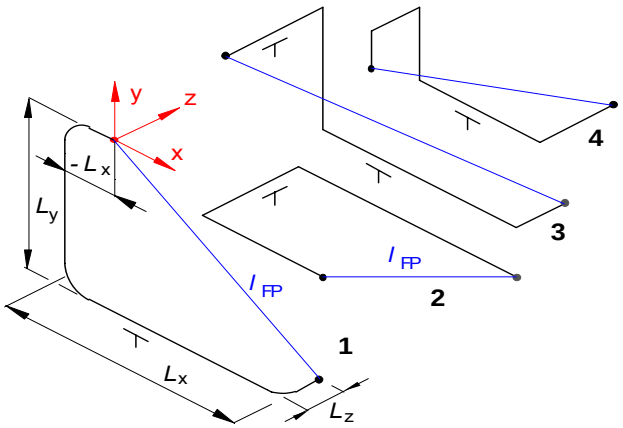
1	task	data elected : pipe line, load alterations < 7000	M 5
2	field of application	EN 13480-3:2002 - 2007; ANSI- method ; TGL 22160/06-07:1985, Pkt.4	
3	literature, source	Rohrleitungstechnik W.Wagner; Vogel Verlag 2006, Tabb.Rohrltg.-Bau / Rohrleitg-Handbuch Vulkan-V.	
4	*mathem.symbols, units and comments:see red corner triangle are part of computing and shall be consider. To read: move the curser into the cell*		

simplified elasticity analysis, EN 13480-3

figure isometrie: practical installation in plants

recommendations and tips

- for well proven or comparable systems
- straightforward strain characteristic
- constant pipe cross section between fixed points
- free moving space available: loose bearing, hanger
- load alterations: gas pipeline≤ 1000, others ≤ 7000



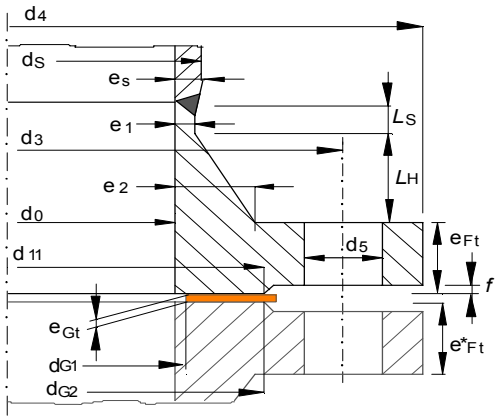
	name	unit	formula / symbol	data			Intern
16							
17	design pressure internal	N/mm²	$p \le PS$, $p \ge p_{operat.}$	0,80			
18	design temperature in °C	-10 ≤ t ≤ 650	*ending* 0 *or* 5	285			
19	**material selection: pipe**			*correct*			
20	steel name / Rp,t / T / N / S / Bl	–	*data base*	1.4301 / X5CrNi18-10 / Rp1,0 / N			
21	additional - safety factor	–	$S_z = 1$ *or* $S_z \ge 1{,}2$	1,00			
22	strength value, yield point	N/mm²	$R_{m\,20°}$ $R_{p\,0{,}2,t}$ $R_{p\,1{,}0,t}$	500,00	0,00	138,00	
23	allowed tension	N/mm²	f_t		92,00		
24	thermal expansion coefficient	1 / K	$ß_t$		1,7120E-05		
25	**pipeline design**			*correct*			
26	outer Ø: pipe	mm	$D_0 \ge 8$		273,00		
27	∑C: Corros./abrasion (wear), tolerance	mm	$C_{0,1} \ge 0$		0,80		
28	welding seam factor longitudinal seam	–	$0{,}8 \le z \le 1$		1,00		
29	*guide value: order wall thickness pipe*	mm	$e_{ord,s}$*		*1,982*		
30	order wall thickness pipe	mm	$e_{ord,s} \ge e_{ord,s}$*		**3,20**		√
31	coordinates length, analysis according	–		∑ $L_x \ge 0$	∑ $L_y \ge 0$	∑ $L_z \ge 0$	
32	figure	mm	*note*	5.500,0	3.220,0	3.760,0	√
33	allowed internal pressure	N/mm²	p_c		**1,632**		√
34	thermal expansion	–		ΔL_x	ΔL_y	ΔL_z	
35		mm	$\Delta L_{x,y,z}$	26,83	15,71	18,35	
36	resulting fix point distance	mm	l_{FP}		7.399,7		
37	resulting strain	mm	ΔL_{res}		36,10		
38	*guide value: required elongated length of the pipeline*		L_{min}*		*14.278,5*		
39	elongated length, pipe centreline	mm	$L_{min} \ge L_{min}$*		12.480,0		
40	$L = \|L_x\| + \|L_y\| + \|L_z\|$						
41	elasticity conditions	$D_0 \cdot Y / (L_S - l_{FP})^2 \le 208{,}3$		381,9	>	208,3	
42				*incorrect*			
43	**with pre-tension,** *if criterium incorrect*		*note*				
44	pre-tension factor	%	$0 < V \le 50$		50,0		
45	pre-tension length, installation …	–	*note*	ΔL_x	ΔL_y	ΔL_z	
46	*lenght: Δ Lx,y,z are controlled reduced*		[mm]	**13,4**	**7,9**	**9,2**	
47	residual strain in operation	mm	ΔL_{res}		18,1		
48	*guide value: required elongated length of the pipeline*		L_{min}*		*12.263,8*		
49	elongated length, pipe centreline	mm	$L_{min} \ge L_{min}$*		12.480,0		
50	elasticity conditions	$D_0 \cdot Y / (L_S - l_{FP})^2 \le 208{,}3$			190,95		
51				*stress analysis passed, no further calculations required*			
52	note	L = 5500 + 3220 + 3760 = 12480					
53	date editor						

