
ASME BPVC Section VIII Division 1 2013 Edition Appendix 2 によるフランジの強度計算及びサイジング プログラムです. 計算対応フランジは次のタイプです.

(1) インテグラル タイプ フランジ: FIG. 2-4 (5), (6)
(2) ルース タイプ フランジ : FIG. 2-4 (2), (3)

以下にサンプル アウトプットを添付しています. プログラムの仕様, 試用版の提供, サイジング方法のカスタマイズ等のお問い合わせは naoki@naoki.co.jp に連絡ください.

〈終〉

Item No.: ChkIntFlg
Doc. No.:
Page No.:

Integral Flange

INTEGRAL TYPE FLANGES UNDER INTERNAL PRESSURE

According to APPENDIX 2 of ASME BPVC Sec. VIII Div. 1, 2013 Edition

design condition				bolting calculations		
internal design pressure	P	0.590 MPa	W_{m2}	$3.14bGy+b_r r_\ell y'$	470225.861 N
design temperature		82.000 °C	H_p	$2P(3.14bGm+b_r r_\ell m')$	115117.535 N
ambient temperature		20.000 °C	H	$0.785G^2P$	260116.922 N
corrosion allowance	c	3.200 mm	W_{m1}	$H+H_p$	375234.456 N
material for flange		SA-266MGr4	W_g	$0.5(A_m+A_b)S_a$	772428.624 N
material for nozzle neck		SA-516MGr415	A_{m2}	W_{m2}/S_a	2728.161 mm^2
material for bolt		SA-193MGrB7	A_{m1}	W_{m1}/S_b	2177.039 mm^2
allowable flange stress: design temp.	S_{fb}	138.000 MPa	A_m	greater of A_{m1} or A_{m2}	2728.161 mm^2
allowable flange stress: ambient temp.	S_{fa}	138.000 MPa	A_b	194.838 × 32	6234.807 mm^2
allowable neck stress: design temp.	S_{nb}	117.900 MPa		W_{m1}, W_{m2} for flange pairs used to contain a tube-sheet, use the larger of W_{m1}, W_{m2} for each flange	
allowable neck stress: ambient temp.	S_{na}	117.900 MPa			
allowable bolt stress: design temp.	S_b	172.360 MPa	W_{m1}	for pair flange	0.000 N
allowable bolt stress: ambient temp.	S_a	172.360 MPa	W_{m2}	for pair flange	0.000 N

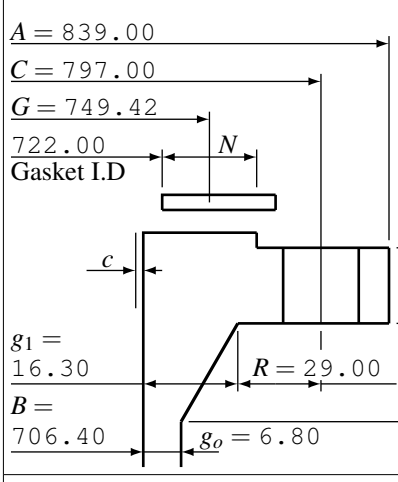
gasket and facing detail

peripheral gasket: GARLOCK #3500				pass partition gasket:			
m	5.000	y	24.100 MPa	m'		y'	MPa
N	22.000 mm	b_o	11.000 mm	b_r	mm	r_ℓ	mm
b	$2.5\sqrt{b_o}$		8.292 mm	b_r = effective seating width of pass partition rib(s)			
min. gasket width $=A_bS_a/(2y\pi G)$			9.47 mm	r_ℓ = total length of pass partition rib(s)			(*1)

moment calculations

flange loads		N	lever arms		mm	flange moments		N-mm
operating condition								
H_D	$0.785B^2P$	231112.295	h_D	$R+0.5g_1$	37.15	M_D	H_Dh_D	8585822
H_G	$W_{m1}-H$	115117.535	h_G	$(C-G)/2$	23.79	M_G	H_Gh_G	2738826
H_T	$H-H_D$	29004.627	h_T	$(R+g_1+h_G)/2$	34.55	M_T	H_Th_T	1001987
						M_o	$M_D+M_G+M_T$	12326635
gasket seating								
H_G	W_g	772428.624	h_G	$(C-G)/2$	23.79	M_g	W_gh_G	18377283

