SDC SOLENOID DESIGN NOTE 178 (EAR # 38)

TITLE: A Flange Design Based on ASME Code

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INTRODUCTION: This design note contains ASME code [1] calculations for the chimney nozzle of the SDC solenoid vacuum vessel shown in Figure 1. The top flange (not shown) is a blind flange with 15 psi pressure acting on the top, and the lower flange is subjected to an external pressure of 15 psi. The 12" pipe is considered to be a shell with an external pressure of 15 psi. Results are shown in Table 1; calculation details are in the Appendix.

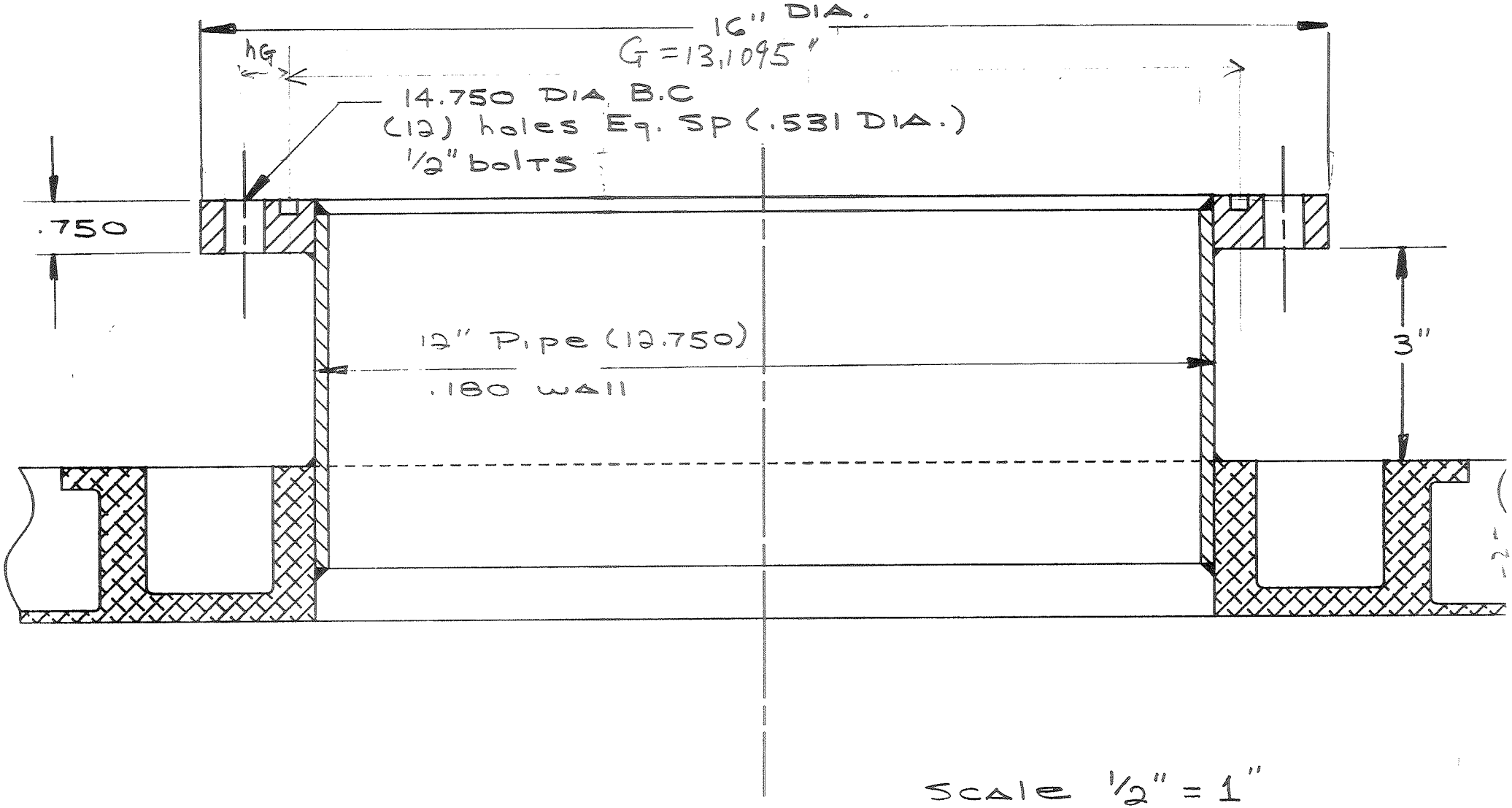
Table 1 ASME--- Current design

Component	Material	ASME Code	Current Design	Adequate
Blind Flange	5083-0	t(min)=0.3184"(a)	tc=0.75"	yes
Lower Flange	5083-0	t(min)=0.283" (b)	tc=0.75"	yes
12" Pipe	5083-0	Pa=132 psi (c)	Pc=15 psi	yes
Bolt(12x1/2")	stainless steel	A(min)=0.09 in^2 (d)	Ac=1.639 in^2	yes

Note: (a)UG-34; (b) App. 2-11; (c) UG-28; (d) App. 2-5. in ASME Sec VIII, DIV. 1

REFERENCE:

1. ASME boiler and Pressure Vessel Code, Section VIII, Division 1, American Society of Mechanical Engineers, New York, 1987



Scale 1/2" = 1"

Alum. 5083-H321

Fig 1

Based ASME Code: DIV. VIII, Section-1 UG-34.

