

**API 653
Inspection Report**

**Internal Inspection and
Out-of-Service
or
Internal Inspection
w/ External Checklist**

Report Prepared For
**U.S. CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD
FREEDOM INDUSTRIES**

CHARLESTON, WV

4-METHYLCYCLOHEXANEMETHANOL (MCHM)

Tank Number
396

Inspected on
APRIL 29 – MAY 1, 2014

Report Prepared By

POWERS

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Inspection History

Constructed	Re-Erect	Second Bottom	External Inspection	Internal Inspection	Shell UT Inspection
1940?	N/A	N/A	5/1/2014	5/1/2014	5/1/2014

Next Inspection:

N/A	N/A	N/A
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Revisions

Rev. 0	6/12/2014	Initial Report
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Tank 396**EXECUTIVE SUMMARY**

Powers Engineering and Inspection, Inc. was contracted by the U.S. Chemical Safety and Hazard Investigation Board Inc. to provide API 653 Internal Inspection services for Tank 396 at the Freedom Industries Facility in Charleston, WV.

Tank 396 was most likely constructed during the 1940s. The tank is 20-ft diameter x 20-ft tall and has a lap-riveted shell, cone roof, and a 1/4-in lap-welded bottom. It is the inspector's opinion that the existing lap welded bottom is at least 25 years old and was installed to replace the original lap riveted bottom and riveted shell to chime angle.



The tank was recently in 4-methylcyclohexanemethanol (MCHM) service.

In January 2014 a leak was detected and the tank and its sister tanks 395 and 397 were removed from service.

After this inspection the tanks will be dismantled.

The report and executive summary are based on field inspection and evaluation in accordance with the API 653 Standard. Since these tanks are to be dismantled, no repair recommendations were provided to return the tank back to service.

If for some reason the tank is returned to service all the requirements of API 650 and 653 should be met.

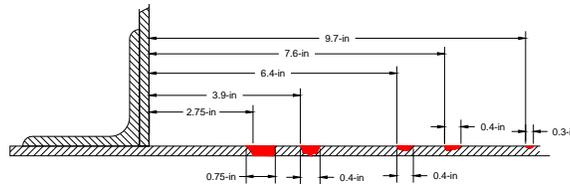
INSPECTION SUMMARY**1. Inspect the tank and identify any current leak paths resulting from corrosion, internal or external.**

- 1.1. During the last week of April 29th thru May 1, 2014 a large door sheet was cut in the 1st shell course and the bottom cleaned. In order to identify corrosion pitting, weld defects or other product side indications the surface of the bottom should be clean and dry. Unfortunately, during the week of the inspection, heavy rains caused the area surrounding the tank to flood resulting in wet muddy conditions in and around the tank. Leaks in the roof and tracking of mud and dirt into the tank resulted in poor visual inspection conditions. Despite these poor conditions, the hole in the bottom on plate 9 was easy to find, due to the infiltration of water from outside the tank thru the hole.



Muddy Conditions around the base of the tank and debris inside tank

- 1.2. **Product Side Visual Bottom Inspection:** At the time of the inspection a series of deep isolated product side pits were identified on bottom plate 9. A hole through the bottom from product side corrosion was present in the pit nearest the shell resulting in an active leak path. The edge of the ¾-in diameter hole is 2 ¾-in from the shell is located in the API 653 designated critical zone (3-in from shell of the inside edge of the shell, measured radially inward).
- 1.3. Product side Corrosion Rate: (loss/age of bottom = 0.25-in/25 years= 0.01 in/year)

**Hole on Bottom Plate 9**

- 1.4. A “Amoeboid” shaped deep product side area of pitting (possible indication of MIC – microbologically induced corrosion) was also found on bottom plate 9. This isolated area of pitting was approximately 2-in in diameter and resulted in a loss of 0.07-in as determined via pit gauging. Remaining thickness (0.25-0.07=0.18-in +/-)



- 1.5. **Soil Side Bottom Inspection:** The 0.250-in thick bottom was inspected for soil-side corrosion utilizing the MFE 2412 Mark II scanner. Extensive magnetic flux differential indications were recorded on every bottom plate. Some of these indications most likely result from soil side corrosion damage. Unfortunately, (in order to preserve the condition of the bottom as close to the conditions at the time of the product leakage) at the time the inspection the bottom was muddy and dirty. (see photo below)

Note: It is the inspector’s experience that it is unlikely that all the indications are from soil side corrosion damage. In addition to soil side corrosion the MFE 2412 scanner can indicate on ‘old weld-joints’, mechanical dents, bottom plate warp age, debris or dirty plates, and rough areas of corrosion scale or pitting loss. In order to properly classify and quantify these indications precisely, the bottom would need to have been sand blasted and immaculately clean.

**Bottom Conditions at Time of Inspection**

- 1.6. During the MFE 2412 bottom scan each significant MFE indication was marked on the bottom with "Mark-al® Paint stick".



**MFE Bottom Indication Marks
(Immediately after marking)**

- 1.7. The marks were quickly obscured by dirt and mud.

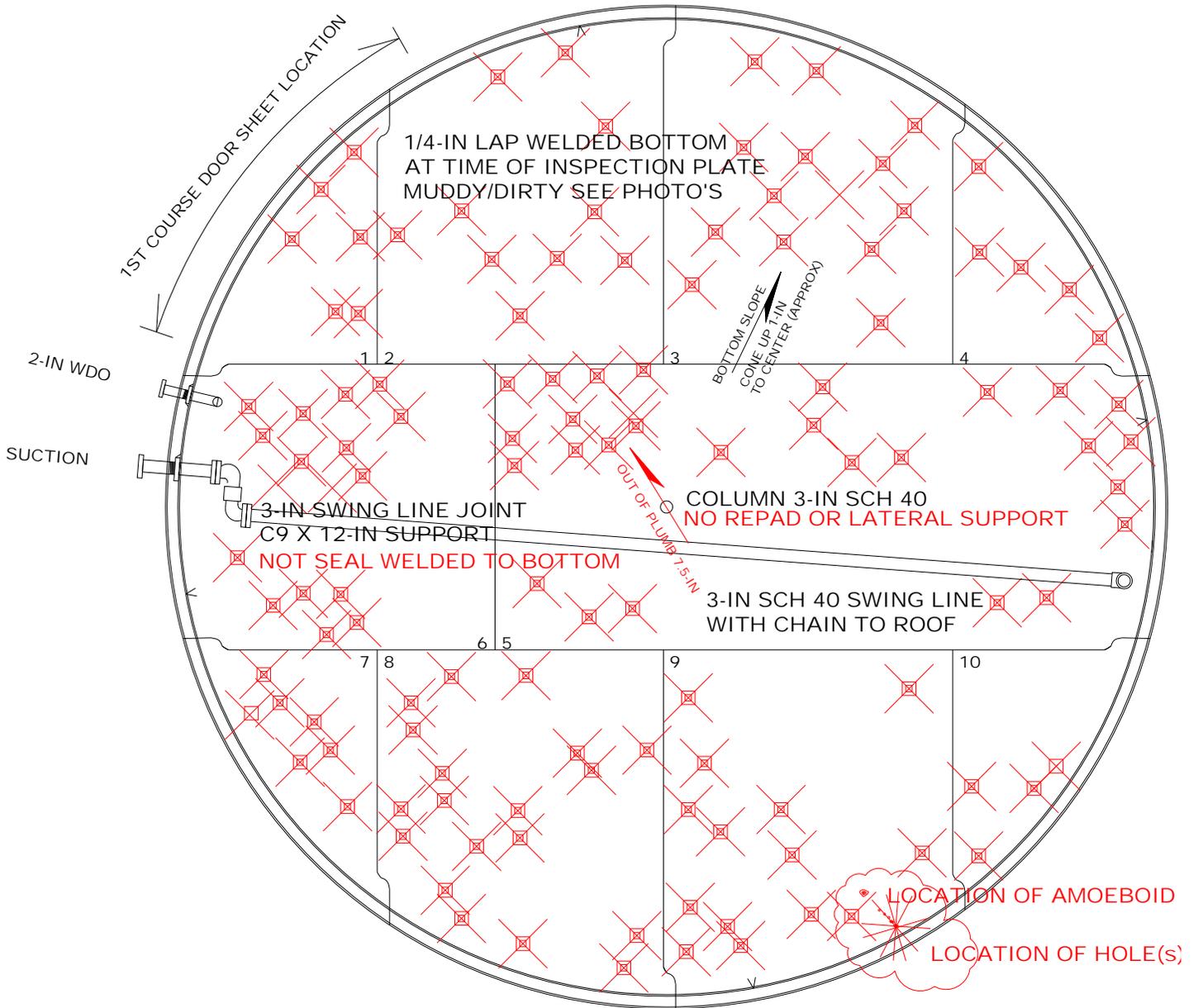


**MFE Bottom Indication Marks
(shortly after marking)**

- 1.8. Limited prove-up of the MFE indications resulted in remaining UT thickness of 0.18-in or a loss of 0.25-0.18=0.07-in). Note it is the inspector's opinion that the limited UT prove up did not identify the worst are of soil side corrosion. In order to conduct this type inspection at a minimum a full inspection blast of the bottom to remove all scale/dirt and debris would need to be conducted.

- 1.9. Soil side corrosion rate. 0.07-in loss/25 years age of bottom = 0.0028-in/year.

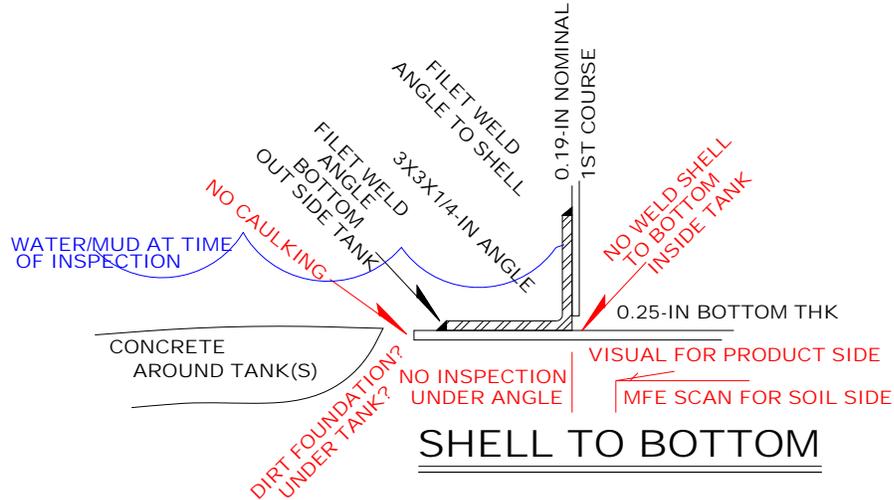
1.10. In the Bottom Corrosion Map the MFE indications are marked with red X's.



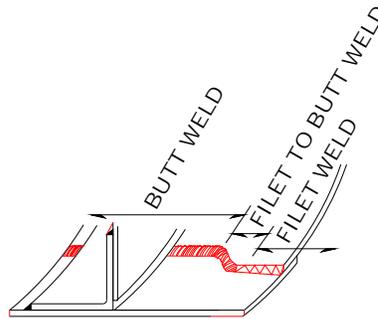
BOTTOM CORROSION MAP

2. Identify any risk of future leak paths resulting from corrosion, internal or external.

2.1. **There is a possibility that significant undetected bottom corrosion is present under non API 650 tank shell to bottom joint.** This joint is formed with a 3 x 3 x 1/4-in angle as illustrated. Note: Inspection of the bottom plate under the shell and extending outward is almost impossible short of excavating around the base of the tank and utilizing mirrors to view the bottom condition in this area.