bolt spacing				corrected moments		
$B_s=C\sin(\pi/n)$	78.12 mm	$B_{SC}=\sqrt{B_s/(2a+t)}$		M_o	M_oB_{SC}	12742834
$B_{smax}=2a+6t/(m+0.5)$	76.28 mm	(min. 1)	1.03	M_g	M_gB_{SC}	18997778



bolting data
size: U 3/4
no. of bolts
$n=32$
nominal diameter
$a=19.05$

dimensions in mm

flange factors			
$K=A/B$	1.1877	g_1/g_o	2.3971
T	1.8439	h/h_o	0.6926
Z	5.8702	F	0.7713
Y	11.3772	V	0.1490
U	12.5024	f (min. 1)	1.0536
$h_o=\sqrt{Bg_o}$		69.3074 mm	
$e=F/h_o$		0.0111 mm^{-1}	
$d=(U/V)h_og_o^2$		268924 mm^3	
$\alpha=te+1$		1.3895	
$\beta=1.33te+1$		1.5180	
$L=\alpha/T+t^3/d$		0.9130	
$B_1=B$		706.4000 mm	
for B_1, APPENDIX 2-3 is not considered.			

stress calculation at operating			MPa	stress calculation at gasket seating			MPa
S_H	$fM_o/(Lg_1^2B_1)$	$78.35 \le 1.5S_{fb}=$	207.00	S_H	$fM_g/(Lg_1^2B_1)$	$116.81 \le 1.5S_{fa}=$	207.00
		$78.35 \le 2.5S_{nb}=$	294.75			$116.81 \le 2.5S_{na}=$	294.75
S_R	$\beta M_o/(Lt^2B)$	$24.48 \le S_{fb}=$	138.00	S_R	$\beta M_g/(Lt^2B)$	$36.50 \le S_{fa}=$	138.00
S_T	$YM_o/(t^2B)-ZS_R$	$23.81 \le S_{fb}=$	138.00	S_T	$YM_g/(t^2B)-ZS_R$	$35.50 \le S_{fa}=$	138.00
	$(S_H+S_R)/2$	$51.42 \le S_{fb}=$	138.00		$(S_H+S_R)/2$	$76.66 \le S_{fa}=$	138.00
	$(S_H+S_T)/2$	$51.08 \le S_{fb}=$	138.00		$(S_H+S_T)/2$	$76.16 \le S_{fa}=$	138.00

flange rigidity at operating per APPENDIX 2-14			flange rigidity at gasket seating per APPENDIX 2-14		
E	modulus of elasticity	198960.00 MPa	E	modulus of elasticity	202350.00 MPa
K_I	rigidity factor	0.30	K_I	rigidity factor	0.30
J	$52.14VM_o/(LEg_o^2K_Ih_o)$	$0.57 \le 1.0$	J	$52.14VM_g/(LEg_o^2K_Ih_o)$	$0.83 \le 1.0$

(*1) according to TEMA.

