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## INTEGRAL FLANGE DESIGN PROGRAM

By

John F. Wilson

March 1974



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16. Abstract  This paper describes an automated "interactive" flange design program utilizing an electronic desk top calculator. The design equations are from the ASME Boiler and Pressure Vessel Code, Section VIII. The program calculates the operating and seating stresses for circular flanges of the integral or optional type subjected to internal pressure. The required input information is documented. The program provides an automated procedure for computing stresses in selected flange geometries for comparison to the allowable code values.					
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## SUMMARY

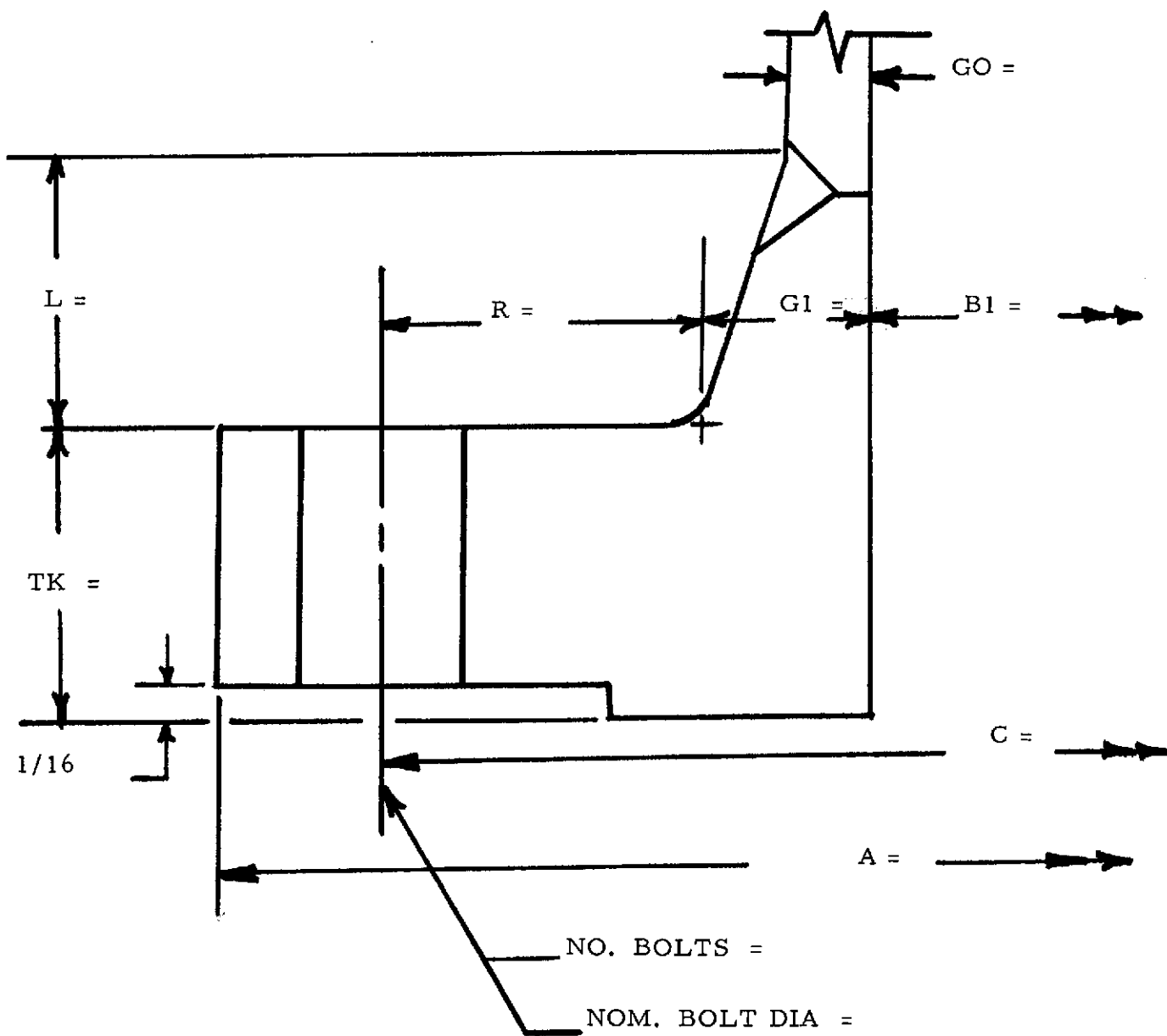
The flange design methods in this program are applicable to circular flanges under internal pressure. The gaskets must be entirely within the bolt circle and the outer rims of the flanges must not touch under the applied loading. This paper presents an automated design solution to integral and optional type flanges using the methods in the 1971 edition of the ASME Boiler and Pressure Vessel Code, Section VIII, Division I, Appendix II, pages 210-221 (reference 1).

The program calculates the stresses associated with a given geometry and prints the required flange thickness to assure that the working stresses are within the allowed code values. It is the responsibility of the designer to be sure the geometry conforms to code requirements such as maximum hub taper, maximum bolt spacing, number of bolts and size of bolts, as well as allowable materials and material properties.

The program was written for use with the Hewlett-Packard Model 9810A Calculator and programmed using their operating manuals (reference 2).



### INTEGRAL FLANGE GEOMETRY



## PRESSURE VESSEL CONSTRUCTION

### FACINGS AND GASKETS

(Reference 3)

Suggestions as to the choice of facing and type of gasket to suit particular applications and service conditions are not covered in this Manual. Pressure, temperature, thermal shock, cyclic operation and the fluid handled are all factors to be considered. All sections of the American National Standard Code for Pressure Piping (ANSI B31) contain rules for flange facings and gaskets and these serve as valuable guides. Reference should also be made to American National Standard ANSI B16.5, covering "Steel Pipe Flanges and Flanged Fittings". This Standard provides facing dimensions for flanges in the 150 lb. through 2500 lb. classes in sizes through 24" and also refers to gasketing. Similar data for sizes 12" through 36" in classes 150, 300, 400, 600 and 900 lb. is given in the Manufacturers Standardization Society's Standard Practice MSS SP-44.

Flange facings may be classified as (1) those sealed by pressure on the gasket from bolt loading and (2) those sealed by self equalizing gaskets that function by internal fluid pressure. The first group includes raised and flat faces where the gasket is restrained only by loading. The gasket is confined in a recess when Male and Female, Tongue and Groove, and Ring Joint are used. Such facings provide greater unit pressure and offer more protection against blow-out.

Raised Face Gaskets for raised faces may extend to the inner edge of the bolt holes for centering control. The O.D. of the raised face may extend to the same point at the option of the designer, but because of machining tolerances, it is advisable to keep it smaller. The gasket O.D. for design purposes is equal to the O.D. of the raised face. Spiral Wound gaskets work best when the O.D. of the gasket is slightly smaller than the O.D. of the raised face. They should be provided with a compression and centering guide to insure proper location.

The gasket need not cover the entire width of the raised face as this requires additional bolt load. For certain corrosive services, locating the gasket 1/8" from the flange I.D. helps protect the flange face.

Male and Female In this type of joint the O.D. of the gasket is the same as that of the male face. The female facing is made larger than the male face to receive the gasket and provide interlock.

Tongue and Groove For this type of facing the width of the gasket is made equal to the width of the tongue, which, for clearance purposes, is narrower than the groove. The joint proportions are shown in Figure 1c, page 6. The detail shows a "nubbin". This is used to reduce the effective seating width of the gasket.

Ring Joint Suggested minimum edge distances are shown in Figure 1g. For reasons of economy and sound design, it is recommended that grooves for ring type joints conform with ANSI or MSS Standards whenever possible. ANSI B16.5 and B16.20 cover sizes through 24" and MSS SP-44 covers sizes 26" through 36". In larger sizes the configuration and proportions of the groove should follow those established by these Standards.

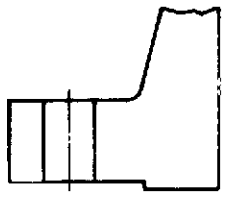
It should be noted that neither Standard refers to rounded-bottom grooves. Unless otherwise specified, flat bottom grooves should be provided. While either oval or octagonal rings may be used with flat bottom grooves, the octagonal type is preferred.

Self Equalizing Types The self equalizing type of gasket, such as O-Ring, Delta-Ring and Lens-Type, are useful for high pressure applications. These gaskets and the special flange facings required for them are shown in Figure 1e, page 6. Joints of this kind have the distinct advantage of not requiring mechanical loading for gasket seating. Since the gasket reaction can be considered negligible, the total bolting is only that necessary to retain the hydrostatic end force.

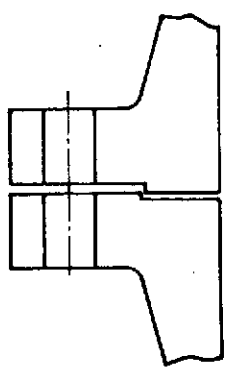
A great deal of research and experimental work has been done in connection with joints of this type. No attempt is made here to cover the subject in detail. Where metal O-Rings are required, they should have a plating of soft metal (copper, for example) and be used with 16 AA maximum surface finishes.

**\*TYPICAL FLANGE FACINGS—Fig. 1**  
(Reference 3)

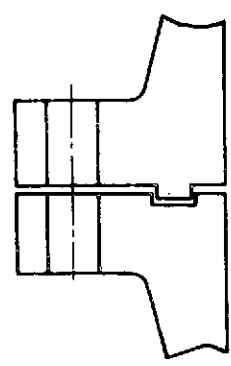
**a.**  
**Raised Face**



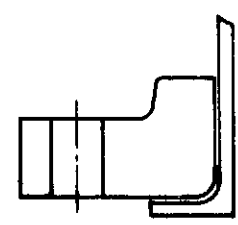
**b.**  
**Male And Female**



**c.**  
**Tongue And Groove**

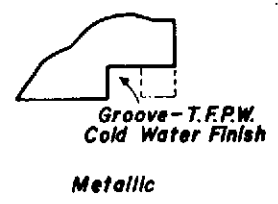
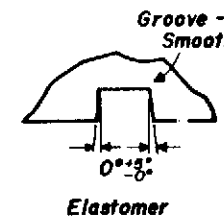
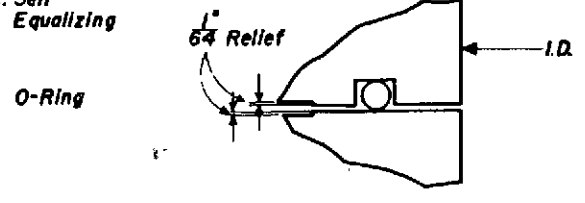


**d.**  
**Lap Joint**

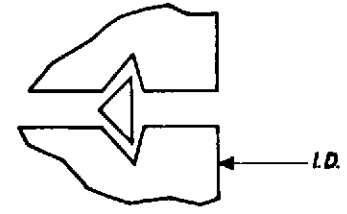


**FACING DETAILS**

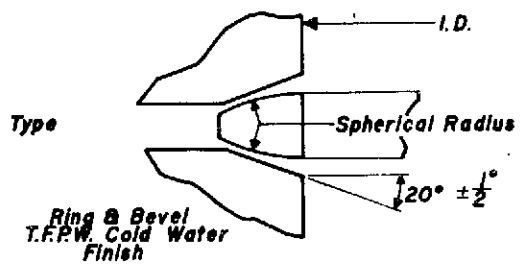
**e.** Self Equalizing



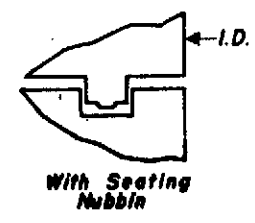
**Delta Ring**



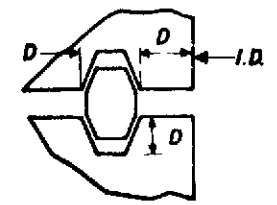
**Lens Type**



**f.**  
**Tongue And Groove**



**g.**  
**Ring Joint**



\*From Taylor Forge "Modern Flange Design", Bulletin 741



## INTEGRAL FLANGE DESIGN

### NOTATION SYMBOLS AND DEFINITIONS

ALL SYMBOLS ARE SHOWN IN THE ORDER THEY APPEAR IN THE PROGRAM

The definitions are those given in Appendix II of the 1971 ASME Boiler and Pressure Vessel Code, Section VIII, Division I.