2.2. **There may be existing cracks or weld defects in the existing bottom butt welds.** The lap welded bottom is 1/4-in nominal thick plate with an under the shell bottom breakdown detail (as illustrated) that transitions from a lap weld to a butt weld. This joint is susceptible to cracking and is located in the API 653 area of the bottom called the “Critical Zone” or CZ. Most of the CZ joint is obscured from inspection by the shell to bottom angle detail.

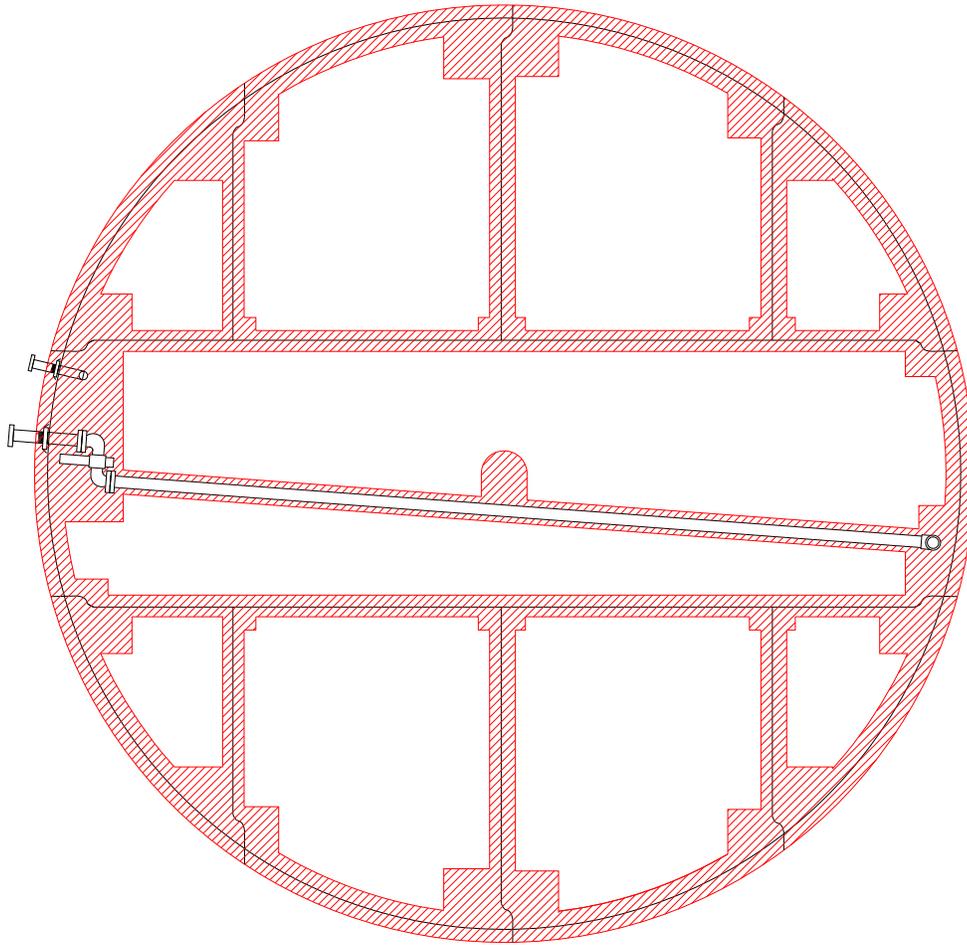


BREAK-DOWN DETAIL



Photo of typical lap weld to butt weld transition

- 2.3. **There may be significant soil side corrosion in the areas of the bottom difficult for access with the MFE 2412 scanner.** The MFE coverage was limited to approximately 75% of the bottom area and indicated in the next drawing. Under normal conditions the scanner coverage near the bottom to shell joint is plus or minus 1 to 2-in, at the square plate intersections plus or minus 4-in, around nozzles and swing lines plus or minus 3 to 12-in, and near the triangular corners of sketch plates plus or minus 6 to 12-in. In addition on this tank the shell to bottom detail eliminates from MFE coverage, the outer 4 inches of the bottom that extends under the shell.



MFE SCAN COVERAGE

- 2.4. These areas that were difficult to reach with the scanner (<2-in from the corner weld, tight angled bottom plates, under columns and base plates, around supports, and under low shell nozzles). If conditions were optimal Ultrasonic thickness testing or UT would be performed in these areas, however because of the rough and dirty bottom conditions, effective UT of these areas was not possible.

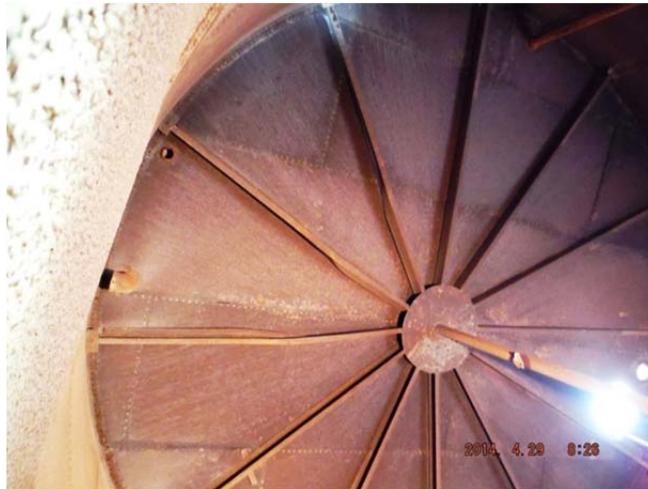
- 2.5. In addition to visual inspection the bottom lap welds are typically tested with a Vacuum Box, during an API 653 bottom inspection. Unfortunately the conditions did not allow for affective inspection by either method.



Typical Bottom Lap Weld

3. Identify any physical abnormalities to the shell, roof, access structure or appurtenances.

- 3.1. **Shell Settlement.** The maximum out-of-plane base of shell settlement was approximately 0.5-in, which is within acceptable limits of API 653 Appendix B calculations for differential settlement. See survey results.
- 3.2. **Shell Verticality.** The shell has some existing cosmetic dents and minor deformation. (see shell roll out drawing and photos)
- 3.3. **Access Structure.** The roof access is via a common catwalk servicing all 3 tanks. The vertical handrail support and connection to the catwalk is poorly designed allowing deflection of the handrail.
- 3.4. **Roof Support Rafters.** Several of the roof deck support rafters are damaged.



- 3.5. **Roof Support Column.** The roof support column is a pipe design and is susceptible to undetected internal corrosion damage.
- 3.6. **Column Base.** The base of the column does not appear to be restrained from lateral movement. A doubler plate or repad is not present underneath the column. There is a risk that an undetected leak path is present underneath the column.



Base of Column (no repad or lateral restraint present)

- 3.7. **Roof Venting.** The roof venting appears to be via a 3-in PVV vent flame arrestor. The condition of this vent was not determined at the time of the inspection.
- 3.8. **Coating Condition.** The shell and roof coatings were intact but aged. Some isolated areas of failure were noted.

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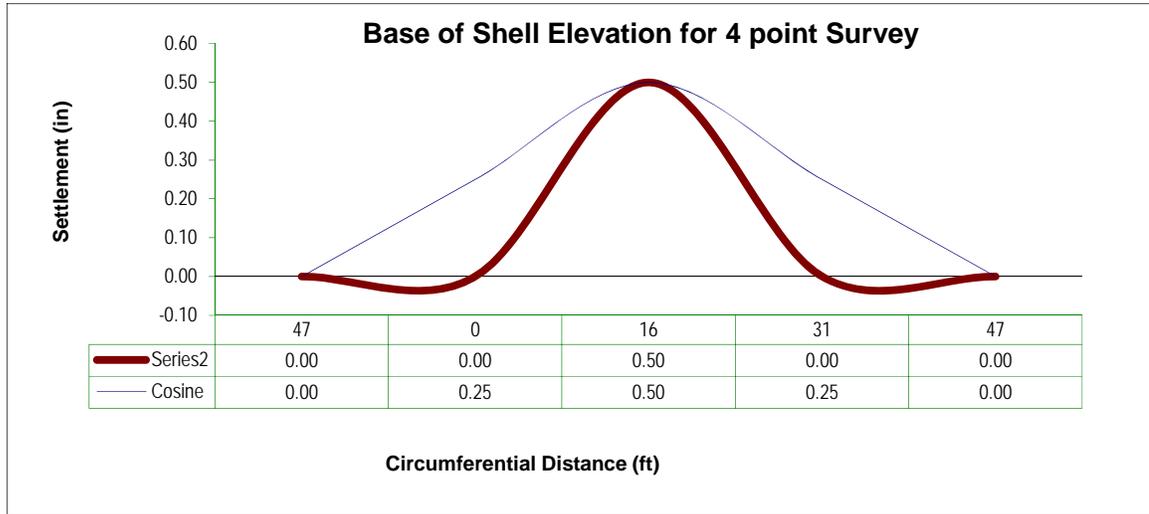
 Inspection Significant Photos

 Inspection General Photos

BASIC TANK INFORMATION

Tank Number: 396	Owner: FREEDOM INDUSTRIES	Location: CHARLESTON, WV	Unit/Zone/Area: TANK FARM
Product: 4- METHYLCYCLOHEXANE METHANOL (MCHM)	Diameter (ft): 20	Height (ft): 20	Capacity (bbls): 1,119 bbls.
Type Tank: RIVETED WITH FIXED CONE ROOF	Year Built: 1940s?	Design Standard: API 12C	Manufacturer: UNKNOWN
Type Shell: SINGLE LAP RIVETED	Type Roof: CONE ROOF LAP RIVETED	Type Foundation: SOIL FOUNDATION WITH COCRETE SKIRT AROUND SOME OF THE TANK AND MOST OF THE CONTAINEMENT AREA	Type Bottom: 1/4-IN LAP-WELDED
Roof Access: CATWALK	Floating Roof Access: N/A	Floating Roof Type: NONE	Roof Man ways: 20-IN MANWAY
Pumping Rate: --	Suction Line: 1:3-IN	Receipt: 1:3-IN	Shell Manways: 1:20-IN - REMOVED FOR DOOR SHEET AT TIME OF INSPECTION
Leak Detection: VISUAL	Secondary Containment: CONCRETE COVER OF DIKE IS MOST LIKELY NOT IMPERMIABLE	Cathodic Protection: NONE	Insulation: NONE
Shell Coatings: AGING BUT INTACT	Roof Coatings: AGING BUT INTACT	Bottom Coating: NONE	

SHELL SETTLEMENT SURVEY



- The settlement for the tank is planer or roughly approximates the shape of a cosine curve.
- The evaluation of this “out-of-levelness” or settlement, utilizing the criterion for “out-of-plane distortion” as described in API 653 Appendix B.3.2, indicates that the settlement is well within the acceptable limits.

Applicable Standards:

Shell settlement surveys were conducted in accordance with the requirements of API 653 Figure B-1. These surveys were evaluated in accordance with the API 653 Appendix B.2.2 and compared with the acceptance criteria outlined in API 653 Appendix B.3.2.