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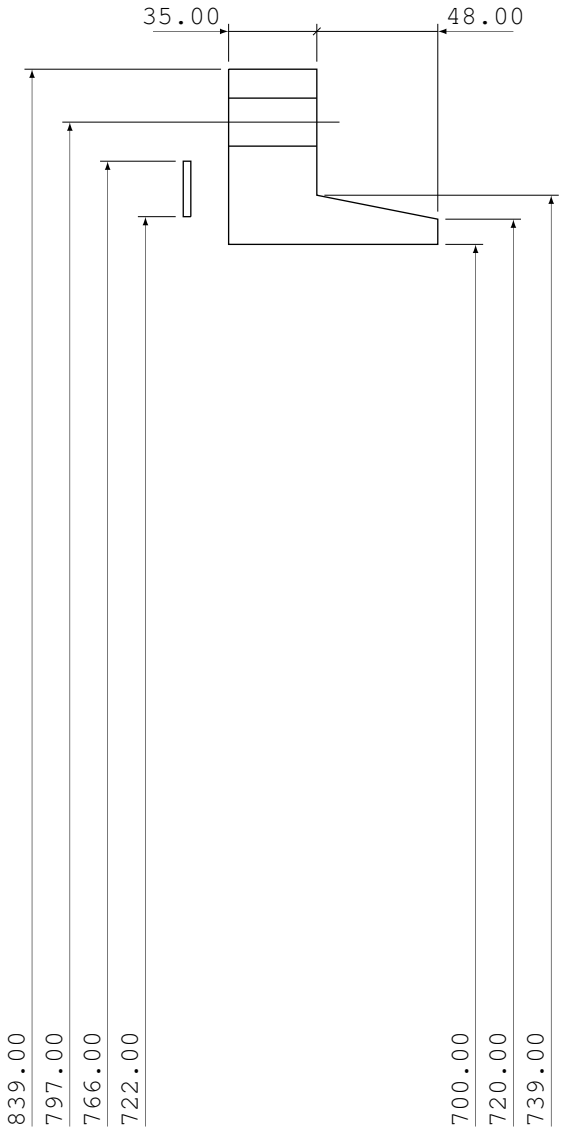
Design is acceptable

Integral Flange

INTEGRAL TYPE FLANGES

According to APPENDIX 2 of ASME BPVC Sec. VIII Div. 1, 2013 Edition



Approximate Mass: 55.3 kg

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Item No.: ChkIntFlg
Doc. No.:
Page No.:

Integral Flange

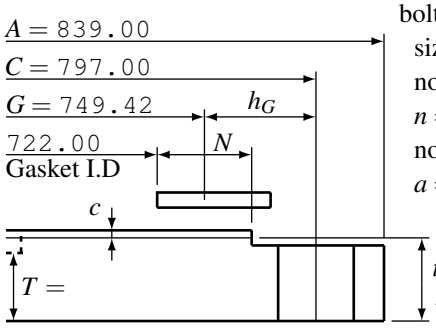
UNSTAYED FLAT HEADS AND COVERS

According to UG-34 (c) of ASME BPVC Sec. VIII Div. 1, 2013 Edition

design condition				bolting calculations		
internal design pressure		P	0.590 MPa	W_{m2}	$3.14bGy+b_r r_\ell y'$	470225.861 N
design temperature			82.000 °C	H_p	$2P(3.14bGm+b_r r_\ell m')$	115117.535 N
ambient temperature			20.000 °C	H	$0.785G^2P$	260116.922 N
corrosion allowance		c	3.200 mm	W_{m1}	$H+H_p$	375234.456 N
material for cover		SA-266MGr4		W_g	$0.5(A_m+A_b)S_a$	772428.624 N
material for bolt		SA-193MGrB7		A_{m2}	W_{m2}/S_a	2728.161 mm^2
allowable	design temp.	S_{fb}	138.000 MPa	A_{m1}	W_{m1}/S_b	2177.039 mm^2
cover stress	ambient temp.	S_{fa}	138.000 MPa	A_m	greater of A_{m1} or A_{m2}	2728.161 mm^2
allowable	design temp.	S_b	172.360 MPa	A_b	194.838 × 32	6234.807 mm^2
bolt stress	ambient temp.	S_a	172.360 MPa			

gasket and facing detail

peripheral gasket: GARLOCK #3500				pass partition gasket:			
m	5.000	y	24.100 MPa	m'		y'	MPa
N	22.000 mm	b_o	11.000 mm	b_r	mm	r_ℓ	mm
b	$2.5\sqrt{b_o}$		8.292 mm	b_r = effective seating width of pass partition rib(s)			
min. gasket width $= A_b S_a/(2y\pi G)$			9.47 mm	r_ℓ = total length of pass partition rib(s)			(*1)



