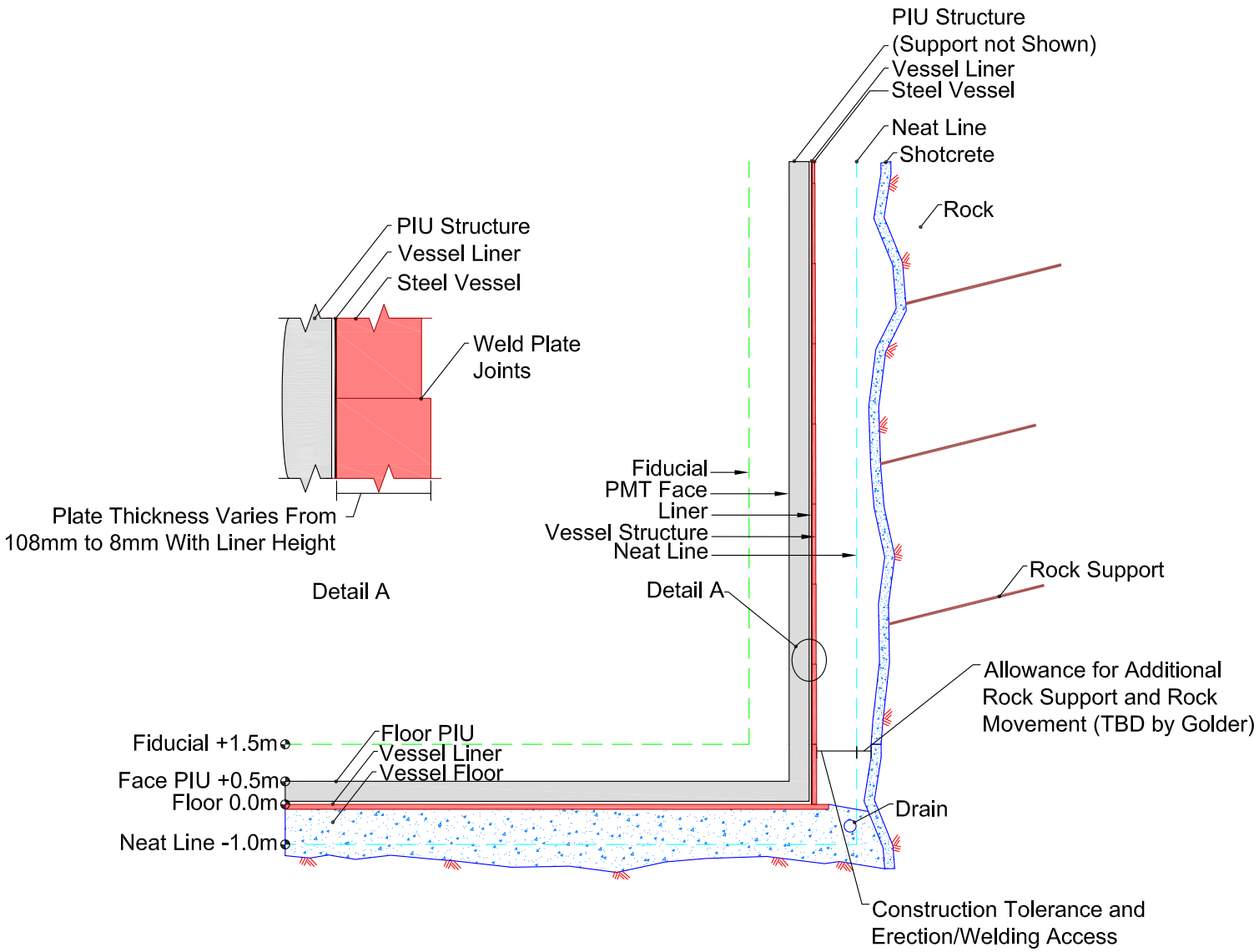