- |   |   |
|---|---|
| <p><b>B</b> = Effective gasket or joint contact-surface seating width, inches.</p> <p><math>B = b_o</math>, when <math>b_o \leq \frac{1}{4}</math> inch</p> <p><math>B = \frac{\sqrt{b_o}}{2}</math>, when <math>b_o &gt; \frac{1}{4}</math> inch</p> <p><math>b_o</math> = basic gasket seating width, inches, see Table UA-49.2, page 14.</p> | <p><b>WM2</b> = Minimum required bolt load for gasket seating, pounds,<br/><math>\equiv B\pi GY</math></p>                                |
| <p><b>Y</b> = Gasket or joint-contact-surface seating load, pounds per square inch, Table UA-49.1, page 15.</p>   | <p><b>P</b> = Design pressure, pounds per square inch.</p>  |
| <p><b>M</b> = Gasket factor, Table UA-49.1 page 15.</p>   | <p><b>HP</b> = Total-joint-contact surface compression load, pounds,<br/><math>\equiv 2\pi BGMP</math></p>                                |
| <p><b>G</b> = Diameter at location of gasket load reaction.</p> <p>when <math>b_o \leq \frac{1}{4}</math> inches, <math>G</math> = mean diameter of gasket contact face, inches.</p> <p>when <math>b_o &gt; \frac{1}{4}</math> inches, <math>G</math> = outside diameter of gasket contact face less <math>2\theta</math>, inches.</p>          | <p><b>H</b> = Total hydrostatic end force, pounds, <math>\equiv \frac{\pi}{4} G^2 P</math>.</p>   |
| <p><b>G</b> = Diameter at location of gasket load reaction.</p> <p>when <math>b_o \leq \frac{1}{4}</math> inches, <math>G</math> = mean diameter of gasket contact face, inches.</p> <p>when <math>b_o &gt; \frac{1}{4}</math> inches, <math>G</math> = outside diameter of gasket contact face less <math>2\theta</math>, inches.</p>          | <p><b>WM1</b> = Required bolt load for operating conditions, pounds,<br/><math>\equiv HP + H</math></p>                                   |
| <p><b>G</b> = Diameter at location of gasket load reaction.</p> <p>when <math>b_o \leq \frac{1}{4}</math> inches, <math>G</math> = mean diameter of gasket contact face, inches.</p> <p>when <math>b_o &gt; \frac{1}{4}</math> inches, <math>G</math> = outside diameter of gasket contact face less <math>2\theta</math>, inches.</p>          | <p><b>SA</b> = Allowable bolt stress at atmospheric temperature, pounds per square inch. Select from ASME Code for required material.</p> |
| <p><b>G</b> = Diameter at location of gasket load reaction.</p> <p>when <math>b_o \leq \frac{1}{4}</math> inches, <math>G</math> = mean diameter of gasket contact face, inches.</p> <p>when <math>b_o &gt; \frac{1}{4}</math> inches, <math>G</math> = outside diameter of gasket contact face less <math>2\theta</math>, inches.</p>          | <p><b>SB</b> = Allowable bolt stress at design temperature, pounds per square inch. Select from ASME Code for required materials.</p>     |
| <p><b>G</b> = Diameter at location of gasket load reaction.</p> <p>when <math>b_o \leq \frac{1}{4}</math> inches, <math>G</math> = mean diameter of gasket contact face, inches.</p> <p>when <math>b_o &gt; \frac{1}{4}</math> inches, <math>G</math> = outside diameter of gasket contact face less <math>2\theta</math>, inches.</p>          | <p><b>AM</b> = Total required cross-sectional area of bolts taken as the greater of AM1 or AM2, square inches.</p>                        |

- AM1 = Total cross-sectional area of bolts at root of thread or section of least diameter under stress required for the operating conditions, square inches,  $\equiv \frac{VM1}{(SB)}$
- AM2 = Total cross-sectional area bolts at root of thread or section of least diameter under stress required for gasket seating, square inches,  $\equiv \frac{VM2}{(SA)}$
- AB = Actual total cross-sectional area of bolts at root of thread or section of least diameter under stress, square inches. (Must be equal to or greater than AM).
- W = Flange design bolt load for the operating conditions or gasket seating, as may apply, pounds,  $\equiv .5(AM+AB)(SA)$
- N(Min) = Minimum width, in inches, required for the basic gasket seating width, based upon the possible contact width of the gasket. Has no meaning if  $Y=0$ ,  $\equiv (AB)(SA)/2Y\pi G$ .
- B1 = Inside diameter of flange, inches. When B1 is less than  $20 G1$ , it will be optional for the designer to substitute BB for B1 in the formula for longitudinal hub stress, SH.
- BB =  $B1+G0$  for integral-type flanges when FC is equal to or greater than 1.
- HD = Hydrostatic end force on area inside of flange, pounds,  $\equiv \frac{\pi}{4} B^2 P$ .
- HG = Gasket Load (difference between flange design bolt load and total hydrostatic end force), pounds,  $= W-H \equiv H_p$
- HT = Difference between total hydrostatic end force and the hydrostatic end force on area inside of flange, pounds,  $\equiv H-HD$
- HGG = Possible gasket seating load due to bolting, pounds, see UA-49, paragraph (b) item (3), sub item (d), formula (4),  $\equiv W$
- R = Radial distance from bolt circle to point of intersection of hub and back of flange, inches, (integral and hubbed flanges).
- G1 = Thickness of hub at back of flange, inches.
- C = Bolt-circle diameter, inches.
- HD1 = Radial distance from the bolt circle to the circle on which HD acts, inches,  $= R+.5(G1)$ .
- HG1 = Radial distance from gasket load reaction to the bolt circle, inches,  $\equiv \frac{C-G}{2}$ .
- HT1 = Radial distance from the bolt circle on which HT acts, inches  $\equiv .5(R+(G1)+HG)$
- HG1G = Radial distance from gasket load reaction to the bolt circle, inches,  $\equiv \frac{C-G}{2}$
- MD = Component of moment due to HD, inch-pounds,  $\equiv (HD)(HD1)$
- MG = Component of moment due to HG, inch-pounds,  $\equiv (HG)(HG1)$
- MT = Component of moment due to HT, inch-pounds,  $\equiv (HT)(HT1)$

- MO = Total moment acting upon the flange for the operating conditions, inch-pounds,  $\equiv MD+MG+MT$
- MOG = Total moment acting upon the flange for the gasket seating, inch-pounds,  $\equiv (HGG)(HG1)$
- A = Outside diameter of flange or, where slotted holes extend to the outside of the flange, the diameter to the bottom of the slots, inches.
- K = Ratio of outside diameter of flange to inside diameter of flange,  $= \frac{A}{(BT)}$
- T = Factor involving K, shape constant.
- U = Factor involving K, shape constant.
- Z = Factor involving K, shape constant
- YS = Factor involving K, shape constant
- GO = Thickness of hub at small end, inches
- G1/GO = Shape constant.
- HO = Factor  $= \sqrt{(BT)(GO)}$ , inches.
- L = Hub length, inches
- H/HO = Shape Constant.
- F = Factor for integral-type flanges, figure UA-51.2, page 16.
- V = Factor for integral-type flanges, figure UA-51.3, page 16
- FC = Hub stress-correction factor (for integral-type flanges). For values below limit of chart use FC = 1. Figure UA-51.6, page 17.
- E = Factor for integral-type flanges,  $\equiv \frac{F}{(HO)}$
- D = Factor for integral-type flanges,  $\equiv \frac{U}{V} (HO)(GO)^2$ .
- TK = Flange thickness, inches, assumed value.
- ALF = Stress formula factor,  $\equiv (TK)(E)+1$ .
- BTA = Stress formula factor,  $\equiv (4/3)(TK)E+1$ .
- GMA = Stress formula factor,  $\equiv ALF(T)$ .
- DEL = Stress formula factor,  $\equiv (TK)^3/D$ .
- LMA = Stress formula factor,  $\equiv GMA+DEL$ .
- MM =  $\frac{MO}{BT}$
- MMG =  $\frac{MOG}{BT}$
- BS = Bolt spacing, inches
- SH = Calculated longitudinal stress in hub, pounds per square inch, (operating conditions),  $\equiv (FC)(MM)/(LMA)(G1)^2$ .
- SR = Calculated radial stress in flange, pounds per square inch, (operating conditions),  $\equiv (BTA)(MM)/(LMA)(TK)^2$ .
- ST = Calculated tangential stress in flange, pounds per square inch, (operating conditions),  $\equiv \left[ \frac{(MM)(Y)}{(TK)^2} \right] - Z(SR)$
- SC = Combined stress greater of .5(SH+SR) or .5(SH+ST)

SFO = Allowable design stress for material of flange, nozzle neck vessel or pipe wall, at design temperature (operating conditions), pounds per square inch. Select from ASME Code for required material.

SHG = Calculated longitudinal stress in hub, pounds per square inch, (gasket seating condition),  $\equiv (FC)(MMG)/(LMA)(G1)^2$ .

SRG = Calculated radial stress in flange, pounds per square inch, (gasket seating conditions),  $\equiv (BTA)(MMG)(LMA)/(TK)^2$ .

STG = Calculated tangential stress in flange, pounds per square inch, (gasket seating conditions),  $\equiv [(MMG)(Y)/(TK)^2] - Z(SR)$ .

SCG = Combined stress greater of .5(SHG+SRG) or .5(SHG+STG).

SFA = Allowable design stress for material of flange, nozzle neck vessel or pipe wall, at atmospheric temperature (gasket seating), pounds per square inch. Select from ASME Code for required material.



