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Transition #1

ASME Section VIII Division 2, 2013 Edition Metric				
Component		Cone		
Material		SA-516 70 (II-D Metric p. 398, ln. 10)		
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Optimize MDMT/ Find MAWP**
Yes (0°C)	Yes	Yes	Yes	No
		Design Pressure (bar)	**Design Temperature (°C)**	**Design MDMT (°C)**
Internal		50	100	0
Static Liquid Head				
Condition		**P_s (bar)**	**H_s (mm)**	**SG**
Test horizontal	**Left**	0.49	5,000	1
	Right	0.34	3,500	
Dimensions				
Inner Diameter	**Large**	5,000 mm		
	Small	2,000 mm		
Length		5,000 mm		
Nominal Thickness		90 mm		
Corrosion	**Inner**	3 mm		
	Outer	0 mm		
		Weight (kg)		**Capacity (liters)**
New		41,550.61		51,050.88
Corroded		40,200.71		51,223.22
NDE				
Longitudinal seam		Full		
Left Circumferential seam		Full		
Right Circumferential seam		Full		

Results Summary	
Governing condition	Operating Hot & Corroded
Design thickness due to internal pressure (t)	86.49 mm
Minimum thickness per 4.1.2	5.4 mm
Maximum allowable working pressure (MAWP)	52.07 bar
Maximum allowable pressure (MAP)	59.33 bar
Rated MDMT	-4.7°C
6.4.2.2: PWHT is required for P-No 1, G-No 2 materials for governing thickness at weld of 90 mm.	

3.11.2 Material Toughness Requirements	
Material impact test temperature per 3.11.7 =	0°C
Stress ratio, R_{ts} = 78.93*1 / (90 - 3 - 0) =	0.9072
Reduction in MDMT, T_R from Table 3.17 =	4.7°C
MDMT = max[T_{impact} - T_R, -104] = max[0 - 4.7 , -104] =	-4.7°C
Design MDMT of 0°C is acceptable.	

4.4.6.1.e Cone Half Apex Angle	
$\beta = \arctan[\{(R_L - r_k) - (R_S + r_f)\} / L_{ce}]$	(4.4.49)
$\phi = \arcsin[(r_f + r_k)*\cos[\beta] / L_{ce}]$	(4.4.52)
$\alpha = \beta + \phi$	(4.4.48)
Results	
$\beta = \arctan[\{(2{,}500 - 0) - (1{,}000 + 0)\} / 5{,}000] =$	16.6992°
$\phi = \arcsin[(0 + 0)*\cos[16.6992] / 5{,}000] =$	0°
$\alpha = 16.6992 + 0 =$	16.6992°

4.3.4.1 Design Thickness for Internal Pressure		
$t_d = D / (2*\cos[\alpha]) * (\exp[P / (S*E)] - 1) + Corrosion$		(4.3.2)
Operating Hot & Corroded		
Left	t_d = 5,006.26 / (2*cos[16.6992]) * (exp[((50 + 0)*1.02) / (1,621.348*1)] - 1) + 3 =	86.49 mm
Right	t_d = 2,006.26 / (2*cos[16.6992]) * (exp[((50 + 0)*1.02) / (1,621.348*1)] - 1) + 3 =	36.46 mm
Operating Cold & Corroded		
Left	t_r = 5,006.26 / (2*cos[16.6992]) * (exp[((52.07 + 0)*1.02) / (1,784.502*1)] - 1) =	78.93 mm
Right	t_r = 2,006.26 / (2*cos[16.6992]) * (exp[((52.07 + 0)*1.02) / (1,784.502*1)] - 1) =	31.63 mm

4.3.4.1 Maximum Pressure Circumferential Stress		
P_{max} = S*E*ln[2*t*cos[α] / D + 1]		(4.3.2)
MAWP		
Left	P_{max} = 1,621.348 / 1.02*1*ln[2*87*cos[16.6992] / 5,006.26 + 1] - 0 =	52.07 bar
Right	P_{max} = 1,621.348 / 1.02*1*ln[2*87*cos[16.6992] / 2,006.26 + 1] - 0 =	126.88 bar
MAP		
Left	P_{max} = 1,784.502 / 1.02*1*ln[2*90*cos[16.6992] / 5,000 + 1] =	59.33 bar
Right	P_{max} = 1,784.502 / 1.02*1*ln[2*90*cos[16.6992] / 2,000 + 1] =	144.71 bar

6.1.2.3 % Extreme Fiber Elongation	
ε_f = 50*t / R_f*(1 - R_f / R_o)	(Table 6.1)
ε_f = 50*93.96 / 1,046.98*(1 - 1,046.98 / ∞) =	4.4873%
The extreme fiber elongation does not exceed 5%.	