US Army Corps of Engineers
Omaha District
API 653 Out-of-Service Inspection Report

Andrews AFB
Facility 3474
Tank 2

US Army Corps of Engineers Center of Expertise for Petroleum, Oils and Lubricants
(USACE POL-MCX)
2/5/2018

Table of Contents

ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
API	American Petroleum Institute
ATG	Automatic Tank Gauge
BBL	Barrel
BMP	Best Management Practice
COMAR	Code of Maryland Regulations
DB&B	Double Block and Bleed
HHLA	High-High Level Alarm
HLA	High Level Alarm
HLCV	High Level Control Valve
IAW	In Accordance With
ICCP	Impressed Current Cathodic Protection
IFR	Internal Floating Roof
LLA	Low Level Alarm
LLLA	Low-Low Level Alarm
MFL	Magnetic Flux Leakage
NDT	Non-Destructive Testing
NFPA	National Fire Protection Association
OOS	Out-of-Service
SG	Specific Gravity
UFC	Unified Facilities Criteria
USACE	United States Army Core of Engineers
UTT	Ultrasonic Thickness Testing
VT	Visual Testing
W/	With
W/O	Without

GENERAL SUMMARY

POND was under contract to the United States Army of Engineers (USACE), Omaha District, to provide an out-of-service (OOS) American Petroleum Institute (API) 653 tank inspection, provide a hydrostatic test of the tank containment, and replace the internal floating roof primary and secondary seals with double wiper seals on Tank 2 (Facility 3474), at Andrews Air Force Base (AFB) located in Joint Base Andrews, Maryland.

The OOS API 653 inspection was performed 30-31 January, 2018 in accordance with (IAW) API 653, 5th Edition. Results of this inspection and testing activities identified recommended repairs and upgrades required to comply with API 650/653, Unified Facilities Criteria (UFC) 3-260-01/3-460-03, AW 78-24-27, Code of Maryland Regulations (COMAR), and industry standards.

Contained in this report is a detailed account of the tank inspection, non-destructive testing (NDT) methods, and conclusions derived from the inspection and testing activities. Findings from this inspection are further detailed in Section B of this report. Recommended repairs and upgrades identified in Section B are further classified and listed in Section C of this report.

INSPECTION DATE

API Out-of-Service Inspection Date: 30-31 January, 2018
Equipment Used:

Manufacturer:	MFE Enterprises Tank Floor Scanner
Model Number:	MFE 2412 Mark III
Calibration Method:	Function Plate with Known Defect
Manufacturer:	GE Krautkramer Ultrasonic Thickness Gauge with Topcoat
Model Number:	DMS GO+
Calibration Method:	1-point Calibration
Manufacturer:	Fisher Technologies Dry Film Thickness Gauge
Model Number:	Dual Scope MPOR
Calibration Method:	Calibration to Known Thickness Standard
Manufacturer:	Johnson Self-Leveling Rotary Laser Level
Model Number:	40-6515
Calibration Method:	Self-Leveling

Inspector(s):

John Cronin
Andrew Morrissette

PREVIOUS INSPECTION DATES

API Out-of-Service (Internal) Inspection Date:	Unknown
API In-Service (External) Inspection Date:	Unknown

RECOMMENDED FUTURE INSPECTION DATES

Routine In-Service:	Monthly
API 653 Out-of-Service (Internal):	31 January 2028
API In-Service (External) w/o UTT:	31 January 2023
w/ UTT:	31 January 2033

NOTE:

IAW UFC 3-460-03, New Summary Sheet, Unification Issues, the Air Force requires tanks above 20,000 gallons in capacity to be cleaned on a ten (10) year cycle. Coating along the shell-to-bottom weld is in poor condition displaying disbondment from the shell and allowing water ingress due to tank sweating. Integrity of this weld could not be inspected due to the presence and condition of the coating. Based on the significance of the integrity of this weld, it is recommended to maintain a ten (10) year inspection interval to further evaluate the coating and weld integrity.



John Cronin, EIT	Andrew Morrissette	Brian W. Lunsford, P.E.
Integrity Engineer	Integrity Engineer	Program Manager / Integrity Engineer
API 653 Inspector # 77554		API 653 Inspector #28526

GENERAL TANK INFORMATION

ITEM	DESCRIPTION		
Owner	U.S. Air Force		
Location	Andrews AFB		
Facility Number	3474		
Tank Number	2		
State / Country	Maryland / United States		
City	Joint Base Andrews		
Inspection Date	30-31 January, 2018		
Tank Manufacturer	Witherup Fabrication and Erection, Inc.		
Design Standard	API 650, 10th Edition, Revision B		
Date of Construction	2005		
Tank Contents	JET-A (F-24) (SG = 0.85)		
Tank Diameter	31'-0"		
Tank Height	41'-3"		
Design Liquid Level	37'-7"		
Tank Capacity	5,000 Barrels (BBL) – 210,000 Gallons		
Foundation	Concrete Ring Wall		
Construction	Bottom	Cone Down / Lap-Welded Steel Plates	
	Shell	Butt-Welded Steel Plates / Five (5) Shell Courses	
	Floating Roof	Aluminum Honeycomb Pan / Double Wiper Seal System	
	Fixed Roof	Lap-Welded Steel Plates / Cone-Up / Self-Supported	
Material	Bottom	Carbon Steel	
	Shell	A-36 MOD Carbon Steel	
	Floating Roof	Aluminum	
	Fixed Roof	Carbon Steel	
Cathodic Protection	Impressed Current Cathodic Protection (ICCP) System		
Interior Coating System	Unknown (Assumed Epoxy Based)		
Exterior Coating System	Unknown (Assumed Epoxy Based)		
Level Gauging	Enraf Automatic Tank Gauge (ATG)		
Overfill Protection	High Level Control Valve (HLCV) and HLCV Shut-Off Switch / Four (4) Overflow Vents		
Piping	Product Receipt	8"	Carbon Steel
	Main Suction	12"	Carbon Steel
	Water Draw-Off	1 ½"	Carbon Steel
	Low Suction	4"	Carbon Steel
Level Alarms	High Level Alarm (HLA), High-High Level Alarm (HHLA), Low Level Alarm (LLA), and Low-Low Level Alarm (LLLA)		

A. GENERAL PROJECT INFORMATION

1. API 653 Inspection

An OOS API 653 inspection was performed 30-31 January, 2018 on Tank 2 (Facility 3474). Results of this inspection identified recommended repairs and upgrades required to comply with API 650/653, UFC 3-460-01/3-460-03, AW 78-24-27, and industry standards.

2. Site Information

Andrews Air Force Base is the airfield portion of Joint Base Andrews which is under the jurisdiction of the United States Air Force. In 2009, Andrews Air Force Base merged with Naval Air Facility Washington to form Joint Base Andrews. Andrews is the home base of two Boeing VC-25A aircraft with the call sign Air Force One when the president is on board, that serve the President of the United States.

The host unit at Andrews is the 11th Wing, assigned to the Air Force District of Washington. It is responsible for maintaining emergency reaction rotary-wing airlift and other National Capital Region contingency response capabilities critical to national security; and for organizing, training, equipping and deploying combat-ready forces for Air and Space Expeditionary Forces.

B. TANK INSPECTION COMMENTS

1. Tank Construction

Tank 2 (Facility 3474) is a welded, steel, single-wall, JET-A (F-24), vertical aboveground storage tank. The tank was constructed in 2005 by Witherup Fabrication and Erection, Inc. IAW API 650 10th Edition, Revision B. Tank 2 is 31'-0" in diameter and 41'-3" high with a nominal capacity of 5,000 BBL. Construction drawings were not available for review. The facility possesses strapping charts for the tank. Strapping charts are provided in 1" increments with a separate column for calculating values within 1/16" increments.

2. Tank Foundation

Tank 2 rests on a concrete ring wall foundation. The tank chime-to-ring wall interface is provided with sealant in good overall condition displaying only minor signs cracking and staining. Sealant provided at the tank ring wall-to-containment interface is in poor condition and exhibits signs of voids, cracking, disbondment, and vegetation growth. A settlement evaluation was performed during the inspection. No signs of settlement were noted. See Appendix A for settlements results.

3. Cathodic Protection

The tank is cathodically protected from soil-side corrosion by an ICCP system.

4. Tank Bottom

The tank bottom is of cone-down construction with lap-welded carbon steel plates. The tank bottom was examined using magnetic flux leakage (MFL), ultrasonic thickness testing (UTT), and visual testing (VT) methods. The MFL bottom scan revealed no indications of top-side or soil-side indications. Five (5) UTT measurements were taken on each bottom plate. One (1) UTT reading was taken every 2 feet around the tank perimeter within the tank bottom critical zone.

UTT readings revealed no significant metal loss on bottom plates. VT was performed along the bottom plate lap-welds and the bottom-to-shell weld. Coating along the shell-to-bottom weld displays disbondment. Due to possible sweating of the tank during change in temperatures throughout the day, moisture may seep behind the coating and come in contact with the shell-to-bottom weld. VT examination of the shell-to-bottom weld was limited due to the presence and condition of the internal coating. Two (2) anti-rotation cables are attached to the bottom via square-cornered attachments. Square corners present stress risers that could affect the integrity of the weld. The tank is currently equipped with a 29" diameter, 9" deep center sump. Coating provided for the center sump displays minor signs of failure and deterioration. Widespread pitting was observed throughout the tank bottom. Maximum pit depth was found to be 0.035". This value is within the maximum tolerance allowed by API. At the time of the inspection, pitting was coated and inactive. Pitting may have been limited to impurities and inclusions in the coating, caused by improper application or incorrect surface preparation.

Refer to Drawing 01, "Bottom Layout" for the bottom plate layout and Table 1, "Tank Bottom Ultrasonic Thickness Readings" and Table 2, "Tank Bottom Critical Zone Ultrasonic Thickness Readings" in Appendix A for bottom plate UTT readings.

5. Tank Shell

The tank shell is equipped with five (5) butt-welded A-36 MOD steel shell courses. Shell plates were examined using UTT and VT methods. Nine (9) UTT measurements were taken on each plate of the 1st shell course. Nine (9) UTT measurements were taken on the 2nd through 5th shell course using the spiral staircase for access. UTT readings indicated no significant metal loss. The tank shell is not provided with a National Fire Protection Association (NFPA) emergency responder diamond. Conduit provided for the HLCV shutoff and visible alarm system is supported along the tank shell via-stitch welded connections. Stitch-welding creates a crevice between the shell and support. Crevice corrosion and weep staining was observed during the inspection at the interstice.

Refer to Drawing 02, "Shell Rollout" and Table 4, "Shell Plate Ultrasonic Thickness Readings" in Appendix A for the shell plate layout and UTT readings.

6. Fixed Roof

The self-supported fixed roof is of cone-up construction with fully coated lap-welded steel plates. Fixed roof plates were examined using UTT and VT methods. Five (5) UTT measurements were taken on each fixed roof plate. UTT readings indicated no significant metal loss on the fixed roof plates.

Refer to Drawing 03, "Fixed Roof Layout" and Table 5, "Fixed Roof Ultrasonic Thickness Readings" in Appendix A for plate location and UTT readings.

7. Tank Appurtenances

a. Tank Shell

Shell nozzles consist of three (3) 36" manways, one (1) 8" receipt, two (2) 1 ½" HLCV shut-off switch penetrations, two (2) 1 ½" high level alarm penetrations, two (2) low level alarm (2) penetrations, one (1) 12" main suction, one (1) 4" low suction, and one (1) 1 ½" water draw-off line. Shell nozzles and reinforcement pads were examined using UTT and VT methods. Four (4)

UTT reading were taken on each nozzle with a welded connection in each of four (4) quadrants (0°, 90°, 180°, and 270°). One (1) UTT reading was taken on each reinforcement pad. UTT readings indicated no significant metal loss. Tell-tale holes provided for reinforcement pads are open to the atmosphere. The main suction and receipt piping is not provided standard military labeling. Crossover piping provided for the receipt and main suction lines are provided with sight flow indicators. Sight flows are no longer used in this application as they present potential leak paths. Coating provided for the main suction and receipt crossover piping, HLA, HHLA, HLCV shutoff, and the LLA displays flaking, corrosion staining, and deterioration. The HLA, HHLA, HLCV, and LLA are provided with threaded connections. The low suction line is provided with a 4" threaded connection proceeding the cam lock connection. UFC limits the use of threaded connections as they may not provide an adequate seal. The water draw-off line is provided with a ball valve at the tank skin location. Double block and bleed (DB&B) valves should always be used at the skin location as a ball valve may not provide adequate isolation during maintenance and inspection activities.

The internal main suction line extends half the tank radius; however, does not turn down towards the tank bottom. Neither the main suction nor low suction piping is provided with U-bolt attachments to limit lateral movement of the internal piping.

Refer to Drawing 02, "Shell Rollout" and Table 6, "Nozzles and Appurtenances" in Appendix A for nozzle location and data.

b. Fixed Roof

Fixed roof nozzles consist of two (2) 2 ½" anti-rotation cables, one (1) 36" manway with an 8" gauge hatch and internal access ladder, one (1) 6" Enraf automatic tank gauge (ATG) with an attached VITO temperature/water probe, one (1) 72" x 24" hatch, two (2) 2 ½" pan ground cables, one (1) 4" cap, one (1) 24" center vent, and one (1) 1 ½" tape level gauge penetration. Fixed roof nozzles and reinforcement pads were examined using UTT and VT methods. Four (4) UTT reading were taken on each nozzle with a welded connection in each of four (4) quadrants (0°, 90°, 180°, and 270°). One (1) UTT reading was taken on each reinforcement pad. UTT readings indicated no significant metal loss on nozzles and associated reinforcement pads. The Enraf ATG nozzle is equipped with carbon steel bolts that exhibit corrosion. The VITO temperature/water probe is provided in the same stilling well and riser as the Enraf ATG. To accurately gauge water levels within the tank, the VITO temperature/water probe should be placed as close to the tank sump as feasible. A cap located on a 1" pipe extruding the Enraf ATG riser is severely corroded exhibiting surface corrosion with metal loss.

