ATMOSPHERIC STORAGE TANK

INTERNAL & ULTRASONIC

API 653 OUT-OF-SERVICE INSPECTION REPORT

SHELL PIPELINE COMPANY LP

TANK NO. 2

ST. JAMES TERMINAL

ST. JAMES, LA

JULY 14 – 19, 2014

Prepared by:

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A Division of HMT LLC
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INTRODUCTION

HMT Inspection, a division of HMT LLC, provided on-site inspection services in accordance with API Standard 650, “Welded Steel Tanks for Oil Storage” (11th edition, June 2007, addendum 1, November 2008) and API Standard 653, “Tank Inspection, Repair, Alteration, and Reconstruction” (3rd edition, December 2001, includes addendum 1 (September 2003), addendum 2 (November 2005), addendum 3 (February 2008), and errata (April 2008) to establish the current condition of Tank No. 2 at the St. James Terminal in St. James, LA.

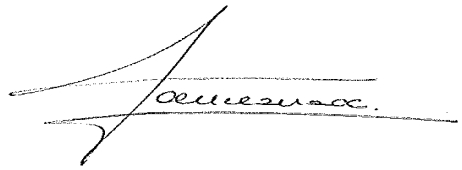
This report is being provided to document these inspection findings based on the inspections performed on July 14 – 19, 2014 and to summarize the evaluation of the AST assessment in accordance with the guidelines of API 653 as applicable.

The owner / user is ultimately responsible for establishing the final suitability for service of Tank No. 2 using the current condition of this tank as detailed herein and the decisions made by the owner / user in satisfying API 653 guidelines for continued operation / repair / alteration / modification as appropriate, subject to the following conditions being met:

1. That the owner / user reviews, evaluates and implements the recommendations set forth in Section 2.0, Summary and Repair Recommendations, of this report or, the owner / user determines that no action(s) need be taken prior to continued service and such decision(s) are documented in the AST historical record file.

2. That the owner / user adheres to the safe fill height recommendations given herein in Section 2.0 for continued service until such time as tank operating conditions change or another inspection assessment per API 653 guidelines determines that an adjustment in safe operating height for this tank should be made.

HMT Inspection provided the following personnel:



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1.0 DESCRIPTION

GENERAL:

TANK NUMBER / IDENTIFICATION:	2
OWNER:	Shell Pipeline Company LP
TANK LOCATION:	St. James, LA
TYPE OF FACILITY:	Terminal
MANUFACTURER:	Graver Tank & Mfg. Co. Inc.
DESIGN STANDARD:	API 650, 6th Edition, w/Appendices D and K
PRODUCT PRIOR TO INSPECTION:	Crude Oil
DESIGN SPECIFIC GRAVITY:	0.876
PRODUCT SPECIFIC GRAVITY:	Data Not Available
DESIGN PRESSURE:	Atmospheric
OPERATING TEMPERATURE:	Ambient
CATHODIC PROTECTION & TYPE:	Yes (Impressed Current)
NAMEPLATE PRESENT:	Yes
DOT REGULATED TANK:	Yes
LATITUDE:	30° 00' 36" N
LONGITUDE:	90° 51' 22" W

DIMENSIONS:

DIAMETER:	300.00 ft.
HEIGHT:	36.42 ft.
CAPACITY GROSS:	452,892 bbls. (calculated)
OPERATING HEIGHT:	33.25 ft. (Per Design)
CAPACITY NOMINAL:	418,707 bbls. (per Data Plate)

GEOMETRY:

FOUNDATION:	Concrete Ringwall
BOTTOM:	Lap Welded
SHELL:	Butt Welded
MATERIAL OF CONSTRUCTION:	Carbon Steel (Grade Not Known)
COURSE 1 AVERAGE THICKNESS:	1.077 inches
FIXED ROOF:	N/A
FLOATING ROOF:	Lap Welded Annular Pontoon w/ Deck Pontoons
PRIMARY SEAL:	Mechanical Shoe
SECONDARY SEAL:	Metalic Wiper

DATES:

YEAR OF CONSTRUCTION:	1979
SECOND BOTTOM & DATE INSTALLED	N/A
LAST COATED:	Data Not Available
LAST INSPECTION:	March 2014 (In-Service)

ACCESS:

STAIRWAY:	Spiral
FLOATING ROOF ACCESS:	Rolling Ladder

COATINGS / LININGS:

BOTTOM & DATE APPLIED:	External – White Paint
SHELL:	Internal – Thin- Film Epoxy on Lower 36 in.
FIXED ROOF:	N/A
FLOATING ROOF:	External – White Paint Internal – None

2.0 SUMMARY AND REPAIR RECOMMENDATIONS

The following is a summary of the significant findings of the inspection.

FOUNDATION: The survey found the tank out of level by 1.68 inches. API 653 calculation for deflection of this tank is 0.37 inch. API 653 maximum deflection permitted for this tank is calculated at 1.83 inches (ref. API 653, Appendix B, Para. B.3). Differential settlement for this tank does not exceed the API allowable (ref. API 653, Appendix B, Para. B.3).

The moisture barrier has deteriorated. Consideration should be given to properly removing the moisture barrier and replacing it with new material to seal against water intrusion under the tank bottom.

The bottom edge projection has minor and isolated areas of coating failure with rust and early stages of corrosion present. Consideration should be given to properly cleaning and re-coating the affected areas.

BOTTOM: Tank 2 was constructed by Graver Tank and Manufacturing Co in 1979 to API 650, 6th Ed. with Appendices D and K. Nominal bottom plate thickness is 0.312 inch. Thin-film epoxy coating has been applied for corrosion protection. The scope of work at this time was to perform internal inspection only.

Magnetic Flux Leakage (MFL) scanning did not reveal any areas of soil side corrosion with a remaining thickness at or below 0.180 inch. Visual (VT) inspection, in conjunction with Magnetic Flux Leakage (MFL) scanning, revealed eight hundred eighty-seven (887) indications grouped into five hundred twenty-three (523) areas of product side corrosion pitting 0.130 inch deep or more. Thirty-six (36) through-thickness holes were located in the bottom plates. The corroded areas should be repaired by fabricating and installing patch plates in accordance with the guidelines of API 653, Para. 9.10.1.1.a / b. Isolated pits to be repaired by weld overlay should be ground flush after completion. Vacuum Box (LT/BT) testing should be performed on all patch plate welds and individual areas of weld overlay.

Numerous weld defects were observed on the lap welds throughout the entire bottom. These weld defects are the result of coating failure and corrosion. These weld defects were identified, marked on the bottom and recorded on the Bottom Reduction Table for later repair by others. These areas should be repaired using approved welding and NDE procedures per API 653 guidelines. Vacuum Box (LT/BT) testing should be performed on all weld repairs.

SUMMARY AND REPAIR RECOMMENDATIONS (CONT'D.)

BOTTOM (CONT'D.): Visual (VT) inspection performed on the bottom welds was very limited due to the presence of coating. No recordable weld defects were noted on the internal shell-to-bottom weld.

The floating roof leg striker plates were found with coating failure and are deteriorated where the floating roof legs land. The striker plates located at the outer perimeter have more severe corrosion present. Weld defects were also observed on some of the striker plate welds. Consideration should be given to repairing or replacing the striker plates as necessary and then re-coating all these items. The same condition was observed on the striker plates beneath the vacuum breaker legs.

Visual (VT) inspection of the sump revealed product side pitting on the sump bottom ranging from 0.100 inch to 0.450 inch deep. The nominal thickness of the sump wall and bottom is 0.500 inch. Consideration should be given to properly repairing the affected areas, then re-coating as necessary. The sump measures 72 inches in diameter and 32 inches deep.

Weld defects were also noted on the wall-to-bottom weld of the sump. Visual (VT) inspection of the sump welds was limited due to the presence of coating. The coating should be removed and the welds re-inspected, any areas with defects repaired and then re-coated.

The next internal inspection should be conducted within 11 years if all areas of product side corrosion with a pit depth of 0.130 inch or greater are repaired. If all such areas are repaired and the bottom is internally coated, the next inspection should be conducted within 20 years, provided that the expected life of the coating meets or exceeds this interval. If all such areas are repaired and reinforced lining is installed, the next inspection should be conducted within 20 years (ref. API 653, Para. 4.4.5).

SHELL: Visual (VT) inspection of the external shell-to-bottom weld revealed three (3) areas of weld defect (lack of weld). These areas are located on the left side of the cleanout at Stations 933.80 and 935.00 and on the left side of Nozzle X (inlet line) at Station 531.00 (all stations measured in feet counterclockwise from Cleanout A). Consideration should be given to repairing these areas per API 653 guidelines.

No evidence of corrosion or any other defect was noted on the internal shell.

SUMMARY AND REPAIR RECOMMENDATIONS (CONT'D.)

NOZZLES AND APPURTENANCES: The internal nozzles and appurtenances were found in acceptable condition.

The floating roof drain is a combination of a flexible hose and carbon steel piping. This drain system should be cleaned and pressure tested to verify current integrity. Another auxiliary roof sump is connected to the main roof sump. Areas of coating failure and product side corrosion were noted on the bottom plates near and under the flexible hose, apparently the result of the hose dragging across the bottom plates. Consideration should be given to repairing the affected areas, then re-coating as necessary and to restricting hose movement or providing improved coating protection in these areas.

Four (4) supports associated with the auxiliary roof sump piping that is welded to the underside of the floating roof have detached from the piping. These piping supports are located near the center of the tank. Consideration should be given to repairing the affected items.

FLOATING ROOF: Through-thickness holes were observed in eight (8) seal hangers. Signs of corrosion were also noted on most of the hangers. Since the next out-of-service inspection will be in 20 years (per client), consideration should be given to replacing the primary floating roof seal now. Both floating roof seals will be replaced before the tank is returned to service (per client).

The mechanical vacuum breaker legs are not adjustable and will only operate when the roof is in low position. Consideration should be given to making the vacuum breaker legs adjustable (pin settings for both high and low roof positions).

3.0 INSPECTION REPORT

3.1 FOUNDATION

3.1.1 FOUNDATION INSPECTION CHECKLIST

ITEM NO.	FOUNDATION	INSPECTION COMMENTS
F1	Type of tank foundation present (ref. API 653, Para. 4.5.1): A) Concrete ringwall B) Concrete pad C) Earth D) Gravel / crushed rock E) Structural	Acceptable
F2	Perform bottom settlement survey (ref. API 653, Para. B.2.1).	Acceptable
F3	Identify and measure the dimensions of all areas of tank bottom deformation (up or down) & settlement (ref. API 653, Paras. B.2.5 & B.3.3).	Acceptable
F4	Identify and measure all areas of internal bottom edge settlement (ref. .API 653, Paras. B.2.3 & B.3.4 Figs. B.10 / B.11).	Acceptable
F5	Concrete ringwall free of debris (ref. API 653, Para. 6.3.1).	Acceptable
F6	Concrete ringwall beveled away from tank.	Acceptable
F7	Concrete ringwall free of cracks, breaks, spalling, exposed rebar, etc. (ref. API 653, Para. 4.5.1).	Acceptable
F8	Earth eroded due to water running off the tank (ref. API 653, Paras. 6.3.1, & 4.4.2).	N/A
F9	Check for proper drainage and water runoff away from the tank (ref. API 653, Para. C.1.1.5).	Acceptable
F10	Check around the tank and within the dike for build-up of trash and vegetation (ref. API 653, Para. C.1.1.6).	Acceptable
F11	Moisture barrier condition (bottom edge projection to concrete ringwall) (ref. API 653, Para. 6.3.1).	Reference Section 2.0
F12	Indications of bottom leakage (ref. API 653, Para. 6.3.1).	Acceptable
F13	Cavities or holes around / under tank perimeter (ref. API 653, Paras. 6.3.1 & C.1.1.1).	Acceptable
F14	Bottom edge projection condition and UT readings taken (corroded or pitted, thinning, deformed, obstructed) (ref. API 653, Paras. 4.4.5.7 & 6.3.1).	Reference Section 2.0
F15	Check for anchorage. Record sizes, spacing between anchors and condition (ref. API 653, Paras. 4.5.3 & 8.8).	N/A
F16	List any limitations to the foundation inspection.	Acceptable

3.1.2 FOUNDATION SETTLEMENT SURVEY

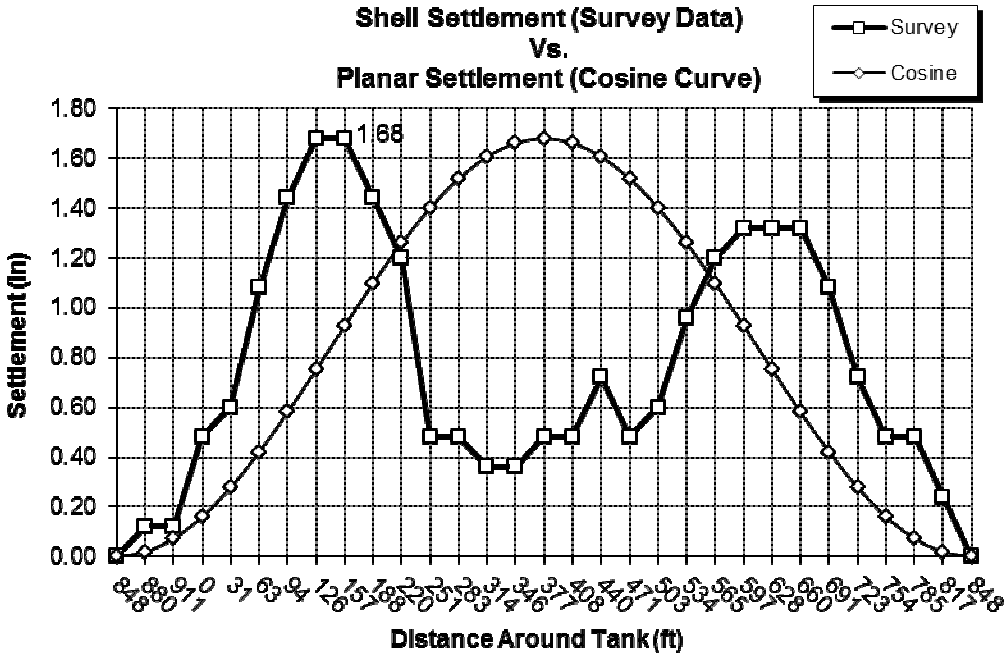
The survey was conducted internally counterclockwise from the reference Shell Manway A located at Station 0.0. The circumferential distance between the readings is 31.416 feet.

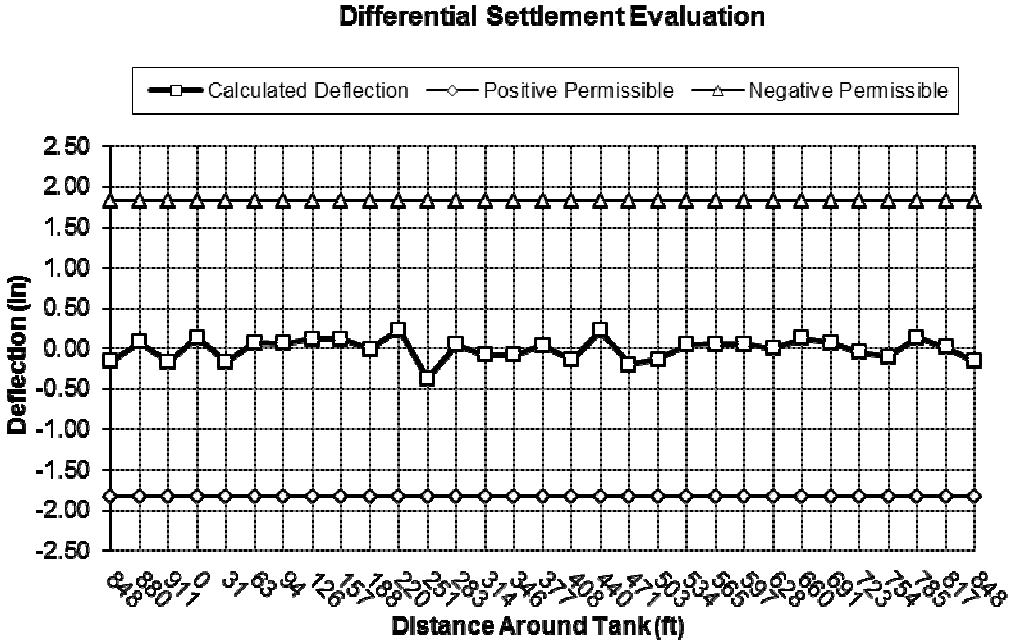
Point No.	Distance from Shell (ft.)										
	Shell	1'	2'	3'	4'	5'	6'	10'	20'	30'	40'
	Rod Readings (ft.)										
1	4.12	4.13	4.16	4.21	4.24	4.29	4.27	4.35	4.48	4.39	4.23
2	4.13	4.20	4.22	4.25	4.27	4.28	4.30	4.32	4.49	4.37	4.28
3	4.17	4.21	4.27	4.29	4.32	4.31	4.32	4.32	4.54	4.48	4.31
4	4.20	4.24	4.29	4.34	4.35	4.35	4.36	4.32	4.50	4.44	4.26
5	4.22	4.24	4.25	4.27	4.32	4.36	4.38	4.37	4.45	4.36	4.28
6	4.22	4.22	4.30	4.33	4.34	4.32	4.33	4.33	4.40	4.37	4.24
7	4.20	4.23	4.27	4.29	4.29	4.28	4.28	4.31	4.39	4.34	4.19
8	4.18	4.21	4.25	4.27	4.28	4.26	4.26	4.30	4.39	4.25	4.16
9	4.12	4.13	4.13	4.14	4.15	4.16	4.17	4.24	4.29	4.26	4.16
10	4.12	4.17	4.22	4.23	4.22	4.20	4.20	4.20	4.31	4.31	4.18
11	4.11	4.14	4.21	4.26	4.28	4.28	4.29	4.27	4.36	4.34	4.22
12	4.11	4.16	4.20	4.23	4.24	4.23	4.24	4.33	4.39	4.42	4.24
13	4.12	4.17	4.21	4.25	4.26	4.27	4.29	4.27	4.35	4.37	4.18
14	4.12	4.17	4.22	4.27	4.28	4.30	4.31	4.31	4.36	4.32	4.20
15	4.14	4.16	4.19	4.25	4.29	4.31	4.31	4.32	4.39	4.30	4.18
16	4.12	4.16	4.21	4.25	4.25	4.26	4.22	4.23	4.36	4.22	4.08
17	4.13	4.16	4.21	4.19	4.21	4.23	4.24	4.28	4.32	4.25	4.17
18	4.16	4.17	4.19	4.20	4.17	4.16	4.15	4.19	4.30	4.35	4.21
19	4.18	4.16	4.14	4.15	4.16	4.19	4.23	4.32	4.40	4.33	4.14
20	4.19	4.21	4.24	4.23	4.25	4.28	4.31	4.31	4.43	4.35	4.20
21	4.19	4.15	4.12	4.12	4.15	4.18	4.22	4.35	4.41	4.35	4.26
22	4.19	4.21	4.20	4.21	4.22	4.22	4.24	4.30	4.36	4.35	4.30
23	4.17	4.19	4.23	4.24	4.23	4.20	4.19	4.23	4.36	4.31	4.22
24	4.14	4.17	4.19	4.21	4.23	4.23	4.25	4.28	4.44	4.36	4.28
25	4.12	4.15	4.19	4.21	4.23	4.24	4.25	4.32	4.46	4.47	4.37
26	4.12	4.13	4.17	4.21	4.23	4.21	4.22	4.34	4.45	4.40	4.32
27	4.10	4.14	4.19	4.21	4.21	4.21	4.23	4.31	4.41	4.41	4.35
28	4.08	4.12	4.18	4.22	4.24	4.25	4.27	4.29	4.35	4.37	4.33
29	4.09	4.12	4.18	4.22	4.23	4.23	4.26	4.25	4.39	4.27	4.15
30	4.09	4.14	4.16	4.20	4.23	4.24	4.26	4.27	4.45	4.39	4.18

3.1.2 FOUNDATION SETTLEMENT SURVEY (CONT'D.)

Point No.	Distance from Shell (ft.)										
	50'	60'	70'	80'	90	100'	110'	120'	130'	140'	Center
	Rod Readings (ft.)										
1	4.12	3.89	3.70	3.48	3.25	3.06	2.91	2.60	2.38	2.21	2.08
2	4.19	4.07	3.80	3.58	3.27	3.10	2.93	2.26	2.43	2.28	--
3	4.12	3.96	3.69	3.53	3.27	3.07	2.87	2.68	2.46	2.29	--
4	4.11	3.88	3.71	3.54	3.26	3.06	2.89	2.78	2.54	2.29	--
5	4.09	3.90	3.68	3.51	3.26	3.01	2.86	2.71	2.53	2.28	--
6	4.09	3.83	3.68	3.42	3.16	2.99	2.80	2.70	2.41	2.27	--
7	4.03	3.91	3.60	3.37	3.16	3.00	2.84	2.59	2.33	2.23	--
8	3.95	3.71	3.51	3.30	3.15	3.00	2.78	2.53	2.35	2.16	--
9	3.95	3.76	3.55	3.33	3.16	2.91	2.64	2.46	2.32	2.12	--
10	4.01	3.84	3.66	3.42	3.20	2.95	2.66	2.43	2.25	2.09	--
11	4.00	3.75	3.49	3.24	2.98	2.71	2.52	2.42	2.27	2.13	--
12	4.00	3.74	3.51	3.33	3.11	2.88	2.63	2.46	2.30	2.14	--
13	4.00	3.84	3.53	3.34	3.10	2.94	2.71	2.42	2.28	2.14	--
14	4.04	3.85	3.54	3.37	3.19	2.97	2.73	2.49	2.26	2.11	--
15	4.06	3.82	3.59	3.38	3.24	2.90	2.75	2.53	2.24	2.09	--
16	4.02	3.69	3.59	3.43	3.21	2.94	2.70	2.51	2.24	2.09	--
17	3.97	3.80	3.56	3.41	3.15	3.00	2.75	2.55	2.36	2.12	--
18	4.12	3.91	3.67	3.44	3.20	3.00	2.81	2.54	2.36	2.11	--
19	4.09	3.86	3.64	3.36	3.16	2.93	2.81	2.45	2.29	2.11	--
20	4.08	3.95	3.63	3.37	3.14	2.96	2.80	2.46	2.22	2.11	--
21	4.15	3.96	3.70	3.47	3.20	3.05	2.86	2.57	2.26	2.06	--
22	4.09	3.87	3.72	3.46	3.25	3.06	2.83	2.54	2.27	2.06	--
23	4.13	3.98	3.72	3.46	3.25	3.06	2.80	2.52	2.26	2.03	--
24	4.20	4.00	3.73	3.50	3.30	3.00	2.76	2.42	2.23	2.04	--
25	4.27	4.09	3.82	3.61	3.34	3.06	2.77	2.50	2.22	2.06	--
26	4.19	3.97	3.74	3.50	3.23	3.00	2.72	2.51	2.28	2.03	--
27	4.20	3.96	3.74	3.54	3.31	3.10	2.86	2.62	2.31	2.13	--
28	4.16	3.95	3.72	3.50	3.26	3.00	2.79	2.64	2.39	2.14	--
29	4.15	4.04	3.78	3.46	3.26	3.05	2.82	2.62	2.41	2.16	--
30	4.04	3.89	3.74	3.42	3.22	3.02	2.77	2.54	2.42	2.18	--

3.1.3 SETTLEMENT EVALUATION





3.2 BOTTOM

3.2.1 BOTTOM INSPECTION CHECKLIST

ITEM NO.	BOTTOM	INSPECTION COMMENTS
B1	Record minimum bottom plate thickness requirements (ref. API 653, Para. 4.4.5).	Acceptable
B2	MFL scan of accessible bottom plates. Quantify all findings (ref. API 653, Paras. 4.4.4 & 4.4.5)	Reference Section 2.0
B3	Visual inspection of bottom plate surface condition (ref. API 653, Para. 4.4.1)	Reference Section 2.0
B4	Conduct Ultrasonic thickness readings of bottom plates. Record all data (ref. API 653, Para. 4.4.4).	Acceptable
B5	Locate unacceptable voids beneath bottom. Record the locations (ref. API 653, Para. 4.4.2.h & j) (ref. API 653, Para. 9.10.2.1.3).	Acceptable
B6	Visual inspection of bottom plate lap welds (for reportable indications or other anomalies) (ref. API 653, Para. 4.4.2,).	Reference Section 2.0
B7	Perform Vacuum Box testing of bottom lap welds.	N/A
B8	Shell-to-bottom weld condition (ref. API 653, Para. 4.4.2).	Acceptable
B9	Perform Magnetic Particle testing of internal shell-to-bottom weld.	N/A
B10	Perform Vacuum Box testing of internal shell-to-bottom weld.	N/A
B11	Identify all signs of product leakage.	N/A
B12	Reinforcing pads present under all clips, brackets and supports / condition (ref. API 650, Paras. 5.10.4.7 / H.4.6.7), (ref. API 653, Para. 9.10.2.2).	Acceptable
B13	Floating roof leg striker plate condition (pitting, cutting, and dimpling).	Reference Section 2.0
B14	Fixed roof column bearing / base plate condition (corrosion, weld failure).	N/A
B15	Fixed roof column lateral clips (align tank columns) (ref. API 650, Para. 5.10.4.7)	N/A
B16	Conduct Visual inspection of reinforcing, bearing, base, striker plates and existing lap patches (ref. API 653, Paras. 9.10.1.2, & 9.10.3 & Fig. 9-6)	Reference Section 2.0
B17	List any limitations to bottom inspection.	Reference Section 2.0
ITEM NO.	**SUMP**	**INSPECTION COMMENTS**
BS1	Describe sump type / condition (Modified, false bottom, dish / bowl, etc.) details to include physical dimensions (ref. API 653, Paras. 4.4.2, 9.10.1.5 & C.2.3), (ref. API 650, Table 5-16b & Fig. 5-21).	Reference Section 2.0
BS2	Perform Visual inspection of the sump (including all sump welds).	Reference Section 2.0
BS3	Perform Magnetic Particle testing examination on all sump welds (including sump-to-bottom weld).	N/A
BS4	Perform Sump UT. Record lowest UT reading per grid in sump UT form.	Acceptable
BS5	List any limitations to the sump inspection.	Acceptable

3.2.2 SERVICE INTERVAL

The next internal inspection should be conducted within 11 years if all areas of soil side corrosion resulting in a remaining thickness of 0.180 inch or below are repaired and all areas of product side corrosion with a pit depth of 0.130 inch or greater are repaired. If all such areas are repaired and the bottom is internally coated, the next inspection should be conducted within 20 years, provided that the expected life of the coating meets or exceeds this interval (ref. API 653, Para. 4.4.5).

