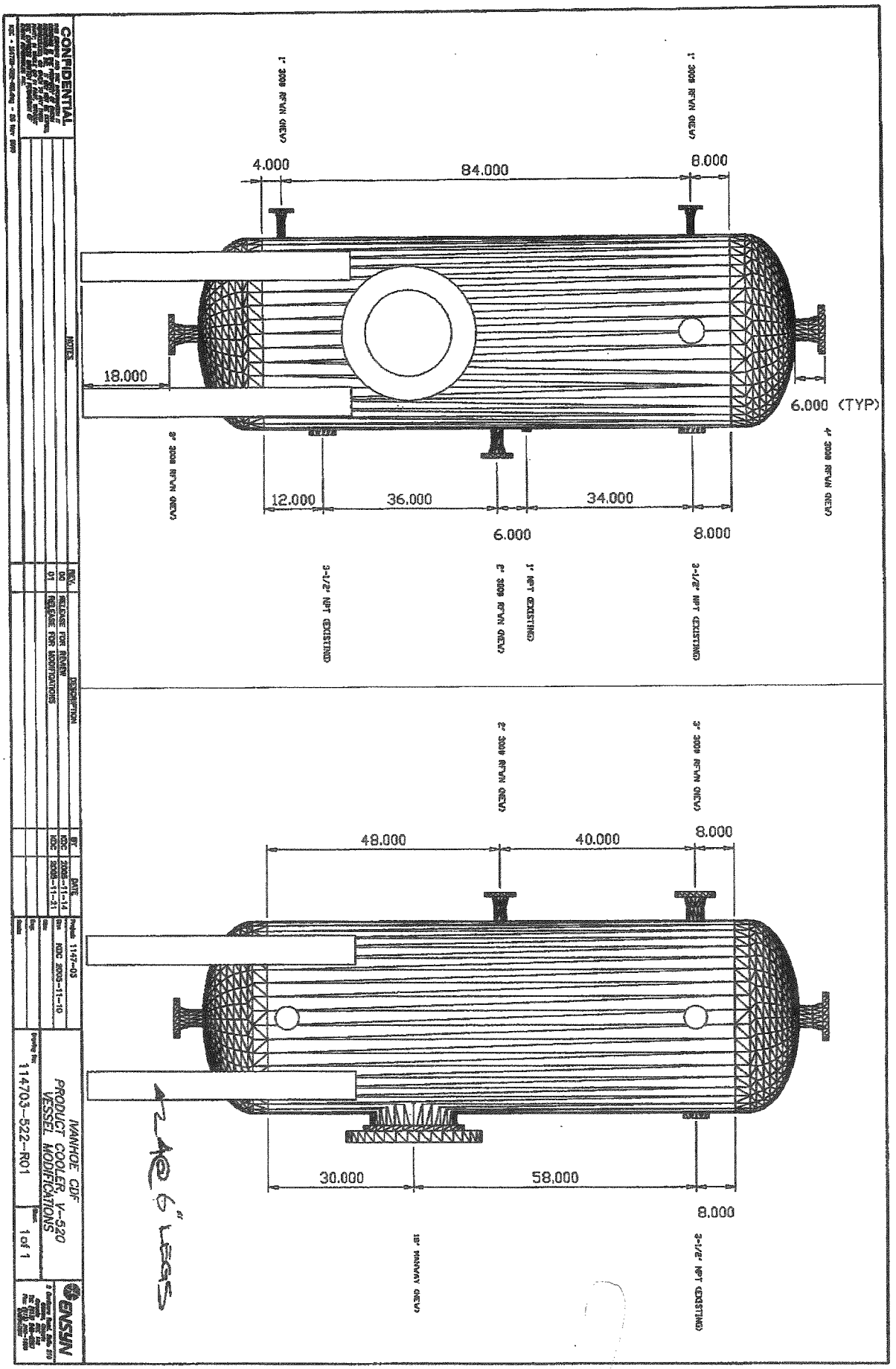
CONFIDENTIAL
NOTES
REV.
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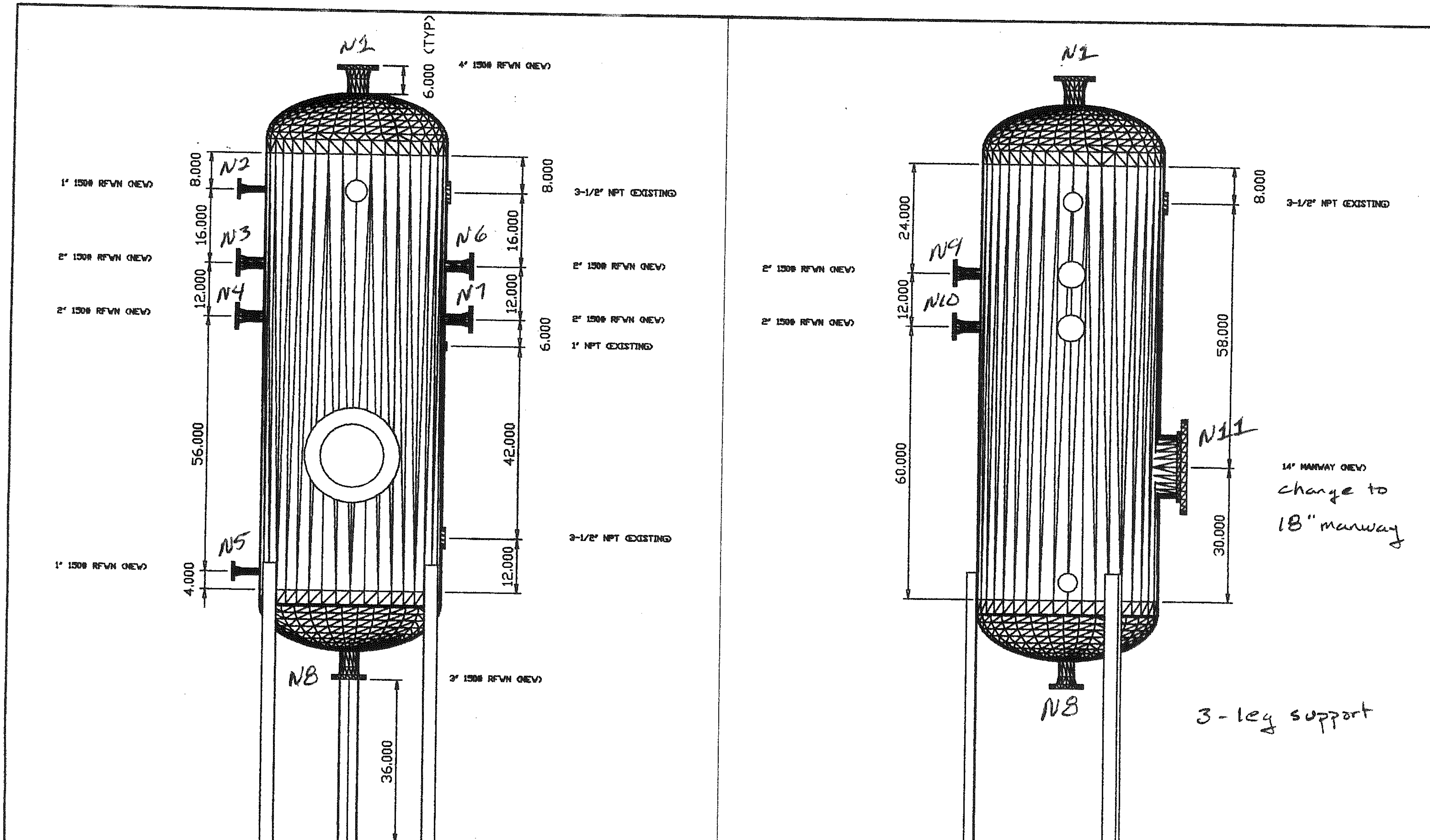
DESCRIPTION
RELEASE FOR BOARD
RELEASE FOR ADDITIONS
BY
RDC
RDC
DATE
2005-11-14
2005-11-21
Project 1147-03
Date RDC 2005-11-10
Drawing No. 114703-522--R01
Sheet 1 of 1
MANHOLE CDF
PRODUCT COOLER, V-520
VESSEL MODIFICATIONS
ENSYN
1" 3000 RFWN ONLY
4.000
84.000
8.000
18.000
6.000 (TYP)
2" 3000 RFWN ONLY
4" 3000 RFWN ONLY
12.000
36.000
34.000
6.000
8.000
3-1/2" NPT (EXISTING)
2" 3000 RFWN ONLY
1" NPT (EXISTING)
3-1/2" NPT (EXISTING)
2" 3000 RFWN ONLY
3" 3000 RFWN ONLY
48.000
40.000
8.000
30.000
58.000
8.000
18" MANWAY ONLY
3-1/2" NPT (EXISTING)