1	Task	data see M 1.1 : flange DN 500 / PN 25, user defined gasket, see gask1 - gask3	M 6.1
2	field of application	Integrated flange / welded neck flange; EN 1591-1:2001/ A1:2005	
3	literature, source	physic.specific value EN 13445-3, TGL 32903 / 13-1983	
4	*mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the curser into the cell*		

Welded neck flange - joint allowed: equal / similar counter flange (armature) in comparable steel type

The figures are not defining the construction, they are only for indication of necessary dimensions of the calculation.

gasket system: flat face or groove - key



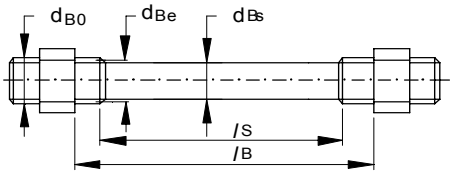
guide value: ideal outer Ø dG 2 615,0

available flange thickness for load capacity eF **42,10** mm

input data of flange connection; dimensions in mm

name	symbol	data	calculation		
flange outer Ø	d_4	730,0			
cylindrical shell Ø	d_s	508,0	$d_m=d_s-e_s$	500,9	mm
pitch Ø	d_3	660,0			
flange internal Ø	d_0	488,0	d_1 =	498,0	mm
bolt hole Ø	$d_5 \geq 10$	36,0	d_2 =	523,0	mm
cylin.shell thickness	e_s	7,1			
neck thickness	e_1	10,0			
shoulder thickness	$e_2 > e_1$	35,0			
flange neck	$L_s \geq 0$	20,0			
flange neck conical	$L_H > 0$	61,0			
flange thickness	e_{Ft}	44,0			
Ø of gasket face	$d_{11} \geq 0$	615,0			
height of gasket face	$f \geq 0$	4,0	√		
counter flange	e^*_{Ft}	44,0			
gasket thickness	e_{Gt}	2,0			
gasket internal Ø	d_{G1}	500,0			
gasket outer Ø	d_{G2}	550,0	b_{Gt} =	25	
groove depth	$h \geq 0$	0,0			

correct



available Ø for load capacity d_{Bzul} **29,70** mm

database	rolled thread with shaft			
database	manually, competend checked			
database	d_{B0} = M	33		
washer, thickness	U = ∑ mm	4,0	*guide value, dimensions*	
clamping length	l_B	94,0	l_B	94,0
shaft length	$l_s \geq 0$	72,0	$l_S \approx 0{,}8\ l_B$	72,0
shaft Ø	d_{Bs}	31,0	d_{Bs}	31,00
effective Ø	d_{Be}	29,70	d_{Be}	29,72
mean friction coeffic.	η	0,25		
number of bolts	n ≥ 4	20		

correct

operation parameter / load

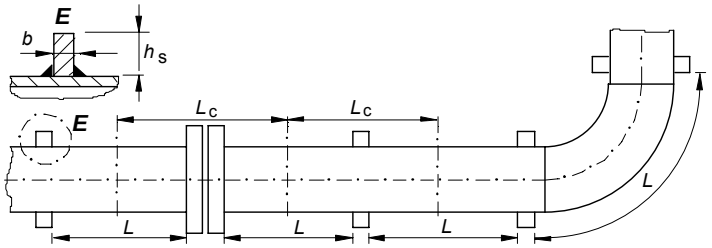
	name	**unit**	**formular / symbol**	**data**	**intern**
41	selection of load types to proof	–	*database*	install.(0), operation stat (1), test stat (2)	
42	max inter. pressure in operation status (1)	N/mm²	$P_{(1)} \geq -0{,}1$	2,20	
43	max internal pressure in test status (2)	N/mm²	$P_{(2)} \geq 0$	3,10	
44	**design temperature**		*ending 0 or 5*	*correct*	
45	operation temperature	°C	$0 \leq T \leq 650$	165,0	√
46	bolt: design temperature	°C	$0 \leq T \leq T_{operat.}$	155,0	√
47	test temperature, no test=0	°C	$10 \leq T \leq 40$	20,0	√
48	**external axial additional loads, torques**			*correct*	
49	installation (0)	N	$F_{compress} < 0$ *or* $F_{tensile} \geq 0$	0,0	
50	operation status (1)	N	$F_{compress} < 0$ *or* $F_{tensile} \geq 0$	5.000,0	
51	test status (2)	N	$F_{compress} < 0$ *or* $F_{tensile} \geq 0$	0,0	
52	torque in operation status (1)	Nmm	$\pm M_{bending}$	350.000,0	
53				*correct*	
54	safety factor: operation status (1)	–	$S_{(1)} \geq 1{,}5$	1,50	
55	test status (2)	–	$S_{(2)} = 0$ *or* $S_{(2)} \geq 1{,}05$	1,05	
56				*correct*	

