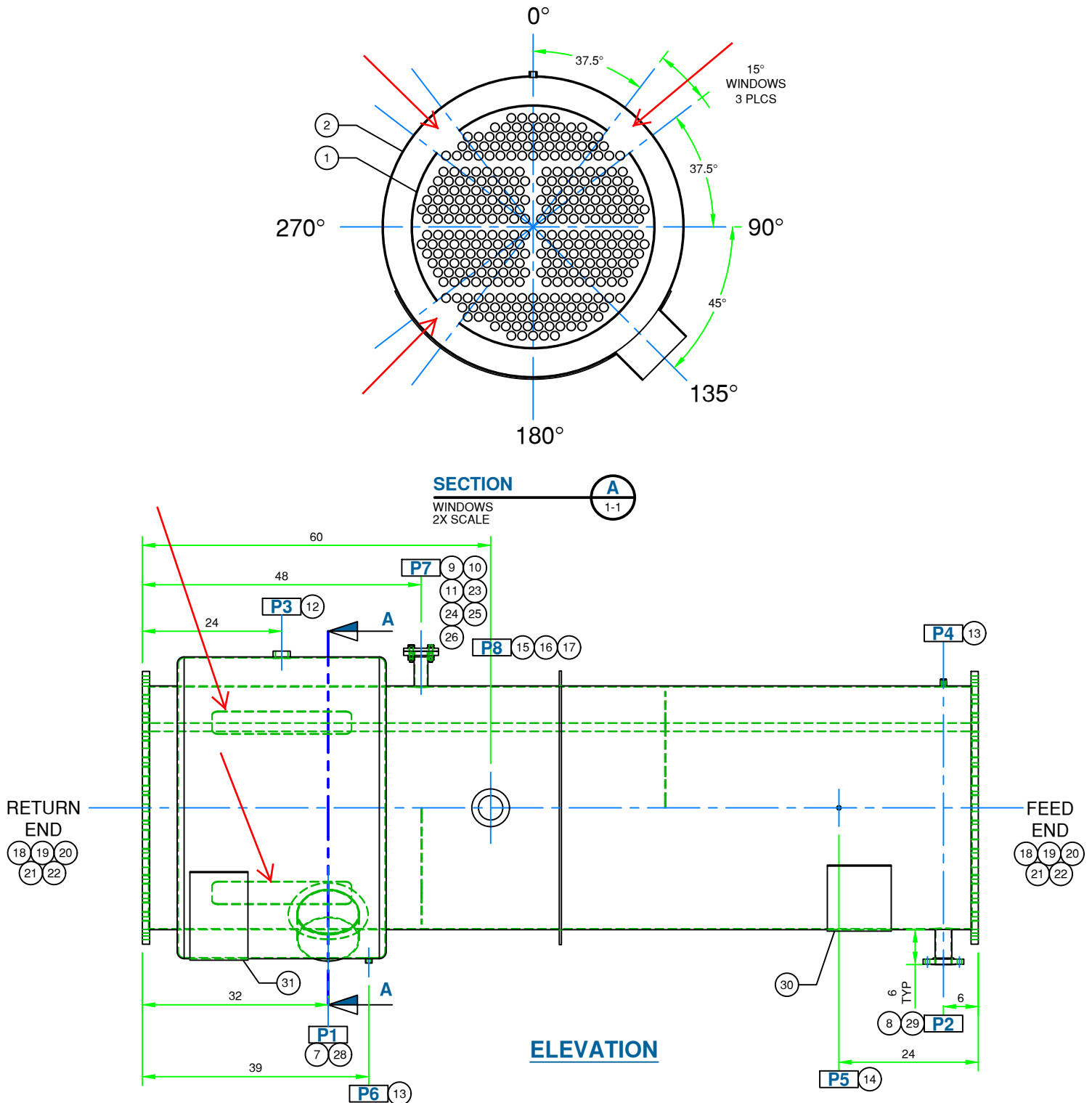


## Shell Stress Calculations with Cutouts for Vapor Band

A 52" diameter vapor band, 36" long is included at the return end, per the drawing below. This vapor band covers three vapor windows cut into the shell section, again per the drawing. The strength of the shell with these windows removed has been calculated separately, as Compress has no means to input this configuration. This was done by modifying the available shell stress as calculated by Compress without the windows, multiplying those calculated stresses by the ratio of remaining shell material after the windows were removed, shown on the next page, as prescribed in UHX Section 13.5.10, step 10 for the eight cases of the Operating Condition. Shell stresses were acceptable.