Bottom Plates

Nominal Bottom Plate Thickness (inches)	0.312	inch
Maximum Soil Side Corrosion Depth	0.042	inch
Maximum Product Side Corrosion Depth	0.312	inch
Minimum Remaining Thickness at Next Inspection (MRT)	0.100	inch
Year of Inspection (Yi)	2014	year
Year of Bottom Installation (Yo)	1979	year
Minimum Remaining Thickness from Soil Side Corrosion after Repairs (RTbc)	0.180	inch
Minimum Remaining Thickness from Product Side Corrosion after Repairs (RTip)	0.180	inch
Soil Side Corrosion Rate (UPr)	**0.0038**	inch/yr
Product Side Corrosion Rate (StPr)	**0.0038**	inch/yr

Repaired Soil Side Corrosion Evaluation (assume 0.250 in. patch): 0.250 in. Patch Plate **Acceptable**
(per API 653, 4.4.5, UPr Def.)

$$O_r = \frac{(\min RT_{bc} or RT_{ip}) - MRT}{S_t P_r + UP_r}$$

Interval to next inspection **11 Years**
(RRT-0.10)/(PS + SS C.R.)

If thin-film lining is installed after repairs
(expected life of lining must equal or exceed this interval) **20 Years**
(Product Side Corrosion Rate = 0) (RRT-0.10)/(0 + SS C.R.)

3.2.2 SERVICE INTERVAL (CONT'D.)

Critical Zone

Nominal Bottom Plate Thickness (inches)	0.312	inch
Maximum Soil Side Corrosion Depth	0.062	inch
Maximum Product Side Corrosion Depth	0.150	inch
Minimum Remaining Thickness at Next Inspection (MRT)	**0.156**	inch
Year of Inspection (Yi)	2014	year
Year of Bottom Installation (Yo)	1979	year
Minimum Remaining Thickness from Soil Side Corrosion after Repairs (RTbc)	0.215	inch
Minimum Remaining Thickness from Product Side Corrosion after Repairs (RTip)	0.215	inch
Soil Side Corrosion Rate (UPr)	**0.0028**	inch/yr
Product Side Corrosion Rate (StPr)	**0.0028**	inch/yr

Repaired Soil Side Corrosion Evaluation (assume 0.250 in. patch): 0.250 in. Patch Plate **Acceptable**
(per API 653, 4.4.5, UPr Def.)

$$O_r = \frac{(\min RT_{bc} or RT_{ip}) - MRT}{S_t P_r + UP_r}$$

Interval to next inspection **11 Years**
(RRT-0.156/(PS+SS C.R.)

If thin-film lining is installed after repairs
(expected life of lining must equal or exceed this interval) **20 Years**
(Product Side Corrosion Rate = 0) (RRT-0.156)/(0+SS C.R.)

3.2.3 SUMP ULTRASONIC (UT) THICKNESS READINGS

SUMP READINGS
(in inches)

WALL			
N	READING	S	READING
1	0.520	1	0.509
2	0.518	2	0.510
3	0.519	3	0.509
4	0.515	4	0.510
E	READING	W	READING
1	0.515	1	0.522
2	0.516	2	0.522
3	0.515	3	0.521
4	0.515	4	0.519

BOTTOM		
LOCATION	READING	READING
N	0.558	0.558
S	0.551	0.554
E	0.550	0.548
W	0.552	0.553
CENTER	0.550	0.552

3.2.4 BOTTOM REDUCTION TABLE

BOTTOM REDUCTION TABLE

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS	*COMMENTS
12A	0.200 – 0.250	--	12 – 18	24 – 26	2	--	12X12
B	0.210	--	32	67	1	--	12X12
C	0.130 – 0.150	--	94 – 104	24 – 41	2	--	PW
14A	0.130	--	74	21	1	--	NE, PW
B	0.130	--	65	60	1	--	NE, PW
15A	0.150	--	82	86	1	--	PW
16A	0.160	--	49	3	1	--	PW
17A	0.150	--	24 – 30	12 – 15	3	--	16X14 NE
B	0.150	--	74	48	1	--	NE, PW
C	0.130	--	81	83	1	--	NE, PW
D	0.17	--	88 – 94	60 – 73	2	--	16X22 NE
E	00.180	--	204 – 206	85	2	--	12X12 NE
20A	0.180	--	93	81	1	--	12X12 NE
B	0.130	--	36	76	1	--	NE
C	0.130	--	29	58	1	--	NE
D	0.150	--	12	80	1	--	NE
21A	0.210	--	8	13	1	--	12X12
B	0.210	--	72	82	1	--	12X12
C	0.130	--	80	58	1	--	PW
D	0.130	--	78	12	1	--	PW
E	0.130	--	120	91	1	--	PW
F	0.130	--	220	68	1	--	PW
G	0.160	--	235	60	1	--	PW
H	Hole	--	257	7	1	--	12X12 Hole
I	0.160	--	212	40	1	--	PW
J	0.140	--	291	63	1	--	PW
K	0.140	--	291	37	1	--	PW
L	0.170 – 0.210	--	314 – 320	19 – 24	3	--	12X12
22A	0.180	--	1	33	1	--	12X12

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE (CONT'D.)

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	*COMMENTS
22B	0.140	--	135	58	1	--	PW
23A	0.130 – 0.210	--	86 – 94	25 – 48	6	--	26X14
25A	0.130	--	83	2	1	--	PW
B	0.180	--	211	37	1	--	12X12
26A	0.190 – 0.130	--	14	9 – 10	3	--	24X24
B	0.130 – 0.240	--	1 – 2	23 – 41	3	--	16X32
C	0.200	--	7	71	1	--	12X12
D	0.200	--	35	47	1	--	12X12
E	0.160	--	229 – 234	34 – 36	2	--	PW
27A	0.130	--	29	67	1	--	PW
B	0.130 – 0.150	--	31 – 35	45 – 51	2	--	PW
C	Hole – 0.220	--	101 – 132	28 – 45	4	--	40x28
D	0.140	--	214	38	1	--	PW
E	0.140	--	237	29	1	--	PW
28A	0.140	--	1	55	2	--	PW
B	0.130 – Hole	--	24 – 37	41 – 45	2	--	18x16
C	0.130	--	227	21	1	--	PW
D	0.130	--	267	15	1	--	PW
29A	0.150	--	128	42	1	--	NE, PW
31A	0.180	--	2	27	1	--	12x12 NE
32A	0.140	--	97	84	1	--	
B	0.150 – 0.160	--	226 – 237	10 – 28	3	--	PW
C	0.160	--	285	9	1	--	PW
D	0.130	--	305	53	1	--	PW
E	0.130 – 0.150		341 – 351	15 – 48	4		PW
33A	0.150 – 0.300	--	5 – 78	53 – 55	2	--	26X14
B	0.130 – 0.150	--	114 – 128	56 – 71	3	--	PW
35A	0.130	--	37	20	1	--	PW
B	0.150	--	97	31	1	--	PW
C	0.160	--	198	25	1	--	12X12

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE (CONT'D.)

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	*COMMENTS
35D	0.150	--	171	59	1	--	PW
E	0.150	--	224	30	1	--	PW
36A	0.130	--	131	29	1	--	PW
B	0.140	--	75	48	1	--	PW
37A	0.140	--	114	60	1	--	PW
B	0.150	--	151	84	1	--	PW, CZ
39A	0.140	--	165	65	1	--	PW
41A	0.180	--	134	81	1	--	12X12
43A	0.180	--	23	118	1	--	PW
B	0.150	--	53	73	1	--	PW
C	0.130	--	57	6	1	--	PW
D	0.130	--	158	70	1	--	PW
E	0.160	--	315	71	1	--	PW
44A	0.190	--	92	78	1	--	12X12
B	0.130 – 0.230	--	155	22 – 30	2	--	16X12
C	0.130 – 0.160	--	239 – 281	37 – 62	5	--	PW
D	0.160 – 0.180	--	282 – 294	39 – 41	2	--	24X12
E	0.130	--	278	71	1	--	PW
F	0.140	--	320	75	1	--	PW
47A	0.130	--	20	58	1	--	PW
B	0.130	--	28	23	1	--	PW
52A	0.130	--	18	59	1	--	PW
B	0.220	--	195	32	1	--	12X12
C	0.140	--	309	54	1	--	PW
53A	0.145 – 0.180	--	14 – 17	1	2	--	12X12
B	0.160 – 0.280	--	65 – 67	10 – 12	2	--	12X12
55A	0.140	--	53	71	1	--	PW
B	0.240	--	113	24	1	--	12X12
C	0.160	--	271	27	1	--	PW

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE (CONT'D.)

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	*COMMENTS
56A	0.130	--	1	60	1	--	PW
B	0.170 – 0.220	--	176 – 190	63 – 64	3	--	24X14
C	0.130	--	218	40	1	--	PW
D	0.140 – 0.180	--	222 – 238	58 – 69	3	--	26X20
E	0.180	--	271	76	1	--	12X12
F	0.130	--	307	11	1	--	PW
G	0.160	--	350	54	1	--	PW
57A	Hole	--	131	50	1	--	12X12 NE
61A	0.140	--	13	30	1	--	PW
B	0.140	--	31	59	1	--	PW
C	0.150	--	136	10	1	--	PW
D	0.130	--	238	24	1	--	PW
E	0.130	--	264	54	1	--	PW
63A	0.150	--	133	42	1	--	NE, PW
64A	0.230	--	57	16	1	--	12X12 NE
69A	0.130	--	8	6	1	--	PW
B	0.170	--	87	82	1	--	12X12
70A	0.150	--	133	53	1	--	PW
B	0.130 – Hole	--	206 – 214	20 – 40	5	--	26X28
C	0.200	--	357	68	1	--	12X12
71A	0.220 – Hole	--	320	1 – 9	2	--	36X30
B	0.140 – 0.180	--	32 – 33	37 – 48	2	--	16X20
73A	--	--	220	16	1	--	12X12
B	0.220	--	81	56	1	--	12X12
C	0.130 – 0.150	--	126 – 145	6 – 15	4	--	28X24
D	0.140	--	307	43	1	--	PW
74A	0.230	--	60	12	1	--	12X12 NE
75A	0.130	--	164	24	1	--	PW

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE (CONT'D.)

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	*COMMENTS
79A	0.130	--	166	20	1	--	PW
80A	0.140	--	149	32	1	--	NE, PW
B	0.140	--	12	23	1	--	NE, PW
82A	0.170 – 0.200	--	4 – 21	36 – 43	2	--	28X16 NE
83A	0.160	--	159	42	1	--	NE, PW
B	0.180	--	44	5	1	--	12X12 NE
85A	0.150	--	153	19	1	--	PW
B	0.130	--	243 – 249	3 – 6	2	--	PW
86A	0.140	--	7	80	1	--	PW
89A	0.200	--	232	58	1	--	12X12
B	0.130	--	238	22	1	--	PW
C	0.130	--	307	44	1	--	PW
D	0.130	--	336	37	1	--	PW
90A	0.160	--	65	37	1	--	PW
B	0.160	--	82	48	1	--	PW
C	0.130	--	116	30	1	--	PW
D	0.170	--	159	16	1	--	12X12
91A	0.130	--	20	21	1	--	PW
B	0.130	--	47	17	1	--	PW
92A	0.130	--	14	67	1	--	PW
B	0.130	--	24	51	1	--	PW
C	0.140	--	44	19	1	--	PW
D	0.130	--	129	65	1	--	
E	0.130 – Hole	--	144 – 360	87	50	--	PR
97A	0.130	--	0.180	2	1	--	PW
99A	0.130	--	92	36	1	--	PW
B	0.130	--	244	38	1	--	PW
102A	0.160	--	70	84	1	--	PW
B	0.160	--	176	79	1	--	PW

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE (CONT'D.)

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	*COMMENTS
102C	0.160	--	196	24 – 36	3	--	PW
D	0.130	--	280	51	1	--	PW
104A	0.130	--	22	15	1	--	NE, PW
B	0.190	--	2	22	1	--	12X12 NE
109A	0.130	--	118	32	1	--	NE, PW
B	0.150	--	75	15	1	--	NE, PW
110A	0.130	--	64	50	1	--	PW
B	0.130	--	115	67	1	--	PW
C	0.160	--	127	49	1	--	PW
D	0.160 – 0.210	--	175 – 187	6	2	--	34X26
E	Hole	--	110	16	1	--	12X12
112A	0.130	--	31	61	1	--	PW
113A	0.150	--	189	38	1	--	PW
B	Hole	--	240	51	1	--	12X12
C	0.160 – Hole	--	279 – 306	11 – 43	4	--	42X18
D	0.220	--	284	8	1	--	12X12
E	0.130 – 0.160	--	348 – 354	4 – 6	2	--	PW
114A	0.140	--	160	68	1	--	PW
115A	0.130	--	151	17	1	--	NE, PW
117A	0.130	--	32	53	1	--	PW
B	0.140	--	41	22	1	--	PW
C	0.200	--	54	54	1	--	12X12
D	0.170	--	106	15	1	--	12X12
E	0.190	--	110	55	1	--	12X12
F	0.150	--	144	38	1	--	PW
G	0.150 – 0.190	--	251	74 – 76	2	--	12X12
118A	0.200	--	73	2	1	--	12X12
B	0.170	--	92	9	1	--	12X12
C	0.180	--	122	63	1	--	12X12

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE (CONT'D.)

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	*COMMENTS
118D	0.130	--	248	18	1	--	PW
E	0.130	--	259	64	1	--	PW
F	0.130	--	277 – 283	9 – 12	2	--	PW
G	0.180	--	284	67	1	--	12X12
H	0.130	--	302	32	1	--	PW
I	0.130	--	316	66	1	--	PW
J	0.130 – 0.160	--	336 – 384	50 – 63	4	--	PW
120A	0.210 – 0.240	--	13 – 21	35 – 56	2	--	22X32
123A	0.150 – Hole	--	51 – 206	88	25	--	PR
B	0.160	--	255	46	1	--	PW
125A	0.130	--	4	34	1	--	PW
B	0.180	--	129	17	1	--	12X12
126A	0.160	--	26	80	1	--	PW
B	0.160	--	186	58	1	--	PW
C	0.130 – 0.160	--	205 – 214	23 – 24	2	--	PW
D	0.130	--	237	26	1	--	PW
127A	0.160	--	90	88	1	--	NE, PW
128A	0.160	--	175	21	1	--	PW
129A	0.130	--	11	4	1	--	PW
B	0.130 – 0.150	--	218 – 227	87	1	--	PW
C	0.200	--	305	54	1	--	12X12
D	0.150	--	322	73	1	--	PW
131A	0.200	--	28	42	1	--	12X12
B	0.130	--	90	111	1	--	PW
C	0.150	--	84	40	1	--	PW
D	0.130 – 0.200	--	161 – 194	2 – 38	10	--	50X72
E	0.180	--	240	59	1	--	PW
F	0.140	--	245	37	1	--	PW
G	0.140	--	294	54	1	--	PW
H	0.140	--	296	38	1	--	PW

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE (CONT'D.)

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	COMMENTS
133A	0.130	--	12 – 13	10 – 17	2	--	PW
B	0.150 – 0.220	--	55 – 81	10 – 55	5	--	34X44
C	0.260	--	72	2	2	--	16X20
D	0.130	--	117	58	1	--	PW
E	0.130 – 0.250	--	125 – 126	7 – 26	5	--	32X26
134A	Hole	--	144	62	1	--	12X12
B	0.160 – Hole	--	196 – 211	67 – 81	3	--	22X22
C	0.150	--	255	76	1	--	PW
D	0.220	--	266	52	1	--	12X12
E	0.130	--	288	54	1	--	PW
F	0.130 – 0.170	--	338 – 343	65 – 78	3	--	20X12
G	0.130	--	340	32	1	--	PW
H	0.130	--	342	13	1	--	PW
135A	0.130 – 0.180	--	178 – 181	60 – 67	2	--	12X12
B	0.130	--	202	21	1	--	PW
C	0.160	--	354	54	1	--	PW
138A	0.140	--	66	4	1	--	PW
B	0.130	--	79	55	1	--	PW
C	0.170 – 260	--	185 – 132	55 – 62	2	--	12X12
D	0.130	--	159	62	1	--	PW
E	0.160 – 0.200	--	185 – 189	43 – 50	3	--	12X12
F	0.150	--	189	21	1	--	PW
G	0.150 – 0.160	--	207 – 218	38 – 44	3	--	PW
139A	0.140	--	141	27	1	--	PW
B	0.150	--	343	79	1	--	PW
141A	0.150 – 0.200	--	3 – 5	21 – 22	2	--	14X12
142A	0.150 – 0.200	--	8 – 14	47 – 50	3	--	12X12 NE, PW
B	0.250	--	60	56	1	--	12X12 NE, PW
C	0.250	--	60	88	1	--	12X12 NE, PW

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE (CONT'D.)

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	*COMMENTS
142D	0.130 – 0.160	--	93 – 105	78 – 86	3	--	NE, PW
143A	0.130	--	44 – 50	64 – 65	3	--	NE, PW
144A	0.130 – Hole	--	54 – 140	90	20	--	PR
B	0.250 – 0.270	--	231 – 248	26 – 40	2	--	28X24
145A	0.140	--	147	12	1	--	PW
B	0.150 – 0.160	--	22 – 242	29 – 57	3	--	PW
C	0.130	--	275	21	1	--	PW
D	0.210	--	307	33	1	--	12X12
E	0.140	--	344	41	1	--	PW
F	0.130	--	348	68	1	--	PW
146A	0.140	--	98	13	1	--	PW
B	0.130	--	186	9	1	--	PW
C	0.130	--	186	58	1	--	PW
147A	0.160	--	139 – 142	24 – 25	3	--	PW
B	0.130	--	195	118	1	--	PW
C	0.140	--	217	2	1	--	PW
D	0.140	--	270	61	1	--	PW
E	0.170	--	317 – 320	37 – 33	2	--	12X12
F	0.150	--	345	38	1	--	PW
G	0.130	--	342	22 – 24	2	--	PW
148A	0.150	--	90	57	1	--	PW
B	0.160	--	116	26	1	--	PW
C	0.130	--	144	39	1	--	PW
D	0.140	--	167	25	1	--	PW
E	0.140	--	182	64	1	--	PW
149A	0.250	--	160	88	1	--	12X12
152A	0.150 – 0.220	--	71 – 78	66 – 71	2	--	12X12
B	0.130 – 0.250	--	77 – 84	38 – 72	7	--	12X12
C	0.140	--	71	10	1	--	PW

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE (CONT'D.)

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	*COMMENTS
152D	0.140	--	105	31	1	--	PW
E	0.170	--	179	78	1	--	12X12
F	0.130 – 0.150	--	179 – 197	43 – 51	3	--	PW
G	0.250	--	245	82	2	--	
H	0.130 – 0.180	--	247 – 254	38 – 46	5	--	12X16
I	0.190	--	305	31	1	--	PW
J	0.130 – 0.200	--	269 – 273	76 – 88	5	--	30X18
K	0.160	--	268	55	1	--	PW
L	0.250	--	273	43	1	--	12X12
M	0.180	--	343	67	1	--	PW
154A	0.150	--	33	13	1	--	PW
B	0.180	--	53	45	1	--	12X12
C	0.180 – 0.210	--	51 – 62	1	3	--	12X12
D	0.180 – 0.220	--	96 – 103	9 – 31	6	--	24X40
E	0.210	--	78	86	1	--	12X12
155A	0.130 – 0.150	--	247 – 250	14 – 31	2	--	PW
B	0.130	--	287	40	1	--	PW
C	0.210	--	335	77	1	--	12X12
D	0.140	--	335	37	1	--	PW
157A	0.230	--	108	56	1	--	12X12
158A	0.290	--	20	79	1	--	12X12
B	0.170	--	34	11	1	--	12X12
C	0.250	--	73	86	1	--	12X12
D	0.200 – 0.250	--	154 – 176	38 – 68	4	--	34X40
E	0.210	--	224	2	1	--	12X12
159A	0.150 – 0.180	--	96 – 110	57 – 78	3	--	24X28
B	0.160	--	166	36	1	--	PW
C	0.130	--	169	78	1	--	PW
D	0.170	--	198	34	2	--	PW

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE (CONT'D.)

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	*COMMENTS
159E	0.160	--	218 – 221	28 – 31	2	--	PW
F	0.170	--	285	37	1	--	12X12
G	0.150	--	214	5	1	--	PW
160A	0.290	--	260	1	1	--	12X12
B	0.160	--	244	47	1	--	PW
161A	0.150	--	2	1	1	--	PW
162A	0.130	--	6	6	1	--	PW
B	0.160	--	4	48	1	--	PW
C	0.130	--	24 – 53	84 – 81	3	--	PW
D	0.140	--	84	27	1	--	PW
E	0.190	--	46	15	1	--	PW
F	0.140 – 0.160	--	218 – 284	11 – 18	3	--	PW
163A	Hole	--	212	47	1	--	12X12
B	0.240	--	241	50	1	--	12X12
C	0.130	--	337	36	1	--	PW
164A	0.260	--	214	74	1	--	12X12
B	0.210	--	174	40	1	--	12X12
165A	0.130 – Hole	--	0 – 195	0 – 87	15	--	PR
B	0.150 – 0.250	--	250 – 262	40 – 57	2	--	16x16
166A	0.150	--	9	6	1	--	PW
B	0.170	--	121	2	1	--	12X12
C	0.170	--	206	72	1	--	12X12
D	0.160	--	269	37	1	--	PW
E	0.130	--	354	14	1	--	PW
167A	0.140	--	31	1	1	--	PW
B	0.130 – 0.150	--	115	20 – 33	2	--	PW
C	0.130 – 0.150	--	142 – 174	15 – 16	4	--	PW
D	0.140	--	348	63	1	--	PW
168A	0.130 – 0.140	--	11 – 14	73 – 79	2	--	PW

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE (CONT'D.)