Note:

Calculation of maximum permissible \underline{S} or out-of-plane distortion per API 653 Appendix B.3.2 was made using:

Find: Shell Settlement API 653 4th edition Addendum 1 Appendix B Methodology

Given:	Tank Number	396	Circumference	62.8 (ft)
	Tank Diameter	20.0 (ft)	Req'd Stations	63 / 32 = 2 ref API 653 12.5.12
	Fit Cosine to Data	4	Actual Stations	4
	Spacing Between (ft)	15.7 L	< 32-ft OK	
	Allowable Stress (psi)	30,000 Y	Survey Max	0.042 (ft)
	Modulus of Elasticity (ksi)	29,000 E		0.5 (in)
	Tank Height (ft)	20.0 H	Curve Fit R^2	1.0000 Curve Fit OK
				R^2 >= 90%

Results:	Allowable	>	Actual	
Differential (ft)	0.070	>	0.021	Pass
(in)	0.842	>	0.250	

$$|S| \leq \frac{(L^2 \times Y \times 11)}{2[(E \times H)]}$$

SHELL THICKNESS CALCULATION

Shell Thickness Calculations per API 653 4.3.3.1

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Find: Minimum shell thickness (t min) for each shell course utilizing the API 653 standard for tanks less than 200 ft dia.

Given:

Variable Identifier	Description	Value	Reference
H	Fill height (ft)	20.00	Measured from the base of each shell course (see column H in the table below)
D	Tank Diameter (ft)	20.00	
G	Specific Gravity	0.96	
S	Allow stress (psi)	Varies	Reference API 653 Table 4-1
E	Joint Efficiency	Varies	Reference API 653 table 4.2 for Welded and 4.3 for Riveted construction
M	Temp Modifier	1.00	Reference API 650 Appendix M Elevated temperature modifier

Solution:

Table for Calculating minimum shell thickness (t min) for each shell course												
Course	H		Product Height Above Course (ft)	Type of Joint for each Course	E Joint Eff API 653 Tbl 4.2 and 4.3 %	Material Type or Unknown Welded or Riveted	S Maximum Allowable Stress (psi)	API 653 Required Calculation		Actual Req'd t min (in)	Minimum Thickness for Course (in)	Solution Actual Vs Req'd OK?
	Height of each Course							t min = $\frac{2.6 (H - 1) DG}{SEM}$	Req'd t min (in)			
	(in)	(ft)										
1	60.00	5	20.00	1 Lap Rivet	0.45	Riveted Unknown	41,999	$\frac{2.6 \times (20.00 - 1) \times 20.00 \times 0.96}{(41,999 \times 0.45 \times 1.00)}$	0.1000	0.1870	Ok	
2	60.00	5	15.00	1 Lap Rivet	0.45	Riveted Unknown	41,999	$\frac{2.6 \times (15.00 - 1) \times 20.00 \times 0.96}{(41,999 \times 0.45 \times 1.00)}$	0.1000	0.1560	Ok	
3	60.00	5	10.00	1 Lap Rivet	0.45	Riveted Unknown	46,209	$\frac{2.6 \times (10.00 - 1) \times 20.00 \times 0.96}{(46,209 \times 0.45 \times 1.00)}$	0.1000	0.1560	Ok	
4	60.00	5	5.00	1 Lap Rivet	0.45	Riveted Unknown	46,209	$\frac{2.6 \times (5.00 - 1) \times 20.00 \times 0.96}{(46,209 \times 0.45 \times 1.00)}$	0.1000	0.1560	Ok	

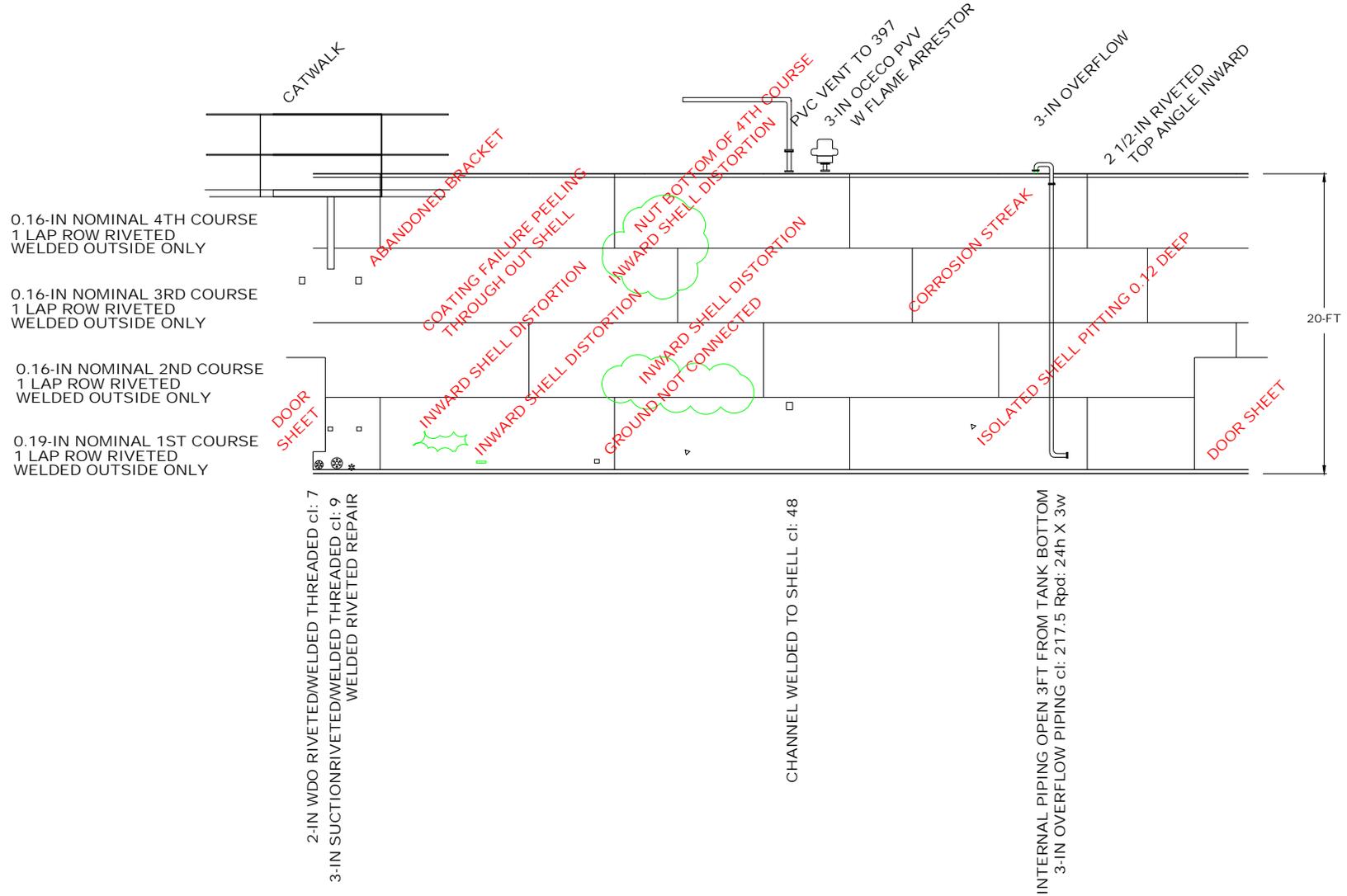
Shell Corrosion Rate Calculations API 653 6.3

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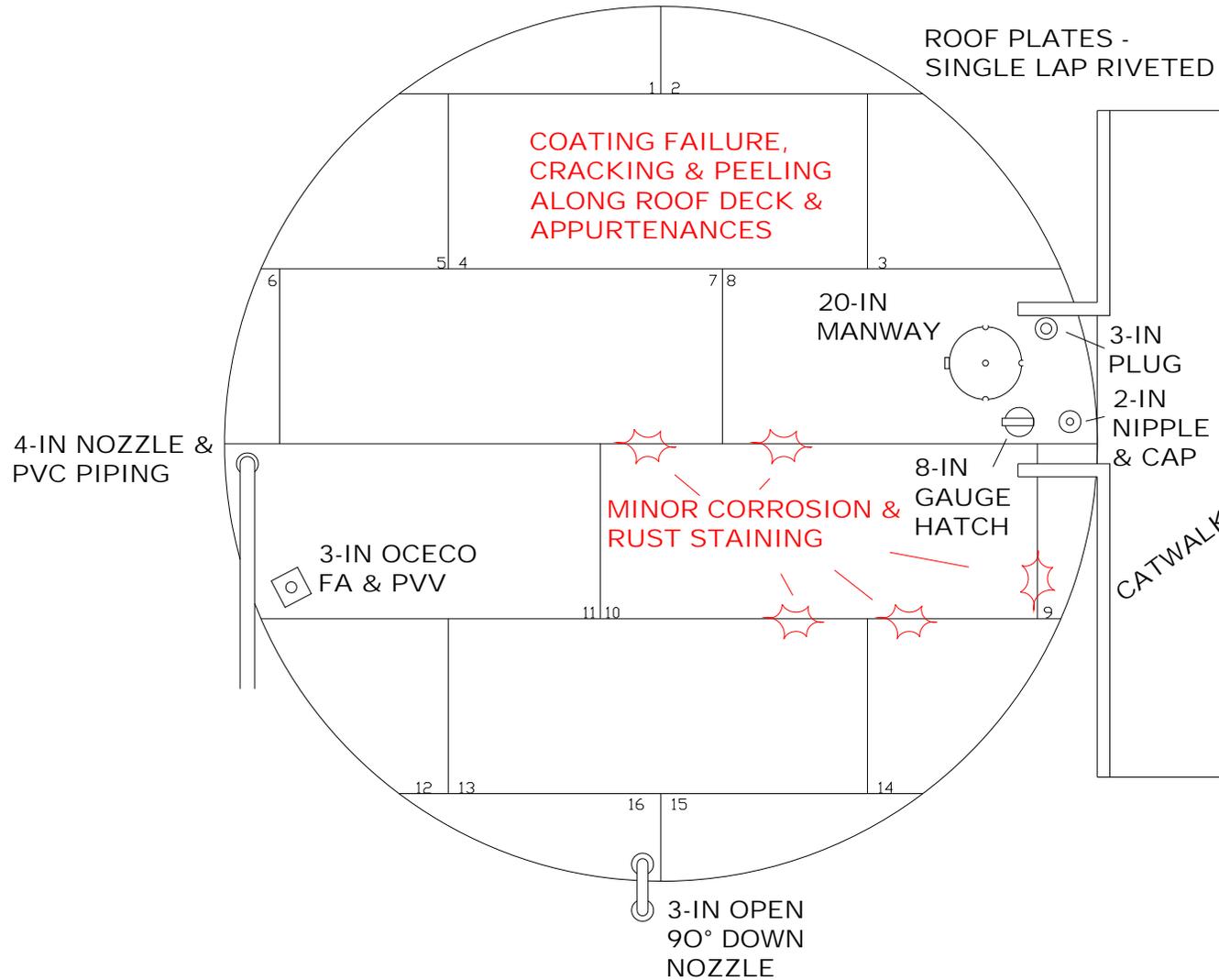
Course	Date(s)			As Built (in)	Current (in)	A (in)	B (in)	N (in/yr)	RCA (in)	RCA/4N Next External API 653 6.3.2 (yr)	RCA/2N Next UT Inspection API 653 6.3.3 (yr)				
	Inspection Year		Thickness									Corrosion Rate(s)			
	Prev	Current	Measured									Calculated			
	(yr)	(yr)	Prev									Current	t min	Previous	Current
	(yr)	(yr)	(in)									(in)	(in)	(in/yr)	(in/yr)
1	1940	2014	2014	0.188	0.188	0.187	0.100	0.00000	0.0000	0.0870	5	15			
2	1940	2014	2014	0.156	0.156	0.156	0.100	0.00000	0.0000	0.0560	5	15			
3	1940	2014	2014	0.156	0.156	0.156	0.100	0.00000	0.0000	0.0560	5	15			
4	1940	2014	2014	0.156	0.156	0.156	0.100	0.00000	0.0000	0.0560	5	15			
minimum:										0	0				