DESIGN OF  
WELDING NECK  
FLANGES

12

PROGRAM OUTPUT

DESIGN OF  
WELDING NECK  
FLANGES

B= 0.3060\*

Y= 3700.0000\*

M= 2.7500\*

G= 33.8880\*

WM2= 120536.6060

P= 400.0000\*

HP= 71670.4149

H= 360779.4146

WM1= 432449.8295

BOLTING STRESS  
ATM. TEMP PSI  
SA= 20000.0000\*

BOLT STRESS  
DESIGN TEMP-PSI  
SB= 20000.0000

AM= 21.6225

NO. BOLTS= 40.0000\*

ROOT AREA BOLTS= 0.5510\*

AB= 22.0400

U= 436624.9147

NMIN= 0.5594

B1= 32.0000\*

HD= 321699.0877

HG= 71670.4149

HT= 39080.3269

HGG= 436624.9147

R= 1.3750\*

G1= 1.1250\*

C= 37.0000\*

HD1= 1.9375

HG1= 1.5560

HT1= 2.0280

HG1G= 1.5560

HD= 623291.9825

HG= 111519.1655

HT= 79254.9029

HD= 814066.0509

HGG= 679388.3673

R= 39.1250\*

K= 1.2227

T= 1.8298

U= 10.7399

Z= 5.0413

YS= 9.7733

G0= 0.5000\*

G1/G0= 2.2500

H0= 4.0000

L= 2.7500\*

H/H0= 0.6875

FIND F -V FROM  
INTEGRAL FLANGE  
FACTOR TABLE

F = 0.7800\*

V = 0.1630\*

FIND HUB STRESS  
CORRECTION FACTR

FC= 1.0000\*

E= 0.1950

D= 65.8889

ASSUME FLG THICK  
TK= 1.0000\*

ALF= 1.1950

BTA= 1.2600

GMA= 0.6531

DEL= 0.0152

LMA= 0.6683

MM= 25439.5641

MMG= 21230.8865

NOM. BOLT DIA.= 1.0000\*

BS= 3.0000

NO. BOLTS-SAME  
AS BEFORE= 40.0000\*

OPERATING STRESS

SH= 30078.2679

SR= 47965.4378

ST= 6820.1798

SC= 39021.8528

SFO= 17530.0000\*

SC GTR SFO PICK  
NEW THICKNESS

SR GTR SFO PICK  
NEW THICKNESS

SH GTR 1.5(SFO)  
PICK NEW THICK

TYPE ERROR MESSAGE

PROGRAM OUTPUT

FOR GASKET SEAT

SHG= 25102.1711  
 SRC= 40030.1185  
 STG= 5691.8610  
 SCG= 32566.1448  
 SFA= 17500.0000\*  
 SGC GTR SFA  
 NEW TK  
 SRG GTR SFA  
 NEW TK  
**ASSUME FLG THICK**  
TK= 2.0000\*  
 ALF= 1.3900  
 BTA= 1.5200  
 GMA= 0.7597  
 DEL= 0.1214  
 LMA 0.8811  
 MM 25439.5641  
 MNG 21230.8865

**ERROR MESSAGE**

NOM. BOLT DIA.= 1.0000\*  
 BS= 4.0000  
 NO. BOLTS-SAME AS BEFORE= 40.0000\*  
 OPERATING STRESS

SH= 22813.3413  
 SR= 10971.7913  
 ST= 6845.0099  
 SC= 16892.5663  
 SFO= 17500.0000\*  
 FOR GASKET SEAT

**NO ERROR MESSAGES**

SHG= 19039.1415  
 SRG= 9156.6371  
 STG= 5712.5833  
 SCG= 14097.8893  
 SFA= 17500.0000\*  
**ASSUME FLG THICK**  
**TK=**  
**DO NOT NEED**  
**A NEW TK.**  
**DESIGN SATIS-**  
**FACTORY**

Table UA-49.2

SECTION VIII - DIVISION 1 PRESSURE VESSELS (Reference 1)

TABLE UA-49.2 EFFECTIVE GASKET WIDTH

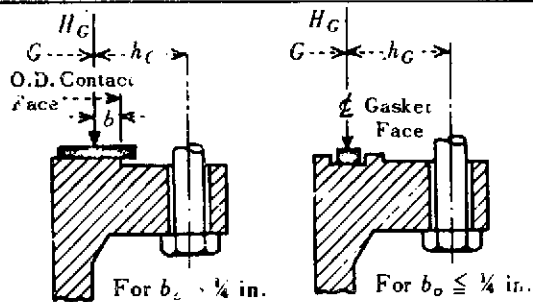
FACING SKETCH Exaggerated	BASIC GASKET SEATING WIDTH, $b_o$	
	COLUMN I	COLUMN II
1a 		
1b* 	$\frac{N}{2}$	$\frac{N}{2}$
1c 	$\frac{w + T}{2} ; \left( \frac{w + N}{4} \text{ max} \right)$	$\frac{w + T}{2} ; \left( \frac{w + N}{4} \text{ max} \right)$
1d* 		
2 1/64" Nubbin 	$\frac{w + N}{4}$	$\frac{w + 3N}{8}$
3 1/64" Nubbin 	$\frac{N}{4}$	$\frac{3N}{8}$
4* 	$\frac{3N}{8}$	$\frac{7N}{16}$
5* 	$\frac{N}{4}$	$\frac{3N}{8}$
6 	$\frac{w}{8}$	

EFFECTIVE GASKET SEATING WIDTH, "b"

$b = b_o$ , when  $b_o \leq \frac{1}{4}$  in.

$b = \frac{\sqrt{b_o}}{2}$ , when  $b_o > \frac{1}{4}$  in.

LOCATION OF GASKET LOAD REACTION



NOTE: The gasket factors listed only apply to flanged joints in which the gasket is contained entirely within the inner edges of the bolt holes

\*Where serrations do not exceed 1/64 in. depth and 1/32 in. width spacing, sketches 1b and 1d shall be used.



## MANDATORY APPENDICES (Reference 1)

Table UA-49.1

TABLE UA-49.1  
GASKET MATERIALS AND CONTACT FACINGS

Gasket Factors ( $m$ ) for Operating Conditions and Minimum Design Seating Stress ( $\gamma$ )				Refer to Table UA-49.2				
NOTE: This table gives a list of many commonly used gasket materials and contact facings with suggested design values of $m$ and $\gamma$ that have generally proved satisfactory in actual service when using effective gasket seating width $b$ given in Table UA-49.2. The design values and other details given in this table are suggested only and are not mandatory.				Use facing sketch	Use column			
Gasket material	Gasket factor $m$	Min design seating stress $\gamma$	Sketches and notes					
Self-Energizing Types O Rings, Metallic, Elastomer other gasket types considered as self-sealing	0	0	—	—	—			
Elastomers without fabric or a high percentage of asbestos fiber: Below 75 Shore Durometer 75 or higher Shore Durometer	0.50 1.00	0 200		1 (a, b, c, d) 4, 5				
Asbestos with a suitable binder for the operating conditions	$\frac{1}{4}$ thick $\frac{1}{16}$ thick $\frac{1}{32}$ thick	2.00 2.75 3.50						
Elastomers with cotton fabric insertion	1.25	400						
Elastomers with asbestos fabric insertion, with or without wire reinforcement	3-ply	2.25	2200					
	2-ply	2.50	2900					
	1-ply	2.75	3700					
Vegetable fiber	1.75	1100						
Spiral-wound metal, asbestos filler	Carbon Stainless or Monel	2.50 3.00	2900 4500				1 (a, b)	II
	Corrugated metal, asbestos inserted or Corrugated metal, jacketed asbestos filled	Soft aluminum Soft copper or brass Iron or soft steel Monel or 4-6% chrome Stainless steels	2.50 2.75 3.00 3.25 3.50			2900 3700 4500 5500 6500		
Corrugated metal	Soft aluminum Soft copper or brass Iron or soft steel Monel or 4-6% chrome Stainless steels	2.75 3.00 3.25 3.50 3.75	3700 4500 5500 6500 7600				1 (a, b, c, d)	
Flat metal jacketed asbestos filled	Soft aluminum Soft copper or brass Iron or soft steel Monel 4-6% chrome Stainless steels	3.25 3.50 3.75 3.50 3.75 3.75	5500 6500 7600 8000 9000 9000		1a, 1b, 1c*, 1d*, 2*			
Grooved metal	Soft aluminum Soft copper or brass Iron or soft steel Monel or 4-6% chrome Stainless steels	3.25 3.50 3.75 3.75 4.25	5500 6500 7600 9000 10100		1 (a, b, c, d) 2, 3			
Solid flat metal	Soft aluminum Soft copper or brass Iron or soft steel Monel or 4-6% chrome Stainless steels	4.00 4.75 5.50 6.00 6.50	8800 13000 18000 21800 26000		1 (a, b, c, d) 2, 3, 4, 5	I		
Ring joint	Iron or soft steel Monel or 4-6% chrome Stainless steels	5.50 6.00 6.50	18000 21800 26000		6			

\*The surface of a gasket having a lap should not be against the nubbin.

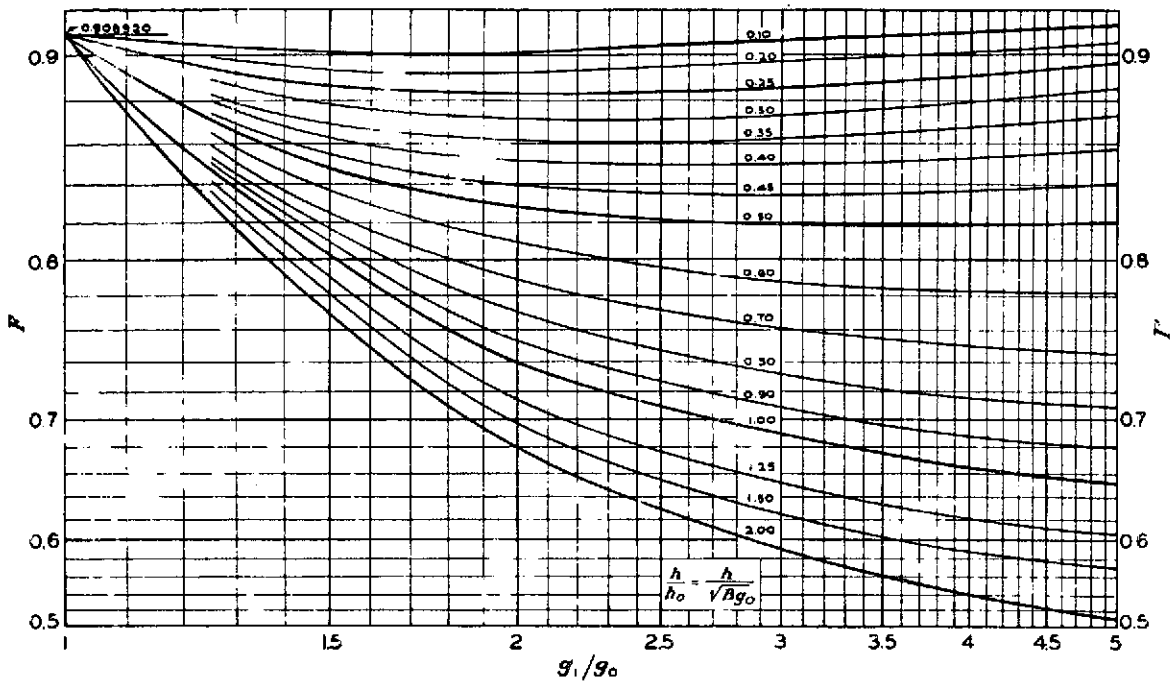


FIG. UA-61.2 VALUES OF  $F$  (Integral flange factors) (Reference 1)

Figs. UA-51.3- UA-51.5 SECTION VIII - DIVISION 1 PRESSURE VESSELS (Reference 1)

