

DESIGN OF FLANGES
FOR
FULL FACE GASKETS

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DESIGN OF FLANGES FOR FULL FACE GASKETS

The Rules for Bolted Flanged Connections of the ASME Unfired Pressure Vessel Code cover only ring gasket types, i.e., types having the gasket entirely within the bolt holes. For flanges using full face gaskets the Rules simply recommend that they be designed in accordance with good engineering practice.

Several approaches to the problem are currently employed. Until such time as the Code actually establishes a design procedure, the following method may be used for safe construction. This method is a slight modification (see footnote) of that originally suggested by D. B. Rossheim and is recommended because it follows the framework and the terminology of the Code Rules and provides for simplicity of calculation.

To use it, the following assumptions must be made:

It is assumed that full fixation at the bolt circle is produced during bolting up, prior to the application of the internal pressure load; the inner edge of the flange in this condition is assumed unrestrained, so that the reaction of the outer gasket is determined from static equilibrium about the bolt circle as follows:

$$(\text{outside gasket reaction}) = \frac{h_G}{h'_G} \times (\text{inside gasket reaction});$$

where the inside gasket reaction is defined as either H_{Gp} or H_{Gy} in accordance with the Code, and the outside gasket reaction is symbolized by H'_{Gp} or H'_{Gy} .

The total required bolt load then is obtained as the greater of the following two values:

$$W_P = H + H_{Gp} \left(1 + \frac{h_G}{h'_G}\right) = H + H_{Gp} + H'_{Gp}$$

$$W_y = H_y \left(1 + \frac{h_G}{h'_G}\right) = H_y + H'_{Gy}$$

Note: Mr. Rossheim's original proposal was made in 1943. The modifications included herein are primarily for the purpose of bringing it into accord with the latest code rules in so far as it is possible.

With the reactions thus determined, the flange can now be calculated like any other flange including the internal pressure load; it will be noted, however, that the sum of the inside and outside gasket moments equals zero, and accordingly the applied moment becomes:

$$M_O = M_D + M_T$$

There is one difference, however, as compared with regular flange design. In the case of a ring gasket, the moment remains of the same sign throughout, while in the case of a full-face gasket a moment reversal occurs. Since the moment $M_G = H_G h_G$ may be greater than the moment M_O given above, an additional check of the radial bending stress at the bolt center line will be required:

$$S'_R = \frac{6M_G}{\pi t^2 C}$$

In this formula the ring effect and the reduction in section caused by the bolt holes have been neglected; the latter procedure is quite defensible, since the moment at this location may be expected to be lower than calculated.

Method of Solution

Design in accordance with the Rules for Bolted Flange Connections, Par. UA-45 to UA-51 of the 1950 Edition of Section VIII, Unfired Pressure Vessels, of the ASME Boiler Code with the following modifications:

The gasket contact area shall be divided into two parts by the bolt circle. The inner gasket reaction shall be determined as the larger of H_{Gp} and H_{Gy} as given in Par. UA-47; the outer gasket reaction shall be taken as the larger of

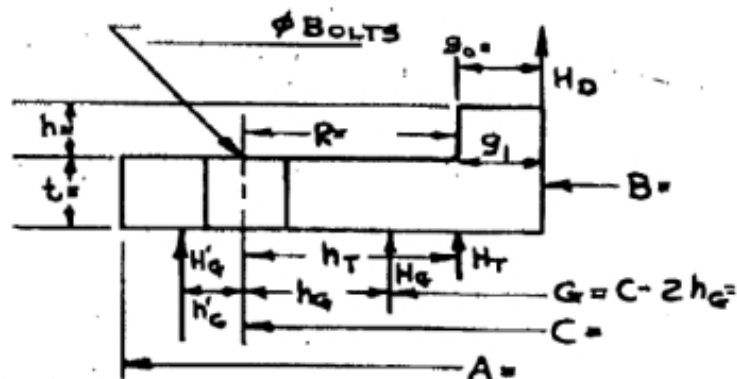
$$\frac{h_G}{h'_G} \times H_{Gp} \text{ or } \frac{h_G}{h'_G} \times H_{Gy}$$

where: h_G and h'_G represent the moment arms of the resultant gasket reactions with respect to the bolt circle.