Eq-2 for Blind Flange, the thickness of the Blind Flange: t:

$$t = d\sqrt{\frac{C \cdot P}{SE} + 1.9\, w \cdot \frac{h_G}{SEd^3}} \qquad (2).$$

where: p — operating pressure 15 psi.

S — Allowable STRESS for SA3-0 (10. KSI.) (UNF-23.1)

E — Joint Eff. =1

C — factor 0.3 (Sketch 4. P.38).

h_G — The distance between Bolt center and gasket center

$$h_G = \frac{14.750'' - 13.1095''}{2} = 0.82''$$

d: — diameter of gasket center 13.1095''

$W = W_{m1}$ (2-5(e): equation-3)

where: $W_{m1} = 0.785\,G^2 \cdot P = 0.785 \times (13.1095'')^2 \times 15$

$= 2023.63$ (lbf). FOR

<u>substitute them into Eq 1</u>

$$t = d\sqrt{\frac{C \cdot P}{SE} + 1.9\,W \cdot \frac{h_G}{SE\,d^3}}$$

$$= 13.1095\sqrt{\frac{0.3 \times 15}{10{,}000 \times 1} + 1.9 \times 2023.63 \cdot \frac{0.82}{10{,}000 \times 1 \times 13.1095^3}}$$

$= 0.3184''$

$$\boxed{t_{min} = 0.3184''}$$

Based ASME DIV VIII Sec: 1 appendix 2-11

"flange subjected to external pressure" 7.537;

total moment M_o

$$M_o = H_D (h_D - h_G) + H_T (h_T - h_G)$$

for operating condition

where $H_D = 0.785\, B^2 \cdot P_e$

$H_T = H - H_D$

$H = 0.785\, G^2 \cdot P_e$

B: — inside diameter of flange $= 12'' - 0.18'' - 0.18'' = 11.64''$

G: — diameter of gasket center line $13.1095''$.

$$H_D = 0.785\, B^2 \cdot P_e = 0.785 \times 11.64^2 \times 15 = 1595.4$$

$$H = 0.785\, G^2 \cdot P_e = 0.785 \times 13.1095^2 \times 15 = 2023.63$$

$$H_T = H - H_D = 2023.63 - 1595.4 = 428$$

$$\boxed{H_D = 1595.4, \quad H_T = 428}$$

$$h_D = \frac{C-B}{2} = \frac{14.750 - 11.64}{2} = 1.555''$$

where: C: — diameter of Bolt circle. 14.75''

B: — inside diameter flange.

$$h_G = \frac{C-G}{2} = \frac{14.75'' - 13.1095''}{2} = 0.8202''$$

G: — diameter of gasket circle. 13.1095''.

$$h_T = \frac{h_D + h_G}{2} = \frac{0.8202 + 1.555}{2} = 1.188.$$

Then Total Moment M_o.

$$M_o = H_D.(h_D - h_G) + H_T(h_T - h_G)$$

$$= 1595.4(1.555 - 0.8202) + 428(1.188 - 0.8202)$$

$$= 1329.7.$$

Based ASME 2-7 ①, for loose type flanges.

without hubs.

$$S_T = \frac{Y M_0}{t^2 \cdot B}$$

where Y is determined from Fig 2-7.1 based ($K = \frac{A}{B}$)
(pp. 521).

A: outside diameter of large. 16''.

$$K = \frac{A}{B} = \frac{16''}{11.64''} = 1.3745$$

$Y \approx 7$.

$$S_T = \frac{Y M_0}{t^2 \cdot B} < S_f$$

where: S_f — allowable stress from Table UNF-23.1.

For 508 3-0 : $S_f = 10$ ksi

$$\therefore \quad t \geq \sqrt{\frac{Y M_0}{S_f \cdot B}} = \sqrt{\frac{7 \times 1329.7}{10{,}000 \times 11.64}} = 0.283$$

$$\boxed{t_{MIN} = 0.283''}$$

Based ASME, DIV. VIII. Sec-1, UG-28,

"Shell subjected To a External Pressure",

$$\frac{D_o}{t} = \frac{12''}{0.18''} = 66.66 > 10 .$$

AND. $$\frac{L}{D_o} = \frac{3}{12} = 0.25 .$$

From. Fig 5-UGO-28.0 P.549

$$A = 0.0125$$

From Fig 5-UNF-28.23. P.561 (curve ⑥).

$$B = 6700 .$$

$$\therefore \quad P_a = \frac{4B}{3\left(\frac{D_o}{t}\right)} = \frac{4 \times 6700}{3\left(\frac{12}{0.18}\right)} = 134 \text{ PSI}$$

$$\boxed{P_a = 134 \text{ PSI}}$$

Based Appendix 2-5 (c) ③.

$$W_{m1} = H = 0.785 G^2 P = 0.785 \times 131.095^2 \times 15$$

$$= 2023.63.$$

Bolt Material 316 stainless steel, Tensile strength = 90,000 psi

AND. Allowable stress. $S = \frac{90,000}{4} = 22,500$ psi

MIN. Bolt Area:

$$A_{MIN} = \frac{W_{m1}}{S} = \frac{2023.63}{22,500} = 0.08993 \text{ in}^2$$

where: $d_{minor} = 0.419''$