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EVALUATION OF THE VESSEL TO CALCULATE THE MINIMUM RETIREMENT THICKNESS VALUES FOR VARIOUS COMPONENTS OF THE VESSEL AND TO RE-RATE THE VESSEL TO A HIGHER TEMPERATURE

PROBLEM DESCRIPTION:

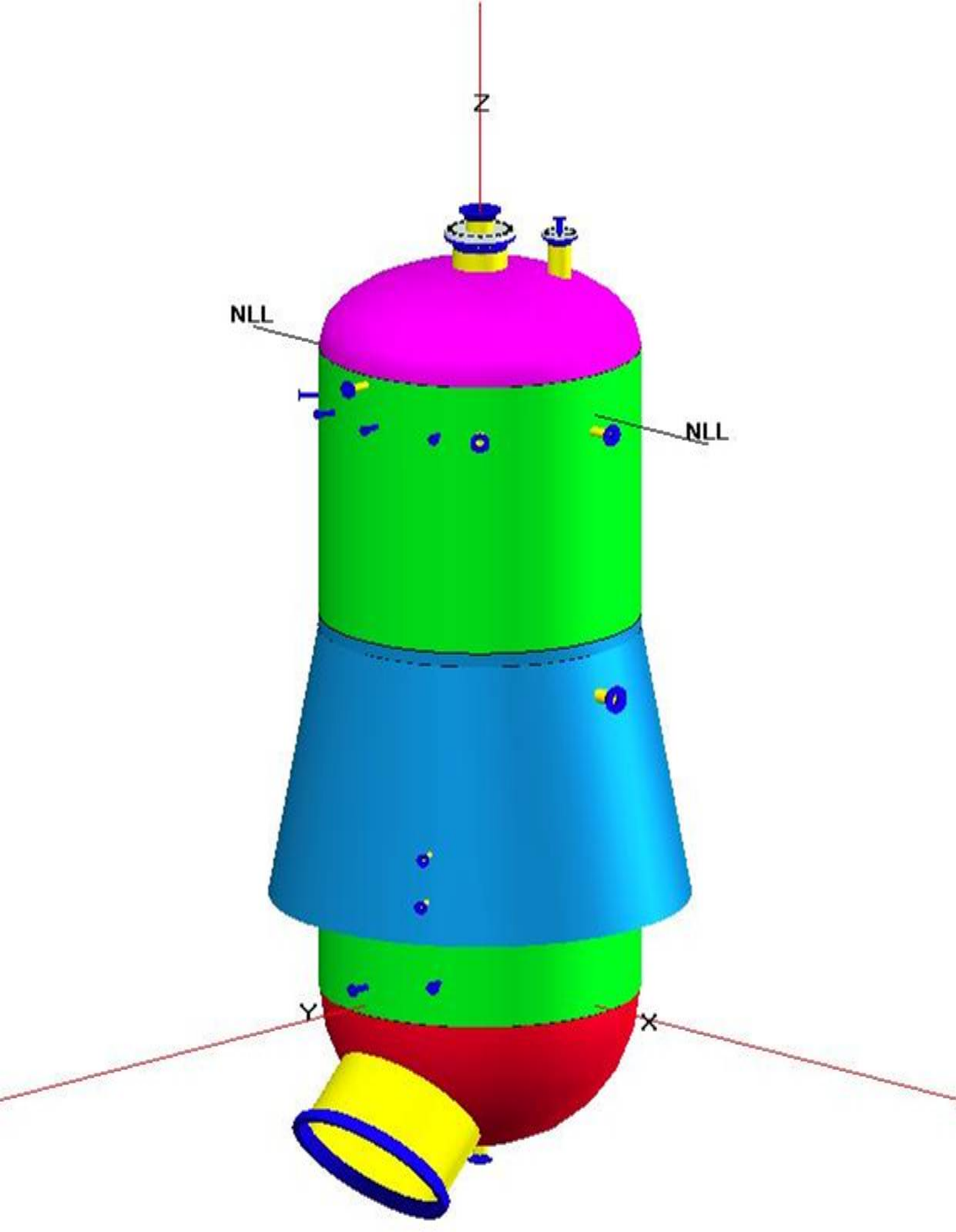
The current design conditions for the carbon steel vessel were 86 psig @ 400 °F. It was requested to re-rate the vessel to a possible higher temperature of 820 °F.