57	name	unit	formular / symbol	data				intern
58	**flange couple**	–	*user defined : spezification*	vessel-flange				
59	material flange	–	*database*	1.4301 / X5CrNi18-10 / Rp1,0				
60	strength value, max tension [N/mm²]	K_{20}	$K_{20}/1{,}05$ $K/S_{(2)}$ $K/S_{(1)}$	250,0	238,1	238,1	111,7	
61	modulus of elasticity calculation EN13445	N/mm²	$E_{F(0)}$ $E_{F(2)}$ $E_{F(1)}$	199964,0	199964,0		187668,0	
62	*value confirmed or other value*	N/mm²	$E_t \geq 0{,}95 \cdot E_F$	200000,0	200000,0		187700,0	√
63	thermal expansion coefficient	1/ K	α_{Ft} [EN 13445]	0,00001635				
64	*value confirmed or other value*	1/ K		0,00001635				
65	material cylinder shell	–	*database*	1.4301 / X5CrNi18-10 / Rp1,0				
66	strength value, max tension [N/mm²]	K_{20}	$K_{20}/1{,}05$ $K/S_{(2)}$ $K/S_{(1)}$	250,0	238,1	238,1	111,7	
67	welding seam rating	–	$0{,}8 \leq v \leq 1$	1,00				√
68	*test row* 14, 15 thickness: $e_{s,1,min}$ = √			*correct*				
69	material bolt	–	*database*	strength A5-50, Ø ≤ M 39				
70	strength value, max tension [N/mm²]	K_{20}	$K_{20}/1{,}05$ $K/S_{(2)}$ $K/S_{(1)}$	210,0	200,0	200,0	109,3	
71	modulus of elasticity calculation EN13445	N/mm²	$E_{B(0)}$ $E_{B(2)}$ $E_{B(1)}$	199964,0	199964,0		188516,0	
72	*value confirmed or other value*	N/mm²	$E_t \geq 0{,}95 \cdot E_B$	200000,0	200000,0		188600,0	√
73	thermal expansion coefficient	1/ K	α_{Ft} [EN 13445]	0,00001628				
74	*value confirmed or other value*	1/ K		0,00001628				
75	ultimate strain of bolt	%	A	≥ 10 %				
76	number of re-tightening sequences	–	$N_{Rmin} \geq 1$	8				
77	range of dispersion: tightening of bolt	–	ϵ_{1-} ϵ_{1+}	0,200	0,250			√
78				*correct*				
79	**gasket according sheet of ENV 1591-2:2001 / prA1 : 2005 (D),** *annex: user defined entry in gasket 1-3*							
80	flat gasket / shape / materials	–	*database*	user defined gasket / specific values				
81		–	*database*	Gylon X				√
82	gasket class, leakage rate	–	*select*	L0,1:standard leakage tightness L ≤ 0,1mg /s·m				
83	**gasket characteristics**			*correct*				
84	*important: read notes*							
85	min contact pressure per unit: installation	N/mm²	gask1: *guide value* ~ $Q_{min(L0,1)}$*	*20,0*				
86	*for optimized pressure / surface alignment*		*note*	20,00				
87	*value confirmed or other value*		$Q_{min(L0,1)} \sim Q_{min(L0,1)}$*					√
88	**min contact pressure per unit in operation for**		*guide value :* ~ Q / P	*6,200*				
89	**keeping leakage free**		*note*	**7,00**				
90	*value confirmed or other value*		$Q/P \leq Q_{Smin(L)} \leq n \cdot Q/P$ [N/mm²]					
91	max allowed contact pressure per unit operation		gask1: *guide value* ~ Q_{max}*	*160,0*				
92	*value confirmed or other value*	N/mm²	$Q_{max,y} \leq Q_{max}$* *note*	160,0				√
93	modulus of elasticity: installation/operation	N/mm²	gask2: *guide value* E_{G0}, E_{G1}	*1.060,0*	*950,0*			
94	*value confirmed or other value*		$E_{G0} > 0$ $E_{G1} > 0$	1.060,0	950,0			
95	middle module, EN 1591 / prA1:2005	N/mm²	soft matrieal : $E_{Gm} = 0{,}5 \cdot E_{G0}$	530,0				
96	E_{Gm} : *inscribed according formular*		metal : $E_{Gm} = E_{G0}$					
97	creeping factor: installation / operation	–	gask3: *guide value* $P_{QR,0}$, $P_{QR,1}$	*1,0*	*0,85*			
98	*value confirmed or other value*		$P_{QR,0} > 0$ $P_{QR,1} > 0$	1,00	0,85			
99	thermal expansion coefficient of gasket	1/ K	*guide value:* α_{Ft}	*0,00001635*				
100	*value confirmed or other value*		$\alpha_{Gt} > 0$ *note*	0,00001635				√
101	**assembling during installation**			*correct*				
102								
103	*guide value:* **min pre-tension force**	N	$F_{G0,min}$ (37)	*923.722,5*				
104	*confirmed or other pre-tension force*	N	$F_{G0} \geq F_{G0,min}$	1.000.000,0				
105	computing result after iteration	N	$F_{G0,erf}$					
106	theoretical gasket width	mm	$b_{Gt} = (d_{G2} - d_{G1}) / 2$	*25,00*				√
107	*entry :* theoretical gasket width	mm	b_{Gt}	18,2194				
108	computing result after iteration	mm	$b_{Ge} \leq b_{Gt}$					
109	*entry check:* geometrical data, materials, parameter			*correct*				
110			*correct row 109, then* →	***click here***				
111			**calculation values and results**	*ideal, accuracy ≤ 0,1 %*				
112			*important note*					