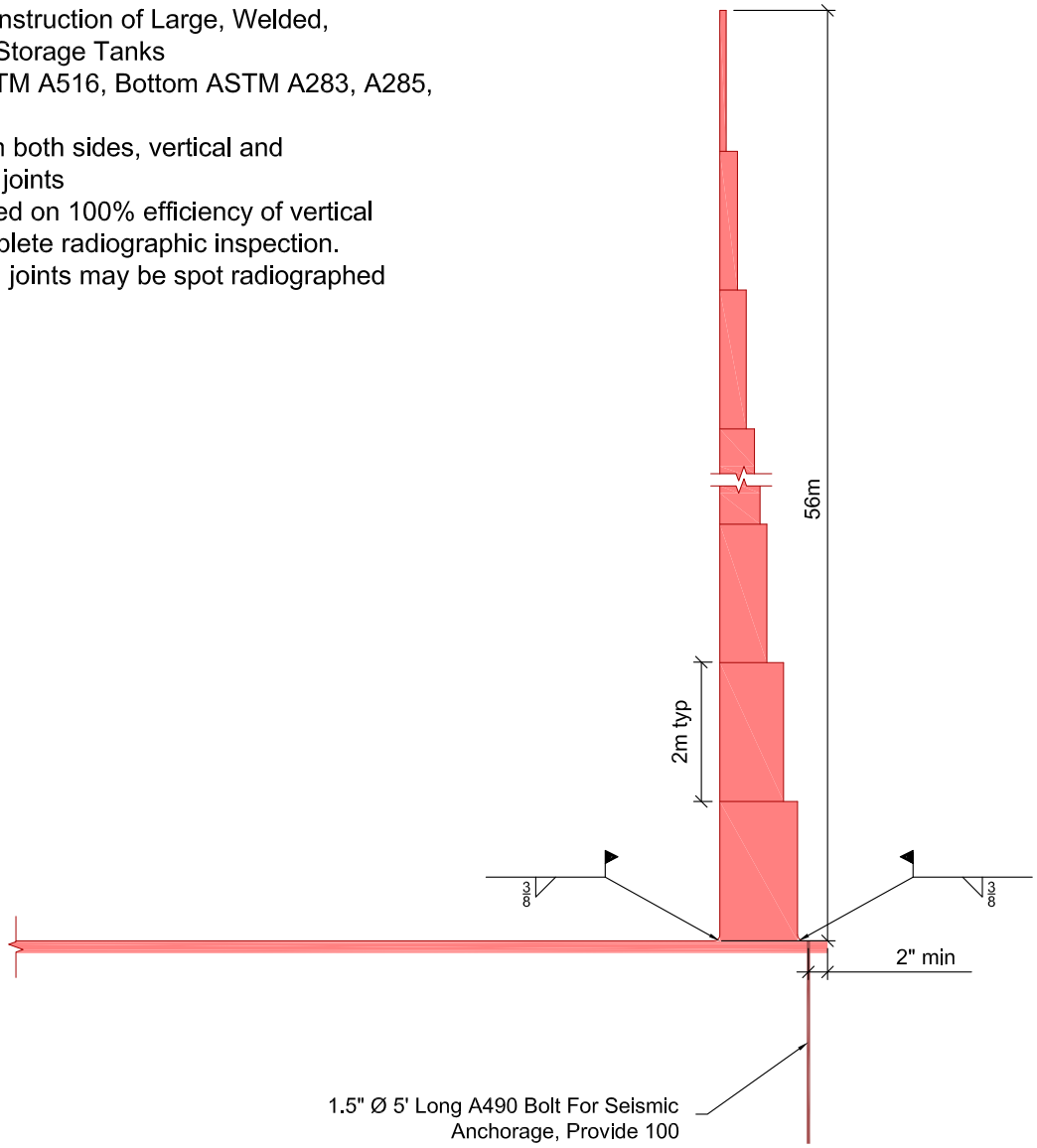


