CHAPTER 6: WELD SIZING AND SPACING IN TANKS

First let me ask you a question: In which plane are tank shell stresses higher, in a vertical or a horizontal plane...?

Weld spacing in tanks depends on several factors. First, the extent of the HAZ (Heat affected zone) of a weld, in which the magnitude of property change depends primarily on the base material, the weld filler metal, and the amount and concentration of heat input by the welding process. And second, and most importantly, weld spacing depends on the magnitude of the stress of the joint being considered.

Let´s go to the meat. That´s it, what the BOK for the API 653 says is this:

> The inspector should be familiar with determining the sizes and spacing of welds for shell openings to the extent of being able to use the information in the following Figures and Tables:
>
> a) API-650, Figures 5-7A, 5-7B, 5-8, 5-9, 5-12, 5-14, 5-16, 5-17, 5-19, 5-20, 5-21
>
> b) API-650, Tables 5-6, 5-7, 5-9
>
> c) API-653, Figures 9-1, 9-2, 9-4, 9-5

Watching this tables and figures in the standards, you can see that questions for them will rather be made in the open book part of the exam, as difficult it is to illustrate it is to remember.

Therefore, the bulk of tables and figures in this part of the BOK is not treated in this book

For example, check the following, based on figure 9-1 of API 653. This is for shells thinner than 0.5in.

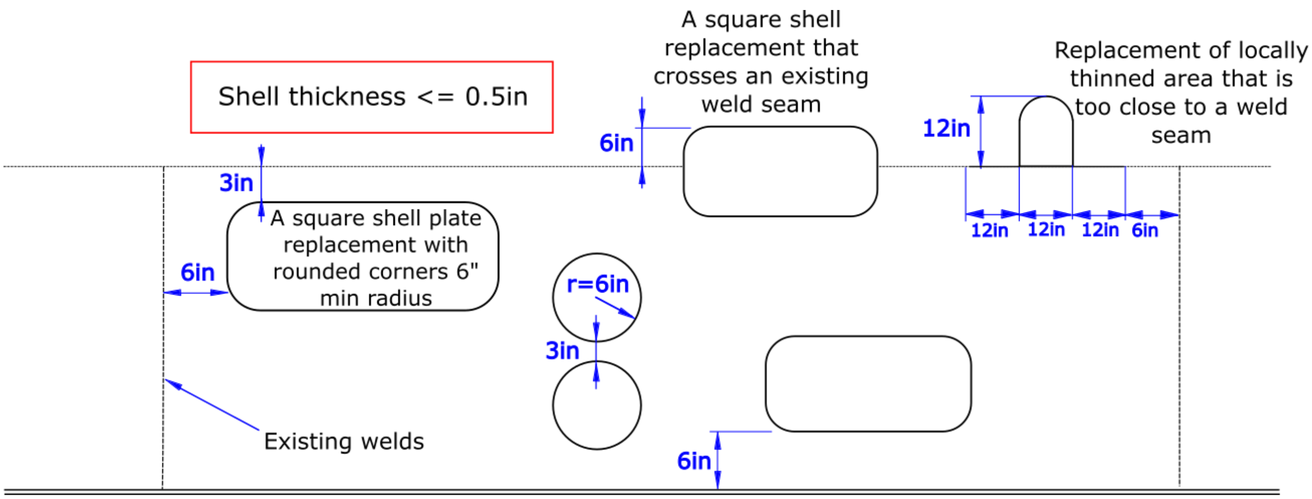


FIGURE 11. FIGURE 9.1-WELD SPACING REQUIREMENTS OF A SHELL 0.5IN OR LOWER

The following figure and table (9) stablishes minimum weld spacing between the toes of welds for thickness of replacement shell plate for sets of thickness above and below 0.5*in*.

