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

Andrews Air Force Base, Morningside, Maryland
Facility 3473
Tank 73

US Army Corps of Engineers Center of Expertise for Petroleum, Oils and Lubricants
USACE POL-MCX

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ACRONYMS AND ABBREVIATIONS

AFFF	Aqueous Firefighting Foam
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASNT	American Society of Non-Destructive Testing
ATG	Automatic Tank Gauge
BBL	Barrel
CFR	Code of Federal Regulations
CMU	Concrete Masonry Unit
CP	Cathodic Protection
DFT	Dry Film Thickness
FAC	Facility
HLA	High Level Alarm
HHLA	High-High Level Alarm
IFR	Internal Floating Roof
LCV	Level Control Valve
LLA	Low Level Alarm
LLLA	Low-Low Level Alarm
MFL	Magnetic Flux Leakage
MT	Magnetic Particle Testing
NA	Not Applicable
NACE	National Association of Corrosion Engineers
NDT	Non-Destructive Testing
NFPA	National Fire Protection Association
NPT	National Pipe Taper Thread
PSI	Pounds per Square Inch
PT	Penetrant Testing
PTFE	Polytetrafluoroethylene (e.g., Teflon)
P/V	Pressure/Vacuum
RP	Recommended Practice
TRV	Thermal Relief Valve
UFC	Unified Facilities Criteria
UFGS	Unified Facilities Guide Specifications

GENERAL SUMMARY

Austin Brockenbrough & Associates, LLP (Brockenbrough) was retained by Omaha District USACE under Contract No. W9128F-12-D-0006 Delivery Order 0036 to perform SPCC Mandated API 653 Out-of-service (internal and external) Inspection of Facility 3473 (locally known as Tank 73) at Andrews Airforce Base in Morningside, Maryland. This inspection was completed on August 5, 2017 in accordance with API Standard 653, "Tank Inspection, Repair, Alteration, and Reconstruction," and the referenced contract. The out-of-service inspection was performed by Brockenbrough and our sub-consultant, InterSpec, LLC (InterSpec).

Facility 3473, locally known as Tank 73, is a 31-foot and 0-inch diameter by 41-foot and 3-inch tall, single wall, vertical, field erected tank with a nominal storage capacity of 5,000 barrels of jet fuel (F-24). The tank erectors nameplate indicates a date of construction of 2005. Table 3-1 of the Facility's 2011 SPCC plan indicates a date of construction of 2006. The tank's aluminum internal floating pan was manufactured by Petrex. Secondary containment is provided by concrete dike walls and basin, which is shared with Facility 3474.

There are no Mandatory Repairs noted that need immediate attention. Details of tank construction and appurtenances are included in the Tank Information Table in Section 'B'. Additional noted deficiencies are discussed in more detail in Section 'C', and should be addressed in a timely manner. Our sub-consultant's report is included in Appendix 'A'. Additional photographs are included in Appendix 'B'.

The next API Standard 653 In-Service (visual external) Inspection should be performed by October 2022. The next ultrasonic thickness inspection of the shell should be performed by October 2032. While the current UFC 3-460-03 requires out-of-service inspection to occur every 10 years of service, an upcoming revision allows the frequency to be extended as determined by a certified API 653 tank inspector. While the corrosion rate calculations indicate the inspection-interval could be extended to 30 years, the presence of stainless steel piping on the interior of the tank increases the risk of concentrated internal corrosion. Therefore, the next API Standard 653 Out-Of-Service (internal and external) Inspection should be performed by October 2037. This inspection should include an examination of the tank bottom by magnetic flux leakage (MFL or MFE) technology, and a thorough code compliance evaluation.

THIS INSPECTION

API Out-of-Service (internal and external) Inspection Date: 5 October 2017
Equipment Used:

(See sub-consultant report.)

PREVIOUS INSPECTION DATES

API Out-of-Service (Internal) Inspection Date: NA
API In-Service (External) Inspection Date: October 2015

STATE REGULATIONS

State Regulation for API In-Service Tank Inspections NA
State Regulation for API Out-of-Service Tank Inspections NA

RECOMMENDED FUTURE INSPECTION DATES

API Out-of-service (Internal) Inspection Date: October 2037
API Ultrasonic Thickness Inspection of Shell Date: October2032
API In-Service (External) Inspection Date: October 2022

Mike O'Connor

Mike O'Connor
Mechanical Designer
API 653 Inspector No. 6230

GENERAL TANK INFORMATION

ITEM	DESCRIPTION		
Owner	U.S. Air Force		
Location	Joint Base Andrews		
Facility Number	3473		
Tank Number	Tank 73		
State / Country	Maryland / U.S.A.		
City	Morningside		
Inspection Date	October 5, 2017		
Tank Manufacturer	Witherup Fabrication and Erection, Inc.		
Design Standard	API 650		
Date of Construction	2005 (per nameplate)		
Tank Contents	Jet fuel (F-24)		
Tank Serial Number	09654		
Tank Diameter	31'-0"		
Shell Height	41'-3"		
Product Height	37'-6 3/4" (limited by overflow)		
Tank Capacity	5,000 bbl nominal. (4,500 useable)		
Foundation	18" concrete ring wall.		
Construction/Material	Bottom	5/16-inch, lap welded, carbon steel plate, unknown grade, cone-down.	
	Shell	Five butt-welded shell courses 1/4-inch plate /A36 Mod.	
	Floating Roof	Petrex aluminum honeycomb pan.	
	Fixed Roof	Partially supported cone roof. 1/4-inch plate / carbon steel.	
Cathodic Protection	Impressed current.		
Interior Coating System	Interior 100% coated, likely epoxy. Applied in 2006		
Exterior Coating System	Epoxy/polyurethane assumed. Applied in 2006		
Level Gauging	6-inch well with Enraf ATG and Vito water probe, 8-inch manual gauge ladder well, Shand and Jurs Autogauge.		
Overfill Protection	Independent high and high-high level alarms, float operated LCV.		
Piping	Receipt	8"	Carbon Steel
	Issue	12"	Carbon Steel
	Water Draw-off	1"	Carbon and Stainless Steel
Level Alarms	Independent high, high-high, and low level alarms; ATG Alarms.		
Cleaning, Inspection, Repair	In-service inspection in 2015.		
RPB/Leak Detection	Under bottom liner, 3 leak detection ports, 1 leak detection well.		
Stairs/Ladders	Circumferential stairway w/lower, middle, and upper landings. Internal ladder.		
Manholes	Two 36-inch lower shell manholes. One 36-inch upper shell manhole. One 36-inch roof manhole.		
Venting/Vapor Controls	Center roof vent, 4 roof perimeter vent/inspection hatches, 4 shell overflows.		
PST	Yes		
Secondary Containment	Concrete dike wall and basin shared with adjacent tank (Facility 3474).		
Fire Protection System	(4) fire hydrants within 300 feet.		

A. GENERAL PROJECT INFORMATION

1. API 653 Inspection

This project will perform API 653 Inspections of various tanks at facilities throughout the United States. Additional consideration is given to federal, state, and local regulations as well as applicable military criteria and general industry standards.

For Facility 3473 (Tank 73), an API Standard 653 Out-of-service (internal and external) Inspection was performed, which included a shell settlement survey, a shell UT inspection, and evaluation of the of the shell plumbness and roundness. See subconsultant's report in Appendix 'A' for details.

2. Site Information

On October 3 through 5, 2017 Brockenbrough performed API 653 Out-of-service (internal and external) Inspection of Facility 3473 (Tank 73) located at Andrews Air Force Base, which is located in Morningside, Prince George's County, Maryland. The facility is under the jurisdiction of the United States Air Force 11th Wing, Air Force District of Washington. In 2009, Andrews Air Force Base and Naval Air Facility Washington were merged to form Joint Base Andrews. The Base is named for Lieutenant General Frank Maxwell Andrews (1884–1943), former Commanding General of United States Armed Forces in the European Theater of Operations during World War II. The Base is widely known for serving as the home base of two Boeing VC-25 aircraft which have the call sign Air Force One while the President of the United States is on board. As of the 2010 census, the resident population was 2,973. The host unit at Andrews is the 11th Wing, assigned to the Air Force District of Washington. The Wing 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 (AEFs). The Wing also provides installation security, services and airfield management to support the President, Vice President, other U.S. senior leaders and more than 50 tenant organizations and federal agencies. The list of the types of aircraft that fly out of Andrews Air Force Base is extensive, as are the list of the branches of the military that fly out of Andrews Airforce Base.

3. Previous Repairs

Base personnel indicated no repairs have been performed on the tank since its construction.

4. Future Projects

Base personnel indicated there are no known future projects affecting the tank.

B. TANK INSPECTION COMMENTS

1. Tank Construction

Facility 3473 is a nominal 5,000 bbl, 31-foot diameter by 41-foot and 3-inch tall, Jet Fuel (F-24) aboveground vertical storage tank. The tank erectors nameplate indicates the tank was constructed in 2005. Table 3-1 of the Facility's SPCC Plan indicates a date of construction of 2006. The tank has a cone down bottom, with a center sump, a Petrex aluminum honeycomb internal floating pan, and cone roof.

2. Tank Foundation

The tank rests on an 18-inch tall ringwall foundation. Three leak detection tell-tale pipes project out of the ringwall. There is also a leak detection well cast into a projection of the concrete ringwall. The leak detection pipes and well, along with the year of construction, suggest there is a liner under the tank bottom. The foundation was visually evaluated during the inspection for broken concrete, spalling, cracks, and vegetation against the bottom of the tank. Approximately one-quarter of the tank bottom to foundation seal has failed. A shell settlement (foundation) survey was performed during the inspection in accordance with Appendix B of API Standard 653. The shell settlement evaluation indicates no significant shell settlement and the elevation of the bottom of the shell is within tolerance for new construction. No cracks were noted in the ringwall. The measured out of plane deflection does not indicate significant settlement. Therefore, no action is required. The measurements and analysis are recorded in our sub-consultant's report.

3. Tank Shell

The vertical and cylindrical shell consists of five butt-welded courses. The exterior of the shell was visually inspected and evaluated for plumbness, roundness, peaking, and banding. No significant peaking or banding of the shell seams was noted, the shape of the shell appears to be within the allowable tolerances of API Standard 653. The coating was evaluated for deterioration. The ultrasonic thickness measurements of the shell and calculations included in Appendix 'A' indicate the shell has more than 30 years of remaining life. API 653 recommends ultrasonic thickness measurements of the shell be taken at least every 15 years.

4. Tank Appurtenances

a. Tank Roof

The tank's steel, lap welded cone roof shows sign of water ponding around the perimeter. There are only eight rafters. The rafters are spaced more than 12 feet apart as measured on the circumference of the perimeter of the roof. As early as 1996, API 650 required the rafter spacing at the perimeter of the tank roof to be no greater than 75 inches apart. Earlier API requirements may have been more stringent. Later editions of API 650, paragraph 5.10.4.4 increased the maximum allowable circumferential spacing to 84 inches.

b. Internal Floating Pan

The tank's aluminum honeycomb internal floating pan was manufactured by Petrex. The floating pan perimeter seal is a double foam log. The foam log primary seal is cracked, several areas are saturated with fuel. One area of the foam log primary seal located near the internal ladder was noted to be sagging and dripping fuel.

c. Venting

The tank has a 26-inch diameter roof center vent, 4 perimeter vent inspection hatches and 4 shell overflow/vents. The vents are covered with insect screen. API 650 does not allow insect screen on vents as this significantly reduces the ventilation capacity and is subject to clogging.

d. Gauging

The tank's Enraf ATG is installed in a 6-inch flanged aluminum stilling well suspended from an 8-inch carbon steel roof nozzle with an internal flange just under the roof. A Vito water probe is installed in the same stilling well as the ATG. Manual gauging may be performed through the 8-inch ladder stilling well/side rail under the roof manhole cover, which is equipped with a gauge hatch. The internal ladder side rails are securely fastened to neck of the roof manhole by U-bolts. The manual and ATG stilling wells are also welded to their bottom guides, which are bolted rigidly to their mounting plates, which in turn are welded to the tank bottom. API 650 does not allow columns to be fastened to both the tank roof and the tank bottom. The bolt holes are not slotted, however slotted bolt holes and their length are included in USACE Standard Design AW 78-24-27 for adjusting the datum plate elevation only. While perhaps not obvious, the intent of the detail included in the USACE Standard Design AW 78-24-27 in effect at the time was that the guides touch but not be welded to the stilling wells, so that the datum plates, which were to be welded to the bolted guides, could be adjusted using the slotted bolt holes. There is no standard in API 650 for the design of slotted bolt holes to allow movement of the roof and bottom connected by a column. The 2010 release of the DoD Standard Design AW 78-24-27 clarified the detail.

e. Level Alarms

The tank has independent (shell mounted) high, high-high, and low level alarms. The high level alarms are accessible from the circumferential stairway intermediate landing. The alarms are plumbed to allow testing when the receipt piping is pressurized.

f. Stairs, Landings and Ladders

The tank's steel cone roof is accessible by a circumferential stairway mounted on the shell of the tank. A concrete landing with radial approach steps provides access to the bottom of the stairway. The circumferential stairway incudes a lower landing for accessing the upper shell manhole and floating pan at high leg position. The circumferential stairway also includes an intermediate landing for accessing the high level alarms and controls.

g. Grounding and Bonding

There are four grounding cables bolted to couplings, which are welded to the shell.

h. Shell Manholes

The tank has two lower 36-inch shell manholes and one upper 36-inch shell manhole. The shell manhole covers are hinged.

5. Tank Coating

The interior and exterior of the shell are coated. There is coating failure and corrosion on the receipt and issue DBB valves, TRV valves and their connecting flanges, and on the roof perimeter vent/inspection hatches at the roof penetration frames, hinges and bottoms of the covers.

6. Tank Piping System

Fuel is received into the tank through 8-inch carbon steel piping via underground piping from the adjacent pumphouse, which receives fuel via underground pipeline from the bulk tanks in the southeast tank farm, and is issued from the tank through 12-inch carbon steel underground piping through the adjacent pumphouse to a hydrant system.

7. Fire Protection System

There are four fire hydrants within 300 feet of the tank.

8. Secondary Containment

A concrete dike and basin provide secondary containment, which is shared with the sister tank (Facility 3474). The distance of the swale from the tank varies from 6 to 10 feet from the tank. Filling the secondary containment drainage sump with water and holding for more than an hour while observing a stable water level in the sump (hydrostatic testing) indicates the integrity of the drain valve, sump, and drain piping is acceptable. The receipt piping runs over the swale. NFPA 30 paragraph 22.11.2.1 requires the dike basin to be sloped away from the tank for a distance of 50 feet or to the dike wall, whichever is less. NFPA 30 paragraph 22.12.2.1 requires the dike basin to also be sloped away from the piping for a distance of 50 feet.

The expansion joints between the dike basin and the foundation as well as between the dike basin and the dike walls have failed.

The grounding cables penetrate the concrete ringwall foundation through unsealed pipe. The three (3) leak detection tell-tale pipes also penetrate the concrete ringwall through unsealed penetrations.

The volume of the secondary containment is sufficient to hold the contents of the tank full to the bottom of the overflow as required by NFPA 30, plus approximately 12 inches of freeboard. Guidance for the design of new tanks included in UFC 3-460-01 includes only 12 inches of freeboard.

C. FINDINGS AND RECOMMENDATIONS

Tank Facility 3473 was found to be in generally good condition. The tank is fully serviceable, with no mandatory deficiencies that would require immediate removal of the tank from service. However, there were several items observed, that are not in full compliance with federal, state, and local regulations or military criteria.

1. MANDATORY REPAIRS per API 653, NFPA, or CFRs

Mandatory repairs represent items that require immediate attention in order to prevent imminent risk to system operators, equipment, or the adjacent environment. The tank would have to be taken out-of-service to complete these repairs. **No Mandatory Repairs are required to be performed.**

2. SIGNIFICANT FINDINGS per API 653, NFPA 30 or CFRs

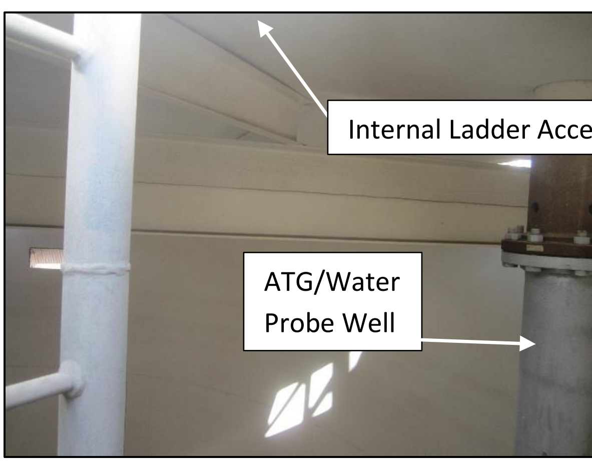
The following information identifies the significant findings found during the tank inspection, and includes repair recommendations.

