



ویسٹ فادرلٹی اسٹریٹر - سرمد ہاؤس ہوسٹل

Data:

Design pressure : 7 bar

Shell: A53 Gr B - NPS 20 - Sch 40

Nozzle: SA-53 Gr B - NPS 12 - Sch 40

Design Temp: 50°C

CET = Critical Exposure Temperature
= 10°C

Flat Head: SA-283 Gr C - t_{HK} = 14mm

note: The Flat head will be replaced
by ellipsoidal head

Step ①: References:

1- ASME Sec VIII - Div 1:

UG-16	UG-36
UG-27	UG-37
UG-45	UG-40
Appendix A	UG-22

2- ASME Sec II - Part D - Table 1A

Step 2: Nozzle Consideration : Conventional or Large Opening

OPENINGS AND REINFORCEMENTS

UG-36 OPENINGS IN PRESSURE VESSELS

(a) Shape of Opening²⁷

(1) Openings in cylindrical or conical portions of vessels, or in formed heads, shall preferably be circular, elliptical, or obround.²⁸ When the long dimension of an elliptical or obround opening exceeds twice the short dimensions, the reinforcement across the short dimensions shall be increased as necessary to provide against excessive distortion due to twisting moment.

(2) Openings may be of other shapes than those given in (1) above, and all corners shall be provided with a suitable radius. When the openings are of such proportions that their strength cannot be computed with assurance of accuracy, or when doubt exists as to the safety of a vessel with such openings, the part of the vessel affected shall be subjected to a proof hydrostatic test as prescribed in UG-101.

(b) Size of Openings

(1) Properly reinforced openings in cylindrical and conical shells are not limited as to size except with the following provisions for design. The rules in UG-36 through UG-43 apply to openings not exceeding the following: for vessels 60 in. (1 520 mm) inside diameter and less, one-half the vessel diameter, but not to exceed 20 in. (510 mm); for vessels over 60 in. (1 520 mm) inside diameter, one-third the vessel diameter, but not to exceed 40 in. (1 020 mm). (For conical shells, the inside shell diameter as used above is the cone diameter at the center of the opening.) For openings exceeding these limits, supplemental rules of 1-7 shall be satisfied in addition to the rules of this paragraph.

UG-36 (b)

Conventional opening

$$1 - ID_{shell} \leq 60''$$

$$opening \leq \frac{1}{2} ID_{shell} \text{ or } 20''$$

min

$$2 - ID_{shell} > 60''$$

$$opening \leq \frac{1}{3} ID \text{ or } 40''$$

min

$$ID_{shell} = 18.812$$

NPS 20-Sch40

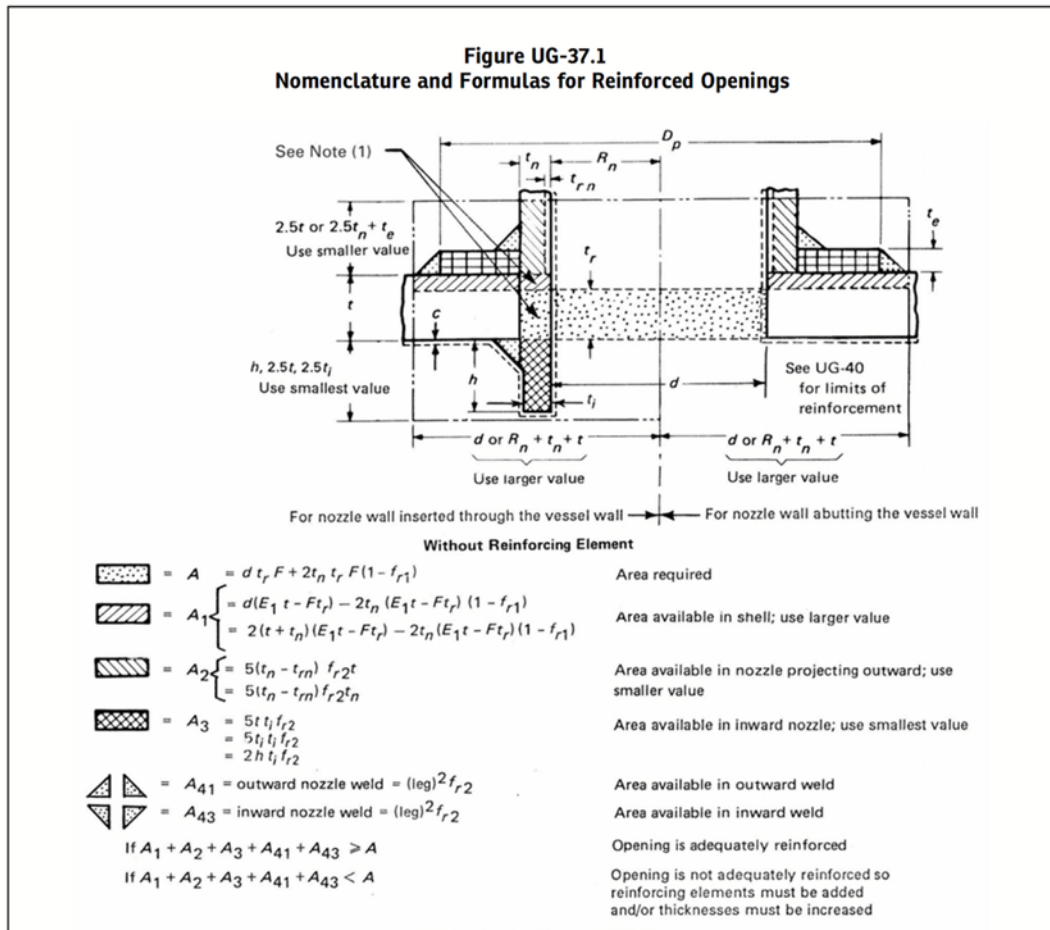
$$\Rightarrow \text{max opening size} = \frac{1}{2} \times 18.812 \text{ or } 20''$$