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DESIGN CONDITIONS

OPERATING PRESSURE		$p =$
OPERATING TEMP.		
ATMOSPHERIC TEMP.		
FLANGE MATERIAL		
BOLTING MATERIAL		
ALLOWABLE BOLT STRESS	OPER. TEMP.	$S_{op} =$
	ATM. TEMP.	$S_{ATM} =$
ALLOWABLE FLANGE STRESS	OPER. TEMP.	$S_{FOC} =$
	ATM. TEMP.	$S_{FA} =$



ALL DIMENSIONS SHOWN IN CORRODED CONDITION

GASKET AND BOLTING CALCULATIONS

GASKET & FACING DETAILS		FROM SHEET B	$y =$ $m =$	$b = (C-B)/4$ $=$ $=$
GASKET LEVER ARMS	$h_G = \frac{(C-B)(2B+C)}{6(B+C)} =$		$h'_G = \frac{(A-C)(2A+C)}{6(C+A)} =$	$G = C - 2h_G$ $=$
GASKET REACTIONS	$H_{Gy} = b \pi G_y =$		$H'_{Gy} = \frac{h_G}{h'_G} H_{Gy} =$	
	$H_{Gp} = 2b \pi G_{mp} =$		$H'_{Gp} = \frac{h_G}{h'_G} H_{Gp} =$	
BOLT LOADS	$H = \frac{G^2 \pi P}{4} =$		$H_D = \frac{B^2 \pi P}{4} =$	$H_T = H - H_D =$
	$W_p = H + H_{Gp} + H'_{Gp} =$		$W_y = H_{Gy} + H'_{Gy} =$	$W_m = \text{GREATER OF } W_p \text{ OR } W_y =$
	$W_a =$	(MUST BE GREATER THAN W_m)	$W = \frac{W_m + W_a}{2} =$	

FLANGE MOMENTS

LEVER ARMS	$h_o = R + g_i =$	$h_T = .5(R + g_i + h_G) =$	$M = \frac{M_o}{B} =$
MOMENTS	$M_o = M_D + M_T = H_D h_o + H_T h_T =$		

SHAPE CONSTANTS

SHAPE CONSTANTS				t (ASSUMED)			
K = A/B =		h ₀ = $\sqrt{Bg_0}$ =		$\alpha = te + 1$			
FROM FIG. I OR FIG. Ia	T =	h/h ₀ =		$\beta = \frac{4}{3}te + 1$			
	Z =	FROM	F _L =	$\gamma = \alpha/T$			
	Y =	FIG. III	V _L =				
	U =	e = F _L /h ₀ =			$\delta = t^3/d$		
g ₁ /g ₀ =		d = $\frac{4}{3}h_0 g_1 =$		$\lambda = \gamma + \delta$			

STRESS CALCULATIONS

ALLOWABLE	STRESS CALCULATIONS			
1.5 S _{FO}	LONGITUDINAL HUB STRESS, $S_H = M/\lambda g_1^2$			
S _{FO}	RADIAL FLANGE STRESS, $S_R = \beta M/\lambda t^2$			
S _{FO}	TANGENTIAL FLANGE STRESS, $S_T = (MY/t^2) - ZS_R$			
S _{FO}	GREATER OF .5 (S _H + S _R) OR .5 (S _H + S _T)			

CHECK OF RADIAL BENDING STRESS AT BOLT CENTERLINE

REVERSE MOMENT	$M_G = H_G h_G = (W-H)/[\frac{1}{h_G} + \frac{1}{h_{CG}}] =$			
ALLOWABLE = S_{FE}	RADIAL STRESS AT BOLT ϵ , $S_R = 6 M_G / \pi t^2 c$			

DATE _____

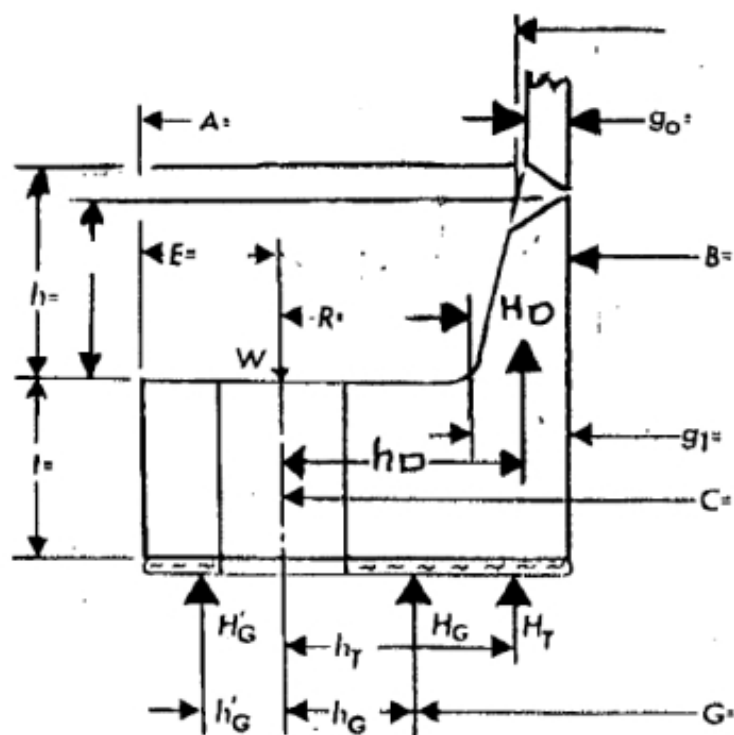
COMPUTED

CHECKED

Revised.

SHEET F

Computed _____ Date _____
Checked _____ Number _____



4 Bolts