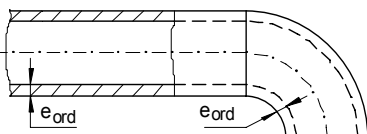
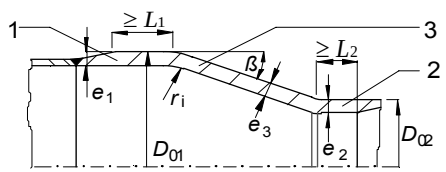
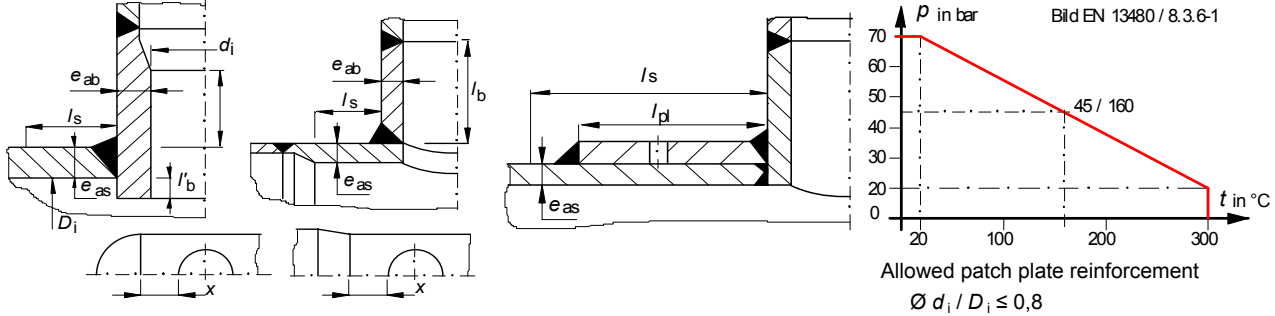
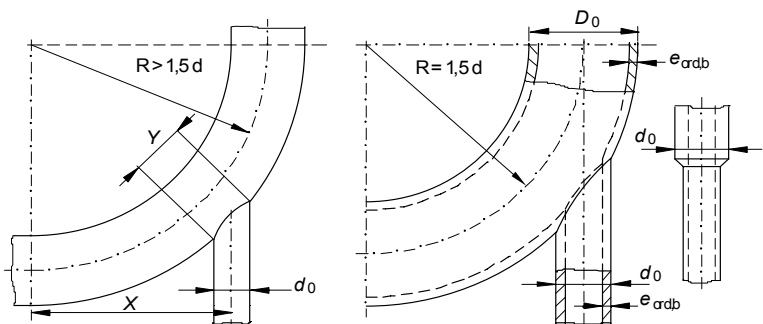


1	Task	pipe elements : steel 1.4301, DN 500, EN 10220, pc = 22 bar, t = 162 °C			M 1.1
2	field of application	EN 13480-3:2002-8 / Code-Revision until 2007: 6.1 pipe, 6.2 pipe elbow standard method			
3	literature, source	Rohrleitungstechnik, W.W. 9.Auflage Vogel Verlag, TabBuch für Rohrl.Bau,15.Aufl.Vulkan-Verlag			
4	mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the cursor 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 _{p0,2t} /1,5 ; R _m /2,4)				
7	A : EN 13480: A > 35% (DB : A40) : f = R _{p1,0t} /1,5				
8	A : EN 13480: 30% ≤ A ≤ 35% (DB : A35) : f = min (R _{p1,0t} /1,5 ; R _m /2,4)				
9	Test: EN 13480; 5.2.1.2 and 5.2.2.2				
10	name	unit	formular / symbol	data	intern
11	design pressure internal	N/mm ²	p _c ≤ PS, p _c ≥ 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 / B /	–	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/mm ²	R _{m20°} , R _{p0,2,t} , R _{p1,0,t}	500,00	0,00 167,50
17	allowed tension	N/mm ²	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 ≤ 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	ΣC:Corrosion / abrasion (wear), tolerance	mm	C _{0,1} = (C ₀ + C ₁) ≥ 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/mm ²	p _{allow}	2,759	
34	correct				
35	elbow, standard method section 6.2.3.1				
36	ΣC:Corrosion / abrasion (wear), tolerance	mm	(C _{0,1} + C ₂) ≥ 0	0,90	
37	guide value: radius pipe elbow	mm	R _{min}	508,0	R _{max} 5.080,0
38	radius: pipe bend / pipe elbow	mm	D ₀ ≤ R ≤ 10·D ₀	762,00	
39	correct				
40	required min thickness straight pipe	mm	e (6.1-1 / 6.1-3)	4,955	✓
41	parameter	–	R / D ₀	1,500	
42	min thickness internal side	mm	e _{int}	6,19	
43	min order wall thickness internal side	mm	e _{int,ord} * =e _{int} +C _{0,1,2}	7,09	
44	min thickness exterior side	mm	e _{ex}	4,34	
45	min order wall thickness exterior side	mm	e _{e x,ord} * =e _{ex} +C _{0,1,2}	5,24	
46	name	mm	elbow	DIN 2605/2 - 3 - 90	
47	order wall thickness internal side	mm	e _{int,ord} ≥ e _{int,ord} *	7,90	
48	order wall thickness exterior side	mm	e _{e x,ord} ≥ e _{ex,ord} *	5,60	
49	arch - circumferential tension, EN1594:2000	N/mm ²	f _{c,int}	87,20 < 111,67	
50		N/mm ²	f _{c,ex}	86,50 < 111,67	
51	correct				
52	note				
	date	editor			

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						
12	name	unit	formular / symbol	data	intern	
13	design pressure internal	N/mm ²	$p_c \leq PS, p_c \geq p_{operat}$	2,200		
14	design temperature in °C	-10 ≤ t ≤ 650	ending 0 or 5	165		
15	material selection, part 1 - 3					
16	steel name / R _{p,t} / T / N / S / B/	—	data base	1.4301 / X5CrNi18-10 / Rp1,0		
17	additional - safety factor	—	S _Z = 1 or S _Z ≥ 1,2	1,00		
18	strength value, yield point	N/mm ²	R _{m20} , R _{p0,2,t} , R _{p1,0,t}	520,00	0,00 167,50	
19	allowed tension	N/mm ²	f _s	111,67		
20	design details					
21	outer Ø large cylinder	mm	D ₀₁ ≥ 20	508,00		
22	outer Ø small cylinder	mm	10 ≤ D ₀₂ < D ₀₁	273,00		
23	aperture angle of the cone	grd	5 ≤ β ≤ 60	24		
24	radius of welding seam in mm		0 ≤ r _i ≤ 0,3 · D _{cyl} , welded: r _i = 0	80,00	✓	
25	ΣC:Corrosion / abrasion (wear), tolerance	mm	C _{0,1} ≥ 0 note	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 ~ 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	—	β* ≥ 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/mm ²	p _{allow}	2,201237084	p _{allow} ≥ p _c 2,200	
38	guide value: S*	mm / mm	S* = e ₃ / e ₂	1,90		
39	design value	mm / mm	S ~ 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	—	ζ (6.4.8-2)	3,169	β _H (6.4.8-4) 1,017	
45	allowed internal pressure: part 2, 3	N/mm ²	P _{cyl} (6.4.8-5)	2,200348052	p _{allow} ≥ p _c 2,200	
46	min required construction dimension, including allowance C _{0,1}					
47	large cylinder Ø, part 1	mm	e _{ord,1} ≥	6,50		
48	small cylinder Ø part 2	mm	e _{ord,2} ≥	6,22		
49	cone shell thickness, constant part 3	mm	e _{ord,3} ≥	6,50		
50	die out length	mm	L ₁ ≥ 1,4 · l	76,8	L ₂ 55,0	
51	For the die out length L1 applies: wall thickness = max (e _{ord,1} ; e _{ord,3}) . For L2 applies: wall thickness = max (e _{ord,2} ; e _{ord,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		β ≤ 60° ; e _a · cosβ / D _C ≤ 0,001	0,01092	> 0,0010	
54	allowed internal pressure: reducer	N/mm ²	p _{allow}	2,2003		
55	note					
56	date	editor				