CNA CONSULTING ENGINEERS 2800 University Ave Minneapolis, Mn 55414	Drawing Title:	Concept 1E Steel Free Standing Vessel	Issued by: DLP	Date:	03/17/2010
			Drawn by: BDZ	Project No:	UW 10-01
	Project Title:	LBNE Water Containment Vessel	Field Order:	Drawing No:	1

Free Standing Vessel - Steel (Concept 1E):

1. Design Basis: API 620, 10th Ed, ADD 1, 2004. Design and Construction of Large, Welded, Low-Pressure Storage Tanks
2. Steel: Wall ASTM A516, Bottom ASTM A283, A285, or A36
3. Butt welds from both sides, vertical and circumferential joints
4. Thickness based on 100% efficiency of vertical joints and complete radiographic inspection. Circumferential joints may be spot radiographed



Cell Number	1E Thickness (mm)
1	108
2	102
3	95
4	95
5	89
6	89
7	83
8	76
9	73
10	70
11	67
12	64
13	60
14	54
15	51
16	48
17	44
18	41
19	35
20	32
21	29
22	25
23	21
24	17
25	13
26	8.7
27	8.0
28	8.0

Actual plate thicknesses will match availability in the U.S. market

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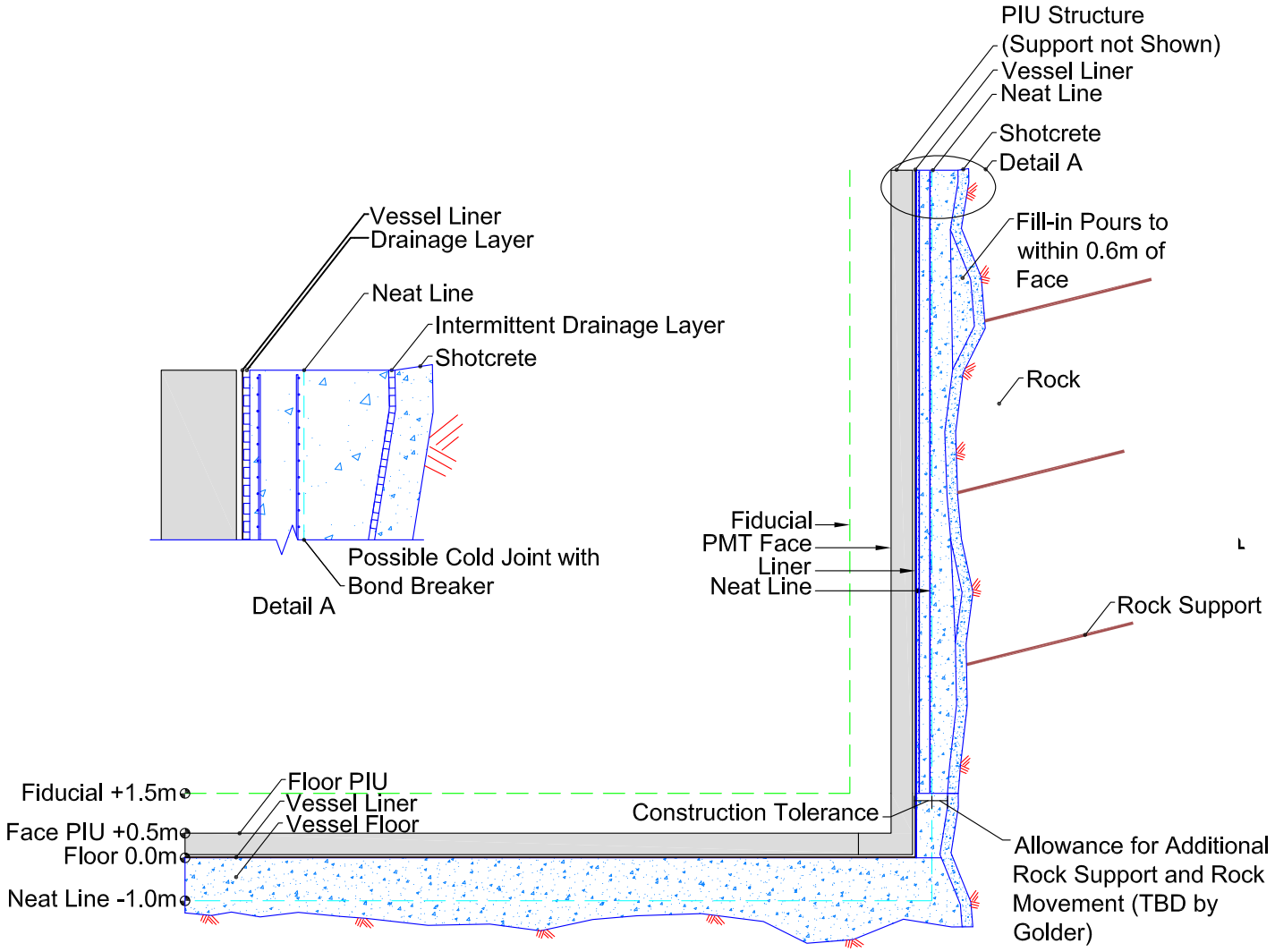
2800 University Ave
Minneapolis, Mn 55414