$$= 9''$$

$\Rightarrow$ It shall be considered as Large Opening and 1-7 shall take account at calculations



Step 3 - Reinforcement Calculation Based on the UG-37



The Required Area:

$$A = d t_r F + 2 t_n t_r F (1 - f_{r1})$$

Nozzle: pipe NPS 12

$$\Rightarrow OD = 12.75$$

d = finished diameter of circular opening or finished dimension (chord length at mid-surface of thickness excluding excess thickness available for reinforcement) of nonradial opening in the plane under consideration, in. (mm) [see Figures UG-37.1 and UG-40]

$$\Rightarrow d = 12.75 + 2 \times C.A$$

$$= 12.75 + 2 \times 0.118"$$

$$= 12.99 \text{ inch} \quad \checkmark$$

$$C.A = 3 \text{ mm} = 0.118"$$

t_r = required thickness of a seamless shell based on the circumferential stress, or of a formed head, computed by the rules of this Division for the designated pressure, using $E = 1$, and, for shells fabricated from welded pipe or tubing, the allowable stress of the corresponding seamless product form. If there is no corresponding seamless product form, use the allowable stress for the welded product form divided by 0.85, except that

t_r = shell mkt

$$= \max(UG-16, 22, 27)$$

$$\underline{UG-16} \leadsto t_r = \underline{1.5 \text{ mm}} = 0.06''$$

$$\underline{UG-27} \leadsto t_r = \frac{PD}{2SE + 0.8p} = \frac{7 \times 14.5 \times 20''}{2 \times 17100 \times 1 + 0.8 \times 7 \times 14.5}$$

$$S = 17100 \text{ psi} \quad = \underline{0.0592}$$

$$E = 1$$

$$p = 7 \text{ bar}$$

$$\underline{UG-22} : \text{Supplemental Thickness} = \underline{0.12''}$$

or
ASME FFS-1 - Annex 2c

$$\Rightarrow t_r = \max(0.06, 0.0592, 0.12'')$$

$$\Rightarrow t_r = 0.12'' \quad \checkmark$$

$$A = dt_r F + 2t_n t_r F (1 - f_{r1})$$

$$F = ?$$

F = correction factor that compensates for the variation in internal pressure stresses on different planes with respect to the axis of a vessel. A value of 1.00 shall be used for all configurations except that [Figure UG-37](#) may be used for integrally reinforced openings in cylindrical shells and cones. [See [UG-16\(c\)\(1\)](#).]

$$\Rightarrow F = 1 \quad \checkmark$$

$$t_n = ?$$

nozzle wall

t_n = nozzle wall thickness.²⁹ Except for pipe, this is the wall thickness not including forming allowances. For pipe, use the nominal thickness [see [UG-16\(d\)](#)].

$$\Rightarrow t_n = \text{Nozzle Nominal Thick.} - \text{Undertolerance}$$

$$= 0.406 - 0.406 \times 0.125 = 0.355$$

$$\Rightarrow t_n = 0.355 \quad \checkmark$$

$$A = dt_r F + 2t_n t_r F (1 - f_{r1})$$

$$f_{r1} = ?$$

$f_{r1} = S_n/S_v$ for nozzle wall inserted through the vessel wall
= 1.0 for nozzle wall abutting the vessel wall and for nozzles shown in Figure UG-40, sketch (j), (k), (n), and (o).