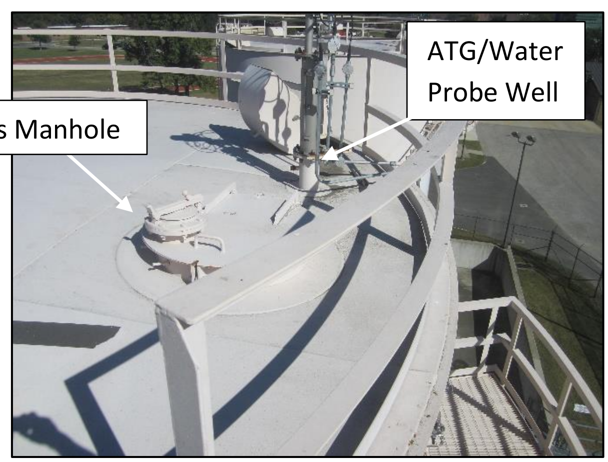
a. Provide Stilling Wells

Observation: The internal ladder side rail well, which is accessible through a roof manhole cover provides the only means of manual gauging, is not slotted above 5-foot level, and does not have a floating plug retriever. The Enraf ATG and Vito Water/Temperature Probe share a 6-inch well located near the perimeter of the tank. The 6-inch ATG/Water Probe well transitions to stainless steel just under the roof and is not slotted above the 5-foot level. The stainless steel may result in galvanic corrosion under any interior coating flaws, if water is present. If the well were made of aluminum it could provide some passive cathodic protection.

Reference: Guidance for new construction provided in DoD Standard Design AW 78-24-27 includes an 8-inch aluminum full length slotted stilling well for the ATG and a 6-inch aluminum stilling well near the tank center for the Vito Water/Temperature probe.

Recommendation: Provide a 10-inch roof nozzle with an 8-inch aluminum full length slotted stilling well for the ATG and a separate 8-inch roof nozzle with a 6-inch aluminum stilling well in or near the bottom sump for the Vito Water/Temperature probe. Eliminate the stainless steel stilling well. Full length slot the ladder well.



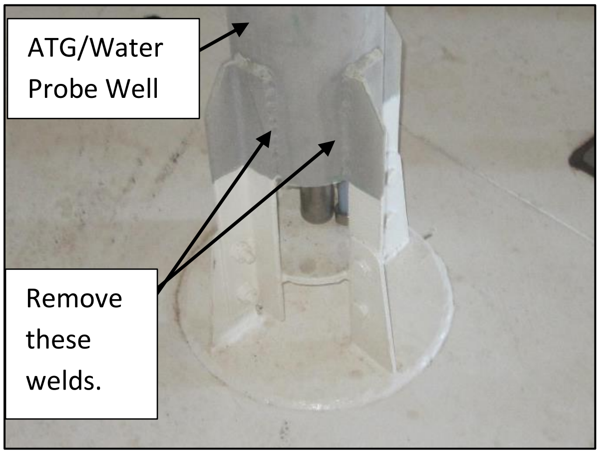


b. Modify Stilling Well Guides

OBSERVATION: The 6-inch combination ATG and Vito Water Probe well is bolted to the tank bottom, as well as attached to the tank roof. In addition, the internal ladder is attached to the tank roof manhole neck as well as bolted to its bottom end guides, which are welded to the tank bottom.

REFERENCE: API 650 paragraph 5.10.4.7.d) requires columns to be free to move vertically relative to the tank bottom. Guidance for the design of new storage tanks provided in DoD Standard Design AW 78-24-27 allows stilling wells and ladders to be free to move vertically.

RECOMMENDATION: Loosen the U-bolts attaching the internal ladder to the roof manhole neck, and double nut the U-bolts to the manhole neck. If the well is not demolished, remove the welds attaching the combination ATG and Vito Water Probe well to the bottom guides.



c. Provide OSHA Compliant Ladder Access Hatch

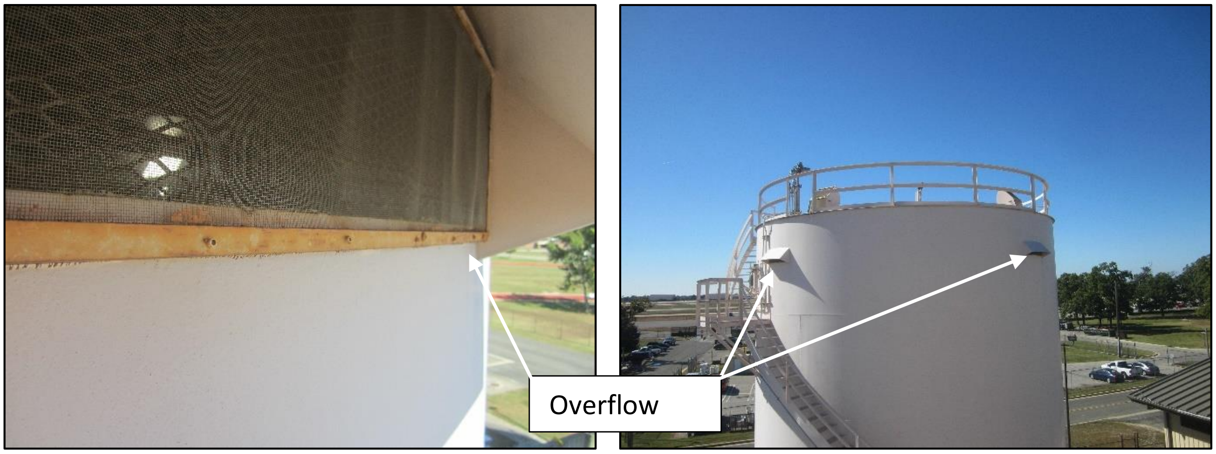
OBSERVATION: The internal ladder access round roof manhole provides less than 28 inches of clearance on the climbing side of the ladder, does not have a deflector plate, is not gasketed or bolted, does not have a rain lip, and allows rain water to enter the tank.

REFERENCE: OSHA regulation 29 CFR 1910.27 (c) requires 30 inches of clearance on the climbing side of a ladder, or a deflector plate on the underside of the opening, set at an angle of 60 degrees from horizontal. API 650 paragraph 5.8.4 requires round roof manholes to be gasketed and bolted. Guidance for new construction provided in DoD Standard Design AW 78-24-27 includes a rectangular ladder access hatch with hinges and a rain lip as allowed by API 650 Paragraph 5.8.6.

RECOMMENDATION: Provide an OSHA and API compliant internal ladder access hatch.

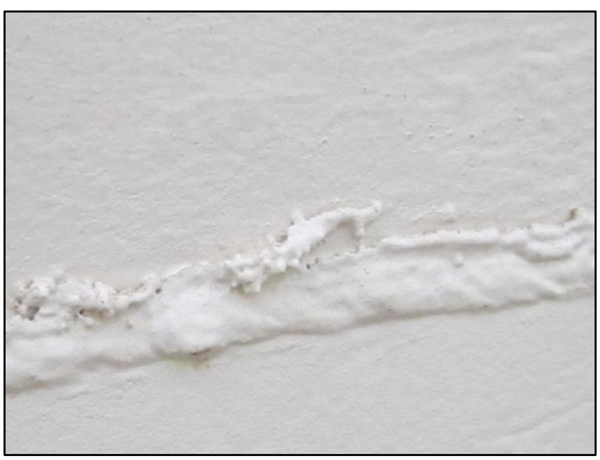
d. Remove Insect Screens

OBSERVATION: The four (4) shell overflows are covered with insect screen. Insect screen significantly reduces the ventilation capacity and is subject to clogging. However, as discussed in Section C.4 of this report, only the overflow opposite the stairway and tank nozzles is necessary.
REFERENCE: API 650 paragraph H-5.2.2 requires vent screens with 1/2-inch openings.
RECOMMENDATION: Remove the insect screen from the shell overflow opposite the stairway and product nozzles.



e. Smooth the Interior Horizontal Welds

OBSERVATION: As observed from on top of the floating pan at high leg position, the interior horizontal welds appear to have a rougher profile and more weld spatter than allowed by the current UFGS Specification 33 56 13.13 for new construction. Rough surfaces of welds may reduce the life of the floating pan perimeter seals and the interior coating.
REFERENCE: Guidance for new construction provided in UFGS Specification 33.56.13.13 includes evaluating the finish of welds in accordance with NACE using a visual comparator for reference.
RECOMMENDATION: When the interior coating is replaced grind the interior horizontal weld surfaces smooth and remove weld splatter.



f. Modify the Roof Support Structure

OBSERVATION: The tank's steel, lap welded, cone roof shows sign of water ponding around the perimeter. There are only eight rafters. The rafters are spaced more than 12 feet apart at the perimeter of the roof.

REFERENCE: As early as 1996, API 650 required rafter spacing at the perimeter of the tank roof to be no greater than 75 inches apart. Earlier API requirements may have been more stringent. Later editions of API 650, paragraph 5.10.4.4 increased the maximum allowable spacing to 84 inches.

RECOMMENDATION: Modify the roof support structure to eliminate the water ponding and bring the roof into compliance with API 650.

g. Provide Conduit and Connector

OBSERVATION: A conduit, with wiring connections inside an electrical junction box, is not properly connected to the junction box, but is only butted up against the box and caulked.
REFERENCE: NFPA 70 paragraph 500.5(B)(2)(1) and guidance for new construction provided in UFC 3-460-01 Paragraph 2-12.1.1 considers all outdoor locations within 5 feet of fuel storage tanks to be Class 1 Division 2. NFPA 70 paragraph 500.7 requires electrical equipment that is not intrinsically Safe and used in Class I Division 2 locations to be explosion proof.
RECOMMENDATION: Provide an explosion proof conduit connection to the electrical junction box.


h. Replace Floating Pan Penetration and Perimeter Seals

OBSERVATION: The internal floating pan's original penetration seals are deteriorated. The internal floating pan's original double wiper perimeter foam log seal is showing signs of wear. An area of the primary perimeter foam log seal near the internal ladder is starting to sag and retain fuel.
REFERENCE: Guidance for new construction provided in DoD Standard Design AW 78-24-27 and UFGS Specification 33 56 13.13 includes double wiper squeegee urethane perimeter seals.
RECOMMENDATION: Replace the floating pan perimeter seals with urethane double wiper squeegee perimeter seals. Replace the floating pan penetration seals with urethane wiper seals.


i. Seal Secondary Containment

OBSERVATION: There are approximately 60 feet of unsealed cracks in the shared dike walls and 30 feet of unsealed cracks in the shared dike basin. Rainwater entering the concrete through the cracks may cause deterioration of the reinforcing steel and/or freeze and expand causing widening of the cracks and further deterioration. In addition, the expansion joint sealants between the dike basin and the dike wall and foundations, and 10 feet of dike basin expansion joint have failed.

REFERENCE: NFPA 30 paragraph 22.11.2.4 and CFR 112.7(c)(1) require dikes to be liquid tight.

RECOMMENDATION: Rout and seal 50 feet of unsealed cracks in the shared dike walls and 30 feet of unsealed cracks in the shared dike basin. Replace the sealants between the dike basin and the dike wall and foundations and in 10 feet of dike basin expansion joint.


j. Provide Penetration Seals

OBSERVATION: The receipt piping and the issue piping both penetrate the dike basin through pipe sleeves without any seals between the sleeves and the piping. Drawings for the dike basin and penetrations were not available at the time of the inspection to confirm if there is a liner under the concrete sealed to the piping.

REFERENCE: NFPA 30 paragraph 22.11.2.4 and CFR 112.7(c)(1) require dikes to be liquid tight.

RECOMMENDATION: If as-built drawings indicating a liner sealed to the piping under the dike basin cannot be located, the gap between the product piping and the dike basin penetration sleeves should be sealed using a modular elastomeric compression seal.


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. Remove the Insect Screens

OBSERVATION: The four (4) roof perimeter vent and the four (4) shell overflows are covered with insect screen. Insect screen significantly reduces the ventilation capacity and is subject to clogging.
REFERENCE: API 650 paragraph H-5.2.2 requires vent screens with 1/2-inch openings.
RECOMMENDATION: Remove the insect screens from the perimeter vents and shell overflows.

b. Adjust Enraf Door Latches

OBSERVATION: The Enraf ATG access door latches are out of adjustment and do not properly engage the door seal so as to prevent rainwater from entering the tank.
REFERENCE: NA.
RECOMMENDATION: Adjust the Enraf access door latches so that all latches engage the door seal.

c. Repair Concrete

OBSERVATION: The concrete dike basin is spalled around the base of the dike access steps support pedestal.

Reference: NFPA 30 paragraph 22.11.2.4 and CFR 112.7(c)(1) require dikes to be liquid tight.

RECOMMENDATION: Repair the concrete where it is spalled around the base of the dike access steps support pedestal.

d. Repair Tank Bottom-to-Foundation Seal

OBSERVATION: Approximately a quarter of the tank bottom to foundation seal has failed.

REFERENCE: Guidance for maintenance of fuel storage facilities provided in UFC 3-460-03 paragraph 8-4.1. B. includes monthly inspection and repair of the tank bottom to foundation seal.

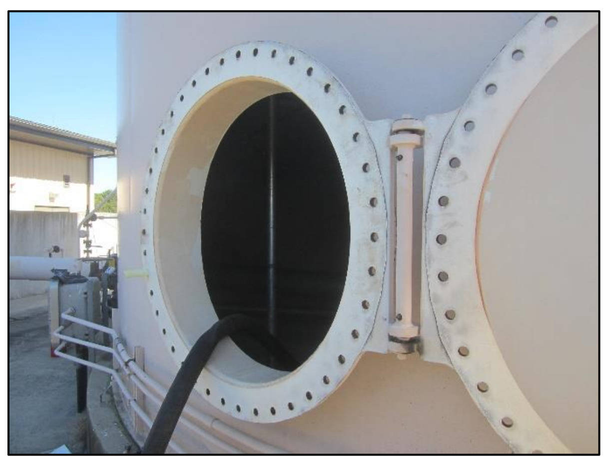
RECOMMENDATION: Replace the failed areas of the tank bottom to foundation seal.

e. Provide Junction Box Gasket

OBSERVATION: A conduit junction box with a threaded cover is missing its gasket/ O-ring.
REFERENCE: NFPA 70 paragraph 500.5(B)(2)(1) and guidance for new construction provided in UFC 3-460-01 Paragraph 2-12.1.1 considers all outdoor locations within 5 feet of fuel storage tanks to be Class 1 Division 2. NFPA 70 paragraph 500.7 requires electrical equipment that is not intrinsically safe and used in Class I Division 2 locations to be explosion proof.
RECOMMENDATION: Provide a gasket/O-ring for the electrical junction box shown to ensure the electrical junction box is explosion proof.


f. Replace Grease Fitting

OBSERVATION: A grease fitting on the northwest shell manhole cover hinge shaft is broken.
REFERENCE: Guidance for new construction provided in DoD Standard Design AW 78-24-27 includes a grease fitting on shell manhole cover davits.
RECOMMENDATION: Replace a grease fitting on the northwest shell manhole cover hinge shaft.

g. Remove Vegetation

OBSERVATION: There is a small amount of vegetation growing out of the secondary containment expansion joints.

Reference: Guidance for maintenance of fuel storage facilities provided in UFC 3-460-03 paragraph 8-10.2.2 includes daily inspection of concrete secondary containment for cleanliness and removal of vegetation.

RECOMMENDATION: Continue to inspect and remove vegetation from the expansion joints of the concrete secondary containment.

h. Seal Secondary Containment

OBSERVATION: The grounding cables penetrate the concrete ringwall foundation through unsealed pipe. The three (3) leak detection tell-tale pipes also penetrate the concrete ringwall through unsealed penetrations.

REFERENCE: NFPA 30 paragraph 22.11.2.4 and CFR 112.7(c)(1) require dikes to be liquid tight.

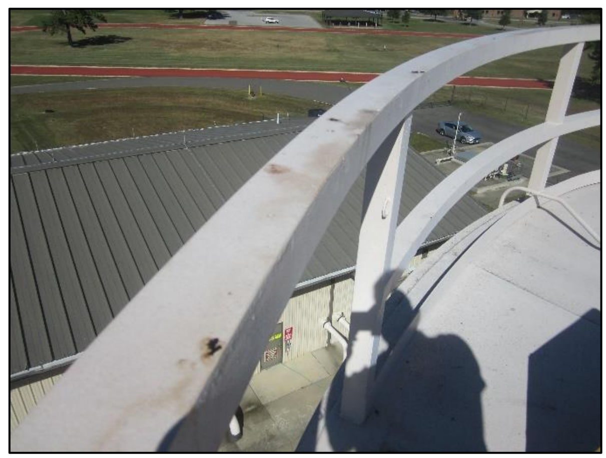
RECOMMENDATION: Seal the grounding cables where they penetrate the concrete ringwall foundation through pipe sleeves. Seal the three (3) leak detection tell-tale pipes where they penetrate the concrete ringwall through pipe sleeves.

i. Pressure Wash Exterior

OBSERVATION: The isolated areas of the exterior of the shell and roof are covered with mold and algae, which can lead to coating failure. In addition, bird droppings were observed on the roof guardrail. API 570 paragraph 4.3.2.3.h) reads, "bird turds can also cause accelerated corrosion and unsightly stains."

REFERENCE: Guidance for the design of new storage tanks provided in UFC 3-460-01 paragraph 8-3.10 requires the exterior to be coated.