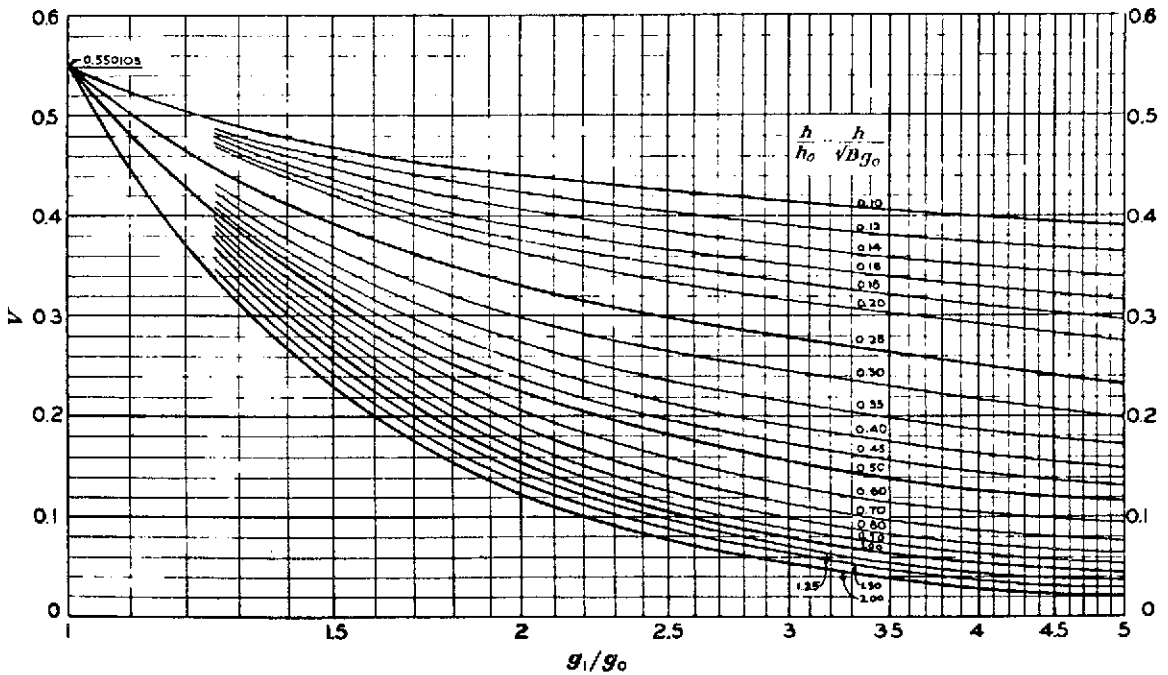


FIG. UA-61.3 VALUES OF  $V$  (Integral flange factors)

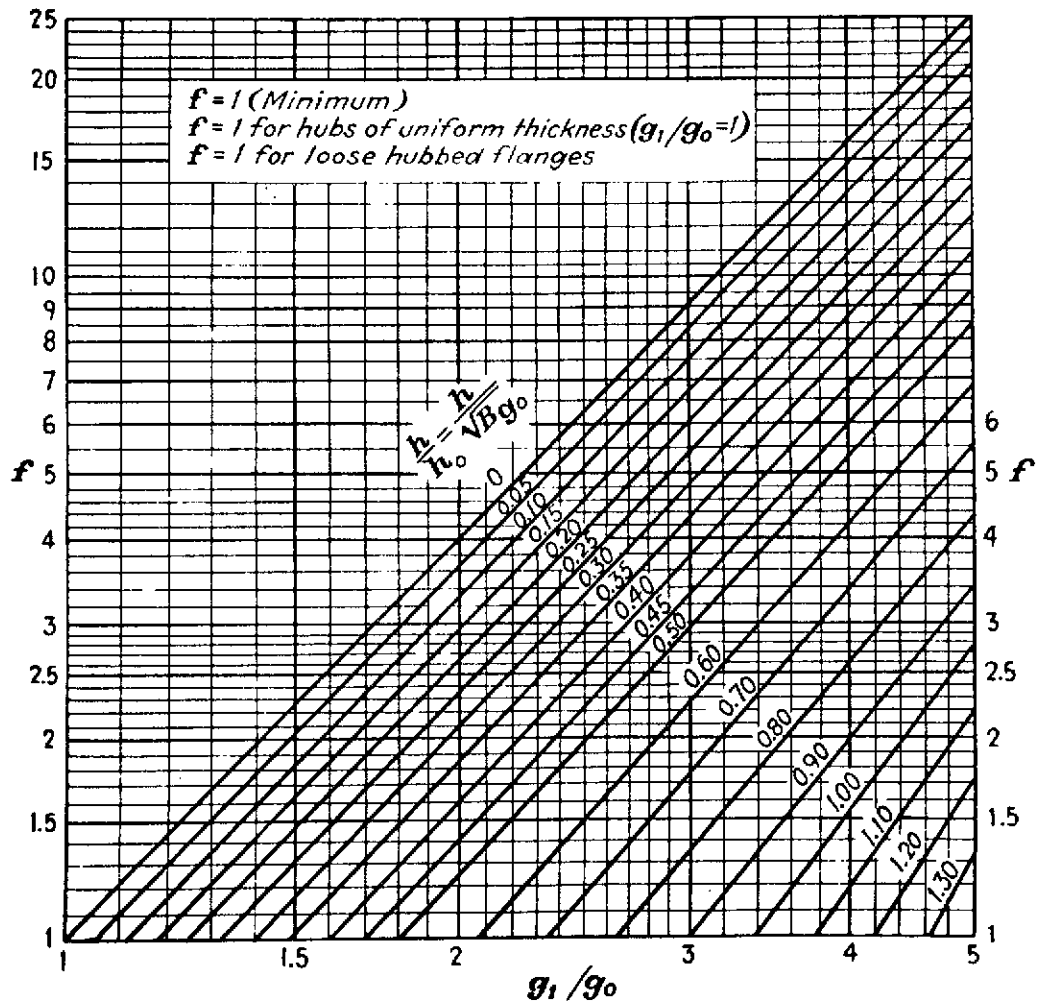


FIG. UA-51.6 VALUES OF  $f$  (Hub stress correction factor) (Reference 1)

DESIGN OF  
WELDING NECK  
FLANGES

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PROGRAM

0000--FMT---42	0056--FMT---42	0112--XTO---23
0001--FMT---42	0057--FMT---42	0113-- 6 ---06
0002--PNT---45	0058--XFR---67	0114--GTO---44
0003--PNT---45	0059--SFL---54	0115-- 1 ---01
0004--PNT---45	0060--FMT---42	0116-- 8 ---10
0005-- D ---63	0061--STP---41	0117-- 6 ---06
0006-- E ---60	0062--PNT---45	0118-- 4 ---04
0007--YTO---40	0063--XTO---23	0119--CNT---47
0008-- I ---65	0064-- 2 ---02	0120--CNT---47
0009-- G ---15	0065--FMT---42	0121-- UP---27
0010-- N ---73	0066--FMT---42	0122-- 2 ---02
0011--PNT---45	0067-- M ---70	0123-- X ---36
0012-- O ---71	0068--SFL---54	0124-- π ---56
0013-- F ---16	0069--FMT---42	0125-- X ---36
0014--CLR---20	0070--STP---41	0126--XEY---30
0015--PNT---45	0071--PNT---45	0127--FMT---42
0016--PNT---45	0072--XTO---23	0128--FMT---42
0017--JND---31	0073-- 3 ---03	0129-- H ---74
0018-- E ---60	0074--FMT---42	0130-- π ---56
0019-- L ---72	0075--FMT---42	0131--SFL---54
0020-- D ---63	0076-- G ---15	0132--FMT---42
0021-- I ---65	0077--SFL---54	0133--PNT---45
0022-- N ---73	0078--FMT---42	0134--XTO---23
0023-- G ---15	0079--STP---41	0135-- 7 ---07
0024--PNT---45	0080--PNT---45	0136--XFR---67
0025-- N ---73	0081--XTO---23	0137-- 4 ---04
0026-- E ---60	0082-- 4 ---04	0138--XSO---12
0027-- C ---61	0083--XFR---67	0139--RUP---22
0028-- K ---55	0084-- 1 ---01	0140-- π ---56
0029--PNT---45	0085--XFR---67	0141-- X ---36
0030--PNT---45	0086-- X ---36	0142--XFR---67
0031--PNT---45	0087-- 2 ---02	0143-- 6 ---06
0032--PNT---45	0088--XFR---67	0144-- X ---36
0033--PNT---45	0089-- X ---36	0145-- 4 ---04
0034--PNT---45	0090-- 4 ---04	0146--DIV---35
0035-- F ---16	0091--RUP---22	0147--XEY---30
0036-- L ---72	0092-- π ---56	0148--FMT---42
0037-- A ---62	0093-- X ---36	0149--FMT---42
0038-- N ---73	0094--XEY---30	0150-- H ---74
0039-- G ---15	0095--FMT---42	0151--SFL---54
0040-- E ---60	0096--FMT---42	0152--FMT---42
0041--YTO---40	0097--IND---31	0153--PNT---45
0042--PNT---45	0098-- M ---70	0154--XTO---23
0043--PNT---45	0099-- 2 ---02	0155-- 8 ---10
0044--PNT---45	0100--SFL---54	0156--RUP---22
0045--PNT---45	0101--FMT---42	0157--XFR---67
0046--CLR---20	0102--PNT---45	0158-- 7 ---07
0047--CLR---20	0103--XTO---23	0159-- + ---33
0048--CLR---20	0104-- 5 ---05	0160--XEY---30
0049-- B ---66	0105--FMT---42	0161--FMT---42
0050--SFL---54	0106--FMT---42	0162--FMT---42
0051--FMT---42	0107-- π ---56	0163--IND---31
0052--STP---41	0108--SFL---54	0164-- M ---70
0053--PNT---45	0109--FMT---42	0165-- 1 ---01
0054--XTO---23	0110--STP---41	0166--SFL---54
0055-- 1 ---01	0111--PNT---45	0167--FMT---42

DESIGN OF  
WELDING NECK  
FLANGES

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0168--PNT---45  
0169--XTO---23  
0170-- 9 ---11  
0171--FMT---42  
0172--FMT---42  
0173-- B ---66  
0174-- 0 ---71  
0175-- L ---72  
0176--XTO---23  
0177-- I ---65  
0178-- N ---73  
0179-- G ---15  
0180--CNT---47  
0181--YTO---40  
0182--XTO---23  
0183-- a ---13  
0184-- E ---60  
0185--YTO---40  
0186--YTO---40  
0187--CLR---20  
0188-- A ---62  
0189--XTO---23  
0190-- M ---70  
0191-- . ---21  
0192--CNT---47  
0193--XTO---23  
0194-- E ---60  
0195-- .M ---70  
0196-- n ---56  
0197--CNT---47  
0198-- n ---56  
0199--YTO---40  
0200-- I ---65  
0201--CLR---20  
0202--YTO---40  
0203-- A ---62  
0204--SFL---54  
0205--FMT---42  
0206--STP---41  
0207--PNT---45  
0208--XTO---23  
0209-- 1 ---01  
0210-- 0 ---00  
0211--FMT---42  
0212--FMT---42  
0213-- B ---66  
0214-- 0 ---71  
0215-- L ---72  
0216--XTO---23  
0217--CNT---47  
0218--YTO---40  
0219--XTO---23  
0220-- a ---13  
0221-- E ---60  
0222--YTO---40  
0223--YTO---40  
0224--CLR---20  
0225-- D ---63