The engineering analysis and fitness-for-service evaluation of the vessel was required to see if the vessel can be qualified for 86 psig @ 820 °F operation. Also, it was required to calculate the minimum retirement thickness values based on the re-rated design conditions.

RESULTS:

The vessel was analyzed using the Pressure vessel design and analysis software COMPRESS.
It should be noted that the vessel has Class 150 and Class 300 flanges. The Carbon steel Class 150 flanges are not rated for 86 psig @ 820 °F. Hence, the temperature rating of 86 psig @ 820 °F could not be achieved for this vessel. However, the vessel was found to be suitable for 86 psig @ 720 °F and it has been rated for these conditions. The re-rated design temperature was acceptable for the operation of the vessel. The new recommended minimum retirement thickness values were based on the re-rated MAWP condition of 86 psig @ 720 °F.

It was also determined that with the new retirement thickness values, the vessel had enough safe and useful life for continued operation for next 3 - 4 years.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Pressure Summary

Pressure Summary for Chamber bounded by Bottom Head - Hemispherical and Top Head - Ellipsoidal

Identifier	T Design (°F)	MAWP (psi)	MAP (psi)	MDMT Rating		Corrosion Allowance (in)	Impact Test
				MDMT (°F)	Exemption		
Top Head - Ellipsoidal	720.0	127.35	140.35	1.1	Note 1	0.000	No
Straight Flange on Top Head - Ellipsoidal	720.0	126.84	139.78	1.1	Note 2	0.000	No
Shell - Cylindrical	720.0	130.59	151.73	-0.5	Note 3	0.000	No
Bottom Head - Hemispherical	720.0	133.18	156.59	-35.8	Note 4	0.000	No
Nozzle A - 12" Dia. (A)	720.0	104.00	N/I	-20.0	Note 5	0.000	No
Nozzle AL - 1-1/2" LWN (AL)	720.0	103.89	N/I	-20.0	Note 5	0.000	No
Nozzle B - 3" Dia. (B)	720.0	87.13	N/I	-20.0	Note 5	0.000	No
Nozzle BL - 1-1/2" LWN (BL)	720.0	103.89	N/I	-20.0	Note 5	0.000	No
Nozzle C - 6" Dia. (C)	720.0	117.54	N/I	-5.5	Nozzle Note 6; Pad note 7	0.000	No
Nozzle CL - 1-1/2" LWN (CL)	720.0	103.89	N/I	-20.0	Note 5	0.000	No
Nozzle D - 4" Dia. (D)	720.0	120.64	N/I	-7.9	Nozzle Note 8; Pad note 9	0.000	No
Nozzle DL - 1-1/2" LWN (DL)	720.0	103.89	N/I	-20.0	Note 5	0.000	No
Nozzle E - 6" Dia. (E)	720.0	94.84	N/I	-20.0	Nozzle Note 5; Pad note 10	0.000	No
Nozzle EL - 2" Dia. (EL)	720.0	99.03	N/I	-20.0	Note 5	0.000	No
Nozzle F - 10" Dia. (F)	720.0	126.24	N/I	-7.2	Nozzle Note 11; Pad note 12	0.000	No
Flange for F	720.0	562.03	562.03	-55.0	Note 13	0.000	No
Bolted Cover for F	720.0	311.30	343.05	-155.0	Note 14	0.000	No
Nozzle G - 2" LWN (G)	720.0	97.24	N/I	-20.0	Note 5	0.000	No
Nozzle GL - 2" Dia. (GL)	720.0	98.50	N/I	-20.0	Note 5	0.000	No

Nozzle H - 2" LWN (H)	720.0	104.00	N/I	-20.0	Note 5	0.000	No
Nozzle HL - 2" LWN (HL)	720.0	97.42	N/I	-20.0	Note 5	0.000	No
Nozzle J - 4" Dia. (J)	720.0	103.89	N/I	-7.9	Nozzle Note 8; Pad note 15	0.000	No
Manway MH1 - 24" Dia. (MH1)	720.0	126.24	N/I	-7.2	Nozzle Note 16; Pad note 12	0.000	No
Flange for MH1	720.0	458.89	458.89	-55.0	Note 17	0.000	No
Bolted Cover for MH1	720.0	149.67	164.94	-52.2	Note 18	0.000	No
Manway MH2 - 72" Dia. (MH2)	720.0	145.45	N/I	0.0	Nozzle Note 19; Pad note 20	0.000	No
Flange for MH2	720.0	160.56	169.47	-55.0	Note 21	0.000	No