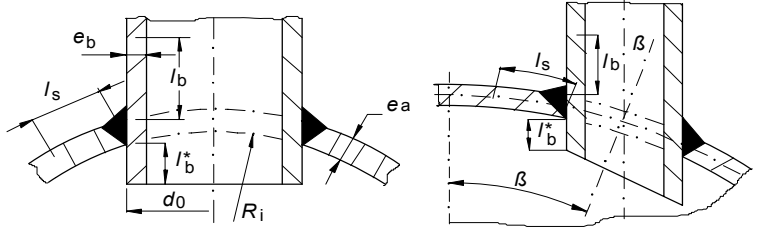
1	Task	data see M 1.1			M 2.1
2	field of application	EN 13480-3: 2002-05 / 8.3; FDBR-M. 2004: cut out, cut out re-inforcements			
3	mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the curser into the cell				
4	Selected Joints : 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.				
6					
13	Close-by disturbance, allowed distance X				
17	name	unit	formular / symbol	data	intern
19	design pressure internal	N/mm ²	$p_c \leq PS, p_c \geq p_{operat}$	2,20	
20	design temperature in °C	-10 ≤ t ≤ 650 ending 0 or 5		165	
21	reinforcement construction correct				
22	area of disturbance, see distance X	—	select	cap, head, reducer, flange, armature	
23	construction: reinforcement	—	select	cut out with reinforcement pad	
24	welded in neck	—	select	inserted through internal flush	
25	material selection: pipe correct				
26	steel name / R _{p,t} / T / N / S / B / I	—	data base	1.4301 / X5CrNi18-10 / Rp1,0 / S	
27	additional - safety factor	—	$S_Z = 1 \text{ or } S_Z \geq 1,2$	1,00	
28	strength value, yield point	N/mm ²	$R_{m20^+}, R_{p0,2,t}, R_{p1,0,t}$	500,00 0,00 167,50	
29	allowed tension	N/mm ²	f_s	111,67	
30	material selection: neck or branch correct				
31	steel name / R _{p,t} / T / N / S / B / I	—	data base	1.4301 / X5CrNi18-10 / Rp1,0 / N	
32	additional - safety factor	—	$S_Z = 1 \text{ or } S_Z \geq 1,2$	1,00	
33	strength value, yield point	N/mm ²	$R_{m20^+}, R_{p0,2,t}, R_{p1,0,t}$	500,00 0,00 165,50	
34	allowed tension	N/mm ²	f_b	110,33	
35	material selection: plate correct				
36	steel name / R _{p,t} / T / N / S / B / I	—	data base	1.4301 / X5CrNi18-10 / Rp1,0	
37	additional - safety factor	—	$S_Z = 1 \text{ or } S_Z \geq 1,2$	1,00	
38	strength value, yield point	N/mm ²	$R_{m20^+}, R_{p0,2,t}, R_{p1,0,t}$	520,00 0,00 167,50	
39	allowed tension	N/mm ²	f_{Pl}	111,67	
40	design details correct				
41	outer Ø: pipe, cylindrical shell	mm	Ø D ₀	508,0	✓
42	ΣC: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	ΣC: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	mm	l _s	55,78	
52	dimension: length around the neck	mm	recommended L _s ≥ 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 ≥ l _b	100,00	
55	inserted through length	mm	l _b * ≥ 0, if plate l _b * = 0	0,00	
56	correct				
57	page 1 / 2				

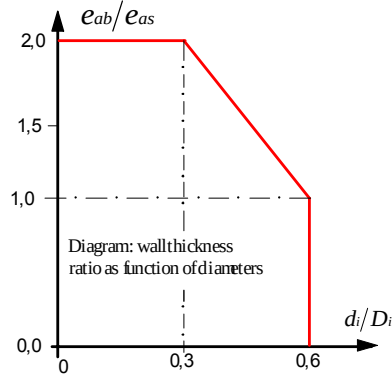
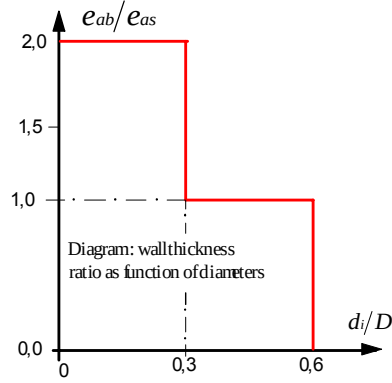
58	name	unit	formular / symbol	data			intern
59	construction, reinforcement plate						
60	thickness of stiffening plate	mm	$e_{pl} > 0$	8,00			
61	guide value: plate width	mm	$L_{pl}^* \geq$	55,8			
62	selected: plate width	mm	L_{pl}	60,00			
63	correct						
64	field of application, data						
65	strength thickness: shell, neck, plate	mm	$e_{as} \quad e_{ab} \quad e_{apl}$	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	$f_s \quad f_b \quad f_{pl}$	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	Diagram : wallthickness ratio as function of diameters						
72	Diagram : wallthickness ratio as function of diameters						
73	Diagram : wallthickness ratio as function of diameters						
74	Diagram : wallthickness ratio as function of diameters						
75	Diagram : wallthickness ratio as function of diameters						
76	Diagram : wallthickness ratio as function of diameters						
77	Diagram : wallthickness ratio as function of diameters						
78	Diagram : wallthickness ratio as function of diameters						
79	Diagram : wallthickness ratio as function of diameters						
80	Diagram : wallthickness ratio as function of diameters						
81	steel: $f_s \leq 250 \text{ N/mm}^2$						
82	steel: $f_s > 250 \text{ Nmm}^2$						
83	click here > conditions checked and in limits						
84	calculation section 8.3						
85	reinforcements length: pipe, neck, plate	mm	$l_s \quad l_b \quad l_b^* \quad l_{pl} \quad (8.4.3-1/2)$	55,78	56,57	0,00	55,78
86	pressure imposed area	mm ²	A_p		63.478		
87	pressure supporting area	mm ²	$A_{f,s} \quad A_{f,b} \quad A_{f,pl}$	346	640	346	
88	condition: term (8.4.3-3 ; 8.4.3-6 ; 8.4.3-7)		$\geq p_c \cdot A_p$	146.405,7	>	139.651,0	
89	allowed internal pressure	N/mm ²	$p_{allow.}$		2,305		
90	correct						
91	further required construction dimensions						
92	min required plate Ø	mm	$\varnothing D_{pl} \geq$	447,9			
93	min distance to disturbance	mm	$X_{min} \geq (8.3.2-1/2)$	56			
94	note						
95							
96	date editor						