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	*COMMENTS
168B	0.130	--	38	38	1	--	PW
C	0.150	--	95	13	1	--	PW
D	0.140	--	108	42	1	--	PW
E	0.130	--	134	10	1	--	PW
F	0.160	--	266	10	1	--	PW
G	0.160	--	286	18	1	--	PW
169A	0.130	--	12	40	1	--	PW
B	0.130 – 0.260	--	44 – 84	48 – 87	10	--	40X50
C	0.160	--	102	46	1	--	PW
D	0.140 – 0.150	--	108 – 117	17 – 24	3	--	PW
E	0.150 – 0.200	--	162 – 167	32 – 44	3	--	12X18
171A	0.140	--	99	81	1	--	PW
B	0.130 – 0.160	--	199	23 – 30	4	--	12X12
173A	0.150	--	138	43	1	--	PW
B	0.250	--	157	41	1	--	12X12
C	0.140 – 0.160	--	173	79	1	--	PW
D	0.160	--	176	7 – 19	2	--	PW
E	0.140 – Hole	--	207 – 318	0 – 89	8	--	PR
F	0.130	--	345	34	1	--	PW
174A	0.240	--	7	88	1	--	12X12
B	0.250	--	6	45	1	--	12X12
176A	0.140 – 0.200	--	50 – 80	21 – 40	5	--	26X32
177A	0.220	--	38	82	1	--	12X14 NE
B	0.130 – 0.180	--	6 – 40	32 – 66	9	--	34X36 NE
178A	0.150 – 0.160	--	70	42 – 45	2	--	PW
B	0.130	--	197	29	1	--	PW
179A	0.130	--	125	13	1	--	PW
B	0.150	--	202	29	1	--	PW
180A	0.190	--	47	4	1	--	12X12
B	0.140	--	154	53	1	--	PW
181A	0.130	--	19	38	1	--	PW

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE (CONT'D.)

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	*COMMENTS
181B	0.170	--	154	33	1	--	12X12
C	0.130 – 0.150	--	181 – 190	7 – 22	4	--	PW
D	0.130 – 0.180	--	218	6 – 10	2	--	PW
E	0.130 – Hole	--	250 – 330	0 – 42	12	--	12X12
F	0.140 – 0.250	--	346 – 351	47 – 67	4	--	PW
182A	0.130	--	159	78	1	--	12X14
B	0.150	--	188	41	1	--	98X74
C	0.210	--	202	26	1	--	18X26
D	0.150 – 0.160	--	216 – 244	1 – 16	4	--	PW
E	0.140	--	222	52	1	--	PW
183A	0.170	--	44	82	1	--	12X12
B	0.200	--	70	80	1	--	PW
C	0.210	--	86	88	1	--	PW
D	0.130	--	183	62	1	--	12X12
E	0.170	--	126	83	1	--	12X12
F	0.130	--	165	35	1	--	12X12
G	0.200	--	314	71	1	--	PW
184A	0.140	--	152	25	1	--	12X12
B	0.150	--	166	13	1	--	PW
185A	0.130 – Hole	--	45 – 124	0 – 89	8	--	12X12
186A	0.300	--	20	43	1	--	PW
187A	0.310	--	20	30	1	--	12X12
B	0.150	--	47	42	1	--	PW
188A	0.160 – 0.210	--	22 – 56	5 – 26	6	--	32X32
B	0.150 – 0.280	--	66 – 82	61 – 73	5	--	26X24
C	0.130 – Hole	--	84 – 100	7 – 11	2	--	28X24
D	0.130 – Hole	--	111 – 120	24 – 44	6	--	18X28
E	0.130 – 0.140	--	135 – 148	39 – 46	3	--	PW
F	0.210	--	137	71	1	--	12X12

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE (CONT'D.)

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	*COMMENTS
188G	0.260	--	163	41	1	--	12X12
H	0.130	--	169	86	1	--	PW
I	0.160	--	177	34	1	--	PW
J	0.260	--	209	82	1	--	12X12
K	0.170	--	248	66	1	--	12X12
190A	0.130	--	63	22	1	--	NE, PW
B	0.130 – 0.140	--	1 – 13	8 – 10	2	--	NE, PW
192A	0.130 – 0.160	--	13	67 – 70	2	--	PW
B	0.180	--	56	64	1	--	12X12
C	0.130 – 0.210	--	84 – 168	60 – 90	15	--	
D	0.140 – 0.200	--	171 – 175	48 – 56	2	--	12X12
E	0.140 – 0.200	--	193	62 – 70	3	--	12X12
F	0.160	--	207	4	1	--	PW
G	0.130	--	193	57	1	--	PW
196A	0.130	--	72	65	1	--	PW
B	0.140 – 0.170	--	136 – 156	70 – 80	4	--	
C	0.160	--	181	80	1	--	PW
199A	0.140	--	21	61	1	--	PW
205A	0.180	--	44	70	1	--	12X12
B	0.170	--	62	82	1	--	12X12
C	0.140	--	70	68	1	--	PW
D	0.130	--	358	33	1	--	PW
206A	0.180	--	52	76	1	--	12X12
B	0.130	--	324	15	1	--	PW
208A	0.130 – 0.150	--	81 – 90	24	2	--	PW
B	0.160	--	142	60	1	--	PW
211A	0.170 – 0.210	--	70 – 81	56	2	--	18X12
B	0.160	--	94	82	1	--	PW
C	0.160	--	266	80	1	--	PW

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE (CONT'D.)

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	*COMMENTS
212A	0.140	--	219	87	1	--	PW
B	0.150	--	271	71	1	--	PW
C	0.140	--	270	14	1	--	PW
D	0.170 – 0.180	--	287 – 299	21 – 32	2	--	12X22
213A	0.130	--	227	67	3	--	12X12
B	0.140	--	244	52	2	--	PW
219A	0.210	--	122	59	1	--	12X12 NE
B	0.160	--	143	47	1	--	NE, PW
221A	0.160	--	70	43	1	--	PW
B	0.140	--	310 – 314	44 – 53	2	--	PW
223A	0.140	--	74	15	1	--	PW , NE
228A	0.150	--	45	27	1	--	PW
B	0.140	--	54	64	1	--	PW
C	0.130	--	267 – 272	41 – 46	3	--	12X12
232A	0.150	--	243	26	1	--	PW
B	0.140	--	326	32	1	--	PW
234A	0.130 – 0.140	--	121 – 129	67 – 74	2	--	PW
B	0.150	--	218	6	1	--	PW
235A	0.150	--	145	86	1	--	PW
241A	0.150	--	37	20	1	--	NE, PW
250A	0.140	--	45	50	1	--	12X12
B	0.230	--	65	18	1	--	12X12
251A	0.130	--	19	55	1	--	NE, PW
B	0.170	--	57	80	1	--	12X12 NE
253A	0.210	--	194	84	1	--	12X12
B	0.140	--	287	33	1	--	PW
C	0.150	--	325	26	1	--	PW
255A	0.180	--	230	80	1	--	12X12
B	0.130	--	250	81	1	--	PW

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE (CONT'D.)

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	*COMMENTS
255C	0.140	--	272	65	1	--	PW
256A	0.180	--	169	41	1	--	12X12
261A	0.130 – 0.240	--	181 – 189	52 – 74	4	--	12X25
B	0.170	--	291	53	1	--	12X12
263A	0.140	--	62 – 65	44 – 53	4	--	16X14 NE
264A	0.150	--	104	67	1	--	NE, PW
268A	0.140	--	20	76	1	--	PW
269A	0.130	--	26	51	1	--	NE, PW
B	0.150	--	52	4	1	--	NE, PW
271A	0.130	--	13	28	1	--	PW
B	0.130	--	55	31	1	--	PW
C	0.160	--	115	62	1	--	PW
272A	Hole	--	1	1	1	--	24X24 NE
274A	0.160	--	154	35	1	--	
B	0.130	--	209	78	1	--	
C	0.140	--	355	71	1	--	
D	0.150	--	355 – 357	53 – 55	2	--	16X16
275A	0.140 – 0.160	--	0 – 3	46	2	--	16X16
276A	0.140	--	37	36	1	--	NE, PW
B	0.130	--	14	49	1	--	NE, PW
277A	0.140	--	148	60	1	--	PW
B	0.150	--	177	67	1	--	PW
281A	0.150	--	88	56	1	--	NE, PW
282A	0.130	--	6	60	1	--	PW
292A	0.150	--	97	24	1	--	PW
B	0.130	--	157	27	1	--	PW
C	0.130	--	192	60	1	--	PW
D	0.130	--	165	24	1	--	PW
E	0.140	--	180	36	1	--	PW

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE (CONT'D.)

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	*COMMENTS
292F	0.160	--	190 – 192	48 – 52	5	--	PW
294A	0.150	--	132	49	1	--	NE, PW
195A	0.150	--	140	59	1	--	NE
B	0.160	--	167	50	1	--	NE
311A	0.140	--	18	42	1	--	PW
B	0.150	--	112	25	1	--	PW
C	0.130	--	214	68	1	--	PW
D	0.150	--	312	79	1	--	PW
314A	0.140	--	100	23	1	--	PW
323A	0.130 – 0.220	--	54 – 65	48 – 68	4	--	20X24 NE
328A	0.130	--	16	42	1	--	PW
B	0.130 – 0.170	--	43 – 46	55 – 57	2	--	12X12
C	0.130	--	137	47	1	--	PW
D	0.130 – 0.180	--	211 – 212	48 – 51	2	--	12X12
E	0.180 – 0.210	--	267 – 270	42 – 44	2	--	12X12
329A	0.140	--	69	66	1	--	NE, PW
B	0.140	--	29	60	1	--	NE, PW
C	0.140	--	19	82	1	--	NE, PW
331A	0.130	--	10	80	1	--	NE, PW
B	0.150	--	76	86	1	--	NE, PW
332A	0.130	--	21	60	1	--	NE, PW
B	0.190	--	71	20	1	--	12X12
337A	0.130	--	109	28	1	--	PW
B	0.130	--	124	32	1	--	PW
340A	0.150	--	141	48	1	--	PW
B	0.140	--	166	66	1	--	PW
344A	0.160	--	69	51	1	--	12X12 NE
B	0.130 – 0.160	--	71 – 76	72	3	--	12X12 NE
348A	0.200	--	1	50	1	--	12X12 NE

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE (CONT'D.)

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	*COMMENTS
348B	0.180	--	44	29	1	--	12X12
349A	0.150 – 0.180	--	62 – 67	59 – 61	2	--	12X12
352A	0.250	--	225	36	1	--	12X12
B	0.150	--	30	69	1	--	PW
C	0.180	--	56	60	1	--	12X12
356A	0.130	--	6	63	1	--	PW
B	0.130	--	224	62	1	--	PW
358A	0.140	--	10	7	1	--	NE, PW
361A	0.130 – 0.160	--	154 – 155	57 -68	1	--	12X18
B	Hole	--	155	16	1	--	12X12
363A	0.140	--	93	57	1	--	PW
369A	0.130	--	256	31	1	--	PW
371A	0.180	--	46	88	1	--	12X12
381A	0.130	--	29	28	1	--	NE, PW

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	PW	=	PUDDLE WELD
LP	=	LEAK PATH	PR	=	PLATE REPLACEMENT

***Note**: Area to be Patched - This is for reference only and weld spacing of patch plates should be verified by repair contractor.

3.2.4 BOTTOM REDUCTION TABLE

BOTTOM REDUCTION TABLE – WELD REPAIRS

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	COMMENTS
15A	--	--	80	88	--	--	NE, WR
21A	--	--	16	41	--	--	WR, SP
B	--	--	281	44	--	--	WR, SP
27A	--	--	180	0	--	--	WR
28A	--	--	1	0	--	--	WR
35A	--	--	0	17	--	--	WR
36A	--	--	221	0	--	--	WR
44A	--	--	185	0	--	--	WR
B	--	--	227	0	--	--	WR
C	--	--	260	0	--	--	WR
53A	--	--	72	0	--	--	WR
55A	--	--	150	0	--	--	WR, SP
56A	--	--	55	56	--	--	WR
B	--	--	126	0	--	--	WR
C	--	--	238	0	--	--	WR
62A	--	--	107	70	--	--	NE, WR
66A	--	--	0	8	--	--	WR
73A	--	--	209	34	--	--	WR, SP
86A	--	--	0	82	--	--	WR
99A	--	--	39	0	--	--	WR
B	--	--	165	0	--	--	WR
C	--	--	184	0	--	--	WR
D	--	--	212	0	--	--	WR
102A	--	--	260 – 290	0	--	--	WR
107A	--	--	7	0	--	--	WR
110A	--	--	128	0	--	--	WR
112A	--	--	0	15	--	--	WR
B	--	--	55	10	--	--	WR, SP
113A	--	--	181	69	--	--	WR, SP

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	SP	=	STRIKER PLATE
WR	=	WELD REPAIR	TS	=	TOMBSTONE STYLE PATCH

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE – WELD REPAIRS

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	COMMENTS
113B	--	--	273 – 356	0	--	--	WR
124A	--	--	0	68	--	--	WR
138A	--	--	282	0	--	--	WR
141A	--	--	12	0	--	--	WR
149A	--	--	117 – 123	89	--	--	WR
152A	--	--	312	67	--	--	WR, SP
158A	--	--	80 – 97	89	--	--	WR
B	--	--	117	89	--	--	WR
166A	--	--	108	89	--	--	WR
185A	--	--	150	0	--	--	WR
188A	--	--	0	45	--	--	WR
188B	--	--	0	0	--	--	WR
199A	--	--	139	0	--	--	WR
201A	--	--	83	0	--	--	WR
B	--	--	273	0	--	--	WR
213A	--	--	198	0	--	--	WR
B	--	--	225	0	--	--	WR
218A	--	--	142	0	--	--	WR
232A	--	--	229	0	--	--	WR
242A	--	--	15	88	--	--	WR
250A	--	--	77	72	--	--	WR, SP
B	--	--	0	9	--	--	WR
282A	--	--	190	12	--	--	WR, SP
292A	--	--	41 – 118	0	--	--	WR
295A	--	--	115	0	--	--	WR
B	--	--	171	0	--	--	WR
300A	--	--	148	42	--	--	WR, SP
313A	--	--	147	48	--	--	NE, WR, SP
329A	--	--	57	59	--	--	NE, WR, SP
332A	--	--	0	37	--	--	WR
337A	--	--	0	4 – 12	--	--	WR

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	SP	=	STRIKER PLATE
WR	=	WELD REPAIR	TS	=	TOMBSTONE STYLE PATCH

3.2.4 BOTTOM REDUCTION TABLE (CONT'D.)

BOTTOM REDUCTION TABLE – WELD REPAIRS

(in inches)

SW reference corner unless otherwise indicated.

PLATE NO./ID	PIT DEPTH	REMAINING THICKNESS	X LOCATION	Y LOCATION	PS (# IND)	SS (# IND)	COMMENTS
338A	--	--	0	40	--	--	WR
341A	--	--	330	0	--	--	WR
351A	--	--	23	0	--	--	WR
356A	--	--	300	0	--	--	WR

NOTES:

SS	=	SOIL-SIDE	CZ	=	CRITICAL ZONE
PS	=	PRODUCT-SIDE	NE	=	NORTHEAST REFERENCE CORNER
IND	=	INDICATIONS	SP	=	STRIKER PLATE
WR	=	WELD REPAIR	TS	=	TOMBSTONE STYLE PATCH

3.2.5 BOTTOM ULTRASONIC (UT) THICKNESS READINGS

BOTTOM PLATE READINGS
(in inches)

PLATE NO.	Reading	PLATE NO.	Reading	PLATE NO.	Reading	PLATE NO.	Reading
1	0.334	33	0.309	65	0.331	97	0.308
2	0.337	34	0.326	66	0.319	98	0.309
3	0.330	35	0.313	67	0.326	99	0.339
4	0.329	36	0.335	68	0.324	100	0.351
5	0.329	37	0.327	69	0.331	101	0.327
6	0.310	38	0.312	70	0.313	102	0.319
7	0.308	39	0.316	71	0.307	103	0.313
8	0.308	40	0.328	72	0.314	104	0.335
9	0.309	41	0.323	73	0.320	105	0.316
10	0.306	42	0.304	74	0.309	106	0.319
11	0.313	43	0.307	75	0.311	107	0.322
12	0.304	44	0.315	76	0.339	108	0.325
13	0.307	45	0.321	77	0.341	109	0.317
14	0.310	46	0.311	78	0.321	110	0.320
15	0.305	47	0.308	79	0.326	111	0.325
16	0.310	48	0.313	80	0.335	112	0.311
17	0.305	49	0.328	81	0.330	113	0.317
18	0.303	50	0.323	82	0.311	114	0.326
19	0.319	51	0.308	83	0.321	115	0.319
20	0.307	52	0.313	84	0.307	116	0.315
21	0.305	53	0.317	85	0.313	117	0.314
22	0.311	54	0.319	86	0.319	118	0.320
23	0.312	55	0.330	87	0.326	119	0.348
24	0.316	56	0.316	88	0.330	120	0.309
25	0.317	57	0.328	89	0.320	121	0.310
26	0.319	58	0.333	90	0.314	122	0.313
27	0.325	59	0.309	91	0.315	123	0.317
28	0.310	60	0.317	92	0.317	124	0.320
29	0.307	61	0.319	93	0.321	125	0.307
30	0.315	62	0.303	94	0.310	126	0.309
31	0.311	63	0.318	95	0.311	127	0.311
32	0.316	64	0.316	96	0.315	128	0.315

3.2.5 BOTTOM ULTRASONIC (UT) THICKNESS READINGS (CONT'D.)

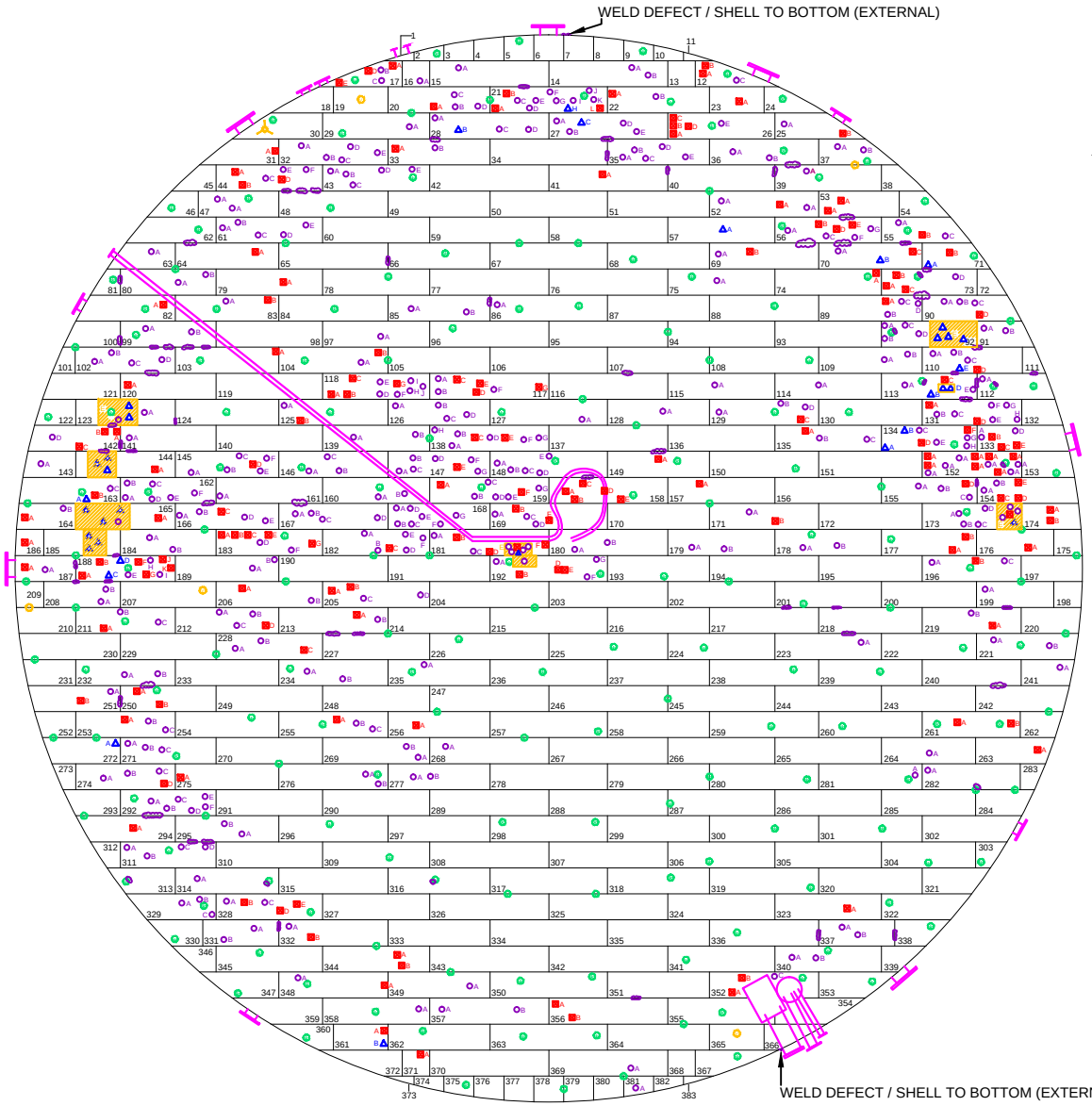
BOTTOM PLATE READINGS (CONT'D.)
(in inches)

PLATE NO.	Reading	PLATE NO.	Reading	PLATE NO.	Reading	PLATE NO.	Reading
129	0.339	161	0.321	193	0.307	225	0.315
130	0.321	162	0.325	194	0.315	226	0.315
131	0.326	163	0.330	195	0.319	227	0.307
132	0.313	164	0.327	196	0.303	228	0.312
133	0.307	165	0.329	197	0.315	229	0.319
134	0.321	166	0.317	198	0.316	230	0.325
135	0.302	167	0.315	199	0.303	231	0.320
136	0.331	168	0.307	200	0.307	232	0.321
137	0.307	169	0.303	201	0.313	233	0.325
138	0.339	170	0.307	202	0.316	234	0.322
139	0.321	171	0.315	203	0.310	235	0.330
140	0.326	172	0.336	204	0.315	236	0.320
141	0.329	173	0.327	205	0.310	237	0.315
142	0.313	174	0.301	206	0.321	238	0.310
143	0.310	175	0.315	207	0.330	239	0.313
144	0.315	176	0.312	208	0.326	240	0.315
145	0.317	177	0.310	209	0.330	241	0.319
146	0.319	178	0.309	210	0.321	242	0.330
147	0.321	179	0.317	211	0.317	243	0.329
148	0.314	180	0.321	212	0.318	244	0.321
149	0.316	181	0.306	213	0.311	245	0.326
150	0.323	182	0.315	214	0.315	246	0.331
151	0.330	183	0.320	215	0.325	247	0.335
152	0.337	184	0.315	216	0.327	248	0.320
153	0.320	185	0.314	217	0.329	249	0.315
154	0.318	186	0.316	218	0.315	250	0.319
155	0.319	187	0.319	219	0.307	251	0.315
156	0.321	188	0.320	220	0.303	252	0.320
157	0.320	189	0.321	221	0.319	253	0.321
158	0.307	190	0.325	222	0.321	254	0.326
159	0.315	191	0.314	223	0.326	255	0.315
160	0.319	192	0.310	224	0.327	256	0.310