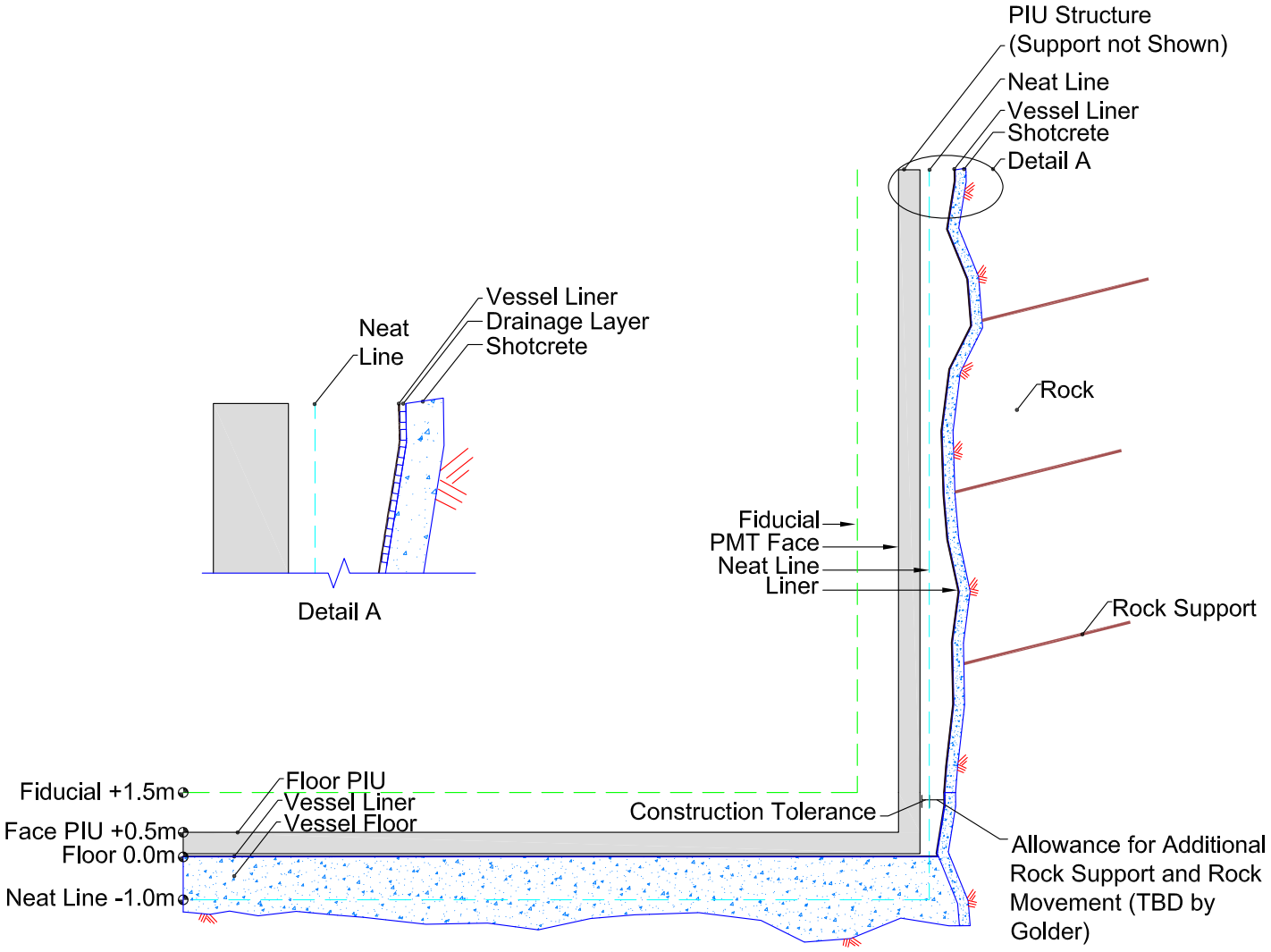
Drawing Title	Concept 1E Steel Free Standing Vessel	Issued by:	DLP	Date	03/17/2010
		Drawn by:	BDZ	Project No.	UW 10-01
Project Title	LBNE Water Containment Vessel	Field Order:		Drawing No.	2

