Agenda Item:	650-1117

Title:	**Review and Revise 5.7.2.7 Effective Attachment Length**	
Date:	May 09, 2023	
Contact:	Originator Name:	Bhana Mistry, M.A.Sc., P.Eng. bdmistry@rogers.com
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Purpose:	To align API 650 and API 620 requirements for peripheral welds on reinforcing plates.	
Source:	Bhana Mistry's e-mail	
Revision:	0	
Impact:	The business impact of this item is neutral	
Rationale:	API-650 requires full fillet weld for attaching a reinforcing pad to the shell, but the basis of full-size fillet weld is not explained. By doing some reverse engineering, it can be shown that full size weld is required using effective length of weld attachment shown in API-620 5.16.8.1. The effective weld attachment in 5.7.2.7 of API-650 does not quite prove full size fillet weld. API 650 would require a slightly larger fillet weld, which is not possible. The effective weld attachment length in both API-620 and API-650 should be the same. Present wording in API-650 and API-620 are different. There is no technical justification for having a difference between the two codes. Please see attached PDF showing derivation for outer fillet weld size. Note to SGD: Outer fillet size can be reduced when full penetration through neck and pad is provided saving cost. Some customer do specify full penetration weld but API-650 still requires full fillet at outer edge. SGD may consider revising it in separate Agenda Item.	
Proposal:	Revise 5.7.2.7 as below 5.7.2.7 The attachment weld to the shell along the outer periphery of a reinforcing plate or proprietary connection that lap welds to the shell shall be considered effective only for the parts lying outside the area bounded by vertical lines drawn parallel, halfway between edge of the opening and centre of opening ~~tangent to the shell opening~~; however, the outer peripheral weld shall be applied completely around the reinforcement. See 5.7.2.8 for allowable stresses. All of the inner peripheral weld shall be considered effective. The strength of the effective attachment weld shall be considered as the weld's shear resistance at the stress value given for fillet welds in 5.7.2.8. The size of the outer peripheral weld shall be equal to the thickness of the shell plate or reinforcing plate, whichever is thinner, but shall not be greater than 40 mm ($1^1/_2$ in.). When low-type nozzles are used with a reinforcing plate that extends to the tank bottom (see Figure 5.8), the size of the portion of the peripheral weld that attaches the reinforcing plate to the bottom plate shall conform to 5.1.5.7. The inner peripheral weld shall be large enough to sustain the remainder of the loading. API-620 5.16.8.1 (note 2) For Reference (2) For an opening in a cylindrical or conical surface or in a surface of some other shape where one of the principal biaxial stresses is less than 75 % of the other, the critical plane shall be one that is parallel to the plane described in Item 1 for the shape of opening involved but **is located halfway between that plane and the edge of the opening (see Annex-F Example2)**	

SHELL REINFORCING COMPARISON

Bhana Mistry July 22, 2022

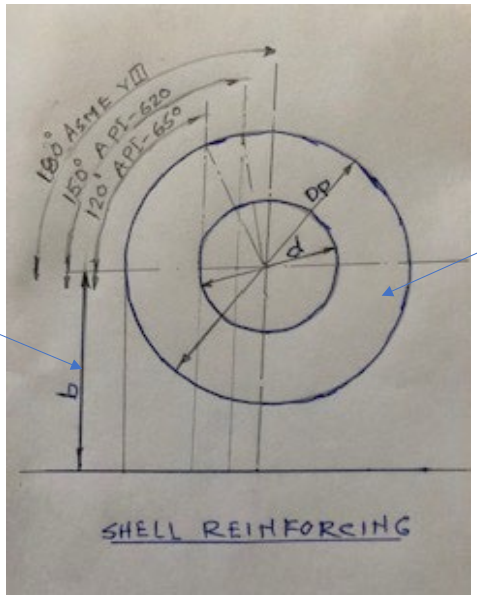
Purpose: To review Nozzle reinforcing in API-650, API-620 and ASME Sect. VIII

References: API-650 Para.5.7.2 , API-620 F.5.2 Example 2,ASME Sect.VIII UG-37

API-650, API-620 and ASME Sect.VIII Div,.1 have similar requirements for nozzle area replaement area. However, rules for weld strenth attaching reinforcing pads are different.