4 @ 6" LEGS

V-520

AFC Drawing # 73102-39

PWHT = NO



CONFIDENTIAL

KDC - 114703-522-R00.dwg - 14 Nov 2005

NOTES	REV.	DESCRIPTION	BY	DATE
	00	RELEASE FOR REVIEW	KDC	2005-11-14

Project: 1147-03

Drw: KDC 2005-11-10

IVANHOE CDF
PRODUCT COOLER, V-520
VESSEL MODIFICATIONS

Drawing No: 114703-522-R00

Sheet: 1 of 1

ENSYN

IVANHOE

Bill Salzman / Tom Steel
831-8782 831-5019
201-5922 831-8782 x150

Customer: **TIC The Industrial Company**
Job No: DS-05544-04
Mark Number: LEG1

Vessel Number: V-520

Date Printed: 11/15/2005

Leg Information

Design Temperature:	100	°F	Factor B Chart:	CS-2	
Material:	SA-36		Material Stress (Hot):	14500	PSI
Condition:			Material Stress (Cold):	14500	PSI
B.P. to Vessel Attachment Length (L):	54.0000	in.	Modulus of Elasticity:	28.0	10^6 PSI
Direction of Applied Force:	0	°	Yield Strength:	36000	PSI
Length of Supports:	72.0000	in.	Dist. From Reference Line:	18.0000	in.
Quantity:	3		Method of Attachment:	Leg In	
Type:	Angle		Molded to Head Curvature:	No	
Description:	6 x 6 x 3/8				
d_1:	6.0000	in.	t_1:	0.3750	in.
d_2:	6.0000	in.	t_2:	0.3750	in.
Weld Attachment Length Top (W_t):	5.6250	in.	Side (W_s):	18.0000	in.
Weld Leg Dimension (W_l):	0.2500	in.			

Base Plate Information

Design Temperature:	100	°F			
Material:	SA-36 Plate		Material Stress (Hot):	14500	PSI
Condition:			Material Stress (Cold):	14500	PSI
Length:	8.0000	in.	Yield Strength:	36000	PSI
Width:	8.0000	in.	Thickness:	0.5000	in.
Leg to B.P. Attachment Factor:	0.7500		Bending Coefficient (C_m):	1.0000	
Effective Length Factor (K):	1.5000				

Anchor Bolt Information

Material:	SA-193 Gr B16 <=2.5"		Material Stress (Hot):	25000	PSI
Condition:			Material Stress (Cold):	25000	PSI
Diameter:	0.7500	in.	Root Area:	0.3020	sq. in.
Quantity:	3		Bolt Circle Diameter:	42.0000	in.
Ultimate 28 Day Concrete Strength:	3000	PSI			

Operating Conditions

Support Leg Properties

Section Modulus, $S_x = \frac{I_x}{C_x} = \frac{24.5726}{4.2426}$ = **5.7919** in.^{3}

Section Modulus, $S_y = \frac{I_y}{C_y} = \frac{6.2006}{2.3181}$ = **2.6749** in.^{3}

Radius of gyration, $r_x = \sqrt{\frac{I_x}{A}} = \sqrt{\frac{24.5726}{4.3594}}$ = **2.3742** in.

Radius of gyration, $r_y = \sqrt{\frac{I_y}{A}} = \sqrt{\frac{6.2006}{4.3594}}$ = **1.1926** in.

Least radius of gyration, $r_{min} = \sqrt{\frac{I_{min}}{A}} = \sqrt{\frac{6.2006}{4.3594}}$ = **1.1926** in.