3.2.5 BOTTOM ULTRASONIC (UT) THICKNESS READINGS (CONT'D.)

BOTTOM PLATE READINGS (CONT'D.)
(in inches)

PLATE NO.	Reading	PLATE NO.	Reading	PLATE NO.	Reading	PLATE NO.	Reading
257	0.315	289	0.314	321	0.340	353	0.320
258	0.317	290	0.310	322	0.337	354	0.314
259	0.320	291	0.315	323	0.315	355	0.319
260	0.317	292	0.309	324	0.310	356	0.321
261	0.325	293	0.320	325	0.309	357	0.323
262	0.326	294	0.317	326	0.315	358	0.325
263	0.331	295	0.314	327	0.319	359	0.330
264	0.340	296	0.317	328	0.315	360	0.315
265	0.327	297	0.321	329	0.313	361	0.317
266	0.335	298	0.325	330	0.321	362	0.320
267	0.337	299	0.319	331	0.326	363	0.313
268	0.321	300	0.310	332	0.310	364	0.310
269	0.315	301	0.316	333	0.314	365	0.307
270	0.310	302	0.319	334	0.312	366	0.315
271	0.315	303	0.320	335	0.307	367	0.317
272	0.319	304	0.313	336	0.320	368	0.319
273	0.318	305	0.310	337	0.321	369	0.330
274	0.317	306	0.321	338	0.315	370	0.326
275	0.310	307	0.326	339	0.316	371	0.331
276	0.316	308	0.325	340	0.315	372	0.329
277	0.320	309	0.323	341	0.318	373	0.322
278	0.321	310	0.337	342	0.320	374	0.337
279	0.325	311	0.370	343	0.316	375	0.330
280	0.325	312	0.333	344	0.313	376	0.315
281	0.320	313	0.315	345	0.310	377	0.319
282	0.318	314	0.317	346	0.315	378	0.330
283	0.317	315	0.315	347	0.320	379	0.327
284	0.310	316	0.310	348	0.321	380	0.335
285	0.315	317	0.315	349	0.315	381	0.332
286	0.317	318	0.320	350	0.321	382	0.330
287	0.325	319	0.321	351	0.323	383	0.327
288	0.335	320	0.331	352	0.317	--	--



REFERENCE
N

DRAWING NOT TO SCALE

GENERAL

RECORDING CRITERIA :
0.180" BOTTOM / 0.215" CRITICAL ZONE
11 YRS AFTER REPAIRS
WITH THIN - FILM : 20 YRS
AFTER REPAIRS

PROGRAM NAME : AUTO CAD LT.
LAYER NOZZLES = NOZZLES
LAYER INDICATIONS = INDICATIONS

HOLE

REFERENCE CORNER

LEGEND

- = REPAIR w/ PATCH PLATE
- = REPAIR w/ PUDDLE WELD
- = WELD REPAIR
- = PARTIAL PLATE REPLACEMENT
- = AREA TO PATCH WITH PLATE
- = VACUUM BREAKER
- = FLOATING ROOF LEG

HMT INSPECTION
8979 MARKET STREET RD
HOUSTON, TX 77029-3421

TITLE: BOTTOM LAYOUT

CUSTOMER: SHELL PIPELINE

TANK NO:	JOB NO:
2	224-41766
DRAWN BY: J.NAUGLE	DATE: 19 JULY 2014

3.3 SHELL

3.3.1 SHELL INSPECTION CHECKLIST

ITEM NO.	EXTERNAL SHELL	INSPECTION COMMENTS
S1	Shell weld / seam condition. Perform shell thickness calculations (ref. API 653, Paras. 4.3.3.1, 4.3.4, 4.3.8 & 4.3.10).	N/A
S2	Record number and pattern of rivets or bolts (ref. API 653, Table 4-3).	N/A
S3	Check exterior shell-to-bottom weld condition (ref. API 653, Para. 6.3).	Reference Section 2.0
S4	Identify all signs of product leakage (exterior) (ref. API 653, Para. 6.3)	N/A
S5	Perform Magnetic Particle testing of exterior shell-to-bottom weld (ref. API 653, Para. 4.3.6)	N/A
S6	Coating condition (Coating failure such as blistering, thinning, cracks, or discolored) (ref. API 653, Para. 6.3).	N/A
S7	Shell condition (deformations, corrosion, pitting). (ref. API 653, Para. 4.3)	N/A
S8	Rivet condition (worn, corroded, loose rivet sealer, leaking).	N/A
S9	Perform UT thickness readings on shell per job scope.	N/A
S10	Inspect support welds to shell for corrosion or defects.	N/A
S11	Wind girder, supports, handrail condition (corrosion, weld failure). (ref. API 653, Para. 4.3.7)	N/A
S12	Note whether supports have reinforcing pads welded to shell.	N/A
S13	Shell-mounted vents / overflow slots present. Check for debris covering & condition of screens (ref. API 650, App. H, Para. H.5.3.3).	N/A
S14	Conduct Visual inspection of shell insulation. Inspect for damage (ref. API 653, Para. 6.3.2.2)	N/A
ITEM NO.	**INTERNAL SHELL**	**INSPECTION COMMENTS**
S15	Visual inspection of the internal shell surface for corrosion and pitting (ref. API 653, Para. 4.3).	Acceptable
S16	Visual inspection of interior shell welds / seams (ref. API 653, Para. 4.3.8).	Acceptable
S17	Visual inspection of rivets (Check for corrosion pitting, or looseness and riveted seams leaks).	N/A
S18	Inspect support welds to shell for corrosion or defects.	Acceptable
S19	Note whether supports have reinforcing pads welded to shell.	Acceptable
S20	List any limitations to shell inspection.	Acceptable

3.4 NOZZLES AND APPURTENANCES

3.4.1 NOZZLE AND APPURTENANCE INSPECTION CHECKLIST

ITEM NO.	EXTERNAL NOZZLES AND APPURTENANCES	INSPECTION COMMENTS
N1	Document nozzle / manway information on the Nozzle and Appurtenance Table (ref. API 653, Para. 4.3.9).	N/A
N2	Evaluate nozzle(s) / manway(s) acceptability to current API 650 / 653 guidelines. Weld spacing, centerline, reinforcement size, nozzle neck thickness (inspect shell nozzles for thinning, pitting and coating failure) and telltale holes, etc. (ref. API 650, Paras. 5.7, 5.7.5.1 and 5.7.2.10 & API 650, Table 5-6b & Fig. 5-6)	N/A
N3	Visual inspection of all external welds (ref. API 653, Para. 4.3.9.1)	N/A
N4	Indications of leakage around manways, nozzles, flanges, valves and appurtenances (including reinforcement, bolting, gaskets, seals, and mixers).	N/A
N5	Check piping and valves for leaks, thermal relief, or signs of damage (ref. API 653, Para. C.1.3.2).	N/A
N6	Inspect mixer for support, leakage and defects (ref. API 653, Para. C.1.3.6).	N/A
N7	Roof drain leakage.	N/A
N8	Temperature indicators / probes (corrosion, mechanical damage).	N/A
N9	Automatic gauge condition (corrosion, mechanical damage) (ref. API 653, Para. C.1.3.3) & (ref. API 653, Para. 6.9.3.2 b).	N/A
N10	Check welds on shell-mounted davit clips above large valves or equipment (ref. API 650, Para. 5.8.3.5) & (ref. API 653, Para. C.1.3.2h).	N/A
N11	Welds on stairways / ladders, gauge platform / ladder, stringers (corrosion, broken) (ref. API 650, Para. 5.8.1.2.a & API 653, Para. C.2.12.4).	N/A
N12	Stairway / ladder condition, and / or landing platform (coating failure) (ref. API 653, Para. C.2.12.4).	N/A
N13	Verify requirements for Platforms, Walkways & Stairways (ref. API 650, Table 5-17 & Table 5-18).	N/A

NOZZLE AND APPURTENANCES (CONT'D.)		
ITEM NO.	**INTERNAL NOZZLES AND APPURTENANCES**	**INSPECTION COMMENTS**
N14	Shell nozzle and internal piping condition.	Acceptable
N15	Hot tap nozzles (sealed internally) (ref. API 653, Para. 9.14 & Table 9-1) (ref. API 653, Para. 12.1.2.1b).	N/A
N16	Check for possible causes of damage to the seal (i.e. nozzle interference).	Acceptable
N17	Visual inspection of all welds (ref. API 653, Para. 4.3.9.1) (weld defects and location).	Acceptable
N18	Check automatic gauge condition.	Acceptable
	INTERNAL APPURTENANCES / FLOATING SUCTION LINE	
N19	Visual inspection of internal piping and connection condition (corrosion, cracking).	Acceptable
N20	Visual inspection of piping supports and pads (structurally adequate, weld failure).	Acceptable
N21	Determine condition / length of swing line / limit chain (ref. API 653, Para. C. 2.11.6).	N/A
	INTERNAL APPURTENANCES / FLOATING ROOF DRAIN	
N22	Type and condition (cutting or dragging on tank bottom) (ref. API 653, Para. 4.2.3.3) (ref. API 653, C. 2.10).	Reference Section 2.0
N23	Internal piping and connection condition (corrosion, cracking).	Reference Section 2.0
N24	Check for obstructions that pipe could catch on (ref. API 650, Para. C.3.8.1).	Reference Section 2.0
N25	Swing line hold-down cable (damaged or loose).	N/A
N26	Swing line safety hold-down chains (corrosion, weak links).	N/A
N27	List any limitations to inspection.	Acceptable

3.5 FLOATING ROOF

3.5.1 FLOATING ROOF INSPECTION CHECKLIST

ITEM NO.	FLOATING ROOF	INSPECTION COMMENTS
	FLOATING ROOF PRIMARY MECHANICAL SHOE SEAL	
FLR1	Inspect seal condition, hangers, shoes (system vapor barrier, and attachment hardware) (ref. API 653, Paras. 4.2.3.3 & 6.2.3).	Reference Section 2.0
	FLOATING ROOF PRIMARY FOAM LOG SEAL	
FLR2	Inspect seal fabric, foam, hardware (ref. API 653, Para. 4.2.3.3).	N/A
	FLOATING ROOF PRIMARY SEAL (OTHER)	
FLR3	Type of primary seal (ref. API 653, Para. 4.2.3.3).	Acceptable Type: Mechanical Shoe
FLR4	Check for mechanical damage, corrosion (wear on tip contact with shell) (ref. API 653, Para. 4.2.3.3).	Reference Section 2.0
FLR5	Measure seal gaps at regular intervals and record any visible seal damage (ref. API 653, Para. 4.2.3.3).	N/A
FLR6	Conduct Visual inspection of bolts and fasteners, with special attention to product interface areas (ref. API 653, Para. 4.2.3.3).	Acceptable
	FLOATING ROOF SECONDARY SEAL	
FLR7	Type of rim-mounted seal. (ref. API 653, Para. 4.2.3.3)	N/A Type: Metallic Wiper
FLR8	Check for mechanical damage, corrosion (wear on tip contact with shell) (ref. API 653, Para. 4.2.3.3).	N/A
FLR9	Measure seal gaps at regular intervals and record any visible seal damage (ref. API 653, Para. 4.2.3.3).	N/A
FLR10	Conduct Visual inspection of bolts and fasteners, with special attention to product interface areas (ref. API 653, Para. 4.2.3.3).	N/A

FLOATING ROOF (CONT'D.)		
ITEM NO.	**FLOATING ROOF LEGS**	**INSPECTION COMMENTS**
FLR11	Floating roof support legs: Record sizes and locate on layout. Count floating roof legs and match number on Layout(s) (ref. API 653, Paras. 4.2.3 & 9.10.2.1.5).	Acceptable Number of Legs: 188 Adjustable Leg Size = 3.5 in. Sleeve Size = 4.5 in.
FLR12	Visual inspection of floating roof legs (bending, thinning or buckling) (ref. API 653, Para. 4.2.3 & API 650, Paras. C.3.3.3, C.3.10 & H.4.6).	Acceptable
FLR13	Condition of roof leg sleeves (cracking, thinning, buckling and presence of drain notch) (ref. API 653, Paras. 4.2.3 & API 650, Paras. C.3.3.3 & C.3.10).	Acceptable
FLR14	Condition of roof leg reinforcing pads (cracking, buckling & inspect gussets) (ref. API 653, Para. 4.2.3).	Acceptable
FLR15	Roof leg pins (corrosion, sticking, missing) (ref. API 653, Para. 4.2.3)	Acceptable
FLR16	All roof legs at the same level (floating roof level) (ref. API 653, Paras. 4.2.3 & 9.10.2.1.5).	Acceptable
	FLOATING ROOF APPURTENANCES	
FLR17	Binding of roof columns or supports (ref. API 653, Para. 4.2.3).	N/A
FLR18	Damage to ladder or column wells and covers (ref. API 653, Para. 4.2.3).	N/A
FLR19	Bonding static cable attached and in good condition (ref. API 653, Paras. 4.2.3 & 6.3.2.3) (API 650, Para. H.4.1.6).	N/A
FLR20	Roof drain sump condition (clean and free of debris) (ref. API 653, Para. 4.2.3 & API 650 Para. C.3.8.1).	N/A
FLR21	Inspect rolling ladder or vertical ladder assembly (ref. API 653, Paras. 4.2.3 & 4.2.3.3) (API 650 Paras. C.3.7 & H.5.1).	N/A
FLR22	Identify type, number and condition of anti-rotation details (ref. API 653, Para. 4.2.3 & API 650, Para. H.5.4).	Acceptable Type: Gauge Pole Number: One (1)

FLOATING ROOF (CONT'D.)		
ITEM NO.	**FLOATING ROOF APPURTENANCES (CONT'D.)**	**INSPECTION COMMENTS**
FLR23	Inspect & report gauge pole diameter and type (Solid, slotted) (ref. API 653, Para. 4.2.3 & API 650, Paras. C.3.3.6, C.3.14 & H.5.7).	Acceptable Slotted Size: 8 in.
FLR24	Inspect manway and appurtenances (ref. API 653, Para. 4.2.3 & API 650, Paras. C.3.3.6 & H.5.5).	Acceptable
FLR25	Inspect Vacuum Breaker, rim vent, gauge hatch, gasket, etc. Record size and location on layout (ref. API 653, Para. 4.2.3 & API 650, Paras. C.3.3.6, C.3.9, C.3.15.3 & H.5.2.1).	Reference Section 2.0
	FLOATING ROOF – GENERAL	
FLR26	Levelness / condition of floating deck (ref. API 653, Paras. 4.2.3 & 9.10.2.1.5).	Acceptable
FLR27	Signs of product on the floating roof (May indicate loss of flotation) (ref. API 653, Para. 4.2.3).	Acceptable
	EXTERNAL FLOATING ROOF	
FLR28	Condition of roof plates / welds (corrosion, coating failure, leaks, and debris on roof) (ref. API 653, Para. 4.2.3).	N/A
FLR29	Inspect pontoons for water, product, residue and vapors. Check for presence of lock-down attachments on pontoon covers (ref. API 653, Paras. 4.2.3 & 9.12.3 & C.1.5.13) (ref. API 650, Para. C.3.5).	N/A
	ALUMINUM PONTOON FLOATING ROOF	
FLR30	Check floating roof condition (rips, tears, buckled member, condition of hardware, broken or missing parts, product in panels) (ref. API 653, Para. 4.2.3).	N/A
FLR31	If the floating roof has deck drains, check that all drains have working closures and bottom side tubes are below the product level.	N/A
FLR32	Inspect aluminum pontoons for product inside.	N/A
	ALUMINUM FULL-CONTACT FLOATING ROOF	
FLR33	Check floating roof condition (rips, tears, buckled member, condition of hardware, broken or missing parts, product in panels). (ref. API 653, Para. 4.2.3)	N/A
FLR34	Check manway latches for workability and ensure that all opening manways are self-closing (should not be open during service).	N/A
	INTERNAL STEEL FLOATING ROOF	
FLR35	Visual inspection for signs of corrosion or pitting on top and product side surfaces (ref. API 653, Para. 4.2.3).	N/A
FLR36	Visual inspection of all welds (ref. API 653, Para. 4.2.3).	N/A
FLR37	List any limitations to floating roof inspection.	N/A

4.0 NDT INSPECTION

4.1 NDT INSPECTION SCOPE

The following Nondestructive Testing (NDT) was conducted to evaluate the physical characteristics of the tank:

A) Magnetic Flux Leakage (MFL) examination. Performed in accordance with HMT Inspection MFL Procedure No. 1611.5, Revision No. 4.

B) Quantitative remaining thickness measurements in any area of significant metal loss. Performed in accordance with HMT Inspection UT Procedure No. 1611.1, Revision No. 6.

C) Random Ultrasonic (UT) examination. Performed in accordance with HMT Inspection UT Procedure No. 1611.1, Revision No. 6.

D) Visual (VT) inspection of areas for the detection of anomalies or significant metal loss which may affect the integrity. Performed in accordance with HMT Inspection VT Procedure No. 1611.9, Revision No. 4.

4.2 BOTTOM INSPECTION

Bottom plates were inspected utilizing MFL, UT and VT inspection methods. The bottom was inspected for the detection of both product side and soil side metal loss. Areas identified as exceeding or closely approaching the critical thickness were quantified by UT and pit gauge measurements as applicable. Recording criteria was set by the client at 0.180 inch or less remaining thickness for the bottom plates and at 0.215 inch or below for the critical zone (ref. Section 3.2.4). Nominal interior bottom plate thickness is 0.312 inch.

Areas of restricted access to MFL examination coverage included: near the shell-to-bottom weld, plate-to-plate lap welds, floating roof supports, near the automatic gauge base, sump, gauge pole and under internal piping.

Bottom lap welds were inspected utilizing VT inspection method.

The internal shell-to-bottom weld was inspected utilizing VT inspection method.

Bottom plate UT data was collected utilizing random readings. One (1) reading per bottom plate was taken (ref. Section 3.2.5).

4.3 SUMP INSPECTION

Sump weld was inspected utilizing VT inspection method.

Sump was inspected utilizing UT and VT inspection methods.

Sump was examined utilizing random readings. Sixteen (16) readings were taken along the wall, and ten (10) readings were taken across the bottom (ref. Section 3.2.3).

4.4 SHELL INSPECTION

The internal shell plates and welds were inspected utilizing VT inspection method along accessible areas as applicable and per client work scope.

4.5 NOZZLE INSPECTION

The internal shell nozzle welds were inspected utilizing VT inspection method.

4.6 FLOATING ROOF INSPECTION

The internal floating roof plates were inspected utilizing VT inspection method.

5.0 EQUIPMENT

5.1 MAGNETIC FLUX LEAKAGE

MFL equipment utilized consisted of a MFE Enterprises Floor Scanner Type 2412 (Serial No. 128).

5.2 ULTRASONIC

UT equipment utilized for the inspection was a GE Inspection Technologies USM GO Flaw Detector (Serial No. 12075188).

Transducer equipment utilized was a Britek, 7.5 MHz, 0.312 inch, dual element.

Calibration block equipment utilized was a 5 step, carbon steel test block.

Echogel 20 and water were used as a couplant.

5.3 LEVEL

Level equipment utilized was a Spectra LL-300 self-leveling laser.

5.4 PIT GAUGE

Pit gauge equipment utilized was a W.R. Thorpe Co. standard pipe pit gauge.

6.0 WARRANTY

WARRANTY

HMT Inspection, a division of HMT LLC, has evaluated the condition of this tank based on the observations and measurements made by the HMT Inspection tank inspector. While our evaluation accurately describes the condition of the tank at the time of inspection, the tank owner / operator must independently assess the inspection information / report provided by HMT Inspection and any conclusions reached by the tank owner / operator and any action taken or omitted to be taken are the sole responsibility of the owner / operator. With respect to inspection and testing, HMT Inspection warrants only that the services have been performed in accordance with accepted industry practice. If any such services fail to meet the foregoing warranty, HMT Inspection shall re-perform the service to the same extent and on the same conditions as the original service.

The preceding paragraph sets forth the exclusive remedy for claims based on failure or of defect in materials or services, whether such claim is made in contract or tort (including negligence) and however instituted, and, upon expiration of the warranty period, all such liability shall terminate. The foregoing warranty is exclusive and in lieu of all other warranties, whether written, oral, implied or statutory. NO IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE SHALL APPLY, nor shall HMT Inspection be liable for any loss or damage whatsoever by reason of its failure to discover, report, repair or modify latent defects or defects inherent in the design of any tank inspected. In no event, whether a result of breach of contract, warranty or tort (including negligence) shall HMT Inspection be liable for any consequential or incidental damages including, but not limited to, loss of profit or revenues, loss of use of equipment tested or services by HMT Inspection or any associated damage to facilities, down-time costs or claims of other damages.