0226-- E ---60  
0227--YTO---40  
0228-- I ---65  
0229-- G ---15  
0230-- N ---73  
0231--CNT---47  
0232--XTO---23  
0233-- E ---60  
0234-- M ---70  
0235-- n ---56  
0236-- n ---34  
0237-- n ---56  
0238--YTO---40  
0239-- I ---65  
0240--CLR---20  
0241--YTO---40  
0242-- B ---66  
0243--SFL---54  
0244--FMT---42  
0245--STP---41  
0246--PNT---45  
0247--XTO---23  
0248-- 1 ---01  
0249-- 1 ---01  
0250--RUP---22  
0251--XFR---67  
0252-- 9 ---11  
0253--XEY---30  
0254--DIV---35  
0255--RUP---22  
0256--XFR---67  
0257-- 5 ---05  
0258--XEY---30  
0259--XFR---67  
0260-- 1 ---01  
0261-- 0 ---00  
0262--DIV---35  
0263-- DN ---25  
0264--XCY---52  
0265--XEY---30  
0266--CNT---47  
0267--CNT---47  
0268--CNT---47  
0269--FMT---42  
0270--FMT---42  
0271-- A ---62  
0272-- M ---70  
0273--SFL---54  
0274--FMT---42  
0275--PNT---45  
0276--XTO---23  
0277-- 1 ---01  
0278-- 2 ---02  
0279--FMT---42  
0280--FMT---42  
0281-- N ---73  
0282-- 0 ---71  
0283-- . ---21  
0284--PNT---45

0285-- B ---66  
0286-- 0 ---71  
0287-- L ---72  
0288--XTO---23  
0289--YTO---40  
0290--SFL---54  
0291--FMT---42  
0292--STP---41  
0293--PNT---45  
0294--RUP---22  
0295--FMT---42  
0296--FMT---42  
0297-- a ---13  
0298-- 0 ---71  
0299-- 0 ---71  
0300--XTO---23  
0301--PNT---45  
0302-- A ---62  
0303-- a ---13  
0304-- E ---60  
0305-- A ---62  
0306--PNT---45  
0307-- B ---66  
0308-- 0 ---71  
0309-- L ---72  
0310--XTO---23  
0311--YTO---40  
0312--SFL---54  
0313--FMT---42  
0314--STP---41  
0315--PNT---45  
0316-- X ---36  
0317--XEY---30  
0318--FMT---42  
0319--FMT---42  
0320-- A ---62  
0321-- B ---66  
0322--SFL---54  
0323--FMT---42  
0324--PNT---45  
0325--XTO---23  
0326-- 1 ---01  
0327-- 3 ---03  
0328--RUP---22  
0329--XFR---67  
0330-- 1 ---01  
0331-- 2 ---02  
0332-- + ---33  
0333-- . ---21  
0334-- 5 ---05  
0335-- X ---36  
0336--XFR---67  
0337-- 1 ---01  
0338-- 0 ---00  
0339-- X ---36  
0340--XEY---30  
0341--FMT---42  
0342--FMT---42  
0343--IND---31  
0344--SFL---54

DESIGN OF  
WELDING NECK  
FLANGES

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0345--FMT---42  
0346--PNT---45  
0347--XTO---23  
0348-- 1 ---01  
0349-- 4 ---04  
0350--XFR---67  
0351-- 1 ---01  
0352-- 3 ---03  
0353--RUP---22  
0354-- 2 ---02  
0355--DIV---35  
0356--XFR---67  
0357-- 1 ---01  
0358-- 0 ---00  
0359-- X ---36  
0360-- a ---56  
0361--DIV---35  
0362-- 1 ---01  
0363--XFR---67  
0364-- + ---33  
0365-- 2 ---02  
0366--DIV---35  
0367--CNT---47  
0368--XFR---67  
0369-- 4 ---04  
0370--DIV---35  
0371--KEY---30  
0372--FMT---42  
0373--FMT---42  
0374-- N ---73  
0375-- M ---70  
0376-- I ---65  
0377-- N ---73  
0378--SFL---54  
0379--FMT---42  
0380--PNT---45  
0381--FMT---42  
0382--FMT---42  
0383-- B ---66  
0384-- 1 ---01  
0385--SFL---54  
0386--FMT---42  
0387--STP---41  
0388--PNT---45  
0389--XTO---23  
0390-- 1 ---01  
0391-- 5 ---05  
0392--XSO---12  
0393--RUP---22  
0394-- a ---56  
0395-- X ---36  
0396-- 4 ---04  
0397--DIV---35  
0398--XFR---67  
0399-- 6 ---06  
0400-- X ---36  
0401--KEY---30  
0402--FMT---42

0403--FMT---42  
0404-- H ---74  
0405-- D ---63  
0406--SFL---54  
0407--FMT---42  
0408--PNT---45  
0409--XTO---23  
0410-- 1 ---01  
0411-- 6 ---06  
0412--RUP---22  
0413--XFR---67  
0414-- 7 ---07  
0415--FMT---42  
0416--FMT---42  
0417-- H ---74  
0418-- G ---15  
0419--SFL---54  
0420--FMT---42  
0421--PNT---45  
0422--XFR---67  
0423-- 8 ---10  
0424--KEY---30  
0425-- - ---34  
0426--FMT---42  
0427--FMT---42  
0428-- H ---74  
0429--XTO---23  
0430--SFL---54  
0431--FMT---42  
0432--KEY---30  
0433--PNT---45  
0434--XTO---23  
0435-- 1 ---01  
0436-- 7 ---07  
0437--XFR---67  
0438-- 1 ---01  
0439-- 4 ---04  
0440--FMT---42  
0441--FMT---42  
0442-- H ---74  
0443-- G ---15  
0444-- G ---15  
0445--SFL---54  
0446--FMT---42  
0447--PNT---45  
0448--FMT---42  
0449--FMT---42  
0450-- a ---13  
0451--SFL---54  
0452--FMT---42  
0453--STP---41  
0454--PNT---45  
0455--XTO---23  
0456-- 1 ---01  
0457-- 8 ---10  
0458--FMT---42  
0459--FMT---42  
0460-- G ---15

0461-- 1 ---01  
0462--SFL---54  
0463--FMT---42  
0464--STP---41  
0465--PNT---45  
0466--XTO---23  
0467-- 1 ---01  
0468-- 9 ---11  
0469--FMT---42  
0470--FMT---42  
0471-- C ---61  
0472--SFL---54  
0473--FMT---42  
0474--STP---41  
0475--PNT---45  
0476--XTO---23  
0477-- 2 ---02  
0478-- 0 ---00  
0479--XFR---67  
0480-- 4 ---04  
0481--CNT---47  
0482--CNT---47  
0483--XTO---23  
0484-- 2 ---02  
0485-- 1 ---01  
0486--XFR---67  
0487-- 1 ---01  
0488-- 8 ---10  
0489-- UP---27  
0490--XFR---67  
0491-- 1 ---01  
0492-- 9 ---11  
0493-- UP---27  
0494-- . ---21  
0495-- 5 ---05  
0496-- X ---36  
0497-- DN---25  
0498-- + ---33  
0499-- DN---25  
0500--FMT---42  
0501--FMT---42  
0502-- H ---74  
0503-- D ---63  
0504-- 1 ---01  
0505--SFL---54  
0506--FMT---42  
0507--PNT---45  
0508--XTO---23  
0509-- 2 ---02  
0510-- 2 ---02  
0511--XFR---67  
0512-- 2 ---02  
0513-- 0 ---00  
0514--XFR---67  
0515-- - ---34  
0516-- 2 ---02  
0517-- 1 ---01  
0518--RUP---22  
0519-- . ---21

DESIGN OF  
WELDING NECK  
FLANGES

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0520-- 5 ---05	0578-- 2 ---02	0637-- 0 ---71
0521-- X ---36	0579--FMT---42	0638-- G ---15
0522--XEY---30	0580--FMT---42	0639--SFL---54
0523--FMT---42	0581-- N ---70	0640--FMT---42
0524--FMT---42	0582-- D ---63	0641--PNT---45
0525-- H ---74	0583--SFL---54	0642--XTO---23
0526-- G ---15	0584--FMT---42	0643-- 2 ---02
0527-- 1 ---01	0585--PNT---45	0644-- 6 ---06
0528--SFL---54	0586--RUP---22	0645--FMT---42
0529--FMT---42	0587--XFR---67	0646--FMT---42
0530--PNT---45	0588-- 7 ---07	0647-- R ---62
0531--XTO---23	0589--XFR---67	0648--SFL---54
0532-- 2 ---02	0590-- X ---36	0649--FMT---42
0533-- 3 ---03	0591-- 2 ---02	0650--STP---41
0534--RUP---22	0592-- 3 ---03	0651--PNT---45
0535--XFR---67	0593--FMT---42	0652--XTO---23
0536-- 1 ---01	0594--FMT---42	0653-- 2 ---02
0537-- 8 ---10	0595-- M ---70	0654-- 7 ---07
0538-- + ---33	0596-- G ---15	0655--RUP---22
0539--XFR---67	0597--SFL---54	0656--XFR---67
0540-- 1 ---01	0598--FMT---42	0657-- 1 ---01
0541-- 9 ---11	0599--PNT---45	0658-- 5 ---05
0542-- + ---33	0600-- + ---33	0659--DIV---35
0543-- . ---21	0601--XFR---67	0660--XEY---30
0544-- 5 ---05	0602-- 1 ---01	0661--FMT---42
0545-- X ---36	0603-- 7 ---07	0662--FMT---42
0546--CNT---47	0604--XFR---67	0663-- K ---55
0547--CNT---47	0605-- X ---36	0664--SFL---54
0548--XEY---30	0606-- 2 ---02	0665--FMT---42
0549--FMT---42	0607-- 4 ---04	0666--PNT---45
0550--FMT---42	0608--FMT---42	0667--XTO---23
0551-- H ---74	0609--FMT---42	0668-- 0 ---00
0552--XTO---23	0610-- M ---70	0669--XSO---12
0553-- 1 ---01	0611--XTO---23	0670--XTO---23
0554--SFL---54	0612--SFL---54	0671-- 1 ---01
0555--FMT---42	0613--FMT---42	0672--CNT---47
0556--PNT---45	0614--PNT---45	0673--XFR---67
0557--XTO---23	0615-- + ---33	0674-- 0 ---00
0558-- 2 ---02	0616--XEY---30	0675-- 0 ---00
0559-- 4 ---04	0617--FMT---42	0676-- 0 ---00
0560--XFR---67	0618--FMT---42	0677-- K ---55
0561-- 2 ---02	0619-- M ---70	0678-- 4 ---04
0562-- 3 ---03	0620-- 0 ---71	0679--XTO---23
0563--FMT---42	0621--SFL---54	0680-- 0 ---00
0564--FMT---42	0622--FMT---42	0681-- 2 ---02
0565-- H ---74	0623--PNT---45	0682-- UP---27
0566-- G ---15	0624--XTO---23	0683-- 0 ---10
0567-- 1 ---01	0625-- 2 ---02	0684-- . ---21
0568-- G ---15	0626-- 5 ---05	0685-- 5 ---05
0569--SFL---54	0627--XFR---67	0686-- 5 ---05
0570--FMT---42	0628-- 1 ---01	0687-- 2 ---02
0571--PNT---45	0629-- 4 ---04	0688-- 4 ---04
0572--XFR---67	0630--XFR---67	0689-- 6 ---06
0573-- 1 ---01	0631-- X ---36	0690-- X ---36
0574-- 6 ---06	0632-- 2 ---02	0691-- 1 ---01
0575--XFR---67	0633-- 3 ---03	0692-- + ---33
0576-- X ---36	0634--FMT---42	0693--XFR---67
0577-- 2 ---02	0635--FMT---42	0694-- 0 ---00
	0636-- H ---70	0695-- 0 ---00
		0696-- 1 ---01