RECOMMENDATION: Pressure wash the exterior of the tank regularly.

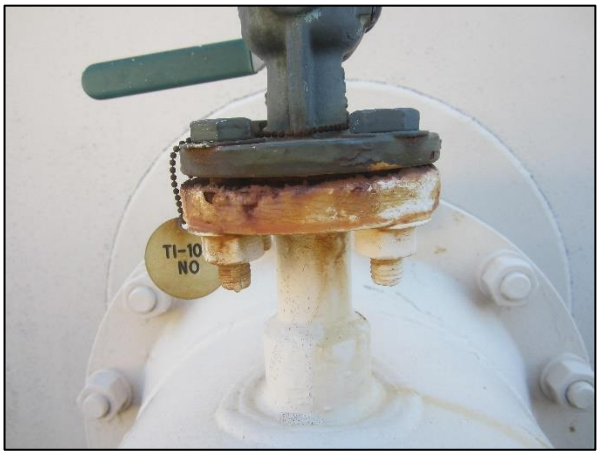


j. Repair Appurtenance Coatings

OBSERVATION: There is coating failure and corrosion on the receipt and issue DBB valves, TRV valves and their connecting flanges, and on the roof perimeter vent/inspection hatches at the roof penetration frames, hinges and edges of the covers. There is coating failure on the cathodic protection conduit, underside of the roof manhole cover and on the flange; level alarm sensor mounting flanges, and underside of the center vent cover.

REFERENCE: Guidance for new construction provided in UFC 3-460-01 paragraph 8-3.9 includes coating the interior. Paragraph 8-3.10 includes coating the exterior.

RECOMMENDATION: Repair the coatings on the cathodic protection conduit, receipt and issue DBB valves; TRV valves and their connecting flanges; the roof perimeter vent/inspection hatches at the roof penetration frames, hinges, and edges of the covers; level alarm sensor mounting flanges; underside of the roof manhole cover and on the flange; and underside of the center vent cover.



k. Replace Nuts and Bolts

OBSERVATION: The nuts and bolts on the Enraf access/mounting chamber are corroded.

REFERENCE: Guidance for the design of new storage tanks provided in UFC 3-460-01 paragraph 8-3.10 requires the exterior to be coated.

RECOMMENDATION: Replace the bolting on the Enraf access/mounting chamber with corrosion resistant bolting.

4. REPAIRS to Fully Comply with API 653, or UFC 3-460-01 and/or AW 78-24-27 Guidance

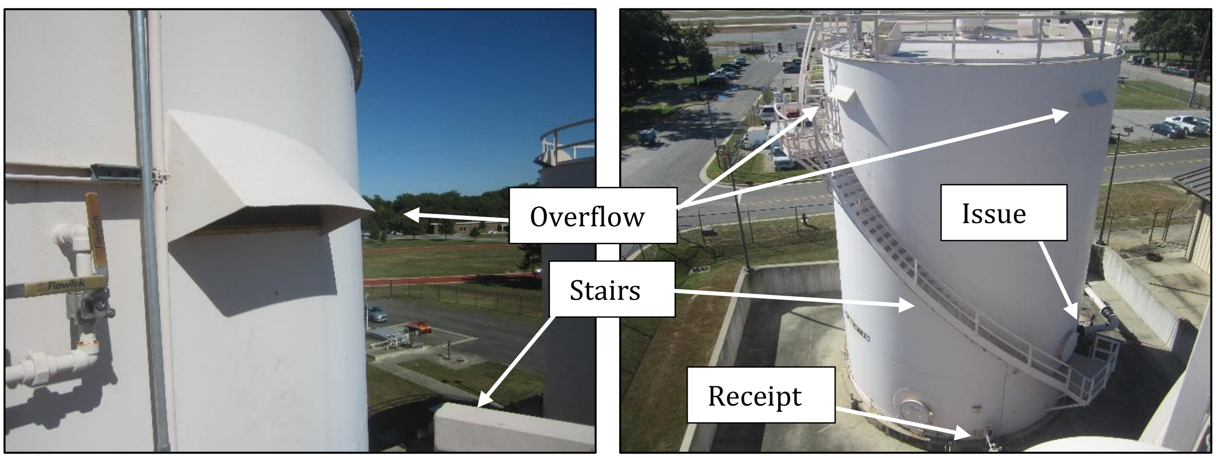
These items represent repairs and/or upgrades that could be performed to bring the tank into full compliance with current standards, but that do not represent potential risks to system operators, equipment integrity, or the adjacent environment. Our recommendations to perform, or not to perform these repairs and/or upgrades, take into consideration the cost of the repair, the operational benefit of the repairs, the age of the tank/system, operator safety, environmental risks, and equipment integrity.

a. Modify Overflows

OBSERVATION: The tank has four (4) shell overflows measuring approximately 3 feet by 1 foot, which are covered with expanded metal and insect screen. Two of the shell overflows are located over the stairs and the receipt nozzle isolation valve. A third shell overflow is located over the issue isolation valve and the stairway radial approach steps. Fuel is received into the tank through two parallel 600 gpm filter/separators and an 8-inch nozzle.

REFERENCE: API 650 paragraph H.5.3.3 does not allow overflows to be located over stairways or tank nozzle isolation valves with limited exceptions. Guidance for new construction included in DoD Standard Design shows only one overflow with 2 square feet of net open area on 5,000 through 30,000 bbl tanks with 8-inch receipt nozzles. The Standard Design drawings show the overflow on the side of the tank opposite the product nozzles and not over the stairway.

RECOMMENDATION: If the safety of personnel who may be on the roof or access to shell nozzle valves during an overflow event are a concern, eliminate the three shell overflows located over the circumferential stairway and/or shell nozzle isolation valves, and repair the shell at those locations.



b. Modify the Receipt Piping

OBSERVATION: There is no isolation valve upstream and adjacent to the level control valve.
REFERENCE: Guidance provided in UFC 3-460-01 paragraph 7-6.3.4 and DoD Standard Design AW 78-24-27 include an isolation valve upstream and adjacent to the level control valve on new storage tanks.
RECOMMENDATION: If the ability to service the level control valve without having to drain the piping is desired, provide an isolation ball valve upstream and adjacent to the level control valve.

c. Provide Exothermic Grounding Connections

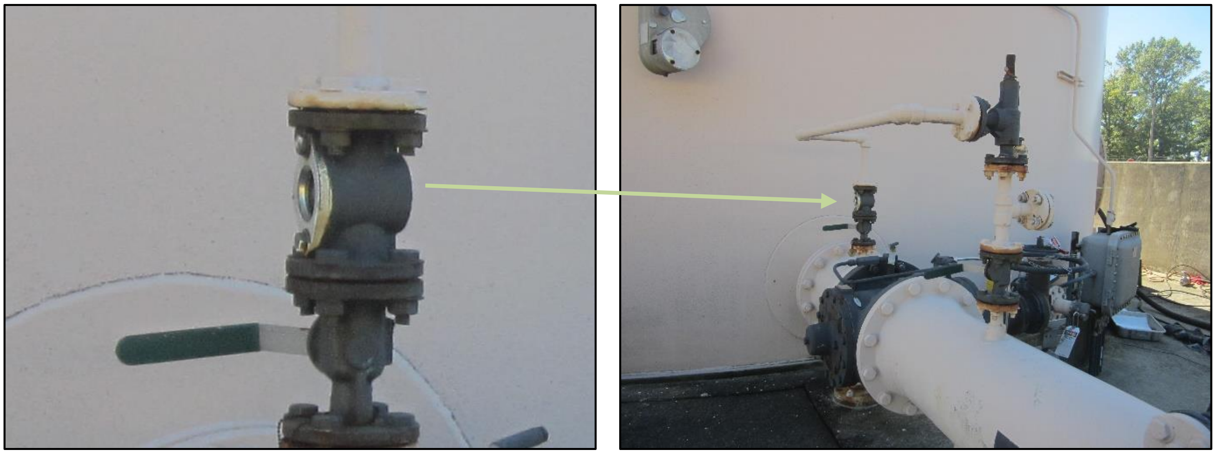
OBSERVATION: The tank's grounding cables are bolted to couplings welded to the shell.
REFERENCE: Guidance for new construction provided in DoD Standard Design AW 78-24-27 Detail 2/ED.02 includes exothermic-welding the grounding cables to stainless steel grounding lugs.
RECOMMENDATION: If in addition to lightning protection, a means to reliability control stray electrical currents is desired, provide grounding lugs and exothermically welded grounding connections.

d. Modify Thermal Relief Piping

OBSERVATION: The receipt and issue thermal relief piping includes sight flow indicators. Facility personnel indicated they want to keep the sight flow indicators.

REFERENCE: Guidance for the design of new storage tanks provided in UFC 3-460-01 paragraph 9-3.5 includes TRV piping around isolation valves; paragraph 9-3.5.1 discourages site flow indicators on thermal relief valve piping.

RECOMMENDATION: If Facility personnel agree, modify the thermal relief piping to eliminate the site flow indicators.

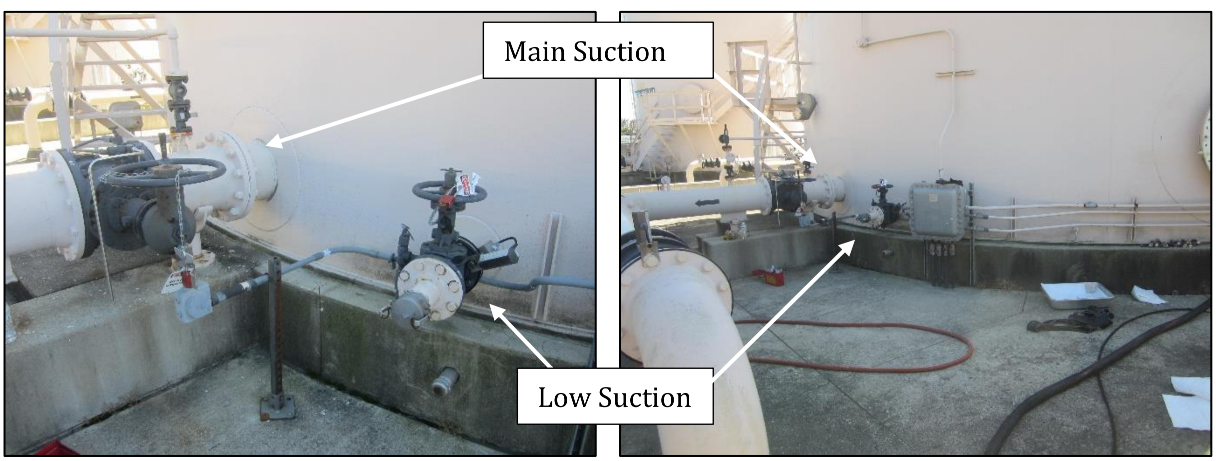


e. Pipe low Suction to Main Suction

OBSERVATION: The low suction nozzle is not piped to allow using the issue pumps to drain the tank in preparation for tank cleaning and entry. In theory, the location of the internal low suction piping could potentially reduce the self-cleaning action of the cone down bottom.

REFERENCE: Guidance for the design of new storage tanks provided in UFC 3-460-01 Table 8-1, Item v and DoD Standard Design AW 78-24-27 include hard piping the low suction to the main suction.

RECOMMENDATION: If the time and cost of removing the last few hundred barrels of fuel from the tank in preparation for cleaning and or maintenance is an issue, consider providing piping and valves to connect the low suction to the main suction.



f. Adjust Internal Pipe Supports

OBSERVATION: The internal issue piping is not resting on its pipe support. The internal pipe supports are adjustable. However, the tank bottom may be expected to flex downward and piping to flex upward, due to the weight of the fuel and buoyancy of the pipe, when the tank is filled, thus widening the gap between the piping and the supports.

REFERENCE: DoD Standard Design AW 78-24-27 includes internal bolted pipe supports with slotted holes for adjusting the height of the support.

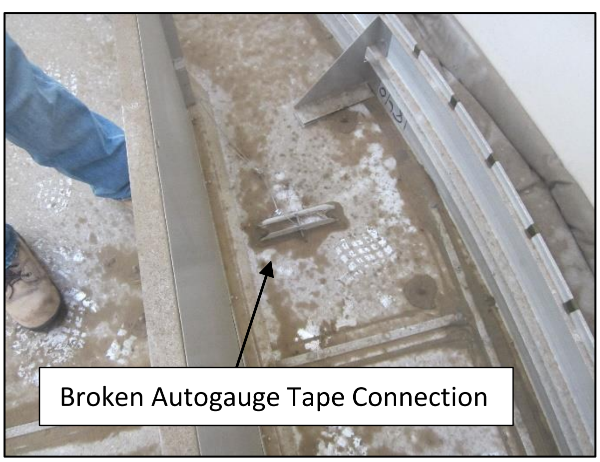
RECOMMENDATION: If supporting the internal piping when the tank is empty is a concern continue to readjust the internal pipe supports whenever the tank is taken out of service for cleaning.

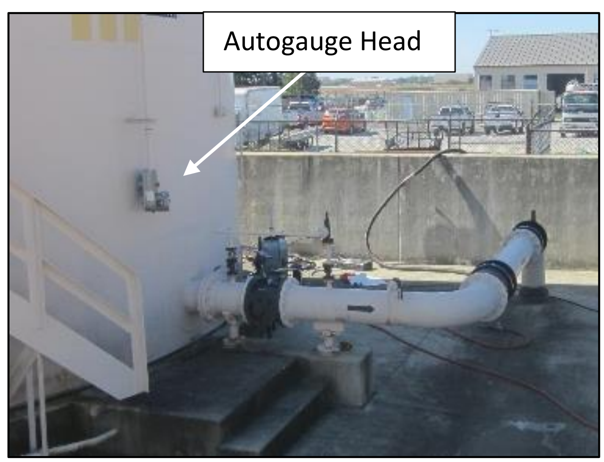
g. Reinstall Autogauge Tape

OBSERVATION: The Shand and Jurs autogauge tape was connected directly to the floating pan. As a result, the gauge is inoperable.

REFERENCE: Guidance for new construction provided in UFC 3-460-01, Table 8-1, Item o, includes a liquid level gauge. Guidance for new construction provided in DoD Standard Design AW 78-24-27 includes a mechanical tape level autogauge. Manufacturers of mechanical tape level autogauges (Varec and Shand & Jurs) recommend attaching the tape to a float in a floating pan penetration well or to a weight resting on top of the pan, but not directly to the pan to avoid damage to the tape or gauge head in the event the pan does not descend smoothly with the fuel.

RECOMMENDATION: Consider reinstalling the autogauge tape in accordance with the manufacturer's recommendations and instructions.



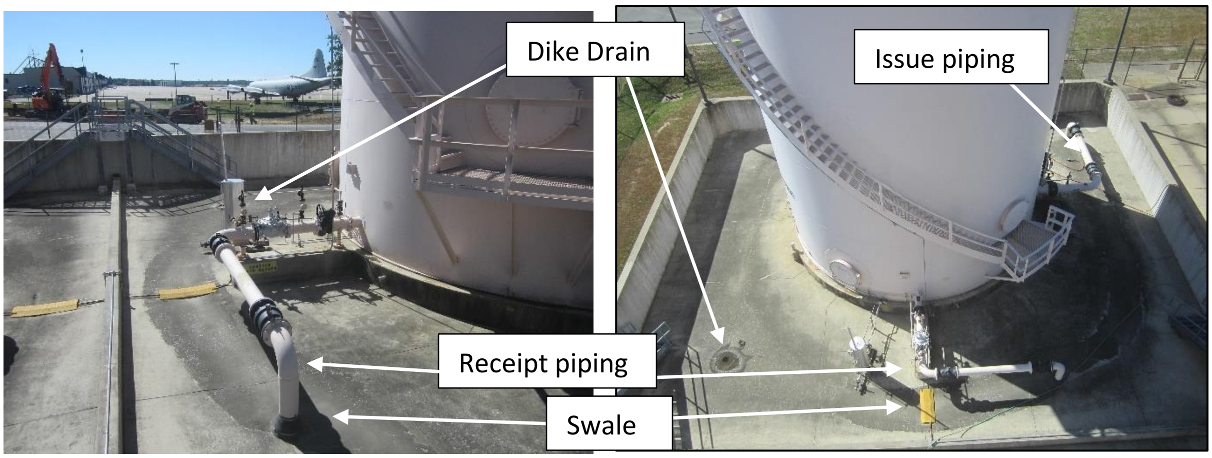


h. Modify Secondary Containment

OBSERVATION: A concrete dike and basin provide secondary containment, which is shared with the sister tank (Facility 3474). The distance of the swale from the tank varies from 6 to 10 feet from the tank. The receipt piping runs over the swale.

REFERENCE: NFPA 30 paragraph 22.11.2.1 requires secondary containment to be sloped away from the tank for 50 feet or to the dike wall, whichever is less. NFPA 30 paragraph 22.12.2.1 requires the dike basin to also be sloped away from the piping for a distance of 50 feet.

RECOMMENDATION: If future projects include major modifications to the site, consider modifying the secondary containment to slope to the drain and away from the tank all the way to the dike wall and away from the piping.