	name	unit	formular / symbol		data		intern
114	**calculation / results**	–			flange 1 ≈ flange 2		
115	hole distance	mm	p_B (1)		103,67	103,67	
116	effective hole Ø	mm	d_{5e} (2)		21,21	21,21	
117	effective flange width	mm	b_F (5)		99,79	99,79	
118	effective mean flange Ø	mm	d_F (5)		609,00	609,00	
119	calculation flange cross section	mm^2	$A_F = e_F \cdot (d_4 - d_0)/2$		***5094,00***	*relevant for load capacity*	
120	effective flange plate thickness	mm	$e_F = e_P$ (5 , 6)		42,10	42,10	
121	effective pitch Ø	mm	d_{3e} (4)		656,70	656,70	
122	effective ratio of flange neck thickness	mm	$ß = e_2 / e_1$		3,500		
123	effective value of connecting shell	mm	e_E (9)		20,64	20,64	
124	effective mean upper shell Ø	mm	d_E (10)		508,64	508,64	
125	elasticity related flange parameter	–	γ (17)		0,2477	0,2477	
126	of cylinder shell	–	δ (18)		1,3386	1,3386	
127		–	λ (19)		0,0000	0,0000	
128		–	C_F (20)		0,1456	0,1456	
129	elasticity factor of the flange	$1/mm^3$	Z_F (27)		1,1375E-05	1,1375E-05	
130		$1/mm^3$	Z_L (27)		0	0	
131	arm of lever flange - correction	mm	h_s (21)		16,3842	16,3842	
132		mm	h_T (22)		17,5875	17,5875	
133		mm	h_Q (23)		15,9299	15,9299	
134		mm	h_R (23)		-2,4576	-2,4576	
135	bolt: SUM section	mm^2	A_B (33)		13.855,8		
136	elasticity parameter	1/mm	X_B (34)		0,007901		
137	**gasket:** theoretical Ø	mm	d_{Gt}		525,00		
138	theoretical gasket face	mm^2	A_{Gt}		41.233,4		
139	theoretical gasket width	mm	b_{Gt}		25,0		
140	elasticity parameter	1/mm	X_G (42)		0,00006562		
141	**opimized calculation parameter**						
142	effective gasket Ø	mm	$d_{Ge} = d_{G2} - b_{Ge}$		531,78		
143	effective gasket face	mm^2	A_{Ge} (39)		30.438		
144	effective arms of lever	mm	h_P (13)		8,130	8,130	
145		mm	h_G (40)		62,460		
146		mm	h_H (14)		74,030	74,030	
147	**internal forces due to medium pressure**	N	F_{Q1} (43)	test	688.520		
148		N	F_{Q2} (43)	operation	488.627		
149	outer additional force	N	F_{R0}	installation	0		
150	outer additional force	N	$F_{R(2)}$ (44)	test	0		
151	outer resulting force (from F_A, M_A)	N	$F_{R(1)}$ (44)	operation	7.132		
152	decisive clamping length	mm	e_B (45)	installation	94,0		
153	axial thermal expansion	mm	ΔU (45)	operation	-0,006774		
154	**axial elasticity of the mounted flange connection**						
155	E-modulus of gasket	N/mm^2		installation	1.092,9		
156	$E_{G,1,2} = E_0 + F_{G0} / A_{GE}$	N/mm^2	E_{Gi} (46)	test	1.092,9		
157	*DIN EN1591-1:2001/ A1:2005*	N/mm^2		operation	982,9		
158		mm / N		installation	5,43301E-07		
159	elasticity under sealing compressing force	mm / N	Y_{Gi} (46)	test	5,43301E-07		
160		mm / N		operation	5,81488E-07		
161		mm / N		Montage	0		
162	elasticity under medium presssure force	mm / N	Y_{Qi} (47)	installation	6,2088E-07		
163		mm / N		operation	6,61366E-07		
164	elasticity under additional force	mm / N		installation	0		
165		mm / N	Y_{Ri} (48)	test	0		
166	$F_{RI} \leq 0 \rightarrow Y_{RI} = 0$	mm / N		operation	5,83712E-07		page 3 v 5

	name	unit	formular / symbol		data		intern
168	min gasket force	N	F_{G0min} (49)	installation	608.760		
169	min gasket force in latter stage	N	F_{Gmin} (50)	test	213.066		
170		N		operation	213.066		
171	required mounting sealing force	N	F_{GA} (51)	installation	999.902		
172	for tightness in state of test-/ operation	N					
173	actual required sealing force	N	F_{G0req} (52)	installation	999.902		
174	actual required bolt force	$F_{B0,req} = F_{G0req} + F_{R0}$		installation	999.902		
175	**existing pre tension sealing force**	N	$F_{G0req} \le F_{G0}$	installation	1.000.000		
176		N	$F_{B0} \approx F_{G0req}$	installation	*correct*		
177	checking of gasket parameter	$Q_{min(L)} \le F_{G0}/A_{Ge} \le Q_{max,y}$			**20,0** < **32,854** <		**160,0**
178	in state of installation		*important note*		*criterion leak-tightness Pkt.5.3.2- see NOTE : correct*		
179	**consideration of dispersion at bolt tightening** *(approximation of systematic error at tightening: 57a,b)*						
180	resulting dispersion	–	ϵ_+ (58a)	installation	0,1044		
181	at tightening of all bolts	–	ϵ_- (58b)	installation	0,0835		
182	**monitored bolt forces and method of tightening**						
183	nominal bolt force for tightening	N	F_{B0nom} (63)	installation	1.091.049		
184	max. possible bolt force	N	F_{B0max} (65)	installation	1.204.984		
185	max. possible sealing force	N	F_{G0max} (66)	installation	1.204.984		
186	***calculation valid for non controlled bolt forces/torque, manual tightening;*** *see data base row 29*						
187	nominal bolt force for tightening	N	F_{B0nom} (63)	*installation*	0		
188	fixed min bolt force	N	$F_{B0nom} = F_{B0av}$	*installation*	0		
189	criterion	$F_{B0nom} = F_{B0av} \ge 2\,F_{B0req}$					
190	**mounting - load limits: maximum forces for proof of load bearing capacity** (*under consideration of dispersion*)						
191	max considered bolt force	N	F_{B0max} (65)	installation	**1.204.984**		
192	max considered stress to the gasket	N	F_{G0max} (66)	installation	**1.204.984**		
193	always to maintain sealing force	N	F_{G0d} (67)	installation	**999.902**		
194	**loads in state of testing / operation: max forces for proof of load bearing capacity**						
195	existing gasket force	N	F_G (68)	test	213.066		
196		N		operation	242.843		
197	existing bolt force	N	F_B (69)	test	901.586		
198		N		operation	738.602		
199	**calculation parameter of flange connection according section 6.4**						
200	wall thickness of equivalent shell	mm	e_D (75)		27,34		
201	standard calculation of tension	N / mm²	f_E	install / test	238,1	238,1	
202		N / mm²		operation	111,7		
203	auxilary variables (77)	–	δ_Q δ_R	installation	0,0000	0,0000	
204		–		test	0,1211	0,0000	
205		–		operation	0,2582	0,0015	
207	auxilary variables (78)	–	C_M	installation	*1,3330*	1,1546	
208		–		test	*1,3147*	1,1466	
209		–		operation	*1,2473*	1,1168	
210			*note*		*load capacity for flange-cylinder : correct*		
211	auxilary variables flange	jM = sign () (80)		installation	*62.453.566,734* →	**1**	
212				test	*58.681.736,374* →	**1**	
213		js = +1 *oder* -1; als f(jM)		operation	*47.896.582,884* →	**1**	
215	auxilary variables (79)	F_{L1}	F_{L2}	installation	0,78540	0,78540	
216		Cs (js=+1)	Cs (js=-1)	test	0,71298	0,85565	
217				operation	0,62883	0,93189	
218							