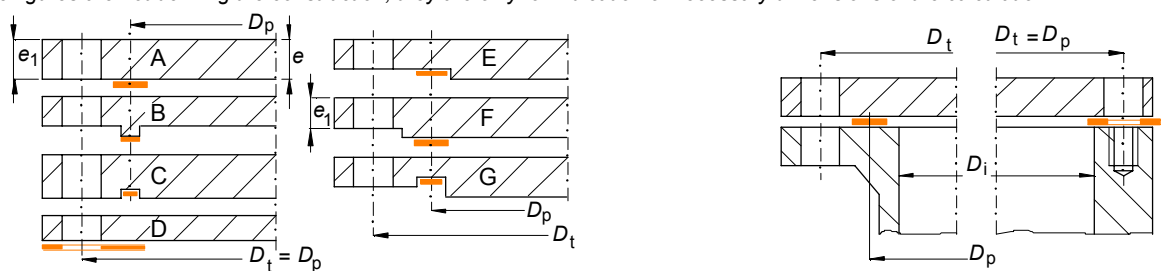
1	Task	data see M 1.1			M 2.4
2	field of application	EN 13480-3: 2002-05 / E ; cut out, cut out reinforcements			
3	mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the cursor into the cell				
4	Branch pipe joint: put on neck 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 ≤ D0				
13		note			
14					
15					
16	name	unit	formular / symbol	data	intern
17	design pressure internal	N/mm²	p_c ≤ 4, p_c ≥ 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	correct				
21	material selection: pipe elbow				
22	steel name / R_p,t / T / N / S / B /	–	data base	1.4301 / X5CrNi18-10 / Rp1,0 / S	
23	additional - safety factor	–	S_z = 1 or S_z ≥ 1,2	1,00	
24	strength value, yield point	N/mm²	R_m20°, R_p0,2,t, R_p1,0,t	500,00	0,00 167,50
25	allowed tension	N/mm²	f_s	111,67	
26	correct				
27	material selection: neck or branch				
28	steel name / R_p,t / T / N / S / B /	–	data base	1.4301 / X5CrNi18-10 / Rp1,0 / N	
29	additional - safety factor	–	S_z = 1 or S_z ≥ 1,2	1,00	
30	strength value, yield point	N/mm²	R_m20°, R_p0,2,t, R_p1,0,t	500,00	0,00 165,50
31	allowed tension	N/mm²	f_b	110,33	
32	correct				
33	design details				
34	outer Ø elbow, allowable :	mm	168,3 ≤ D_0 ≤ 609,6	508,00	✓
35	construction	mm	select	seamless pipe elbow R = 1,5 D_0	
36	bending radius, dimension	mm	R ≥ 1,5 · D_0, toler = ± 10%	762,00	
37	ΣC:Corrosion/abrasion (wear), tolerance	mm	C_0,1 ≥ 0	1,00	
38	welding seam factor longitudinal seam	–	0,7 ≤ z ≤ 1	1,00	
39	guide value: min. order wall thickness pipe elbow		e_ord,int*	7,19 e_ord,ex* 5,34	
40	thickness: internal arch side	mm	e_ord,int ≥ e_ord,int*	11,00	
41	thickness: external arch side	mm	e_ord,ex ≥ e_ord,ex*	11,00	
42	correct				
43	Tab. EN 13480-3 / E.1.1-2 and -3	pressure N/mm²		recommended combination	
44	bending radius R = 1,5 · D } bending radius R > 1,5 · D	p ≤ 0,5	select	pipe elbow Ø 508 max neck Ø 114,3	✓
45		0,5 < p ≤ 1	select		
46		1 < p ≤ 4	select		
47		0 < p ≤ 4	select		
48	correct				
49	neck or branch				
50	external Ø	mm	d_0 Tab. E.1.1-2 und 3	88,90	
51	ΣC:Corrosion/abrasion (wear), tolerance	mm	C_0,1 ≥ 0	0,35	
52	welding seam factor longitudinal seam	–	0,7 ≤ z ≤ 1	1,00	
53	guide value: min. wall thickness neck	mm	e_ord,b	1,23	
54	order wall thickness: neck	mm	e_ord,b ≥ 2	3,60	
55	guide value: allowed built in distance	mm	X_min X_max	762,00	762,00
56	built in distance, see figure	mm	X	762,00	
57	correct				

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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	$e_{int} \quad e_{ext} \quad e_b$	10,00	10,00	3,25
59	effective length elbow, neck	mm	$L_s \quad l_b$	70,57	16,68	
60	parameter E.2.1.1	grd	$\alpha \quad \beta \quad \gamma$	41,410	45,069	37,463
61		grd	$\tau \quad A^* \quad B^*$	4,000	40,930	33,463
62	sector area, max pressure area	mm ²	$\Omega \quad G_2 \quad E.2.1-6 / -7$	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	$p_c \leq S_2 \cdot f / G_2$	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					

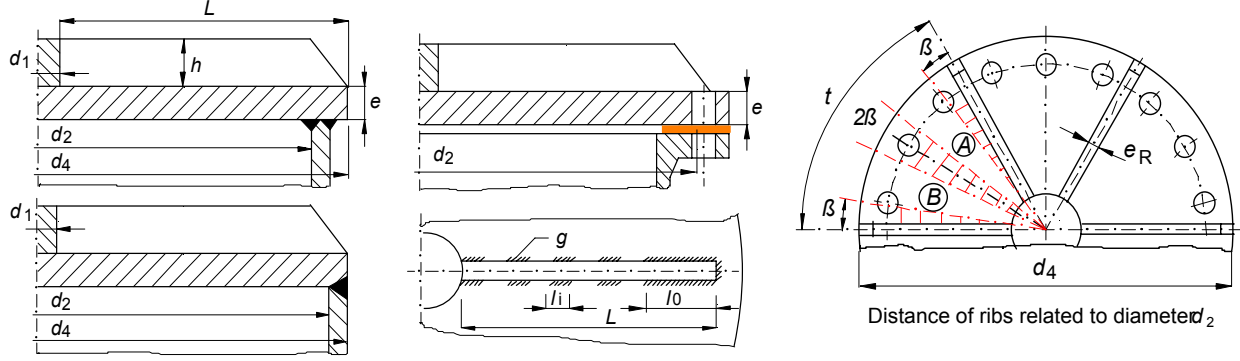
1	Task	data see M 1.1			M 3.2
2	field of application	EN 13480-3 / 7.1.3; EN 13445-3 / 2003-07:Torospherical head, Dished head, Basket arch head			
3	literature, source	Rohrleitungstechnik, W.W. 9.Auflage Vogel Verlag, TabBuch für Rohrl.Bau,15.Aufl.Vulkan-Verlag			
4	mathematical symbols, units and comments: 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/mm ²	$p_c \leq PS, p_c \geq p_{operat}$	2,20	
19	design temperature in °C	-10 ≤ t ≤ 650	ending 0 or 5	165	
20	material selection: head correct				
21	steel name / $R_{p,t}$ / T / N / S / B /	—	data base	1.4301 / X5CrNi18-10 / Rp1,0	
22	additional - safety factor	—	$S_z = 1 \text{ oder } S_z \geq 1,2$	1,00	
23	factor of cold hardening against buckling	—	1,0 or 1,6 note	1,00	
24	strength value, yield point	N/mm ²	$R_{m20^\circ}, R_{p0,2,t}, R_{p1,0,t}$	520,00 0,00 167,50	
25	allowed tension / - buckling tension	N/mm ²	f_c	111,67 f_{buck} 111,67	
26	material selection: neck correct				
27	steel name / $R_{p,t}$ / T / N / S / B /	—	data base	1.4301 / X5CrNi18-10 / Rp1,0 / N	
28	additional - safety factor	—	$S_z = 1 \text{ or } S_z \geq 1,2$	1,00	
29	strength value, yield point	N/mm ²	$R_{m20^\circ}, R_{p0,2,t}, R_{p1,0,t}$	500,00 0,00 165,50	
30	allowed tension	N/mm ²	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	ΣC: 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	$\varnothing d_0$	168,30	
43	ΣC: 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	$0 \leq \beta^\circ \leq 50$	0,00	✓
48	guide value: effective, undisturbed length around the neck	mm	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				