Tank 396

SHELL ROLLOUT VIEW



CONE ROOF LAYOUT



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API 653 Inspection Checklist

Freedom Industries

Tank: 396

Charleston, WV

APPENDIX A API 653 CHECKLIST

1.1 FOUNDATION

1.1.0 All

1	C.1.1	Measure foundation levelness and bottom elevations (see Appendix B for extent of measurements).	See Report 0.5-in overall out-of-level
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1.1.1 Concrete Ring

2	C.1.1.1.a	Inspect for broken concrete, spalling, and cracks, particularly under backup bars used in welding butt welded annular rings under the shell.	Foundation type undetermined.
3	C.1.1.1.b	Inspect drain openings in ring, back of waterdraw basins and top surface of ring for indications of bottom leakage.	N/A
4	C.1.1.1.c	Inspect for cavities under foundation and vegetation against bottom of tank.	Visually Acceptable
5	C.1.1.1.d	Check that runoff rainwater from the shell drains away from tank.	rain water drains towards base of shell and tank bottom
6	C.1.1.1.e	Check for settlement around perimeter of tank.	no obvious indications of settlement observed

1.1.2 Asphalt

7	C.1.1.2.a	Check for settling of tank into asphalt base which would direct runoff rain water under the tank instead of away from it.	N/A
8	C.1.1.2.b	Look for areas where leaching of oil has left rock filler exposed, which indicates hydrocarbon leakage.	N/A

1.1.3 Oiled Dirt or Sand

9	C.1.1.3.a	Check for settlement into the base which would direct runoff rain water under the tank rather than away from it.	the concrete containment around the perimeter of the tank slopes towards the base of the shell . . . Inspectors opinion that condition is asbuilt and not from settlement
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1.1.4 Rock

10	C.1.1.4.a	Presence of crushed rock under the steel bottom usually results in severe underside corrosion. Make a note to do additional bottom plate examination (ultrasonic, hammer testing, or turning of coupons) when the tank is out of service.	No access at time of the inspection however coupons to be recovered when tank is removed.
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1.1.5 Site Drainage

11	C.1.1.5.a	Check site for drainage away from the tank and associated piping and manifolds.	site drains towards tank
12	C.1.1.5.b	Check operating condition of the dike drains.	NOT PERFORMED

1.1.6 Housekeeping

13	C.1.1.6.a	Inspect the area for buildup of trash, vegetation, and other inflammables buildup.	Visually Acceptable
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1.2 SHELLS

1.2.1 External Visual Inspection

14	C.1.2.1.a	Visually inspect for paint failures, pitting, and corrosion.	Isolated areas of failure and active corrosion. (see photos and report the bottom extension was visually inspected
15	C.1.2.1.b	Clean off the bottom angle area and inspect for corrosion and thinning on plate and weld.	no seal present . .
16	C.1.2.1.c	Inspect the bottom-to-foundation seal, if any.	

1.2.2 Internal (Floating Roof Tank)

17	C.1.2.2.a	Visually inspect for grooving, corrosion, pitting, and coating failures.	N/A
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1.2.3 Riveted Shell Inspection

18	C.1.2.3.a	Inspect external surface for rivet and seam leaks	Visually Acceptable
19	C.1.2.3.b	Locate leaks by sketch or photo (location will be lost when shell is abrasive cleaned for painting).	None identified, however when tank is filled inspector expects some seeps would be present
20	C.1.2.3.c	Inspect rivets for corrosion loss and wear	some corrosion loss was observed (see photos)
21	C.1.2.3.d	Inspect vertical seams to see if they have been full fillet lap welded to increase joint efficiency	Ok
22	C.1.2.3.e	If no record exists of vertical riveted seams, dimension and sketch (or photograph) the rivet pattern: number of rows, rivet size, pitch length, and note whether the joint is butt riveted or lap riveted.	shell and roof are single rivet row lap construction (see photos)

1.2.4 Wind Girder (Floating Roof Tanks)

23	C.1.2.4.a	Inspect windgirder and handrail for corrosion damage (paint failure, pitting, corrosion product buildup), especially where it occurs at tack welded junction, and for broken welds.	N/A
24	C.1.2.4.b	Check support welds to shell for pitting, especially on shell plates.	N/A
25	C.1.2.4.c	Note whether supports have reinforcing pads welded to shell.	N/A

1.3 SHELL APPURTENANCES

1.3.1 Manways and Nozzles

26	C.1.3.1.a	Inspect for cracks or signs of leakage on weld joint at nozzles, manways, and reinforcing plates.	difficult to assess with tank empty
27	C.1.3.1.b	Inspect for shell plate dimpling around nozzles, caused by excessive pipe deflection.	no distortion around nozzles was observed however shell has numerous areas of isolated shell distortion
28	C.1.3.1.c	Inspect for flange leaks and leaks around bolting.	Ok
29	C.1.3.1.d	Inspect sealing of insulation around manways and nozzles.	N/A
30	C.1.3.1.e	Check for inadequate manway flange and cover thickness on mixer manways.	N/A

1.3.2 Tank Piping Manifolds

31	C.1.3.2.a	Inspect manifold piping, flanges, and valves for leaks.	Visually Acceptable
32	C.1.3.2.b	Inspect fire fighting system components	none present
33	C.1.3.2.c	Check for anchored piping which would be hazardous to the tank shell or bottom connections during earth movement.	Visually Acceptable
34	C.1.3.2.d	Check for adequate thermal pressure relief of piping to the tank.	none present
35	C.1.3.2.e	Check operation of regulators for tanks with purge gas systems.	N/A
36	C.1.3.2.f	Check sample connections for leaks and for proper valve operation	none present
37	C.1.3.2.g	Check for damage and test the accuracy of temperature indicators.	none present
38	C.1.3.2.h	Check welds on shell-mounted davit clips above valves 6 inches and larger.	none present

1.3.3 Autogauge System

39	C.1.3.3.a	Inspect autogauge tape guide and lower sheave housing (floating swings) for leaks	none present
40	C.1.3.3.b	Inspect autogauge head for damage	none present
41	C.1.3.3.c	Bump the checker on autogauge head for proper movement of tape.	none present
42	C.1.3.3.d	Identify size and construction material of autogauge tape guide (floating roof tanks).	N/A
43	C.1.3.3.e	Ask operator if tape tends to hang up during tank roof movement (floating roof tanks).	N/A
44	C.1.3.3.f	Compare actual product level to the reading on the autogauge (maximum variation is 2 inches).	N/A
45	C.1.3.3.g	On floating roof tanks, when the roof is in the lowest position, check that no more than two feet of tape are exposed at the end of the tape guide.	N/A
46	C.1.3.3.h	Inspect condition of board and legibility of board-type autogauges.	N/A
47	C.1.3.3.i	Test freedom of movement of marker and float.	N/A

1.3.4 Shell-Mounted Sample Station

48	C.1.3.4.a	Inspect sample lines for function of valves and plugging of lines, including drain or return-to-tank line.	none present
49	C.1.3.4.b	Check circulation pump for leaks and operating problems.	none present
50	C.1.3.4.c	Test bracing and supports for sample lines and equipment.	none present

1.3.5 Heater (Shell Manway Mounted)

51	C.1.3.5.a	Inspect condensate drain for presence of oil indicating leakage	none present
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1.3.6 Mixer

52	C.1.3.6.a	Inspect for proper mounting flange and support.	none present
53	C.1.3.6.b	Inspect for leakage.	none present
54	C.1.3.6.c	Inspect condition of power lines and connections to mixer.	none present

1.3.7 Swing Lines: Winch Operation

55	C.1.3.7.a	Non floating. Raise, then lower the swing line with the winch, and check for cable tightness to confirm that swing line lowered properly.	NOT PERFORMED the internal swing line has a chain that doesn't appear to be connected to winch or other activator.
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- | | | | |
|----|-----------|---|-----|
| 56 | C.1.3.7.b | Floating. With tank half full or more, lower the swing line, then let out cable and check if swing has pulled cable tight, indicating that the winch is operating properly. | N/A |
| 57 | C.1.3.7.c | Indicator. Check that the indicator moves in the proper direction: Floating swing line indicators show a lower level as cable is wound up on the winch. Non-floating swing line indicators show the opposite. | N/A |

1.3.8 Swing Lines: External Guide System

- | | | | |
|----|-----------|---|-----|
| 58 | C.1.3.8.a | Check for leaks at threaded and flanged joints. | N/A |
|----|-----------|---|-----|

1.3.9 Swing Lines: Identify Ballast Varying Need

- | | | | |
|----|-----------|---|-----|
| 59 | C.1.3.9.a | Check for significant difference in stock specific gravity. | N/A |
|----|-----------|---|-----|

1.3.9.1 Swing Lines: Cable Material and Condition

- | | | | |
|----|------------|--|-----|
| 60 | C.1.3.10.a | For non-stainless steel cable, check for corrosion over entire length. | N/A |
| 61 | C.1.3.10.b | All cable: check for wear or fraying. | N/A |

1.3.9.1 Swing Lines: Product Sample Comparison

- | | | | |
|----|------------|---|-----|
| 62 | C.1.3.11.a | Check for water or gravity differences that would indicate a leaking swing joint. | N/A |
|----|------------|---|-----|

1.3.9.1 Swing Lines: Target

- | | | | |
|----|------------|---|-----|
| 63 | C.1.3.12.a | Target should indicate direction of swing opening (up or down) and height above bottom where suction will be lost with swing on bottom support. | N/A |
|----|------------|---|-----|

1.4 ROOFS

1.4.1 Deck Plate Internal Corrosion

- | | | | |
|----|-----------|---|--|
| 64 | C.1.4.1.a | For safety, before accessing the roof, check with ultrasonic instrument or lightly use a ball peen hammer to test the deck plate near the edge of the roof for thinning. (Corrosion normally attacks the deck plate at the edge of a fixed roof and at the raft | Inspector did not leave roof gaugers platform to conduct inspection. |
|----|-----------|---|--|

1.4.2 Deck Plate External Corrosion

- | | | | |
|----|-----------|---|---|
| 65 | C.1.4.2.a | Visually inspect for paint failure, holes, pitting, and corrosion product on the roof deck. | SEVERAL ISOLATED AREAS OF COATING FAILURE AND CORROSION THAT MAY EVENTUALLY PRODUCE THRU HOLES. |
|----|-----------|---|---|