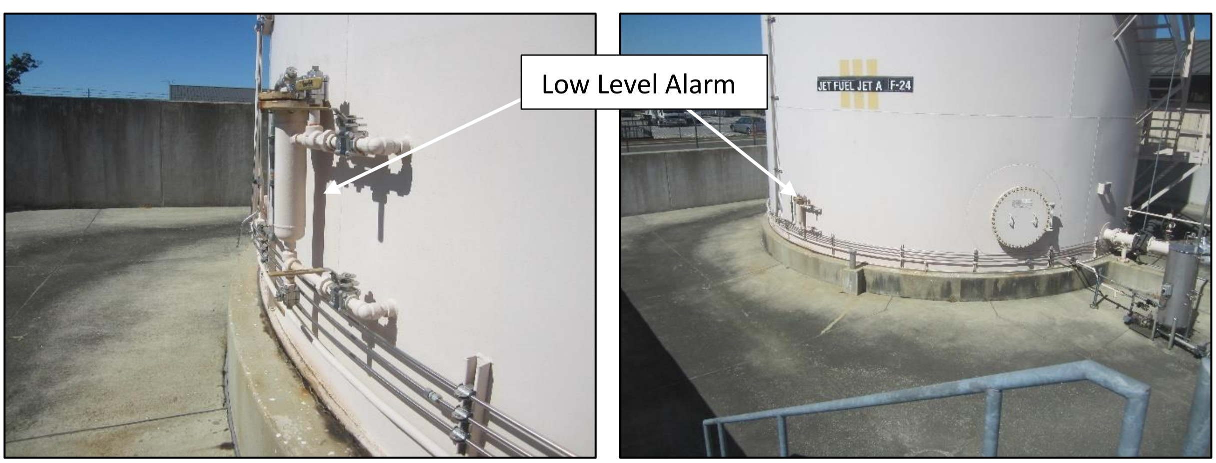


i. Provide Low-low Level Alarm

OBSERVATION: The only shell mounted low level alarm is located below the low leg level of the floating pan and has threaded connections.

REFERENCE: Guidance for new construction provided in DoD Standard Design AW 78-24-27 includes low and low-low level alarm chambers above the low leg level of the floating pan. Guidance for new construction provided in UFC 3-460-01 paragraph 9-8.e) prohibits installing threaded piping on new fuel piping.

RECOMMENDATION: If ensuring the operating level of the fuel is high enough to realize the benefit of a full contact floating pan is desired, demolish the existing low level alarm chamber, nozzles, piping, and sensors. Provide new shell mounted low and low-low level alarms at the proper levels.



j. **Reinstall Latch**

OBSERVATION: The roof perimeter vent/inspection hatches have two latches each. However, one of the latches on the roof perimeter vent/inspection hatch counter clockwise of the ATG has one latch that is inoperable due to faulty installation.

Reference: Guidance for new construction provided in DoD Standard Design AW-24-27 includes roof perimeter vent/inspection hatches with two latches per hatch.

RECOMMENDATION: The next time other welded repairs are performed on the tank,reinstall the faulty latch on one of the roof perimeter vent inspection hatches so that the latch is operable.

k. **Provide Grounding for the Product Saver Tank**

OBSERVATION: The product saver tank stainless steel piping is isolated from the tank by the isolation flange kit on the shell nozzle isolation valve. The piping between the stainless steel product saver tank piping and the water draw-off nozzle isolation valve is carbon steel. An electric motor is mounted on the product saver tank piping, but the product saver tank is not grounded.

REFERENCE: Guidance provided in DoD Standard Design AW 78-24-27 and UFC 3-460-01 paragraph 2-12.3 include grounding for new product saver tanks. Paragraph 9-8 i) includes isolation flanges for connecting dissimilar metals.

RECOMMENDATION: If lightning protection is desired, provide a grounding system for the product saver tank. Do not bond the product saver tank to the same grounding system as that on the tank in order to maintain some degree of electrical isolation. Replace with stainless steel piping, the carbon steel piping between the stainless steel piping and the water draw-off nozzle isolation valve.

l. Replace Internal Piping

OBSERVATION: The receipt, issue, low suction and water draw-off nozzles are internal flanged and their internal piping is stainless steel. The ATG stilling well is also stainless steel. Galvanic corrosion of the interior of the tank may occur, if water is present. The issue internal piping terminates horizontally inside the tank.

REFERENCE: Guidance for the design of new storage tanks provided in DoD Standard Design AW 78-24-27 indicates issue piping that terminates inside the tank with a turn down elbow approximately 4 inches above the tank bottom, carbon steel internal receipt, issue, low suction, and water draw-off piping, and aluminum stilling wells. Guidance for the design of new fuel facilities provided in UFC , and 3-460-01 paragraph 2-12.3.3 prohibit the bonding of dissimilar metals.

RECOMMENDATION: If water is expected inside the tank, replace the stainless steel receipt, issue, low suction and water draw-off internal piping with carbon steel per DoD Standard Design AW 78-24-27. Replace the stainless steel stilling well with aluminum, or if 8-inch aluminum stilling wells are provided as recommended elsewhere in this report, demolish the 6-inch stainless steel stilling well.

m. Remove Stainless Steel IFR Striker Plates

OBSERVATION: The internal floating pan support leg striker plates are stainless steel and glued to the tank bottom. Galvanic corrosion of the interior of the tank may occur, if water is present and the stainless steel striker plates make contact with the pan support legs or the tank bottom.

REFERENCE: API 650 paragraph H.4.6.6 (paragraph H.4.7.4 in the 1993 and previous editions) requires that if striker plates are used, they be welded to the tank bottom. Guidance included in UFC 3-460-01 paragraph 2-12.3.3 discourages the bonding of dissimilar metals in new storage tanks. Guidance for new construction included in UFGS Guide Specification 33 56 163.13 includes PTFE feet on the bottoms of IFR support legs.

RECOMMENDATION: When major repairs to the internal coating are performed, remove the stainless steel IFR support leg striker plates, examine the tank bottom under the striker plates, repair the tank bottom and internal coating if indicated, and provide PTFE feet on the IFR support legs.

APPENDIX A: SUB-CONSULTANT REPORTS

API 653 OUT-OF-SERVICE INSPECTION REPORT

Inter Spec LLC
Environmental Inspection Services
464 S Independence Blvd, C-104, Virginia Beach, VA 23452
www.interspecllc.net

Office: 757-622-6299
Fax: 757-622-9103
Toll Free: 800-546-7853

API-653 Engineering Inspection Report
Tank # 3473 (Andrews AFB, MD)

Prepared for

Austin Brockenbrough & Associates, L.L.P.

October 03, 2017

API Standard 653 recommends this document containing valuable historical information be retained for the life of the tank.

Signature(s):

Daniel C. Bailey, Inspector, API-653 #56207, STI SP-001 #AST-134002, NDT Level II

General Conditions

The information referenced in this engineering report is based solely upon the area or areas agreed upon and contracted for inspection on the date of the inspection and under those present, known, same, and current conditions. This report was prepared using retrievable data from those areas that were made available and accessible during the inspection. Areas not contracted for inspection and/or made available and accessible are not included in this report.

The methods, standards and regulations used by InterSpec, LLC during the inspection and in preparing this engineering report comply with the most current and widely accepted standards and regulations in the industry, in which these standards and regulations make no representation, warranty or guarantee. The professional opinions and recommendations stated in this report, including predictability of life, maximum length of time for re-inspection, suitability for product storage, and safe fill height are conclusive approximations and are intended to serve mainly as guidelines for obtaining the utmost in spill prevention and environmental protection. The listed recommendations may not necessarily be mandatory actions, but corrective actions that InterSpec, LLC suggests would better preserve the owners'/operators' facility components and may contribute to a safer and more convenient operation. Failure to comply with these could result in, but may not be limited to, reduction of service life, tank mishap, legal consequences and/or fines for owners/operators. It is best advised that the recommended repairs, corrective actions and procedures be fully and accurately complied with in order to meet the required and applicable federal, state and local regulations, and to have the necessary repairs and up-grades performed prior to making any change in service, product and/or current conditions. Some recommendations and requirements are necessary to bring the component(s) into compliance with federal, state, and local regulations. InterSpec, LLC recommends re-inspection after any corrective action, repair or change in usage when the change is to a more severe service. Any change in facility conditions that are applicable to this inspection report, such as, but not limited to, a change in service or usage could result in outdating this report. The predictability of any component in this report is a result of following the procedures in the applicable industry standard. InterSpec, LLC accepts absolutely no responsibility or liability for any mishap or failure, including any subsequent clean-up costs or legal ramifications, resulting from owners'/operators' failure to perform the required repairs, inspections and re-inspections, as they apply.

Executive Summary

An API Standard 653 Out-of-Service inspection of Tank # 3473 was completed on October 03, 2017 to evaluate the tank's integrity, collect data, and establish a database for future inspections and evaluations. A service life evaluation performed on the tank shows it as having greater than 30 years of remaining shell life under current conditions. Inspection Results are listed in section 4.1. Maintenance Recommendations are listed in section 4.2. Compliance Requirements are listed in section 4.3. All engineering calculations are provided in Appendix A.

The tank does not meet the compliance requirements mandated by federal, state, and/or local regulatory bodies and requires that corrective action(s) be taken; however, the tank does meet requirements for structural integrity in accordance with the API-653 standard. The owner/operator may follow the schedule(s) in section 4.4. Refer to Compliance Requirements section 4.3 for details.

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2.5 American Society of Nondestructive Testing (ASNT)

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4.0 Inspection

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1.0 Introduction

1.1 Purpose:

1.1.1 This report presents an analysis of data collected during an inspection conducted on October 03, 2017 for Tank # 3473, servicing Jet A , located at the US Air Force - Andrews AFB facility in Andrews AFB, MD. The inspection was performed by a certified API-653 inspector. This report summarizes the results of the inspection meeting the requirements of API Standard 653 and API-650. The primary and secondary containments including the supports, foundation, vents, gauges, and appurtenances were evaluated. The inspection was conducted by *InterSpec, LLC.*

2.0 References

2.1 Code of Federal Regulations (CFR):

United States Department of Labor, Occupational Safety & Heath Administration

2.1.1 CFR, Title 29, Subtitle B, Volume 5, Chapter XVII, Part 1910, Subpart H, Section 119, Process safety management of highly hazardous chemicals
2.1.2 CFR, Title 29, Subtitle B, Volume 5, Chapter XVII, Part 1910, Subpart J, Section 147, The control of hazardous energy (lockout/tagout)
2.1.3 CFR, Title 29, Subtitle B, Volume 5, Chapter XVII, Part 1910, Subpart S, Section 331-335, Safety-Related Work Practices

United States Environmental Protection Agency

2.1.4 CFR, Title 40, Volume 21, Chapter I, Subchapter D, Part 112, Oil Pollution Prevention

2.2 American Petroleum Institute (API):

2.2.1 API Standard 650, Welded Steel Tanks for Oil Storage
2.2.2 API Standard 653, Tank Inspection, Repair, Alteration, and Reconstruction
2.2.3 API RP 652, Lining of Aboveground Petroleum Storage Tank Bottoms
2.2.4 API RP 651, Cathodic Protection of Aboveground Petroleum Storage Tanks
2.2.5 API RP 575, Inspection of Atmospheric and Low-Pressure Storage Tanks
2.2.6 API RP 577, Welding Inspection and Metallurgy
2.2.7 API RP 2000, Venting Atmospheric and Low Pressure Storage Tanks
2.2.8 API Standard 570, Piping Inspection Code: Inspection, Repair, Alteration, and Rerating of In-Service Piping Systems

2.3 American Society of Mechanical Engineers Codes (ASME):

2.3.1 ASME Boiler and Pressure Vessel Code; Section V, Non-Destructive Examination
2.3.2 ASME Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

2.4 National Fire Protection Association (NFPA):

2.4.1 NFPA-30, 2012 Ed., Flammable and Combustible Liquids Code
2.4.2 NFPA-70, 2011 Ed., National Electrical Code
2.4.3 NFPA-780, 2008 Ed., Standard for the Installation of Lightning Protection Systems

2.5 American Society of Nondestructive Testing (ASNT):

2.5.1 ASNT-SNT-TC-1A

3.0 Description

3.1 Job Description:

Job Number:	17-0826
Contracted by:	Austin Brockenbrough & Associates

3.2 Tank Description:

Owner/Operator:	US Air Force - Andrews AFB
Location:	Andrews AFB, MD
Tank Identification:	3473
Diameter:	31.00 feet
Shell Height:	41.30 feet
Capacity:	5,000 BBL (Nominal)
Configuration:	Vertical
Foundation:	Concrete Ringwall
Secondary Containment:	Concrete Dike
Year Installed:	2005
Age:	12 years
Construction Code:	API-650
Manufacturer Name:	Witherup Fabrication and Erection, Inc.
Manufacturer Address:	Kennerdell, PA 16374
Manufacturer Serial Number:	09654

3.3 Service Description:

Service:	Jet A	
Specific Gravity:	0.84	
Operating Limits:		
	Minimum Metal Temperature:	Ambient
	Maximum Metal Temperature:	200 ˚F
	Minimum Pressure:	Atmospheric (no vacuum)
	Maximum Pressure:	Product
Seismic Zone:	1	

(Alarm Set Points from Strapping Chart)

Low Level Alarm Set point: 2’ 3”
High Level Alarm Set Point: 35’ 7 11/16”
High-High Level Alarm Set Point: 36’ 4 3/16”
High Level Control Valve (HLCV) Set Point: 36’ 3 ¼”

3.4 Part Description:

Bottom

Material:	Carbon Steel
Specification:	Unknown Specification
Design:	Cone-Down

Shell

Material:	Carbon Steel
Specification:	ASTM 36
Design:	Cylindrical

Floating Roof	
Material:	Aluminum
Grade:	Unknown
Manufacturer:	Petrex
Design:	Full Contact Floating Pan
Fixed Roof	
Material:	Carbon Steel
Grade:	Unknown
Design:	Cone-Up

3.5 Joint Type Description:

Bottom Plate-to-Plate:	Lap-Welded
Shell Plate-to-Plate:	Butt-Welded
Floating Roof Plate-to-Plate:	Bolted
Fixed Roof Plate-to-Plate:	Lap-Welded
Bottom-to-Shell:	Fillet-Welded
Shell-to-Fixed Roof:	Fillet-Welded

3.6 Inspection Description:

Inspection Type:	API-653 Out-of-Service Equipment Used: Ultrasonic Thickness Meter, Magnetic Flux Leakage, Rotating Laser Transit, and Laser Distance Meter
Last Inspection Date:	January 01, 2015
Inspection Date:	October 03, 2017
Inspector(s):	Daniel C. Bailey

3.7 Equipment Description:

Ultrasonic Thickness Meter

Manufacturer:	General Electric
Model:	DMS GO+
Calibration Methods Used:	Zeroing Procedure, Copper Coating Calibration Procedure, and Two Point Calibration Procedure

Magnetic Flux Leakage

Manufacturer:	MFE Enterprise
Model:	MFE 2412 Mark II
Calibration Methods Used:	Manufacturer Calibration Procedure

Rotating Laser Transit

Manufacturer:	Hilti
Model:	Hilti 286210 Rotating Laser PR 25 IF
Calibration Methods Used:	Main and transverse horizontal axes checks at 20 m < 6 mm

Laser Distance Meter

Manufacturer:	Leica Geosystem
Model:	3D Disto
Calibration Methods Used:	Tilt sensor calibration automatically performed with unit set at < 3° and crosshairs calibration using target at a distance > 25 m

4.0 Inspection

4.1 Results:

4.1.1 **Foundation:** The tank sits on a concrete ringwall foundation. The foundation was visually evaluated during the inspection for broken concrete, spalling, cracks, and vegetation against the bottom of the tank. Four grounding cables are not sealed at their penetration through the concrete ringwall. Three leak detection pipes are not sealed at their penetration through the concrete ringwall. The sealant between the tank bottom extension and the concrete ringwall has failed in several areas (Approximately 25% failure). Failure to correct these will allow the intrusion of water and other forms of moisture to the tank bottom, accelerating the corrosion process. Shell settlement surveys were performed during the inspection in accordance with Appendix B of the API Standard 653.

4.1.2 **Secondary Containment:** The tank sits on a concrete ringwall foundation which is enclosed in a concrete secondary containment floor with concrete dike walls. The secondary containment is shared with Tank 3474. The secondary containment measures 102’8” x 63’6” x 6’ tall and has an intermediate wall between Tank 3473 and 3474 measuring 63’6” x 1’6” tall. The secondary containment is equipped with a drain. The containment drain line was hydrostatically tested during the inspection, with no loss of water noted. The secondary containment was visually evaluated during the inspection for broken concrete, spalling, cracks, and vegetation growth. The secondary containment has minor vegetation growth. Approximately 30 total linear feet of cracking was noted on the secondary containment floor, and 60 linear feet of vertical cracking was noted on the concrete secondary containment walls. Hairline cracks do not seriously affect the strength of the concrete structures; however, these cracks can be potential access points for moisture or water seepage that could corrode the reinforcing steel (rebar). Approximately 10 linear feet of failed joint sealant was noted on the secondary containment floor. The secondary containment wall to the secondary containment floor sealant has failed completely. The area where the 12" issue line and 8" receipt line penetrate the secondary containment floor is not sealed. The concrete ringwall to the secondary containment floor sealant has failed completely.