Refer to Drawing 03, "Fixed Roof Layout" and Table 6, "Nozzles and Appurtenances" in Appendix A for nozzle location and data.

c. Gauging

The tank is provided with an Enraf ATG system for automatic tank gauging. The Enraf ATG has a fill height label stating 33'-0", while the strapping charts state the safe fill height as 34'-0". The Enraf ATG shares the same riser and stilling well as the VITO temperature/water probe. Manual

gauging is performed through the gauging hatch located on the fixed roof manway. Neither the Enraf ATG nor manual gauging hatch stilling wells are fully slotted. Stilling wells provided for the manual gauging hatch and Enraf ATG are attached directly to well guides at the tank bottom. If the tank begins to settle, this configuration may cause icreased stress at the tank bottom. The tank is provided with a Shand and Jurs float gauge for gauging the tank volume from the ground level.

d. Level Alarms

The tank is equipped with shell-mounted independent level alarms in the high, high-high, low, and low-low level positions. The tank is provided with a HLCV shutoff for overfill protection.

e. Stairs and Platforms

The tank is provided with a spiral staircase with three (3) platforms. The first platform as for access to MW3 and the internal floating roof (IFR). The second platform is for level alarm access and maintenance. The third platform is for access to the fixed roof.

f. Grounding and Bonding

The tank is equipped with four (4) grounding lugs and cables that are in good overall condition with no signs of damage or detachment.

8. Tank Coating

All exterior and internal surfaces of the tank are coated. Coating was in good overall condition with only minor signs of failure located primarily on nozzles, appurtenances, and in the center sump with the exception of the shell-to-bottom weld which displayed disbondment.

9. Fire Protection System

For internal fire protection, Tank 2 is provided with a full contact aluminum honeycomb IFR.

10. Secondary Containment

Tank 2 is located within a concrete containment dike. Control joints for the concrete dike floor exhibit damaged (voids, cracking, disbondment, and vegetation growth) sealant. Minor signs of cracking and spalling were observed throughout the containment dike floor. Based on year of construction of the tank, it could be assumed a flexible membrane liner is provided under the tank containment; however, due to lack of as-built or construction drawings this could not be verified. In the event of a spill, the containment dike can hold approximately 40,000 BBLs. This value is approximately 127% greater than the maximum capacity of the tank.

A leak test was performed by Dark Horse on the containment dike drainage system. The leak test consisted of filling the dike drain to 3 7/16" below the drain grate and holding this volume for approximately 2 hours and 15 minutes. At the end of this time interval there was no change in height from the drain grate.

11. Internal Floating Roof

The tank is provided with an aluminum honeycomb (IFR. The IFR was provided with foam log primary and secondary seals. The foam log seals were replaced with a double wiper seal system as part of this

inspection. The IFR was examined using VT methods. No gross defects nor damage were noted. The IFR is provided with six (6) support legs. Each support leg is provided with a landing pad that are sealed to the tank bottom. Two (2) mounting clips for the IFR anti-rotation cables are welded directly to the tank bottom and not provided with a fully seal welded base plate.

C. OBSERVATIONS AND RECOMMENDATIONS

The following subsections outline the itemized tank repairs/upgrades. Repairs and upgrades shall be completed IAW API 653, UFC 03-460-01, requirements and best engineering practice.

1. MANDATORY REPAIRS per API 653, UFC 3-460-01, or AW 78-24-27 Standards

Mandatory repairs represent items that require immediate attention, in order to prevent imminent risk to system operators, equipment integrity, or the adjacent environment. The tank should remain OOS until these repairs are completed.

There are no mandatory repairs required to return the tank to service.

2. RECOMMENDED REPAIRS to Fully Comply with API 653, UFC 3-460-01, or AW 78-24-27 Standards

Recommended repairs represent items that should be addressed in a timely manner in order to prevent future potential risks to system operators, equipment integrity, or the adjacent environment. These items may be required by Federal, State and Local Codes or by Military Criteria.

a. Tank Chime Sealant

OBSERVATION: Sealant provided for the tank chime displays cracking and staining.
CODE REFERENCE: UFC 3-460-03 SECTION 8-4.1.B
RECOMMENDATION: Provide approximately 5 linear feet of sealant repair at the tank chime-to-ring wall interface.

b. Pipeline Labeling

OBSERVATION: Piping within the containment dike is not provided with standard military labeling.

CODE REFERENCE: UFC 3-460-01, 2-18

RECOMMENDATION: Provide MIL-STD-161H labeling and flow arrows on the receipt and main suction line.

c. Ring Wall Control Joint

OBSERVATION: The tank ring wall-to-containment interface exhibits voids, cracking, disbondment, and vegetation growth.

CODE REFERENCE: UFC 3-460-03 SECTION 8-10.2.2 (C)

RECOMMENDATION: Provide approximately 100 linear feet (100%) of sealant repair at the tank ring wall-to-containment interface with a flexible, UV protective, and fuel resistant sealant.

d. Control Joint Sealant

OBSERVATION: Sealant provided for control joints located in the containment dike exhibit voids, cracking, disbondment, and vegetation growth.

CODE REFERENCE: UFC 3-460-03 SECTION 8-10.2.2 (C)

RECOMMENDATION: Provide approximately 50 linear feet of sealant repair at control joints within the containment dike with a flexible, UV protective, and fuel resistant sealant.

e. Containment Floor Cracking

OBSERVATION: Cracking was observed throughout the containment dike floor.

CODE REFERENCE: UFC 3-460-03 SECTION 8-10.2.2 (C)

RECOMMENDATION: Provide approximately 25 linear feet of sealant to cracking located throughout the containment dike.

f. Containment Floor Spalling

OBSERVATION: Spalling and damage was observed throughout the containment dike floor.
CODE REFERENCE: UFC 3-460-03 Section 8-10.2.2 (B)
RECOMMENDATION: Repair concrete dike floor. Existing floor exhibits approximately 10 ft^2 of spalling and damage.


g. Emergency Responder Diamond

OBSERVATION: The tank is not provided with an emergency responded diamond.
CODE REFERENCE: UFC 3-460-01 2-18 (C)
RECOMMENDATION: Provide emergency responder diamond in accordance with NFPA 704.


h. Coating Failure

OBSERVATION: Coating provided for various piping, nozzles, and appurtenance displays flaking, corrosion staining, and deterioration.

CODE REFERENCE: UFC 3-460-03, Section 8-3.1

RECOMMENDATION: Provide approximately 12 ft^2 of coating repair at the following piping, nozzles, and appurtenances:

- Main suction crossover piping – 2 ft^2
- Receipt crossover piping – 2 ft^2
- HLA, HHLA, and high level control valve (HLCV) shutoff switch – 2 ft^2
- LLA and LLLA – 3 ft^2
- Center sump – 1 ft^2

i. Low Suction Piping

OBSERVATION: The low suction line is provided with 4" threaded piping. Threaded piping is not recommended for piping larger than 2".

CODE REFERENCE: UFC 3-460-01, 7-5.2 (a)

RECOMMENDATION: Replace 1 linear foot of threaded piping located on the 4" low suction line.

j. Water Draw-Off Line

OBSERVATION: The water draw-off line is provided with a ball valve at the skin location. Ball valves may not provide adequate isolation during maintenance and inspection operations.
CODE REFERENCE: UFC 3-460-01, Table 8-1 (Z)
RECOMMENDATION: Replace 1" ball valve with a 1" DB&B valve on the water draw-off line.


k. Internal Shell-to-Bottom Weld

OBSERVATION: Coating along the shell-to-bottom weld displayed cracking and disbondment.
CODE REFERENCE: UFC 3-460-03, Section 8-3.2
RECOMMENDATION: Recoat 100 ft^2 (100%) of internal shell-to-bottom weld.


l. Sight Flow Indicators

OBSERVATION: Sight flow indicators are located in crossover piping for the main suction and receipt line. Sight flow indicators are no longer used in this application as they present potential leak paths.

CODE REFERENCE: UFC 3-460-01 9-3.5.1

RECOMMENDATION: Remove two (2) sight flow indicators located in the crossover piping provided for the receipt and main suction lines.

m. HLA, HHLA, HLCV, LLA, and LLLA

OBSERVATION: Piping provided for the HLA, HHLA, HLCV, LLA, and LLLA and provided with threaded connections.

CODE REFERENCE: UFC 3-460-01, 7-5.2 (b)

RECOMMENDATION: Either replace the HLA, HHLA, HLCV, LLA, and LLLA piping with welded/flanged connections or seal weld existing threaded connections.

n. VITO Temperature/Water Probe

OBSERVATION: The VITO temperature/water probe shares a nozzle riser and stilling well with the Enraf ATG.

CODE REFERENCE: UFC 3-460-01, Table 8-1 (S) / DLA-E ATG Policy

RECOMMENDATION: Provide the VITO temperature/water probe with an 8" riser and 6" fully slotted stilling well as close to the center sump as feasible.

o. Enraf ATG Fasteners

OBSERVATION: Fasteners provided for the Enraf ATG flanges display coating failure and surface corrosion.

CODE REFERENCE: UFC 3-460-01, 9-8 (f)

RECOMMENDATION: Replace sixteen (16) corroded fasteners located in the Enraf ATG flange.

p. Main Suction Internal Piping

OBSERVATION: Internal piping provided for the main suction line does not turn down, and is not provided with an anti-vortex plate.

CODE REFERENCE: AW 78-24-27, D.08 (4)

RECOMMENDATION: Provide the 12" main suction line with a short radius elbow and anti-vortex plate.

q. Tell-Tale Hole

OBSERVATION: Tell-tale holes provided for nozzle reinforcement pads are opened to the atmosphere allowing water ingress, and place for insects nesting.

CODE REFERENCE: UFC 3-460-03, 8-9.13.4.1

RECOMMENDATION: Provide a heavy lithium grease to all nozzle reinforcement pad tell-tale holes to prevent water ingress.

r. Gauging Stilling Wells

OBSERVATION: Stilling wells provide for the Enraf ATG and manual gauging hatch are partially slotted, with slots only running up to initial 4 ft of the stilling well.

CODE REFERENCE: UFC 3-460-01, Table 8-1 (R)/(S) / DLA-E ATG Policy

RECOMMENDATION: Fully slot stilling wells provided for the manual gauging hatch and Enraf ATG.

s. Anti-Rotation Cable

OBSERVATION: Two (2) anti-rotation cables are attached directly to the tank bottom via square corner attachments.

CODE REFERENCE: API 653 Figure 9-13

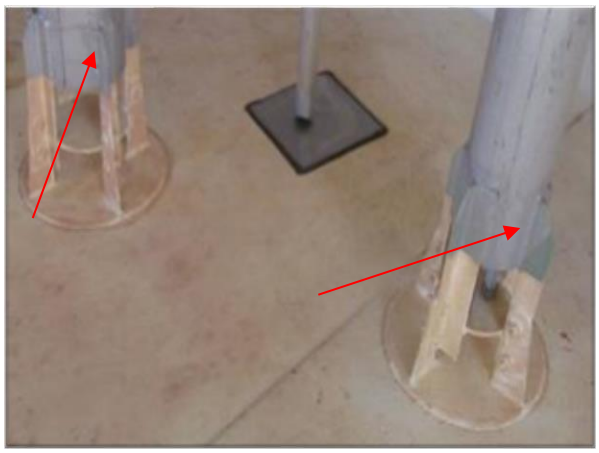
RECOMMENDATION: Provide two (2) circular bearing plates for both anti-rotation cables.

t. U-bolt

OBSERVATION: The main suction and low suction lines are not provided with U-bolts, used to limit lateral movement of the piping during regular operations.
CODE REFERENCE: AW 78-24-27, D.08 (6)
RECOMMENDATION: Provide one (1) stainless steel u-bolt restraint with loosened nuts for both the internal main suction and low suction line. Internal piping must be allowed to move vertically with the tank bottom.


u. Attached Stilling Wells

OBSERVATION: Stilling wells provided for the manual gauging hatch and Enraf ATG are attached directly to well guides. This attachment may cause severe damage to the tank bottom should the tank begin to settle.
CODE REFERENCE: AW 78-24-27, D.08 (6)
RECOMMENDATION: Rework stilling wells for the manual gauging hatch and Enraf ATG by removing welds attaching the stilling wells to well guides.

3. RECOMMENDED REPAIRS as Part of Regular Maintenance

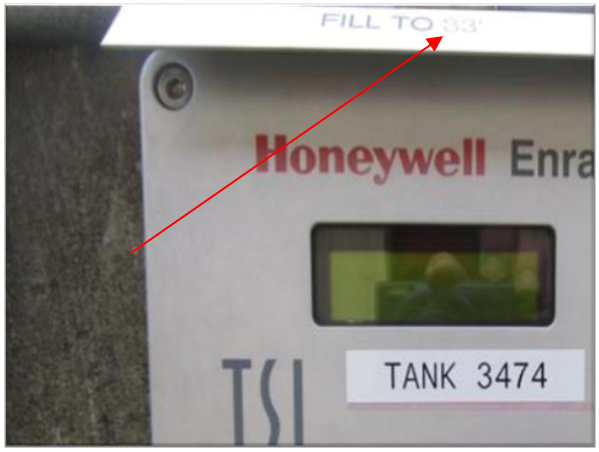
Recommended repairs represent items that should be addressed in a timely manner in order to prevent future potential risks to system operators, equipment integrity, or the adjacent environment.

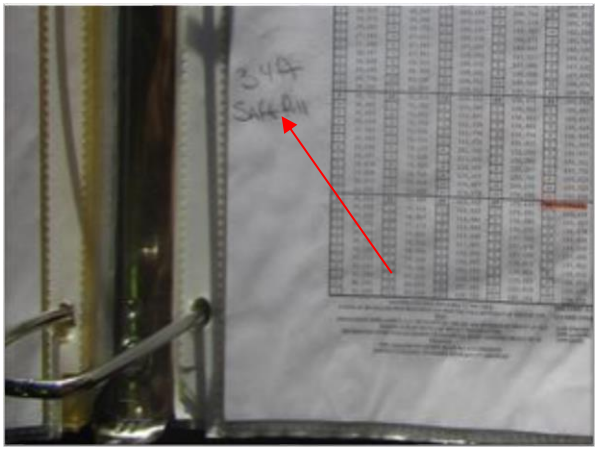
a. Conduit Support

OBSERVATION: Conduit supports provided for the HLCV and visible alarm conduit is stitch-welded. Crevice corrosion and staining was observed between the conduit-to-shell interfaces.
CODE REFERENCE: BMP
RECOMMENDATION: Provide sealant or fully weld eighteen (18) stitch-welded conduit supports provided for both the HLCV conduit and the visible alarm conduit.

b. Fill Height

OBSERVATION: A white label is placed on the Enraf ATG stating a fill height of 33'-0" while the strapping charts list the safe fill height as 34'-0".
CODE REFERENCE: BMP
RECOMMENDATION: Correct safe fill limit shown on the Enraf ATG display.





c. Pipe Cap

OBSERVATION: Cap located on piping extruding from the Enraf ATG riser displays significant surface corrosion with noticeable metal loss.