Slenderness ratio, $SR_x = \frac{K L}{r_x} = \frac{1.5000 * 54.0000}{2.3742}$ = **34.1168**

Slenderness ratio, $SR_y = \frac{K L}{r_y} = \frac{1.5000 * 54.0000}{1.1926}$ = **67.9188**

Largest, $SR_{max} = \frac{K L}{r_{min}} = \frac{1.5000 * 54.0000}{1.1926}$ = **67.9188**

Critical slenderness ratio, $C_c = \sqrt{\frac{2 \pi^2 E}{F_y}} = \sqrt{\frac{2 * \pi^2 * (28.0 * 10^6)}{36000}}$ = **123.91**

$F'_{ex} = \frac{4}{3} \frac{12 \pi^2 E}{23 SR_x^2} = \frac{4}{3} * \frac{12 * \pi^2 * (28.0 * 10^6)}{23 * 34.1168^2}$ = **165163** PSI

$F'_{ey} = \frac{4}{3} \frac{12 \pi^2 E}{23 SR_y^2} = \frac{4}{3} * \frac{12 * \pi^2 * (28.0 * 10^6)}{23 * 67.9188^2}$ = **41675** PSI

For $SR_{max} <= C_c$, Allowable compressive stress:

$$F_a = \frac{4}{3} \frac{\left(1 - \frac{SR_{max}^2}{2 C_c^2}\right) F_y}{\frac{5}{3} + \frac{3 SR_{max}}{8 C_c} - \frac{SR_{max}^3}{8 C_c^3}} = \frac{4}{3} * \frac{\left(1 - \frac{67.9188^2}{2 * 123.91^2}\right) * 36000}{\frac{5}{3} + \frac{3 * 67.9188}{8 * 123.91} - \frac{67.9188^3}{8 * 123.91^3}}$$ = **22029** PSI

Allowable bending stress : $S_b = \frac{4}{3} 0.6 F_y = \frac{4}{3} 0.6 * 36000$ = **28800** PSI

Allowable tension stress : $S_t = \frac{4}{3} 0.6 F_y = \frac{4}{3} * 0.6 * 36000$ = **28800** PSI

Leg to Vessel Weld Properties

Distance between welds along side of legs (b) = **= 7.9550 in.**

$L_w = (2\ W_s) + W_t = (2 * 18.0000) + 5.6250$ **= 41.6250 in.**

$$I_{wy} = \frac{W_s^3\ (2\ W_t + W_s)}{3\ L_w} = \frac{18.0000^3 * (2 * 5.6250 + 18.0000)}{3 * 41.6250}$$ **= 1366.0541 in.³**

$$I_{wz} = \frac{6\ W_s\ b^2 + W_t^3}{12} = \frac{6 * 18.0000 * 7.9550^2 + 5.6250^3}{12}$$ **= 584.3628 in.³**

$J_{wx} = I_{wy} + I_{wz} = 1366.0541 + 584.3628$ **= 1950.4168 in.³**

Distance from weld neutral axis to top of welds:

$$EF_{yt} = \frac{W_s^2}{L_w} = \frac{18.0000^2}{41.6250}$$ **= 7.7838 in.**

Distance from weld neutral axis to bottom of welds:

$EF_{yb} = W_s - EF_{yt} = 18.0000 - 7.7838$ **= 10.2162 in.**

Distance from weld neutral axis to side of welds:

$$EF_z = MAX\left(\frac{b}{2}, \frac{W_t}{2}\right) = MAX\left(\frac{7.9550}{2}, \frac{5.6250}{2}\right)$$ **= 3.9775 in.**

UBC 1997 Wind Analysis Information

Basic Wind Speed (V):	80 MPH	Wind Exposure type:	C
Importance factor (I_w):	1.0000		

Wind Analysis Calculations

Wind Center of Gravity **= 101.9133 in.**

$P = C_e\ C_q\ q_s\ Iw = 1.06 * 0.8 * 16.400 * 1.0000$ **= 13.90 lb./ft²**

Wind Load, F_w = P A = 13.90 * 34.0957 **= 474 lb.**

UBC 1997 Seismic Design Information

Seismic zone factor (Z):	0.4	Soil profile type:	SD
Importance factor (I):	1.0000		
Seismic source type:	A	Distance to seismic source (km):	15

Seismic Analysis Calculations

Seismic Center of Gravity: **= 91.7221 in.**

$$V_1 = \frac{2.5\ C_a\ I\ W}{R} = \frac{2.5 * 0.4400 * 1.0000 * 5356.94}{2.2}$$ **= 2678 lb.**

$$V_2 = \frac{1.6\ Z\ N_v\ I\ W}{R} = \frac{1.6 * 0.4000 * 1.0 * 1.0000 * 5356.94}{2.2}$$ **= 1558 lb.**