bolting data
size: U 3/4
no. of bolts
$n = 32$
nominal diameter
$a = 19.05$

dimensions in mm

minimum required thickness

for operating condition
$t = d\sqrt{CP/SE+1.9Wh_G/SEd^3} =$ 29.738 mm
where, $d = G$, $C = 0.3$, $S = S_{fb}$, $E = 1$, $W = W_{m1}$

for gasket seating
$t = d\sqrt{1.9Wh_G/SEd^3} =$ 18.375 mm
where, $d = G$, $S = S_{fa}$, $E = 1$, $W = W_g$

flat channel cover deflection (*1)

modulus of elasticity for cover material at design temperature, $E =$ MPa

recommended limit for channel cover deflection mm
(0.8 mm for nominal diameter thru 610 mm, 0.125% of nominal diameter for large sizes)

flat channel cover deflection, $Y = \dfrac{G}{ET^3}(0.0435G^3P+0.5S_bA_bh_G) =$ mm

(*1) according to TEMA.

Design is acceptable

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Item No.: ChkSOHFlg
Doc. No.:
Page No.:

Loose Flange With Hub

LOOSE TYPE FLANGES WITH HUB UNDER INTERNAL PRESSURE
According to APPENDIX 2 of ASME BPVC Sec. VIII Div. 1, 2013 Edition

design condition				bolting calculations		
internal design pressure	P	1.569 MPa	W_{m2}	$3.14bGy+b_r r_\ell y'$	145845.280 N
design temperature		205.000 °C	H_p	$2P(3.14bGm+b_r r_\ell m')$	83362.930 N
ambient temperature		20.000 °C	H	$0.785G^2P$	256466.511 N
corrosion allowance	c	0.000 mm	W_{m1}	$H+H_p$	339829.441 N
material for flange	Unknown		W_g	$0.5(A_m+A_b)S_a$	389606.468 N
material for nozzle neck	Unknown		A_{m2}	W_{m2}/S_a	1487.307 mm^2
material for bolt	Unknown		A_{m1}	W_{m1}/S_b	3465.526 mm^2
allowable flange stress: design temp.	S_{fb}	110.810 MPa	A_m	greater of A_{m1} or A_{m2}	3465.526 mm^2
allowable flange stress: ambient temp.	S_{fa}	110.810 MPa	A_b	280.048 × 16	4480.762 mm^2
allowable neck stress: design temp.	S_{nb}	MPa	W_{m1}, W_{m2} for flange pairs used to contain a tube-sheet, use the larger of W_{m1}, W_{m2} for each flange		
allowable neck stress: ambient temp.	S_{na}	MPa			
allowable bolt stress: design temp.	S_b	98.060 MPa	W_{m1}	for pair flange	0.000 N
allowable bolt stress: ambient temp.	S_a	98.060 MPa	W_{m2}	for pair flange	0.000 N

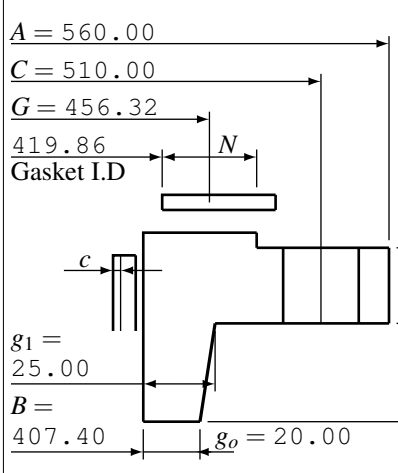
gasket and facing detail

peripheral gasket: Unknown				pass partition gasket:			
m	2.000	y	10.980 MPa	m'		y'	MPa
N	27.500 mm	b_o	13.750 mm	b_r	mm	r_ℓ	mm
b	$2.5\sqrt{b_o}$		9.270 mm	b_r = effective seating width of pass partition rib(s)			
	min. gasket width $=A_bS_a/(2y\pi G)$		13.96 mm	r_ℓ = total length of pass partition rib(s)			(*1)