CODE REFERENCE: BMP

RECOMMENDATION: Replace corroded cap located on the 1" pipe extruding from the Enraf ATG riser.

D. INSPECTION INTERVALS

Intervals between tank inspections (both internal and external) should be determined by the tank service history, corrosion rates, and regulatory requirements. Corrosion rates can only be determined when a comparison is made between measurements taken over an interval of time. In this case, corrosion rates were determined based on the assumed nominal thicknesses and actual thickness measurements taken during this inspection.

1. Routine In-service Inspection

Facility personnel shall perform a visual inspection of the tank exterior surfaces, containment, and associated piping. Gross defects, leaks, shell distortions, signs of settlement, and corrosion should all be monitored along with the foundation condition (including tank chime-to-foundation interface), coating, and appurtenances.

Interval: Monthly

2. External (In-Service) Inspection

An API certified inspector shall perform this inspection every five (5) years or RCA/4N years (where RCA is the difference between the measured shell thickness and the minimum required thickness and N is the shell corrosion rate) whichever is less. This inspection includes inspection requirements of the routine in-service inspection as well as a visual inspection of the tank grounding system (shunts and cables) for damage.

Interval: Five (5) years; January 2023

3. Ultrasonic Thickness Inspection

An external UT inspection of the tank shell and roof (if applicable) shall be performed by an API certified inspector every fifteen (15) years or RCA/4N, whichever is less. The UT inspection may be performed in conjunction with the external inspection.

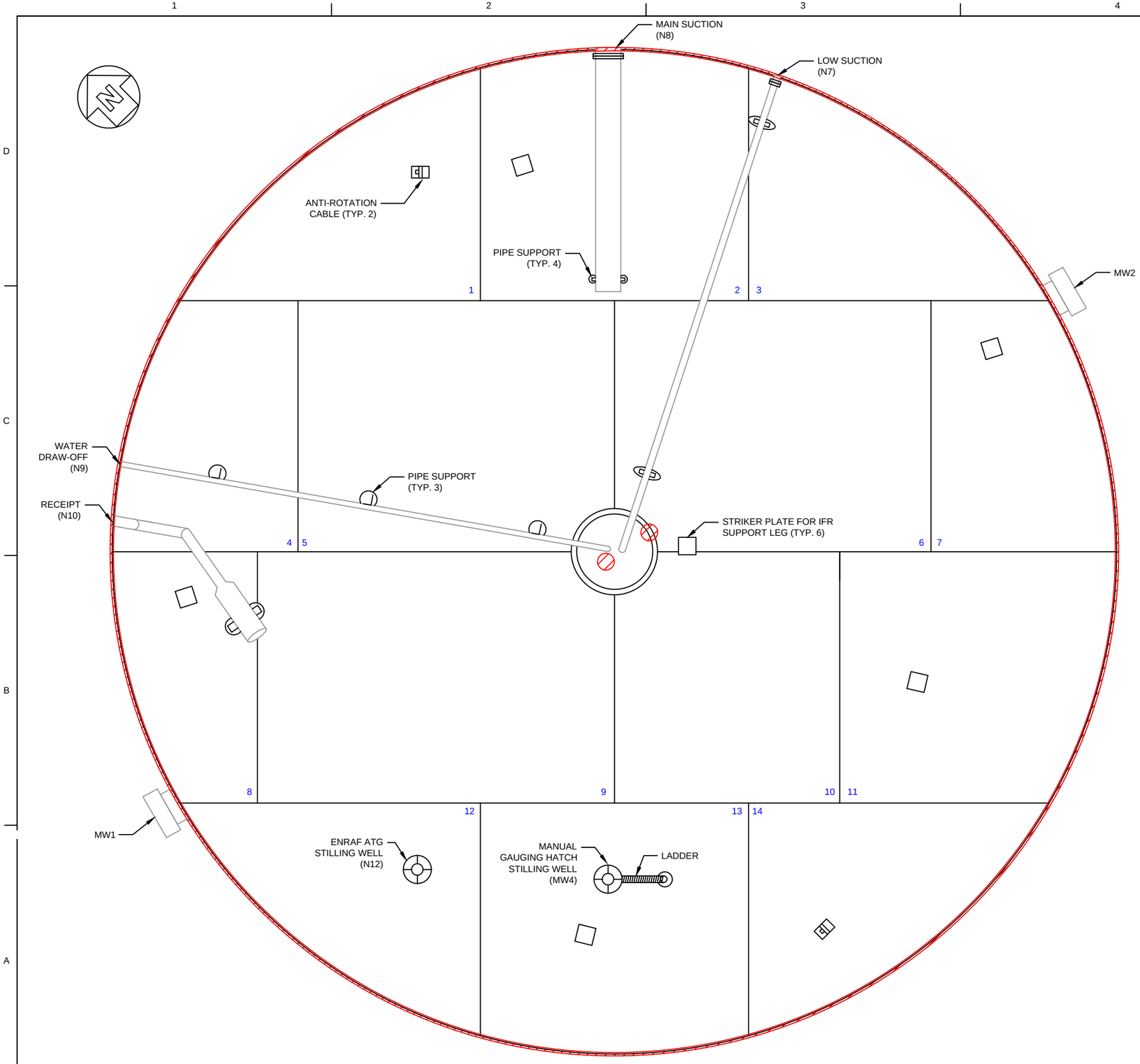
Interval: Fifteen (15) years; January 2033

4. Internal (Out-of-Service) Inspection

An API certified inspector shall perform the internal inspection every 20 years or ½ remaining life of the tank bottom, whichever is less. This inspection includes a visual inspection of the tank interior surfaces and associated piping and an evaluation of the tank bottom via NDT methods. Since UFC requires tank cleaning every ten (10) years, it is recommended to perform the next internal inspection at this date to further evaluate the shell-to-bottom weld.

Interval: Ten (10) years; January 2028

APPENDIX A: ENGINEERING CALCULATIONS AND DRAWINGS



TANK INFORMATION

TANK NO. (FACILITY NO.):	2 (3474)
MANUFACTURER:	WITHERUP FABRICATION AND ERECTION, INC.
YEAR BUILT:	2005
TANK DIAMETER:	31'-0"
TANK HEIGHT:	41'-3"
MAX FILL CAPACITY:	5,000 BBLS
PRODUCT:	JET-A (F-24)
PRODUCT SPECIFIC GRAVITY:	0.85
GPS COORDINATES:	N 38° 48' 56.16"
	W 76° 51' 28.67"

NOTES:

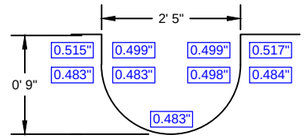
1. REFER TO TABLE 1, "TANK BOTTOM PLATE ULTRASONIC THICKNESS READINGS" IN APPENDIX A FOR INDIVIDUAL BOTTOM PLATE UTT READINGS.
2. REFER TO TABLE 2, "TANK BOTTOM CRITICAL ZONE ULTRASONIC THICKNESS READINGS" IN APPENDIX A FOR CIRCUMFERENTIAL UTT READINGS.
3. REFER TO TABLE 6, "NOZZLES AND APPURTENANCES", IN APPENDIX A FOR NOZZLE DATA.

LEGEND

.XXX" - UTT READING

- COATING FAILURE

SUMP DETAIL



MARK	DESCRIPTION	DATE	APPR.	MARK	DESCRIPTION	DATE	APPR.

DATE: 2/6/2018
CONTRACT NO.: W912HF-17-D-0016
DELIVERY ORDER NO.: W912BF17F0192
FILE NUMBER: N/A
DESIGNED BY: N/A
CAD BY: DLC
PLOT DATE: 2/6/2018
FILE NAME: N/A
DWN BY: BSM
SUBMITTED BY: KBB
PLOT SCALE: NTS
SIZE: 11" X 17"

USACE
OMAHA DISTRICT

POND
POND & COMPANY
3985 Research Park Drive, Suite 400
Peachtree Corners, GA 30092
Phone: (770) 325-7740
Fax: (678) 336-2714
POND NO. 1182748

TANK 2 LAYOUT
ANDREWS AFB
JOINT BASE ANDREWS, MARYLAND
BOTTOM LAYOUT

SHEET IDENTIFICATION
01
SHEET 1 OF 3

Table 1: Tank Bottom Ultrasonic Thickness Readings

	Plate 1		Plate 2		Plate 3		Plate 4		Plate 5	
	.306	.306	.316	.315	.307	.305	.309	.305	.302	.302
		.303		.316		.304		.315		.303
	.306	.305	.310	.316	.306	.305	.312	.315	.304	.302
Avg.		.305		.315		.305		.311		.303
	Plate 6		Plate 7		Plate 8		Plate 9		Plate 10	
	.309	.306	.303	.304	.301	.303	.302	.312	.310	.306
		.311		.304		.305		.317		.304
	.308	.309	.300	.301	.301	.303	.310	.313	.304	.307
Avg.		.309		.302		.303		.311		.306
	Plate 11		Plate 12		Plate 13		Plate 14			
	.306	.312	.299	.301	.311	.311	.304	.304		
		.317		.303		.313		.306		
	.316	.314	.305	.312	.314	.303	.306	.305		
Avg.		.313		.304		.310		.305		

Thickness reading in inches.
Average tank bottom thickness reading: 0.307”
Refer to Drawing 01, Bottom Layout, for plate layout.

Table 2: Tank Bottom Critical Zone Ultrasonic Thickness Readings

0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32
.300	.306	.302	.307	.319	.323	.320	.313	.310	.299	.307	.311	.310	.309	.309	.309	.319
34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66
.319	.320	.309	.309	.310	.307	.309	.312	.303	.306	.300	.303	.316	.319	.314	.316	.317
68	70	72	74	76	78	80	82	84	86	88	90	92	94	96		
.306	.311	.309	.308	.304	.302	.313	.315	.314	.318	.311	.306	.309	.306	.301		

Thickness readings are in inches.
Average tank bottom critical zone plate thickness reading: 0.310”
Refer to Drawing 01, Bottom Layout, for plate layout and UTT reading locations.
0’ = directly below manway opening.
Thickness readings were taken within 3” of the shell-to-bottom weld proceeding clockwise around the tank.

STORAGE TANK FLOOR EVALUATION
MINIMUM REMAINING THICKNESS (MRT) CALCULATIONS

Date 01/31/2018

File No	Report No	Client	Inspector	Tank No	Temp (degF)
766	Andrews AFB Tank 2 (3474)	USACE Omaha	John Cronin (POND)	Tank 2 (3474)	

Liner	CP Protec	50mil Liner	RPB	Ca	Shell tmin	Shell tnom	D	H
Yes	Yes	No	N/A	0.188	0.101	0.250	31.000	37.583

Where;
Ca = corrosion allowance, in (inch).
MRT = minimum remaining thickness at the end of interval Or. This value must meet the requirements of Table 4-1 and sections 2.4.7.4 and 2.4.8.
Or = In-service interval of operation (years to next internal inspection) not to exceed that allowed by 4.4.2.
RTbc = minimum remaining thickness from bottom side corrosion after repairs.
RTip = minimum remaining thickness from internal corrosion after repairs.
StPr = maximum rate of corrosion not repaired on the top side. StPr = 0 for coated areas of the bottom. The expected life of the must equal or exceed Or to use StPr = 0.
tmin = minimum allowable thickness in accordance with requirements of Table 4-1 and sections 2.4.7.4 and 2.4.8.
to = bottom plate original thickness.
UPr = maximum rate of corrosion on the bottom side. To calculate the corrosion rate, use the minimum remaining thickness after repairs. Assume a linear rate based on the age of the tanks. UPr = 0 for areas that have effec
D = nominal diameter of tank, in (ft),
H =Height, in (ft), from the bottom of the 1st shell course to the maximum allowable fill height
S=Stresses are calculated from 2.6(H-1)DG/SE.

GENERAL PLATES-AFTER INSPECTION / REPAIRS

Age	to	RTbc	RTip	UPr	StPr	Or	MRT	tmin	Results
13	0.313	0.307	0.307	0.00000	0.00000	20	0.307	0.100	ACCEPTABLE

PLATES IN CRITICAL ZONE (3") - AFTER INSPECTION / REPAIRS

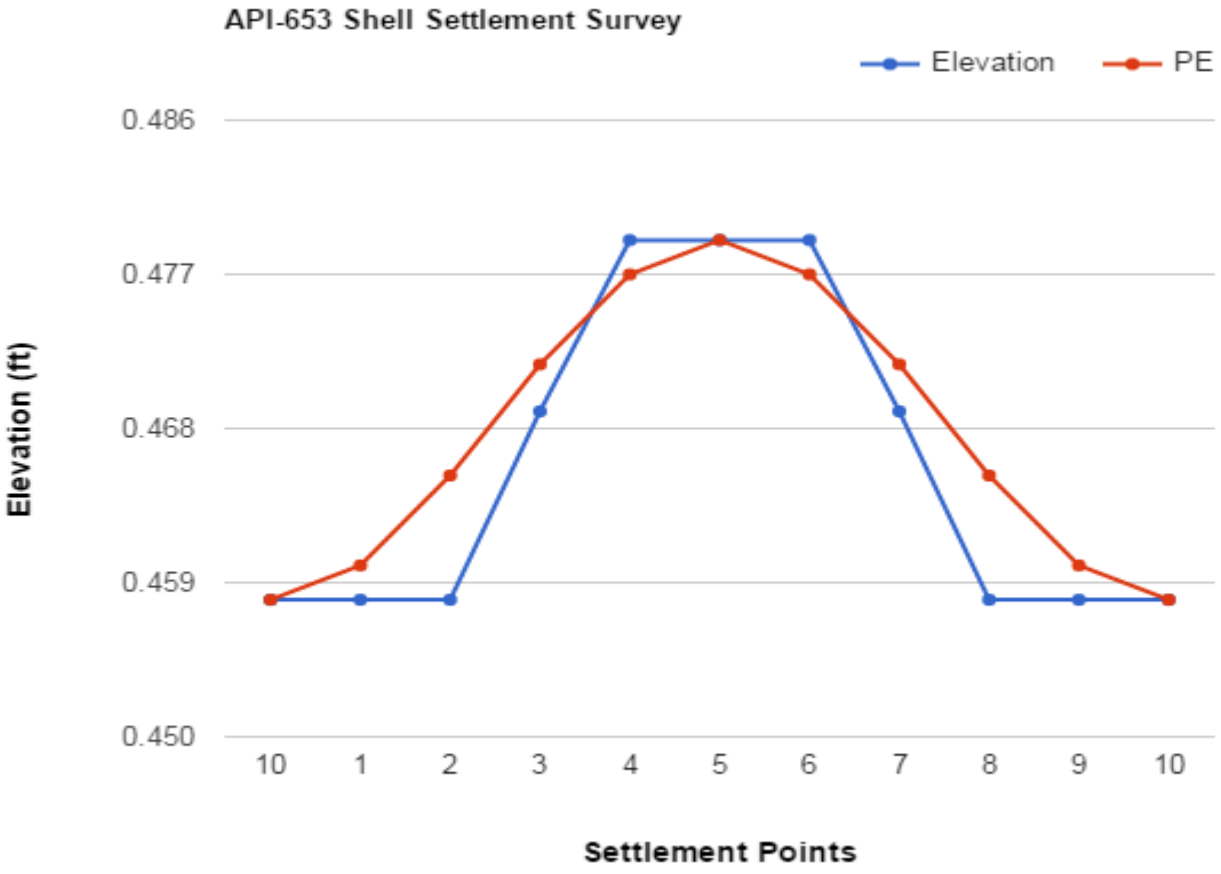
Age	to	RTbc	RTip	UPr	StPr	Or	MRT	tmin	Results
13	0.313	0.310	0.310	0.00000	0.00000	20	0.310	0.100	ACCEPTABLE

Nominal thickness was assumed to be 0.3125" (5/16").