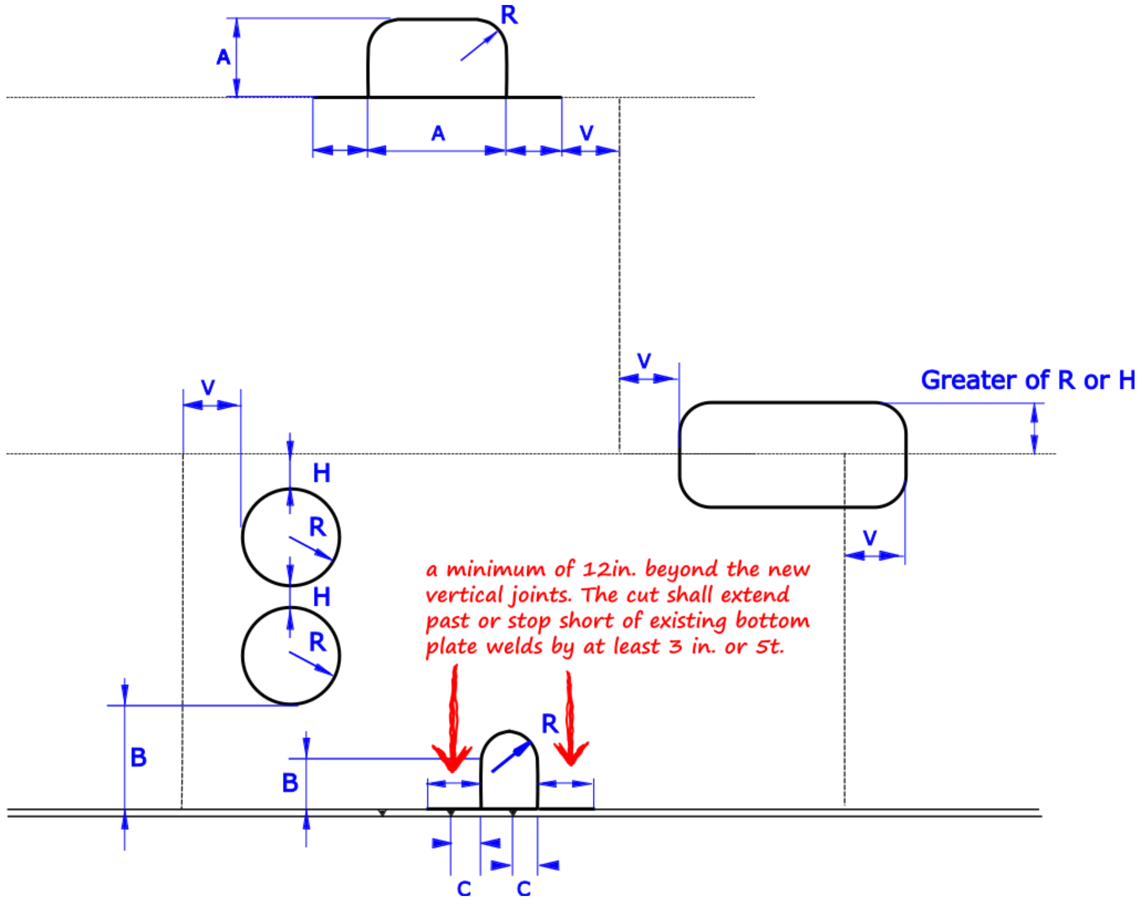
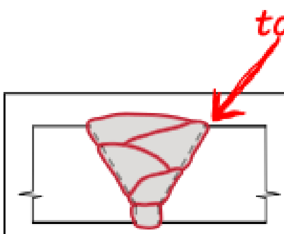


FIGURE 12, FIGURE 9-1 -WELD SPACING IN GENERAL (WORKS WITH THE FOLLOWING TABLE)



Dimension	Minimum Weld Spacing Between Toes of Welds for Thickness of replacement Shell Plate, *t* , (inches)	
	t<=0.5in	*t*>0.5in
R	6in	Greater of 6in. or 6*t*
B	6in	Greater of 10in. or 8*t*
H	3in	Greater of 10in. or 8*t*
V	6in	Greater of 10in. or 8*t*
A	12in	Greater of 12in. or 12*t*
C	Greater of 3in. or 5*t*	

FIGURE 13 - WELD SPACING (WORKS WITH FIGURE 9-1 OF API 653)

You can see that, in general, weld spacing is higher related to vertical joints. The vertical spacing also dictates the sizes of rounded corners.

Arrived to this point, I think it is important to remember the formulas for longitudinal and circumferential stress in a thin walled cylindrical vessel like large tanks are.

Following are the equations used to calculate the stress of a thin wall vessel with an internal pressure. The forces related are a consequence of pressure inside the cylindrical vessel.