moment calculations

flange loads		N	lever arms		mm	flange moments		N-mm
operating condition								
H_D	$0.785B^2P$	204425.303	h_D	$(C-B)/2$	51.30	M_D	H_Dh_D	10487018
H_G	$W_{m1}-H$	83362.930	h_G	$(C-G)/2$	26.84	M_G	H_Gh_G	2237482
H_T	$H-H_D$	52041.208	h_T	$(h_D+h_G)/2$	39.07	M_T	H_Th_T	2033256
						M_o	$M_D+M_G+M_T$	14757756
gasket seating								
H_G	W_g	389606.468	h_G	$(C-G)/2$	26.84	M_g	W_gh_G	10457134

bolt spacing				corrected moments		
$B_s=C\sin(\pi/n)$	99.50 mm	$B_{SC}=\sqrt{B_s/(2a+t)}$		M_o	M_oB_{SC}	16885600
$B_{smax}=2a+6t/(m+0.5)$	120.80 mm	(min. 1)	1.14	M_g	M_gB_{SC}	11964894



dimensions in mm

bolting data
size: M 22
no. of bolts
$n=16$
nominal diameter
$a=22.00$

flange factors			
$K=A/B$	1.3746	g_1/g_o	1.2500
T	1.7653	h/h_o	0.2437
Z	3.2486	F_L	3.1397
Y	6.2643	V_L	8.9951
U	6.8838	f	1.0000
$h_o=\sqrt{Bg_o}$		90.2663 mm	
$e=F_L/h_o$		0.0348 mm^{-1}	
$d=(U/V_L)h_og_o^2$		27632 mm^3	
$\alpha=te+1$		2.1130	
$\beta=1.33te+1$		2.4804	
$L=\alpha/T+t^3/d$		2.3829	
$B_1=B$		407.4000 mm	
for B_1, APPENDIX 2-3 is not considered.			

stress calculation at operating			MPa
S_H	$fM_o/(Lg_1^2B_1)$	$27.83 \le 1.5S_{fb}=$	166.22
S_R	$\beta M_o/(Lt^2B)$	$42.13 \le S_{fb}=$	110.81
S_T	$YM_o/(t^2B)-ZS_R$	$116.68 > S_{fb}=$	110.81
	$(S_H+S_R)/2$	$34.98 \le S_{fb}=$	110.81
	$(S_H+S_T)/2$	$72.26 \le S_{fb}=$	110.81

stress calculation at gasket seating			MPa
S_H	$fM_g/(Lg_1^2B_1)$	$19.72 \le 1.5S_{fa}=$	166.22
S_R	$\beta M_g/(Lt^2B)$	$29.85 \le S_{fa}=$	110.81
S_T	$YM_g/(t^2B)-ZS_R$	$82.68 \le S_{fa}=$	110.81
	$(S_H+S_R)/2$	$24.79 \le S_{fa}=$	110.81
	$(S_H+S_T)/2$	$51.20 \le S_{fa}=$	110.81

flange rigidity at operating per APPENDIX 2-14			flange rigidity at gasket seating per APPENDIX 2-14		
E	modulus of elasticity	179840.00 MPa	E	modulus of elasticity	202350.00 MPa
K_L	rigidity factor	0.20	K_L	rigidity factor	0.20
J	$52.14V_LM_o/(LEg_o^2K_Lh_o)$	$2.56 > 1.0$	J	$52.14V_LM_g/(LEg_o^2K_Lh_o)$	$1.61 > 1.0$

(*1) according to TEMA.