API-653 APPENDIX B SHELL SETTLEMENT EVALUATION

(para. B.2.2.4)

Report No	Client	Inspector	Vessel	Date
Andrews AFB Tank 2 (3474)	USACE Omaha	John Cronin (POND)	Tank 2 (3474)	02/06/2018



	Base Elev	Max Elev	ΔElev		
FT	0.458	0.479	0.021	R^2 =	0.960
IN	5.496	5.748	0.252		

API-653 APPENDIX B SHELL SETTLEMENT EVALUATION

Report No.: Andrews AFB
Tank 2 (3474)

D	H	Roof Type	L	1st Crs Plt Spec	Y	E
31	41.3	F	9.74	A 36	36000	29000000

Where:
D = Tank Diameter, in ft
H = Tank Height, in ft
Roof Type: F = fixed, O = Open
L = Arc length between measurement points, in ft (32' max) (greatest dist. allowed based on even # of points)
Y = Yield strength of shell 1st course , in pounds per Sq.Inch (psi)
E - Young's modulus, in pounds per Sq.Inch (psi)
θ = Angle theta at elevation point, in degrees
PE = Predicted elevation, in ft
Ui = Measured out-of-plane settlement in relation to a cosine curve, in ft
Si = Deflection, in ft, (out-of-plane distortion)
Smax = Maximum allowed deflection, in ft, (out-of-plane distortion)

Smax =((L^2*Y*11)/2*(E*H)) = **0.016**

Point	*Elevation*	*θ*	*PE*	*Ui*	*Si*	*Results*
1	0.458	0	0.460	-0.002	0.002	SAT
2	0.458	36	0.465	-0.007	-0.005	SAT
3	0.469	72	0.472	-0.003	0.000	SAT
4	0.479	108	0.477	0.002	0.003	SAT
5	0.479	144	0.479	0.000	-0.002	SAT
6	0.479	180	0.477	0.002	0.003	SAT
7	0.469	216	0.472	-0.003	0.000	SAT
8	0.458	252	0.465	-0.007	-0.005	SAT
9	0.458	288	0.460	-0.002	0.002	SAT
10	0.458	324	0.458	0.000	0.002	SAT

Table 3: Tank Bottom Elevation Measurements

Point	Arc Length (ft.)	0'-2"	10'-0"	15'-0"
1	0.00	.458	1.083	1.271
2	9.74	.458	1.042	1.271
3	19.48	.469	1.000	1.271
4	29.22	.479	.948	1.271
5	38.96	.479	1.052	1.260
6	48.69	.479	1.063	1.271
7	58.43	.469	1.010	1.271
8	68.17	.458	.854	1.271
9	77.91	.458	OBS	1.271
10	87.65	.458	1.000	1.271

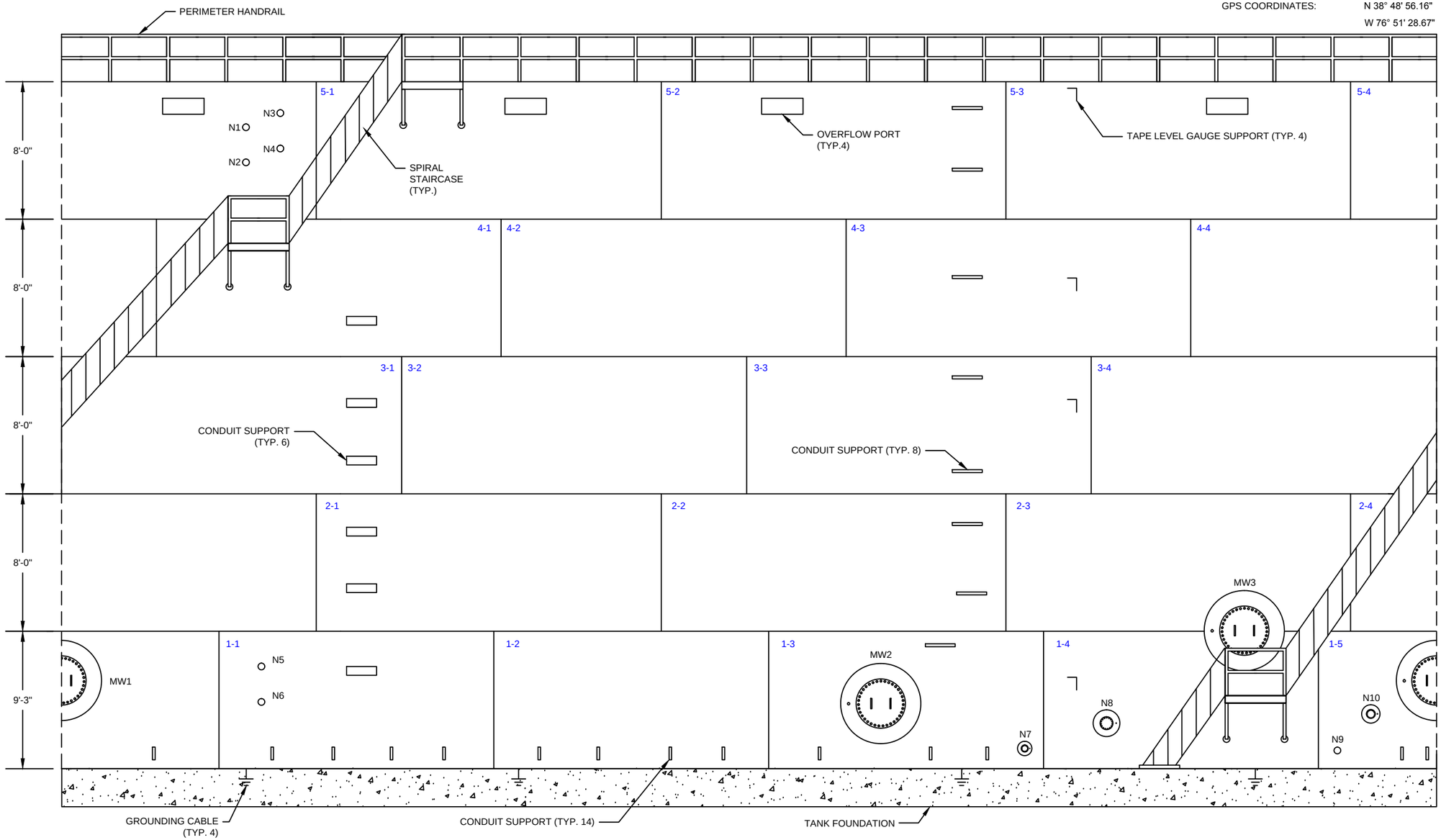
Point 1 is located at Manway 1 and subsequent points are measured clockwise circumferentially every 9.74'.

NOTES:

1. REFER TO TABLE 5, "SHELL PLATE ULTRASONIC THICKNESS READINGS", IN APPENDIX A FOR INDIVIDUAL SHELL PLATE UTT READINGS.
2. REFER TO TABLE 6, "NOZZLES AND APPURTENANCES", IN APPENDIX A FOR NOZZLE DATA.

TANK INFORMATION

TANK NO. (FACILITY NO.):	2 (3474)
MANUFACTURER:	WITHERUP FABRICATION AND ERECTION, INC.
YEAR BUILT:	2005
TANK DIAMETER:	31'-0"
TANK HEIGHT:	41'-3"
MAX FILL CAPACITY:	5,000 BBLS
PRODUCT:	JET-A (F-24)
PRODUCT SPECIFIC GRAVITY:	0.85
GPS COORDINATES:	N 38° 48' 56.16"
	W 76° 51' 28.67"



MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: N/A
DRAWN BY: JRD
SUBMITTED BY: KBB
PLOT SCALE: NTS
PLOT DATE: 2/6/2019
FILE NAME: N/A
SIZE: 11" X 17"
DATE: 2/6/2019
CONTRACT NO.: W912BF-17-D-0016
DELIVERY ORDER NO.: W912BF17F0192
FILE NUMBER: N/A

USACE
OMAHA DISTRICT

BOND
BOND ARCHITECTS, INC.
Peachtree Corners, GA 30092
Phone (678) 336-7140
Fax (678) 336-7144
FOB NO. 13357-99

TANK 2 LAYOUT
ANDREWS AFB
JOINT BASE ANDREWS, MARYLAND
SHELL ROLLOUT

SHEET IDENTIFICATION
02
SHEET 2 OF 3

Table 4: Shell Plate Ultrasonic Thickness Readings

Roof				
Shell Course 5	Plate 5-1	Plate 5-2	Plate 5-3	Plate 5-4
	.277 .266 .280 .269 .265 .275 .267 .261 .278	N/A	N/A	N/A
Avg.	.271			
Circumferential Weld C5				
Shell Course 4	Plate 4-1	Plate 4-2	Plate 4-3	Plate 4-4
	.284 .285 .309 .288 .295 .288 .294 .274 .300	N/A	N/A	N/A
Avg.	.291			
Circumferential Weld C4				
Shell Course 3	Plate 3-1	Plate 3-2	Plate 3-3	Plate 3-4
	.304 .270 .277 .286 .271 .283 .284 .271 .302	N/A	N/A	N/A
Avg.	.266			
Circumferential Weld C3				
Shell Course 2	Plate 2-1	Plate 2-2	Plate 2-3	Plate 2-4
	N/A	N/A	N/A	.274 .285 .297 .270 .284 .285 .269 .278 .285
Avg.				.281
Circumferential Weld C2				
Shell Course 1	Plate 1-1	Plate 1-2	Plate 1-3	Plate 1-4	Plate 1-5
	.276 .284 .288 .285 .283 .282 .281 .280 .279	.286 .296 .310 .282 .283 .308 .290 .279 .285	.306 .309 .276 .305 .321 .287 .298 .317 .271	.288 .310 .279 .289 .297 .278 .296 .281 .275	.288 .292 .280 .274 .284 .277 .275 .298 .276
Avg.	.282	.291	.299	.288	.283
Circumferential Weld C1					

Thickness readings are in inches.
Shell Course 1 Average: 0.289”
Shell Course 2 Average: 0.281”
Shell Course 3 Average: 0.266”
Shell Course 4 Average: 0.291”
Shell Course 5 Average: 0.271”
Refer to Drawing 02, Shell Rollout, for shell layout.

Tank Shell Minimum Thickness and Remaining Life Calculations Date 02/06/2018

File No.	Report No.	Client	Tank No.	Temp. (degF)	Initials
1908	Andrews AFB Tank 2 (3474)	USACE Omaha	Tank 2 (3474)		John Cron

SHELL MINIMUM THICKNESS CALCULATIONS

$$t_{min} = \frac{2.6(H-1)DG}{SE}$$

Where:

H = The height above the bottom of the course of study to the maximum liquid level height of the product, in ft. For corroded or pitted areas, H = the height from the bottom of the corroded or pitted area to the maximum liquid level height of the product, in ft.

tmin = The calculated minimum acceptable shell thickness, in inch (cannot be less than 0.10 inch for any course). The minimum acceptable shell thickness allowed by API-653 and STI-SP001 for tank size, in inch .

D = Nominal diameter of tank, in ft.

G = Highest specific gravity of the contents (including test water if tank will, or may, be tested in the future).

S = Maximum allowable stress, in psi. For welded tanks; use the smaller of 0.80Y of 0.429T for bottom and second course or the smaller of 0.88Y or 0.472T for all other courses. For riveted tanks; S = 21000 psi. For STI Tank Inspections S = 26000 psi (E = 1)

Y = Specified minimum yield strength of the plate, in psi; use 30000 psi if not known (N/A for riveted tanks).

T = The smaller of the specified minimum tensile strength of the plate or 80000 psi; use 55000 psi if not known (N/A for riveted tanks).

E = Original joint efficiency for the tank. For welded tanks; use API-653, Table 2-1 ; use E = 1.0 when evaluating the retirement thickness in a corroded plate, when away from welds or joints by at least the greater of one inch or twice the plate thickness. For riveted tanks; use E = 1.0 for shell plates greater than 1 inch away from rivets; use the value of E from API-653 Table 2-1 when within 1 inch of rivets. For STI Tank Inspections E = 1 where S = 26000 psi.