Rock Integrated Vessel - CIP (Concept 2A):

1. Wall section is constant with tank height.
2. Vessel wall concrete: 5000psi;
   Overbreakage fill: 3000psi.
3. Reinforcing Steel: ASTM A615 Grade 60.
   Resteel 0.0025 Ag each direction for each face.
4. Design basis: ACI 350, ACI 373



CNA CONSULTING ENGINEERS 2800 University Ave Minneapolis, Mn 55414	Drawing Title:	Concept 2A Vessel Integrated with Rock	Issued by:	DLP	Date: 03/17/2010
			Drawn by:	BDZ	Project No: UW 10-01
	Project Title:	LBNE Water Containment Vessel	Field Order:		Drawing No: 3

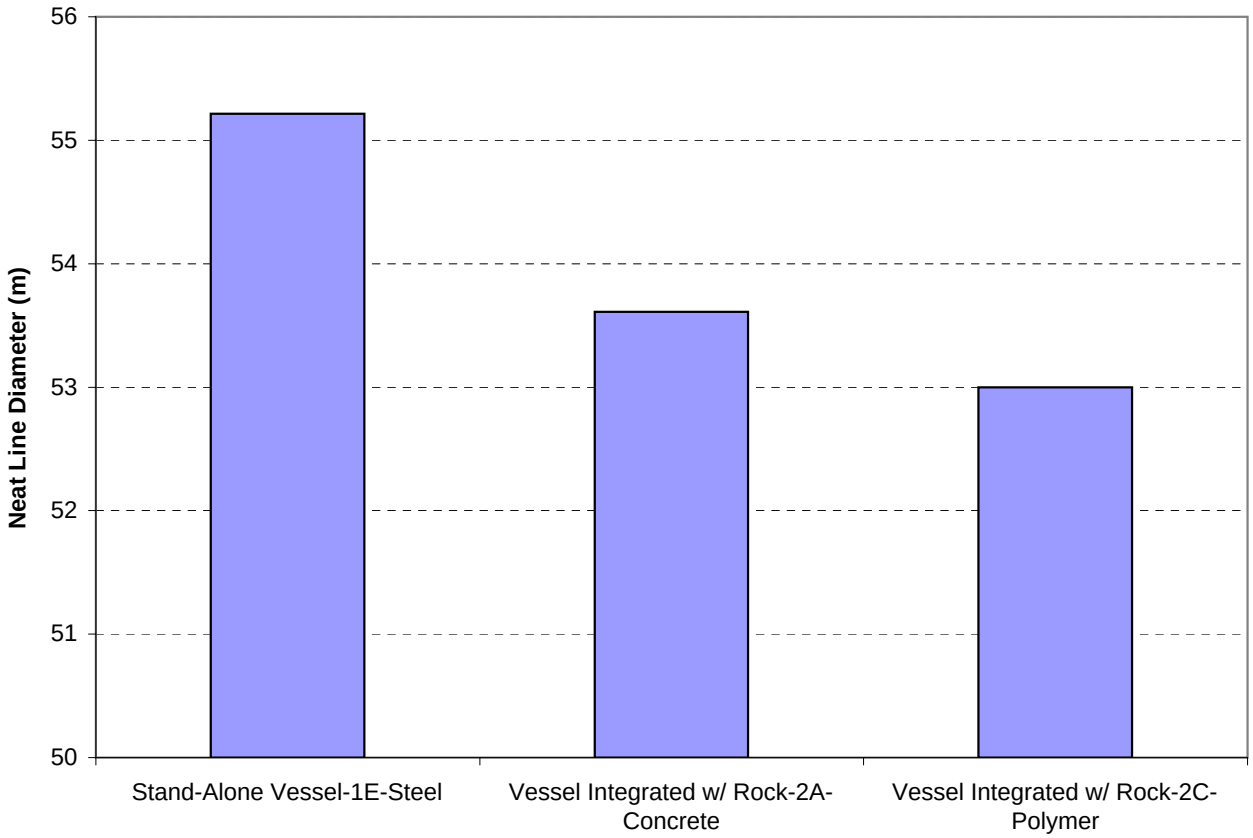


CNA CONSULTING ENGINEERS 2800 University Ave Minneapolis, Mn 55414	Drawing Title:	Concept 2C Liner Against Shotcrete	Issued by:	DLP	Date: 03/17/2010
			Drawn by:	BDZ	Project No: UW 10-01
	Project Title:	LBNE Water Containment Vessel	Field Order:		Drawing No: 4

Major Concept	Concept ID	Material	Weld Inspection	Key Material Strength	Concrete Quantity (cy)	Concrete Quantity (tons)	Concrete Hoist Loads	Steel Plate Quantity (tons)	Steel Plate Hoist Loads	Steel Rebar Quantity (tons)	Post-tensioning Strand Quantity (tons)	Vertical Post Tensioning Quantity (tons)	Tie Down Bolts