Weld Defects on External Shell-to-Bottom Weld

Sump View

Sump View

7.0 PHOTOGRAPHS

Top Side Pitting

Product Side Corrosion

Weld Defects

Weld Defects

7.0 PHOTOGRAPHS

Bottom View

Bottom View

Bottom View

Bottom View

7.0 PHOTOGRAPHS

Bottom View

Weld Defects on Lap Welds

Weld Defects on Lap Welds

Weld Defects on Lap Welds

Weld Defects on Lap Welds

Weld Defects on Lap Welds

Product Side Corroded Areas

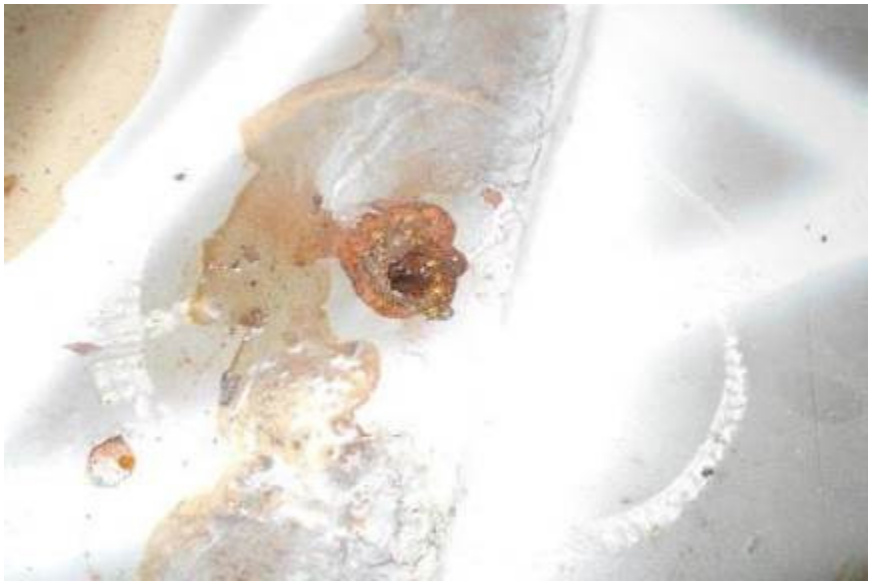
Product Side Corroded Areas

7.0 PHOTOGRAPHS

Product Side Corroded Areas

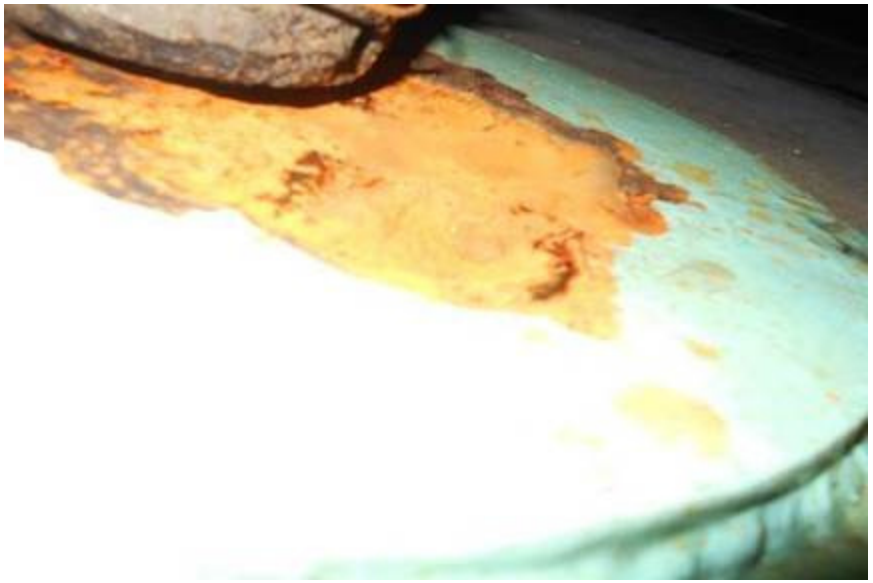
Product Side Corroded Areas

Product Side Corrosion



Through-Thickness Hole on Bottom Plates

Corrosion on Striker Plates



Corrosion on Striker Plates

Corrosion on Striker Plates

Corrosion on Vacuum Breaker Leg Striker Plates

7.0 PHOTOGRAPHS

Corrosion under Flexible Hose

Dragging Areas of Flexible Hose

Cleanout

Nozzles B and C

7.0 PHOTOGRAPHS

Nozzle F

Nozzle G

Nozzle J

Nozzle K

7.0 PHOTOGRAPHS

Nozzle L

Manway N

Nozzle R

Nozzle T

7.0 PHOTOGRAPHS

Nozzle X

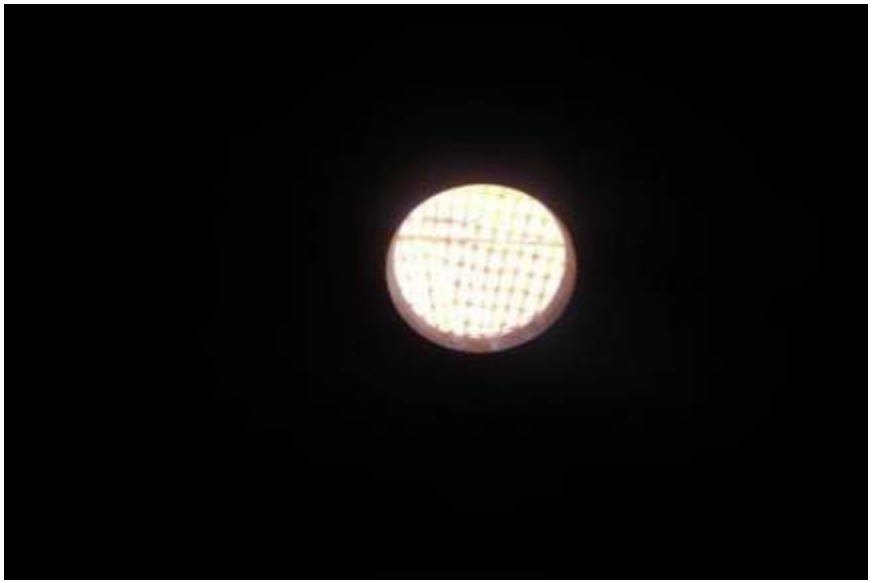
Nozzle Y

Nozzle Z

Nozzle CC

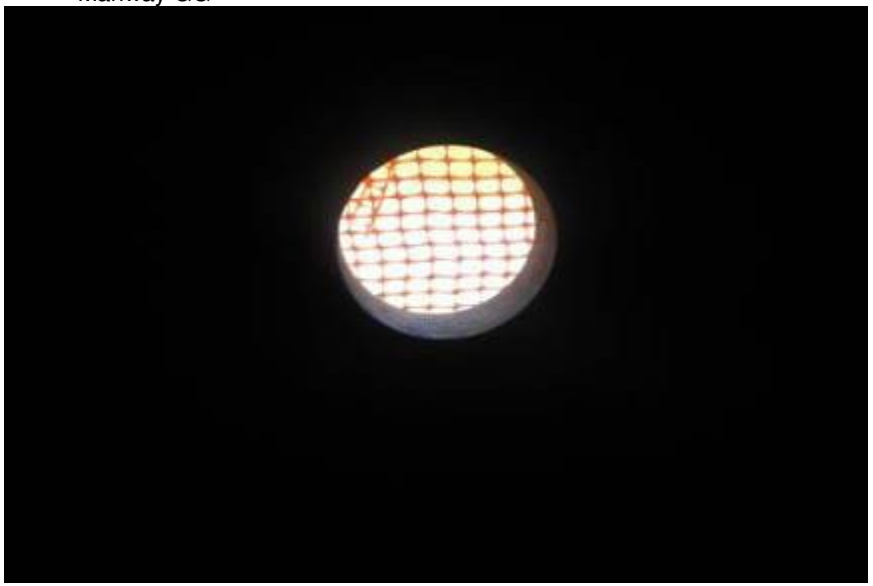
7.0 PHOTOGRAPHS

Nozzle EE



Manway GG

Nozzle JJ



Manway KK

7.0 PHOTOGRAPHS

Internal Piping

Gauge Pole

Corrosion on Hanger Plate

Through-thickness Hole on Hanger Plate

7.0 PHOTOGRAPHS

Corrosion on Hanger Plate

Corrosion on Hanger Plate

Vacuum Breaker leg

Piping Supports Broken

Piping Supports Broken

Auxiliary Sump Pipeline Support Detached

Certificate of Qualification

HMT

INSPECTION

This is to Certify

Fausto Alejandro Maldonado

is qualified in accordance with the HMT Procedure for Qualification and Certification of Nondestructive Examination Personnel which is in compliance with the requirements of the American Society for Nondestructive Testing Recommended Practice SNT-TC-1A-2006 ed.

Method	Level	Expiration Date
API 653	No. 25916	04/30/2016
API 570	No. 34334	01/31/2015

Hugh K. Howerton

Hugh K. Howerton
ASNT Level III

January 15, 2014
Date

AMERICAN PETROLEUM INSTITUTE
INDIVIDUAL CERTIFICATION PROGRAMS

API Individual Certification Programs

certifies that

Fausto Alejandro Maldonado

has met the requirements to be a certified

API-653 Above Ground Storage Tank Inspector

Certification Number *25916*

Original Certification Date *April 30, 2004*

Current Certification Date *April 30, 2013*

Expiration Date *April 30, 2016*

Tina Briskin
Manager, Individual Certification Programs

ICP

2012-038 | 10M | Printed in the USA |

Certificate of Qualification

HMT

INSPECTION

This is to Certify

Daniel Barron

is qualified in accordance with the HMT Procedure for Qualification and Certification of Nondestructive Examination Personnel which is in compliance with the requirements of the American Society for Nondestructive Testing Recommended Practice SNT-TC-1A-2006 ed.

Method	Level	Expiration Date
LT/BT	II	Oct/02/2018
MFL	II	Oct/02/2018

Hugh K. Howerton

Hugh K. Howerton
ASNT Level III

February 20, 2014
Date

Certificate of Qualification

HMT

INSPECTION

This is to Certify

Daniel Poarch

is qualified in accordance with the HMT Procedure for Qualification and Certification of Nondestructive Examination Personnel which is in compliance with the requirements of the American Society for Nondestructive Testing Recommended Practice SNT-TC-1A-2006 ed.

Method	Level	Expiration Date
LT/BT	II	10/18/2018
MFL	II	10/18/2018

Hugh K. Howerton

Hugh K. Howerton
ASNT Level III

MAY 20, 2014
Date

Certificate of Qualification

HMT

INSPECTION

This is to Certify

Nicholas Smith

is qualified in accordance with the HMT Procedure for Qualification and Certification of Nondestructive Examination Personnel which is in compliance with the requirements of the American Society for Nondestructive Testing Recommended Practice SNT-TC-1A-2006 ed.

Method	Level	Expiration Date
UT(t)	II	05/08/2019
MFL	II	02/25/2018
LT/BT	II	02/28/2018

Hugh K. Howerton

Hugh K. Howerton
ASNT Level III

May 28, 2014
Date

Downstream - Supply and Distribution

Technical Specification

Doc No
Inspection of Aboveground Vertical Storage Tanks

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Revision History

18 May 2010	Draft	1			
Date	**Description**	**Rev. No**	**Prepared By**	**Reviewed By**	**Approved By**

Disclaimer:

The companies in which Royal Dutch Shell plc directly and indirectly own investments are separate entities. In this manual the terms 'Shell', 'Group' and 'Shell Group' may be used for convenience to refer to some or all of these companies in general. Likewise the words “we”, “us” and “our” are also used to refer to Group companies in general or those who work for them. These expressions are used where no useful purpose is served by identifying particular companies.

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Foreword

The management of assets in Distribution presents some very specific challenges. These include:

a) The scatter of Distribution assets over remote locations throughout the world.

b) The unavailability of all of the engineering disciplines, required for effective asset management, at any single site (unlike a refinery).

c) The availability of competent contractors at the remote sites

d) The locations of many of these sites are in environmentally and socially sensitive areas.

Fundamentally the business operates with scattered sites in remote locations without all of the competencies at one place. The Distribution Engineer or Technician is by their very nature, required to be a “master of all trades” thus requiring Engineers to make informed decisions concerning matters not traditionally associated with their own disciplines or training.

The Distribution Engineering Technical Services Team recognizes these issues and the need to introduce specialist subjects to the non-specialist and be able to share and keep updated ‘Best Practice’ on detailed procedures that are frequently used. The series of “Engineering Guidelines” and “Recommended Engineering Practice” documents of which this is one, have been developed to provide the field Engineer and operator access to the key resources and advice they need on key subjects.

It is not the intention - written or implicit - of these documents to replace or supplement the large number of company, industry, and statutory agencies’ standards and documents already available. They do however; refer to these codes and standards at the appropriate sections of the document as a reference. The aggregation of company documentation will happen progressively over time.

This document may set requirements supplemental to applicable law. However nothing herein is intended to replace, amend, supersede or otherwise depart from any applicable law relating to the subject matter of this document. In the event of any conflict or contradiction between the provisions of this document and applicable law as to the implementation and governance of this document, the provisions of applicable law shall prevail.

This document should not be used as a substitute for new construction requirements or prevailing regulatory requirements governing a newly constructed piping system before it is placed in service.

Kiriti Bhattacharya

General Manager - Distribution Engineering

1. Introduction

1.1 Overview and Scope

This Technical Specification (TS) covers requirements for inspection of aboveground vertical atmospheric storage tanks in accordance with API Standard 653 or EEMUA Publication 159. It covers requirements for the following three types of tank inspections:

- External inspection
- Ultrasonic thickness inspection
- Internal inspection

This TS is intended primarily for use by Contractor personnel who conduct inspections, but can also be used by Company personnel. Where Contractors conduct the inspections, Company will complete the data sheet in Appendix D to define the scope of work, including:

- Which type(s) of inspection is to be conducted
- If external inspection, whether a perimeter settlement survey is to be included
- If internal inspection, whether an edge settlement survey is to be included
- Which industry code to follow (API 653 or EEMUA 159)

This TS does not cover owner/operator routine in-service inspections.

1.2 Summary of Changes

This is the first issue of this document.

1.3 References

The following documents are referred to in this specification. Unless otherwise specified, the latest edition is applicable.

Ref No	Document Title
API Std 653	Tank Inspection, Repair, Alteration, and Reconstruction
EEMUA Pub 159	Users' Guide to the Inspection, Maintenance and Repair of Aboveground Vertical Cylindrical Steel Storage Tanks

1.4 Conformance to Standards

This document is consistent with recognized and referenced international and company standards.

The most stringent of company or local regulations will be applied.

1.5 Glossary of terms

The following terms and abbreviations are used in this document; this table presents a summary of their meaning.

Term	Definition
API	American Petroleum Institute
ASNT	American Society for Nondestructive Testing
Company	Shell or Motiva organization that has entered into a contract with a Contractor to perform the tank inspection.
Contractor	Firm responsible for performing the inspection. Same as the "authorized inspection agency" as defined in API 653.
EEMUA	The Engineering Equipment and Materials Users' Association
Magnetic Flux Leakage (MFL)	Scanning technique that uses a permanent magnet in close proximity to the steel bottom surface. The magnetic field concentrates in areas that are not in uniform thickness to identify anomalies. Technique is utilized for bare steel or tanks with thin-filmed coatings.
NIST	National Institute of Standards and Technology
PCN	Personal Certification in Non-Destructive Testing
SLOFEC	Saturation LOw Frequency Eddy Current - uses eddy currents to determine the thickness of a steel bottom. Measures magnetic density based on the remaining thickness of the steel bottom. Anomalies cause the magnetic field to compress and remaining thickness is measured. Can be used for bare steel floors, or floors with coatings up to 8 mm including GRE liners.
Tank Integrity Assessor	Individual who is certified by API and authorized by the Company to perform tank inspections in accordance with API Std

(TIA)	653. Same as the "authorized inspector" as defined in API 653. Alternatively, individual is trained for the interpretation of EEMUA 159 for visual inspection, interpretation of NDT results, and sign off on final reports.
UT	Ultrasonic Testing

2. General Requirements

2.1 Maps and Records

Prior to any inspection, existing maps and records, including records of previous inspections, shall be reviewed to determine if there are any particular areas of concern that may warrant closer inspection.

2.2 Personnel Qualifications

A qualified tank integrity assessor (TIA) shall be available to evaluate all inspection results. The TIA must hold a current API Standard 653 Authorized Inspector Certification or a Certificate of Competence issued by EEMUA 159 for:

- Visual Inspection
- Interpretation of NDT results, and
- Sign off on final reports

The TIA and/or their operators are expected to have experience in operating and calibrating the required equipment and should have qualifications that can satisfy the applicable country's requirements for certification in the use and application of non-destructive inspection techniques. Specifically this can include qualification to PCN level 2/ASNT level II.

Scanning operators (MFL, SLOFEC or UT) shall be certified through the plate testing process established in Distribution. The names of the proposed operators shall be submitted to Company at least 48 hours before the operators travel to the job site.

Contractor should only supply staff that can demonstrate that they have knowledge of tank construction and have had relevant experience with tank inspections. They need to be knowledgeable in the operation and calibration of all equipment they bring to the site to complete the work. It is the TIA's responsibility to ensure that staff are

trained in the equipment's use, and that the equipment is in good working order.

Only a Tank Engineer experienced in tank design and stress analysis, and approved by Company, should be engaged to perform any stress analysis work required.

2.3 Equipment

2.3.1 Ultrasonic Equipment

To carry out satisfactory ultrasonic thickness scans the testing equipment should possess:

- A system accuracy conforming to the requirements of ASNT, and/or other location relevant codes.
- As a minimum, an 'A' scan display with a twin crystal probe and able to separate coating thickness
- A copy of the calibration certificate (manufacturer and NIST or equivalent) for the equipment.
- A monitoring range capability to suit the thickness range of the plate being inspected; to an accuracy of +/-0.1mm (0.004in) or better and negate paint thickness. The unit should be able to show the reading in waveform as a minimum.
- The necessary fixed and angle probes to complete the inspections specified.

For tank shells:

- A crawler-type magnetic hand or winch drawn trolley on which the probe can be mounted, with a continuous pressure-fed supply of couplant.
- The calibration should be checked prior to the commencement of work and after the unit has been temporarily switched off using a steel plate step-wedge gauge.
- If a display directly showing net plate thickness recordings is not available, sample paint thickness readings should be taken to determine the coverage correction factor to be subtracted to give the corrected net plate thicknesses.

- If the paint thickness readings are widespread, consider additional validation scans using UT as a calibration.
- For riveted tanks where crawlers are not practical alternate equipment approved by Company can be used.

2.3.2 Floor Scanning Equipment

The floor scanning equipment, either MFL or SLOFEC, is used to detect magnetic flux leakage fields from corrosion pitting on the top and bottom surfaces of floor plates.

MFL and eddy current equipment used for tank bottom inspection shall be the same equipment make and model used by the operator when certified through the plate testing process established in Distribution

The unit should possess the following characteristics:

- The floor-mapping unit should be of a permanent magnet type and should provide a ‘C’ scan type mapping representation with color coding for different percentage material loss. In the absence of ‘C’ scan equipment, ‘B’ Scan equipment can be used provided quality of the data is not compromised.
- Be equipped with colored images and digital readout.
- Have a monitoring range to suit the thickness of the plate being inspected and be able to identify the areas of the floor with corrosion with 20% material loss.
- Must be able to negate paint thickness (Note: MFL cannot be used on thick film coatings or mat glass systems, only SLOFEC can be used for these applications).
- Shall be capable of scanning plates to within 2 in. of the seam welds and 2 in. of the shell. Hand scanners should always be used around seams and other hard to access areas.

Ultrasonic testing equipment should be used to close grid and accurately define the extent of plate condition where corrosion is evident over the Company nominated threshold.

The calibration of the instrument should be checked prior to the commencement and after completion of work, at appropriate intervals during the scanning process and after the unit has been temporarily switched off during inspection.

Calibration of MFL or SLOFEC floor scanning equipment should be performed in accordance with the manufacturer's instructions.

The use of test plates is required to ensure accuracy of result. These have known defects and plate thicknesses already mapped, and can be used to check the overall machine and operator accuracy.

2.3.3 Visual Inspection Equipment

The TIA should provide all necessary equipment in addition to the ultrasonic flaw detector and probes required to complete the inspections as specified. Equipment shall be calibrated according to the manufacturer's specifications.

2.4 Plate Numbering and Datum

The use of the same plate numbering and datum practice through the life of the tank for documenting inspection findings allows for tracking the results of inspections over time. Where existing practices exist they should be followed. Where none exist or they are inconsistent or don't provide sufficient data for evaluation, the following recommended practice should be used.

2.4.1 Floor and Roof

Numbering should commence from the plate that is the furthest NW to the extent possible. Subsequent plates should be numbered by proceeding eastward across the first row then westward across the second row continuing in a zigzag fashion until all plates are numbered.

Where annular plates exist, the numbering should continue with the annular plate adjacent to the last plate numbered above. All other annular plates are numbered in a clockwise direction.

The tank map should be oriented with the long axis of the plates horizontal. True North should be shown on the tank map and should be to the top of the page to the extent allowed by the orientation of the plates.

When numbering the top half of the floor the plate number should be written in the bottom left or right

corner of the plate. When numbering the lower half of the floor the number should be written on the top left or right corner of the plate.

The datum for recording inspection findings on a plate is normally established as the corner where the number is written. The datum point should be documented on the inspection report.

2.4.2 Shell

Shell strakes (courses) are to be numbered sequentially, starting with the bottom strake as being the first strake.

Shell plates are to be identified alphabetically, sequentially from the bottom of the tank's stairway from the first full plate in a clockwise direction.

Nozzles, manways, stairways, and fittings are to be accurately shown on the drawings.

2.4.3 Settlement

The tank datum for settlement measurements and thickness measurements is the first vertical weld, on strake one from the bottom of tank stairway in a clockwise direction.

Settlement measurements should be referenced to the Site Datum and where appropriate the local survey datum.

2.5 Conducting Inspections

Contractor shall complete all tank inspection work per company scope and / or data sheet. Company, or contractor equivalent checklists if approved by Company, should be utilized as a tool to help capture all required inspections.

If any condition exists that may inhibit a good quality inspection, the Contractor shall notify Company. Contractor shall advise Company of any inspection disclaimers that will be included in the inspection report that result from conditions that inhibit the inspection.

All pertinent observations shall be documented in the final report.

When performing thickness and/or pit depth measurements, the surface shall be brushed, filed, ground or otherwise cleaned of foreign matter as necessary to improve measurement accuracy and visual examination. Deep pits shall be probed with a sharp instrument to identify any perforations.

Prior to any testing that utilizes oil medium, Contractor shall discuss with Company contamination considerations, i.e. future linings or hydrotest water discharge. The company representative shall specify proper post-test cleaning when necessary.

All findings of significance shall be clearly marked with an oil-free, chloride-free, greaseless, semi-permanent marker, e.g. fluorescent paint, and be discussed with Company. In addition, these findings shall be recorded with digital photography and included in the Final Report.

TIA shall be present at the tank site during all phases of the inspection.

3. External Inspection

3.1 Scope

This inspection comprises:

- A detailed and thorough external visual inspection of the tank shell, roof and appurtenances, including a thorough inspection for deterioration of external surfaces, and corrosion under insulation where applicable, the tank foundation and surrounding bund/dike area.
- Ultrasonic thickness measurement check of the shell thickness
- A tank settlement survey if specified by Company

The primary function of this inspection is to identify if there is any discernable change in the tank condition since the previous external inspection.

3.2 Visual Inspection

Close visual inspection, looking for any signs of deterioration or change since the previous inspection, is the primary requirement of the external inspection. The visual inspection is initially limited to those areas that can be readily inspected from ground level and the existing stairways and platforms of the tank and roof (except internal floating roofs). Tools such as mirrors and flashlights (as approved on the work permit) can be used. Particular attention should be paid to areas of concentrated corrosion and accelerated degradation on surfaces and fittings and upon the identification of corroded or questionable sections of the tank by the visual inspection, Company may authorize further inspections and revised access.

Shell and roof appurtenance details as applicable, including reinforcing plate dimensions, weld spacing, tell-tale holes, neck thicknesses, cover plate thicknesses, and flange thicknesses shall be measured and documented.

Details of stairs, walkways, platforms, and walking surfaces shall be checked against requirements of API Std 650 and applicable safety standards/regulations.

The detailed checklist in Appendix A, or equivalent, can be used to ensure that the condition of the tank and associated appurtenances and fittings as well as the foundation and surrounding area are thoroughly investigated and reported. Alternatively, Contractor may use their own checklist format if it provides an equivalent level of detail and thoroughness and is approved by Company.

3.3 Shell Thickness

External ultrasonic thickness measurement of the shell shall be taken as a check that no unexpected deterioration of the tank shell is occurring and to conduct a quick validation of the tank fill height. As a minimum, three average readings per coarse, (top, middle, bottom) are to be taken from the spiral stairway. For tanks without spiral stairways, an alternate method for obtaining readings should be used, e.g. using a manlift or crawler.

These readings alone are not to be used as a basis for determining tank corrosion rates and are not considered sufficient to meet the requirements of an ultrasonic thickness inspection. Section 4 provides requirements for UT readings for calculating tank corrosion rates when ultrasonic thickness inspections are specified.

3.4 Tank Settlement Survey

A perimeter settlement survey, per section 5.6.1, shall be conducted in conjunction with the external inspection if authorized by Company.

4. Ultrasonic Thickness Inspection

4.1 Scope

This inspection comprises

- Inspection and ultrasonic testing of the tank shell
- Inspection and profile gauging of rivet connections and lap joints where applicable
- Inspection and ultrasonic testing of manway and nozzle walls.

The primary purpose is to determine corrosion rates and confirm the tank fill height with respect to hydrostatic and seismic loads as well the general condition of the tank. This inspection may be a stand-alone inspection or may be conducted in conjunction with an external or internal inspection.

4.2 Locations to be Scanned

If previous ultrasonic thickness inspections have been conducted and the number of scans taken ~~are~~ is sufficient to meet the required number of scans indicated below, the practice followed previously for vertical scan locations should be used.

Where previous scans have not been taken or are insufficient, vertical shell scans should be located at the cardinal points of the tank (N, S, E, W), and referenced from the first vertical weld on strake one clockwise from the bottom of the tank's stairway. The location of all succeeding vertical scans should be established and recorded in a clockwise direction from the reference point. Care should be taken with any markings so as not to detrimentally affect the shell protective coating.

The number of scans taken will depend on the diameter and condition of the tank shell, but the number of scans in the initial survey should not be less than shown below.

Tank Diameter	**No. of Initial Vertical Scans**
Up to 18m (60ft)	4
Over 18m (60ft) to 36m (120ft)	8
Over 36m (120ft)	At intervals around the tank circumference not greater than 15m (50ft)

Vertical scans should be at approximately equal intervals around the tank circumference, but the interval should be varied where necessary to allow a clear and unobstructed vertical run by the crawler mounted probe. Drawing of the shell and scan points should be drawn as a surface development (rolled out) view.