D (ft) 31 G 0.85 E 1.00 Fill Height (ft) 37.6

	Material	Crs H (ft)	H (ft)	S (psi)	tmin (inch)
Course 1	A 36	9.25	37.6	24900	0.101
Course 2	A 36	8	28.3	24900	0.100
Course 3	A 36	8	20.3	27400	0.100
Course 4	A 36	8	12.3	27400	0.100
Course 5	A 36	8	4.3	27400	0.100

Tank Shell Minimum Thickness and Remaining Life Calculations Date 02/06/2018

File No.	Report No.	Client	Tank No.	Temp. (degF)	Initials
1908	Andrews AFB Tank 2 (3474)	USACE Omaha	Tank 2 (3474)		John Cron

SHELL REMAINING LIFE CALCULATIONS

Ca = tact-tmin = Remaining Corrosion Allowance (inch)
Cr = tprev-tact / Y = Corrosion Rate (inch/Yr)
RL = Ca / Cr = Remaining Life (year)
Y = 13 = Tank age (year)

Where:

Ca = Remaining corrosion allowance of the shell course under consideration, in inch.

Cr = Corrosion rate of the shell course under consideration, in inch per year.

FHc = Calculated fill Height = (SEtact/2.6DG+1) + (product height below course of interest), in ft.

tact = Minimum thickness measurement of the shell course under consideration, as recorded at the time of inspection, in inch.

tmin = minimum required thickness of shell course, at the maximum allowable fill height, in inch.

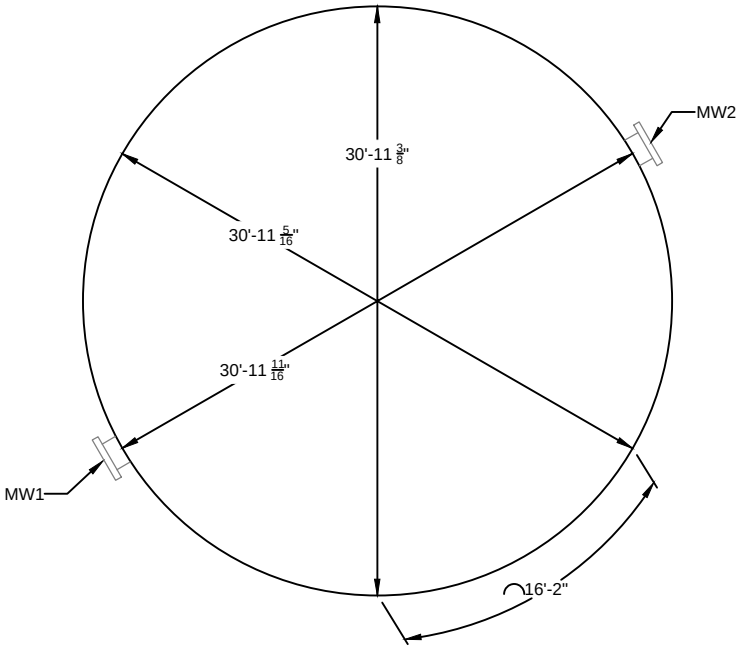
tprev = previous thickness measurement of shell course under consideration, as recorded at last inspection or nominal thickness if no previous thickness measurements, in inch.

RL = Estimated remaining life of the shell course under consideration, in year.

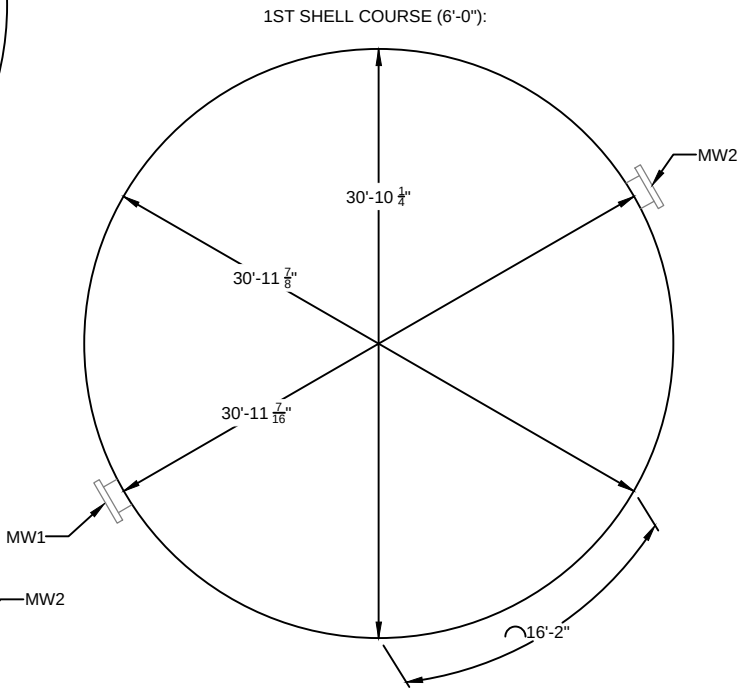
Y = Time span between thickness readings or age of the tank if nominal thickness is used for tprev, in year.

	tprev	tact	tmin	Ca	Cr	RL	FHc
Course 1	0.250	0.289	0.101	0.188	0.0000	>40	106.04
Course 2	0.250	0.281	0.100	0.181	0.0000	>40	112.38
Course 3	0.250	0.266	0.100	0.166	0.0000	>40	124.63
Course 4	0.250	0.291	0.100	0.191	0.0000	>40	142.63
Course 5	0.250	0.271	0.100	0.171	0.0000	>40	142.63

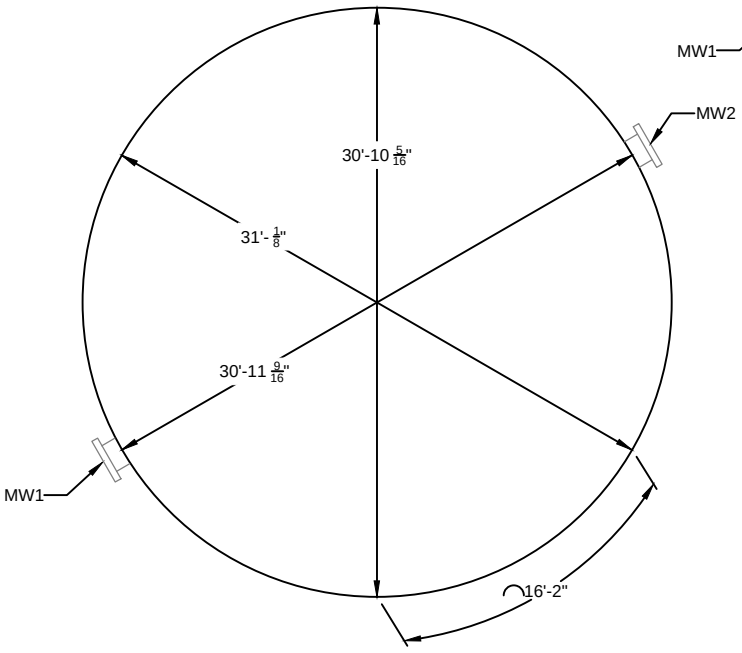
1ST SHELL COURSE (0'-3"):

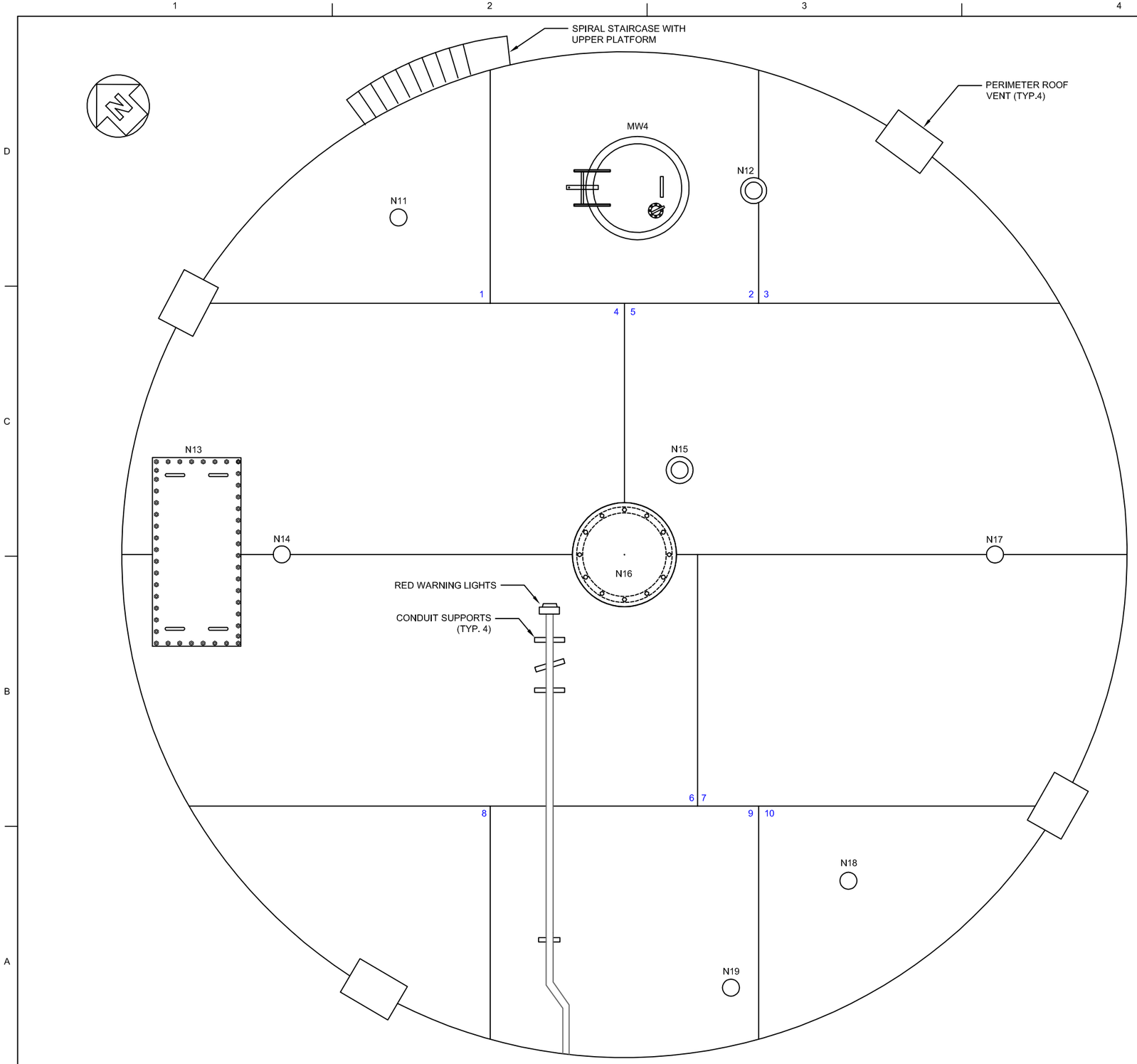


1ST SHELL COURSE (6'-0"):



1ST SHELL COURSE (3'-0"):





TANK INFORMATION

TANK NO. (FACILITY NO.):	2 (3474)
MANUFACTURER:	WITHERUP FABRICATION AND ERECTION, INC.
YEAR BUILT:	2005
TANK DIAMETER:	31'-0"
TANK HEIGHT:	41'-3"
MAX FILL CAPACITY:	5,000 BBLS
PRODUCT:	JET-A (F-24)
PRODUCT SPECIFIC GRAVITY:	0.85
GPS COORDINATES:	N 38° 48' 56.16"
	W 76° 51' 28.67"

NOTES:

1. REFER TO TABLE 5, "FIXED ROOF ULTRASONIC THICKNESS READINGS" IN APPENDIX A FOR INDIVIDUAL FIXED ROOF PLATE UTT MEASUREMENTS.
2. REFER TO TABLE 6, "NOZZLES AND APPURTENANCES", IN APPENDIX A FOR NOZZLE DATA.

MARK	DESCRIPTION	DATE	APPR.
MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: N/A
DRWN BY: JRG
SUBMITTED BY: KBB
DATE: 2/6/2018
CHECKED BY: GGC
PLOT SCALE: NTS
PLOT DATE: 2/6/2018
SIZE: 11" X 17"
CONTRACT NO.: W912BP-14-D-0016
DELIVERY ORDER NO.: W912BP17F0192
FILE NUMBER: N/A
FILE NAME: N/A

USACE
OMAHA DISTRICT

PGND ENGINEERS, INC.
3500 Parkway Lane, Suite 600
Peachtree Corners, GA 30092
Phone: (678) 336-2744
Fax (678) 336-2744
JOB NO. 1160049

TANK 2 LAYOUT
ANDREWS AFB
JOINT BASE ANDREWS, MARYLAND
FIXED ROOF LAYOUT

SHEET IDENTIFICATION
03
SHEET 3 OF 3

Table 5: Fixed Roof Ultrasonic Thickness Readings

	Plate 1	Plate 2	Plate 3	Plate 4	Plate 5
	.295 .293 .300 .294 .284	.288 .275 .274 .271 .281	.298 .298 .297 .291 .295	.294 .288 .288 .282 .292	.289 .286 .301 .297 .283
Avg.	.293	.278	.296	.289	.291
	Plate 6	Plate 7	Plate 8	Plate 9	Plate 10
	.293 .308 .286 .286 .298	.305 .289 .299 .291 .285	.281 .304 .297 .298 .291	OBS OBS OBS OBS OBS	.290 .291 .300 .281 .293
Avg.	.294	.294	.294		.291

Thickness readings are in inches.
Average fixed roof plate thickness reading: 0.291”
OBS - Obstructed
Refer to Drawing 03, Fixed Roof Layout, for fixed roof layout and UTT reading locations.

AST ATMOSPHERIC STORAGE TANK FIXED ROOF EVALUATION
MINIMUM THICKNESS, REMAINING LIFE, PRESSURE CALCULATIONS

Date: 02/06/2018

File No	Report No	Client	Inspector	Tank No	Temp(degF)
1053	Andrews AFB Tank 2 (3474)	USACE Omaha	John Cronin (POND)	Tank 2 (3474)	

Where;
Ca = remaining corrosion allowance of the tank component under consideration, in inch (t act - t min).
Cr = corrosion rate of the tank component under consideration, in inch per year (t prev - t act / Y).
oz = unit of measurement, (weight, in ounces, per square inch), (16 oz per pound)
psi = unit of measurement, (weight, in pounds, per square inch)
RL = estimated remaining life of the tank component under consideration, in year (Ca / Cr).
t act = actual thickness measurement of the tank component under consideration, as recorded at the time of inspection, in inch.
t min = minimum required thickness of tank component, at the design MAWP at the design temperature (200 degF for atm AST's), in inch (greater of psi/wt or 0.090").
t nom = design nominal thickness of tank component under consideration, in inch.
t prev = previous thickness measurement of the tank component under consideration, as recorded at last inspection or nominal thickness if no previous thickness measurements, in inch.
t yn = thickness of the tank component under consideration at the next inspection at twice the calculated corrosion rate, in inch (t act - (2*Cr*Yn).
wt = weight of plate per cubic inch.
wc = unit of measurement, (height, in inch, of water column bearing on 1 Sq.Inch area), (27.7 wc per pound)
Y = time span between thickness readings or age of the tank component if tnom is used for tprev, in year.
Yn = estimated time span to next inspection of the tank component under consideration, in year.