Stand-Alone Vessel	1E	Steel	100%	ASTM A516 steel	n.a.	n.a.	n.a.	4340	781	n.a.	n.a.	n.a.	100 1.5" diam
Vessel Integrated w/ Rock	2A	Concrete	n.a.	5000 psi concrete	11810	23118	3853	n.a.	n.a.	250	n.a.	n.a.	n.a.
Vessel Integrated w/ Rock	2C	Polymer	n.a.	Polymer sheet	0	0	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Major Concept	Concept ID	Material	Fiducial Allowance (m)	PIU Allowance (m)	Liner Allowance (m)	Vessel Thickness (Maximum) (m)	Construction Tolerance and Access Allowance (m)
Stand-Alone Vessel	1E	Steel	2	1	0	0.22	2
Vessel Integrated w/ Rock	2A	Concrete	2	1	0	0.61	0
Vessel Integrated w/ Rock	2C	Polymer	2	1	0	0	0

Major Concept	Concept ID	Material	Fiducial Diameter (m)	PMT Face Diameter (m)	Liner Inside Face Diameter (m)	Vessel Inside Face Diameter (m)	Construction Tolerance and Access Inside Face Diameter (m)	Neat Line Diameter (m)
Stand-Alone Vessel	1E	Steel	50	52	53	53.00	53.22	55.22
Vessel Integrated w/ Rock	2A	Concrete	50	52	53	53.00	53.61	53.61
Vessel Integrated w/ Rock	2C	Polymer	50	52	53	53.00	53.00	53.00