Field assessment indicates that the secondary containment is of sufficient size to contain a total tank loss. The secondary containment is sloped to allow for drainage away from the tank. A formal evaluation of the secondary containment, in accordance with 40 CFR 112, may be required in order to satisfy federal, state, and local requirements.

4.1.3 **Cathodic Protection:** An impressed current Cathodic Protection (CP) system is installed on this tank. The CP system is tested annually and was in satisfactory condition at the last assessment.

4.1.4 **Bottom:** The bottom is constructed from carbon steel of unknown specification. The bottom is of cone-down design, lap-welded together and fillet-welded to the shell. Inspected the interior coating for disbonding, adhesion, deterioration, and discoloration. The condition of the liner is satisfactory. The bottom is equipped with a 30-inch sump. A visual inspection was conducted over the entire bottom, including the bottom welds and the bottom-to-shell weld. See Painting/Insulation section. Evaluated the attachments and piping supports. The issue line piping is not fully resting on its support. The pipe support is adjustable. The evaluation showed no corrosion on the bottom, bottom-welds, or the bottom-to-shell weld. Thickness measurements are listed in the Engineering Data section in Appendix B.

4.1.5 **Shell:** The shell is constructed from carbon steel with ASTM A36 material specification. The shell is a cylindrical design, consisting of five courses, butt-welded together. Evaluated the shell for plumbness, roundness, peaking, and banding; all of which were found to be within the allowable tolerances of the API Standard 653. Visually inspected the interior and exterior of the shell. Inspected the coating for disbonding, adhesion, deterioration, and discoloration. The shell was evaluated for remaining metal thickness utilizing ultrasonic technology. Thickness measurements are listed in the Engineering Data section in Appendix B. A service life evaluation shows the shell with greater than 30 years of remaining life under current conditions. The engineering calculations, as per API Standard 653, for the service life evaluation are shown in Appendix A under “Service Life Evaluation.”

4.1.6 **Floating Roof:** Inspected and evaluated the internal floating roof. The internal floating roof (IFR) is a full contact honey comb design with foam log primary and secondary seals. Evaluated the structural integrity of the floating roof. Evaluated the condition of the floating roof seals. The foam log primary seal is cracked and dry rotted; several areas are saturated with fuel, with one area located near the IFR ladder sagging and dripping fuel. The penetration seals through the IFR for the internal ladder and Enraf/Vito stilling well are deteriorated. Measured the annular space at several locations from the tank bottom, and the floating roof is determined to be properly centered inside the tank.

4.1.7 **Fixed Roof:** The roof is constructed of carbon steel of unknown specification. The roof is of cone-up design, lap-welded together, consisting of fourteen (14) plates which are fillet-welded to the shell rim angle. Evaluated the exterior coating and interior coating. See Painting/Insulation section. Evaluated the roof nozzles. Inspected the vents. See Painting/Insulation section. Measured the general thickness throughout the roof utilizing an ultrasonic thickness tester. Thickness measurements are listed in the Engineering Data section in Appendix B.

4.1.8 **Appurtenances:** Inspected and evaluated each tank nozzle in accordance with API Standards 650 and 653. Identified the type and use of each shell nozzle and measured the nozzle neck thickness on all accessible shell nozzles. Evaluated all nozzles and reinforcement plates for leaks and corrosion. See Painting/Insulation section. The tank has means of grounding via ground straps. Inspected the ATG and its operation. The tank is equipped with leak detection inspection ports. Inspected the circumferential stairway. Evaluated the handrails; their condition is satisfactory. Inspected the platforms and frames for corrosion and structural soundness; their conditions are satisfactory. The tank is equipped with a 12-inch issue line, 8-inch receipt line, 4-inch low suction line, and 1-inch water draw-off line.

Four shell overflow vents have insect mesh screen in addition to the 1/2" mesh bird screen required by API-650. The conduit coming from the alarm outlet box near the stairway was not properly installed and has come loose.

A junction box for the alarm conduit located on the back side on the tank near the low level alarm is not properly sealed with a gasket. The manholess have algae/mildew growth on the nozzle necks. One of the manholes on the first course has a grease fitting that has broken off.

The tank is equipped with shell mounted high, high-high, and low alarms. The tank is also equipped with a High Level Control Valve (HLCV). The Shand and Jurs model mechanical tape gauge is broken. The tape has broken free from the floating roof. The Vito probe for water detection is located in the same stilling well as the Enraf probe, near the edge of the tank. The 36-inch manhole on the roof is not a bolted design per API-650 and does not have a gasket.

The flanges inside the tank for the receipt, issue, low suction, and water draw-off piping are carbon steel connected to stainless steel with no isolation kits installed.

The stilling wells for manual gauging and the Enraf/Vito probes are not slotted past the IFR. The base of the stilling wells does not have slotted holes to allow for adjustment of the datum plate.

The four inspection hatches along the perimeter of the roof have insect mesh screening in addition to the bird screen. One of the latches on one hood does not engage due to improper installation. (first one counterclockwise from the Enraf nozzle).

4.1.9 **Painting/Insulation:** The tank interior and exterior are fully coated with an epoxy/polyurethane coating. The flanges on the top of the housing chambers for the low and high level alarms have minor to moderate failure on the flange and hardware. The conduit has several small areas of coating failure where the previously existing clamp supports have been removed. Several flanges associated with the stainless steel water draw-off piping have bolting that is experiencing minor galvanic corrosion.

Moderate to major coating failure with minor associated corrosion was noted on the DBB valves and TRVs and their flanges for the issue and receipt lines. Minor coating failure was noted at the flange for the low suction line. The nozzle for the Enraf/Vito probe on the floating roof has minor corrosion on the flange hardware. Water has collected between the flange face and manhole cover and caused minor corrosion on the 36-inch manhole on the roof.

There are several low spots on the roof that allow for standing water during precipitation. Minor coating discoloration was noted at these locations. There is minor to moderate coating failure and associated corrosion on the hinges and base of the hoods on the inspection hatches.

There are minor to moderate coating failure and associated corrosion on the hinges and base of the hood of the four inspection hatches.

4.2 Maintenance Recommendations:

4.2.1 **Foundation:** Seal the concrete ringwall to secondary containment floor, the four grounding cables at their penetration through the concrete ringwall, the three leak detection pipes at their penetration through the concrete ringwall, and the tank bottom extension and concrete ringwall.

4.2.2 **Secondary Containment:** Seal the cracks in the secondary containment walls and floor. Repair all expansion joints with a fuel resistant type caulking.

Seal the area where the 12" issue line and 8" receipt line penetrate the secondary containment.

Remove the vegetation from the secondary containment.

4.2.3 **Cathodic Protection:** None.

4.2.4 **Bottom:** See Painting/Insulation section.

Ensure that the issue line piping is fully resting on its support.

4.2.5 **Shell:** None.

4.2.6 **Floating Roof:** Replace the foam log primary seal.

Replace the penetration seals through the IFR for the internal ladder and Enraf/ Vito stilling well.

4.2.7 **Fixed Roof:** See Painting/Insulation section.

4.2.8 **Appurtenances:** Remove the insect mesh screen on the four shell overflow vents.

Reinstall the conduit coming from the alarm outlet box near the stairway.

Seal the junction box for the alarm conduit located on the back side of the tank near the low level alarm with a gasket.

Remove the algae/mildew growth on the manhole nozzle necks.

Install a grease fitting on the hinge on the manhole on the first course.

Repair the broken Shand and Jurs model mechanical tape gauge.

Remove the Vito probe from the Enraf stilling well and install it over the sump in order to detect water in the tank.

Install isolation kits on the flanges inside the tank for the receipt, issue, low suction, and water draw off piping.

Install slots past the IFR for the stilling wells for manual gauging and the Enraf Probes.

Remove the welds attaching the ATG well to the guides.

Remove the insect mesh screen on the four inspection hatches.

See Painting/Insulation section.

4.2.9 **Painting/Insulation:** Mechanically clean and coat the areas of coating failure. All coating repairs should be accomplished utilizing an epoxy based coating system or equivalent.

4.3 Compliance Requirements:

4.3.1 **Foundation:** Seal the concrete ringwall around the ground strap in accordance with NFPA 30.

4.3.2 **Secondary Containment:** None.

4.3.3 **Cathodic Protection:** None.

4.3.4 **Bottom:** None.

4.3.5 **Shell:** None.

4.3.6 **Floating Roof:** None.

4.3.7 **Fixed Roof:** None.

4.3.8 **Appurtenances:** Install a 36" roof manhole that is a bolted design per API 650.

4.3.9 **Painting/Insulation:** None.

4.4 Serviceability:

4.4.1 API-653 Schedule:

Tank # 3473 is in compliance with the requirements of API Standard 653 for structural integrity; however, the tank does not meet the compliance requirements mandated by federal, state, and/or local regulatory bodies and requires that corrective actions be taken. The following schedule may be implemented:

4.4.1.1 Perform routine monthly visual inspections by owner/operator personnel that are knowledgeable of the storage facility operations, the tank, and the characteristics of the product stored; conduct in accordance with API Standard 653.

4.4.1.2 The next visual external inspection should be accomplished by a certified API-653 inspector prior to October 2022 in accordance with API-653.

4.4.1.3 The next ultrasonic thickness measurement inspection should be accomplished by a certified API-653 inspector prior to October 2032 in accordance with API-653.

4.4.1.4 The next internal inspection should be accomplished by a certified API-653 inspector prior to October 2037 in accordance with API-653.

Appendix A
Engineering Calculations

1. Bottom Service Life
2. Shell Service Life
3. Shell Settlement Survey

Bottom Service Life Evaluation

$$MRT = \left(Minimum\ of\ RT_{bc}\ and\ RT_{ip}\right) - O_r(StP_r + Up_r)$$

$$O_r = \frac{\left(Minimum\ of\ RT_{bc}\ and\ RT_{ip}\right) - MRT}{StP_r + Up_r}$$

Where:

MRT = minimum remaining thickness at the end of the in-service period of operation, in inches.

O_r = in-service interval of operation (years to next internal inspection), in years; not to exceed that allowed by 6.4.2.

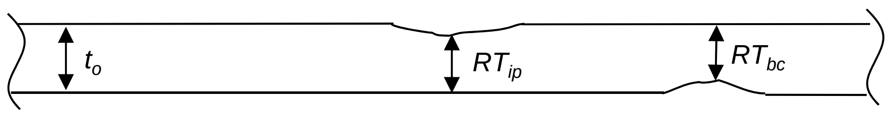
t_o = original plate thickness, in inches.

RT_{bc} = minimum remaining thickness from bottom side corrosion after repairs, in inches.

Rt_{ip} = minimum remaining thickness from internal corrosion after repairs, in inches.

StP_r = maximum rate of corrosion not repaired on the top side, in inches per year. StP_r = 0 for coated areas of the bottom. The expected service life of the coating must equal or exceed O_r to use $StP_r = 0$.

UP_r = maximum rate of corrosion on the bottom, in inches per year. To calculate the corrosion rate, use the minimum remaining thicknesses after repairs. Assume a linear rate based on the age of the tanks. UP_r = 0 for areas that have effective cathodic protection.



MRT (inches)	Tank Bottom/Foundation Design
0.1	Tank bottom/foundation design with no means for detection and containment of bottom leak
0.05	Tank bottom/foundation design with means to provide detection and containment of bottom leak
0.05	Applied tank bottom reinforced lining, > 0.05 in. thick, in accordance with API RP 652

Note: For areas of a bottom that have been scanned by the magnetic flux leakage (or exclusion) process, and do not have effective cathodic protection, the thickness used for calculating UPr must be the lesser of the MFL threshold or the minimum thickness of corrosion areas that are not repaired. The MFL threshold is defined as the minimum remaining thickness to be detected in the areas inspected. The MFL unit used for scanning the bottom does not have a threshold set point. This unit visually displays all anomalies. The confidence level of this unit diminishes greatly for underside pitting/corrosion that is less than 0.04 inches in depth, based on company experience.

Areas of bottom side corrosion that are repaired should be evaluated with the corrosion rate for the repaired area unless the cause of corrosion has been removed. The evaluation is done by using the corrosion rate of the repaired area for UP_r, and adding the patch plate (if used) thickness to the term "minimum of RT_{bc} or RT_{ip}".

NOTE: The engineering data used to calculate the in-service interval of operation (O_r) assumes the tank remains in the same service and all corrosion rates remain constant.

Bottom Service Life Evaluation

Present Condition:

1) In-Service Interval of Operation (years to next internal inspection)

Cathodic Protection:	Yes
Bottom Coated	Yes
Containment of Bottom:	Yes
Bottom Leak Detection:	Yes

MRT = 0.05 inches

RT_{ip} = 0 inches

RT_{bc} 0.306 inches

StP_r = 0 inches/year

UP_r = 0.000542 inches/year

$$O_r = \frac{0.306 - 0.05}{0 + 0.000542}$$

Therefore, the in-service interval of operation (years to next internal inspection) is:

O_r = 447.4 years

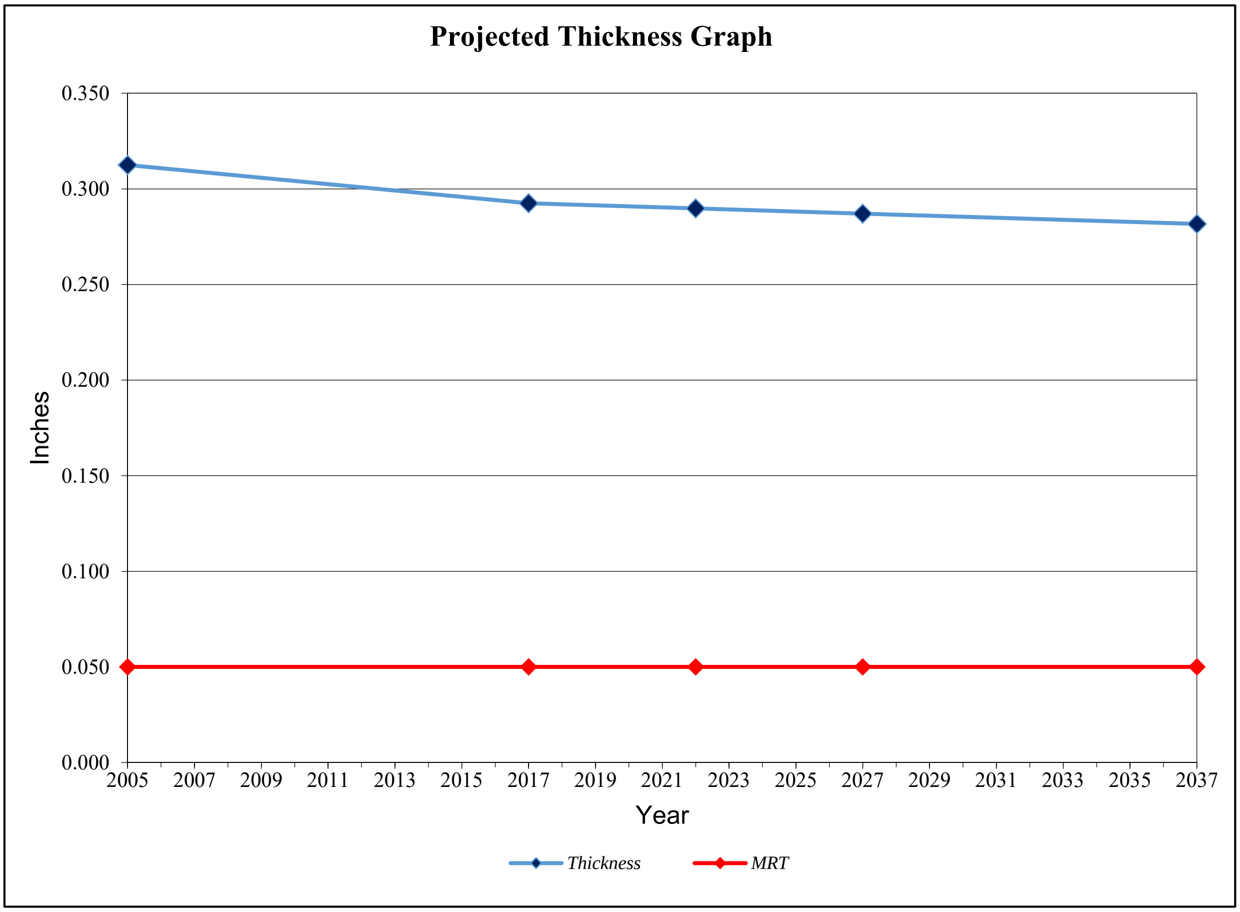
Bottom Service Life Evaluation

Present Condition:

2) Projected Thickness Chart and Graph

	Year	Thickness	MRT
Nominal:	2005	0.313	0.05
Current Lowest Remaining Thickness:	2017	0.293	0.05
Anticipated Thickness (5 yrs)*:	2022	0.290	0.05
Anticipated Thickness (10 yrs)*:	2027	0.287	0.05
Anticipated Thickness (20 yrs)*:	2037	0.282	0.05
Anticipated Thickness (30 yrs)*:	2047	0.276	0.05

*based on same service and corrosion rates.