Chamber design MDMT is 20.00°F
Chamber rated MDMT is 1.08°F

Chamber MAWP hot & corroded is 87.13 psi @ 720.0°F

Chamber MAP cold & new is 87.13 psi @ 70.0°F

This pressure chamber is not designed for external pressure.

Design notes are available on the Settings Summary page.

Thickness Summary

Component Identifier	Material	Diameter (in)	Length (in)	Nominal t (in)	Design t (in)	Joint E	Load
Top Head - Ellipsoidal	SA-515 70	145.69 OD	36.71	0.5800*	0.3926	1.0000	Internal
Straight Flange on Top Head - Ellipsoidal	SA-515 70	145.69 OD	2.00	0.5800	0.3937	1.0000	Internal
Shell - Cylindrical	SA-515 70	145.69 OD	299.00	0.7400	0.5010	0.8500	Internal
Bottom Head - Hemispherical	SA-515 70	145.00 OD	72.50	0.3800*	0.2542	0.8500	Internal
Support Skirt #1	SA-515 70	146.29 OD	6.00	0.3000	0.0495	0.5500	Wind
Support Skirt #2	SA-515 70	146.29/192.00 OD	125.00	0.3000	0.0662	0.5500	Wind

Nominal t: Vessel wall nominal thickness

Design t: Required vessel thickness due to governing loading + corrosion

Joint E: Longitudinal seam joint efficiency

* Head minimum thickness after forming

Load

internal: Circumferential stress due to internal pressure governs

external: External pressure governs

Wind: Combined longitudinal stress of pressure + weight + wind governs

Seismic: Combined longitudinal stress of pressure + weight + seismic governs

Nozzle Summary

Nozzle mark	OD (in)	t_n (in)	Req t_n (in)	A_1?	A_2?	Shell			Reinforcement Pad		Corr (in)	A_a/A_r (%)
						Nom t (in)	Design t (in)	User t (in)	Width (in)	t_{pad} (in)		
A	12.75	0.4000	0.3281	Yes	Yes	2.3125*	N/A		N/A	N/A	0.0000	Exempt
AL	2.62	0.2500	0.0625	Yes	Yes	0.7400	N/A		N/A	N/A	0.0000	Exempt
B	3.50	0.1500	0.0714	Yes	Yes	0.7400	0.3988		N/A	N/A	0.0000	100.1
BL	2.62	0.2500	0.0625	Yes	Yes	0.7400	N/A		N/A	N/A	0.0000	Exempt
C	6.63	0.2500	0.0714	Yes	Yes	0.7400	0.5530		3.0000	0.7500	0.0000	175.6
CL	2.62	0.2500	0.0625	Yes	Yes	0.7400	N/A		N/A	N/A	0.0000	Exempt
D	4.50	0.2000	0.0714	Yes	Yes	0.7400	0.5528		3.0000	0.7500	0.0000	176.6
DL	2.62	0.2500	0.0625	Yes	Yes	0.7400	N/A		N/A	N/A	0.0000	Exempt
E	6.63	0.2500	0.0714	Yes	Yes	0.3800*	0.2368		3.0000	0.7500	0.0000	375.2
EL	2.38	0.1200	0.0714	Yes	Yes	0.7400	N/A		N/A	N/A	0.0000	Exempt
F	10.75	0.4000	0.0625	Yes	Yes	0.5800*	0.5195		3.2500	0.7500	0.0000	131.0
G	3.06	0.3500	0.0625	Yes	Yes	0.7400	N/A		N/A	N/A	0.0000	Exempt
GL	2.38	0.1200	0.0714	Yes	Yes	0.7400	N/A		N/A	N/A	0.0000	Exempt
H	3.06	0.3500	0.1890	Yes	Yes	1.1900*	N/A		N/A	N/A	0.0000	Exempt
HL	3.06	0.3500	0.0625	Yes	Yes	0.7400	N/A		N/A	N/A	0.0000	Exempt
J	4.50	0.2000	0.0714	Yes	Yes	0.7400	0.4760		3.0000	0.7500	0.0000	221.0
MH1	25.00	0.4000	0.0967	Yes	Yes	0.5800*	0.5195		9.2500	0.7500	0.0000	133.0
MH2	72.00	0.4000	0.3495	Yes	Yes	0.3800*	0.3524		12.0000	1.0000	0.0000	100.1