API 620 -- 100 percent joint weld inspection -- ASTM A517

		0.0254		26.5				6	12	
Segment	thickness (in)	thickness (m)	Segment Height (m)	Centroid Radius (m)	Centroid Circumference (m)	Segment Volume (m^3)	Segment Weight (tons)	Number of Pieces (maximum weight 6 tons)	Number of Pieces (maximum length 12 m)	Maximum Number of Pieces
28	0.31	0.0080	2.00000	26.50398	166.52939	2.64788	22.91	4	14	14
27	0.31	0.0080	2.00000	26.50398	166.52939	2.64788	22.91	4	14	14
26	0.34	0.0087	2.00000	26.50437	166.53186	2.91018	25.18	5	14	14
25	0.50	0.013	2.00000	26.50635	166.54431	4.23023	36.60	7	14	14
24	0.69	0.017	2.00000	26.50874	166.55931	5.82131	50.37	9	14	14
23	0.81	0.021	2.00000	26.51033	166.56929	6.87938	59.52	10	14	14
22	1.00	0.025	2.00000	26.51270	166.58421	8.46248	73.22	13	14	14
21	1.13	0.029	2.00000	26.51429	166.59418	9.52086	82.37	14	14	14
20	1.25	0.032	2.00000	26.51588	166.60416	10.57936	91.53	16	14	16
19	1.38	0.035	2.00000	26.51746	166.61413	11.63800	100.69	17	14	17
18	1.63	0.041	2.00000	26.52064	166.63408	13.75564	119.01	20	14	20
17	1.75	0.044	2.00000	26.52223	166.64405	14.81466	128.18	22	14	22
16	1.88	0.048	2.00000	26.52381	166.65403	15.87380	137.34	23	14	23
15	2.00	0.051	2.00000	26.52540	166.66400	16.93306	146.51	25	14	25
14	2.13	0.054	2.00000	26.52699	166.67398	17.99246	155.67	26	14	26
13	2.38	0.060	2.00000	26.53016	166.69393	20.11162	174.01	30	14	30
12	2.50	0.064	2.00000	26.53175	166.70390	21.17140	183.18	31	14	31
11	2.63	0.067	2.00000	26.53334	166.71388	22.23130	192.35	33	14	33
10	2.75	0.070	2.00000	26.53493	166.72385	23.29132	201.52	34	14	34
9	2.88	0.073	2.00000	26.53651	166.73383	24.35148	210.69	36	14	36
8	3.00	0.076	2.00000	26.53810	166.74380	25.41176	219.86	37	14	37
7	3.25	0.083	2.00000	26.54128	166.76375	27.53269	238.21	40	14	40
6	3.50	0.089	2.00000	26.54445	166.78370	29.65414	256.57	43	14	43
5	3.50	0.089	2.00000	26.54445	166.78370	29.65414	256.57	43	14	43
4	3.75	0.095	2.00000	26.54763	166.80365	31.77609	274.93	46	14	46
3	3.75	0.095	2.00000	26.54763	166.80365	31.77609	274.93	46	14	46
2	4.00	0.102	2.00000	26.55080	166.82360	33.89855	293.29	49	14	49
1	4.25	0.108	2.00000	26.55398	166.84355	36.02152	311.66	52	14	52
						501.58928	4340	Ok		781

ft^3 / m^3	35.3143472	17713	ft^3
lb / ft^3	490	8679516	lb
tons / lb	2000	4340	tons