Low Type

Regular



Description	API-650		API-620		ASME Sect.VIII	
	Regullar	Low Type	Regular	Low Type	Regular	Low Rtpe
Nozzle Cut out in shell	d	d	d	d	d	d
Diameter of Reinforcing Pad= Dp	2d	2d	2d	2d	2d	2d
Design thickness of shell	t	t	t	t	t	t
Design Allowable stress	Sd	Sd	Sd	Sd	Sd	Sd
Allowble Shear stress in weld Ss	0.6 Sd	0.6 Sd	0.6 Sd	0.6 Sd	0.6 Sd	0.6 Sd
Thickness of reinforcing pad= tp	t	t	t	t	t	t
Elevation of Low Type b=d		d		d		d
Effetive Length of Weld Attachment	Lw=π d Z	Lw=d *(1+π Z/2)	Lw=π d Z	Lw=d *(1+π Z/2)	Lw=π d Z	Lw=d *(1+π Z/2)
Factor Z	120/180=0.667	120/180=0.667	150/180=0.833	150/180=0.833	180/180=1	180/180=1
Attachment weld size Calculation						
Shell Load= Sl	d*t*Sd	d*t*Sd	d*t*Sd	d*t*Sd	d*t*Sd	d*t*Sd
Weld Leg Size	tw	tw	tw	tw	tw	tw
Weld Load=Wl=Lw*tw*.707*SS	1.33 d tw Sd Z	0.87*d*Sd*tw	1.33 d tw Sd Z	0.98*d*Sd*tw	1.33 d tw Sd Z	1.09*d*Sd*tw
Equate Sl=Wl and solve for tw	tw=1.125 t	tw=1.15 t	tw=0.9 t	**tw=1.021**	tw=0.75	tw=0.917 t
	API-650 uses 1.0	API 650 1.0				

Observations

1 API-650 require full fillet between re-pad and shell.
2 Effective weld length used in API-650 and API-620 should be same.
3 Effective weld length reduction in API-650 and 620 appears some what arbitrary.
4 Weld shear strength around attachment varies since weld is neither parrell or perpendicular to load.
5 API-620 effective attachment is in agreement with full size fillet weld for repad attachment.

Nomenclature:

d= Nozzle Cut out in shell
Dp= Diameter of Reinforcing Pad= 2d
t= Design thickness of shell
Sd= Design Allowable stress

Ss= Allowble Shear stress in weld=0.6 Sd

tp= Thickness of reinforcing pad= t

Lw= Effetive Length of Weld Attachment= п Dp Z/2=п d Z

Z= 0.667 for API-650, 0.833 for API-620, 1.0 for ASME Sect.VIII

tw= Attachment weld size

Sl= Shell Load= d*t*sd

Wl= Weld Load= Lw*tw*.707*0.6*Sd=п d Z*tw*0.707*0.6*Sd

Wl= 1.3326 d *tw*Sd*Z

Equate Sl=Wl and solve for tw

tw= t /0.8888=1.125 t for API-650 (uses 1 t)

tw= 0.9 t for ALI-620

tw= 0.75 tw for ASME Sect. VIII Div.1

b= Elevation for Low Type Nozzle=d

Lwl= Effective weld Length for low type= d +п d Z/2=d *(1+п Z/2)

Wll= Weld Load= Lwl*tw*0.707*.6*Sd

twl= t/0.8686=1.15 t (API-650 uses 1 t)

Lwl620= Effective weld Length for low type= d +п d Z/2=d *(1+п Z/2) Per API-620

Lwl620= 2.3078 d Effective Length Low type per API-620

Twl620= t/0.9789=1.021 t Per API-620