219	name	unit	formular / symbol		data		intern
220	ψ (js, k_M, ks)		ψ_{opt} (83)	installation	1,0000		
221				test	1,0000		
222				operation	1,0000		
223	js = +1; js = -1		ψ_{max} = ψ (+1, +1, + 1) (82)	installation	0,51684	0,51684	
224	-1 ≤ k_M ≤ +1			test	0,45755	0,53760	
225	0 ≤ ks ≤ 1			operation	0,38409	0,55331	
226			ψ_{min} = ψ (-1, -1, +1) (82)	installation	-0,51684	-0,51684	
227				test	-0,52392	-0,53760	
228				operation	-0,52560	-0,62446	
229			ψ_0 = ψ (0, 0, 0) (82)	installation	0,00000		
230				test	-0,03318		
231				operation	-0,07075		
232			*note*		*load capacity : correct*		
233	parameter k_M		k_M = f (j_M ; ψ_{opt})	installation	1		
234				test	1		
235				operation	1		
236					*parameter correct*		
237	parameter ψ_z		ψ_z = min (ψ_{opt} ; ψ_{max})	installation	0,516838348		
238				test	0,457554073		
239				operation	0,384093881		
240	**flange section modulus**	Nmm	W_F (74)	installation	198.945.585,2		
241		Nmm		test	194.358.791,7		
242		Nmm		operation	87.521.807,5		
243	flange slanting position / inclination	grd	Θ_F *E*.3	installation	***0,2454***		
244	critical maximum value appr. 0.5°	grd		operation	***0,2660***		
245					*correct*		
246	**proof of load bearing capacity bolt, gasket, flange**						
247	**bolt** : degree of utilisation Φ ≤ 1	*recommended : utilization* > 0,3	Φ_B (71)	installation	**0,5355**		
248				test	**0,3253**		
249				operation	**0,4876**		
250			*correction bolt*		*correct*		
251	**gasket** : degree of utilisation Φ ≤ 1		Φ_G (72)	installation	**0,1826**		
252				test	**0,0323**		
253				operation	**0,0368**		
254			*correction gasket*		*correct*		
255	**flange** : degree of utilisation Φ ≤ 1		Φ_F (73)	installation	**0,3783**		
256				test	**0,3019**		
257				operation	**0,5473**		
258			*flange correction*		*correct*		
259					*proof correct*		
260	**required bolt tightening torque at installation, calculated according annex D**						
261	torque for tightening of each bolt	Nmm	$M_{t,nom}$ (D.1)	installation	540.069,4		
262		Nm			**541,0**		
263	note						
264							
265	date editor						

1	Task	external pressure : 3,6 bar superheated steam, double jacket		M 7.2
2	field of application	EN 13480-3: 2002 / 9.3; Appendix G; not valid for creep behavior		
3	literature, source	AD -2000- B6: 2005; EN 13445-3: 2002; FDBR-MB 5-4 / 2004-01		
4	*mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the curser into the cell*			
5	**Pipe / cylindrical shell with outer welded square bar ring under external pressure**			
6	*out of roundness tolerance≤1%, to reference Ø D_o*			
7				
8	Effective stiffening of pipe / cylindical shell length			
9	Statically efective double wall joint			
10	Circumferential profile with all around welding seam			
11				
12				
13				
14				

	name	unit	formular / symbol	data	intern
15					
16	design pressure external	N/mm²	$p \geq 0{,}1$	0,3600	
17	design temperature in °C		$-10 \leq t \leq 650$ *ending* 0 *or* 5	180	
18	**material selection: pipe**			*correct*	
19	steel name / $R_{p0,2,t}$ / T / N / S / *Bl*	–	*data base*	1.0345 / P235GH, Rp0,2 / T≤ 16	
20	safety factor	–	k ≥ 1,5	1,50	
21	strength value, yield point	N/mm²	$R_{p0,2\,t}$	177,00	
22	elast.-value:non-austenitic and austenitic	$S_{NA} = R_{p0,2\,t}$	$S_A = 0{,}8 \cdot R_{p0,2\,t}$	177,00	
23	modulus of elasticity	N/mm²	$E_t^* = C_0 + t_c \cdot C_1 + t_c^2 \cdot C_2$	200.131,0	
24	*value confirmed or other value*	N/mm²	$E_t \geq 0{,}95 \cdot E_t^*$	200.130,0	√
25	**material selection: stiffening**			*correct*	
26	steel name / $R_{p0,2,t}$ / T / N / S / *Bl*	–	*data base*	1.0036 / S235JRG1 / ≤ 16	
27	production line, factor	–	$k_s = 1{,}2$; $k_s = 1{,}33$	1,20	
28	strength value, yield point	N/mm²	$R_{p0,2\,t}$	166,20	
29	elast.-value: non-austenitic and austenitic	$S_{NA} = R_{p0,2\,t}$	$S_A = 0{,}8 \cdot R_{p0,2\,t}$	166,20	
30	modulus of elasticity	N/mm²	$E_t^* = C_0 + t_c \cdot C_1 + t_c^2 \cdot C_2$	200131,0	
31	*value confirmed or other value*	N/mm²	$E_t \geq 0{,}95 \cdot E_t^*$	200.130,0	√
32	**design details**			*correct*	
33	outer Ø: pipe, cylindrical shell	mm	D_0	2200,0	
34	*guide value: min.wall thickness pipe, cyl.shell*	mm	e_{ord}*	*3,7*	
35	order wall thickness	mm	e_{ord}	**12,00**	√
36	∑C:Corros./abrasion (wear), tolerance	mm	$C_{0,1} \geq 0$	0,80	
37	max distance between 2 stiffener	mm	L	2000,0	
38	max length of stiffener	mm	L_c	2000,0	
39	**stiffener:** bar width	mm	$b \geq 3$	20,0	
40	bar height, h_{max} = *recommended*	mm	$h_s \leq h_{max} = 8 \cdot b$	160,0	√
41				*correct*	
42	**buckling proof between stiffeners**				
43	available strength at thickness	mm	e_a	11,20	
44	mean cylinder radius	mm	$R_m = 0{,}5\,(D_0 - e_a)$	1094,4	
45	buckling number (condition:p_m = min)	–	$n \geq 2$	6,0	
46	coefficient	–	$Z = \pi \cdot R_m / L$	1,719	
47	crictical pressure limit against yielding	N/mm²	$p_y = S \cdot e_a / R_m$	1,8114	
48	elastic buckling pressure at failure	N/mm²	$p_m = E_t \cdot e_a \cdot \varepsilon / R_m$	1,0989	
49	pressure ratio	–	p_m / p_y *table* 9.3.2-1	0,6067	0,6100
50	stiffness ratio	–	p_r / p_y *table* 9.3.2-1	0,3056	
51	lower failure pressure	N/mm²	$p_r = p_y$ · (*table* 9.3.2-1)	0,5535	
52	verified external pressure	N/mm²	$p \rightarrow (k \geq 1{,}5) \cdot p$	0,360	0,540
53	condition against material buckling press.	N/mm²	$p_r \geq k \cdot p$ (9.3.2-5)	0,5535	0,5400
54	max. allowed external pressure …	N/mm²	*note* p_{max}	**0,3690**	
55	between stiffeners		field of application:$U \leq 1\%$		
56				*correct*	