If some initial scans show significant loss of plate thickness due to severe internal corrosion, additional scans located between initial scans should be taken to more clearly define the areas of shell plate having the highest material loss.

4.3 External Scanning

The vertical scans in the locations selected are to be carried out as nearly as possible in continuous scans over the full height of the tank shell from floor level to the top curb angle.

While the probe is in motion, the operator should continuously monitor the readings so that plate flaws such as non-metallic inclusions, laminations and deep corrosive pitting are correctly identified and recorded and to ensure that there is a continuing match between thickness readings and recordings.

A close grid thickness reading should also be carried out on the shell vapor space area of about 300mm (1 ft) from the top curb angle. This should be conducted at the nominated crawler runs.

4.4 Riveted Tanks

For riveted tanks where it is difficult to take continuous vertical scans of the shell, a minimum of 5 readings, equally spaced along the height of the shell, at each vertical location defined in Section 4.2 shall be recorded. At least one continuous vertical scan shall be recorded.

Accessible rivet joints require inspection with particular attention to the shell-to-annular ring connection. Weeping rivets plus any rivet heads that have corroded to less than 60% of their original profile are to be identified on the shell elevation drawings. The TIA should check the extent of preferential corrosion to the perimeter of the rivet head. It is necessary to inspect for cracks around the rivet hole, the elongation of the hole and for crevice corrosion. Hammer testing of any rivets that have corroded in excess of above parameters or appear loose may be required.

4.5 Additional Readings

In addition to the readings obtained at each of the scan locations, where practical additional readings should be taken on each strake from the stairway with a hand held digital instrument.

During the inspection of the first two strakes, it is important to determine the extent of any possible grooving caused by product/water interface, or other defects. If the ultrasonic thickness inspection is being done in conjunction with an internal inspection, this can be done via internal inspection.

In the event that plate defects are detected within the areas of the above scans, (which may cause localized

weakness such as laminations, grooving, inclusions or internal mechanical damage) the profiles of such defects should be plotted and identified with crayon on the plate surface as well as on the shell elevation drawing.

Where preferential corrosion is detected during visual inspection at the stair tread/shell plate and stanchion or brace/shell plate connections, the minimum thickness should be determined by scanning the perimeter of the welded joints and checking pit depth measurements.

Paint and scale adjacent to welds should be chipped back as required. In areas where the tank has become partially buried due to foundation settlement, or erosion and migration of bund/dike wall material, etc., the extent of corrosion that may have occurred at the false grade line or below should be confirmed.

4.6 Tank Nozzles

Carry out ultrasonic thickness measurement on each tank manway/nozzle up to the first flange. A minimum of 4 readings at 0°, 90°, 180° and 270° around each manway/nozzle shall be recorded.

A minimum of one UT measurement shall be taken on each reinforcement pad of the tank nozzles and manways.

The following should be determined and recorded for each manway and nozzle:

- Wall thickness of manway/nozzle exclusive of pits
- Average wall thickness
- Maximum wall thickness
- Minimum wall thickness

Results of the thickness readings should be compared with the nominal wall thickness specified in the tank code applicable for the corresponding manway/nozzle size and reinforcing pads.

4.7 Internal Readings

Where the ultrasonic thickness inspection is being conducted in conjunction with an internal inspection and evidence of corrosion is observed which needs to be investigated further, a detailed internal visual inspection supported by use of a digital ultrasonic thickness instrument is to be conducted with concurrence of Company.

The initial assessment may be conducted with strong lights and binoculars with the follow up work completed from internal scaffolding which allows access to part or all of the tank shell as considered necessary.

Readings should be taken over each strake at areas that show signs of corrosion and shell thinning as determined by the inspection.

5. Internal Inspection

5.1 Scope

The fundamental requirement of the internal (out of service) inspection is to ascertain that the tank is 'fit for service' until the next inspection, in accordance with the appropriate code/guideline requirements generally API 653 or EEMUA 159, but can include local statutory requirements where these are more stringent or considered technically equivalent.

The work must be conducted by a qualified TIA, and the work scope is as follows:

a. A visual inspection of the tank, both externally and internally, to determine the condition of the foundation, shell strakes, roof, roof/blanket seals, floor, protective coating, appurtenances and fittings, including an assessment of propagating defects and corrosion.

b. An ultrasonic thickness inspection of the shell in accordance with Section 4 above, if specified by Company.

c. A tank floor inspection, including thickness survey of the floor plates and vacuum box testing (or magnetic particle inspection or dye penetrant testing) of bottom sketch plate and corner welds.

   Comment: The Company may elect to replace the floor based on prior knowledge of its condition. A floor inspection would not be required in this case.

d. An ultrasonic thickness inspection of the roof plates on cone roof and sphere dome roof or floating roof-design storage tanks.

e. A survey of tank settlement (perimeter, bottom and edge).

f. The preparation of a report documenting thickness survey results on the specified forms plus details of visual inspection findings, including photographs, of defects.

g. A review of the tanks suitability for ongoing service, including if necessary a summary of the recommended repairs to be made in accordance with

API 653/EEMUA 159, and/or tank re-rating as appropriate.

h. A calculation of the maximum corrosion rates based on current and historical data, to be used in calculating the tanks remnant life, and the next inspection period. Reference to EEMUA 159 or API 653 RBI methodology is to be used to substantiate this.

The tank floor inspection (item c above) and tank settlement survey (item e above) should generally be scheduled early in the inspection and preliminary data provided to Company for review to determine whether additional inspection work will be required.

Any areas of the tank that cannot be inspected, visually or otherwise, shall be brought to the attention of Company.

Company will clean, gas free and isolate the tank for safe entry prior to turning over to Contractor for the internal inspection.

5.2 Visual Inspection

A close visual inspection of the entire tank, including roof, shell, floor, appurtenances, foundation and tank surroundings shall be conducted as part of the internal inspection. This inspection will be similar to the external inspection covered in Section 3 but will also include the internal surfaces, including the floor plates, sump, shell, underside of the roof, and roof support structure where applicable.

The detailed checklist in Appendix C can be used to ensure that the condition of the tank and associated appurtenances and fittings as well as the foundation and surrounding area are thoroughly investigated and reported. Alternatively, Contractor may use their own checklist format if it provides an equivalent level of detail and thoroughness and is approved by Company.

5.3 Tank Floor Inspection

5.3.1 General

Weld seams and shell to bottom joint shall be visually inspected for leak wicking and corrosion. Suspect weld seams may be subjected to vacuum or other test as specified by Company.

Shell to bottom weld size shall be checked for minimum filet leg (1/4 in).

Suspect areas identified by the visual inspection in bottom welds and shell welds shall be subjected to

magnetic particle examination. For ethanol tanks wet fluorescent magnetic particle testing must be used

5.3.2 Floor Plate Thickness

The purpose of this inspection is to determine corrosion pitting primarily on the underside of tank floors where visual inspection is impractical but also on the top surface hence providing a complete as possible floor thickness survey.

Maximum coverage is obtained using a combination of techniques including scanning using a MFL or SLOFEC floor scanner, as described in section 2.3.2, plus hand scan and C-Scan U/T, followed by detailed use of an ultrasonic probe to closely examine material loss where identified. 'Dead zones' where it is impracticable to scan with the floor scanners shall be subject to a combination of techniques to achieve maximum practical coverage especially in areas of identified concern.

All significant internal and underside pits and corrosion should be identified, measured and recorded along with their location.

If significant pitting, corrosion or thickness readings exceeds the established threshold a more detailed thickness scanning survey should be taken covering the suspected areas of floor plate using a hand held ultrasonic unit B-Scan to determine the severity. Company will establish the appropriate threshold basis tank conditions, but typical is to start at 20%.

For each individual floor plate, the following measurements should be determined and recorded:

- The least thickness in an area of corrosion exclusive of pits.
- The depth, extent & location of significant identifiable top surface pitting (TSP) and under floor corrosion (UFC)
- The average plate thickness.
- The maximum depth of isolated pitting.
- The density of pitting (%) to the surface.

The Company may elect to remove floor coupons in cases where abnormally aggressive UFC or inconclusive NDT readings are observed.

In conjunction with the bottom plate inspection, inspect and record bulges or depressions on the tank bottom and shell plates.

5.3.3 Floor Sump

Readings of the floor, sidewall and rim of the floor sump(s) should be obtained to identify the extent of corrosion and pitting. Any corrosion, undercutting or other weld defects that could undermine the integrity of the sump should be identified

5.3.4 Roof Columns

For pipe columns the operator should complete a single continuous vertical scan of the lower section (300mm (1ft)) of the columns. For other type columns and base plates and gussets a visual inspection should be conducted to check for corrosion and pitting or other damage. In addition, the TIA should ensure the floor plates adjacent to the areas providing bearing to the columns are scanned, where accessible, and particularly where water entrapment occurs.

5.3.5 Floor Plate Welds

- Floor Sketch Plates

  Floor sketch plate welds should be inspected visually and by vacuum box testing continuously for their entire length. If approved by Company alternate testing methods, i.e. magnetic particle testing or dye penetrant testing may be used to detect for weld cracks or defects if no floor coating or if protective coating is in poor condition or significant weld defects are noted.

  Tanks with unlined floors that have contained ethanol shall be subjected to wet florescent magnetic particle examination. A minimum of 30% of bottom welds and accompanying heat-affected zones, including the inside of the shell-to-bottom welds shall be examined. Areas shall be randomly selected.

- Circumferential Floor to Shell Welds

  If the protective coating is in poor condition or significant weld defects are noted, the TIA should complete a continuous visual survey of the internal and external

circumferential welds. In addition, the internal weld should be inspected using vacuum box testing. If significant defects are found, additional inspection using magnetic particle testing or a dye penetrant testing to detect cracks or weld defects should be conducted.

The TIA should complete a random survey of the heat-affected zone of the floor to shell joint using a shear wave probe (ultrasonic flaw detection). If this is not possible then a visual inspection from a hole under the joint may be required. Specific approval should be obtained from Company before proceeding with any excavations.

- Other Floor plates

  Lap welds on all remaining floor plates should be inspected visually and using vacuum box testing. Where significant weld defects are noted, magnetic particle testing or dye penetrant testing should be conducted.

5.3.6 Floor Plate Projection

The ultrasonic thickness measurement of floor plate projection can be carried out using hand held digital instruments.

Readings should be taken at approximately equal intervals around the floor plate projection starting from the tank datum point and the location plotted on a sketch or drawing of the floor plate layout (see Section 2.4).

The thickness readings should be taken at 2m (6ft) intervals around the tank circumference.

In areas where thickness measurements show significant variations in floor plate projection thickness and if extensive underside corrosion is suspected, an increased number of readings should be taken and thickness measuring location designated for future monitoring.

5.4 Tank Roof Inspection

5.4.1 General

The ultrasonic thickness measurement of roof plates can be carried out using hand held digital instruments.

Measurements shall be taken along radial lines that are an extension of the shell scan lines described in section 4.2 and extend to the center of the tank.

Initially three measurements along each radial line shall be taken; at 200 mm (8 in) from the shell, at 2/3 radius and at 1/3 radius.

In areas where thickness measurements show significant variations in roof plate thickness and where extensive underside roof corrosion is observed or suspected, an increased number of readings should be taken.

Where excessive plate thinning is found by ultrasonic inspection, it should be thoroughly investigated by internal inspection.

The operator should monitor and log details of any visible plate defects such as non-metallic inclusions, laminations and deep corrosive pitting, as observed from the visual inspection.

Proximity of any roof vents to areas of deterioration shall be documented if determined to be contributing to the corrosion.

Roof condition shall be documented on a roof layout drawing that includes nozzle and vent locations.

5.4.2 Cone Roofs

Where internal corrosion is significant, the roof support structure should be inspected for corrosion damage. Pitting damage to rafters, girders, brackets to the shell and connecting bolts should be evaluated. Random thickness measurements shall be recorded on rafters and other applicable support members to the extent necessary to determine general condition (generally the more uniform the corrosion the fewer measurements are necessary). Special attention should be given to the center column plate and the connection to the center rafters.

In lieu of providing access for close inspection, sections of the roof plate can be removed by others to allow close inspection of the roof and upper structure underside. Company shall specify size, number, and location after consultation with TIA for an agreement of this scope.

If rafters are found to be corroded or damaged, structural calculations shall be performed to determine the load(s) that the roof support structure is capable of carrying. Company will

determine if this load carrying capacity is greater than the expected load and if repairs are necessary.

Where cable suspended floating roofs exist or are to be installed, calculations shall be performed to validate the roof support integrity.

5.4.3 Floating Roofs

Floating roof perimeter seals shall be visually inspected as follows:

- Check if seal fabric on primary shoe seal is pulling shoes away from shell (fabric not wide enough).
- Inspect fabric for deterioration, holes, tears, and cracks.
- Inspect visible metallic parts for corrosion and wear.
- Inspect for openings in the seal that will permit vapor emissions.
- Inspect for protruding bolt or rivet heads against the shell.
- Inspect secondary seals for signs of buckling or indications that their angle with the shell is too shallow.
- Inspect wedge-type wiper seals for flexibility, resilience, cracks, and tears.

  Comment: The Company may elect to replace the seal based on prior knowledge of its condition. A seal inspection would not be required in this case.

Inside of pontoons (external or internal floating roofs) shall be inspected for signs of hydrocarbon leakage (odor and stains), spent abrasive, trash, and water.

Roof drains on external floating roof tanks shall be inspected to verify that they are open and free to drain rainwater from the roof, including inspecting for proper coiling, damage, excessive wear, leaks, and corrosion. If the roof drain system is made of steel pipe, UT examination shall be performed to determine pipe wall thickness. UT measurements shall be taken along the bottom of the pipe and at low spots where corrosion thinning is most probable

5.5 Tank Shell

Shell interior surface shall be given a visual inspection for irregularities, with particular attention to any areas that indicate the past flow of water down the tank shell that might have resulted from roof leak, or seal gaps on external floating roof tanks.

Internal appurtenances that are welded to both the shell and the bottom shall be clearly marked and documented.

An ultrasonic thickness inspection of the tank shell, in accordance with Section 4, shall be conducted if requested by Company.

For floating roof tanks, if the floating roof shows signs of restricted movement, Company may elect to have an out of round and/or verticality survey completed. This is also conducted where it is expected that an internal floating cover is to be fitted in the near term.

5.6 Tank Settlement

The tank settlement inspection consists of measuring the extent of settlement of the tank to a fixed datum outside the tank bund/dike wall.

Settlement requiring measurements include:

- Differential settlement
- Planar Tilt
- Edge Settlement
- Shell plate bulges at the bottom plate to shell area (included as part of the floor plate inspection - see section 5.3.1)

A layout drawing of the tank bottom that includes settlement readings and reading locations shall be provided. Elevation readings shall be recorded on the drawing or a location traceable spread sheet.

5.6.1 Tank Perimeter Survey

This survey consists of taking elevation measurements of the floor extension or top of foundation at equidistant points around the circumference of the tank, for evaluation of differential settlement and planar tilt in accordance with API 653 Annex B or EEMUA 159 Section 7.

If previous settlement surveys have been conducted, the same survey points should be used for taking elevation measurements. If not or they do not

provide sufficient points for evaluation, the number of settlement points shall be determined as follows:

The minimum number of survey points should be tank diameter D in meters divided by 3.05 (D in feet divided by 10) but should not be fewer than 8 and the maximum circumferential spacing should not exceed 10 meters (32 feet). If the resultant number of survey points is an odd number, add one more point. An even number of survey points will facilitate tank floor elevation survey points at opposite sides of the tank floor. If differential settlement is known or suspected, the spacing between perimeter survey points shall be half these requirements. Each survey point should be identified numerically in a clockwise direction from the permanent reference point marked on the floor plate projection or the tank shell. The permanent reference point is the first vertical weld on the bottom strake from the stair termination in a clockwise direction

The survey should be “closed” to ensure accuracy in levels of ± 6 mm (0.02 ft).

5.6.2 Edge Settlement

This survey consists of taking measurements for evaluation of edge settlement of the tank floor in accordance with API 653 Annex B or EEMUA Section 7.5.2.

Measurements shall be taken at perimeter locations identified for the perimeter/bottom survey above. At each perimeter location, measurement of “B” and “R”, per Figure 5.5.2-1 shall be taken. In order to determine these measurements, the breakover point “P”, where the settled area begins, must first be determined. Often the unsettled floor is not as flat as shown in the figure so careful field judgment must be used to choose the break over point.

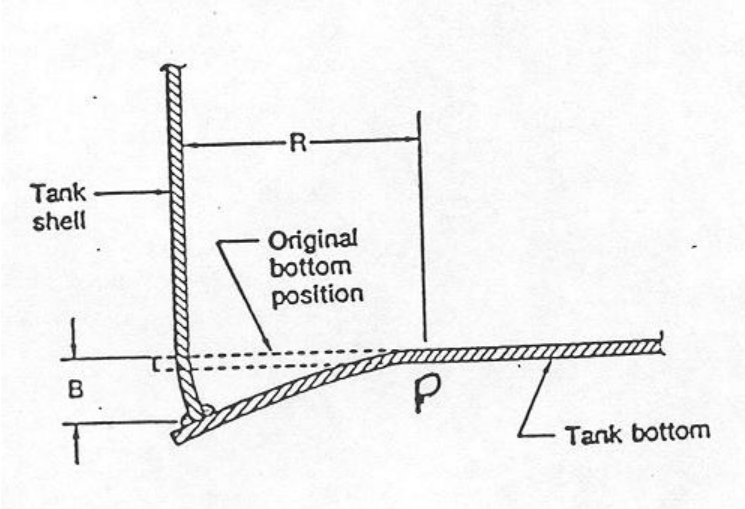


Figure 5.5.2-1

6. Analysis and Documentation of Findings

6.1 Analysis

The TIA is to review the tanks suitability for ongoing service, as applicable for the inspection conducted, based on the acceptance criteria in API653, and/or EEMUA 159 as applicable. The TIA should determine from the codes and tank construction details what criteria are to be applied.

The tanks suitability for ongoing service will consider any repairs that are recommended by the TIA, and include a discussion as to their impact.

6.1.1 Repair Recommendations

The TIA should recommend repairs to the tank for the following reasons:

- Compliance with the appropriate codes, insofar as the tank's original construction standard can no longer be considered satisfactory for ongoing service (as measured by API 653/EEMUA 159).
- Meet or exceed minimum rejection criteria
- Avoid significant down grading of tank capacity as result of re-rating.
- Achieve a target of approximately 15 years before the tank requires it's next out of service inspection (may depend on intended service conditions). A maximum interval of 20 years may be used if determined through appropriate evaluation and endorsed by TIA.

Repair requirements would normally be discussed immediately with Company. A hand written report will be generated to allow immediate action, unless significant calculation and analysis is required before final recommendations can be made.

6.1.2 Calculations

Taking into consideration the condition of the tank and, if appropriate, any repairs that will be implemented (after discussion and agreement with Company) the tank should be re-rated, specifically with regard to safe fill height.

This is primarily appropriate for hydrostatic and/or seismic compliance, but other Code considerations should also be taken into account.

Tank re-rating calculations may need to be completed to determine the impact of any recommended repairs, to determine benefit on tank duty.

The tank’s venting capacity may require verification by calculation. This includes emergency venting requirements. Any requirement for this will be at the discretion of the Company. Tank venting requirements should be determined in accordance with API 2000.

6.1.3 Remnant Life - Next Inspection

The TIA should determine the tank’s remnant life by determining the corrosion rates, against historical data, and the test data retrieved from the inspection. The minimum acceptable thickness “t” min should be based on the relevant codes.

In their simplest form the corrosion rates determine the next theoretical inspection period. However it is expected that the TIA should use their knowledge, and experience, taking consideration of other factors, such as risks and reliability of data in determining this period.

The TIA should also consider what is likely to be the dominant failure mode, taking into consideration the likelihood based on experience and data provided from recent and historical inspections.

In addition other trend-able failures, such as tilt and settlement, should be considered where the data is available.

In order to complete this analysis the TIA will be provided with historical inspection data that Company has on record.

6.2 Documentation

6.2.1 Site Reporting

The TIA should maintain daily communication with Company during the inspection period with progress reports.

Specifically the TIA will note any concerns or non-compliances that may impact on the time that the tank can be recommissioned.

All inspection data shall be prepared in written or electronic format at the site. A draft (site) report will be completed before the TIA leaves the site. The draft report will outline any issues that should be addressed before the tank is recommissioned. As a minimum the draft report should include a discussion on the necessary repairs or uncertainties that will impact on whether the tank can be recommissioned. Data shall be communicated to Company by email, telephone or fax, if necessary.

6.2.2 Final Report

A Final Report shall be prepared and signed by the TIA documenting all of the findings of the inspection(s). The final report should normally be completed within 2 weeks of the inspection.

As a minimum the Final Report shall include:

- A cover page indicating the type of inspection(s) and standard used (API 653 or EEMUA 159). If the report covers more than one type of inspection, all applicable inspections should be indicated on the cover page.
- An executive summary of findings and recommendations
- A Tank Data Sheet
- A summary of procedures and equipment, including calibration certificates, used
- Copies of required personnel certifications
- Applicable completed inspection checklist(s) (forms in Appendices or equivalent) confirming that all inspection tasks have been properly completed and the appropriate data, notes and observations have been recorded.

- Layout drawings of the bottom, shell, roof, as applicable with pertinent data shown, including any areas of corrosion
- Applicable calculations, including
  - Fill height based on water and product stored
  - Remaining life of each shell course based on product stored
  - Remaining life of tank bottom
- A detailed summary of findings and recommendations, including:
  - Items not compliant with current API 653/EEMUA 159 requirements
  - Items to consider for repair
  - Suggested improvements on tank maintenance.
  - Items recommended for observation in the future.
  - Recommended interval(s) for the next inspection and next inspection date(s) (day, month, year), including an explanation and supporting calculations explaining the basis for the recommendation(s) for all inspection type(s) performed:
    - external - maximum of 5 years,
    - ultrasonic thickness - maximum of 15 years,
    - internal - maximum of 20 years)

The Final Report shall be submitted in electronic (e.g. CD) and hard copy. Electronic format shall be compatible with Microsoft™ software and is subject to approval of Company prior to use.

6.2.3 Recommended Final Report Layout

For consistency and ease of review and evaluation by Company, Final Reports should be submitted in a standard format, organized as follows:

- Cover Page, which should include as a minimum:
  - Tank No.
  - Facility Name

- Location
- Type of Inspection(s), including Standard used (API 653/EEMUA 159)
- Date(s) of Inspection
- Inspection Company
- TIA Individual Report Number

- Executive Summary of Findings
- Tank Data Sheet which should include as a minimum:
  - Dimensions - Height, Diameter, Capacity
  - Design standard
  - Manufacturer
  - Year Built
  - Product Stored
  - Geometry - Foundation, Bottom, Shell, Roof Type, Seal Type(s)
- Detailed Findings (as applicable):
  - Foundation
  - Tank Bottom
  - Shell
  - Fixed Roof
  - Floating Roof
  - Nozzles and Appurtenances
  - Surroundings
- Detailed Recommendations
- Appendices
  - Checklists
  - Detailed Calculations
  - Layout Drawings and Corrosion Mapping
  - NDT Data
  - Photographs
  - Procedures and Equipment
  - Personnel Certificates

TANK INFORMATION

Appendix A - External Inspection Checklist (T-170)

System Name (SAP Level 1)	TANK LOCATION (SAP Level 2)St. James, LA	Region
SERVICE or PRODUCT Crude Oil	TANK NUMBER 2	DATE 7/14/2014
MANUFACTURER Graver Tank & Mfg.	DATE CONSTRUCTED 1979	
TANK DIAMETER (FT & IN) 300.00 ft. / TANK HEIGHT (FT & IN) 36.42 ft.	NOMINAL CAPACITY 418,707 bbls.	
TODAY'S DATE 7/19/2014	DATE OF LAST EXTERNAL INSPECTION	

ROOF TYPE
☐ Fixed Cone ☐ Geodesic Dome ☒ External Floater ☐ Internal Steel Floater ☐ Internal Aluminum Floater

SHELL
☐ Riveted ☒ Welded ☐ Bolted

BOTTOM
☐ Riveted ☒ Welded

FOUNDATION
☒ Concrete Ring ☐ Earthen Pad ☐ Shell ☐ Other _____

INSTRUCTIONS

1. Mark X under the Condition Codes on the checklist that best fits the condition of the item being inspected.
2. Black squares indicate the Condition Codes is not applicable for that inspection item.
3. Shaded squares indicate a condition that requires additional evaluation or repair.
4. Comments **are required** for all conditions marked X in shaded squares. When necessary, extend comments to page 4 on the form.
5. Further instructions and guidelines are in other sections of this specification.