Shell Service Life Evaluation

The maximum inspection intervals are determined by the most restrictive shell course in regard to the remaining life and the corrosion rate calculations for each shell course using the following formulas:

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

$$L_r = \frac{t_{act} - t_{min}}{C_r} \quad C_r = \frac{t_{prev} - t_{act}}{\Delta Y} \quad I_{ut} = \frac{t_{act} - t_{min}}{2C_r} \quad I_v = \frac{t_{act} - t_{min}}{4C_r}$$

Where:

t_{min}	=	minimum acceptable shell thickness for each course, in inches; however, t_{min} shall not be less than 0.1 inch for any tank course.
t_{nom}	=	nominal shell thickness, in inches.
t_{act}	=	current measured shell thickness, excluding pits and corrosion, in inches.
t_{prev}	=	previous measured shell thickness, excluding pits and corrosion or t_{nom}, in inches.
D	=	nominal diameter of the tank, in feet.
H	=	height from the bottom of the shell course under considerations to the established maximum liquid level, in feet.
H_c	=	calculated safe fill height, in feet, for the current product.
G	=	specific gravity of the contents.
Y	=	specified minimum yield strength of the plate; use 30,000 pounds per square inch if not known (N/A for riveted tanks).
T	=	smaller of the specified minimum tensile strength of the plate or 80,000 pounds per square inch; use 55,000 psi if not known (N/A for riveted tanks).
S	=	The maximum allowable stress, in pounds per square inch. For welded tanks, use the smaller of $0.80Y$ or $0.429T$ for the bottom and the second course or the smaller of $0.88Y$ or $0.472T$ for all other courses. For riveted tanks, use S=21,000 psi. For elevated temperatures above 200^{O}F, the maximum allowable stress shall be the smaller of 2/3 the minimum yield strength multiplied by the M-factor (M) of API Standard 650 Appendix M or the product design stress value listed in Table M-1a or M-1b of API Standard 650.
E	=	original joint efficiency for the tank. Use Table 4-2 from API Standard 653 if original E is unknown; 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 when greater than 6 inches from rivets; use the value of E from API Standard 653 Table 4-3 when within 6 inches of rivets.
L_r	=	remaining life of the shell, in years.
C_r	=	shell corrosion rate, in inches per year.
I_{ut}	=	inspection interval for the next ultrasonic inspection, in years (not to exceed 15 years).
I_v	=	inspection interval for the next visual external inspection, in years (not to exceed 5 years).
ΔY	=	years between the previous measured shell thickness (t_{prev}) and the current measured shell thickness (t_{act}), in years.

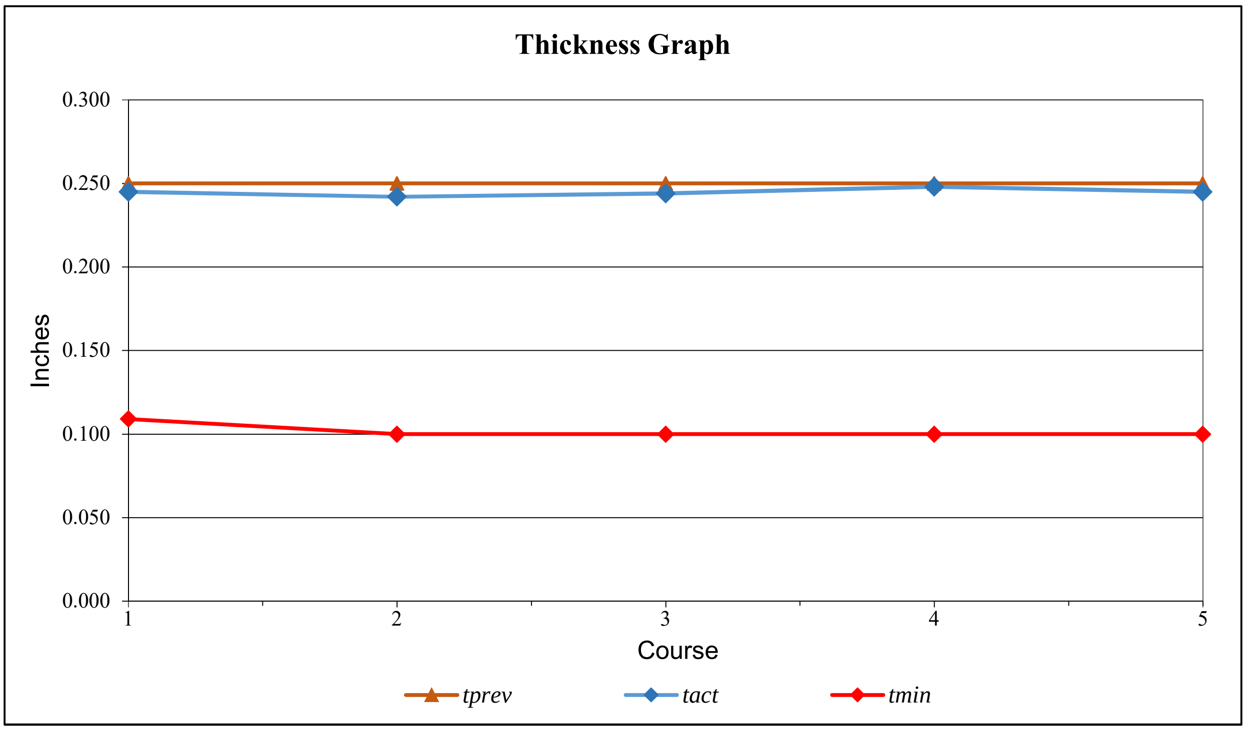
Shell Service Life Evaluation

1) Minimum Required Thickness

D = 31 feet
G = 0.84
ΔY = 12 years

Course No.	Plate Specification	Course Height (feet)	Product Height (feet) (H)	Maximum Allowable Stress (psi) (S)	Joint Efficiency (E)	Minimum Acceptable Thickness (inches) (t_{min})	Previous Measured Thickness (inches) (t_{prev})*	Current Measured Thickness (inches) (t_{act})
1	A 36	9.33	41.3	24,900	1.00	0.109	0.25	0.245
2	A 36	7.92	31.97	24,900	1.00	0.1	0.25	0.242
3	A 36	7.88	24.05	27,400	1.00	0.1	0.25	0.244
4	A 36	7.92	16.17	27,400	1.00	0.1	0.25	0.248
5	A 36	7.92	8.25	27,400	1.00	0.1	0.25	0.245

*The t_{prev} values were based on t_{nom}.

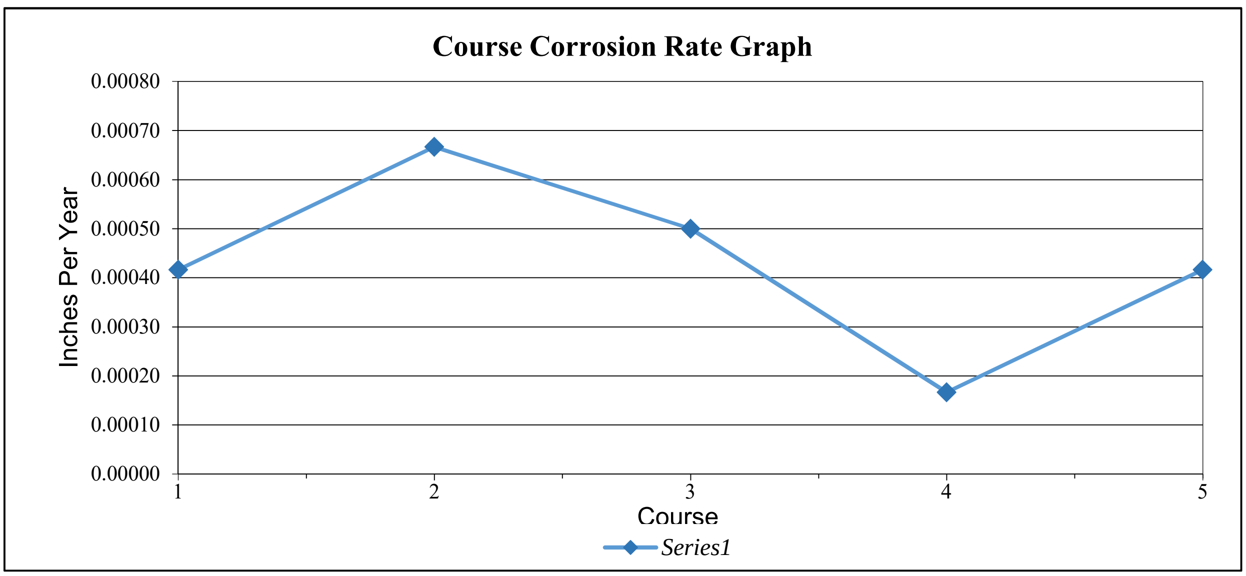


Shell Service Life Evaluation

2) Corrosion Rate, Remaining Life and Inspection Intervals

Course No.	Corrosion Rate (in./yr) (C_r)	Remaining Life (years) (L_r)	Next Visual Inspection (years) (I_v)	Next Ultrasonic Thickness Inspection (years) (I_{ut})
1	0.00042	326	5	15
2	0.00067	213	5	15
3	0.00050	288	5	15
4	0.00017	887	5	15
5	0.00042	348	5	15

Note: The engineering data used to calculate in-service period of operation (Remaining Life) assumes the tank remains in the same service and all corrosion rates remain constant. The maximum safe fill height for the tank is not limited other than by the established maximum operating liquid level and any other appurtenance such as overflow, vents, or firefighting system.



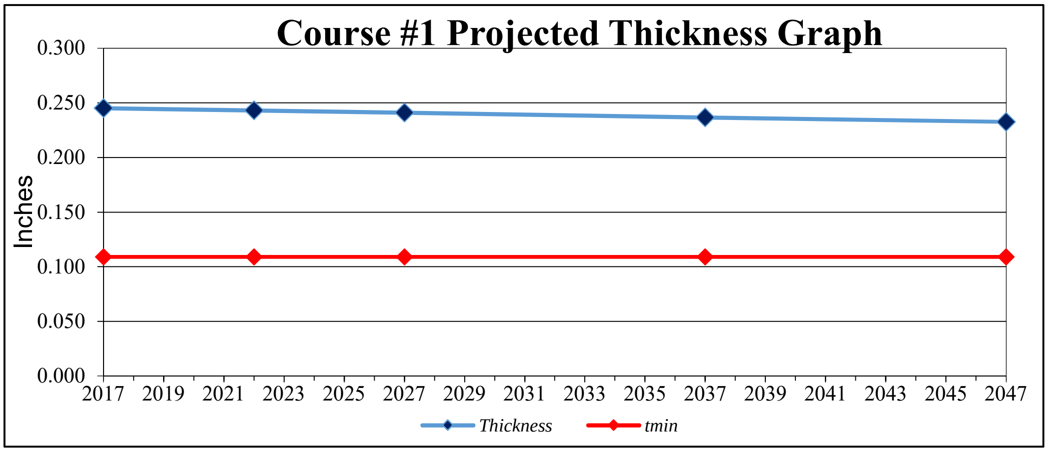
Shell Service Life Evaluation

3) Projected Thickness Chart and Graph

Course #1:

	Year	Thickness	tmin
Current Thickness:	2017	0.245	0.109
Anticpated Thickness (5 yrs)*	2022	0.243	0.109
Anticpated Thickness (10 yrs)*	2027	0.241	0.109
Anticpated Thickness (20 yrs)*	2037	0.237	0.109
Anticpated Thickness (30 yrs)*	2047	0.233	0.109

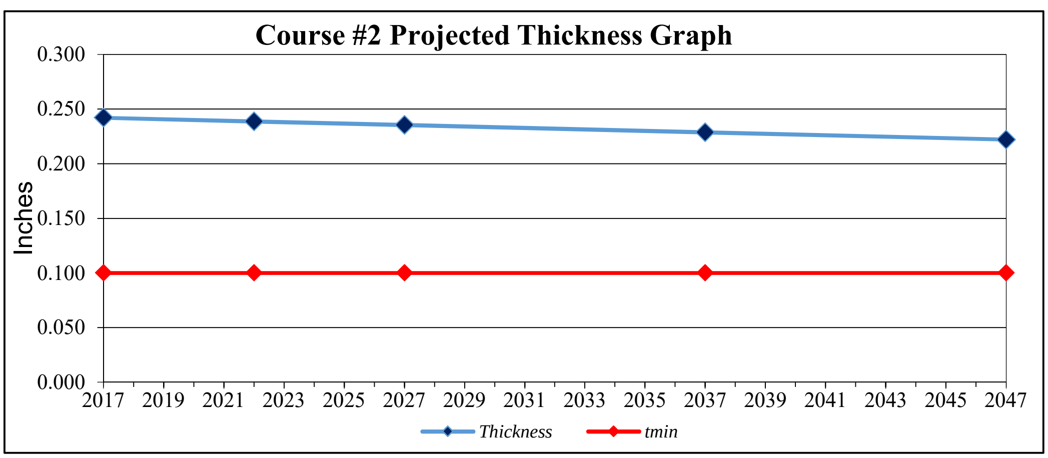
*based on same service and corrosion rates.



Course #2:

	Year	Thickness	tmin
Current Thickness:	2017	0.242	0.1
Anticpated Thickness (5 yrs)*	2022	0.239	0.1
Anticpated Thickness (10 yrs)*	2027	0.235	0.1
Anticpated Thickness (20 yrs)*	2037	0.229	0.1
Anticpated Thickness (30 yrs)*	2047	0.222	0.1

*based on same service and corrosion rates.

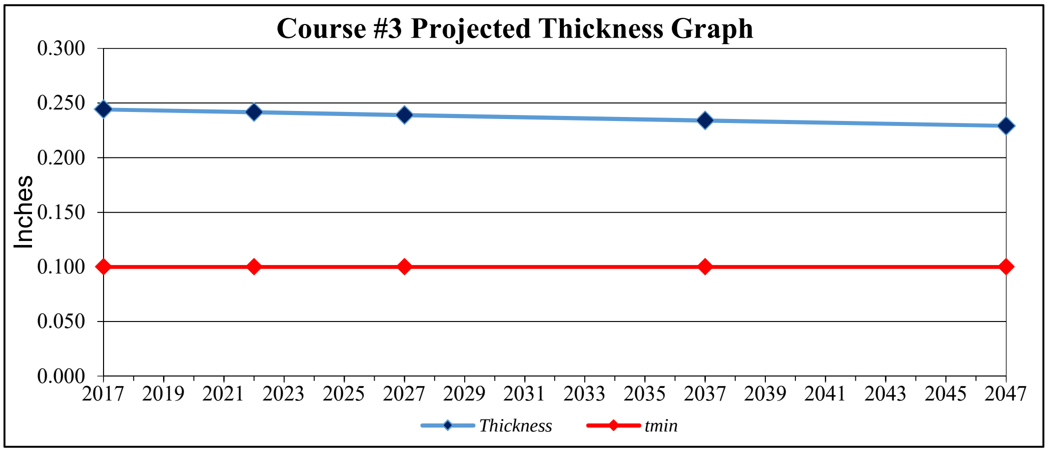


Shell Service Life Evaluation

Course #3:

	Year	Thickness	tmin
Current Thickness:	2017	0.244	0.1
Anticpated Thickness (5 yrs)*	2022	0.242	0.1
Anticpated Thickness (10 yrs)*	2027	0.239	0.1
Anticpated Thickness (20 yrs)*	2037	0.234	0.1
Anticpated Thickness (30 yrs)*	2047	0.229	0.1

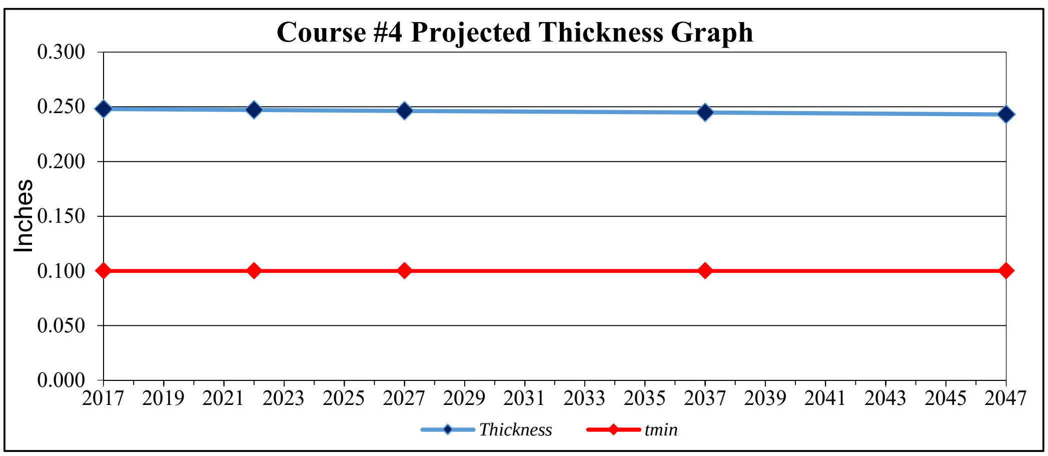
*based on same service and corrosion rates.