$V_1 > V_2$, therefore $F_s = \frac{V_1}{1.4} = \frac{2678}{1.4}$ **= 1913 lb.**

Loadings and Stresses on Support Legs

Direction of Applied Force = **0 °**

Leg Orientation °	Moment of Inertia in.⁴	Lateral Force lb.	Axial Stress PSI	Bending Stresses (f_{bx}) PSI	Bending Stresses (f_{by}) PSI	Acceptance Ratio (Eqn_1)	Acceptance Ratio (Eqn_2)
0	6.2006	257	591	0	5631	0.2229	
120	19.9796	828	-927	5015	8996	0.5286	
240	19.9796	828	-927	5015	8996	0.5286	

Direction of Worst case Force = **4 °**
Highest Stress Ratio = **0.5316**

Loadings and Stresses on Leg to Vessel attachment welds

Leg Orientation °	Load F_x lb.	Load F_y lb.	Load F_z lb.	Moment M_x in.-lb.	Moment M_y in.-lb.	Moment M_z in.-lb.	Total Stress PSI	Stress Ratio
0	257	0	2576	0	-5755	0	316	0.0334
120	-414	717	-4039	29045	9473	1295	946	0.0999
240	-414	717	-4039	29045	9473	1295	946	0.0999

Direction of Worst case Force = **29 °**
Highest Stress Ratio: **0.1339**

Loadings and Pressure on Concrete Foundation

Direction of applied force: = **0 °**

Leg Orientation °	Bearing Pressure PSI	Moment M_x in.-lb.	Moment M_y in.-lb.	Maximum Pressure P_x PSI	Maximum Pressure P_y PSI	Max. Concrete Pressure PSI	Concrete Pressure Ratio
0	-40	1616	1616	18.94	18.94	0.00	0.0000
120	63	16438	16438	192.63	192.63	448.38	0.4982
240	63	16438	16438	192.63	192.63	448.38	0.4982

Direction of Worst case Force: = **29 °**
Highest Stress Ratio = **0.7305**

Loadings and Stresses on BasePlate and Anchor bolts

Leg Orientation °	Moment M_x in.-lb.	Moment M_y in.-lb.	Maximum Pressure P_x PSI	Maximum Pressure P_y PSI	Maximum B.P. Stress PSI	BasePlate Stress Ratio	Anchor Bolt Stress PSI	Anchor Bolt Stress Ratio
0	0	0	0	0	0	0.0000	2675	0.0803
120	489	456	11728	10935	16035	0.5568	4757	0.1427
240	489	456	11728	10935	16035	0.5568	4757	0.1427

Direction of Worst case Force: = **29 °**
Highest Stress Ratio = **0.7886**

Maximum General Longitudinal Stresses

$$S_{L1} = \frac{M_a}{Z} - \frac{W}{A} + \left(\frac{P * D}{4 * t}\right) = \frac{72170}{334.2844} - \frac{5356.94}{32.50} + \left(\frac{165.00 * 41.6350}{4 * 0.2500}\right)$$ = 6921 PSI

$$S_{L2} = -\frac{M_a}{Z} - \frac{W}{A} - \left(\frac{Pe * D}{4 * t}\right) = -\frac{72170}{334.2844} - \frac{5356.94}{32.50} - \left(\frac{15.00 * 41.6350}{4 * 0.2500}\right)$$ = -1005 PSI

Allowable Tension Stress, S_{ta} = 1.2 S E = 1.2 * 18800 * 0.85 = **19176** PSI
Allowable Compressive Stress, S_{ca} = -1.2 B = -1.2 * 9274 = **-11129** PSI

$$R_{SL1} = \frac{S_{L1}}{S_{ta}} = \frac{6921}{19176}$$ = 0.3609

$$R_{SL2} = \frac{S_{L2}}{S_{ca}} = \frac{-1005}{-11129}$$ = 0.0903

Summary

Governing external force	= Seismic load
Total Force	= 1913 lb.
Weight	= 5356.94 lb.
Base Moment	= 175482 in.-lb.
Tangent Moment	= 72170 in.-lb.

Leg Stresses

Maximum combined compressive and bending stress ratio	= 0.5316

Leg BasePlate

Concrete Stress Ratio	= 0.7305
Base Plate Stress Ratio	= 0.7886

Host Stresses

SI1 ratio	= 0.3609
SI2 ratio	= 0.0903

Weld Stresses

Leg to vessel weld stress ratio	= 0.1339