1.4.3 Roof Deck Drainage

- | | | | |
|----|-----------|--|-----|
| 66 | C.1.4.3.a | Look for indication of standing water. (Significant sagging of fixed roof deck indicates potential rafter failure. Large standing water areas on a floating roof indicate inadequate drainage design or, if to one side, a nonlevel roof with possible leaking | N/A |
|----|-----------|--|-----|

1.4.4 Level of Floating Roof

- | | | | |
|----|-----------|---|-----|
| 67 | C.1.4.4.a | At several locations, measure distance from roof rim to a horizontal weld seam above the roof. A variance in the readings indicates a nonlevel roof with possible shell out-of-round, out-of-plumb, leaking pontoons, or hang-up. On small diameter tanks, an | N/A |
|----|-----------|---|-----|

1.4.5 Internal Floating Roof

- | | | | |
|----|-----------|---|-----|
| 68 | C.1.4.5.a | Test for explosive gas on top of the internal floating roof. Readings could indicate a leaking roof, leaking seal system, or inadequate ventilation of the area above the internal floating roof. | N/A |
|----|-----------|---|-----|

1.4.6 Roof Insulation

- | | | | |
|----|-----------|---|-----|
| 69 | C.1.4.6.a | Visually inspect for cracks or leaks in the insulation weather coat where runoff rain water could penetrate the insulation. | N/A |
| 70 | C.1.4.6.b | Inspect for wet insulation under the weather coat. | N/A |
| 71 | C.1.4.6.c | Remove small test sections of insulation and check roof deck for corrosion and holes near the edge of the insulated area. | N/A |

1.4.7 Floating Roof Seal Systems

- | | | | |
|----|-----------|---|---------------|
| 72 | C.1.4.7.a | Measure and record maximum seal-to-shell gaps at: 1.Low pump out. 2. Mid-shell. 3.High liquid level. | NOT PERFORMED |
| 73 | C.1.4.7.b | Measure and record annular space at 30 foot spacing (minimum of four quadrants) around roof and record. Measurements should be taken in directly opposite pairs. 1.Opposite pair 1. 2. Opposite pair 2. | N/A |
| 74 | C.1.4.7.c | Check if seal fabric on primary shoe seals is pulling shoes away from shell (fabric not wide enough). | N/A |
| 75 | C.1.4.7.d | Inspect fabric for deterioration, holes, tears, and cracks. | N/A |

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76	C.1.4.7.e	Inspect visible metallic parts for corrosion and wear.	N/A
77	C.1.4.7.f	Inspect for openings in seals that would permit vapor emissions.	N/A
78	C.1.4.7.g	Inspect for protruding bolt or rivet heads against the shell.	N/A
79	C.1.4.7.h	Pull both primary and secondary seal systems back all around the shell to check their operation.	N/A
80	C.1.4.7.i	Inspect secondary seals for signs of buckling or indications that their angle with the shell is too shallow.	N/A
81	C.1.4.7.j	Inspect wedge-type wiper seals for flexibility, resilience, cracks, and tears.	N/A

1.5 ROOF APPURTENANCES

1.5.1 Sample Hatch

82	C.1.5.1.a	Inspect condition and functioning of sample hatch cover.	Ok
83	C.1.5.1.b	On tanks governed by Air Quality Monitoring District rules, check for the condition of seal inside hatch cover.	N/A
84	C.1.5.1.c	Check for corrosion and plugging on thief and gauge hatch cover.	N/A
85	C.1.5.1.d	Where sample hatch is used to reel gauge stock level, check for marker and tab stating hold off distance.	none present
86	C.1.5.1.e	Check for reinforcing pad where sample hatch pipe penetrates the roof deck.	none present riveted flange to roof deck
87	C.1.5.1.f	On floating roof sample hatch and recoil systems, inspect operation of recoil reel and condition of rope.	N/A
88	C.1.5.1.g	Test operation of system.	Not Performed
89	C.1.5.1.h	On ultra clean stocks such as JP4, check for presence and condition of protective coating or liner inside sample hatch (preventing rust from pipe getting into sample).	N/A

1.5.2 Gauge Well

90	C.1.5.2.a	Inspect visible portion of the gauge well for thinning, size of slots, and cover condition	N/A
91	C.1.5.2.b	Check for a hold off distance marker and tab with hold off distance (legible).	N/A
92	C.1.5.2.c	On floating roofs, inspect condition of roof guide for gauge well, particularly the condition of the rollers for grooving.	N/A
93	C.1.5.2.d	If accessible, check the distance from the gauge well pipe to the tank shell at different levels.	N/A
94	C.1.5.2.e	If tank has a gauge well washer, check valve for leakage and for presence of a bull plug or blind flange.	N/A

1.5.3 Fixed Roof Scaffold Support

95	C.1.5.3.a	Inspect scaffold support for corrosion, wear, and structural soundness.	The catwalk roof access handrail is 'wobbly' unable to support a 1000 lb load because of the attachment to the angle at its base is flexing in torsion. Because the grating rest inside of the support angle a 'toe board of less than 1-in is provided'.
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1.5.4 Autogauge: Inspection Hatch and Guides (Fixed Roof)

96	C.1.5.4.a	Check the hatch for corrosion and missing bolts.	none present
97	C.1.5.4.b	Look for corrosion on the tape guide's and float guides wire anchors.	none present

1.5.5 Autogauge: Float Well Cover

98	C.1.5.5.a	Inspect for corrosion.	N/A
99	C.1.5.5.b	Check tape cable for wear or fraying caused by rubbing on the cover.	N/A

1.5.6 Sample Hatch (Internal Floating Roof)

100	C.1.5.6.a	Check overall conditions.	N/A
101	C.1.5.6.b	When equipped with a fabric seal, check for automatic sealing after sampling.	N/A
102	C.1.5.6.c	When equipped with a recoil reel opening device, check for proper operations	N/A

1.5.7 Roof-Mounted Vents (Internal Floating Roof)

103	C.1.5.7.a	Check condition of screens, locking and pivot pins.	N/A
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1.5.8 Gauging Platform Drip Ring

104	C.1.5.8.a	On fixed roof tanks with drip rings under the gauging platform or sampling area, inspect for plugged drain return to the tank	N/A
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1.5.9 Emergency Roof Drains

105 C.1.5.9.a Inspect vapor plugs for emergency drain: that seal fabric discs are slightly smaller than the pipe ID and that fabric seal is above the liquid level. N/A

1.5.9.1 Removable Roof Leg Racks

106 C.1.5.10.a Check for leg racks on roof. N/A

1.5.9.2 Vacuum Breakers

107 C.1.5.11.a Report size, number, and type of vacuum breakers. Inspect vacuum breakers. If high legs are set, check for setting of mechanical breaker in high leg position. N/A

1.5.9.3 Rim Vents

108 C.1.5.12.a Check condition of the screen on the rim vent cover. N/A

109 C.1.5.12.b Check for plating off or removal of rim vents where jurisdictional rules do not permit removal. N/A

1.5.9.4 Pontoon Inspection Hatches

110 C.1.5.13.a Open pontoon inspection hatch covers and visually check inside for pontoon leakage. N/A

111 C.1.5.13.b Test for explosive gas (an indicator of vapor space leaks). N/A

112 C.1.5.13.c If pontoon hatches are equipped with locked down covers, check for vent tubes. Check that vent tubes are not plugged up. Inspect lock down devices for condition and operation N/A

1.6 ACCESS STRUCTURES

1.6.1 Handrails

113 C.1.6.1.a Identify and report type (steel pipe, galvanized pipe, square tube, angle) and size of handrails. Handrails are 3/4-in round bar and the 40-in vertical support is 1/2-in x 3-in flat bar. Do not appear to be able to support 1000 lbs osha loading

114 C.1.6.1.b Inspect for pitting and holes, paint failure. Ok

115 C.1.6.1.c Inspect attachment welds. Ok

116 C.1.6.1.d Identify cold joints and sharp edges. Inspect the handrails and midrails Ok

117 C.1.6.1.e Inspect safety drop bar (or safety chain) for corrosion, functioning, and length. none present

118 C.1.6.1.f Inspect the handrail between the rolling ladder and the gaging platform for a hazardous opening when the floating roof is at its lowest level. N/A

1.6.2 Platform Frame

119 C.1.6.2.a Inspect frame for corrosion and paint failure. Ok

120 C.1.6.2.b Inspect the attachment of frame to supports and supports to tank for corrosion and weld failure. Ok

121 C.1.6.2.c Check reinforcing pads where supports are attached to shell or roof. none present

122 C.1.6.2.d Inspect the surface that deck plate or grating rests on, for thinning and holes. Ok

123 C.1.6.2.e Check that flat-surface to flat-surface junctures reseal welded. Ok

1.6.3 Deck Plate and Grating

124 C.1.6.3.a Inspect deck plate for corrosion-caused thinning or holes (not drain holes) and paint failure. riveted roof with isolated areas of active corrosion and some internal seeps during rain. No obvious corrosion holes most likely loose rivets or lap joints

125 C.1.6.3.b Inspect plate-to-frame weld for rust scale buildup. Ok

126 C.1.6.3.c Inspect grating for corrosion-caused thinning of bars and failure of welds. Ok

127 C.1.6.3.d Check grating tie down clips. Where grating has been retrofitted to replace plate, Ok

1.6.4 Stairway Stringers

128 C.1.6.4.a Inspect spiral stairway stringers for corrosion, paint failure, and weld failure. Inspect attachment of stairway treads to stringer. no spiral stairway present

129 C.1.6.4.b Inspect stairway supports to shell welds and reinforcing pads. none present

130 C.1.6.4.c Inspect steel support attachment to concrete base for corrosion. N/A

1.6.5 Rolling Ladder

131 C.1.6.5.a Inspect rolling ladder stringers for corrosion. no rolling ladder present

132 C.1.6.5.b Identify and inspect ladder fixed rungs (square bar, round bar, angles) for weld attachment to stringers and corrosion, particularly where angle rungs are welded to stringers N/A

133	C.1.6.5.c	Check for wear and corrosion where rolling ladder attaches to gauging platform.	N/A
134	C.1.6.5.d	Inspect pivot bar for wear and secureness.	N/A
135	C.1.6.5.e	Inspect operation of self-leveling stairway treads.	N/A
136	C.1.6.5.f	Inspect for corrosion and wear on moving parts.	N/A
137	C.1.6.5.g	Inspect rolling ladder wheels for freedom of movement, flat spots, and wear on axle.	N/A
138	C.1.6.5.h	Inspect alignment of rolling ladder with roof rack.	N/A
139	C.1.6.5.i	Inspect top surface of rolling ladder track for wear by wheels to assure at least 18 inches of unworn track (track long enough).	N/A
140	C.1.6.5.j	Inspect rolling ladder track welds for corrosion.	N/A
141	C.1.6.5.k	Inspect track supports on roof for reinforcing pads seal welded to deck plate.	N/A
142	C.1.6.5.l	Check by dimensioning, the maximum angle of the rolling ladder when the roof is on low legs.	N/A
143	C.1.6.5.m	If rolling ladder track extends to within five feet of the edge of the roof on the far side, check for a handrail on the top of the shell on that side. Max. angle	N/A

2.10 OVERVIEW

2.1 Safety

144	C.2.1.a	Check that tank has been cleaned, is gas free, and safe for entry.	Ok, significant dirt and mud was present on the bottom during the inspection. Inspectors utilized scrapers, brooms and rags to attempt to clean the bottom for inspection. In spite of the conditions product side corrosion was visually identified.
145	C.2.1.b	Check that the tank is completely isolated from product lines, all electrical power, and steam lines.	Ok
146	C.2.1.c	Check that roof is adequately supported, including fixed roof structure and floating roof legs	the 3-in center column was 6 6/8-in out of plumb. Pipe columns and not be fully assessed because of the potential for undetected internal corrosion. In order to determine the extent of internal corrosion extensive ultrasound inspection would be required.
147	C.2.1.d	Check for presence of failing object hazards, such as corroded-through roof rafters, asphalt stalactites, and trapped hydrocarbons in unopened or plugged equipment or appurtenances, ledges, etc.	Ok
148	C.2.1.e	Inspect for slipping hazards on the bottom and roof decks.	Ok
149	C.2.1.f	Inspect structural welds on accessways and clips	Ok
150	C.2.1.g	Check surfaces needing inspection for a heavy-scale buildup and check weld seams and oily surfaces where welding is to be done. Note areas needing more cleaning, including blasting.	At the time of the inspection the bottom was covered with mud and dirt that was scraped and swept by the inspectors. This condition most likely did not affect the quality of the MFE bottom scan but visual inspection and marking of indications was.