ROOF PLATES - REMAINING LIFE

Y	t prev (inch)	t act (inch)	t min (inch)	Cr (inch/Yr)	Ca (inch)	RL
13	0.313	0.291	0.090	0.00169	0.201	119

Nominal thickness was assumed to be 0.3125" (5/16").

Table 6: Nozzle and Appurtenances

Nozzle	Nozzle Size (Diameter or Width/Height)	Repad Shape	RepadSize (W X H)	Repad Thickness	Nozzle Thickness				H1	H2	Nozzle Location (Measured circumferentially from Manway A)	Notes
					0°	90°	180°	270°				
MW1	36"	B	6'-0"	.298	.425	.413	.410	-	3'-3"	0'-6"	0'	Manway
N1	1 1/2"	-	-	-	TH	TH	TH	TH	39'-10"	-	9'-6"	HHLA
N2	1 1/2"	-	-	-	TH	TH	TH	TH	36'-1"	-	9'-6"	HLA
N3	1 1/2"	-	-	-	TH	TH	TH	TH	39'-4"	-	12'-9"	HLCV Shutoff
N4	1 1/2"	-	-	-	TH	TH	TH	TH	37'-8"	-	12'-9"	HLCV Shutoff
N5	1 1/2"	-	-	-	TH	TH	TH	TH	3'-0"	-	12'-9"	LLA
N6	1 1/2"	-	-	-	TH	TH	TH	TH	1'-6"	-	12'-9"	LLLA
MW2	36"	B	6'-0"	.261	.410	.412	.390	.408	3'-8"	0'-6"	49'-0"	Manway
N7	4"	B	1'-0"	.273	.303	.329	.313	.323	0'-10"	0'-4"	61'-3"	Low Suction
N8	12"	B	2'-2"	.275	.532	.526	.515	.535	1'-5"	0'-5"	65'-1"	Main Suction
MW3	36"	B	6'-0"	.283	.419	.399	.394	.399	9'-4"	6'-4"	79'-0"	Manway
N9	1 1/2"	-	-	-	.251	-	-	-	0'-6"	-	87'-0"	Water Draw-Off
N10	8"	B	1'-7"	.271	.530	.498	.533	-	1'-6"	0'-9"	89'-7"	Receipt
N11	2 1/2"	-	-	-	TH	TH	TH	TH	Fixed Roof			Anti-Rotation Cable
MW4	36"	B	4'-6"	.273	.265	.242	.255	.257	Fixed Roof			Manway w/ 8" Gauge Hatch
N12	6"	B	1'-3"	.290	.267	.273	.289	.262	Fixed Roof			Enraf ATG / VITO Temp/Water Probe
N13	72" x 24"	-	-	-	.414	.435	.403	.424	Fixed Roof			Hatch
N14	2 1/2"	-	-	-	TH	TH	TH	TH	Fixed Roof			Pan Ground
N15	4"	B	0'-9"	.372	.267	.270	.278	.276	Fixed Roof			Cap
N16	24"	B	2'-9"	.235	.276	.283	.280	.296	Fixed Roof			Center Vent
N17	2 1/2"	-	-	-	TH	TH	TH	TH	Fixed Roof			Pan Ground
N18	2 1/2"	-	-	-	TH	TH	TH	TH	Fixed Roof			Anti-Rotation Cable
N19	1 1/2"	-	-	-	TH	TH	TH	TH	Fixed Roof			Shand and Jurs Tape Level Gauge

Thickness measurements are in inches.
H1 = C/L of pipe to edge of roof or chime
H2 = Edge of tank or chime to nearest weld toe.
TH = Threaded
Repad Shapes:

Table 7: Dry Film (Coating) Thickness

External Shell Coating Thickness				
Average	**Standard Deviation**	**Number of Readings**	**Minimum**	**Maximum**
12.380	2.879	23	8.169	20.000

Internal Shell Coating Thickness				
Average	**Standard Deviation**	**Number of Readings**	**Minimum**	**Maximum**
27.450	5.998	14	18.700	36.950

Bottom Coating Thickness				
Average	**Standard Deviation**	**Number of Readings**	**Minimum**	**Maximum**
16.270	4.130	15	9.624	24.970

Fixed Roof Coating Thickness				
Average	**Standard Deviation**	**Number of Readings**	**Minimum**	**Maximum**
15.200	3.546	13	12.330	23.860

Readings are represented in mils.

APPENDIX B: API 653 CHECKLISTS FOR TANK INSPECTIONS

Tank In-Service Inspection Checklist		
Item		**Completed X**
B.1.1	**Foundation**	
a	Measure foundation levelness and bottom elevations (see Annex B for extent of measurements).	X
B.1.1.1	**Concrete Ring**	
a	Inspect for broken concrete, spalling, and cracks, particularly under backup bars used in welding butt-welded annular rings under the shell.	X
b	Inspect drain openings in ring, back of waterdraw basins and top surface of ring for indications of bottom leakage.	X
c	Inspect for cavities under foundation and vegetation against bottom of tank.	X
d	Check that runoff rainwater from the shell drains away from tank.	X
e	Check for settlement around perimeter of tank.	X
B.1.1.2	**Asphalt**	
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
b	Look for areas where leaching of oil has left rock filler exposed, which indicates hydrocarbon leakage.	N/A
B.1.1.3	**Oiled Dirt or Sand**	
a	Check for settlement into the base which would direct runoff rain water under the tank rather than away from it.	N/A
B.1.1.4	**Rock**	
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.	N/A
B.1.1.5	**Site Drainage**	
a	Check site for drainage away from the tank and associated piping and manifolds.	X
b	Check operating condition of the dike drains.	X
B.1.1.6	**Housekeeping**	
a	Inspect the area for buildup of trash, vegetation, and other inflammables buildup.	X
B.1.1.7	**Cathodic Protection**	
a	Review cathodic protection potential readings.	X
B.1.2	**Shells**	
B.1.2.1	**External Visual Inspection**	
a	Visually inspect for paint failures, pitting, and corrosion.	X

Tank In-Service Inspection Checklist		
Item		**Completed X**
b	Clean off the bottom angle area and inspect for corrosion and thinning on plate and weld.	X
c	Inspect the bottom-to-foundation seal, if any.	X
B.1.2.2	**Internal (Floating Roof Tank)**	
a	Visually inspect for grooving, corrosion, pitting, and coating failures.	N/A
B.1.2.3	**Riveted Shell Inspection**	
a	Inspect external surface for rivet and seam leaks.	N/A
b	Locate leaks by sketch or photo (location will be lost when shell is abrasive cleaned for painting).	N/A
c	Inspect rivets for corrosion loss and wear.	N/A
d	Inspect vertical seams to see if they have been full fillet lap-welded to increase joint efficiency.	N/A
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.	N/A
B.1.2.4	**Wind Girder (Floating Roof Tanks)**	
a	Inspect wind girder 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
b	Check support welds to shell for pitting, especially on shell plates.	N/A
c	Note whether supports have reinforcing pads welded to shell.	N/A
B.1.3	**Shell Appurtenances**	
B.1.3.1	**Manways and Nozzles**	
a	Inspect for cracks or signs of leakage on weld joint at nozzles, manways, and reinforcing plates.	X
b	Inspect for shell plate dimpling around nozzles, caused by excessive pipe deflection.	X
c	Inspect for flange leaks and leaks around bolting.	X
d	Inspect sealing of insulation around manways and nozzles.	N/A
e	Check for inadequate manway flange and cover thickness on mixer manways.	N/A
B.1.3.2	**Tank Piping Manifolds**	
a	Inspect manifold piping, flanges, and valves for leaks.	X
b	Inspect firefighting system components.	N/A
c	Check for anchored piping which would be hazardous to the tank shell or bottom connections during earth movement.	X
d	Check for adequate thermal pressure relief of piping to the tank.	X
e	Check operation of regulators for tanks with purge gas systems.	N/A
f	Check sample connections for leaks and for proper valve operation.	X

Tank In-Service Inspection Checklist		
Item		**Completed X**
g	Check for damage and test the accuracy of temperature indicators.	N/A
h	Check welds on shell-mounted davit clips above valves 6 in. and larger.	N/A
B.1.3.3	**Autogauge System**	
a	Inspect autogauge tape guide and lower sheave housing (floating swings) for leaks.	X
b	Inspect autogauge head for damage.	X
c	Bump the checker on autogauge head for proper movement of tape.	X
d	Identify size and construction material of autogauge tape guide (floating roof tanks).	X
e	Ask operator if tape tends to hang up during tank roof movement (floating roof tanks).	X
f	Compare actual product level to the reading on the autogauge (maximum variation is 2 in.).	N/A
g	On floating roof tanks, when the roof is in the lowest position, check that no more than two ft of tape are exposed at the end of the tape guide.	X
h	Inspect condition of board and legibility of board-type autogauges.	X
i	Test freedom of movement of marker and float.	N/A
B.1.3.4	**Shell-Mounted Sample Station**	
a	Inspect sample lines for function of valves and plugging of lines, including drain or return-to-tank line.	N/A
b	Check circulation pump for leaks and operating problems.	N/A
c	Test bracing and supports for sample lines and equipment.	N/A
B.1.3.5	**Heater (Shell Manway Mounted)**	
	Inspect condensate drain for presence of oil indicating leakage.	N/A
B.1.3.6	**Mixer**	
a	Inspect for proper mounting flange and support.	N/A
b	Inspect for leakage.	N/A
c	Inspect condition of power lines and connections to mixer.	N/A
B.1.3.7	**Swing Lines: Winch Operation**	
a	Nonfloating. Raise, then lower the swing line with the winch, and check for cable tightness to confirm that swing line lowered properly.	N/A
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
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

Tank In-Service Inspection Checklist		
Item		**Completed X**
B.1.3.8	**Swing Lines: External Guide System**	
a	Check for leaks at threaded and flanged joints.	N/A
B.1.3.9	**Swing Lines: Identify Ballast Varying Need**	
a	Check for significant difference in stock specific gravity.	N/A
B.1.3.10	**Swing Lines: Cable Material and Condition**	
a	For nonstainless steel cable, check for corrosion over entire length.	N/A
b	All cable: check for wear or fraying.	N/A
B.1.3.11	**Swing Lines: Product Sample Comparison**	
a	Check for water or gravity differences that would indicate a leaking swing joint.	N/A
B.1.3.12	**Swing Lines: Target**	
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
B.1.4	**Roofs**	
B.1.4.1	**Deck Plate Internal Corrosion**	
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 rafters in the center of the roof first.)	X
B.1.4.2	**Deck Plate External Corrosion**	
a	Visually inspect for paint failure, holes, pitting, and corrosion product on the roof deck.	X
B.1.4.3	**Roof Deck Drainage**	
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 pontoons.)	X
B.1.4.4	**Level of Floating Roof**	
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 unlevel condition can indicate unequal loading at that level.	X
B.1.4.5	**Gas Test Internal Floating Roof**	
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

Tank In-Service Inspection Checklist		
Item		**Completed X**
B.1.4.6	**Roof Insulation**	
a	Visually inspect for cracks or leaks in the insulation weather coat where runoff rain water could penetrate the insulation.	N/A
b	Inspect for wet insulation under the weather coat.	N/A
c	Remove small test sections of insulation and check roof deck for corrosion and holes near the edge of the insulated area.	N/A
B.1.4.7	**Floating Roof Seal Systems**	
a	Inspect the condition of the seal, measure and record maximum rim spaces and sealto- shell gaps around the full roof circumference at the level of inspection. NOTE Inspection of the seal and measurement of the rim spaces and seal-to-shell gaps at more than one level may be necessary to more fully determine if any problems exist at other levels of tank operation).	N/A N/A
b	Measure and record annular space at 30-ft spacing (minimum of four quadrants) around roof and record. Measurements should be taken in directly opposite pairs.	N/A
1)	_____ _____ Opposite pair 1.	N/A
2)	_____ _____ Opposite pair 2.	N/A
c	Check if seal fabric on primary shoe seals is pulling shoes away from shell (fabric not wide enough).	N/A
d	Inspect fabric for deterioration, holes, tears, and cracks.	N/A
e	Inspect visible metallic parts for corrosion and wear.	N/A
f	Inspect for openings in seals that would permit vapor emissions.	N/A
g	Inspect for protruding bolt or rivet heads against the shell.	N/A
h	Pull both primary and secondary seal systems back all around the shell to check their operation.	N/A
i	Inspect secondary seals for signs of buckling or indications that their angle with the shell is too shallow.	N/A
j	Inspect wedge-type wiper seals for flexibility, resilience, cracks, and tears.	N/A
B.1.5	**Roof Appurtenances**	
B.1.5.1	**Sample Hatch**	
a	Inspect condition and functioning of sample hatch cover.	N/A
b	On tanks governed by Air Quality Monitoring District rules, check for the condition of seal inside hatch cover.	N/A
c	Check for corrosion and plugging on thief and gauge hatch cover.	N/A
d	Where sample hatch is used to reel gauge stock level, check for marker and tab stating hold-off distance.	N/A