DESIGN OF  
WELDING NECK  
FLANGES

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0697-- X ---36	0756-- 1 ---01	0816-- 2 ---02
0698-- 1 ---01	0757-- UP---27	0817-- UP---27
0699-- - ---34	0758-- 1 ---01	0818--XFR---67
0700--YTO---40	0759--CHS---32	0819-- 0 ---00
0701-- 3 ---03	0760--XFR---67	0820-- 0 ---00
0702-- 3 ---03	0761-- + ---33	0821-- 1 ---01
0703--CNT---47	0762-- 0 ---00	0822-- X ---36
0704--CNT---47	0763-- 0 ---00	0823-- 5 ---05
0705--CNT---47	0764-- X ---36	0824-- . ---21
0706--CNT---47	0765-- 1 ---01	0825-- 7 ---07
0707-- 1 ---01	0766-- . ---21	0826-- 1 ---01
0708-- . ---21	0767-- 3 ---03	0827-- 6 ---06
0709-- 9 ---11	0768-- 6 ---06	0828-- 9 ---11
0710-- 4 ---04	0769-- 1 ---01	0829-- X ---36
0711-- 4 ---04	0770-- 3 ---03	0830-- 1 ---01
0712-- 8 ---10	0771-- 6 ---06	0831--CHS---32
0713-- UP---27	0772-- X ---36	0832--XFR---67
0714--XFR---67	0773-- DN---25	0833-- + ---33
0715-- 0 ---00	0774--DIV---35	0834-- 0 ---00
0716-- 0 ---00	0775--XEY---30	0835-- 0 ---00
0717-- 1 ---01	0776--FMT---42	0836-- 1 ---01
0718-- X ---36	0777--FMT---42	0837--DIV---35
0719-- 1 ---01	0778--1/X---17	0838-- . ---21
0720-- . ---21	0779--SFL---54	0839-- 6 ---06
0721-- 0 ---00	0780--FMT---42	0840-- 6 ---06
0722-- 4 ---04	0781--PNT---45	0841-- 8 ---10
0723-- 7 ---07	0782--XTO---23	0842-- 4 ---04
0724-- 2 ---02	0783-- 0 ---00	0843-- 5 ---05
0725-- + ---33	0784-- 3 ---03	0844-- + ---33
0726-- 1 ---01	0785-- 1 ---01	0845-- 1 ---01
0727--CHS---32	0786--XFR---67	0846--CHS---32
0728--XFR---67	0787-- 0 ---00	0847--XFR---67
0729-- + ---33	0788-- 0 ---00	0848-- + ---33
0730-- 0 ---00	0789-- 1 ---01	0849-- 0 ---00
0731-- 0 ---00	0790-- UP---27	0850-- 0 ---00
0732-- 0 ---00	0791-- 1 ---01	0851--DIV---35
0733-- X ---36	0792-- + ---33	0852--XEY---30
0734-- DN---25	0793--XFR---67	0853--FMT---42
0735--DIV---35	0794-- 0 ---00	0854--FMT---42
0736--XEY---30	0795-- 0 ---00	0855--XFR---67
0737--FMT---42	0796-- 1 ---01	0856--YTO---40
0738--FMT---42	0797-- UP---27	0857--SFL---54
0739--XTO---23	0798-- 1 ---01	0858--FMT---42
0740--SFL---54	0799-- - ---34	0859--PNT---45
0741--FMT---42	0800-- DN---25	0860--XTO---23
0742--PNT---45	0801--DIV---35	0861-- 0 ---00
0743--XTO---23	0802--XEY---30	0862-- 3 ---03
0744-- 2 ---02	0803--FMT---42	0863-- 0 ---00
0745-- 8 ---10	0804--FMT---42	0864--FMT---42
0746--XFR---67	0805--XSQ---12	0865--FMT---42
0747-- 0 ---00	0806--SFL---54	0866-- G ---15
0748-- 3 ---03	0807--FMT---42	0867-- 0 ---71
0749-- 3 ---03	0808--PNT---45	0868--SFL---54
0750-- UP---27	0809--XTO---23	0869--FMT---42
0751-- 1 ---01	0810-- 0 ---00	0870--STP---41
0752--CHS---32	0811-- 2 ---02	0871--PNT---45
0753--XFR---67	0812-- 9 ---11	0872--XTO---23
0754-- + ---33	0813--XFR---67	0873-- 3 ---03
0755-- 0 ---00	0814-- 0 ---00	0874-- 2 ---02
	0815-- 0 ---00	0875--XFR---67



DESIGN OF  
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0876-- 1 ---01  
0877-- 9 ---11  
0878--XFR---67  
0879--DIV---35  
0880-- 3 ---03  
0881-- 2 ---02  
0882--GTO---44  
0883-- 1 ---01  
0884-- 8 ---10  
0885-- 3 ---03  
0886-- 7 ---07  
0887--CNT---47  
0888--PNT---45  
0889--XFR---67  
0890-- 1 ---01  
0891-- 5 ---05  
0892--XFR---67  
0893-- X ---36  
0894-- 3 ---03  
0895-- 2 ---02  
0896-- F ---76  
0897--FMT---42  
0898--FMT---42  
0899-- H ---74  
0900-- 0 ---71  
0901--SFL---54  
0902--FMT---42  
0903--PNT---45  
0904--XTO---23  
0905-- 3 ---03  
0906-- 4 ---04  
0907--FMT---42  
0908--FMT---42  
0909-- L ---72  
0910--SFL---54  
0911--FMT---42  
0912--STP---41  
0913--PNT---45  
0914--RUP---22  
0915--XFR---67  
0916-- 3 ---03  
0917-- 4 ---04  
0918--DIV---35  
0919--KEY---30  
0920--GTO---44  
0921-- 1 ---01  
0922-- 8 ---10  
0923-- 5 ---05  
0924-- 1 ---01  
0925--CNT---47  
0926--PNT---45  
0927--FMT---42  
0928--FMT---42  
0929-- F ---16  
0930-- I ---65  
0931-- N ---73  
0932-- D ---63  
0933--CNT---47  
0934-- F ---16

0935--CNT---47  
0936-- - ---34  
0937--INT---64  
0938--CNT---47  
0939--CNT---47  
0940-- F ---16  
0941-- a ---13  
0942-- 0 ---71  
0943-- M ---70  
0944--CNT---47  
0945-- I ---65  
0946-- N ---73  
0947--XTO---23  
0948-- E ---60  
0949-- G ---15  
0950-- a ---13  
0951-- A ---62  
0952-- L ---72  
0953--CNT---47  
0954-- F ---16  
0955-- L ---72  
0956-- A ---62  
0957-- N ---73  
0958-- G ---15  
0959-- E ---60  
0960--CNT---47  
0961-- F ---16  
0962-- A ---62  
0963-- C ---61  
0964--XTO---23  
0965-- 0 ---71  
0966-- a ---13  
0967--CNT---47  
0968--XTO---23  
0969-- A ---62  
0970-- B ---66  
0971-- L ---72  
0972-- E ---60  
0973--CLR---20  
0974--CLR---20  
0975-- F ---16  
0976--CNT---47  
0977--SFL---54  
0978--FMT---42  
0979--CNT---47  
0980--STP---41  
0981--PNT---45  
0982--XTO---23  
0983-- 3 ---03  
0984-- 5 ---05  
0985--FMT---42  
0986--FMT---42  
0987--INT---64  
0988--CNT---47  
0989--SFL---54  
0990--FMT---42  
0991--STP---41  
0992--PNT---45  
0993--XTO---23

0994-- 3 ---03  
0995-- 6 ---06  
0996--FMT---42  
0997--FMT---42  
0998-- F ---16  
0999-- I ---65  
1000-- N ---73  
1001-- D ---63  
1002--CNT---47  
1003-- H ---74  
1004--1/X---17  
1005-- B ---66  
1006--CNT---47  
1007--YTO---40  
1008--XTO---23  
1009-- a ---13  
1010-- E ---60  
1011--YTO---40  
1012--YTO---40  
1013--CNT---47  
1014-- C ---61  
1015-- 0 ---71  
1016-- a ---13  
1017-- a ---13  
1018-- E ---60  
1019-- C ---61  
1020--XTO---23  
1021-- I ---65  
1022-- 0 ---71  
1023-- N ---73  
1024--CNT---47  
1025-- F ---16  
1026-- A ---62  
1027-- C ---61  
1028--XTO---23  
1029-- a ---13  
1030--CLR---20  
1031-- F ---16  
1032-- C ---61  
1033--SFL---54  
1034--FMT---42  
1035--STP---41  
1036--PNT---45  
1037--XTO---23  
1038-- 0 ---00  
1039-- 2 ---02  
1040-- 1 ---01  
1041--XFR---67  
1042-- 3 ---03  
1043-- 5 ---05  
1044--XFR---67  
1045--DIV---35  
1046-- 3 ---03  
1047-- 4 ---04  
1048--FMT---42  
1049--FMT---42  
1050-- E ---60  
1051--SFL---54  
1052--FMT---42  
1053--PNT---45