2.12 TANK EXTERIOR

2.2 Inspection

151	C.2.2.a	Inspect appurtenances opened during cleaning such as lower floating swing sheave assemblies, nozzle interiors (after removal of valves).	Ok
152	C.2.2.b	Hammer test or ultrasonically test the roof.	UT conducted at the platform. Visual inspection from the top and underside of the riveted cone roof did not indicate the presence of significant corrosion. Nominal UT thru coatings 0.18-in.
153	C.2.2.c	Enter and inspect the floating roof pontoon compartments.	N/A

2.13 BOTTOM INTERIOR SURFACE

2.3 Inspection

154	C.2.3.a	Using a flashlight held close to and parallel to the bottom plates, and using the bottom plate layout as a guide, visually inspect and hammer test the entire bottom.	MFE scan of bottom conducted. Inspector estimates coverage close to 90%. 15 sq ft area under the bottom angle was not accessible for inspection. (area of the 3-in angle x 2 plus 20-ft diameter of tank minus of the 20 ft tank = approx 15 ft^2)
155	C.2.3.b	Measure the depth of pitting and describe the pitting appearance (sharp edged, lake type, dense, scattered, etc.)	deep isolated product side pitting was indentified 0.15-in loss reported in the worst area on tank 395. Both tanks 396 and 397 had thru hole corosion from product or stock
156	C.2.3.c	Mark areas requiring patching or further inspection.	Tank bottom was not marked for repair.
157	C.2.3.d	Mark locations for turning coupons for inspection.	Ok
158	C.2.3.e	Inspect all welds for corrosion and leaks, particularly the shell-to-bottom weld.	Ok
159	C.2.3.f	Inspect sketch plates for corrosion.	Ok
160	C.2.3.g	Locate and mark voids under the bottom.	Ok
161	C.2.3.h	Record bottom data on a layout sketch using the existing bottom plates as a grid. List the number and sizes of patches required.	See Report
162	C.2.3.i	Vacuum test the bottom lap welds.	Not Performed because of the dirt and mud present on the lap seams.
163	C.2.3.j	Hammer test or ultrasonically examine any slightly discolored spots or damp areas.	Ok
164	C.2.3.k	Check for reinforcing pads under all bottom attached clips, brackets, and supports	none present
165	C.2.3.l	Inspect floating roof leg pads for pitting or cutting, and excessive dimpling (indicating excessive loading).	N/A
166	C.2.3.m	Check the column bases of fixed roof supports for adequate pads and restraining clips.	no bases present . . . 3-in pipe column rest on the bottom in tank 396 and on a stitch welded 1/4-in plate on tanks 395 an 397. undetected holes or significant corroion damage may be present under these areas.
167	C.2.3.n	In earthquake zones 3 and 4, check that roof supports are not welded down to the tank bottom, but are only restrained from horizontal movement.	N/A
168	C.2.3.o	Check area beneath swing line cable for indications of cable cutting or dragging.	N/A
169	C.2.3.p	Mark old oil and air test connection for removal and patching.	N/A
170	C.2.3.q	Identify and report low areas on the bottom that do not drain adequately.	Cone up bottom resulting in water collecting near the shell. (see survey and photos)
171	C.2.3.r	Inspect coating for holes, disbanding, deterioration, and discolorization.	none present

2.14 SHELL SEAMS AND PLATE

2.4 Inspection

172	C.2.4.a	On cone up bottoms, closely inspect and gauge the depth of metal loss on the lower 2 to 4 inches of the shell (area of standing water).	Visually Acceptable
173	C.2.4.b	Measure the depth of pitting on each course.	internal shell was covered with rust scale and not accessible for inspection. External shell isolated pitting corrosion to 0.1-in deep was present. (0.08-in remaining)
174	C.2.4.c	Inspect and estimate the amount of metal loss on the heads of rivets and bolts	SEE PHOTOS

175	C.2.4.d	Inspect shell-to-bottom riveted lap joints.	Shell to bottom joint is a lap welded 3 x 3 angle toe out from base of shell. Bottom is lap welded to this angle 3-in outside of the center line of the shell. 15 sq feet of bottom under this angle could not be inspected. (see drawings)
176	C.2.4.e	Inspect for vertical grooving damage from seal assembly protrusions.	N/A
177	C.2.4.f	Inspect existing protective coatings for damage, deterioration, and disbonding	no internal coatings present . . . external shell and roof coatings are nearing end of useful life. . . Failure from peeling and corrosion present. See photos.
178	C.2.4.g	Check for areas of rubbing (indicating too much pressure by the seal assembly shoes or inadequate annular space).	N/A
179	C.2.4.h	Visually inspect the shell plates and seams for indications of leakage. If the shell has riveted or bolted seams, record the leak locations by film or chart in case the locations are lost during surface preparation for painting	Visually Acceptable
180	C.2.4.i	Measure annular space at 40-foot intervals.	Visually Acceptable
181	C.2.4.j	Survey the shell to check for roundness and plumb.	visually acceptable . . . Some insulated shell distortion (see photos)

2.15 SHELL-MOUNTED OVERFLOWS

2.5 Inspection

182	C.2.5.a	Inspect overflow for corrosion and adequate screening.	N/A
183	C.2.5.b	Check location of overflow that it is not above any tank valves or equipment.	none present

2.16 ROOF INTERIOR SURFACE

2.6.1 General

184	C.2.6.1.a	Visually inspect the underside surface of the roof plates for holes, scale buildup, and pitting.	Visually Acceptable
185	C.2.6.1.b	Hammer test or ultrasonically examine to check for thin areas, particularly in the vapor space of floating roofs and at edge of roof on cone roof tank.	NO ACCESS
186	C.2.6.1.c	Check all clips, brackets, braces, etc., welded to the roof deck plate for welded reinforcing pads and see that they have not broken free.	NO ACCESS
187	C.2.6.1.d	If no pad is present, penetrant test for cracking of the weld or deck plate.	Not Performed
188	C.2.6.1.e	Inspect for protective coating for breaks, disbandment, and deterioration	none present
189	C.2.6.1.f	Spark test the interior surface coating if recoating is not planned.	Not Performed

2.6.2 Fixed Roof Support Structure

190	C.2.6.2.a	Inspect the support columns for thinning in the upper two feet.	Visually Acceptable
191	C.2.6.2.b	On API columns (two channels welded together) check for corrosion scale breaking the tack welds, unless the joint between the channels is completely seal welded.	N/A
192	C.2.6.2.c	Check that the reinforcing pad on the bottom is seal welded to the tank bottom with horizontal movement restraining clips welded to the pad.	Repad on tank(s) 395 and 397 are not seal welded. Tank 396 does not have a repad.
193	C.2.6.2.d	Determine if pipe column supports are concrete filled or open pipe. If open pipe, check for a drain opening in the bottom of the pipe	appears not to be filled with concrete
194	C.2.6.2.e	Inspect and gauge rafters for thinning, particularly near the center of the roof. Report metal loss.	Visually Acceptable
195	C.2.6.2.a	Check for loose or twisted rafters.	Tank 395 and 397 rafters are visually acceptable. Tank 396 has 4 twisted or bowed rafters out of 12 present.
196	C.2.6.2.b	Inspect girders for thinning and check that they are attached securely to the top of the columns.	No girders present
197	C.2.6.2.c	Report if the columns have cross bracing in the area between the low pump out of the top of the shell (for future internal floating roof installation).	single pipe column construction, no bracing present
198	C.2.6.2.d	Inspect and report presence of any roof-mounted swing line bumpers.	N/A
199	C.2.6.2.e	Photograph the roof structure if no rafter layout drawing exists.	See Report

2.17 FIXED ROOF APPURTENANCES

2.7.1 Inspection and Light Hatches

200	C.2.7.1.a	Inspect the hatches for corrosion, paint and coating failures, holes, and cover sealing.	N/A
201	C.2.7.1.b	On loose covers, check for a safety chain in good condition.	N/A
202	C.2.7.1.c	On light hatches over 30 inches across, check for safety rods	N/A
203	C.2.7.1.d	Inspect the condition of the gaskets on bold or latched down hatch covers.	N/A

2.7.2 Staging Support Connection

204	C.2.7.2.a	Inspect the condition of the staging support for corrosion.	N/A
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2.7.3 Breathers and Vents

205	C.2.7.3.a	Inspect and service the breather.	N/A
206	C.2.7.3.b	Inspect screens on vents and breathers.	The tank appears to have a 3-in PV vent w flame arrestor installed on the cone roof. The Vent has the name OCECO cast. It is very important that this type vent be serviced regularly, to prevent damage from over or under pressure.