54	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	$d_i / D_i \leq 0,6$	0,310	$e_{ab} / e_{as} \leq 2$	1,070	
58	allowed tension: head, neck	N/mm ²	f_s	111,67	f_b	110,33	
59							
60	correct						
61	check area of application, allowed conditions according EN 13480 / section 8.3.1-2						
62							
63							
64	steel: $f_s \leq 250 \text{ N/mm}^2$			steel: $f_s > 250 \text{ N/mm}^2$			
65							
66							
67							
68							
69	Diagram: wallthickness ratio as function of diameters			Diagram: wallthickness ratio as function of diameters			
70							
71							
72							
73							
74							
75	click here >			conditions checked and in limits			
76	calculation Pt. 8.3						
77	coefficient: Y ; Z	—	Y (7.1.5-1 bis 7.1.5-8)	0,01398	Z	1,85461	
78	coefficient : X ; N	—	$0,06 \leq X = r_i / D_i \leq 0,2$	0,1033	N	0,8911	
79	coefficient : $\beta_{0,06} ; \beta_{0,1} ; \beta_{0,2}$	—	$\beta_{0,06} ; \beta_{0,1} ; \beta_{0,2}$	0,9532	0,7473	0,5000	
80	coefficient, field of application	—	$0,4 \leq \beta \leq 1,6$		0,7392		
81	head without neck						
82	allowed pressure spherical shell	N/mm ²	p_s (7.1.3-6)		3,100		
83	allow. pressure of brim against yielding	N/mm ²	p_{kny} (7.1.3-7)		2,235		
84	allow. pressure of brim against buckling	N/mm ²	p_{knb} (7.1.3-8)		3,418		
85	allowed internal pressure	N/mm ²	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	mm ²	A_p		46.241,0		
89	pressure supporting area	mm ²	A_f		924,7		
90	condition :	term (8.4.3-3 ; 8.4.3-6 ; 8.4.3-7)	$\geq p_c \cdot A_p$	101.885,4	>	101.730,3	
91	allowed internal pressure	N/mm ²	$p_{allow} \geq p_c$	2,220	>	2,200	
92	with neck to spherical shell						
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 cursor 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.				
7					
16	name	unit	formular / symbol	data	intern
17	design pressure internal	N/mm ²	$p_c \leq PS, p_c \geq p_{operat}$	2,20	
18	design temperature in °C		$-10 \leq t \leq 650$ ending 0 or 5	165	
19	material selection: flat head				
20	steel name /R _{p,t} / T / N / S / B /	—	data base	1.4301 / X5CrNi18-10 / Rp1,0	
21	additional - safety factor Pt. 5.2.5.2	—	$S_Z = 1$ or $S_Z \geq 1,2$	1,00	
22	strength value, yield point	N/mm ²	$R_{m20^\circ}, R_{p0,2,t}, R_{p1,0,t}$	520,00	0,00
23	allowed tension	N/mm ²	$f_{A,20^\circ}, f_1$	166,67	111,67
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	ΣC: Corros./abrasion (wear), tolerance	mm	$C_{0,1} \geq 0$	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	30,00
35	select: gasket	—	data base	spiral carbon steel, asbestos filling	
36	specific gasket value m / y	—, N/mm ²	m table 7.2.4-1	2,50	20,00
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	$e_{ord,heat} \geq e + C_{0,1}$	37,98	
49	order thickness: flat head	mm	$e_{ord,heat}$	38,00	
50	correct				
51	note	weiter siehe : fitted neck			
52	date editor				

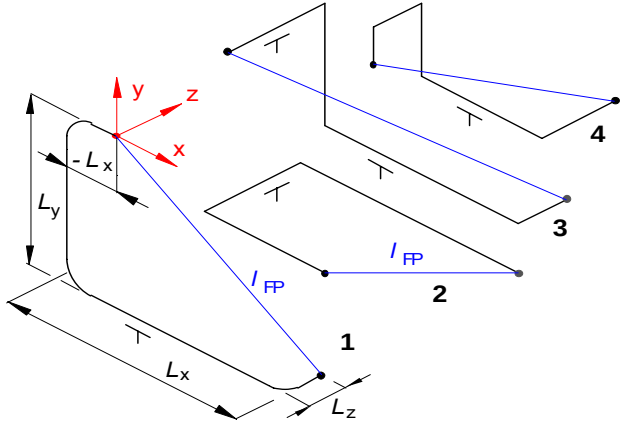
1	Task	data see M 4.2				M 4.3
2	field of application	EN 13480-3 / 7.2.5				
3	literature, source	EN 10216-1,-2,-3,-5, EN 10217-1,-2,-3,-5, prEN 10217-7 ; EN 10028-2,-3, EN 10222-2,-4,-5				
4	mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the cursor 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/mm ²	$p_c \leq P_S, p_c \geq p_{operat}$	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/mm ²	f_1	111,67		
23	head inner Ø; gasket Ø	mm	D_i	488,00	D_p 660,00	
24	ΣC: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 / $R_{p0,1}$ / T / N / S / B /	—	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/mm ²	$R_{m20^\circ}, R_{p0,2,t}, R_{p1,0,t}$	500,00	0,00 165,50	
32	allowed tension	N/mm ²	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	ΣC: 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 page 1 / 2					

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	$K = D_1$ (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: Ø d_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					