t_n: Nozzle thickness

Req t_n: Nozzle thickness required per UG-45/UG-16

Nom t: Vessel wall thickness

Design t: Required vessel wall thickness due to pressure + corrosion allowance per UG-37

User t: Local vessel wall thickness (near opening)

A_a: Area available per UG-37, governing condition

A_r: Area required per UG-37, governing condition

Corr: Corrosion allowance on nozzle wall

* Head minimum thickness after forming

Nozzle Schedule

Nozzle mark	Service	Size	Materials								
			Nozzle	Impact	Norm	Fine Grain	Pad	Impact	Norm	Fine Grain	Flange
A	Nozzle A - 12" Dia.	11.95 IDx0.40	SA-515 70	No	No	No	N/A	N/A	N/A	N/A	WN A105 150#
AL	Nozzle AL - 1-1/2" LWN	2.12 IDx0.25	SA-105	No	No	No	N/A	N/A	N/A	N/A	LWN A105 150#
B	Nozzle B - 3" Dia.	3.20 IDx0.15	SA-106 B Smls pipe	No	No	No	N/A	N/A	N/A	N/A	WN A105 300#
BL	Nozzle BL - 1-1/2" LWN	2.12 IDx0.25	SA-105	No	No	No	N/A	N/A	N/A	N/A	LWN A105 150#
C	Nozzle C - 6" Dia.	6.13 IDx0.25	SA-106 B Smls pipe	No	No	No	SA-515 70	No	No	No	WN A105 300#
CL	Nozzle CL - 1-1/2" LWN	2.12 IDx0.25	SA-105	No	No	No	N/A	N/A	N/A	N/A	LWN A105 150#
D	Nozzle D - 4" Dia.	4.10 IDx0.20	SA-106 B Smls pipe	No	No	No	SA-515 70	No	No	No	WN A105 300#
DL	Nozzle DL - 1-1/2" LWN	2.12 IDx0.25	SA-105	No	No	No	N/A	N/A	N/A	N/A	LWN A105 150#

E	Nozzle E - 6" Dia.	6.13 IDx0.25	SA-106 B Smls pipe	No	No	No	SA-515 70	No	No	No	WN A105 150#
EL	Nozzle EL - 2" Dia.	2.13 IDx0.12	SA-106 B Smls pipe	No	No	No	N/A	N/A	N/A	N/A	WN A105 150#
F	Nozzle F - 10" Dia.	9.95 IDx0.40	SA-515 70	No	No	No	SA-515 70	No	No	No	App 2
G	Nozzle G - 2" LWN	2.36 IDx0.35	SA-105	No	No	No	N/A	N/A	N/A	N/A	LWN A105 150#
GL	Nozzle GL - 2" Dia.	2.13 IDx0.12	SA-106 B Smls pipe	No	No	No	N/A	N/A	N/A	N/A	WN A105 150#
H	Nozzle H - 2" LWN	2.36 IDx0.35	SA-105	No	No	No	N/A	N/A	N/A	N/A	LWN A105 150#
HL	Nozzle HL - 2" LWN	2.36 IDx0.35	SA-105	No	No	No	N/A	N/A	N/A	N/A	LWN A105 150#
J	Nozzle J - 4" Dia.	4.10 IDx0.20	SA-106 B Smls pipe	No	No	No	SA-515 70	No	No	No	WN A105 150#
MH1	Manway MH1 - 24" Dia.	24.20 IDx0.40	SA-515 70	No	No	No	SA-515 70	No	No	No	App 2
MH2	Manway MH2 - 72" Dia.	71.20 IDx0.40	SA-515 70	No	No	No	SA-515 70	No	No	No	App 2