Tank In-Service Inspection Checklist		
Item		**Completed X**
e	Check for reinforcing pad where sample hatch pipe penetrates the roof deck.	N/A
f	On floating roof sample hatch and recoil systems, inspect operation of recoil reel and condition of rope.	N/A
g	Test operation of system.	N/A
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
B.1.5.2	**Gauge Well**	
a	Inspect visible portion of the gauge well for thinning, size of slots, and cover condition.	X
b	Check for a hold-off distance marker and tab with hold-off distance (legible).	X
c	On floating roofs, inspect condition of roof guide for gauge well, particularly the condition of the rollers for grooving.	X
d	If accessible, check the distance from the gauge well pipe to the tank shell at different levels.	X
e	If tank has a gauge well washer, check valve for leakage and for presence of a bull plug or blind flange.	X
B.1.5.3	**Fixed Roof Scaffold Support**	
a	Inspect scaffold support for corrosion, wear, and structural soundness.	N/A
B.1.5.4	**Autogauge: Inspection Hatch and Guides (Fixed Roof)**	
a	Check the hatch for corrosion and missing bolts.	X
b	Look for corrosion on the tape guide's and float guide's wire anchors.	X
B.1.5.5	**Autogauge: Float Well Cover**	
a	Inspect for corrosion.	X
b	Check tape cable for wear or fraying caused by rubbing on the cover.	X
B.1.5.6	**Sample Hatch (Internal Floating Roof)**	
a	Check overall conditions.	N/A
b	When equipped with a fabric seal, check for automatic sealing after sampling.	N/A
c	When equipped with a recoil reel opening device, check for proper operations.	N/A
B.1.5.7	**Roof-mounted Vents (Internal Floating Roof)**	
	Check condition of screens, locking and pivot pins.	X
B.1.5.8	**Gauging Platform Drip Ring**	
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

Tank In-Service Inspection Checklist		
Item		**Completed X**
B.1.5.9	**Emergency Roof Drains**	
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
B.1.5.10	**Removable Roof Leg Racks**	
a	Check for leg racks on roof.	N/A
B.1.5.11	**Vacuum Breakers**	
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.	X
B.1.5.12	**Rim Vents**	
a	Check condition of the screen on the rim vent cover.	N/A
b	Check for plating off or removal of rim vents where jurisdictional rules do not permit removal.	N/A
B.1.5.13	**Pontoon Inspection Hatches**	
a	Open pontoon inspection hatch covers and visually check inside for pontoon leakage.	N/A
b	Test for explosive gas (an indicator of vapor space leaks).	N/A
c	If pontoon hatches are equipped with locked down coves, check for vent tubes. Check that vent tubes are not plugged up. Inspect lock-down devices for condition and operation.	N/A
B.1.6.1	**Accessways**	
a	See Tank Out-of-service Inspection Checklist, Item C.2.12.	See B.2.12.

NOTES:

Seals for the floating roof were being upgraded to double wiper seals at the time of the inspection.

Tank Out-of-Service Inspection Checklist		
Item		**Completed X**
B.2.1	**Overview**	
a	Check that tank has been cleaned, is gas free, and safe for entry.	X
b	Check that the tank is completely isolated from product lines, all electrical power, and steam lines.	X
c	Check that roof is adequately supported, including fixed roof structure and floating roof legs.	X
d	Check for presence of falling object hazards, such as corroded-through roof rafters, asphalt stalactites, and trapped hydrocarbons in unopened or plugged equipment or appurtenances, ledges, etc.	X
e	Inspect for slipping hazards on the bottom and roof decks.	X
f	Inspect structural welds on accessways and clips.	X
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.	X
h	Review cathodic protection potential readings.	X
B.2.2	**Tank Exterior**	
a	Inspect appurtenances opened during cleaning such as lower floating swing sheave assemblies, nozzle interiors (after removal of valves).	N/A
b	Hammer test or ultrasonically test the roof.	X
c	Enter and inspect the floating roof pontoon compartments.	N/A
B.2.3	**Bottom Interior Surface**	
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.	X
b	Measure the depth of pitting and describe the pitting appearance (sharp edged, lake type, dense, scattered, etc.)	X
c	Mark areas requiring patching or further inspection.	X
d	Mark locations for turning coupons for inspection.	X
e	Inspect all welds for corrosion and leaks, particularly the shell-to-bottom weld.	X
f	Inspect sketch plates for corrosion.	X
g	Check condition of internal sump, if applicable. Standing liquid should be removed from the sump to allow for complete inspection and vacuum testing of weld seams as appropriate. Sump bottom and sidewall plate and seams need to be evaluated for both product-side and soil-side corrosion.	X
h	Locate and mark voids under the bottom.	X

Tank Out-of-Service Inspection Checklist		
Item		**Completed X**
i	Record bottom data on a layout sketch using the existing bottom plates as a grid. List the number and sizes of patches required.	X
j	Vacuum test the bottom lap welds.	N/A
k	Hammer test or ultrasonically examine any slightly discolored spots or damp areas.	X
l	Check for reinforcing pads under all bottom attached clips, brackets, and supports.	X
m	Inspect floating roof leg pads for pitting or cutting, and excessive dimpling (indicating excessive loading).	X
n	Check the column bases of fixed roof supports for adequate pads and restraining clips.	N/A
o	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
p	Check area beneath swing line cable for indications of cable cutting or dragging.	N/A
q	Mark old oil and air test connection for removal and patching.	N/A
r	Identify and report low areas on the bottom that do not drain adequately.	X
s	Inspect coating for holes, disbonding, deterioration, and discoloration.	X
B.2.4	**Shell Seams and Plate**	
a	On cone up bottoms, closely inspect and gauge the depth of metal loss on the lower 2 in. to 4 in. of the shell (area of standing water).	N/A
b	Measure the depth of pitting on each course.	X
c	Inspect and estimate the amount of metal loss on the heads of rivets and bolts.	N/A
d	Inspect shell-to-bottom riveted lap joints.	N/A
e	Inspect for vertical grooving damage from seal assembly protrusions.	N/A
f	Inspect existing protective coatings for damage, deterioration, and disbonding.	X
g	Check for areas of rubbing (indicating too much pressure by the seal assembly shoes or inadequate annular space).	X
h	Visually inspect the shell plates and seams for indications of leakage.	X
i	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.	N/A
j	Measure annular space at 40-ft intervals.	N/A
k	Survey the shell to check for roundness and plumb.	X
B.2.5	**Shell-mounted Overflows**	
a	Inspect overflow for corrosion and adequate screening.	X
b	Check location of overflow that it is not above any tank valves or equipment.	X

Tank Out-of-Service Inspection Checklist		
Item		**Completed X**
B.2.6	**Roof Interior Surface**	
B.2.6.1	**General**	
a	Visually inspect the underside surface of the roof plates for holes, scale buildup, and pitting.	X
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.	X
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.	X
d	If no pad is present, penetrant test for cracking of the weld or deck plate.	N/A
e	Inspect for protective coating for breaks, disbondment, and deterioration.	X
f	Spark test the interior surface coating if recoating is not planned.	N/A
B.2.6.2	**Fixed Roof Support Structure**	
a	Inspect the support columns for thinning in the upper 2 feet.	N/A
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
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.	N/A
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.	N/A
e	Inspect and gauge rafters for thinning, particularly near the center of the roof. Report metal loss.	N/A
f	Check for loose or twisted rafters.	N/A
g	Inspect girders for thinning and check that they are attached securely to the top of the columns.	N/A
h	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).	N/A
i	Inspect and report presence of any roof-mounted swing line bumpers.	N/A
j	Photograph the roof structure if no rafter layout drawing exists.	X
B.2.7	**Fixed Roof Appurtenances**	
B.2.7.1	**Inspection and Light Hatches**	
a	Inspect the hatches for corrosion, paint and coating failures, holes, and cover sealing.	X
b	On loose covers, check for a safety chain in good condition.	X

Tank Out-of-Service Inspection Checklist		
Item		**Completed X**
c	On light hatches over 30 in. across, check for safety rods.	N/A
d	Inspect the condition of the gaskets on bold or latched down hatch covers.	X
B.2.7.2	**Staging Support Connection**	
a	Inspect the condition of the staging support for corrosion.	N/A
B.2.7.3	**Breathers and Vents**	
a	Inspect and service the breather.	N/A
b	Inspect screens on vents and breathers.	X
B.2.7.4	**Emergency P/V Hatches**	
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
b	Inspect liquid seal hatches for corrosion and proper liquid level in the seal.	N/A
B.2.7.5	**Sample Hatch**	
a	Inspect sample hatch for corrosion.	N/A
b	Check that the cover operates properly.	N/A
c	If the tank has no gauge well, check for a hold-off distance marker and check measurement.	N/A
B.2.8	**Floating Roof**	
B.2.8.1	**Roof Deck**	
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
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
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
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
B.2.8.2	**Floating Roof Pontoons**	
a	Visually inspect each pontoon for liquid leakage.	N/A

Tank Out-of-Service Inspection Checklist		
Item		**Completed X**
b	Run a light wire through the gooseneck vents on locked down inspection hatch covers to make sure they are open.	N/A
c	Inspect lockdown latches on each cover.	N/A
d	Check and report if each pontoon is:	N/A
1)	vapor tight (bulkhead seal welded on one side on bottom, sides, and top),	N/A
2)	liquid tight (seal-welded on bottom and sides only), or	N/A
3)	unacceptable (minimum acceptable condition is liquid tight).	N/A
B.2.8.3	**Floating Roof Cutouts**	
a	Inspect underside of cutouts for mechanical damage.	N/A
b	Inspect welds for cracks.	N/A
c	Inspect plate for thinning, pitting, and erosion.	N/A
d	Measure mixer cutouts and record plate thickness for future mixer installation or replacement. Plate thickness _____ .	N/A
B.2.8.4	**Floating Roof Supports**	
a	Inspect fixed low and removable high floating roof legs for thinning.	X
b	Inspect for notching at bottom of legs for drainage.	X
c	Inspect for leg buckling or felling at bottom.	X
d	Inspect pin hole in roof guide for tears.	X
e	Check plumb of all legs.	X
f	Inspect for adequate reinforcing gussets on all legs through a single portion of the roof.	X
g	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.	X
h	Inspect the sealing system on the two-position legs and the vapor plugs in the fixed low leg for deterioration of the gaskets.	X
i	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.	X
B.2.9	**Floating Roof Seal Assemblies**	
B.2.9.1	**Primary Shoe Assembly**	
a	Remove four sections of foam log (foam-filled seals) for inspection on 90° locations.	N/A

Tank Out-of-Service Inspection Checklist		
Item		**Completed X**
b	Inspect hanger attachment to roof rim for thinning, bending, broken welds, and wear of pin holes.	N/A
c	Inspect clips welded to roof rim for thinning.	N/A
d	Shoes—inspect for thinning and holes in shoes.	N/A
e	Inspect for bit-metal bolts, clips, and attachments.	N/A
f	Seal fabric—inspect for deterioration, stiffening, holes, and tears in fabric.	N/A
g	Measure length of fabric from top of shoe to roof rim, and check against maximum anticipated annular space as roof operates.	N/A
h	Inspect any modification of shoes over shell nozzles, mixers, etc., for clearance.	N/A
i	Inspect shoes for damage caused by striking shell nozzles, mixers, etc.	N/A
B.2.9.2	**Primary Toroidal Assembly**	
a	Inspect seal fabric for wear, deterioration, holes, and tears.	N/A
b	Inspect hold-down system for buckling or bending.	N/A
c	Inspect foam for liquid absorption and deterioration.	N/A
B.2.9.3	**Rim-Mounted Secondaries**	
a	Inspect the rim-mounted bolting bar for corrosion and broken welds.	N/A
b	Measure and chart seal-to-shell gaps.	N/A
c	Visually inspect seam from below, looking for holes as evidenced by light.	N/A
d	Inspect fabric for deterioration and stiffness.	N/A
e	Inspect for mechanical damage, corrosion, and wear on tip in contact with shell.	N/A
f	Inspect for contact with obstructions above top of shell.	N/A
B.2.10	**Floating Roof Appurtenances**	
B.2.10.1	**Roof Manways**	
a	Inspect walls of manways for pitting and thinning.	X
b	On tanks with interface autogauges, check seal around gauge tape cable and guide wires through manway cover.	X
c	Inspect cover gasket and bolts.	X
B.2.10.2	**Rim Vent**	
a	Check rim vent for pitting and holes.	X
b	Check vent for condition of screen.	X
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.	X
B.2.10.3	**Vacuum Breaker, Breather Type**	
a	Service and check operation of breather valve.	X
b	Check that nozzle pipe projects no more than 1/2 in. below roof deck.	X

Tank Out-of-Service Inspection Checklist		
Item		**Completed X**
B.2.10.4	**Vacuum Breaker, Mechanical Type**	
a	Inspect the stem for thinning. Measure how far the vacuum breaker cover is raised off the pipe when the roof is resting on high or low legs.	N/A
b	On high legs: _____ .	N/A
c	On low legs: _____ .	N/A
B.2.10.5	**Roof Drains: Open Systems, Including Emergency Drains**	
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
b	If tank comes under Air Quality Monitoring District rules, inspect the roof drain vapor plug.	N/A
c	If emergency drain is not at the center of the roof, check that there are at least three emergency drains.	N/A
B.2.10.6	**Closed Drain Systems: Drain Basins**	
a	Inspect for thinning and pitting.	N/A
b	Inspect protective coating (topside).	N/A
c	Inspect basin cover or screen for corrosion.	N/A
d	Test operation of check valve.	N/A
e	Check for presence of check valve where bottom of basin is below product level.	N/A
f	Inspect drain basin(s) to roof deck welds for cracking.	N/A
g	Check drain basin(s) outlet pipe for adequate reinforcement to roof deck (including reinforcing pad).	N/A
B.2.10.7	**Closed Drain Systems: Fixed Drain Line on Tank Bottom**	
a	Hammer test fixed drain line on tank bottom for thinning and scale/debris plugging.	N/A
b	Inspect supports and reinforcing pads for weld failures and corrosion.	N/A
c	Check that pipe is guided, not rigidly locked to support, to avoid tearing of tank bottom plate.	N/A
B.2.10.8	**Closed Drain Systems: Flexible Pipe Drain**	
a	Inspect for damage to exterior of pipe.	N/A
b	Check for obstructions that pipe could catch on.	N/A
c	Inspect shields to protect pipe from snagging.	N/A
d	Inspect results of hydrostatic test on flexible roof drain system.	N/A
B.2.10.9	**Closed Drain Systems: Articulated Joint Drain**	
a	Hammer test rigid pipe in flexible joint systems for thinning and scale/debris plugging.	N/A
b	Inspect system for signs of bending or strain.	N/A