CONDITION CODES

Code 0 Not Applicable
Code 1 Condition warrants immediate action or verbal communication. Possible equipment shutdown.
Code 2 Condition requires repairs be scheduled for the soonest possible time.
Code 3 Condition requires scheduled repairs and possible further investigation and/or inspection.
Code 4 Condition requires minor maintenance repairs.
Code 5 No damage or failures noted.
Code 9 Used only to report items not covered in the procedure that may affect system performance.

SAFETY

	Acceptable (Mark X) Yes	Acceptable (Mark X) No	Comments *(required if not acceptable)*
1. Observe entire tank and surroundings from firewall for entry	x		
2. Tank access ladder and platform structurally sound	x		
3. Tank roof structurally sound	x		

SURROUNDING AREA

	Condition Codes (Mark X) 0	1	2	3	4	5	9	Comments
Surrounding Area								
4. Flammable materials stored inside firewall						x		
5. Site drainage away from tank, piping, and manifolds						x		
6.General housekeeping around the tank (trash, vegetation, debris)						x		
7.Dike condition (breeches and other deterioration)						x		
Foundation								
8. Concrete ring (cracks, breaks, spalling, exposed rebar)						x		
9. Concrete ring drains are free of debris						x		
10. Top of concrete ring sloped away from tank						x		
11. Earthen pads eroded from water running off the tank	x							
12. Indications of bottom leaks						x		
13. Cavities or voids under tank						x		
14. Settlement indications (see instructions, Page 10 of this form)						x		

	Condition Codes (Mark X)							Comments
	0	1	2	3	4	5	9	
15. Bottom extension drains away from tank						x		
16. Bottom extension (corroded, pitting, thinning)						x		
17. Chime weld condition (corrosion, weld defects, etc.)					x			Three welds defects observed
18.Shell to bottom weld and chime area free of dirt and sand						x		
19. Bottom extension welds (pitting, corrosion, undercuts)					x			Same as #17
TANK SHELL								
20. Overall condition of shell						x		
21. Condition of bottom extension seal to foundation					x			Minor coating failure
22. Condition of earth grounding cables and connectors						x		
23. Insulation (cracking, leaking, moisture under weather coat)	x							
24. Shell pitted or corroded						x		
25.Any coating failure						x		
26. Deformation of shell (banding, peaking, bulging, flat spots)						x		
27. Indications of shell leaks (observe seams closely)						x		
28. Condition of rivets (work, corroded, loose rivet sealer)	x							
29. Condition of seam welds (pitted, corroded, or undercut)						x		
30. Indications of roundness, plumbness issues						x		
31. Plate thickness (UT) suitable for service (see page 6)						x		
SHELL APPURTENANCES								
32. Excessive dimpling of shell plate or bowing of piping						x		
33. Weld spacing issues						x		
34. Leakage around support and reinforcement plate welds						x		
35. Attachment supports (corrosion, defects)						x		
36. Reinforcement plates under supports (existing, size, welding)					x			No Reinforcing plates noted.
37. Indications of leakage around manways and nozzles						x		
38. Indications of leakage around flange bolts and welds						x		
39. Sample connection valves (leaking, operational)	x							
40. Leakage around swing line threaded and flanged joints	x							
41. Leakage around autogauge guides and sheave housing						x		
42. Leakage around shaft seal (tank mixer)	x							
43. Leakage of valve packing glands						x		
44. Condition of welds on davits/davit clips (valves, mixers, clean-outs)						x		
45. Windgirder, supports, handrails, top angle (corrosion, weld failure)						x		
46. Windgirder (dust/dirt buildup, paint failure)					x			Standing water and rust present.
47. Temperature indicators (corrosion, mechanical damage)						x		
48. Autogauge system (corrosion, mechanical damage)						x		
49. Autogauge tape free to move and legible (also oil fill in cold climates)						x		
50. High level alarm (mechanical damage)						x		
51. Firefighting system (corrosion, mechanical damage)						x		
52. Spray nozzles (blockage)						x		

	Condition Codes (Mark X)							Comments
	0	1	2	3	4	5	9	
53. Chemicals usable (shelf life)	x							
54. Tank mixer mounting base (weld failure, structural damage)	x							
55. Tank mixer mounting base (loose bolts)	x							
56. Noise level during tank mixer operation	x							
57. Vents in upper shell and overflow slots	x							
58. Nameplate bracket conditions (corrosion, damage)						x		
59. Piping without our flexibility (no bends)						x		
ACCESS STRUCTURE (Note: The inspection should be terminated if the access structure is determined to be unsafe.)								
60. Ladder attachments to concrete base (corrosion, broken)						x		
61. Welds on stairways and ladders stringers (corrosion, broken)						x		
62. Welds on spiral stairway to shell (corrosion, broken)						x		
63. Stairways and ladders (corrosion, broken, paint failure)						x		
64. Handrails (corrosion, pitting, broken welds, paint failure)						x		
65. Stairway/ladder treads securely attached to stringers						x		
66. Safety drop bar or safety chain provides adequate protection	x							
67. Gauger platform frame and supports (corrosion, broken)	x							
68. Gauger platform deck (corrosion, paint or weld failure)	x							
69. Rolling roof ladder/handrail (corrosion, paint or weld failure)						x		
70. Hazardous openings in handrail on rolling roof ladder						x		
71. Rolling roof ladder attachment to shell (corrosion, wear)						x		
72. Self-leveling of rolling roof ladder treads (when applicable)						x		
73. Treads on rolling ladder (wear, corrosion, damage)						x		
74. Alignment of rolling roof ladder with roof rails						x		
75. Rolling roof ladder rails (welds, corrosion, wear)						x		
76. Rolling roof ladder wheels, axle, and securing pins to axle						x		
77. Rolling ladder static cables (frayed, end connections)						x		
TANK ROOF								
78. Thickness readings less than minimum allowable (UT)						x		
Cone Roof								
79. Roof deck (depressed areas)	x							
80. Indications of standing water on roof deck	x							
81. Deck plates (corrosion, pitting, holes, paint failure)	x							
Geodesic Dome								
82. Perimeter flashing (wind damage)	x							
83. Evidence of leaking panels (water spots on internal floater)	x							
84. Deterioration or crazing of skylight (caused by UV light)	x							
85. Panel caulking and rubber seals (entire roof)	x							
External Floating Roof								
86. Floating roof housekeeping (clean, free of rags and debris)					x			Standing water and band observed.
87. Corrosion, pitting, or cracked welds on floating roof						x		
88. Standing water or product on the floating roof deck					x			
89. Levelness of floating roof (visual observation)						x		
90. Water or product in the pontoon compartments				x				23 pontoons out of 40 with water.
91.Condition of floating roof ground connections and cables						x		

	Condition Codes (Mark X)							Comments
	0	1	2	3	4	5	9	
92. Mechanical shoes damaging shell or coating						x		
93.Comment when legs are pinned for high roof operation						x		
Internal Floating Roof								
94. Signs of product on the deck (may indicate loss of floatation)	x							
95. Binding with shell or columns	x							
96. Damage or slack in anti-rotational cable	x							
97. Missing roof support legs	x							
98. Damage to ladder or column wells and covers	x							
99. Comment when legs are pinned for high roof operation	x							
ROOF APPURTENANCES								
100. Manway covers secured in place and in good condition	x							Tank is out of service.
101. Pontoon covers secured in place and in good condition						x		
102. Weld conditions (corrosion, cracks, other defects)						x		
103. Open vents (clean and free of debris)						x		
104. Vacuum pressure vent pallet assembly seals (weathering)	x							
105. Vacuum pressure vent screens (clean and free of debris)	x							
106. Flame arrestor (mechanical integrity)	x							
107. Gauge hatch (clean, operates freely, seals properly)						x		
108. Drain return to tank at gauge hatch clear and operational	x							
109. Stenciled gauging data is legible	x							
110. Floating roof support legs (corrosion, pitting, bending)						x		
111. Roof leg sleeves and retaining pins (corrosion or bending)						x		
112. Roof leg cotter pins (corrosion, missing)						x		
113. Roof leg sleeve reinforcement pads (bending, cracking)						x		
114. All roof legs at the same level						x		
115. Emergency overflow screens clean and free of debris	x							
116. Roof drain sump clean and free of debris						x		
117. Corrosion damage to roof drain sump						x		
118. Weld failure on roof drain sump						x		
119. Roof drain check valve free of corrosion and debris						x		
120. Verify roof drain check valve operates freely	x							
121. Roof drain hose leaking (check by cracking drain valve)						x		
122. Anti-rotational guiding devices (corrosion, wear, aligned)						x		
123. Anti-rotational guiding devices (loose connections, slack)						x		

ADDITIONAL COMMENTS
(Comments are required for condition codes marked X in the shaded areas and must refer to a specific inspection item.)

		Condition Codes (Mark X)							Comments
		0	1	2	3	4	5	9	
ADDITIONAL COMMENTS (cont.) ***(Comments are required for condition codes marked X in the shaded areas and must refer to a specific inspection item.)***									

		Condition Codes (Mark X)							Comments
		0	1	2	3	4	5	9	
ADDITIONAL COMMENTS (cont.) ***(Comments are required for condition codes marked X in the shaded areas and must refer to a specific inspection item.)***									

		Condition Codes (Mark X)							Comments
		0	1	2	3	4	5	9	

SHELL LAYOUT

Instructions

1) Show Stairway and Appurtenances 2) Show Pitting Corrosion, and Paint Failure 3) Show Shell Deformation (Bulging, Peaking, etc.)

N	W	S	E	N
				C10
				C09
				C08
				C07
				C06
				C05
				C04
				C03
				C02
				C01

← Measured Circumference _____ Ft _____ In →

Appurtenances

1. Manway	4. Low Suction Nozzle	7. Jet Nozzle	10. Steam Coil Inlet	13. Miscellaneous Nozzle	16. Foam Chamber	19. Radial or Vertical Ladder
2. Fill Nozzle	5. Swing Line Suction Nozzle	8. Water Draw Nozzle	11. Condensate Outlet	14. Spiral Stairway	17. Overflow Nozzle	20. Other _____
3. Suction Nozzle	6. Mixer Nozzle	9. Transfer/Recirculating Nozzle	12. Air Spider Nozzle	15. Windgirder	18. Thermowell	21. Other ___

TANK NO.	LOCATION	TANK DIAMETER	TANK HEIGHT
2	St. James, LA	300.00 (FT.)	36.42 (FT.)

ROOF

INSTRUCTIONS

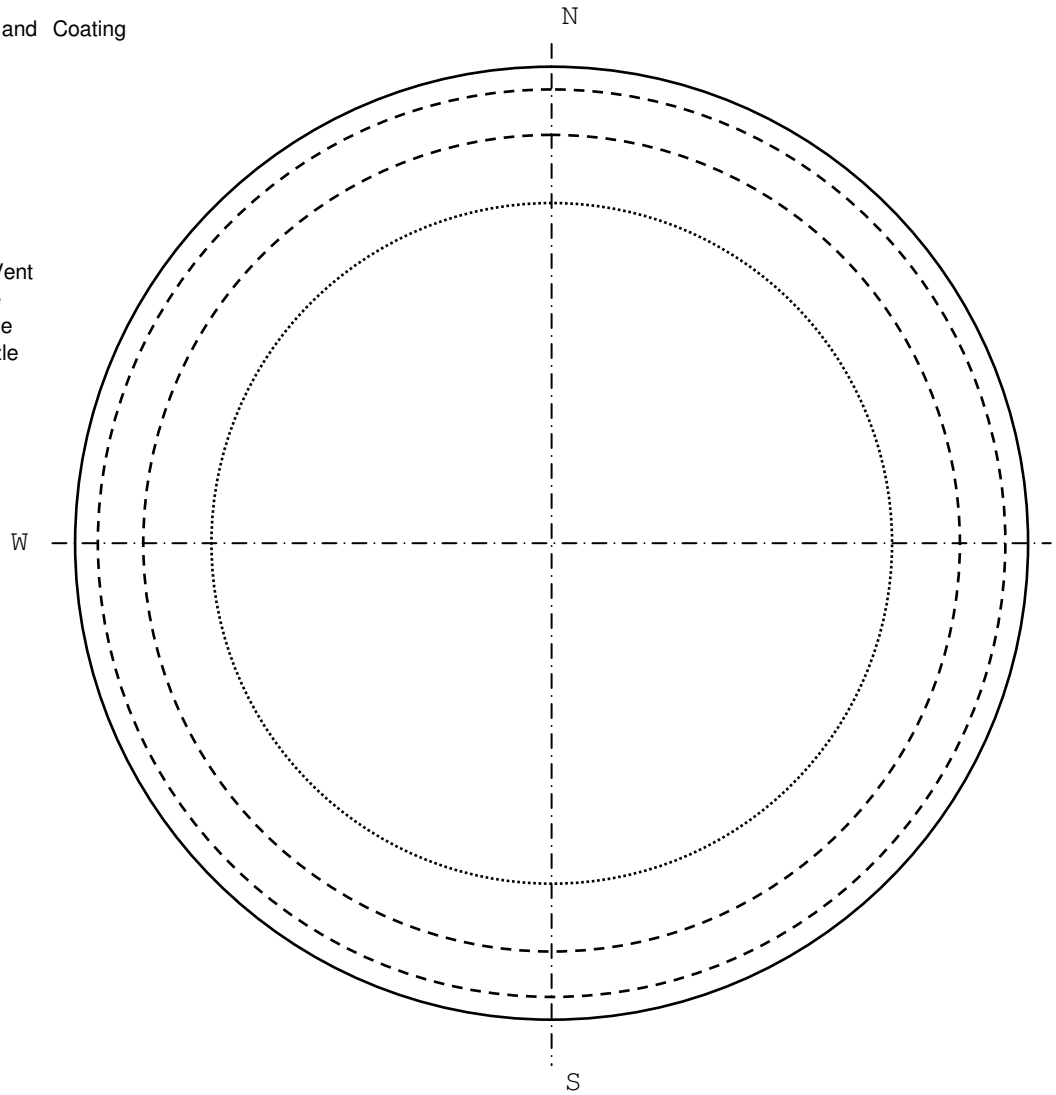
Show Stairway and Appurtenances
Show Plate Layout
Show UT Readings
Show Pitting, Corrosion, and Coating Failure

APPURTENANCES

A. Manway
B. Internal Roof Access
C. Vent Nozzle
D. Gauge Hatch Nozzle
E. Vacuum Vent
F. Emergency Overflow Vent
G. Gas Blanketing Nozzle
H. Overhead Vapor Nozzle
I. High Level Alarm Nozzle
J. Air Circulation Hood
K. Conservation Vent
L. Rolling Ladder
M. Automatic Bleeder Vent
N. Gauge Well
O. Roof Drain
P. Rim Vent
Q. Other
R. Other
S. Other

Column: .....

Pontoons----------



FACILITY		TANK NO. 2
☐ Internal Roof ☐ External Roof	SPECIFIED PLATE THICKNESS	
TANK INTEGRITY ASSESSOR		DATE

ROOF THICKNESS DATA SHEET

BASELINE INFORMATION				DATE:		CURRENT READING DATA:		
Point	Design Thickness	First Reading	Last Reading	Date Last Reading	Minimum Thickness	Remarks And Recommendations	Current Reading	Additional Reading
		.	.	/ /	.		.	.
		.	.	/ /	.		.	.
		.	.	/ /	.		.	.
		.	.	/ /	.		.	.
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		.	.	/ /	.		.	.
		.	.	/ /	.		.	.

SHELL PERIMETER SETTLEMENT DATA

Visual – Does the tank exhibit any indications of settlement?

☒ No Defer settlement survey to out-of-service inspection.

☐ Yes Explain and attach out-of-plane settlement evaluation.

SURVEY INFORMATION

SURVEY COMPANY

DATE

SURVEY POINT SEPARATION (must be uniform to within 25 mm (1 inch)

Note 1: Number of Survey Points shall be an even number.

Note 3: If Out-of-Plane settlement (differential Settlement) is known or suspected, the spacing between perimeter points shall be half of the API 653 requirement, i.e. 16 feet maximum spacing instead of the API 653 spacing of 32 feet maximum.

DESCRIPTION OF TANK MARKING (survey points):

DESCRIPTION & LOCATION OF SITE BENCHMARK

ELEVATION OF BENCHMARK (actual or assumed)

SURVEY CLOSED TO ±.02 FEET (If not, the tank must be re-surveyed)
☐ Yes ☐ No

DESCRIPTION OF SURVEY TECHNIQUES & ADDITIONAL COMMENTS

SURVEY POINT ELEVATIONS

Point No. (Minimum 8 Required)	Elevation (to ± 0.01)	Point No.	Elevation (to ± 0.01)
1.		21.	
2.		22.	
3.		23.	
4.		24.	
5.		25.	
6.		26.	
7.		27.	
8.		28.	
9		29.	
10.		30.	
11.		31.	
12.		32.	
13.		33.	
14.		34.	
15.		35.	
16.		36.	
17.		37.	
18.		38.	
19.		39.	
20.		40.	

A. SUMMARY/OVERVIEW OF INSPECTION
(Note: Overview is the condition of the tank overall and may not be specific to any particular inspection item.)

B. REPAIR RECOMMENDATIONS - (PRIOR TO RETURN TO SERVICE)

Tank is suitable for continued service ☐ Yes, without repairs ☐ Yes, with the following repairs: ☐ No

C. RECOMMENDATION FOR NEXT EXTERNAL "IN-SERVICE" INSPECTION			
Next Service Interval	Years	Months	Next External Inspection (mm/dd/yy)
The next external inspection is recommended based on completion of the above repairs and the following considerations:			
Shell corrosion rate (describe)			

D. CONSIDER THE FOLLOWING REPAIRS AT NEXT "IN-SERVICE" OPPORTUNITY (Normally within 6 months)

E. CONSIDER THE FOLLOWING REPAIRS AT NEXT "OUT-OF-SERVICE" INSPECTION
Remove water from pontoons and identify the source of leaks.

F. ITEMS FOR FOLLOW-UP OBSERVATIONS

SITE REPORT SUMMARY TO	TITLE
PHONE NO. ( )	DATE
TANK INTEGRITY ASSESSOR	API CERT #
COMPANY & ADDRESS	PHONE NO.

	( )

Appendix B – Ultrasonic Thickness Measurements of the Tank Shell (T-173)

TANK INFORMATION			
SYSTEM NAME (SAP Level 1)	TANK LOCATION (SAP Level 2) St. James, LA	TANK NO. 2	REGION

Shell Layout

Instructions

1) Show Stairway and Appurtenances 2) Show UT Readings 3) Show Pitting Corrosion

Design Plate Thickness	N	W	S	E	N	Measured Heights from Bottom
_____					C10	_____ Ft
_____					C09	_____ Ft
_____					C08	_____ Ft
_____					C07	_____ Ft
_____					C06	_____ Ft
_____					C05	_____ Ft
_____					C04	_____ Ft
_____					C03	_____ Ft
_____					C02	_____ Ft
_____					C01	0.00 Ft

← Measured Circumference _____ Ft _____ In →

Appurtenances

1. Manway 2. Fill Nozzle 3. Suction Nozzle 4. Spiral Stairway 5. Radial or Vertical Ladder

TANK DIAMETER	TANK HEIGHT	TANK CAPACITY	THICKNESS MEASURE TAKEN FROM	SPECIFICATION	TYPE OF STEEL/COURSE
300.00 (FT.)	36.42 (FT.)	(bbl)	☐ Internal ☐ External		

TANK INTEGRITY ASSESSOR NAME	DATE

SHELL THICKNESS DATA SHEET

TANK NUMBER	LOCATION	DATE

BASELINE INFORMATION	DATE:	CURRENT READING DATA:

Point	Design Thickness	First Reading	Last Reading	Date Last Reading	Minimum Thickness	Remarks/Recommendations	Current Reading	Additional Reading
	.	.	.	/ /	.		.	.
	.	.	.	/ /	.		.	.
	.	.	.	/ /	.		.	.
	.	.	.	/ /	.		.	.
	.	.	.	/ /	.		.	.
	.	.	.	/ /	.		.	.
C 8 –T	.	.	.	/ /	.		.	.
C 8 –C	.	.	.	/ /	.		.	.
C 8 –B	.	.	.	/ /	.		.	.
C 7 –T	.	.	.	/ /	.		.	.
C 7 –C	.	.	.	/ /	.		.	.
C 7 –B	.	.	.	/ /	.		.	.
C 6 –T	.	.	.	/ /	.		.	.
C 6 –C	.	.	.	/ /	.		.	.
C 6 –B	.	.	.	/ /	.		.	.
C 5 –T	.	.	.	/ /	.		.	.
C 5 –C	.	.	.	/ /	.		.	.
C 5 –B	.	.	.	/ /	.		.	.
C 4 –T	.	.	.	/ /	.		.	.
C 4 –C	.	.	.	/ /	.		.	.
C 4 –B	.	.	.	/ /	.		.	.
C 3 –T	.	.	.	/ /	.		.	.
C 3 –C	.	.	.	/ /	.		.	.
C 3 –B	.	.	.	/ /	.		.	.
C 2 –T	.	.	.	/ /	.		.	.
C 2 –C	.	.	.	/ /	.		.	.
C 2 –B	.	.	.	/ /	.		.	.
C 1 –T	.	.	.	/ /	.		.	.
C 1 –C	.	.	.	/ /	.		.	.
C 1 –B	.	.	.	/ /	.		.	.

Tank Integrity Assessor: _____

Key: C 1 thru C 8 = Course 1 thru Course 8 (add as necessary), B = Bottom, C = Center, T = Top

MAXIMUM FILL-HEIGHT WORK SHEET USING THE "ONE FOOT" METHOD

TANK NUMBER	LOCATION	DATE

The formula below applies to tanks with diameters less than or equal to 200 feet.

For tanks greater than 200 ft. diameter, use the variable-point method.

$$t = \frac{2.6D(H-1)G}{SE}$$

$$HC = 1 + \frac{tSE}{2.6DG}$$

D - Nominal diameter of tank, in feet.
T - Measured shell thickness, in inches.
H_R - Height from the tank floor to the bottom of that particular course, in feet.
S - Design stress based on original shell material, or default value, in psi.
E - Design joint efficiency; see API 653.
G - Specific gravity of liquid (e.g. water = 1.0).
H_C - Calculated maximum fill height for that particular course, in feet. See equation above.
MFH - Add columns 3 and 7, $H_R + H_C$ = MFH.

Current MFH – Smaller of actual shell height or height to bottom of overflow.

The Tank Maximum Fill Height for the specified liquid will be the minimum value of all MFH numbers in column 8, or the Current MFH, whichever is smaller.

NOTE: The arithmetic in the table below will be simplified if all dimensions in feet and inches are converted to feet in whole numbers and decimal form, e.g. 17'4-1/8" = 17.344 ft.