1	Task	data see M 4.2, no leak-tightness required			M 4.4
2	field of application	EN 13480-3; EN 13445-3 / 2002/prA16:2006 ;RKF-Festigkeitsberechnungen BR-A9 / 1973			
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	Circular flat head with stiffening ribs, welded or bolted with end to end gasket				
5	The figures are not defining the construction, they are only for indication of necessary dimensions of the calculation.				
6	to screw, leak-proof : recommended ≤ 6 bar				
7					
8					
9	Distance of ribs related to diameter d_2				
10					
11					
12					
13					
14					
15					
16					
17					
18	name	unit	formular / symbol	data	intern
19	design pressure internal	N/mm ²	$p_c \leq P_S, p_c \geq p_{operat}$	2,20	
20	design temperature in °C	-10 $\leq t \leq$ 650 ending 0 or 5		165	
21	material selection: flat head correct				
22	steel name / $R_{p,t} / T / N / S / B / I$	—	data base	1.4301 / X5CrNi18-10 / Rp1,0	
23	additional - safety factor	—	$S_Z=1$ or $S_Z \geq 1,2$	1,00	
24	strength value, yield point	N/mm ²	$R_{m20^+}, R_{p0,2,t}, R_{p1,0,t}$	520,00 0,00 167,50	
25	allowed tension	N/mm ²	f_B	111,67	
26	material selection: reinforcement ribs, centring ring correct				
27	steel name / $R_{p,t} / T / N / S / B / I$	—	data base	1.0036 / S235JRG1 / ≤ 16	
28	additional - safety factor	—	$S_Z=1$ or $S_Z \geq 1,2$	1,00	
29	strength value, yield point	N/mm ²	$R_{m20^+}, R_{p0,2,t}, R_{p1,0,t}$	340,00 170,10 0,00	
30	allowed tension	N/mm ²	f_R	113,40	
31	design details correct				
32	pressure imposed $\varnothing$	mm	d_2	488,0	
33	bolting: $d2 \leq$ pitch $\varnothing$, see figure	mm			
34	outer $\varnothing$: head / flange	mm	d_4	720,0	
35	welding seam factor head	—	$0,7 \leq z \leq 1$	1,0	
36	ΣC : Corros./abrasion (wear), tolerance	mm	head : $C_{0,1} \geq 0$	0,5	
37	guide value: max / min thickness of heat	mm	e^*_{min}	6,0 e^*_{max} 13,5	
38	selected : head thickness incl. $C_{0,1}$	mm	$e \geq e^*_{min}$ (recomm. = 8)	10,0	✓
39	guide value: number of ribs	—	calculation (22.4-1) : $n_{v,min}$	6 $n_{v,max}$ 24	
40	selected: number of ribs	recommended $n_v \geq 4, 6, 8, 10, 12$ ---		8,0	✓
41	guide value: rib thickness	mm	e_R^*	8,0	
42	selected: rib thickness	mm	recommended $e_R \geq e_R^*$	10,0	✓
43	guide value: outer $\varnothing$ centring	mm	$d_{1,min}^*$	50,9	
44	outer $\varnothing$: centring	mm	$d_1 \geq d_{1,min}^*$	55,0	
45	guide value: length of ribs, see figure	mm	L^*_{min}	216,5 L^*_{max} 332,5	
46	length of ribs	mm	$L \geq L^*_{min}$	320,0	✓
47	guide value: height of ribs	mm	h^*_{min}	50,0 h_{max} 113,3	
48	selected: height of ribs	mm	$h \geq h^*_{min}$	100	
49	welding seam: head with rib	—	select	stitched seams, not fully welded	
50	length of stitchweld, $l = const$	mm	$l_1 = l_i$; no stitchweld = 0	50,0	✓
51	number of stitch weldings without end lag seam/ l_0		$n_{g,i} \geq 0$	4,0	
52	length of lag seam, $\sum l_0$	mm	$l_0 \geq 0,2 \cdot L$ or $l_0 = 0$	100,0	
53	welding seam factor all joints	—	$0,7 \leq z \leq 1$	0,80	✓
54	guide value: fillet weld thickness	mm	g_0	5,33	
55	fillet weld thickness rib, centring ring	mm	$g_1 \geq g_0 (\geq 3)$	6,0	
56	correct				

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57	name	unit	formular / symbol	data			intern
58	faktor	—	C <i>figure (22.5-1)</i>	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	$2 \cdot l_0 \cdot g_0 \leq \sum (l_i \cdot g_i)$	1.066,1	<	1.200,0	✓
65		mm	$l_0 \leq \sum l_i \leq 0,8 \cdot l$	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 2β (red)	grd	critical angle β	5,6			
71	no cut out allowed						
72	field of application, section 22.4		recommended limits				
73	pitch distance relating to $\varnothing d_2$	mm	$t \leq (20 \dots 28) \cdot e_a$	191,6	<	280,0	
74	rib height	mm	$5 \cdot e_R \leq h \leq 15 \cdot e_R$	50,0	100,0	150,0	
75	rib thickness	mm	$0,5 \cdot e \leq e_R \leq 1,5 \cdot e$	5,0	10,0	15,0	
76							
77	note						
78	date	editor					

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.Rohrleitg.-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					
5						
6	simplified elasticity analysis, EN 13480-3					
7	figure isometrie: practical installation in plants					
8	<u>recommendations and tips</u>					
9	- for well proven or comparable systems					
10	- straightforward strain characteristic					
11	- constant pipe cross section between fixed points					
12	- free moving space available: loose bearing, hanger					
13	- load alterations: gas pipelines 1000, others ≤ 7000					
14						
15						
16	name	unit	formula / symbol	data	Intern	
17	design pressure internal	N/mm ²	$p \leq PS, p \geq p_{operat.}$	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 / BI	—	data base	1.4301 / X5CrNi18-10 / Rp1,0 / N		
21	additional - safety factor	—	$S_z = 1 \text{ or } S_z \geq 1,2$	1,00		
22	strength value, yield point	N/mm ²	$R_{m 20^\circ} R_{p 0,2,t} R_{p 1,0,t}$	500,00	0,00	138,00
23	allowed tension	N/mm ²	f_t	92,00		
24	thermal expansion coefficient	1 / K	β_t	1,7120E-05		
25	pipeline design correct					
26	outer Ø: pipe	mm	$D_0 \geq 8$	273,00		
27	ΣC: Corros./abrasion (wear), tolerance	mm	$C_{0,1} \geq 0$	0,80		
28	welding seam factor longitudinal seam	—	$0,8 \leq z \leq 1$	1,00		
29	guide value: order wall thickness pipe	mm	$e_{ord,s}^*$	1,982		
30	order wall thickness pipe	mm	$e_{ord,s} \geq e_{ord,s}^*$	3,20		
31	coordinates length, analysis according	—		$\sum L_x \geq 0$	$\sum L_y \geq 0$	$\sum L_z \geq 0$
32	figure	mm	note	5.500,0	3.220,0	3.760,0
33	allowed internal pressure	N/mm ²	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	I_{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	$L_{min} \geq L_{min}^*$	12.480,0		
40	$L = L_x + L_y + L_z $					
41	elasticity conditions		$D_0 \cdot Y / (L_S - I_{FP})^2 \leq 208,3$	381,9	>	208,3
42	incorrect					
43	with pre-tension, if criterium incorrect note					
44	pre-tension factor	%	$0 < V \leq 50$	50,0		
45	pre-tension length, installation ...	—	note	ΔL_x	ΔL_y	ΔL_z
46	length: $\Delta L_{x,y,z}$ 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	$L_{min} \geq L_{min}^*$	12.480,0		
50	elasticity conditions		$D_0 \cdot Y / (L_S - I_{FP})^2 \leq 208,3$	190,95		
51	stress analysis passed, no further calculations required					
52	note	$L = 5500 + 3220 + 3760 = 12480$				
53	date	editor				