Course #4:

	Year	Thickness	tmin
Current Thickness:	2017	0.248	0.1
Anticpated Thickness (5 yrs)*	2022	0.247	0.1
Anticpated Thickness (10 yrs)*	2027	0.246	0.1
Anticpated Thickness (20 yrs)*	2037	0.245	0.1
Anticpated Thickness (30 yrs)*	2047	0.243	0.1

*based on same service and corrosion rates.

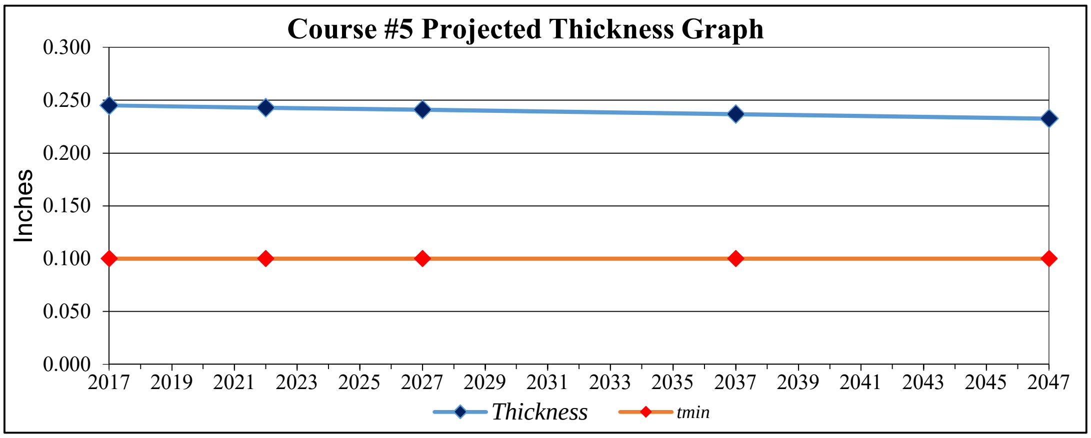


Shell Service Life Evaluation

Course #5:

	Year	Thickness	tmin
Current Thickness:	2017	0.245	0.1
Anticpated Thickness (5 yrs)*	2022	0.243	0.1
Anticpated Thickness (10 yrs)*	2027	0.241	0.1
Anticpated Thickness (20 yrs)*	2037	0.237	0.1
Anticpated Thickness (30 yrs)*	2047	0.233	0.1

*based on same service and corrosion rates.



Shell Settlement Evaluation

1) Maximum Permissible Out-of-Plane Deflection Calculation

$$S_{max} = \frac{11L^2Y}{2EH}$$

Where:

S_{max} = maximum permissible out-of-plane deflection, in feet.
$L = \Pi D/N$ = arc length between measurement points, in feet.
D = tank diameter, in feet
N = number of survey points.
Y = yield strength, in pounds per square inch (psi).
E = young's modulus, in pounds per square inch (psi)
H = tank height, in feet

D = 31 feet
N = 8
L = 3.14(31)/8 = 31 feet
Y = 36,000 psi
E = 29,000,000 psi
H = 40.96 feet
L^2 = 148.1983 square feet

$$S_{max} = \frac{11(148.1983)(36,000)}{2(29,000,000)(40.96)} = 0.0247 \text{ feet}$$

Shell Settlement Evaluation

1) Out-of-Plane Deflection Calculation

$$|S_i| = U_i - (1/2U_{i-1} + 1/2U_{i+1})$$

Where:

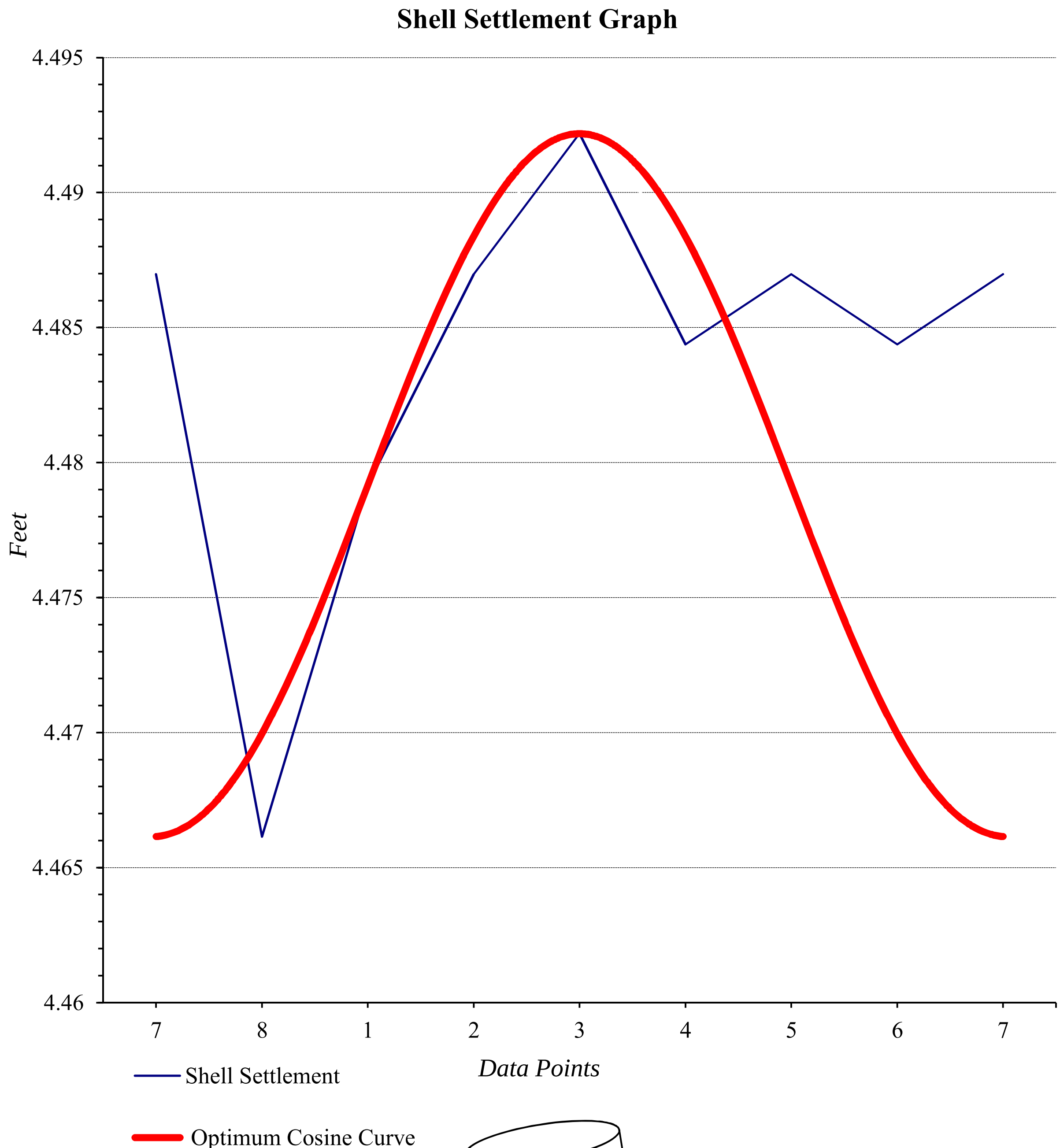
$|S_i|$ = magnitude of the calculated out-of-plane deflection, in feet.

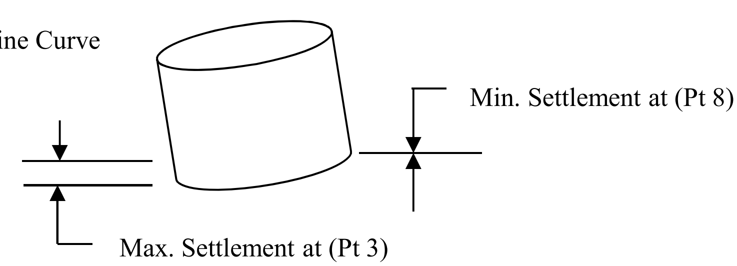
U_i = Out-of-Plane settlement of point "i", in feet
(+) when above cosine curve
(-) when below cosine curve

Point	**Actual**	**Curve Fit**	U_i	U_{i+1}	U_{i-1}	S_i	$\lvert S_i \rvert$
1	4.479167	4.479167	0.000000	-0.022228	0.017020	0.017020	0.002604
2	4.486979	4.469960	0.017020	0.000000	0.026042	0.026042	0.003999
3	4.492188	4.466146	0.026042	0.017020	0.014415	0.014415	0.010324
4	4.484375	4.469960	0.014415	0.026042	0.007813	0.007813	0.002512
5	4.486979	4.479167	0.007813	0.014415	-0.003999	-0.003999	0.002604
6	4.484375	4.488374	-0.003999	0.007813	-0.005208	-0.005208	0.005301
7	4.486979	4.492188	-0.005208	-0.003999	-0.022228	-0.022228	0.007905
8	4.466146	4.488374	-0.022228	-0.005208	0.000000	0.000000	0.019624

The out-of-plane deflection is acceptable.

Shell Settlement Evaluation





Appendix B

Engineering Data

1. Tank UT Readings

Bottom Plate Thickness Data

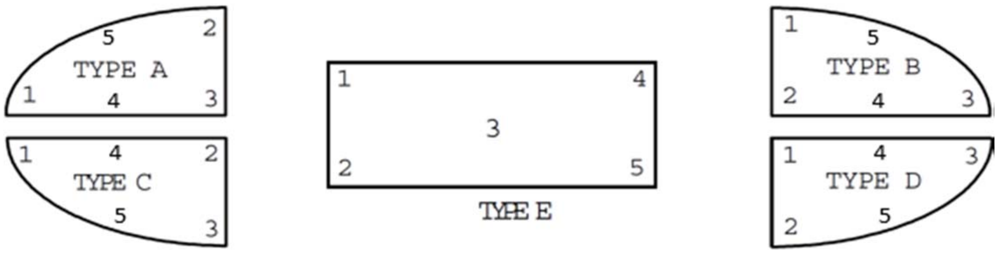


Plate #	Thickness Measurements (inches)					Plate Type
	Point Numbers					
	1	2	3	4	5	
1	0.312	0.313	0.317	0.315	0.313	A
2	0.307	0.307	0.307	0.309	0.308	E
3	0.314	0.317	0.315	0.318	0.313	B
4	0.310	0.312	0.310	0.309	0.310	E
5	0.318	0.317	0.319	0.316	0.318	E
6	0.308	0.307	0.311	0.307	0.306	E
7	0.308	0.310	0.310	0.306	0.308	E
8	0.309	0.308	0.311	0.310	0.308	E
9	0.307	0.308	0.310	0.310	0.311	E
10	0.318	0.321	0.314	0.316	0.316	E
11	0.307	0.307	0.310	0.309	0.308	E
12	0.317	0.314	0.319	0.317	0.315	C
13	0.309	0.310	0.306	0.310	0.308	E
14	0.315	0.315	0.319	0.316	0.318	D

Plate #	Thickness Measurements (inches)					Plate Type
	Point Numbers					
	1	2	3	4	5	

Tank Bottom Sump

Sump Neck

Location #	Thickness in inches
1	0.504
2	0.503
3	0.504
4	0.503

Sump Bottom

Location #	Thickness in inches
1	0.488
2	0.494
3	0.495
4	0.496

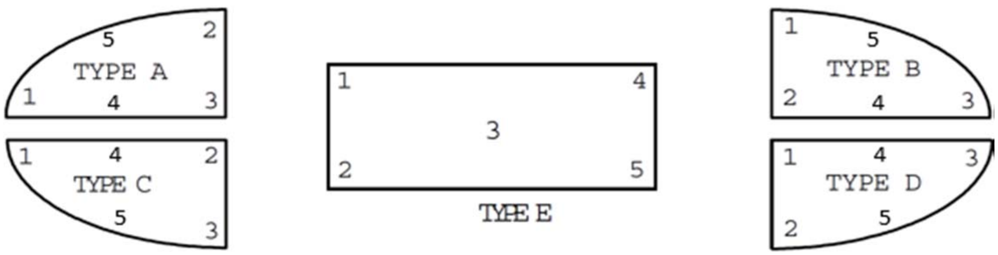
Shell Drop Stairway UT Data

Location #	Thickness Measurements (inches)			
	Point Numbers			
	Drop (1st - 5th) via stairs			Coating
C1-1	0.248			
C1-2	0.247			
C1-3	0.245			
C1-4	0.247			
C1-5	0.248			
C1-6	0.245			
C1-7	0.248			
C1-8	0.248			
C1-9	0.248			
C1-10	0.250			
C2-1	0.244			
C2-2	0.243			
C2-3	0.245			
C2-4	0.243			
C2-5	0.243			
C2-6	0.243			
C2-7	0.245			
C2-8	0.245			
C2-9	0.244			
C2-10	0.242			
C3-1	0.248			
C3-2	0.246			
C3-3	0.246			
C3-4	0.247			
C3-5	0.248			
C3-6	0.247			
C3-7	0.244			
C3-8	0.246			
C3-9	0.244			
C3-10	0.246			
C4-1	0.250			
C4-2	0.250			
C4-3	0.251			
C4-4	0.252			
C4-5	0.252			
C4-6	0.250			
C4-7	0.251			
C4-8	0.250			
C4-9	0.248			
C4-10	0.249			
C5-1	0.245			
C5-2	0.245			
C5-3	0.247			
C5-4	0.248			
C5-5	0.252			
C5-6	0.251			
C5-7	0.249			
C5-8	0.249			
C5-9	0.248			
C5-10	0.249			

Shell 1st Course Shell Plate UT Data

	Thickness Measurements (inches)															
	Point Numbers															
Plate #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 - 1	0.248	0.248	0.247	0.246	0.246	0.247	0.247	0.248	0.246	0.246	0.247	0.247	0.248	0.247	0.252	0.246
1 - 2	0.248	0.247	0.247	0.248	0.248	0.248	0.248	0.249	0.249	0.249	0.250	0.249	0.248	0.249	0.250	0.246
1 - 3	0.252	0.251	0.251	0.251	0.250	0.251	0.251	0.251	0.252	0.250	0.252	0.250	0.245	0.252	0.249	0.252
1 - 4	0.249	0.250	0.250	0.250	0.250	0.248	0.249	0.250	0.250	0.248	0.249	0.248	0.247	0.248	0.247	0.246
1 - 5	0.250	0.250	0.248	0.250	0.248	0.248	0.248	0.248	0.247	0.248	0.246	0.248	0.248	0.247	0.248	0.247

Roof Plate Thickness Data



	Thickness Measurements (inches)					
	Point Numbers					Plate
Plate #	1	2	3	4	5	Type
1	0.249	0.249	0.255	0.256	0.250	A
2	0.249	0.248	0.253	0.250	0.250	E
3	0.256	0.255	0.257	0.255	0.255	B
4	0.255	0.256	0.258	0.256	0.256	E
5	0.259	0.257	0.259	0.257	0.257	E
6	0.258	0.257	0.258	0.258	0.256	E
7	0.257	0.257	0.260	0.258	0.256	E
8	0.252	0.256	0.259	0.256	0.258	C
9	0.244	0.245	0.244	0.247	0.249	E
10	0.257	0.256	0.257	0.257	0.254	D

	Thickness Measurements (inches)					
	Point Numbers					Plate
Plate #	1	2	3	4	5	Type

Shell Nozzle, Nozzle Reinforcement, and Insert Measurements

Nozzle Measurements								
Noz Desig.	Nozzle Description	X-Axis (feet)	Y-Axis (feet)	Thickness Measurements (inches)				
				Nom.	0°	90°	180°	270°
A	36" Manhole	NA	NA	0.375	0.371	0.377	0.376	0.374
B	1" High Level Sensor	NA	NA	NA	NA	NA	NA	NA
C	1" High Level Sensor	NA	NA	NA	NA	NA	NA	NA
D	1" High High Level Alarm	NA	NA	NA	NA	NA	NA	NA
E	1" High Level Alarm	NA	NA	NA	NA	NA	NA	NA
F	1" Low Level Alarm	NA	NA	NA	NA	NA	NA	NA
G	1" Low Low Level Alarm	NA	NA	NA	NA	NA	NA	NA
H	36" Manhole	NA	NA	0.375	0.378	0.375	0.380	0.376
I	1" Water Draw	NA	NA	0.172	0.165	0.178	0.184	0.169
J	8" Receipt	NA	NA	0.500	0.507	0.476	0.493	0.494
K	36" IFR Manhole	NA	NA	0.500	0.492	0.508	0.508	0.496
L	12" Issue	NA	NA	0.328	0.306	0.338	0.327	0.322
M	4" Low Suction	NA	NA	0.375	0.373	0.373	0.372	0.372