57	name	unit	formular / symbol	data			intern
58	**proof against total failure**						
59	design pressure external	N/mm²	p_{max} or p	0,3600			√
60	internal radius	mm	$R_i = 0{,}5 \cdot (D_0 - 2e_a)$	1088,00			
61	R + profil height; R_s (center of gravity)	mm	R_f R_s	1260,00		1145,87	
62	effective stiffening length pipe	mm	l_{ps} (9.3.4-4)	192,21			
63	stiffening area: profil / pipe	mm²	A_s $A_R = l_{ps} \cdot e_a$	3.200,0		2.152,7	
64	combinded stiffening areas	mm²	A_c	5352,7			
65	coefficient	mm	X_c (9.3.3-6)	57,5528			
67	moment of intertia of combined area	mm⁴	I_c *(Satz v.Steiner)*	16.279.108			
68	tension coefficient of stiffener	-	δ (9.3.3-5)	113,65			
69	yield pressure in circumferential orientat.	N/mm²	p_{ys} (9.3.3-3)	2,304			
70	theoretical elastic buckling pressure	N/mm²	p_n (9.3.3-1)	3,728			
71	verified safe stiffening	N/mm²	$k \cdot k_s \cdot p$	0,648			
72	condtion against buckling	N/mm²	$k \cdot k_s \cdot p \le p_n$ (9.3.3-2)	0,648		3,728	√
73	condition of the tension	N/mm²	$0 \le \sigma_s \le S_s$ (9.3.3-7)	112,33		166,20	√
74	**stability of stiffening**			*correct*			
75	*EN 13480-3: buckling can't occur at n > 10 and h_s/R_m > 0,01 under external pressure*						
76	calculation values	-	h_s/R_m	0,1462		0,146	
78	outer stiffening, matrix value	-	*table* 9.3.4-2	1,140000			
79	existing equivalent tension	N/mm²	$4 \cdot p \cdot S_s / p_{ys}$	103,9			
80	buckling tension: lateral buckling	N/mm²	σ_i = *table* $\cdot E_t / (h_s / e_w)^2$	3.564,8			
81	stability of stiffening	N/mm²	$\sigma_i > 4 \cdot p \cdot S_s / p_{ys}$	3564,8		103,9	√
82	maximum allowed external pressure	N/mm²	p_{max}	**0,3600**			
83	under operation or testing conditions						
84				*correct*			
85	note						
86	date editor						

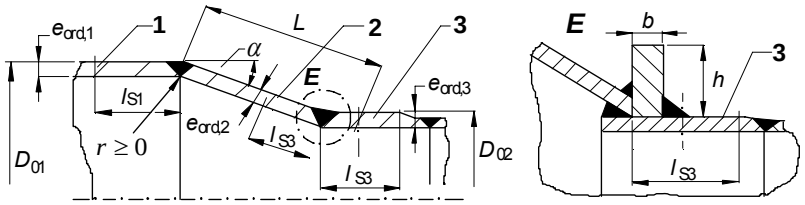
1	Task	see M 7.2	M 7.3
2	field of application	EN 13480-3: 2002 / 9.3; Appendix G; not valid for creep behavior	
3	literature, source	EN 13445-3: 2002; FDBR-MB 5-4 / 2004-01	
4	*mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the curser into the cell*		

reducer under external pressure with stiffener

out of roundness tolerance≤1%, to reference Ø $D_{o,\,max}$

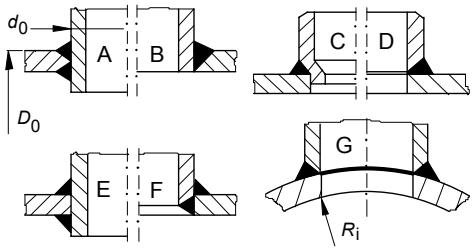
The figures are not defining the construction, they are only for indication of necessary dimensions of the calculation.