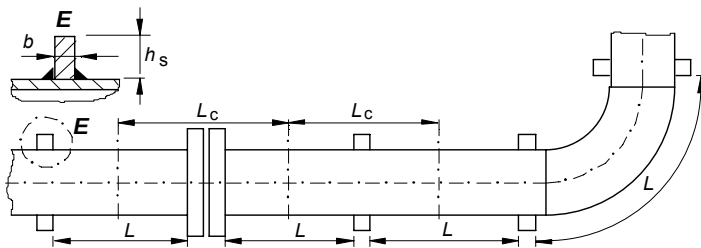
1	Task	data see M 1.1 : flange DN 500 / PN 25, user defined gasket, see gask1 - gask3			M 6.1
2	field of application	Integrated flange / welded neck flange; EN 1591-1:2001/ A1:2005			
3	literature, source	physic.specific value EN 13445-3, TGL 32903 / 13-1983			
4	mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the curser into the cell				
5	Welded neck flange - joint allowed: equal / similar counter flange (armature) in comparable steel type				
6	The figures are not defining the construction, they are only for indication of necessary dimensions of the calculation.				
7	gasket system: flat face or groove - key		input data of flange connection; dimensions in mm		
8			name	symbol	data
9			calculation		
10			flange outer Ø	d_4	730,0
11			cylindrical shell Ø	d_s	508,0
12			pitch Ø	d_3	660,0
13			flange internal Ø	d_0	488,0
14			bolt hole Ø	$d_5 \geq 10$	36,0
15			cylin.shell thickness	e_s	7,1
16			neck thickness	e_1	10,0
17			shoulder thickness	$e_2 > e_1$	35,0
18			flange neck	$L_s \geq 0$	20,0
19			flange neck conical	$L_H > 0$	61,0
20			flange thickness	e_{Ft}	44,0
21			Ø of gasket face	$d_{11} \geq 0$	615,0
22			height of gasket face	$f \geq 0$	4,0
23			counter flange	e^*_{Ft}	44,0
24			gasket thickness	e_{Gt}	2,0
25			gasket internal Ø	d_{G1}	500,0
26			gasket outer Ø	d_{G2}	550,0
27			groove depth	$h \geq 0$	0,0
28			correct		
29			database	rolled thread with shaft	
30			database	manually, competend checked	
31			washer, thickness	$d_{B0} = M$	33
32			clamping length	$U = \sum mm$	4,0
33			shaft length	l_B	94,0
34			shaft Ø	$l_s \geq 0$	72,0
35			effective Ø	d_{Bs}	31,0
36			mean friction coeffic.	d_{Be}	29,70
37			number of bolts	η	0,25
38			available Ø for load capacity d_{Bzul}	$n \geq 4$	20
39			correct		
40	operation parameter / load				
41	name	unit	formular / symbol	data	intern
42	selection of load types to proof	—	database	install.(0), operation stat (1), test stat (2)	
43	max inter. pressure in operation status (1)	N/mm ²	$P_{(1)} \geq - 0,1$	2,20	
44	max internal pressure in test status (2)	N/mm ²	$P_{(2)} \geq 0$	3,10	
45	design temperature		ending 0 or 5	correct	
46	operation temperature	°C	$0 \leq T \leq 650$	165,0	✓
47	bolt: design temperature	°C	$0 \leq T \leq T_{operat.}$	155,0	✓
48	test temperature, no test=0	°C	$10 \leq T \leq 40$	20,0	✓
49	external axial additional loads, torques				
50	installation (0)	N	$F_{compress} < 0$ or $F_{tensile} \geq 0$	0,0	
51	operation status (1)	N	$F_{compress} < 0$ or $F_{tensile} \geq 0$	5.000,0	
52	test status (2)	N	$F_{compress} < 0$ or $F_{tensile} \geq 0$	0,0	
53	torque in operation status (1)	Nmm	$\pm M_{bending}$	350.000,0	
54	correct				
55	safety factor:				
56	operation status (1)	—	$S_{(1)} \geq 1,5$	1,50	
	test status (2)	—	$S_{(2)} = 0$ or $S_{(2)} \geq 1,05$	1,05	
	correct				

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

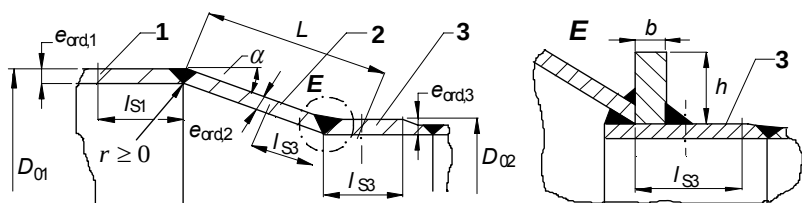
113	name	unit	formular / symbol	data		intern
114	calculation / results	-		flange 1 ≈ flange 2		
115	hole distance	mm	p_B (1)	103,67	103,67	
116	effective hole Ø	mm	d_{5e} (2)	21,21	21,21	
117	effective flange width	mm	b_F (5)	99,79	99,79	
118	effective mean flange Ø	mm	d_F (5)	609,00	609,00	
119	calculation 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	$\beta = e_2 / e_1$	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		N	F_{R0} installation	0		
150		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		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	elasticity under sealing compressing force	mm / N	Y_{Gi} (46)	installation	5,43301E-07	
159		mm / N		test	5,43301E-07	
160		mm / N		operation	5,81488E-07	
161	elasticity under medium presssure force	mm / N	Y_{Qi} (47)	Montage	0	
162		mm / N		installation	6,2088E-07	
163		mm / N		operation	6,61366E-07	
164	elasticity under additional force	mm / N	Y_{Ri} (48)	installation	0	
165		mm / N		test	0	
166		mm / N		operation	5,83712E-07	
						page 3 v 5

167	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		N	$F_{G0req} \leq F_{G0}$	installation	1.000.000		
176	existing pre tension sealing force	N	$F_{B0} \approx F_{G0req}$	installation	correct		
177	checking of gasket parameter	$Q_{min(L)} \leq F_{G0}/A_{Ge} \leq Q_{max,y}$			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	$F_{B0nom} = F_{B0av} \geq 2 F_{B0req}$					
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 / mm ²	f_E	install / test	238,1	238,1	
202		N / mm ²		operation	111,7		
203		-		installation	0,0000	0,0000	
204	auxiliary variables(77)	-	δ_Q δ_R	test	0,1211	0,0000	
205		-		operation	0,2582	0,0015	
207	auxiliary variables(78)	-		installation	1,3330	1,1546	
208		-	C_M	test	1,3147	1,1466	
209		-		operation	1,2473	1,1168	
210	note load capacity for flange-cylinder : correct						
211	auxiliary variables flange	$jM = \text{sign} ()$ (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	auxiliary 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	page 4 v 5						