Design is NOT acceptable

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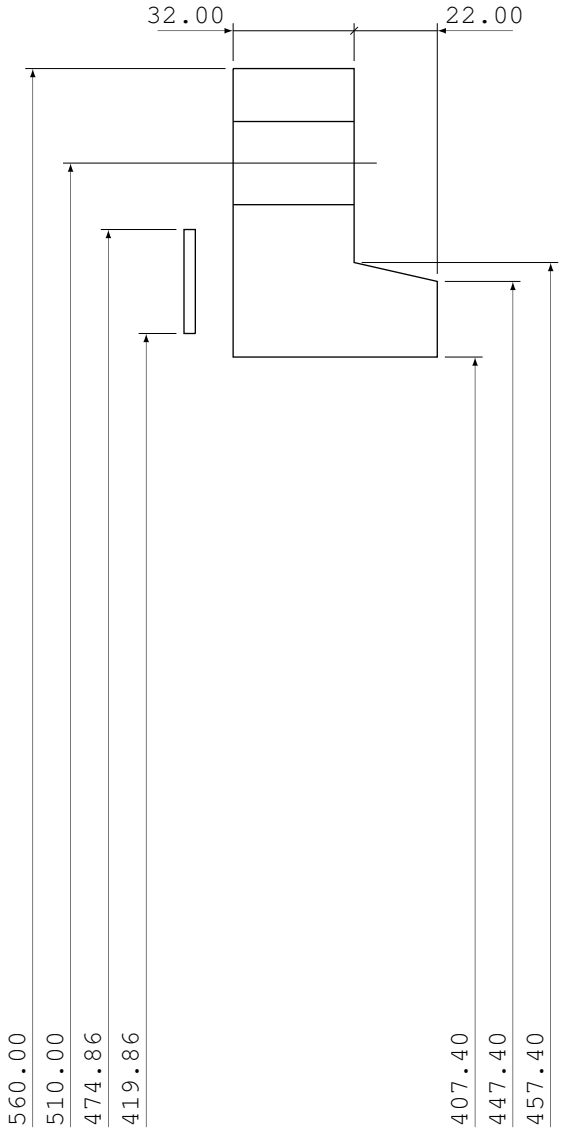
Loose Flange With Hub

LOOSE TYPE FLANGES WITH HUB

According to APPENDIX 2 of ASME BPVC Sec. VIII Div. 1, 2013 Edition



Approximate Mass: 32.4 kg

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Item No.: ChkSOPFlg
Doc. No.:
Page No.:

Loose Flange Without Hub

LOOSE TYPE FLANGES WITHOUT HUB UNDER INTERNAL PRESSURE
According to APPENDIX 2 of ASME BPVC Sec. VIII Div. 1, 2013 Edition

design condition				bolting calculations		
internal design pressure		P	0.098 MPa	W_{m2}	$3.14bGy+b_r r_\ell y'$	181332.352 N
design temperature			90.000 °C	H_p	$2P(3.14bGm+b_r r_\ell m')$	6462.026 N
ambient temperature			20.000 °C	H	$0.785G^2P$	33925.139 N
corrosion allowance		c	1.600 mm	W_{m1}	$H+H_p$	40387.165 N
material for flange		SA-181Gr60		W_g	$0.5(A_m+A_b)S_a$	203453.840 N
material for nozzle neck		SA-283MGrC		A_{m2}	W_{m2}/S_a	3758.963 mm^2
material for bolt		SA-370GrB		A_{m1}	W_{m1}/S_b	837.213 mm^2
allowable	design temp.	S_{fb}	103.360 MPa	A_m	greater of A_{m1} or A_{m2}	3758.963 mm^2
flange stress	ambient temp.	S_{fa}	103.360 MPa	A_b	194.838 × 24	4676.105 mm^2
allowable	design temp.	S_{nb}	MPa	W_{m1}, W_{m2} for flange pairs used to contain a tube-sheet, use the larger of W_{m1}, W_{m2} for each flange		
neck stress	ambient temp.	S_{na}	MPa			
allowable	design temp.	S_b	48.240 MPa	W_{m1}	for pair flange	0.000 N
bolt stress	ambient temp.	S_a	48.240 MPa	W_{m2}	for pair flange	0.000 N

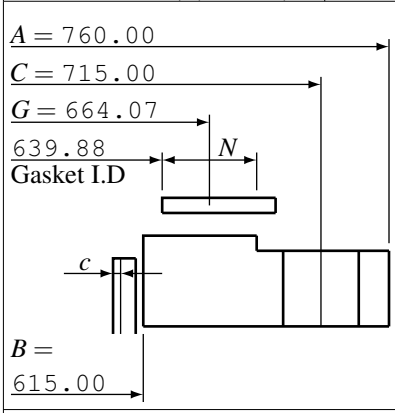
gasket and facing detail

peripheral gasket: GARLOCK #3500				pass partition gasket:			
m	2.000	y	11.000 MPa	m'		y'	MPa
N	20.000 mm	b_o	10.000 mm	b_r	mm	r_ℓ	mm
b	$2.5\sqrt{b_o}$		7.906 mm	b_r = effective seating width of pass partition rib(s)			
	min. gasket width $=A_bS_a/(2y\pi G)$		4.91 mm	r_ℓ = total length of pass partition rib(s)			(*1)