effective stiffened.
large cylinder / converging cone
with an angle > 10 ° (AD 2000)
stiffening of smaller cylinder part 3…
designed as ring or with increased …
thickness



	name	unit	formular / symbol	data			Intern
16	**name**	**unit**	**formular / symbol**	**data**			**Intern**
17	design pressure external	N/mm²	$p \geq 0{,}1$	0,3600			
18	design temperature in °C	-10 ≤ t ≤ 650	*ending* 0 *or* 5	180			
19	**material selection: reducer + stiffening**			*correct*			
20	steel name / $R_{p0,2,t}$ / T / N / S / *Bl*	–	*data base*	1.0345 / P235GH, Rp0,2 /	T ≤ 16		
21	safety factor	–	$k \geq 1{,}5$	1,50			√
22	strength value, yield point	N/mm²	$R_{p0,2\,t}$	177,00			
23	elast.-value: non-austenitic and austenitic	$S_{NA} = R_{p0,2\,t}$	$S_A = 0{,}8 \cdot R_{p0,2\,t}$	177,00			
24	standard proof design stress ..	–, N/mm²	coefficient: S	1,80	R_p / S	98,33	
25	stiffening: rule of interpretat. AD 2000-B2						
26	modulus of elasticity	N/mm²	$E_t^* = C_0 + t_c \cdot C_1 + t_c^2 \cdot C_2$	200.131,0			
27	*value confirmed or other value*	N/mm²	$E_t \geq 0{,}95 \cdot E_t^*$	200.130,0			√
28	**design details**			*correct*			
29	outer Ø: large cylinder	mm	D_{01}	2200,0			
30	brim radius: large cylinder	mm	$r \geq 0$	80,00			
31	brim angle, *see figure*	grd; °	$10° \leq \alpha \leq 60°$	30,00			
32	outer Ø: small cylinder	mm	D_{02}	1600,0			√
33	*guide value: equivalent cylinder shell, length*	mm	L^*	*662,0*			
34	L = distance between 2 effective stiffener	mm	$L \geq L^*$	700,0			
35	*see figure*						
36	∑C:Corros./abrasion (wear), tolerance	mm	$C_{0,1} \geq 0$	1,00			√
37	wall thickness large cylinder, part 1	mm	*recommended:* $e_{ord,1} \geq 2$	**8,50**			
38	*testing: allowed pressure of joint from part 1 + part 2*		$p_{allow}^* \geq p$	*0,405*	>	*0,360*	√
39	wall thickness cone shell, part 2	mm	$e_{ord,2} \geq e_{ord,1}$	**8,50**			
40	wall thickness small cylinder, part 3	mm	$e_{ord,3} \geq e_{ord,2}$	**8,50**			√
41	*testing: allowed pressure of joint from part 3 + part 2*		$p_{allow}^* \geq p$	*0,384*	>	*0,360*	√
42				*correct*			

43	name	unit	formular / symbol	data			Intern
44	**proof of the equivalent pipe = cone shell,** *section 9.4.4*						
45	available strength at thickness	mm	e		7,50		
46	mean Ø, equivalent compensation Ø	mm	D_m D_{eq} (9.4.3-1)	1900,00	D_{eq} (9.4.3-1)	2193,93	
47	mean radius	mm	R_m		1093,2155		
48	buckling number (condition: p_m = min)	–	$n_{cyl} \geq 2$		11		
49	ceoefficient	–	$Z = \pi \cdot R_m / L$		4,9063		
50	critical pressure limit against yielding	N/mm²	$p_y = S \cdot e_a / R_m$		1,2143		
51	elastic buckling pressure at failure	N/mm²	$p_m = E_t \cdot e_a \cdot \varepsilon / R_m$		1,2166		
52	pressure ratio (*real*) / computed value	–	p_m / p_y *table* 9.3.2-1	1,0019	*table* 9.3.2-1	1,0000	
53	stiffness ratio	–	p_r / p_y *table* 9.3.2-1		0,5000		
54	lower failure pressure	N/mm²	$p_r = p_y \cdot$ (*table* 9.3.2-1)		0,6072		
55	verified external pressure	N/mm²	$p \rightarrow (k \geq 1{,}5) \cdot p$	0,3600	$k \cdot p$	0,5400	
56	condition against material buckling press.	N/mm²	$p_r \geq k \cdot p$ (9.3.2-5)	0,6072	>	0,5400	
57	max. allowed external pressure	N/mm²	p_{max}		**0,3843**		
58	under operation or testing conditions		field of application: $U \leq 1\%$		*correct*		
59	effectivity verification of…	N/mm²	*kriterium :* $p_v \geq p$	**0,0889**	<	**0,360**	
60	Re-inforcement: Part 3 and Part 2 with all around corner joint weld				*additional reinforcements necessary*		
61	Additional Stiffening 1.) by increasing of thickness of part 3. 2.) by implementing a stiffening ring se**E**						
62	**Rating of effective stiffening of divergent cone - cylinder joint**						
63	**selected ring stiffener, see figure *E***						
64	selected profile	–	*data base*	dimension b x h = 1 : 7			
65	Width of square profile	mm	*recommended* $b \geq 6$	12,00			
66	height of ring	mm	h		84,00		
67	Center of gravity distance,effective length	mm	X_s	25,75	I_{S3}	136,6	
68	existing / required moment of intertia	mm⁴	$I_{xexist} > I_{xrequired}$ (9.4.2-1)	1.753.714	>	1.332.138	*correct*
69	existing / required cross sectional area	mm²	$A_{exist} > A_{required}$	1008,0	>	710,4	*correct*
70	recommended order wall thickness	mm	$e_{ord,1}$ $e_{ord,2}$ $e_{ord,3}$	**8,50**	**8,50**	**8,50**	
71	constructing effective length	mm	l_{S1}	136,6	l_{S3}	136,6	
72	note						
73	date editor						