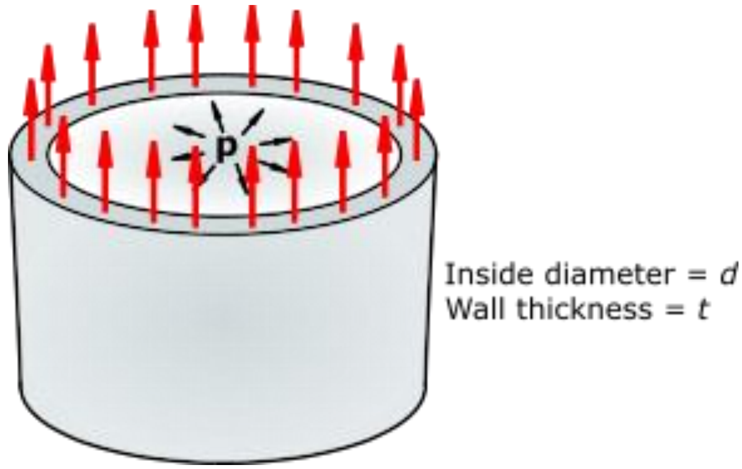


FIGURE 14 - HORIZONTAL STRESS IN A THIN WALL VESSEL

Considering pressure stresses only, the longitudinal weld force P, resulting from internal pressure p, acting on a thin wall tank of thickness t, length l, and diameter d is:

$$\text{Eq. 24.} \quad P = \frac{p\pi d^2}{4}$$

Where P= force tending to rupture the tank horizontally.
If a= area of metal resisting longitudinal force, then

$$\text{Eq. 25.} \quad a = t\pi d$$

Then

$$\text{Eq. 26.} \quad S = \frac{P}{a} = \frac{p\pi d^2/4}{t\pi d} = \frac{pd}{4t}$$

Where S = stress on the wall of the tank
Solving for t

$$\text{Eq. 26.} \quad t = \frac{pd}{4S}$$

Considering pressure stress only, the following analysis can be made.

Where P = force tending to rupture the tank vertically.

$$P = pdl \quad \text{(Eq. 27)}$$

If a = area of metal resisting vertical force, then

$$a = 2tl \quad \text{(Eq. 28)}$$

Then

$$S = \frac{p}{a} = \frac{pdl}{2tl} = \frac{pd}{2t} \quad \text{(Eq. 29)}$$

(Space intentionally left blank)

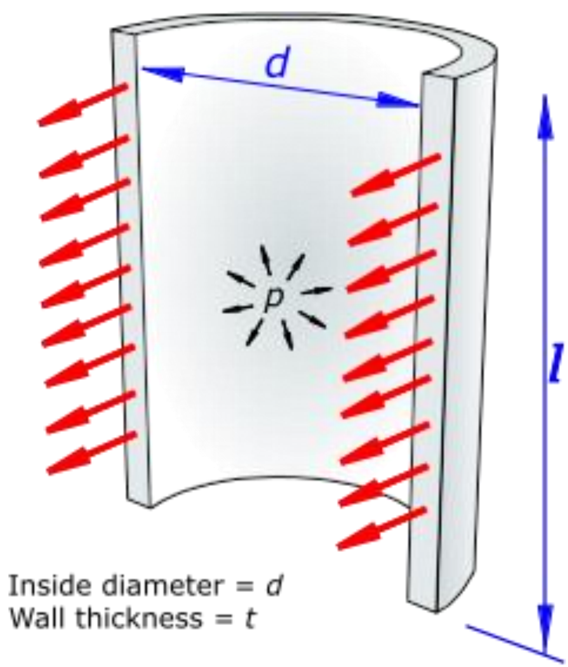


FIGURE 15 VERTICAL STRESS IN A THIN WALL VESSEL

Where S = stress on the wall of the tank

Solving for t

$$t = \frac{pd}{2S} \quad \text{(Eq. 30)}$$

From these equations, you can see that vertical stress is twice as high as horizontal stress. It is more likely that, in normal conditions, a tank shell will be torn apart first in the vertical than in the horizontal welds.

Therefore, weld spacing should be higher related to vertical welds than horizontal welds

Figures 5-7a, 5-7b, 5-8, 5-9, 5-12, 5-14, 5-16, 5-17, 5-19, 5-20, 5-21 and Tables 5-6, 5-7, 5-9 of API 650, and Figures 9-2, 9-4 and 9-5 of API 653, are not part of this review. Please check them in the standards. Questions based in these numerals will likely be open-book.

POINTS TO REMEMBER

Weld spacing is always larger in the vertical than in the horizontal.

Weld spacing in the shell is more critical than in the bottom.

There are no requirements to weld spacing in roofs.

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