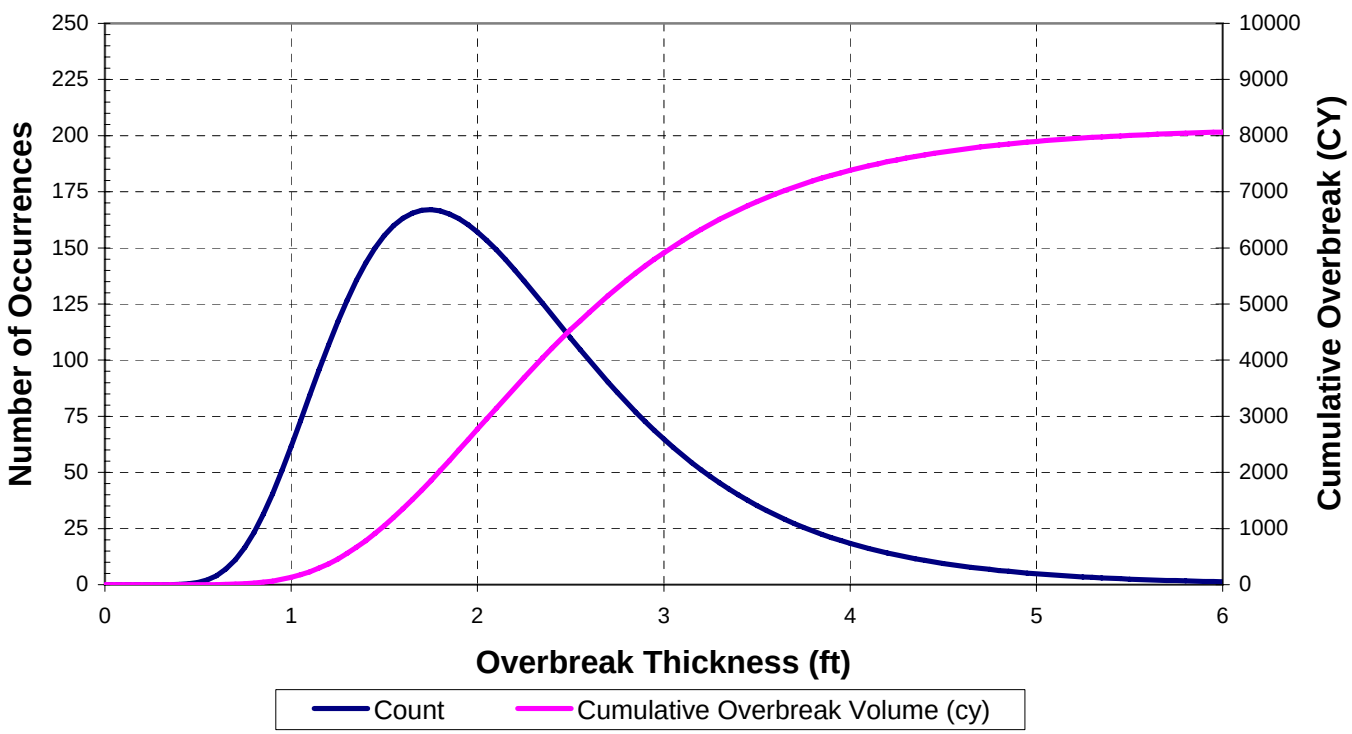
2A Vessel

Inner diameter	53.00	m	
Outer diameter	53.61	m	
Thickness	0.305	m	
Thickness	1	ft	
Height	55	m	
Height	180.4	ft	
Radius at mid thickness	26.65	m	
Radius at mid thickness	87.42	ft	
Volume	99089	ft^3	
Voume	3670	cy	<--- used on pane "Quantity Summary"

Overbreak Estimate -- dlp -- CNA Consulting Engineers
(based on lognormal distribution)

Overbreak Calculations (neat line and out)

		3.28		
	m	ft		
diameter	53.61	175.84		
height	55	180.4		
sidewall surface area		99656.14		
Nominal size		4		
Nominal area		16		
Number		6228.509		
Total Volume		219888.4	ft^3	
Total Volume		8140	cy	
Cavern volume		162255	cy	<--- used on pane "Quantity Summary"
Percentage		5.02%		

Vessel Volume (neat line and in)

	Input ln values		Published for charette--2010-03-09	
mean	0.7	2.181	0.7	2.181
sd	0.4	2.350	0.4	2.350