1	2	3	4	5	6	7	8
Course	Measured Shell Thickness **t**	Relative Storage Height **H_R**	Allowable Stress **S**	Joint Efficiency **E**	Liquid Specific Gravity **G**	Calculated Relative Max Fill Ht. **H_C**	AdjustedMax Fill Ht. **MFH**
C10							
C9							
C8							
C7							
C6							
C5							
C4							
C3							
C2							
C1							

TANK INTEGRITY ASSESSOR NAME	DATE

Appendix C - Internal Inspection Checklist (T-171)

TANK INFORMATION

SYSTEM NAME SAP Level 1)	TANK LOCATION SAP Level 2)	REGION

INSPECTION DATA

TANK NO. 2	LOCATION St. James	SERVICE PRODUCT Crude Oil
MANUFACTURER Graver Tank & Mfg.		DATE CONSTRUCTED 1979
TANK DIA 300.00 ft.	HEIGHT 36.42 ft.	NOMINAL CAPACITY 418,707 bbls.
TODAY'S DATE 7/19/2014		LAST OUT-OF-SERVICE INSPECTION

ROOF TYPE
☐ **Fixed Cone** ☐ **Geodesic Dome** ☒ **External Floater** ☐ **Internal Steel Floater** ☐ **Internal Aluminum Floater**

SHELL
☐ **Riveted** ☒ **Welded** ☐ **Bolted**

BOTTOM
☐ **Riveted** ☒ **Welded** ☐ **Coated: Thickness**

FOUNDATION
☒ **Concrete Ring** ☐ **Earthen Pad** ☐ **Shell** ☐ **Other**

INSTRUCTIONS

1. Mark X under the Condition code on the checklist that best fits the condition of the item being inspected.
2. Black squares indicate the Condition Code is not available for that inspection item.
3. Shaded squares indicate a condition that requires additional evaluation or repair.
4. Comments are required for all conditions marked X in shaded squares. When necessary, extend comments to pages 4 and 5 on the form.
5. Further instructions and guidelines are in other sections of this manual.

CONDITION CODES

Code 0 Not Applicable
Code 1 Condition warrants immediate action or verbal communication. Possible equipment shutdown.
Code 2 Condition requires repairs be scheduled for the soonest possible time.
Code 3 Condition requires scheduled repairs and possible further investigation and/or inspection.
Code 4 Condition requires minor maintenance repairs.
Code 5 No damage or failures noted.
Code 9 Used only to report items not covered in the procedure that may affect system performance.

SAFETY

			Acceptable (Mark X)		Comments (required if not acceptable)
			Yes	No	
1. Tank is gas free			x		
Oxygen	(19.5% to 23.5%)	%	20.8		
% LEL	(10% maximum)	%	0		
H2S	(10 ppm maximum)	ppm	0		
2. Tank totally isolated (product, electrical, steam)			x		
3. Structural and mechanical integrity of the tank (internal)			x		
4. Roof support adequate for safe entry			x		

TANK BOTTOM

	Condition Codes (Mark X)							Comments
	0	1	2	3	4	5	9	
5. Oil or scale buildup on bottom (additional cleaning required)						x		
6. Visual inspection of bottom—overall condition						x		
7. Bottom plate thickness (UT) meet minimum requirements, incl. sump						x		
8. Tightness of bolts or rivets on bottom seams	x							
9. Indication of hydrocarbon under floor where coupons are cut in bottom	x							
10. Cracking, spalling, or cavities in concrete bottom						x		
11. Condition of concrete bottom seal ring mastic top coat					x			Deteriorated
12. Condition of oakum caulk (concrete bottom edge seal)	x							
13. Bulges, depressions (see API 653 Annex B)						x		
14. Edge settlement (see API 653 Annex B)						x		
15. Reinforcement pads under all clips, brackets, and supports						x		
16. Floating roof leg support pads (pitting, cutting, dimpling)				x				Severely corroded
17. Fixed roof column base pads (corrosion, weld failure)	x							

TANK INFORMATION		
SYSTEM NAME SAP Level 1)	TANK LOCATION SAP Level 2)	REGION
18. Fixed roof column base restraining clips (hold column base)	x	

	Condition Codes (Mark X)							Comments
	0	1	2	3	4	5	9	
SHELL APPURTENANCES								
19. Swing line cable (cutting or dragging on bottom plates)	x							
20. Protective coating (holes, disbonding, deterioration)						x		
21. Tank wall (Note bottom 2-4 inches of shell) (corrosion, pitting)						x		
22. Floor and chime weld seams (corrosion, pitting, undercutting)				x				Numerous Weld Defects
23. Rivets (corrosion, pitting, or looseness)	x							
24. Potential leaks (note seams and shell-to-bottom joints)						x		
25. Indications of vertical grooving from seal assembly protrusions						x		
26. Indications of rubbing by seals						x		
27. Tank mixer shaft and propeller (erosion, corrosion)	x							
28. Tank mixer shaft and propeller (alignment, loose connection)	x							
29. Internal piping and connections (corrosion, cracking)						x		
30. Piping supports and pads (structurally adequate, weld failure)				x				Four (4) piping supports detached (roof sump)
31. Piping moves freely along support (no tearing on bottom plate)						x		
32. Shell nozzles (internal thinning)						x		
33. Hot tap nozzles (holes properly trimmed and backwelded)	x							
34. Nozzle valves (packing leaks)	x							
35. Wear plate under elbow-down fill nozzles (erosion, corrosion)						x		
36. Impact area above elbow-up fill nozzles (erosion, distortion)	x							
37. Swing line flex joints (supports for joints over 6 inches)	x							
38. Swing line pipe (deep pitting, weld corrosion)	x							
39. Swing line pull-down cable (damage, looseness)	x							
40. Swing line safety hold-down chains (corrosion, weak links)	x							
41. Manway heater racks (weld failure, bent slides)	x							
42. Comment about any ungrounded, loose or floating objects inside the tank for removal, e.g. loose gauge floats, sample cans, etc. (API 2003 - spark promoters)	x							
TANK ROOF								
Cone Roof								
43. Holes or scale buildup on underside of roof	x							
44. Reinforcement pads, clips, braces (welds to roof)	x							
45. Condition of protective coating on roof underside	x							
46. Support columns (corrosion, pitting, weld failure)	x							
47. Support column bases and restraining clips (weld failure)	x							
48. Pipe columns have adequate drains (unless cement-filled)	x							
49. Condition of roof rafters and girders (loose, twisted, thinning)	x							
50. Roof-mounted swing line bumpers	x							
Geodesic Dome								
51. Perimeter flashing (wind damage)	x							
52. Evidence of leaking panels (water spots on internal floater)	x							
53. Deterioration or crazing of skylight (caused by UV light)	x							
54. Panel caulking and rubber seals (entire roof)	x							
External Floating Roof								
55. Condition of deck plate (weld seams)						x		
56. Thickness readings of outer rim plate satisfactory (pontoons)	x							
57. Indications of liquid leakage in pontoons				x				23 Pontoons noted with water inside.
58. Condition of pontoons (liquid tight, vapor tight)						x		
59. Condition of roof legs (vertical, bending, thinning, buckling)						x		
60. Condition of roof leg sleeves (cracking, thinning, buckling)						x		
61. Condition of roof sleeve reinforcement pads (cracking, buckling)						x		
62. Thinning, bending or weld failure of seal assembly attachments						x		

	Condition Codes (Mark X)							Comments
	0	1	2	3	4	5	9	
63. Thinning of clips welded to roof rim						x		
64. Clearance over shell nozzles, mixers, etc. (modifications)						x		

	Condition Codes (Mark X)							Comments
	0	1	2	3	4	5	9	
65. Condition of shoes (holes, thinning, other damage)						x		
66. Condition of primary seal fabric (holes, tears, stiffening, etc.)				x				Hanger plates corroded
67. Condition of rim-mounted bolting bars (corrosion, weld failure)						x		
68. Openings in seals that will let light through						x		
69. Condition of secondary seal fabric (stiffness, etc.)						x		
70. Clearance from obstruction above the top of the shell						x		
71. Condition of grounding cables at bottom and top of rolling ladder (API 2003). Comment if non-existent or repairs needed.						x		
72. Condition of grounding shunts from floating roof to shell (API 2003). Comment if non-existent or repairs needed.						x		
Internal Floating Roof								
73. Signs of product on deck (may indicate loss of floatation)	x							
74. Binding with shell or columns	x							
75. Damage or slack in anti-rotational cable	x							
76. Missing roof support legs	x							
77. Rim-seal damage	x							
78. Damage to ladder or column wells and covers	x							
79. Effects of mixer operation on roof deck	x							
80. Condition of grounding cables (or shunts) from internal floating roof to cone roof, shell or bottom (API 2003). Comment if non-existent or repairs needed.	x							
ROOF APPURTENANCES								
81. Roof cutout welds (corrosion, cracking)	x							
82. Roof cutout plates (thinning, pitting, erosion)	x							
83. Rim vents and screens (damage, cleanliness)	x							
84. Pressure and vacuum pallets (move freely)	x							
85. Pressure/vacuum vent reinforcement pads (corrosion, weld failure)	x							
86. Proper operation of automatic bleeder (open when roof on legs)				x				Only operates in low leg setting.
87. Condition of sump (thinning, pitting, weld failure)						x		
88. Condition of sump protective coating (topside)						x		
89. Condition of roof drain check valve						x		
90. Fixed drain pipe and flex joints (thinning, scale, plugging)	x							
91. Condition of flexible drain hose (cracks, kinks, deteriorating)						x		
92. Condition of drain hose snag protection shields						x		
93. Autogauge tape attachment to roof (if applicable)						x		
94. Autogauge float guide wires, and anchor (damage, wear, movement)						x		
95. Autogauge tape and tape cable (twisting, fraying)						x		
96. Floatwells in floating roof (corrosion, pitting, thinning)						x		
97. Autogauge tape attachment to float (loose, damaged)						x		
98. Fabric seals of tape and guide wires (deterioration)					x			
99. Bottom guide wire attachment clip permanently welded	x							
100. Autogauge board (legible, moves freely)						x		
101. Gauge pole supports welded to shell (not to bottom, weld failure). NOTE: Report gauge pole diameter and type (solid, slotted)						x		

	Condition Codes (Mark X)							Comments
	0	1	2	3	4	5	9	
102. Gaugewell cover (mechanical damage)						x		

	Condition Codes (Mark X)							Comments
	0	1	2	3	4	5	9	
103. Oil flow in slotted gauge pole (restricted i.e. S&W buildup)						x		
104. Datum plate seal welded to bottom						x		
105. Gauge pole guide in floating roof (pitting, thinning)						x		
106. Gauge pole guide rollers and slide plates (sticking)						x		
107. Vertical alignment of one fixed-roof inspection hatch and one floating roof hatch? (for future robotic inspection)	x							
108. Hatch cover seals (mechanical damage, cleanliness)						x		
109. Air diffusers and supports (damage, corrosion, unusual conditions)	x							
110. Sufficient number of hatches in the fixed roof for internal floating roof seal inspections? Recommended maximum distance between inspection hatches is 75 ft.	x							

ADDITIONAL COMMENTS
(Comments are required for condition codes marked X in the shaded areas and must refer to a specific inspection item.)

ADDITIONAL COMMENTS **(Comments are required for condition codes marked X in the shaded areas and must refer to a specific inspection item.)**	

ADDITIONAL COMMENTS
(Comments are required for condition codes marked X in the shaded areas and must refer to a specific inspection item.)

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BOTTOM APPURTENANCES

INSTRUCTIONS
Show Plate Alignment

Show UT Readings

Show Pitting, Corrosion, and Coating Failure

Show Bulges and Depressions

APPURTENANCES

Piping

Pipe Supports

Autogauge Attachments

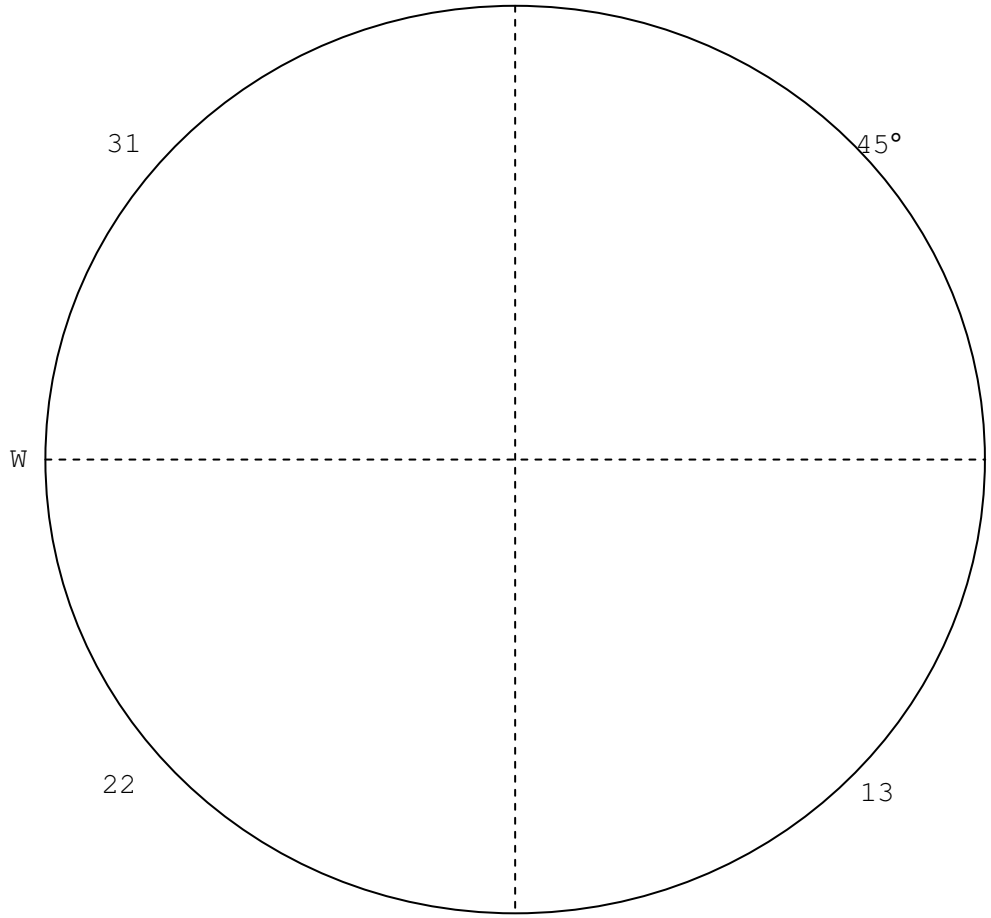
Reinforcement Pads

Wear Plates

Other _____

Other _____

Other _____



FACILITY	TANK NO.	ROOF TYPE
SPECIFIED PLATE		

TANK INTEGRITY ASSESSOR	DATE

BOTTOM PLATE LAYOUT AND THICKNESS READINGS

Normally, the MFE inspection company will furnish a CAD drawing showing the bottom layout and the location of areas of underside or topside corrosion.

INSTRUCTIONS
Show Plate Alignment

Show UT Readings

Show Pitting, Corrosion, and Coating Failure

Show Bulges and Depressions

APPURTENANCES

Piping

Pipe Supports

Autogauge Attachments

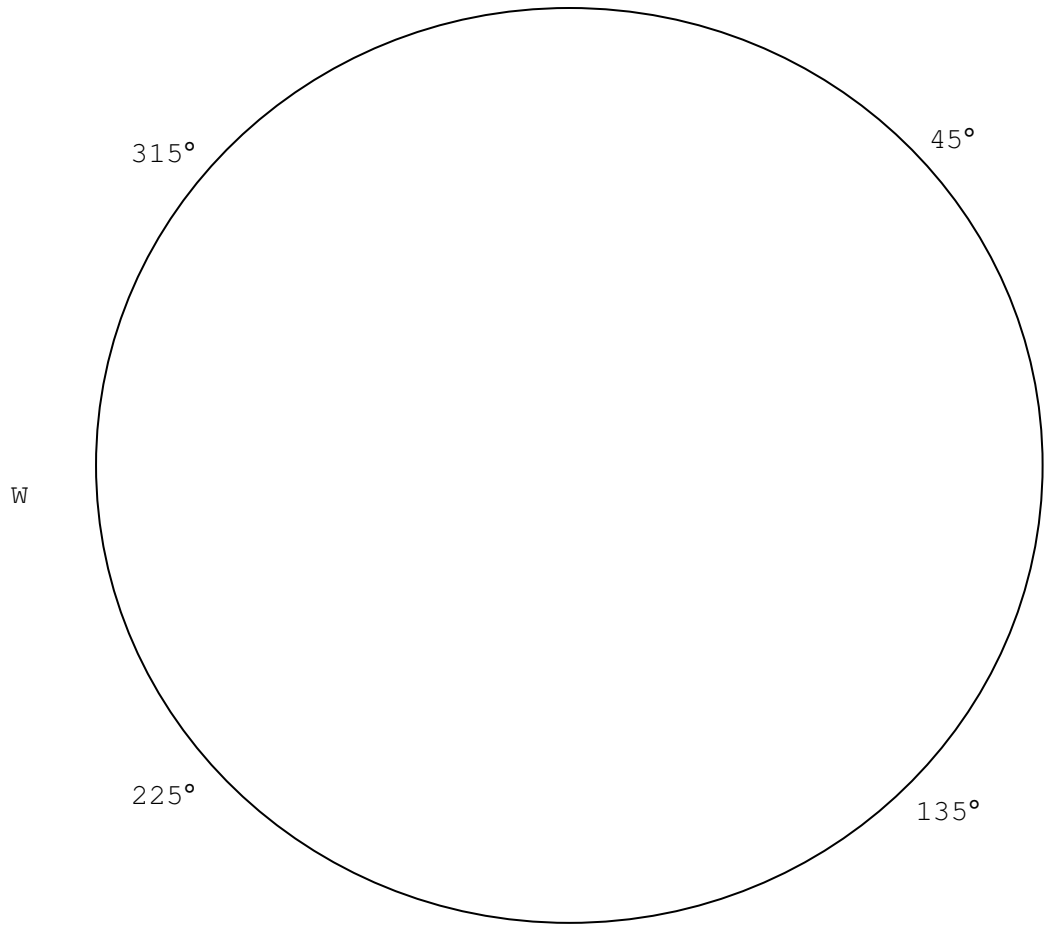
Reinforcement Pads

Wear Plates

Other _____

Other _____

Other _____



FACILITY	TANK NO.	ROOF TYPE
SPECIFIED PLATE THICKNESS		

TANK INTEGRITY ASSESSOR	DATE

BOTTOM SETTLEMENT DATA SHEET

INSTRUCTIONS

Note areas of Bottom Settlement on the Bottom Appurtenances diagram on page 6 of this report

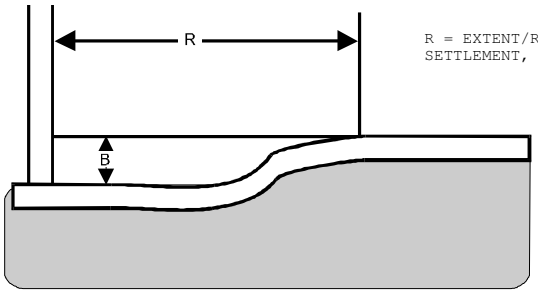
Record critical measurements for each area of Bottom Settlement in the table below.

AREA NO.	SETTLEMENT TYPE (see below)	CRITICAL PARAMETERS (R, d in inches or D in feet)	DEPTH OF SETTLEMENT B (inches)	LESS THAN API 653 ALLOWS?	COMMENTS (Inspection Results)

*Note: Additional inspection required if settlement is greater than API 653 allows

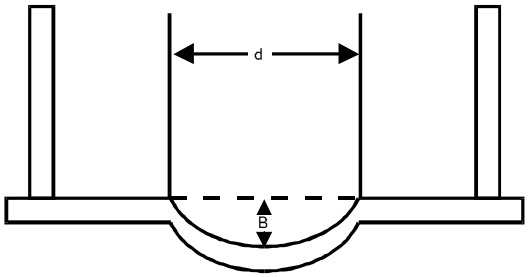
CRITICAL PARAMETER MEASUREMENT

TYPE I: EDGE



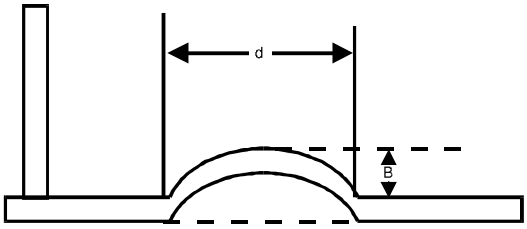
R = EXTENT/RADIUS OF EDGE SETTLEMENT, IN INCHES

TYPE II: DEPRESSION



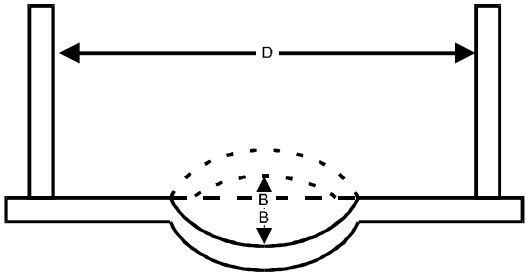
TYPE III: BULGE

d = DEPRESSION WIDTH/DIAMETER IN INCHES



TYPE IV: DISHED BOTTOM

D = TANK DIAMETER IN FEET



Tank Bottom Settlement Survey

ELEVATION AT CENTER of the TANK: _____ ft.

Tank No. _____ Location _____ Date _____

DIRECTIONS:

1. Determine the number of survey points around the shell of the tank, per API 653 paragraph. Select an even number of perimeter survey points.
2. Round up or down on the third decimal
3. It is a good practice to take each reading twice. Simply pick the rod up after the first reading, set it back down and read it again.
4. Customary practice is to take reading in feet and decimal hundredths of a foot, e.g. 2.42 ft or 2.47 ft.
5. Analysis of the survey data becomes easier if the survey is set up so that all the readings are either positive or negative, not a mix of both.

Survey Point around the Tank	Elevation at the Tank Shell	Elevations _____feet from the shell	Elevations _____feet from the shell	Elevations _____feet from the shell	Elevations _____feet from the shell	Elevations _____feet from the shell	Elevations _____feet from the shell	Elevations _____feet from the shell	Elevations _____feet from the shell	Elevations _____feet from the shell
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										

° Tank Bottom Settlement Survey - Page 2

Tank No. _____ Location _____ Date _____

Survey Point around the tank	Elevation at the Tank Shell	Elevations _____feet from the shell	Elevations _____feet from the shell	Elevations _____feet from the shell	Elevations _____feet from the shell	Elevations _____feet from the shell	Elevations _____feet from the shell	Elevations _____feet from the shell	Elevations _____feet from the shell	Elevations _____feet from the shell
14										
15										
16										
17										
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19										
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29										
30										

P. SUMMARY / OVERVIEW of the INSPECTION (Overall condition of the tank)
Numerous areas of product side corrosion found.
Thirty-six (36) holes fond on tank bottom.
Coating failure
Weld defects found on lap welds.
Top side pitting (0.450 in.) depth found on sump.
Q. REPAIR RECOMMENDATIONS (Prior to return to service)
Tank is suitable for continued service ☐ Yes, without repairs ☒ Yes, with the following repairs: ☐ No
Repair the product side corrosion areas.
Repair the weld defects found on the lap welds and on the external shell-to-bottom weld.
Repair the top side pitting on the sump bottom (bottom sump).
Apply coating on bottom plates.
Repair the floating roof leg striker plates.
Repair the pontoons (find the leak sources).
Replace primary seal.
Repair piping supports (internal piping for auxiliary roof sump.)
R. Recommended Next Internal Out-of-Service Inspection
The next internal inspection is based on the above repairs and the following corrosion rate calculations:
Next Service Interval 20 Years Months

Next Internal Inspection	20	(mm/dd/yy)

S. Consider the following repairs at the next "In-Service" opportunity (normally within six months)

T. Consider the following repairs at the next "Out-of-Service" inspection

U. Items for follow-up observation

SITE REPORT SUMMARY TO	TITLE
PHONE NO. ( )	DATE
TANK INTEGRITY ASSESSOR	API CERT #
COMPANY & ADDRESS	PHONE NO. ( )

Appendix D – Tank Inspection Data Sheet

TSXXX Tank
Inspection Data Shee