moment calculations

flange loads		N	lever arms		mm	flange moments		N-mm
operating condition								
H_D	$0.785B^2P$	29096.849	h_D	$(C-B)/2$	50.00	M_D	H_Dh_D	1454842
H_G	$W_{m1}-H$	6462.026	h_G	$(C-G)/2$	25.47	M_G	H_Gh_G	164560
H_T	$H-H_D$	4828.290	h_T	$(h_D+h_G)/2$	37.73	M_T	H_Th_T	182185
						M_o	$M_D+M_G+M_T$	1801588
gasket seating								
H_G	W_g	203453.840	h_G	$(C-G)/2$	25.47	M_g	W_gh_G	5181093

bolt spacing				corrected moments		
$B_s=C\sin(\pi/n)$	mm	$B_{SC}=\sqrt{B_s/(2a+t)}$		M_o	M_oB_{SC}	1801588
$B_{smax}=2a+6t/(m+0.5)$	mm	(min. 1)	1.00	M_g	M_gB_{SC}	5181093



bolting data
size: U 3/4
no. of bolts
$n=24$
nominal diameter
$a=19.05$

dimensions in mm

flange factors			
$K=A/B$	1.2358	Y	9.2935

stress calculation at operating			MPa	stress calculation at gasket seating			MPa
S_T	$YM_o/(t^2B)$	$30.25 \le S_{fb} =$	103.36	S_T	$YM_g/(t^2B)$	$86.99 \le S_{fa} =$	103.36
minimum required flange thickness at operating				minimum required flange thickness at gasket seating			
t_r	$\sqrt{YM_o/(S_{fb}B)}$	16.23 mm		t_r	$\sqrt{YM_g/(S_{fa}B)}$	27.52 mm	
flange rigidity at operating per APPENDIX 2-14				flange rigidity at gasket seating per APPENDIX 2-14			
E	modulus of elasticity	MPa		E	modulus of elasticity	MPa	
K_L	rigidity factor			K_L	rigidity factor		
J	$109.4M_o/(Et^3K_L\ln K)$			J	$109.4M_g/(Et^3K_L\ln K)$		

(*1) according to TEMA.

Design is acceptable

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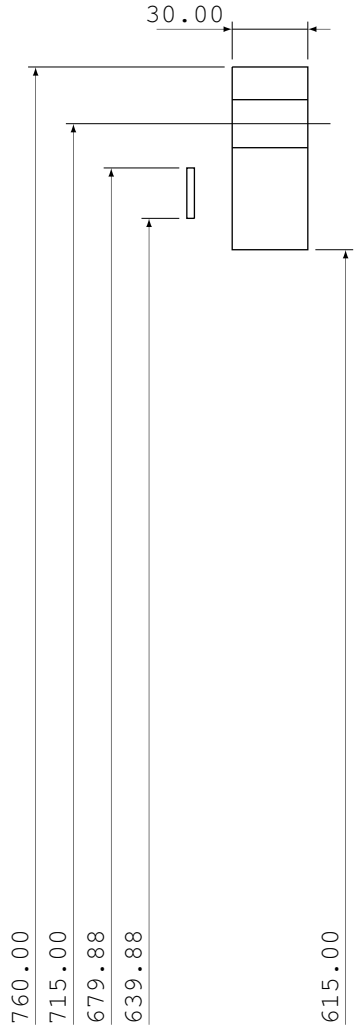
Loose Flange Without Hub

LOOSE TYPE FLANGES WITHOUT HUB

According to APPENDIX 2 of ASME BPVC Sec. VIII Div. 1, 2013 Edition



Approximate Mass: 34.7 kg

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