2.7.4 Emergency PN Hatches

207	C.2.7.4.a	Inspect and service pressure/vacuum hatches. (Setting should be high enough to prevent chattering of breather during normal operation. See breather manufacturer's guide.)	N/A
208	C.2.7.4.b	Inspect liquid seal hatches for corrosion and proper liquid level in the seal.	N/A

2.7.5 Sample Hatch

209	C.2.7.5.a	Inspect sample hatch for corrosion.	N/A
210	C.2.7.5.b	Check that the cover operates properly	N/A
211	C.2.7.5.c	If the tank has no gauge well, check for a hold off distance marker and check measurement.	N/A

2.18 FLOATING ROOF

2.8.1 Roof Deck

212	C.2.8.1.a	Hammer test the area between roof rim and shell. (If access for hammer testing is inadequate, measure the distance from the bottom edge of the roof to the corroded area and then hammer test from inside the pontoon.)	N/A
213	C.2.8.1.b	In sour water service, clean and test all deck plate weld seams for cracking unless the lower laps have been seal welded.	N/A
214	C.2.8.1.c	Check that either the roof drain is open or the drain plug in the roof is open in case of unexpected rain	N/A
215	C.2.8.1.d	On flat bottomed and cone bottom roof decks, check for a vapor dam around the periphery of the roof. The dam should be continuous without break to prevent escape of vapors to the seal area from under the center of the roof.	N/A

2.8.2 Floating Roof pontoons

216	C.2.8.2.a	Visually inspect each pontoon for liquid leakage.	N/A
217	C.2.8.2.b	Run a light wire through the goose neck vents on locked down inspection hatch covers to make sure they are open.	N/A
218	C.2.8.2.c	Inspect lockdown latches on each cover.	N/A
219	C.2.8.2.d	Check and report if each pontoon is: 1. Vapor tight (bulkhead seal welded on one side on bottom, sides, and top), 2. Liquid tight seal welded on bottom and sides only), or 3. Unacceptable (minimum acceptable condition is liquid tight).	N/A

2.8.3 Floating Roof Cutouts

220	C.2.8.3.a	Inspect underside of cutouts for mechanical damage.	N/A
221	C.2.8.3.b	Inspect welds for cracks.	N/A
222	C.2.8.3.c	Inspect plate for thinning, pitting, and erosion.	N/A
223	C.2.8.3.d	Measure mixer cutouts and record plate thickness for future mixer installation or replacement. Plate thickness	N/A

2.8.4 Floating Roof Supports

224	C.2.8.4.a	inspect fixed low and removable high floating roof legs for thinning.	N/A
225	C.2.8.4.b	Inspect for notching at bottom of legs for drainage	N/A

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226	C.2.8.4.c	Inspect for leg buckling or felling at bottom.	N/A
227	C.2.8.4.d	Inspect pin hole in roof guide for tears.	N/A
228	C.2.8.4.f	Check plumb of all legs.	N/A
229	C.2.8.4.g	Inspect for adequate reinforcing gussets on all legs through a single portion of the roof.	N/A
230	C.2.8.4.h	Inspect the area around the roof legs for cracking if there is no internal reinforcing pad or if the topside pad is not welded to the deck plate on the underside.	N/A
231	C.2.8.4.l	Inspect the sealing system on the two-position legs and the vapor plugs in the fixed low leg for deterioration of the gaskets.	N/A
232	C.2.8.4.j	On shell mounted roof supports, check for adequate clearance based on the maximum floating roof movement as determined by the position of the roof relative to the gauge well and/or counter rotational device.	N/A

2.19 FLOATING ROOF SEAL ASSEMBLIES

2.9.1 Primary Shoe Assembly

233	C.2.9.1.a	Remove four sections of foam log (foam filled seals) for inspection on 90° locations.	N/A
234	C.2.9.1.b	Inspect hanger attachment to roof rim for thinning, bending, broken welds, and wear of pin holes.	N/A
235	C.2.9.1.c	Inspect clips welded to roof rim for thinning.	N/A
236	C.2.9.1.d	Shoes-inspect for thinning and holes in shoes.	N/A
237	C.2.9.1.e	Inspect for bit-metal bolts, clips, and attachments.	N/A
238	C.2.9.1.f	Seal fabric-inspect for deterioration, stiffening, holes, and tears in fabric.	N/A
239	C.2.9.1.g	Measure length of fabric from top of shoe to roof rim, and check against maximum anticipated annular space as roof operates.	N/A
240	C.2.9.1.h	Inspect any modification of shoes over shell nozzles, mixers, etc., for clearance.	N/A
241	C.2.9.1.i	Inspect shoes for damage caused by striking shell nozzles, mixers, etc.	N/A

2.9.2 Primary Toroidal Assembly

242	C.2.9.2.a	Inspect seal fabric for wear, deterioration, holes, and tears	N/A
243	C.2.9.2.b	Inspect hold down system for buckling or bending.	N/A
244	C.2.9.2.c	Inspect foam for liquid absorption and deterioration.	N/A

2.9.3 Rim Mounted Secondaries

245	C.2.9.3.a	Inspect the rim-mounted bolting bar for corrosion and broken welds.	N/A
246	C.2.9.3.b	Measure and chart seal-to-shell gaps.	N/A
247	C.2.9.3.c	Visually inspect seam from below, looking for holes as evident by light.	N/A
248	C.2.9.3.d	Inspect fabric for deterioration and stiffness.	N/A
249	C.2.9.3.e	Inspect for mechanical damage, corrosion, and wear on tip in contact with shell	N/A
250	C.2.9.3.e	Inspect for contact with obstructions above top of shell.	N/A

2.20 FLOATING ROOF APPURTENANCES

2.9.4 Roof Manways

251	C.2.10.1.a	Inspect walls of manways for pitting and thinning.	N/A
252	C.2.10.1.b	On tanks with interface autogauges, check seal around gauge tape cable and guide wires through manway cover.	N/A
253	C.2.10.1.c	Inspect cover gasket and bolts.	N/A

2.9.5 Rim Vent

254	C.2.10.2.a	Check rim vent for pitting and holes	N/A
255	C.2.10.2.b	Check vent for condition of screen.	N/A
256	C.2.10.2.c	On floating roof tanks where the environmental rules require closing off the vent, check the vent pipe for corrosion at the pipe-to-rim joint and check that the blinding is adequate.	N/A

2.9.6 Vacuum Breaker, Breather Type

257	C.2.10.3.b	Service and check operation of breather valve.	N/A
258	C.2.10.3.c	Check that nozzle pipe projects no more than 1/2 inch below roof deck	N/A

2.9.7 Vacuum Breaker, Mechanical Type

259	C.2.10.4.a	Inspect the stem for thinning. Measure how far the vacuum breaker cover riser is off the pipe when the roof is resting on high or low legs. A. On high legs: b.	N/A
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2.9.9 Closed Drain Systems: Drain Basins

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263	C.2.10.6.a	Inspect for thinning and pitting	N/A
264	C.2.10.6.b	Inspect protective coating (topside).	N/A
265	C.2.10.6.c	Inspect basin cover or screen for corrosion.	N/A
266	C.2.10.6.d	Test operation of check valve.	N/A
267	C.2.10.6.e	Check for presence of check valve where bottom of basin is below product level.	N/A
268	C.2.10.6.f	Inspect drain basin(s) to roof deck welds for cracking.	N/A
269	C.2.10.6.g	Check drain basin(s) outlet pipe for adequate reinforcement to roof deck (including reinforcing pad).	N/A

2.9.9 Roof Drains: Open Systems, Including Emergency Drains

260	C.2.10.5.a	Check liquid level inside open roof drains for adequate freeboard. Report if there is insufficient distance between liquid level and top of drain.	N/A
261	C.2.10.5.b	If tank comes under Air Quality Monitoring District rules, inspect the roof drain vapor plug	N/A
262	C.2.10.5.c	If emergency drain is not at the center of the roof, check that there are at least three emergency drains.	N/A

2.9.91 Closed Drain Systems: Fixed Drain Line on Tank Bottom

270	C.2.10.7.a	Hammer test fixed drain line on tank bottom for thinning and scale/debris plugging.	N/A
271	C.2.10.7.b	Inspect supports and reinforcing pads for weld failures and corrosion.	N/A
272	C.2.10.7.c	Check that pipe is guided, not rigidly locked to support, to avoid tearing of tank bottom plate.	N/A

2.9.92 Closed Drain Systems: Flexible Pipe Drain

273	C.2.10.8.a	Inspect for damage to exterior of pipe	N/A
274	C.2.10.8.b	Check for obstructions that pipe could catch on.	N/A
275	C.2.10.8.c	Inspect shields to protect pipe from snagging.	N/A
276	C.2.10.8.d	Inspect results of hydrotest on flexible roof drain system.	N/A

2.9.93 Closed Drain Systems: Articulated Joint Drain

277	C.2.10.9.f	Hammer test rigid pipe inflexible joint systems for thinning and scale/debris plugging.	N/A
278	C.2.10.9.g	Inspect system for signs of bending or strain.	N/A
279	C.2.10.9.h	Inspect results of system hydrotest.	N/A
280	C.2.10.9.i	Inspect landing leg and pad.	N/A

2.9.94 Autogauge System and Alarms

281	C.2.10.10.a	Check freedom of movement of tape through autogauge tape guide	N/A
282	C.2.10.10.b	Inspect sheaves for freedom of movement.	N/A
283	C.2.10.10.c	Test operation checker.	N/A
284	C.2.10.10.d	Inspect tape and tape cable for twisting and fraying.	N/A
285	C.2.10.10.e	Test the tape's freedom of movement through guide sheaves and tape guide pipe.	N/A
286	C.2.10.10.f	On open-top tanks, check that gate tapes with cables have no more than one foot of tape exposed with float at lowest point.	N/A
287	C.2.10.10.g	Check float for leakage.	N/A
288	C.2.10.10.h	Test float guide wire anchors for spring action by pulling on wire and releasing	N/A
289	C.2.10.10.i	Inspect floatwells in floating roofs for thinning and pitting of walls just above the liquid level.	N/A
290	C.2.10.10.j	Check that the autogauge tape is firmly attached to the float.	N/A
291	C.2.10.10.k	Inspect the tape cable and float guide wire fabric seals through the float well cover.	N/A
292	C.2.10.10.l	Inspect the bottom guide wire attachment clip: inspect for a temporary weighted bar instead of a permanent welded down clip.	N/A
293	C.2.10.10.m	Inspect board-type autogauge indicators for legibility and freedom of movement of indicator.	N/A
294	C.2.10.10.n	Measure and record these distances to determine if seal damage will occur if tank is run over from: 1.Shell top angle to underside of tape guide system. 2.Liquid level on floating top to top of secondary seal.	N/A
295	C.2.10.10.o	Identify floating roots where the tape is connected directly to the roof.	N/A
296	C.2.10.10.p	Overfill alarm: Inspect tank overfill prevention alarm switches for proper operation.	N/A

2.21 COMMON TANK APPURTENANCES

2.9.95 Gauge Well

297	C.2.11.1.a	Inspect gauge well pipe for thinning at about two-thirds distance above the bottom: look for thinning at the edge of the slots.	N/A
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298	C.2.11.1.b	Check for corrosion on the pipe joint. Check that sample cords, weights, thermometers, etc., have been removed from the pipe.	N/A
299	C.2.11.1.c	Check for cone at bottom end of pipe about one foot above the bottom.	N/A
300	C.2.11.1.d	Check condition of well washer pipe and that its flared end is directed at the near side of the hold off pad.	N/A
301	C.2.11.1.e	Check that supports for gauge well are welded to pad or to shell and not directly to bottom plate,	N/A
302	C.2.11.1.f	Check operation of gauge well cover.	N/A
303	C.2.11.1.g	Check presence of a hold-off distance marker in well pipe and record hold-off distance.	N/A
304	C.2.11.1.h	Identify and report size and pipe schedule, and whether pipe is solid or slotted. Report slot size.	N/A
305	C.2.11.1.i	Check that the hold-off distance plate is seal welded to the bottom and that any gauge well supports are welded to the plate and not directly to the bottom.	N/A
306	C.2.11.1.j	Inspect vapor control float and cable.	N/A
307	C.2.11.1.k	Check for presence and condition of gauge well washer.	N/A
308	C.2.11.1.l	Check for bull plug or plate blind on gauge well washer valve.	N/A
309	C.2.11.1.m	Inspect gauge well guide in floating roof for pitting and thinning.	N/A
310	C.2.11.1.n	Inspect the guide rollers and sliding plates for freedom of movement.	N/A
311	C.2.11.1.o	Inspect condition of gauge well pipe seal system.	N/A
312	C.2.11.1.p	On black oil and diesel services: if gauge well is also used for sampling, check for presence of a thief- and gauge-type hatch to avoid spillage.	N/A
313	C.2.11.1.q	Visually inspect inside of pipe for pipe weld protrusions which could catch or damage vapor control float.	N/A