219	name	unit	formular / symbol		data		intern
220	ψ (j _s , k _M , k _s) j _s = +1; j _s = -1 -1 ≤ k _M ≤ +1 0 ≤ k _s ≤ 1	ψ_{opt} (83)	installation	1,0000			
221			test	1,0000			
222			operation	1,0000			
223		$\psi_{\text{max}} = \psi$ (+1, +1, + 1) (82)	installation	0,51684	0,51684		
224			test	0,45755	0,53760		
225			operation	0,38409	0,55331		
226		$\psi_{\text{min}} = \psi$ (-1, -1, +1) (82)	installation	-0,51684	-0,51684		
227			test	-0,52392	-0,53760		
228			operation	-0,52560	-0,62446		
229		$\psi_0 = \psi$ (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	$\psi_z = \min$ (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			test	194.358.791,7			
242			operation	87.521.807,5			
243	flange slanting position / inclination critical maximum value appr. 0.5°	grd Θ_F E.3	installation	0,2454			
244			operation	0,2660			
245	correct						
246	proof of load bearing capacity bolt, gasket, flange						
247	bolt : degree of utilisation $\Phi \leq 1$	Φ_B (71)	recommended : utilization > 0,3 installation	0,5355			
248			test	0,3253			
249			operation	0,4876			
250	correction bolt correct						
251	gasket : degree of utilisation $\Phi \leq 1$	Φ_G (72)	installation	0,1826			
252			test	0,0323			
253			operation	0,0368			
254	correction gasket correct						
255	flange : degree of utilisation $\Phi \leq 1$	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					

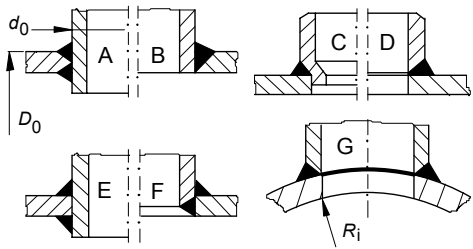
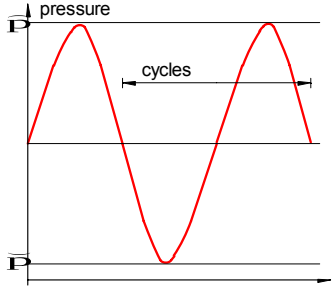
1	Task	external pressure : 3,6 bar superheated steam, double jacket			M 7.2
2	field of application	EN 13480-3: 2002 / 9.3; Appendix G; not valid for creep behavior			
3	literature, source	AD -2000- B6: 2005; EN 13445-3: 2002; FDBR-MB 5-4 / 2004-01			
4	mathematical symbols, units and comments: see red corner triangle are part of computing and shall be considered. To read: move the cursor 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 / cylindrical shell length				
9	Statically effective double wall joint				
10	Circumferential profile with all around welding seam				
11					
12					
13					
14					
15	name	unit	formular / symbol	data	intern
16	design pressure external	N/mm ²	$p \geq 0,1$	0,3600	
17	design temperature in °C	-10 ≤ t ≤ 650	ending 0 or 5	180	
18	material selection: pipe				
19	steel name / R _{p0,2,t} / T / N / S / B /	—	data base	1.0345 / P235GH, Rp0,2 / T ≤ 16	
20	safety factor	—	k ≥ 1,5	1,50	
21	strength value, yield point	N/mm ²	R _{p0,2,t}	177,00	
22	elast.-value:non-austenitic and austenitic	S _{NA} = R _{p0,2,t}	S _A = 0,8·R _{p0,2,t}	177,00	
23	modulus of elasticity	N/mm ²	E _t [*] = C ₀ + t _c ·C ₁ + t _c ² ·C ₂	200.131,0	
24	value confirmed or other value	N/mm ²	E _t ≥ 0,95·E _t [*]	200.130,0	✓
25	material selection: stiffening				
26	steel name / R _{p0,2,t} / T / N / S / B /	—	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/mm ²	R _{p0,2,t}	166,20	
29	elast.-value: non-austenitic and austenitic	S _{NA} = R _{p0,2,t}	S _A = 0,8·R _{p0,2,t}	166,20	
30	modulus of elasticity	N/mm ²	E _t [*] = C ₀ + t _c ·C ₁ + t _c ² ·C ₂	200131,0	
31	value confirmed or other value	N/mm ²	E _t ≥ 0,95·E _t [*]	200.130,0	✓
32	design details				
33	outer Ø: pipe, cylindrical shell	mm	D _o	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	ΣC:Corros./abrasion (wear), tolerance	mm	C _{0,1} ≥ 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 ≥ 3	20,0	
40	bar height, h _{max} = recommended	mm	h _s ≤ h _{max} = 8·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 _o - e _a)	1094,4	
45	buckling number (condition:p _m = min)	—	n ≥ 2	6,0	
46	coefficient	—	Z = π·R _m / L	1,719	
47	critical pressure limit against yielding	N/mm ²	p _y = S·e _a / R _m	1,8114	
48	elastic buckling pressure at failure	N/mm ²	p _m = E _t ·e _a ·ε / 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/mm ²	p _r = p _y ·(table 9.3.2-1)	0,5535	
52	verified external pressure	N/mm ²	p → (k ≥ 1,5) · p	0,360	0,540
53	condition against material buckling press.	N/mm ²	p _r ≥ k·p (9.3.2-5)	0,5535	0,5400
54	max. allowed external pressure ...	N/mm ²	p _{max} note	0,3690	✓
55	between stiffeners	N/mm ²	field of application:U ≤ 1%		
56	correct				

57	name	unit	formular / symbol	data		intern
58	proof against total failure					
59	design pressure external	N/mm ²	$p_{\max}$ 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	I_{ps} (9.3.4-4)	192,21		
63	stiffening area: profil / pipe	mm ²	A_s $A_R = I_{ps} \cdot e_a$	3.200,0	2.152,7	
64	combined stiffening areas	mm ²	A_c	5352,7		
65	coefficient	mm	X_c (9.3.3-6)	57,5528		
67	moment of inertia of combined area	mm ⁴	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/mm ²	p_{ys} (9.3.3-3)	2,304		
70	theoretical elastic buckling pressure	N/mm ²	p_n (9.3.3-1)	3,728		
71	verified safe stiffening	N/mm ²	$k \cdot k_s \cdot p$	0,648		
72	condtion against buckling	N/mm ²	$k \cdot k_s \cdot p \leq p_n$ (9.3.3-2)	0,648	3,728	✓
73	condition of the tension	N/mm ²	$0 \leq \sigma_s \leq S_s$ (9.3.3-7)	112,33	166,20	✓
74	correct					
74	stability of stiffening					
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/mm ²	$4 \cdot p \cdot S_s / p_{ys}$	103,9		
80	buckling tension: lateral buckling	N/mm ²	$\sigma_i = table \cdot E_t / (h_s / e_w)^2$	3.564,8		
81	stability of stiffening	N/mm ²	$\sigma_i > 4 \cdot p \cdot S_s / p_{ys}$	3564,8	103,9	
82	maximum allowed external pressure	N/mm ²	$p_{\max}$	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				
5	reducer under external pressure with stiffener				
6	out of roundness tolerance≤1%, to reference Ø D _{o, max}				
7	The figures are not defining the construction, they are only for indication of necessary dimensions of the calculation.				
8					
9	effective stiffened.				
10	large cylinder / converging cone				
11	with an angle > 10 ° (AD 2000)				
12	stiffening of smaller cylinder part 3...				
13	designed as ring or with increased ...				
14	thickness				
15					
16	name	unit	formular / symbol	data	Intern
17	design pressure external	N/mm ²	p ≥ 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 / B/	—	data base	1.0345 / P235GH, Rp0,2 / T ≤ 16	
21	safety factor	—	k ≥ 1,5	1,50	✓
22	strength value, yield point	N/mm ²	R _{p0,2,t}	177,00	
23	elast.-value: non-austenitic and austenitic	S _{NA} = R _{p0,2,t}	S _A = 0,8·R _{p0,2,t}	177,00	
24	standard proof design stress ..	—, N/mm ²	coefficient: S	1,80	R _p / S 98,33
25	stiffening: rule of interpretat. AD 2000-B2			200.131,0	
26	modulus of elasticity	N/mm ²	E _t [*] = C ₀ + t _c ·C ₁ + t _c ² ·C ₂	200.131,0	
27	value confirmed or other value	N/mm ²	E _t ≥ 0,95·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 ≥ 0	80,00	
31	brim angle, see figure	grd; °	10° ≤ α ≤ 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 ≥ L [*]	700,0	
35	see figure				
36	ΣC:Corros./abrasion (wear), tolerance	mm	C _{0,1} ≥ 0	1,00	✓
37	wall thickness large cylinder, part 1	mm	recommended : e _{ord,1} ≥ 2	8,50	
38	testing: allowed pressure of joint from part 1 + part 2		p _{allow} [*] ≥ p	0,405 > 0,360	✓
39	wall thickness cone shell, part 2	mm	e _{ord,2} ≥ e _{ord,1}	8,50	
40	wall thickness small cylinder, part 3	mm	e _{ord,3} ≥ e _{ord,2}	8,50	✓
41	testing: allowed pressure of joint from part 3 + part 2		p _{allow} [*] ≥ p	0,384 > 0,360	✓
42					correct