**UHX-4 (c) (2): Use 13.5.10 Step 10 for Shell Stress with Bustle Vapor Window Cut-Outs**

$$\left[ \sigma_{s,m} = \frac{a_o^2}{t_s(D_s + t_s)} [P_e + (\rho_s^2 - 1)(P_s - P_t)] + \frac{a_s^2}{t_s(D_s + t_s)} P_t \right] \cdot \left[ \frac{360^\circ}{360^\circ - (\text{shell cut-outs total angle})} \right]$$

Condition Operating	
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Shell Evaluation with 45° Total Cut-Out Angle; 360/(360-45)=1.143			Stress (psi)	S <sub>s</sub> *E <sub>s,w</sub> (psi)	S <sub>ps,s</sub> (psi)	S <sub>s,b</sub> (psi)	Over-stressed?
New or Corr	LC1	$\sigma_{s,m} = \left[ \frac{20.1218^2}{0.1874 \cdot (41.625 + 0.1874)} \cdot [-10.3768 + (1.0343266^2 - 1) \cdot (-15 - 60)] + \frac{20.8125^2}{0.1874 \cdot (41.625 + 0.1874)} \cdot 60 \right] \cdot 1.143 =$	2,869	13,230	N/A	N/A	No
	LC2	$\sigma_{s,m} = \left[ \frac{20.1218^2}{0.1874 \cdot (41.625 + 0.1874)} \cdot [11.7 + (1.0343266^2 - 1) \cdot (25 - -15)] + \frac{20.8125^2}{0.1874 \cdot (41.625 + 0.1874)} \cdot -15 \right] \cdot 1.143 =$	-91	13,230	N/A	7,619	No
	LC3	$\sigma_{s,m} = \left[ \frac{20.1218^2}{0.1874 \cdot (41.625 + 0.1874)} \cdot [1.3764 + (1.0343266^2 - 1) \cdot (25 - 60)] + \frac{20.8125^2}{0.1874 \cdot (41.625 + 0.1874)} \cdot 60 \right] \cdot 1.143 =$	3,728	13,230	N/A	N/A	No
	LC4	$\sigma_{s,m} = \left[ \frac{20.1218^2}{0.1874 \cdot (41.625 + 0.1874)} \cdot [-0.0531 + (1.0343266^2 - 1) \cdot (-15 - -15)] + \frac{20.8125^2}{0.1874 \cdot (41.625 + 0.1874)} \cdot -15 \right] \cdot 1.143 =$	-951	13,230	N/A	7,619	No
	LC5	$\sigma_{s,m} = \left[ \frac{20.1218^2}{0.1874 \cdot (41.625 + 0.1874)} \cdot [-60.66 + (1.0343266^2 - 1) \cdot (-15 - 60)] + \frac{20.8125^2 \cdot 60}{0.1874 \cdot (41.625 + 0.1874)} \right] \cdot 1.143 =$	-101	N/A	56,700	7,619	No
	LC6	$\sigma_{s,m} = \left[ \frac{20.1218^2}{0.1874 \cdot (41.625 + 0.1874)} \cdot [-31.3243 + (1.0343266^2 - 1) \cdot (25 - -15)] + \frac{20.8125^2}{0.1874 \cdot (41.625 + 0.1874)} \cdot -15 \right] \cdot 1.143 =$	-2,632	N/A	56,700	7,619	No
	LC7	$\sigma_{s,m} = \left[ \frac{20.1218^2}{0.1874 \cdot (41.625 + 0.1874)} \cdot [-48.9068 + (1.0343266^2 - 1) \cdot (25 - 60)] + \frac{20.8125^2}{0.1874 \cdot (41.625 + 0.1874)} \cdot 60 \right] \cdot 1.143 =$	758	N/A	56,700	N/A	No
	LC8	$\sigma_{s,m} = \left[ \frac{20.1218^2}{0.1874 \cdot (41.625 + 0.1874)} \cdot [-43.0774 + (1.0343266^2 - 1) \cdot (-15 - -15)] + \frac{20.8125^2}{0.1874 \cdot (41.625 + 0.1874)} \cdot -15 \right] \cdot 1.143 =$	-3,492	N/A	56,700	7,619	No

Shell stress is acceptable with 45 total degrees of shell removed as vapor windows.