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1054--XTO---23	1113--RUP---22	1172--XFR---67
1055-- 3 ---03	1114-- 1 ---01	1173-- 3 ---03
1056-- 7 ---07	1115-- + ---33	1174-- 9 ---11
1057--XFR---67	1116--XEY---30	1175--XSO---12
1058-- 3 ---03	1117--FMT---42	1176--RUP---22
1059-- 2 ---02	1118--FMT---42	1177--XFR---67
1060--XSO---12	1119-- R ---62	1178-- 3 ---03
1061--XFR---67	1120-- L ---72	1179-- 9 ---11
1062-- X ---36	1121-- F ---16	1180-- X ---36
1063-- 3 ---03	1122--SFL---54	1181--XFR---67
1064-- 4 ---04	1123--FMT---42	1182-- 3 ---03
1065--XFR---67	1124--PNT---45	1183-- 8 ---10
1066-- X ---36	1125--XTO---23	1184--DIV---35
1067-- 3 ---03	1126-- 4 ---04	1185--XEY---30
1068-- 1 ---01	1127-- 0 ---00	1186--FMT---42
1069--XFR---67	1128--XFR---67	1187--FMT---42
1070--DIV---35	1129-- 3 ---03	1188-- D ---63
1071-- 3 ---03	1130-- 9 ---11	1189-- E ---60
1072-- 6 ---06	1131--XFR---67	1190-- L ---72
1073--FMT---42	1132-- X ---36	1191--SFL---54
1074--FMT---42	1133-- 3 ---03	1192--FMT---42
1075-- D ---63	1134-- 7 ---07	1193--PNT---45
1076--SFL---54	1135--RUP---22	1194--RUP---22
1077--FMT---42	1136-- 4 ---04	1195--XFR---67
1078--PNT---45	1137-- X ---36	1196-- 4 ---04
1079--XTO---23	1138-- 3 ---03	1197-- 2 ---02
1080-- 3 ---03	1139--DIV---35	1198-- + ---33
1081-- 8 ---10	1140-- 1 ---01	1199--XEY---30
1082--FMT---42	1141-- + ---33	1200--FMT---42
1083--FMT---42	1142--XEY---30	1201--FMT---42
1084-- R ---62	1143--FMT---42	1202-- L ---72
1085--YTO---40	1144--FMT---42	1203-- M ---70
1086--YTO---40	1145-- B ---66	1204-- R ---62
1087--1/X---17	1146--XTO---23	1205--FMT---42
1088-- M ---70	1147-- R ---62	1206--PNT---45
1089-- E ---60	1148--SFL---54	1207--XTO---23
1090--CNT---47	1149--FMT---42	1208-- 4 ---04
1091-- F ---16	1150--PNT---45	1209-- 3 ---03
1092-- L ---72	1151--XTO---23	1210--XFR---67
1093-- G ---15	1152-- 4 ---04	1211-- 2 ---02
1094--CNT---47	1153-- 1 ---01	1212-- 5 ---05
1095--XTO---23	1154--XFR---67	1213--XFR---67
1096-- H ---74	1155-- 4 ---04	1214--DIV---35
1097-- I ---65	1156-- 0 ---00	1215-- 1 ---01
1098-- C ---61	1157--XFR---67	1216-- 5 ---05
1099-- K ---55	1158--DIV---35	1217--FMT---42
1100--XTO---23	1159-- 2 ---02	1218--FMT---42
1101-- K ---55	1160-- 8 ---10	1219-- M ---70
1102--SFL---54	1161--FMT---42	1220-- M ---70
1103--FMT---42	1162--FMT---42	1221--FMT---42
1104--STP---41	1163-- G ---15	1222--PNT---45
1105--PNT---45	1164-- M ---70	1223--XTO---23
1106--XTO---23	1165-- R ---62	1224-- 4 ---04
1107-- 3 ---03	1166--SFL---54	1225-- 4 ---04
1108-- 9 ---11	1167--FMT---42	1226--XFR---67
1109--XFR---67	1168--PNT---45	1227-- 2 ---02
1110-- X ---36	1169--XTO---23	1228-- 6 ---06
1111-- 3 ---03	1170-- 4 ---04	1229--XFR---67
1112-- 7 ---07	1171-- 2 ---02	1230--DIV---35
		1231-- 1 ---01
		1232-- 5 ---05

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1233--FMT---42  
1234--FMT---42  
1235-- M ---70  
1236-- M ---70  
1237-- G ---15  
1238--FMT---42  
1239--PNT---45  
1240--XTO---23  
1241-- 4 ---04  
1242-- 5 ---05  
1243--FMT---42  
1244--FMT---42  
1245-- N ---73  
1246-- O ---71  
1247-- M ---70  
1248-- . ---21  
1249--CNT---47  
1250-- B ---66  
1251-- O ---71  
1252-- L ---72  
1253--XTO---23  
1254--CNT---47  
1255-- D ---63  
1256-- I ---65  
1257-- A ---62  
1258-- . ---21  
1259--SFL---54  
1260--FMT---42  
1261--STP---41  
1262--PNT---45  
1263-- UP---27  
1264-- 2 ---02  
1265-- X ---36  
1266--XFR---67  
1267-- 3 ---03  
1268-- 9 ---11  
1269-- + ---33  
1270--KEY---30  
1271--FMT---42  
1272--FMT---42  
1273-- B ---66  
1274--YTO---40  
1275--SFL---54  
1276--FMT---42  
1277--PNT---45  
1278--XTO---23  
1279-- 4 ---04  
1280-- 6 ---06  
1281-- n ---56  
1282-- UP---27  
1283--XFR---67  
1284-- 2 ---02  
1285-- 0 ---00  
1286-- X ---36  
1287--FMT---42  
1288--FMT---42  
1289-- N ---73  
1290-- O ---71  
1291-- . ---21

1292--CNT---47  
1293-- B ---66  
1294-- O ---71  
1295-- L ---72  
1296--XTO---23  
1297--YTO---40  
1298-- - ---34  
1299--YTO---40  
1300-- A ---62  
1301-- N ---70  
1302-- E ---60  
1303--CLR---20  
1304-- A ---62  
1305--YTO---40  
1306--CNT---47  
1307-- B ---66  
1308-- E ---60  
1309-- F ---16  
1310-- O ---71  
1311-- a ---13  
1312-- E ---60  
1313--SFL---54  
1314--FMT---42  
1315--STP---41  
1316--PNT---45  
1317--DIV---35  
1318--XFR---67  
1319-- 4 ---04  
1320-- 6 ---06  
1321--X<Y---52  
1322--GTO---44  
1323--S/R---77  
1324--LBL---51  
1325-- J ---75  
1326--XFR---67  
1327-- 4 ---04  
1328-- 4 ---04  
1329--XFR---67  
1330--DIV---35  
1331-- 4 ---04  
1332-- 3 ---03  
1333--XFR---67  
1334--DIV---35  
1335-- 1 ---01  
1336-- 9 ---11  
1337--XFR---67  
1338--DIV---35  
1339-- 1 ---01  
1340-- 9 ---11  
1341--XFR---67  
1342-- X ---36  
1343-- 2 ---02  
1344-- 1 ---01  
1345--FMT---42  
1346--FMT---42  
1347-- O ---71  
1348-- 4 ---56  
1349-- E ---60  
1350-- a ---13  
1351-- A ---62

1352--XTO---23  
1353-- I ---65  
1354-- N ---73  
1355-- G ---15  
1356--CNT---47  
1357--YTO---40  
1358--XTO---23  
1359-- a ---13  
1360-- E ---60  
1361--YTO---40  
1362--YTO---40  
1363--CLR---20  
1364--YTO---40  
1365-- H ---74  
1366--SFL---54  
1367--FMT---42  
1368--PNT---45  
1369--XTO---23  
1370-- 4 ---04  
1371-- 7 ---07  
1372--XFR---67  
1373-- 4 ---04  
1374-- 1 ---01  
1375--XFR---67  
1376-- X ---36  
1377-- 4 ---04  
1378-- 4 ---04  
1379--XFR---67  
1380--DIV---35  
1381-- 4 ---04  
1382-- 3 ---03  
1383--XFR---67  
1384--DIV---35  
1385-- 3 ---03  
1386-- 9 ---11  
1387--XFR---67  
1388--DIV---35  
1389-- 3 ---03  
1390-- 9 ---11  
1391--FMT---42  
1392--FMT---42  
1393--YTO---40  
1394-- a ---13  
1395--SFL---54  
1396--FMT---42  
1397--PNT---45  
1398--XTO---23  
1399-- 4 ---04  
1400-- 8 ---10  
1401--XFR---67  
1402-- 4 ---04  
1403-- 4 ---04  
1404--XFR---67  
1405-- X ---36  
1406-- 3 ---03  
1407-- 8 ---00  
1408--XFR---67  
1409--DIV---35  
1410-- 3 ---03  
1411-- 9 ---11

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1412--XFR---67	1471--FMT---42	1530--YTO---40
1413--DIV---35	1472--FMT---42	1531-- a ---13
1414-- 3 ---03	1473--YTO---40	1532--CNT---47
1415-- 9 ---11	1474-- F ---16	1533-- G ---15
1416-- UP---27	1475-- 0 ---71	1534--XTO---23
1417--XFR---67	1476--SFL---54	1535-- a ---13
1418-- 4 ---04	1477--FMT---42	1536--CNT---47
1419-- 8 ---10	1478--STP---41	1537--YTO---40
1420-- UP---27	1479--PNT---45	1538-- F ---16
1421--XFR---67	1480--X>Y---53	1539-- 0 ---71
1422-- 2 ---02	1481-- 1 ---01	1540--CNT---47
1423-- 9 ---11	1482-- 5 ---05	1541-- π ---56
1424-- X ---36	1483-- 1 ---01	1542-- I ---65
1425-- DN---25	1484-- 9 ---11	1543-- C ---61
1426-- - ---34	1485--FMT---42	1544-- K ---55
1427--XEY---30	1486--FMT---42	1545--CNT---47
1428--FMT---42	1487--YTO---40	1546-- N ---73
1429--FMT---42	1488-- C ---61	1547-- E ---60
1430--YTO---40	1489--CNT---47	1548--IND---31
1431--XTO---23	1490-- G ---15	1549--CNT---47
1432--SFL---54	1491--XTO---23	1550--XTO---23
1433--FMT---42	1492-- a ---13	1551-- H ---74
1434--PNT---45	1493--CNT---47	1552-- I ---65
1435--XTO---23	1494--YTO---40	1553-- C ---61
1436-- 0 ---00	1495-- F ---16	1554-- K ---55
1437-- 9 ---11	1496-- 0 ---71	1555-- N ---73
1438--XFR---67	1497--CNT---47	1556-- E ---60
1439-- 4 ---04	1498-- π ---56	1557--YTO---40
1440-- 7 ---07	1499-- I ---65	1558--YTO---40
1441-- UP---27	1500-- C ---61	1559--CLR---20
1442--XFR---67	1501-- K ---55	1560--CLR---20
1443-- 4 ---04	1502--CNT---47	1561--FMT---42
1444-- 8 ---10	1503-- N ---73	1562--XFR---67
1445-- + ---33	1504-- E ---60	1563-- 0 ---00
1446-- . ---21	1505--IND---31	1564-- 0 ---00
1447-- 5 ---05	1506--CNT---47	1565-- 9 ---11
1448-- X ---36	1507--XTO---23	1566--X<Y---52
1449--XFR---67	1508-- H ---74	1567-- 1 ---01
1450-- 4 ---04	1509-- I ---65	1568-- 6 ---06
1451-- 7 ---07	1510-- C ---61	1569-- 0 ---00
1452-- UP---27	1511-- K ---55	1570-- 5 ---05
1453--XFR---67	1512-- H ---73	1571--FMT---42
1454-- 0 ---00	1513-- E ---60	1572--FMT---42
1455-- 9 ---11	1514--YTO---40	1573--YTO---40
1456-- + ---33	1515--YTO---40	1574--XTO---23
1457-- . ---21	1516--CLR---20	1575--CNT---47
1458-- 5 ---05	1517--CLR---20	1576-- G ---15
1459-- X ---36	1518--FMT---42	1577--XTO---23
1460-- DN---25	1519-- UP---27	1578-- a ---13
1461--X<Y---52	1520--XFR---67	1579--CNT---47
1462-- 1 ---01	1521-- 4 ---04	1580--YTO---40
1463-- 8 ---10	1522-- 8 ---10	1581-- F ---16
1464-- 7 ---07	1523--X<Y---52	1582-- 0 ---71
1465-- 8 ---10	1524-- 1 ---01	1583--CNT---47
1466--GTO---44	1525-- 5 ---05	1584-- π ---56
1467-- 1 ---01	1526-- 6 ---06	1585-- I ---65
1468-- 8 ---10	1527-- 2 ---02	1586-- C ---61
1469-- 7 ---07	1528--FMT---42	1587-- K ---55
1470-- 9 ---11	1529--FMT---42	1588--CNT---47
		1589-- N ---73