$$S_n = S_v$$

$$\Rightarrow f_{r1} = 1$$

$$\Rightarrow A = \checkmark$$

$$A = dt_r F + 2t_n t_r F (1 - f_{r1})$$

$$\Rightarrow A = 12.99 \times 0.12 \times 1 + 2 \times 0.355 \times 0.12 \times 1 \times (1 - 1)$$

$$\Rightarrow A = 1.599 \quad \checkmark$$

Now, we shall consider the excess areas

$$A_1, A_2, A_3, A_{41}, A_{43}$$

If $A_1 + A_2 + A_3 + A_{41} + A_{43} \geq A$

If $A_1 + A_2 + A_3 + A_{41} + A_{43} < A$

Opening is adequately reinforced

Opening is not adequately reinforced so reinforcing elements must be added and/or thicknesses must be increased

$$\begin{aligned} \text{[Patterned Box]} &= A = d t_r F + 2 t_n t_r F (1 - f_{r1}) \\ \text{[Hatched Box]} &= A_1 \begin{cases} = d(E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1}) \\ = 2(t + t_n)(E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1}) \end{cases} \end{aligned}$$

$$\text{max } A_1 \begin{cases} = 12.99 \times (1 \times 0.520 - 1 \times 0.12) = 5.196 \\ \text{or} \\ = 2(0.520 + 0.355) \times (1 \times 0.520 - 1 \times 0.12) = 0.684 \end{cases}$$

$$\Rightarrow A_1 = 5.196'' \quad \checkmark$$

$$A_2 = ?$$

$$\text{[Hatched Box]} = A_2 \begin{cases} = 5(t_n - t_{rn}) f_{r2} t \\ = 5(t_n - t_{rn}) f_{r2} t_n \end{cases}$$

$$t_n = 0.355$$

$$f_{r2} \quad \begin{matrix} \text{sketch (j),} \\ f_{r2} = S_n / S_v \end{matrix} \quad \Rightarrow f_{r2} = 1$$

$$t_{rn} = ? = \text{nozzle MAT}$$

$$= \text{max}(UG-16, UG-27, UG-22, UG-45)$$

$$UG-16 = 0.06''$$

$$UG-27 \quad t_n = \frac{PD}{2SE + 0.8P} = \frac{7 \times 145 \times 12.75}{2 \times 17100 \times 1 + 0.8 \times 7 \times 145}$$

$$= 0.377$$

$$UG-22 = \text{Supplemental THK by ASME FFS-1 - Annex 2C}$$

$$= 0.11''$$

$$UG-45 \quad t_n = 0.328$$

$$\Rightarrow t_n = \text{Max} = 0.328'' \quad \checkmark$$

$$A_3 = ?$$

$$\begin{aligned} L &= 5(t_n - t_m) r_2 t_n \\ \text{[Cross-hatched rectangle]} &= A_3 = 5t t_j f_{r2} \\ &= 5t_j t_j f_{r2} \\ &= 2h t_j f_{r2} \end{aligned}$$

projection Area

$$= 0 \text{ mm}$$

$$A_{41} = ?$$

$$A_{43} = ?$$

$$\begin{aligned} &= 2n t_j r_2 \\ \text{[Two triangles pointing outwards]} &= A_{41} = \text{outward nozzle weld} = (\text{leg})^2 f_{r2} \\ \text{[Two triangles pointing inwards]} &= A_{43} = \text{inward nozzle weld} = (\text{leg})^2 f_{r2} \end{aligned}$$

$$\underline{A_{41}} = (0.406)^2 \times 1 = 0.164 \quad \checkmark$$

$$A_{43} = \text{projection Area} = 0 \text{ mm}^8$$

If $A_1 + A_2 + A_3 + A_{41} + A_{43} \geq A$
If $A_1 + A_2 + A_3 + A_{41} + A_{43} < A$

Opening is adequately reinforced

Opening is not adequately reinforced so
reinforcing elements must be added
and/or thicknesses must be increased

With Reinforcing Element Added

$$\Rightarrow A_1 + A_2 + A_3 + A_{41} + A_{43} \geq A$$

$$\Rightarrow 5.196 + 0.048 + 0 + 0.164 + 0 \geq 1.599 \quad \checkmark$$

$\Rightarrow$ By UG-37 No Reinforcement is required

 But opening 12" from shell ID = 18.812
is assumed as Large opening and Refer to
Appendix 1 clause 7.

1-7 LARGE OPENINGS IN CYLINDRICAL AND CONICAL SHELLS

(a) Openings exceeding the dimensional limits given in UG-36(b)(1) shall be provided with reinforcement that complies with the following rules. Two-thirds of the required reinforcement shall be within the following limits:

(1) parallel to vessel wall: the larger of three-fourths times the limit in UG-40(b)(1), or equal to the limit in UG-40(b)(2);

(2) normal to vessel wall: the smaller of the limit in UG-40(c)(1), or in UG-40(c)(2).

(b) In addition to meeting the requirements of (a),

 $\Rightarrow$ All Large Opening
shall be provided
by Reinforcement