2.9.96 Sampling Systems: Roof Sample Hatches

314	C.2.11.2.a	Inspect roof mounted sample hatches for reinforcing pads and cracking.	N/A
315	C.2.11.2.b	Inspect cover for operation.	N/A
316	C.2.11.2.c	For tanks complying with Air Quality Monitoring District rules, inspect sample hatch covers for adequate sealing	N/A
317	C.2.11.2.d	Check horizontal alignment of internal floating roof sample hatches under fixed roof hatches.	N/A
318	C.2.11.2.e	Inspect the sealing system on the internal floating roof sample hatch cover.	N/A
319	C.2.11.2.f	Inspect floating roof sample hatch cover recoil reel and rope.	N/A

2.9.97 Shell Nozzles

320	C.2.11.3.a	Inspect shell nozzles for thinning and pitting.	Corrosion Damaged
321	C.2.11.3.b	Inspect hot tap nozzles for trimming of holes.	N/A
322	C.2.11.3.c	Identify type of shell nozzles.	See Report
323	C.2.11.3.d	Identify and describe internal piping, including elbow up and elbow down types.	See Report

2.9.98 For Nozzles Extended into the Tank

324	C.2.11.4.a	Inspect pipe support pads welded to tank bottom.	none present
325	C.2.11.4.b	Inspect to see that pipe is free to move along support without strain or tearing action on bottom plate.	none present
326	C.2.11.4.c	Inspect nozzle valves for packing leaks and damaged flange faces.	none present
327	C.2.11.4.d	Inspect heater stream nozzle flanges and valves for wire cutting.	N/A
328	C.2.11.4.e	Report which nozzles have thermal pressure relief bosses and valves.	none present
329	C.2.11.4.f	In internal elbow-down fill line nozzles, inspect the wear plate on the tank bottom.	none present
330	C.2.11.4.g	On elbow-up fill lines in floating roof tanks, check that opening is directed against underside of roof, not against vapor space. Inspect impact are for erosion.	N/A

2.9.99 Diffusers and Air Rolling Systems

331	C.2.11.5.a	Inspect diffuser pipe for erosion and thinning.	N/A
332	C.2.11.5.b	Check holes in diffuser for excessive wear and enlargement.	N/A
333	C.2.11.5.c	Inspect diffuser supports for damage and corrosion.	N/A
334	C.2.11.5.d	Check that diffuser supports restrain, not anchor, longitudinal line movement.	N/A
335	C.2.11.5.e	Inspect air spiders on bottom of lube oil tanks for plugging and damaged or broken threaded joints	N/A

2.9.991 Swing Lines

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336	C.2.11.6.a	Inspect flexible joint for cracks and leaks.	3-in swing line removed from tank 395. (present in tanks 396 and 397. Both these tanks had a chain leading to the roof manway for raising the upturned elbow.) see photos
337	C.2.11.6.b	Scribe the flexible joint across the two moving faces and raise end of swing line to check the joint's freedom of movement, indicated by separation of scribe marks.	N/A
338	C.2.11.6.c	Check that flexible joints over six inches are supported.	N/A
339	C.2.11.6.d	Inspect the swing pipe for deep pitting and weld corrosion.	N/A
340	C.2.11.6.e	Loosen the vent plugs in the pontoons and listen for a vacuum. Lack of a vacuum indicates a leaking pontoon.	N/A
341	C.2.11.6.f	Check the results of air test on pontoons during repairs.	N/A
342	C.2.11.6.g	Inspect the pontoons for pitting.	N/A
343	C.2.11.6.h	Inspect the pull-down cable connections to the swing	N/A
344	C.2.11.6.i	Inspect the condition of the bottom-mounted support, fixed roof limiting bumper, or shell mounted limiting bumper for wood condition, weld and bolt corrosion, and seal welding to bottom or shell.	N/A
345	C.2.11.6.j	Inspect safety hold-down chain for corrosion and weak links.	N/A
346	C.2.11.6.k	Check that there is a welded reinforcing pad where the chain connects to the bottom.	N/A
347	C.2.11.6.l	If the floating swing in a floating or internal floating roof tank does not have a limiting device preventing the swing from exceeding 60 degrees, measure and calculate the maximum angle possible with the roof on overflow. Max. angle on overflow (If the c	N/A
348	C.2.11.6.m	Inspect pull down cable for fraying.	N/A
349	C.2.11.6.n	Inspect for three cable clamps where cable attaches to end of swing line (single-reeved) or to roof assembly (double-reeved). Inspect sheaves for freedom of movement.	N/A
350	C.2.11.6.o	Inspect winch operation and check the height indicator for legibility and accuracy.	N/A
351	C.2.11.6.p	Inspect bottom-mounted sheave assembly at end of pontoon for freedom of rotation of sheave.	N/A
352	C.2.11.6.q	Inspect shell-mounted lower sheave assembly for freedom of rotation of sheave, corrosion thinning, and pitting of sheave housing.	N/A
353	C.2.11.6.r	Inspect upper sheave assembly for freedom of movement of sheave.	N/A
354	C.2.11.6.s	Inspect the cable counterbalance assembly for corrosion and freedom of operation.	N/A

2.9.992 Manway Heater Racks

355	C.2.11.7.a	Inspect the manway heater racks for broken welds and bending of the sliding rails.	N/A
356	C.2.11.7.b	Measure and record the length of the heater and length of the track.	N/A

2.9.993 Mixer Wear Plates and Deflector Stands

357	C.2.11.8.a	Inspect bottom and shell plates and deflector stands.	N/A
358	C.2.11.8.b	Inspect for erosion and corrosion on the wear plates. Inspect for rigidity, structural soundness, corrosion, and erosion of deck plates and reinforcing pads that are seal welded to the bottom under the deflector stand legs.	N/A
359	C.2.11.8.c	Measure for propeller clearance between the bottom of deflector stand and roof when the roof is on low legs.	N/A



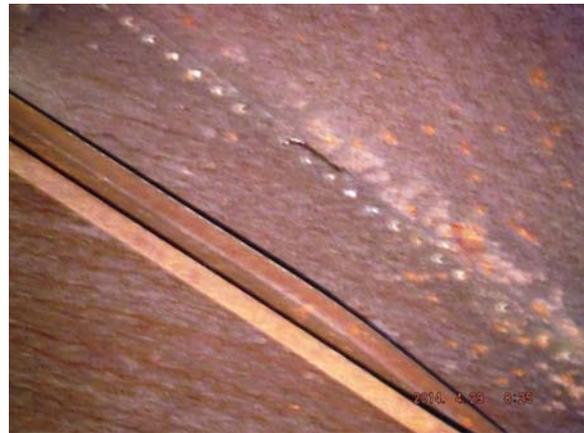
B. FOUNDATION
PORTIONS OF BOTTOM EXTENSION COVERED BY SOIL



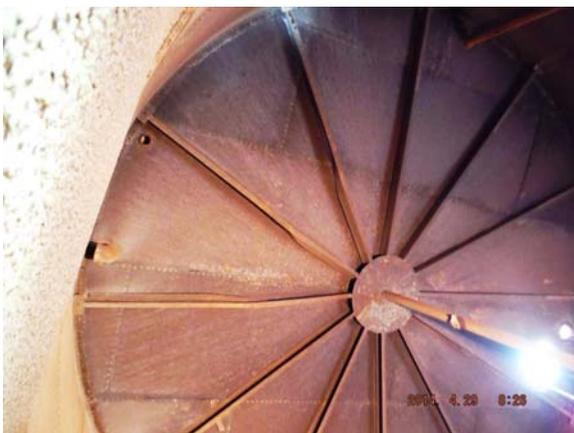
B. FOUNDATION
RAINWATER IN CONTACT WITH BOTTOM PLATES



B. FOUNDATION
MECHANICAL DENT IN LOWER SHELL



D. ROOF
DAMAGED ROOF



D. ROOF
TWISTED RAFTERS



D. ROOF
COATING FAILURE AND CORROSION ALONG CONE ROOF



D. ROOF
CORROSION ALONG UPPER ANGLE



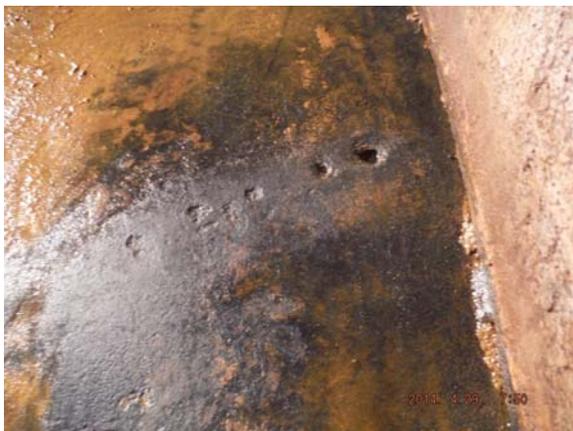
D. ROOF
CORROSION ALONG ROOF LAP WELDS



E. SHELL
CREASE IN SHELL PLATES



E. SHELL
CREASES IN SHELL



F. BOTTOM
**THROUGH-HOLE SOIL-SIDE CORROSION ALONG THE
BOTTOM PLATES**



F. BOTTOM
**POSSIBLE INDICATIONS OF MIC (MICROBIOLOGICALLY
INDUCED CORROSION)**



F. BOTTOM
WIDESPREAD MFL INDICATIONS OF SOIL-SIDE CORROSION ON BOTTOM PLATES



F. BOTTOM
WATER AND DIRT PREVENTED ACCURATE UT PROVE-UP OF MFL INDICATIONS



F. BOTTOM
WIDESPREAD MFL INDICATIONS OF SOIL-SIDE CORROSION

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B. FOUNDATION



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MECHANICAL DENT IN LOWER SHELL



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PORTIONS OF BOTTOM EXTENSION COVERED BY SOIL



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RAINWATER IN CONTACT WITH BOTTOM PLATES



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C. APPURTENANCES



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D. ROOF



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DAMAGED ROOF



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COATING FAILURE AND CORROSION ALONG CONE ROOF



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CORROSION ALONG UPPER ANGLE



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CORROSION ALONG ROOF LAP WELDS



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TWISTED RAFTERS



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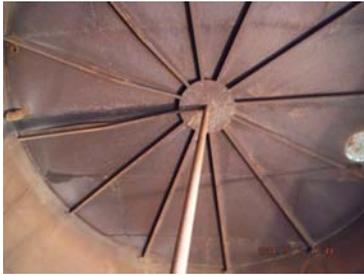


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E. SHELL



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CREASES IN SHELL



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CREASE IN SHELL PLATES



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F. BOTTOM



WIDESPREAD MFL INDICATIONS OF SOIL-SIDE CORROSION ON BOTTOM PLATES

WIDESPREAD MFL INDICATIONS OF SOIL-SIDE CORROSION

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WATER AND DIRT PREVENTED ACCURATE UT PROVE-UP OF MFL INDICATIONS



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THROUGH-HOLE SOIL-SIDE CORROSION ALONG THE
BOTTOM PLATES



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POSSIBLE INDICATIONS OF MIC (MICROBIOLOGICALLY INDUCED CORROSION)



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G. ACCESS STRUCTURE



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