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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	$D_m \quad D_{eq} \text{ (9.4.3-1)}$	1900,00	$D_{eq} \text{ (9.4.3-1)}$	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/mm ²	$p_y = S \cdot e_a / R_m$	1,2143			
51	elastic buckling pressure at failure	N/mm ²	$p_m = E_t \cdot e_a \cdot \varepsilon / R_m$	1,2166			
52	pressure ratio (real) / computed value	—	$p_m / p_y \text{ table 9.3.2-1}$	1,0019	table 9.3.2-1	1,0000	
53	stiffness ratio	—	$p_r / p_y \text{ table 9.3.2-1}$	0,5000			
54	lower failure pressure	N/mm ²	$p_r = p_y \cdot (\text{table 9.3.2-1})$	0,6072			
55	verified external pressure	N/mm ²	$p \rightarrow (k \geq 1,5) \cdot p$	0,3600	$k \cdot p$	0,5400	
56	condition against material buckling press.	N/mm ²	$p_r \geq k \cdot p \text{ (9.3.2-5)}$	0,6072	>	0,5400	
57	max. allowed external pressure	N/mm ²	p_{max}	0,3843			
58	under operation or testing conditions		field of application: $U \leq 1\%$	correct			
59	effectivity verification of...	N/mm ²	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 seeE						
62	Rating of effective stiffening of divergent cone - cylinder joint						
63	selected ring stiffener, see figureE						
64	selected profile	—	data base	dimension b x h = 1 : 7			
65	Width of square profile	mm	recommended b ≥ 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 inertia	mm ⁴	$I_{xexist} > I_{xrequired} \text{ (9.4.2-1)}$	1.753.714	>	1.332.138	
69	existing / required cross sectional area	mm ²	$A_{exist} > A_{required}$	1008,0	>	710,4	
70	recommended order wall thickness	mm	$e_{ord,1} \quad e_{ord,2} \quad e_{ord,3}$	8,50	8,50	8,50	
71	constructing effective length	mm	I_{S1}	136,6	I_{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 cursor into the cell					
5	Proof of welded components under alternating loading; approximation					
6	seam construction for cylinder and dished head 					
7	Design conditions: No time dependent tension factors allowed p_{max}, p_{min} = controlling cycle					
8						
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	–	$1 \leq \eta \leq 5$	3,00		
23	operation data: static loads correct					
24	allowed internal design pressure of construction elements	N/mm ²	$p_{c,max} \geq p_{operat}$ $p_{c,max}$ = design pressure	2,20		
25	max. design temperature	°C	$0 \leq t \leq 650$ ending 0 or 5 $t_c = t_{max}$	285		
26	operation data: periodic loads correct					
27	numbers of cycles within same / different window		$N > 1000$	3500		
28	max. range of pressure fluctuation		$(p_{max} - p_{min}) \leq p_{c,max} (min = 0,1)$	2,20		✓
29	min. design temperature	°C	$0 \leq t_{min} \leq t_c$	20		
30	selection of materials: body material correct					
31	steel name /R _{p,t} / T / N / S / B/	–	data base	1.0345 / P235GH, Rp0,2 / T ≤ 16		
32	additional - safety factor	–	$S_z = 1$ or $S_z \geq 1,2$	1,00		
33	strength value, yield point	N/mm ²	$R_{m20^\circ}, R_{p20^\circ}, R_{p0,2,t}, R_{p1,0,t}$	360,00 235,00 137,00		0,00
34	allowed tension	N/mm ²	f_{20°, f_s	150,00		91,33
35	design details: pipeline $U \leq 1,5\%$ correct					
36	outer Ø: pipe, cylindrical shell, head	mm	$D_0 > 10$	508,00		✓
37	guide value: radius head	mm	R_i	508,00		
38	radius: head, no head $R_i = 0$	mm	$R_i \leq D_0$	508,00		
39	ΣC:Corros./abrasion (wear), tolerance	mm	$C_{0,1} \geq 0$	1,00		
40	welding seam factor longitudinal seam	–	$0,8 \leq z \leq 1$	1,00		
41	guide value: min. wall thickness cylinder, head		$e_{ord,cyl}$	0,00	$e_{ord,head}$ 8,65	
42	order wall thickness	mm	recomm. : $e_{ord} \geq 2$	10,00		✓
43	interposed neck correct					
44	strenght ratio: neck / cylindrical shell	mm/mm	recomm. $0,8 \leq f_b/f_s \leq 1$	1,00		✓
45	outer Ø: neck	mm	d_0	273,00		
46	ΣC:Corros./abrasion (wear), tolerance	mm	$C_{0,1} \geq 0$	1,00		
47	welding seam rating longitudinal seam	–	$0,8 \leq z \leq 1$	1,00		
48	guide value: min. wall thickness neck	mm	$e_{ord,min}$	4,25		
49	order wall thickness: neck	mm	recomm. : $e_{ord,b} \geq 2$	8,00		
50	guide value: min. effective neck lenght	mm	l_b^*	43,15		
51	effective neck lenght	mm	$l_b \geq l_b^*$	50,00		
52	neck inserted through	mm	$l_{b,i} \geq 0$	0,00		
53	guide value: unhindered, clear width neck	mm	$L_R^* [mm]$	95,62		
54	clear width / lenght at neck	mm	recomm. $L_R \geq 0,8 \cdot L_R^*$	100,00		
55	correct					

58	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/mm ²	$(p_{\max} - p_{\min})$		2,20		
64	<u>guide value: allowed substitute pressure</u>	N/mm ²	$p_r^* \quad p_c$	2,99	>	2,20	
65	value confirmed or other value p_r	N/mm ²	$p_r^* \geq p_r \geq p_c$	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/mm ²	$2 \cdot \sigma_a$ 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						