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1650-- I ---65	1590-- E ---60	1710-- 5 ---05
1651-- C ---61	1591--IND---31	1711--XFR---67
1652-- K ---55	1592--CNT---47	1712--DIV---35
1653--CLR---20	1593--XTO---23	1713-- 4 ---04
1654--CLR---20	1594-- H ---74	1714-- 3 ---03
1655--FMT---42	1595-- I ---65	1715--XFR---67
1656--XFR---67	1596-- C ---61	1716--DIV---35
1657-- 4 ---04	1597-- K ---55	1717-- 3 ---03
1658-- 5 ---05	1598-- N ---73	1718-- 9 ---11
1659--XFR---67	1599-- E ---60	1719--XFR---67
1660--DIV---35	1600--YTO---40	1720--DIV---35
1661-- 4 ---04	1601--YTO---40	1721-- 3 ---03
1662-- 3 ---03	1602--CLR---20	1722-- 9 ---11
1663--XFR---67	1603--CLR---20	1723--FMT---42
1664--DIV---35	1604--FMT---42	1724--FMT---42
1665-- 1 ---01	1605--XFR---67	1725--YTO---40
1666-- 9 ---11	1606-- 0 ---00	1726-- 0 ---13
1667--XFR---67	1607-- 4 ---04	1727-- G ---15
1668--DIV---35	1608-- 7 ---07	1728--SFL---54
1669-- 1 ---01	1609--XEY---30	1729--FMT---42
1670-- 9 ---11	1610-- UP---27	1730--PNT---45
1671--XFR---67	1611-- 1 ---01	1731--XTO---23
1672-- X ---36	1612-- . ---21	1732-- 1 ---01
1673-- 0 ---00	1613-- 5 ---05	1733-- 1 ---01
1674-- 2 ---02	1614-- X ---36	1734--XFR---67
1675-- 1 ---01	1615-- DN---25	1735-- 4 ---04
1676--FMT---42	1616--X>Y---53	1736-- 5 ---05
1677--FMT---42	1617-- 1 ---01	1737--XFR---67
1678-- F ---16	1618-- 6 ---06	1738-- X ---36
1679-- 0 ---71	1619-- 5 ---05	1739-- 3 ---03
1680-- 0 ---13	1620-- 6 ---06	1740-- 0 ---00
1681--CNT---47	1621--FMT---42	1741--XFR---67
1682-- G ---15	1622--FMT---42	1742--DIV---35
1683-- A ---62	1623--YTO---40	1743-- 3 ---03
1684--YTO---40	1624-- H ---74	1744-- 9 ---11
1685-- K ---55	1625--CNT---47	1745--XFR---67
1686-- E ---60	1626-- G ---15	1746--DIV---35
1687--XTO---23	1627--XTO---23	1747-- 3 ---03
1688--CNT---47	1628-- 0 ---13	1748-- 9 ---11
1689--YTO---40	1629--CNT---47	1749-- UP---27
1690-- E ---60	1630-- 1 ---01	1750--XFR---67
1691-- A ---62	1631-- . ---21	1751-- 1 ---01
1692--XTO---23	1632-- 5 ---05	1752-- 1 ---01
1693--CNT---47	1633--X<Y---52	1753-- UP---27
1694--CLR---20	1634--YTO---40	1754--XFR---67
1695--YTO---40	1635-- F ---16	1755-- 2 ---02
1696-- H ---74	1636-- 0 ---71	1756-- 9 ---11
1697-- G ---15	1637--PSE---57	1757-- X ---36
1698--SFL---54	1638--CLR---20	1758-- DN---25
1699--FMT---42	1639-- 4 ---56	1759-- - ---34
1700--PNT---45	1640-- I ---65	1760--XEY---30
1701--XTO---23	1641-- C ---61	1761--FMT---42
1702-- 1 ---01	1642-- K ---55	1762--FMT---42
1703-- 0 ---00	1643--CNT---47	1763--YTO---40
1704--XFR---67	1644-- N ---73	1764--XTO---23
1705-- 4 ---04	1645-- E ---60	1765-- G ---15
1706-- 1 ---01	1646--IND---31	1766--SFL---54
1707--XFR---67	1647--CNT---47	1767--FMT---42
1708-- X ---36	1648--XTO---23	1768--PNT---45
1709-- 4 ---04	1649-- H ---74	1769--XTO---23

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1770-- 1 ---01  
1771-- 2 ---02  
1772--XFR---67  
1773-- 1 ---01  
1774-- 0 ---00  
1775-- UP---27  
1776--XFR---67  
1777-- 1 ---01  
1778-- 1 ---01  
1779-- + ---33  
1780-- . ---21  
1781-- 5 ---05  
1782-- X ---36  
1783--XFR---67  
1784-- 1 ---01  
1785-- 0 ---00  
1786-- UP---27  
1787--XFR---67  
1788-- 1 ---01  
1789-- 2 ---02  
1790-- + ---33  
1791-- . ---21  
1792-- 5 ---05  
1793-- X ---36  
1794-- DN---25  
1795--XKY---52  
1796--XEY---30  
1797--CNT---47  
1798--CNT---47  
1799--CNT---47  
1800--FMT---42  
1801--FMT---42  
1802--YTO---40  
1803-- C ---61  
1804-- G ---15  
1805--SFL---54  
1806--FMT---42  
1807--PNT---45  
1808--GTO---44  
1809-- 1 ---01  
1810-- 8 ---10  
1811-- 9 ---11  
1812-- 2 ---02  
1813--LBL---51  
1814-- J ---75  
1815--DIV---35  
1816--XEY---30  
1817-- r ---76  
1818-- UP---27  
1819-- UP---27  
1820--XFR---67  
1821-- 4 ---04  
1822-- 4 ---04  
1823-- X ---36  
1824-- DN---25  
1825--XTO---23  
1826-- 4 ---04  
1827-- 4 ---04

1828--XFR---67  
1829-- 4 ---04  
1830-- 5 ---05  
1831-- X ---36  
1832--XEY---30  
1833--XTO---23  
1834-- 4 ---04  
1835-- 5 ---05  
1836--S/R---77  
1837--FMT---42  
1838--FMT---42  
1839-- G ---15  
1840-- 1 ---01  
1841--DIV---35  
1842-- G ---15  
1843-- 0 ---71  
1844--SFL---54  
1845--FMT---42  
1846--GTO---44  
1847-- 0 ---00  
1848-- 8 ---10  
1849-- 8 ---10  
1850-- 8 ---10  
1851--FMT---42  
1852--FMT---42  
1853-- H ---74  
1854--DIV---35  
1855-- H ---74  
1856-- 0 ---71  
1857--SFL---54  
1858--FMT---42  
1859--GTO---44  
1860-- 0 ---00  
1861-- 9 ---11  
1862-- 2 ---02  
1863-- 6 ---06  
1864--XFR---67  
1865-- X ---36  
1866-- 3 ---03  
1867--XFR---67  
1868-- X ---36  
1869-- 4 ---04  
1870--XFR---67  
1871-- X ---36  
1872-- 1 ---01  
1873--GTO---44  
1874-- 0 ---00  
1875-- 1 ---01  
1876-- 1 ---01  
1877-- 9 ---11  
1878--XEY---30  
1879--FMT---42  
1880--FMT---42  
1881--YTO---40  
1882-- C ---61  
1883--SFL---54  
1884--FMT---42  
1885--PNT---45  
1886-- UP---27

1887--GTO---44  
1888-- 1 ---01  
1889-- 4 ---04  
1890-- 7 ---07  
1891-- 1 ---01  
1892-- UP---27  
1893--FMT---42  
1894--FMT---42  
1895--YTO---40  
1896-- F ---16  
1897-- A ---62  
1898--SFL---54  
1899--FMT---42  
1900--STP---41  
1901--PNT---45  
1902--XKY---52  
1903-- 1 ---01  
1904-- 9 ---11  
1905-- 3 ---03  
1906-- 0 ---00  
1907--FMT---42  
1908--FMT---42  
1909--YTO---40  
1910-- G ---15  
1911-- C ---61  
1912--CNT---47  
1913-- G ---15  
1914--XTO---23  
1915-- a ---13  
1916--CNT---47  
1917--YTO---40  
1918-- F ---16  
1919-- A ---62  
1920--CLR---20  
1921-- N ---73  
1922-- E ---60  
1923--IND---31  
1924--CNT---47  
1925--XTO---23  
1926-- K ---55  
1927--CLR---20  
1928--CLR---20  
1929--FMT---42  
1930-- UP---27  
1931--XFR---67  
1932-- 1 ---01  
1933-- 1 ---01  
1934--XKY---52  
1935-- 1 ---01  
1936-- 9 ---11  
1937-- 6 ---06  
1938-- 2 ---02  
1939--FMT---42  
1940--FMT---42  
1941--YTO---40  
1942-- a ---13  
1943-- G ---15  
1944--CNT---47  
1945-- G ---15

DESIGN OF  
WELDING NECK  
FLANGES

1946--XTO---23	1994-- 5 ---05
1947-- a ---13	1995-- X ---36
1948--CNT---47	1996--XFR---67
1949--YTO---40	1997-- 1 ---01
1950-- F ---16	1998-- 0 ---00
1951-- A ---62	1999--X<Y---52
1952--CLR---20	2000-- 2 ---02
1953-- N ---73	2001-- 0 ---00
1954-- E ---60	2002-- 2 ---02
1955--IND---31	2003-- 9 ---11
1956--CNT---47	2004--FMT---42
1957--XTO---23	2005--FMT---42
1958-- K ---55	2006--YTO---40
1959--CLR---20	2007-- H ---74
1960--CLR---20	2008-- G ---15
1961--FMT---42	2009--CNT---47
1962--XFR---67	2010-- G ---15
1963-- 1 ---01	2011--XTO---23
1964-- 2 ---02	2012-- a ---13
1965--X<Y---52	2013--CNT---47
1966-- 1 ---01	2014-- 1 ---01
1967-- 9 ---11	2015-- . ---21
1968-- 9 ---11	2016-- 5 ---05
1969-- 2 ---02	2017--YTO---40
1970--FMT---42	2018-- F ---16
1971--FMT---42	2019-- A ---62
1972--YTO---40	2020--CLR---20
1973--XTO---23	2021-- N ---73
1974-- G ---15	2022-- E ---60
1975--CNT---47	2023--IND---31
1976-- G ---15	2024--CNT---47
1977--XTO---23	2025--XTO---23
1978-- a ---13	2026-- K ---55
1979--CNT---47	2027--CLR---20
1980--YTO---40	2028--FMT---42
1981-- F ---16	2029--GTO---44
1982-- A ---62	2030-- 1 ---01
1983--CLR---20	2031-- 0 ---00
1984-- N ---73	2032-- 8 ---10
1985-- E ---60	2033-- 2 ---02
1986--IND---31	2034--END---46
1987--CNT---47	
1988--XTO---23	
1989-- K ---55	
1990--CLR---20	
1991--FMT---42	
1992-- 1 ---01	
1993-- . ---21	

## CONCLUDING REMARKS

This computer aided design program presents an "interactive" procedure for the engineer utilizing the electronic desk top calculator to obtain the optimum circular, integral or optional type flanges under internal pressure. The design criteria meets the requirements of the 1971 ASME Pressure Vessel Code. This program provides the flexibility of comparing the computed stresses for a selected flange thickness to the allowed code value for a given geometry. Since the design equations for loose, non-circular and split flanges subject to internal and external pressure are similar to the integral and optional type flange, this program could easily be modified and adapted to those types of design. The other types of flanges in conjunction with different gasket and outer rim contacts are not as easily programmed but the general outline and procedure is valid.

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