1	Task	data selected					M 8.2
2	field of application	EN 13480-3:2002-8 / Code-Revision until 2007: 10.0 alternating loading					
3	literature, source	Rohrleitungstechnik, W.W. 9.Auflage Vogel Verlag, Fachbereichstandard TGL 32903/15					
4	*mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the curser into the cell*						
5	**Proof of welded components under alternating loading; approximation**						
6		seam construction for cylinder and dished head					
7	Design conditions:						
8	*No time dependent tention factors allowed*						
9	p_{max}, p_{min} = controlling cycle						
10							
11							
12							
13							
14							
15	**name**	**unit**	**formular / symbol**	**data**			**intern**
16	**Design shape according EN 13480-3:** specific value: K and η						
17	main component with welded in neck	–	*select*	dished head, thickness=const, neck in shell			
18	welding seam construction, see figures	–	*select*	B: single-sided fully penetrating weld with counter weld			√
19	*guide value: welding class = K1- K3, tension factor η table 10.3.2-4*			K1	η	3,00	
20	***enter guide value or other allowed value...***						
21	welding class	–	K1 - K3	K2			
22	tension factor	–	$1 \le \eta \le 5$	3,00			
23	**operation data: static loads**			*correct*			
24	allowed internal design pressure	N/mm²	$p_{c,max} \ge p_{operat}$	2,20			
25	of construction elements		p_{cmax} = *design pressure*				
26	max. design temperature		$0 \le t \le 650$ *ending 0 or 5*	285			
27		°C	$t_c = t_{max}$				
28	**operation data: periodic loads**			*correct*			
29	numbers of cycles within same / different window		$N > 1000$	3500			
30	max. range of pressure fluctuation		$(p_{max} - p_{min}) \le p_{c,max}$ (min = 0,1)	2,20			√
31	min. design temperature	°C	$0 \le t_{min} \le t_c$	20			
32	**selection of materials: body material**			*correct*			
33	steel name / $R_{p,t}$ / T / N / S / *Bl*	–	*data base*	1.0345 / P235GH, Rp0,2 / T ≤ 16			
34	additional - safety factor	–	S_Z =1 *or* $S_Z \ge 1,2$	1,00			
35	strength value, yield point	N/mm²	$R_{m20°}$, $R_{p20°}$, $R_{p0,2,t}$, $R_{p1,0,t}$	360,00	235,00	137,00	0,00
36	allowed tension	N/mm²	$f_{20°}$ f_s	150,00		91,33	
37	**design details:** pipeline $U \le 1,5$ %			*correct*			
38	outer Ø: pipe, cylindrical shell, head	mm	$D_0 > 10$	508,00			
39	*guide value: radius head*	mm	R_i	*508,00*			
40	radius: head, *no head* R_i = 0	mm	$R_i \le D_0$	508,00			√
41	∑C:Corros./abrasion (wear), tolerance	mm	$C_{0,1} \ge 0$	1,00			
42	welding seam factor longitudinal seam	–	$0,8 \le z \le 1$	1,00			
43	*guide value: min. wall thickness cylinder, head*		$e_{ord,cyl}$	*0,00*	$e_{ord,head}$	*8,65*	
44	order wall thickness	mm	*recomm.* : $e_{ord} \ge 2$	**10,00**			√
45	**interposed neck**			*correct*			
46	strenght ratio: neck / cylindrical shell	mm/mm	*recomm.* $0,8 \le f_b/f_s \le 1$	1,00			
47	outer Ø: neck	mm	d_0	273,00			
48	∑C:Corros./abrasion (wear), tolerance	mm	$C_{0,1} \ge 0$	1,00			
49	welding seam rating longitudinal seam	–	$0,8 \le z \le 1$	1,00			
50	*guide value: min. wall thickness neck*	mm	$e_{ord,min}$	*4,25*			
51	order wall thickness: neck	mm	*recomm* : $e_{ord,b} \ge 2$	**8,00**			√
52	*guide value: min. effective neck lenght*	mm	l_b^*	*43,15*			
53	effective neck lenght	mm	$l_b \ge l_b^*$	50,00			
54	neck inserted through	mm	$l_{b,i} \ge 0$	0,00			
55	*guide value: unhindered, clear width neck*	mm	L_R^* [mm]	*95,62*			
56	clear width / lenght at neck	mm	*recomm.* $L_R \ge 0,8 \cdot L_R^*$	100,00			√
57				*correct*			page 1 / 2

	name	unit	formular / symbol	data			Intern
59	**parameter: allowed substitute pressure**						
60	available netto strength thickness	mm	e_a	9,00	e_b	7,00	
61	internal Ø	mm	$D_i = D_R$	1.016,00	d_R	259,00	
62	weakening rating, Kellog method	–	V_A		0,567		
63	max. range of pressure fluctuation	N/mm²	$(p_{max} - p_{min})$		2,20		
64	*guide value: allowed substitute pressure*	N/mm²	p_r^* p_c	*2,99*	*>*	*2,20*	√
65	*value confirmed or other value* p_r	N/mm²	$p_r^* \geq p_r \geq p_c$		**2,80**		
66			*note*		*correct*		
67	**calculation: allowed numbers of load cycle**						
68	wall thickness correction factor	–	F_d 10.3.2-2		1,00		
69	temperature intervall	° C	t^* 10.3.2-3		218,8		
70	temperat.effect factor, ferrit/austenit	–	$F_{t,ferr}^*$ 10.3.2-4 / 5	0,925	$F_{t,aust}^*$	0,000	
71	standard tension value	–	η		3,000		
72	welding class / coefficient *m*	–	K ()	K2	m	3,00	
73	calculation constant	–	B tab.10.3.2-2		6.300		
74	tension amplitude	N/mm²	$2 \cdot \sigma_a$ 10.3.2-1		382,1		
75	allowed numbers of load cycles	–	$N_{all} = [\ B / 2 \cdot \sigma_a^*\ ]^m$ *note*	**4.483,2**	**>**	**3.500,0**	
76					*correct*		
77			*the max.allowed stress cycle coefficient is the smallest value, which results from the calculation*				
78			*within the pipe system used components*				
79	note						
80							
81	data editor						