Tank Out-of-Service Inspection Checklist		
Item		**Completed X**
c	Inspect results of system hydrostatic test.	N/A
d	Inspect landing leg and pad.	N/A
B.2.10.10	**Autogauge System and Alarms**	
a	Check freedom of movement of tape through autogauge tape guide.	X
b	Inspect sheaves for freedom of movement.	X
c	Test operation checker.	X
d	Inspect tape and tape cable for twisting and fraying.	X
e	Test the tape's freedom of movement through guide sheaves and tape guide pipe.	X
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.	X
g	Check float for leakage.	X
h	Test float guide wire anchors for spring action by pulling on wire and releasing.	X
i	Inspect floatwells in floating roofs for thinning and pitting of walls just above the liquid level.	X
j	Check that the autogauge tape is firmly attached to the float.	X
k	Inspect the tape cable and float guide wire fabric seals through the float well cover.	X
l	Inspect the bottom guide wire attachment clip: inspect for a temporary weighted bar instead of a permanent welded down clip.	X
m	Inspect board-type autogauge indicators for legibility and freedom of movement of indicator.	X
n	Measure and record these distances to determine if seal damage will occur if tank is run over from:	X
1)	Shell top angle to underside of tape guide system.	X
2)	Liquid level on floating top to top of secondary seal.	X
o	Identify floating roofs where the tape is connected directly to the roof.	X
p	Overfill alarm: Inspect tank overfill prevention alarm switches for proper operation.	X
B.2.11	**Common Tank Appurtenances**	
B.2.11.1	**Gauge Well**	
a	Inspect gate well pipe for thinning at about two-thirds distance above the bottom: look for thinning at the edge of the slots.	X
b	Check for corrosion on the pipe joint. Check that sample cords, weights, thermometers, etc., have been removed from the pipe.	X
c	Check for cone at bottom end of pipe about one foot above the bottom.	N/A

Tank Out-of-Service Inspection Checklist		
Item		**Completed X**
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
e	Check that supports for gauge well are welded to pad or to shell and not directly to bottom plate.	X
f	Check operation of gauge well cover.	N/A
g	Check presence of a hold-off distance marker in well pipe and record hold-off distance. Hold-off distance _____ .	N/A
h	Identify and report size and pipe schedule, and whether pipe is solid or slotted. Report slot size.	X
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.	X
j	Inspect vapor control float and cable.	N/A
k	Check for presence and condition of gauge well washer.	N/A
l	Check for bull plug or plate blind on gauge well washer valve.	N/A
m	Inspect gauge well guide in floating roof for pitting and thinning.	N/A
n	Inspect the guide rollers and sliding plates for freedom of movement.	N/A
o	Inspect condition of gauge well pipe seal system.	X
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.	X
q	Visually inspect inside of pipe for pipe weld protrusions which could catch or damage vapor control float.	X
B.2.11.2	**Sampling Systems: Roof Sample Hatches**	
a	Inspect roof-mounted sample hatches for reinforcing pads and cracking.	N/A
b	Inspect cover for operation.	N/A
c	For tanks complying with Air Quality Monitoring District rules, inspect sample hatch covers for adequate sealing.	N/A
d	Check horizontal alignment of internal floating roof sample hatches under fixed roof hatches.	N/A
e	Inspect the sealing system on the internal floating roof sample hatch cover.	N/A
f	Inspect floating roof sample hatch cover recoil reel and rope.	N/A
B.2.11.3	**Shell Nozzles**	
a	Inspect shell nozzles for thinning and pitting.	X
b	Inspect hot tap nozzles for trimming of holes.	N/A

Tank Out-of-Service Inspection Checklist		
Item		**Completed X**
c	Identify type of shell nozzles.	X
d	Identify and describe internal piping, including elbow-up and elbow-down types.	X
B.2.11.4	**For Nozzles Extended Into the Tank**	
a	Inspect pipe support pads welded to tank bottom.	X
b	Inspect to see that pipe is free to move along support without strain or tearing action on bottom plate.	X
c	Inspect nozzle valves for packing leaks and damaged flange faces.	X
d	Inspect heater stream nozzle flanges and valves for wire cutting.	N/A
e	Report which nozzles have thermal pressure relief bosses and valves.	X
f	In internal elbow-down fill line nozzles, inspect the wear plate on the tank bottom.	X
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
B.2.11.5	**Diffusers and Air Rolling Systems**	
a	Inspect diffuser pipe for erosion and thinning.	N/A
b	Check holes in diffuser for excessive wear and enlargement.	N/A
c	Inspect diffuser supports for damage and corrosion.	N/A
d	Check that diffuser supports restrain, not anchor, longitudinal line movement.	N/A
e	Inspect air spiders on bottom of lube oil tanks for plugging and damaged or broken threaded joints.	N/A
B.2.11.6	**Swing Lines**	
a	Inspect flexible joint for cracks and leaks.	N/A
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
c	Check that flexible joints over 6 in. are supported.	N/A
d	Inspect the swing pipe for deep pitting and weld corrosion.	N/A
e	Loosen the vent plugs in the pontoons and listen for a vacuum. Lack of a vacuum indicates a leaking pontoon.	N/A
f	Check the results of air test on pontoons during repairs.	N/A
g	Inspect the pontoons for pitting.	N/A
h	Inspect the pull-down cable connections to the swing.	N/A
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
j	Inspect safety hold-down chain for corrosion and weak links.	N/A
k	Check that there is a welded reinforcing pad where the chain connects to the bottom.	N/A

Tank Out-of-Service Inspection Checklist		
Item		**Completed X**
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 calculated angle exceeds 65 degrees, recommended installation of a limiting bracket.)	N/A
m	Inspect pull-down cable for fraying.	N/A
n	Inspect for three cable clamps where cable attaches to end of swing line (singlereeved) or to roof assembly (double-reeved). Inspect sheaves for freedom of movement.	N/A
o	Inspect winch operation and check the height indicator for legibility and accuracy.	N/A
p	Inspect bottom-mounted sheave assembly at end of pontoon for freedom of rotation of sheave.	N/A
q	Inspect shell-mounted lower sheave assembly for freedom of rotation of sheave, corrosion thinning, and pitting of sheave housing.	N/A
r	Inspect upper sheave assembly for freedom of movement of sheave.	N/A
s	Inspect the cable counterbalance assembly for corrosion and freedom of operation.	N/A
B.2.11.7	**Manway Heater Racks**	
a	Inspect the manway heater racks for broken welds and bending of the sliding rails.	N/A
b	Measure and record the length of the heater and length of the track.	N/A
B.2.11.8	**Mixer Wear Plates and Deflector Stands**	
a	Inspect bottom and shell plates and deflector stands.	N/A
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 sealwelded to the bottom under the deflector stand legs.	N/A
c	Measure for propeller clearance between the bottom of deflector stand and roof when the roof is on low legs.	N/A
B.2.12	**Access Structures**	
B.2.12.1	**Handrails**	
a	Identify and report type (steel pipe, galvanized pipe, square tube, angle) and size of handrails.	X
b	Inspect for pitting and holes, paint failure.	X

Tank Out-of-Service Inspection Checklist		
Item		**Completed X**
c	Inspect attachment welds.	X
d	Identify cold joints and sharp edges. Inspect the handrails and midrails.	X
e	Inspect safety drop bar (or safety chain) for corrosion, functioning, and length.	X
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
B.2.12.2	**Platform Frame**	
a	Inspect frame for corrosion and paint failure.	X
b	Inspect the attachment of frame to supports and supports to tank for corrosion and weld failure.	X
c	Check reinforcing pads where supports are attached to shell or roof.	X
d	Inspect the surface that deck plate or grating rests on, for thinning and holes.	X
e	Check that flat-surface-to-flat-surface junctures are seal-welded.	X
B.2.12.3	**Deck Plate and Grating**	
a	Inspect deck plate for corrosion-caused thinning or holes (not drain holes) and paint failure.	X
b	Inspect plate-to-frame weld for rust scale buildup.	X
c	Inspect grating for corrosion-caused thinning of bars and failure of welds.	X
d	Check grating tie down clips. Where grating has been retrofitted to replace plate, measure the rise of the step below and above the grating surface and compare with other risers on the stairway.	X
B.2.12.4	**Stairway Stringers**	
a	Inspect spiral stairway stringers for corrosion, paint failure, and weld failure. Inspect attachment of stairway treads to stringer.	N/A
b	Inspect stairway supports to shell welds and reinforcing pads.	N/A
c	Inspect steel support attachment to concrete base for corrosion.	N/A
B.2.12.5	**Rolling Ladder**	
a	Inspect rolling ladder stringers for corrosion.	N/A
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
c	Check for wear and corrosion where rolling ladder attaches to gaging platform.	N/A
d	Inspect pivot bar for wear and secureness.	N/A
e	Inspect operation of self-leveling stairway treads.	N/A
f	Inspect for corrosion and wear on moving parts.	N/A
g	Inspect rolling ladder wheels for freedom of movement, flat spots, and wear on axle.	N/A

Tank Out-of-Service Inspection Checklist		
Item		**Completed X**
h	Inspect alignment of rolling ladder with roof rack.	N/A
i	Inspect top surface of rolling ladder track for wear by wheels to assure at least 18 in. of unworn track (track long enough).	N/A
j	Inspect rolling ladder track welds for corrosion.	N/A
k	Inspect track supports on roof for reinforcing pads seal-welded to deck plate.	N/A
l	Check by dimensioning, the maximum angle of the rolling ladder when the roof is on low legs. Max. angle _____ .	N/A
m	If rolling ladder track extends to within 5 ft of the edge of the roof on the far side, check for a handrail on the top of the shell on that side.	N/A

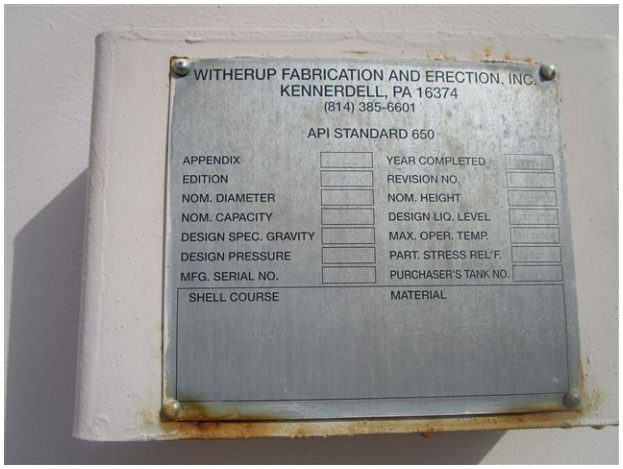
NOTES:

APPENDIX C: PHOTOGRAPHS

C1: Tank Overview

C2: Tank Overview

C3: Manway 2



C4: Nameplate

C5: Main Suction Line

C6: Receipt Line

C7: Main Suction Crossover Piping

C8: Sight Flow Indicators

C9: Low Suction

C10: Threaded Connection on Low Suction

C11: Water Draw-Off with Ball Valve

C12: HLA / HHLA / HLCV

C13: Grounding Cable

C14: Tell-Tale Pipe

C15: LLA / LLLA

C16: LLA / LLLA w/ Threaded Connections

C17: Conduit Support

C18: Conduit Support w/ Crevice Corrosion

C19: Tank Chime

C20: Tank Chime Sealant Failure

C21: Vegetation in Ring Wall Control Joint

C22: Vegetation in Ring Wall Control Joint

C23: Cracking in Containment Dike

C24: Cracking and Spalling in Containment Dike

C25: Fixed Roof Overview

C26: Fixed Roof Overview

C27: Enraf ATG / VITO Temperature Probe

C28: Corroded Fasteners on Enraf ATG

C29: Fixed Roof Manway w/ Access Ladder and Gauging Hatch

C30: Visible Alarms and Center Vent

C31: Tape Level Gauge Penetration

C32: Hatch

C33: Bottom Overview

C34: Bottom Overview

C35: Stilling Wells and Ladder Overview

C36: Partially Slotted Stilling Wells

C37: Wide Spread Pitting along the Tank Bottom

C38: Wide Spread Pitting along the Tank Bottom

C39: Cracked Coating along the Internal Shell-to-Bottom Weld

C40: Cracked Coating along the Internal Shell-to-Bottom Weld

C41: Anti-Rotation Cable

C42: Center Sump

C43: Coating Failure at Center Sump

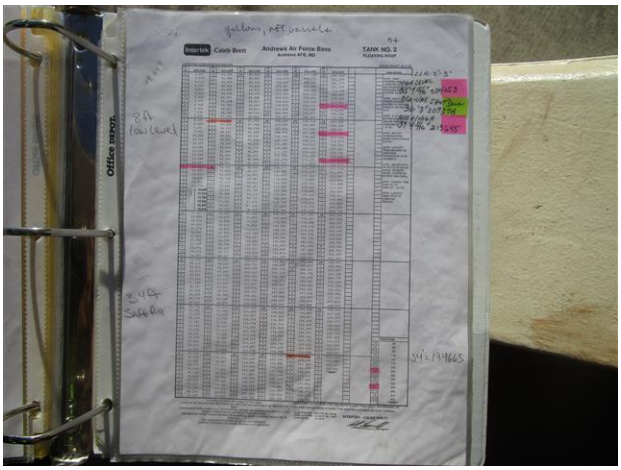
C44: Coating Failure at Center Sump

C45: Main Suction

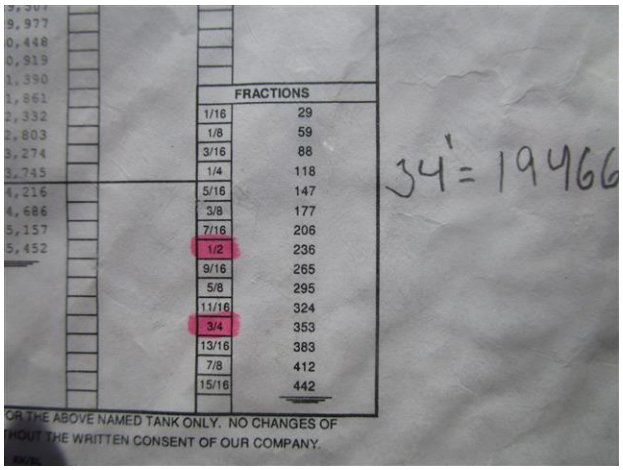
C46: Receipt

C47: Internal Floating Roof Overview

C48: Internal Floating Roof Overview



C49: Strapping Tables



C50: Strapping Tables 1/16” Increments