Nozzle Reinforcement Measurements								
Noz Desig.	Reinforcement Description	Width (inches)	Length (inches)	Thickness Measurements (inches)				
				Nom.	0°	90°	180°	270°
A	Circle	NA	NA	0.250	0.243	0.245	0.246	0.243
H	Circle	NA	NA	0.250	0.243	0.244	0.242	0.243
J	Circle	NA	NA	0.250	0.241	0.246	0.236	0.241
K	Circle	NA	NA	0.250	0.242	0.242	0.241	0.242
L	Circle	NA	NA	0.250	0.240	0.241	0.241	0.244
M	Circle	NA	NA	0.250	0.241	0.241	0.241	0.241

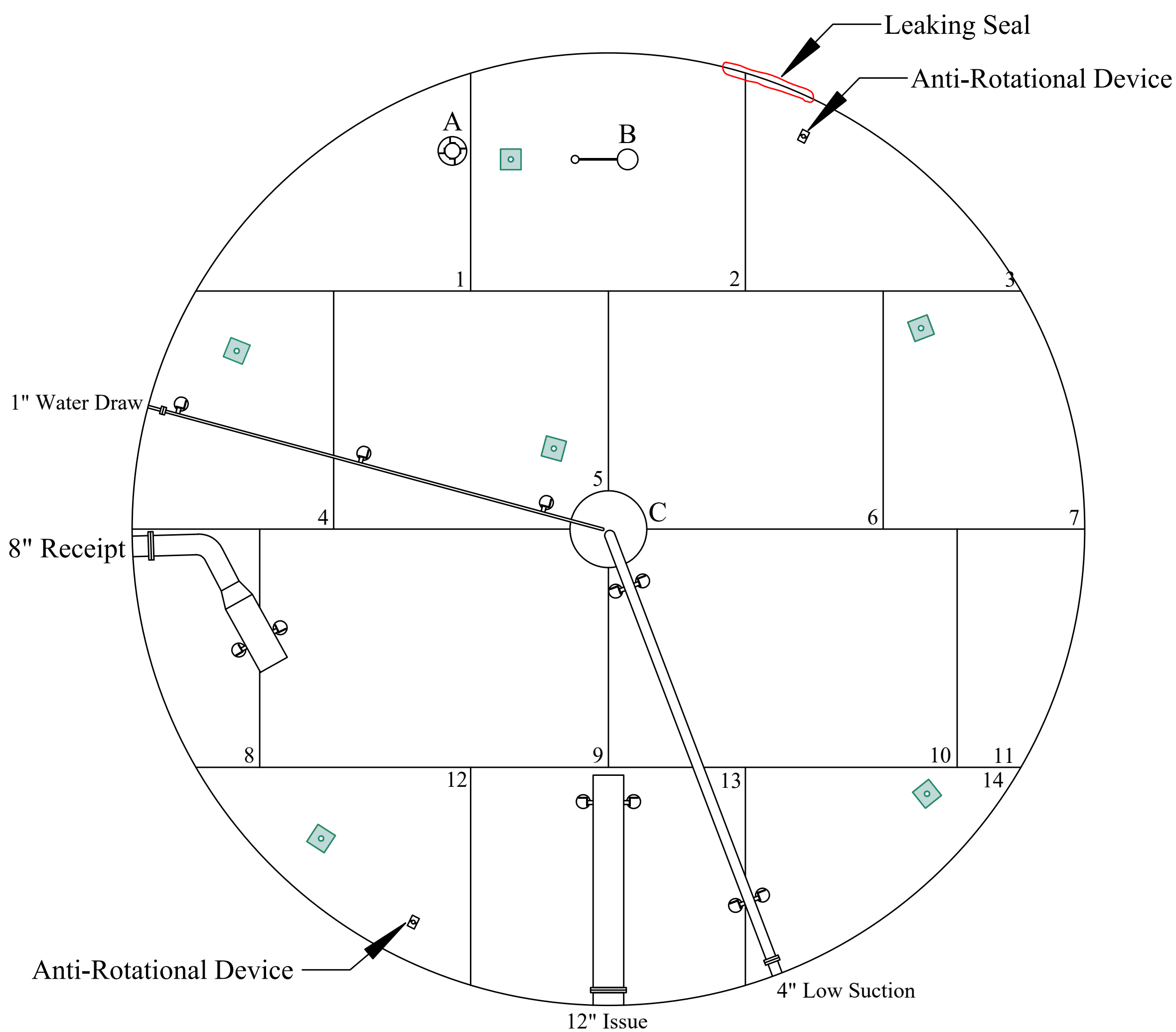
Insert Measurements								
Insert Desig.	Insert Description	Width (inches)	Length (inches)	Thickness Measurements (inches)				
				Nom.	0°	90°	180°	270°
	None							

NOTE: The Sheet Number corresponds to the shell plate in the first shell course. The X-Axis is measured from the Seam #1 in the first shell course to the center of the nozzle. Seam #1 is the first seam left of the first manway left of the stairway in the first shell course viewing from the outside. The Y-Axis is measured from the tank bottom to the center of the nozzle.

Appendix C

Engineering Drawings

1. Bottom Layout
2. Shell Layout
3. Fixed Roof Layout



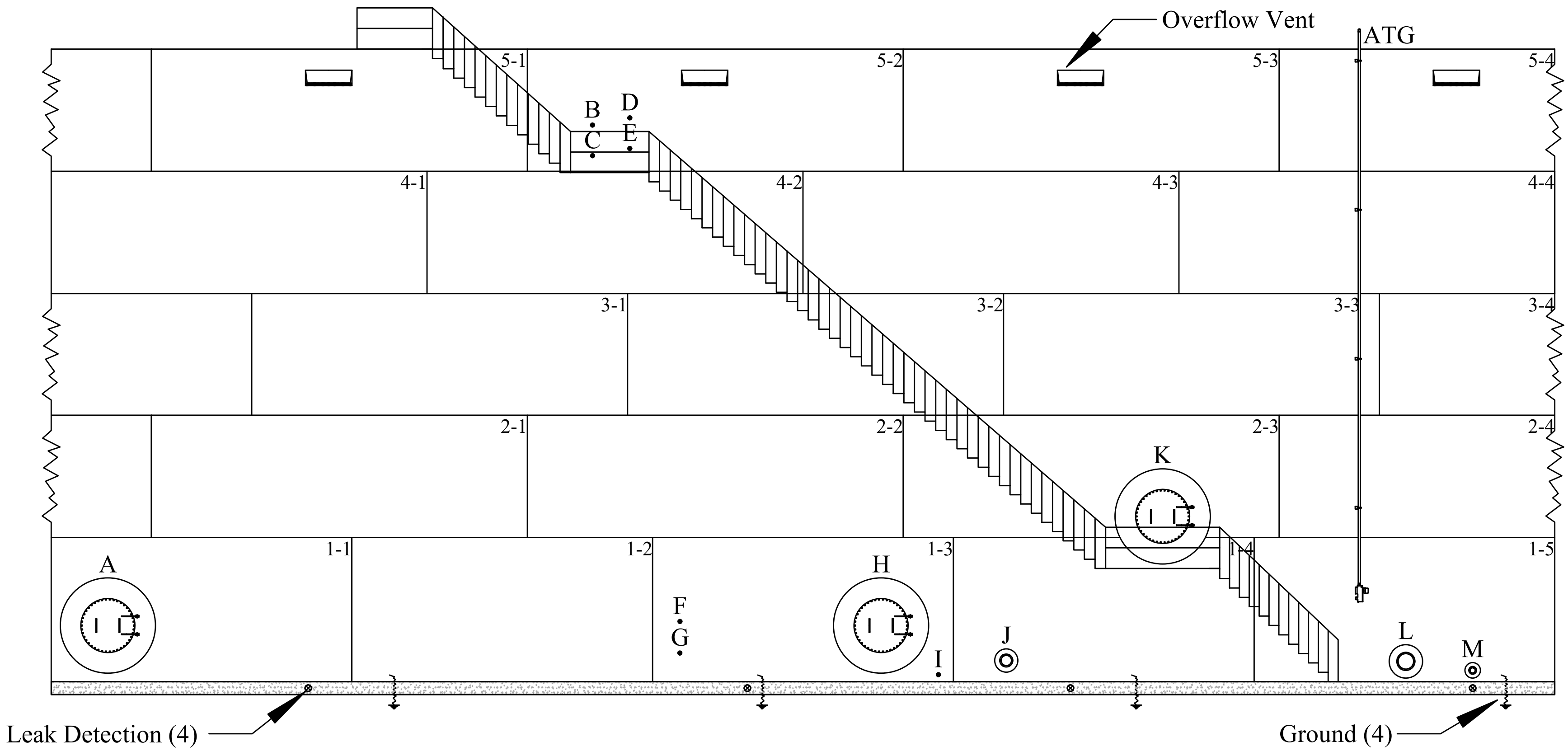
Remarks/Legend:
A - 6" Enraf/Vito Stilling Well
B - 8" Manual Gauge with Ladder
C - 30" Sump
▫ - IFR Leg with Stiffeners

Owner:	**US Air Force - Andrews AFB; Andrews AFB, MD**		
Drawn By:	InterSpec, LLC.	Modified By:	InterSpec, LLC.
Date: 10/03/2017	Rev. No.: N/A	Scale: N/A	

Drawing Title: Bottom Layout [1 of 1]

Description: Tank # 3473

ER-US AIR FORCE - ANDREWS AFB-ANDREWS AFC, MD-TANK-3473-OCTOBER/2017



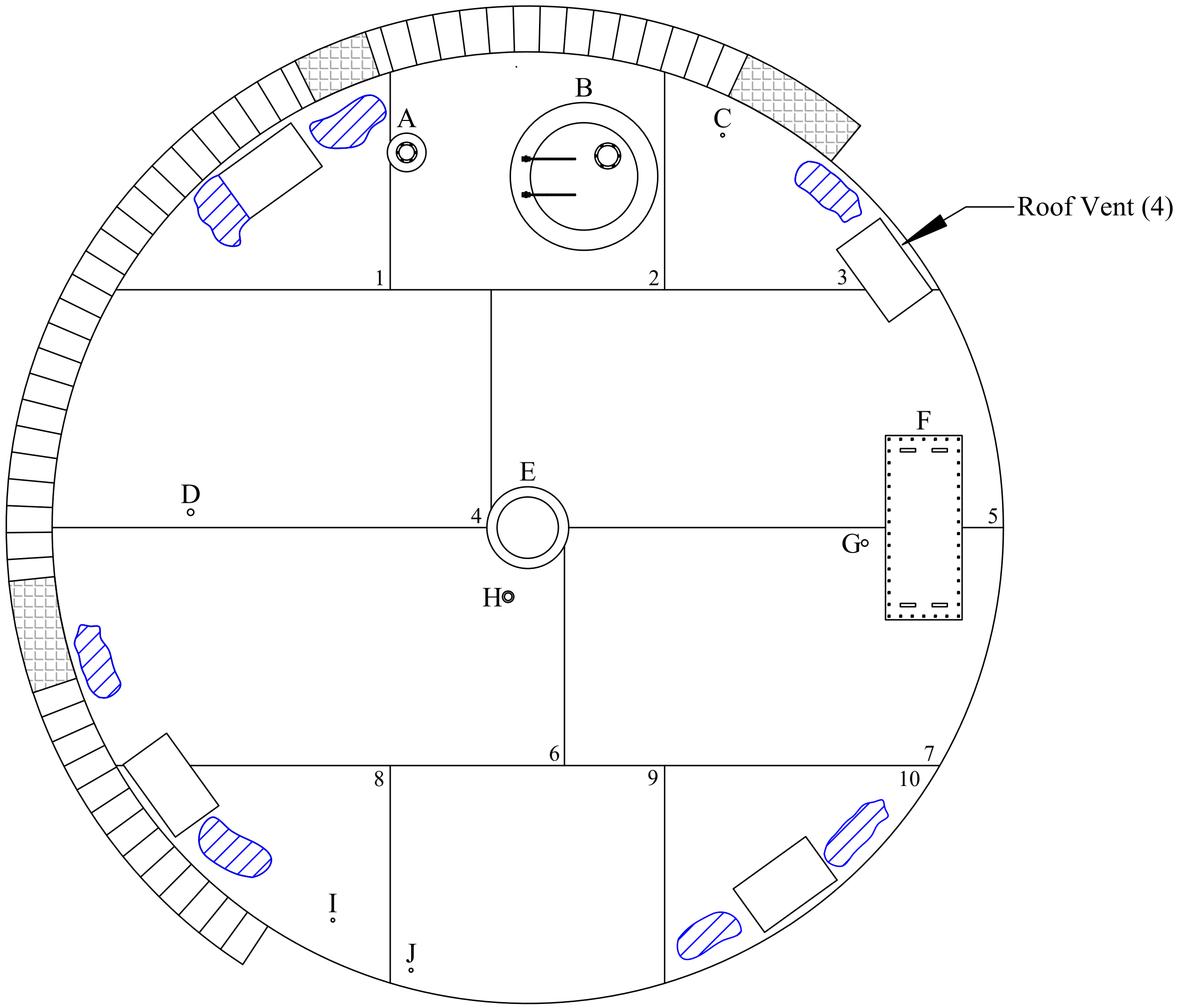
Remarks/Legend:		
A - 36" Manhole with 74" Repad	F - 1" Low Level Alarm	L - 12" Issue with 26" Repad
B - 1" High Level Sensor	G - 1" Low Low Level Alarm	M - 4" Low Suction with 12" Repad
C - 1" High Level Sensor	H - 36" Manhole with 74" Repad	
D - 1" High High Level Alarm	I - 1" Water Draw	
E - 1" High Level Alarm	J - 8" Receipt with 18" Repad	
	K - 36" Internal Floating Roof Manhole	

Owner: **US Air Force - Andrews AFB; Andrews AFB, MD**

Drawn By:	InterSpec, LLC.	Modified By:	InterSpec, LLC.
Date:	10/03/2017	Rev. No.: N/A	Scale: N/A

Drawing Title: Shell Layout [1 of 1]

Description: Tank # 3473



Remarks/Legend:
A - 6" Enraf/Vito Stilling Well
B - 36" Manhole with 8" Manual Gauge Hatch
C - 2-1/2" Anti Rotational Device
D - 2-1/2" Cap
E - 24" Vent
F - 30" x 72" Pan Installation Hatch
G - 2-1/2" Cap
H - 3" Tie-Off
I - 2-1/2" Anti-Rotational Device
J - 1-1/2" Mechanical Float Gauge
- Areas of Standing Water

Owner: **US Air Force - Andrews AFB; Andrews AFB, MD**			
Drawn By: InterSpec, LLC.		Modified By: InterSpec, LLC.	
Date: 10/03/2017	Rev. No.: N/A	Scale: N/A	
Drawing Title: Roof Layout [1 of 1]		Description: Tank # 3473	

Appendix D

API Checklists

1. In-Service Checklist
2. Out-of-Service Checklist

Table C-2 Tank Out-of-Service Inspection Checklist

C.2.1 Overview

a	X	Check that tank has been cleaned, is gas free, and safe for entry.
b	X	Check that the tank is completely isolated from product lines, all electrical power, and steam lines.
c	X	Check that roof is adequately supported, including fixed roof structure and floating roof legs.
d	X	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.
e	X	Inspect for slipping hazards on the bottom and roof decks.
f	X	Inspect structural welds on accessways and clips.
g	X	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.
h	NA	Review cathodic protection potential readings.

C.2.2 Tank Exterior

a	NA	Inspect appurtenances opened during cleaning such as lower floating swing sheave assemblies, nozzle interiors (after removal of valves).
b	X	Hammer test or ultrasonically test the roof.
c	NA	Enter and inspect the floating roof pontoon compartments.

C.2.3 Bottom Interior Surface

a	NA	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.
b	NA	Measure the depth of pitting and describe the pitting appearance (sharp edged, lake type, dense, scattered, etc).
c	NA	Mark areas requiring patching or further inspection.
d	NA	Mark locations for turning coupons for inspection.
e	X	Inspect all welds for corrosion and leaks, particularly the shell-to-bottom weld.
f	X	Inspect sketch plates for corrosion.
g	X	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.
h	NA	Locate and mark voids under the bottom.
i	X	Record bottom data on a layout sketch using the existing bottom plates as a grid. List the number and sizes of patches required.
j	NA	Vacuum test the bottom lap welds.
k	NA	Hammer test or ultrasonically examine any slightly discolored spots or damp areas.
l	X	Check for reinforcing pads under all bottom attached clips, brackets, and supports.
m	X	Inspect floating roof leg pads for pitting or cutting, and excessive dimpling (indicating excessive loading).
n	X	Check the column bases of fixed roof supports for adequate pads and restraining clips.
o	NA	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.
p	NA	Check area beneath swing line cable for indications of cable cutting or dragging.
q	NA	Mark old oil and air test connections for removal and patching.
r	NA	Identify and report low areas on the bottom that do not drain adequately.
s	NA	Inspect coating for holes, disbonding, deterioration, and discolorization.

Table C-2 Tank Out-of-Service Inspection Checklist

C.2.4 Shell Seams and Plate

a	NA	On cone up bottoms, closely inspect and gauge the depth of metal loss on the lower 2 to 4 inches of the shell (area of standing liquid).
b	NA	Measure the depth of pitting on each course.
c	NA	Inspect and estimate the amount of metal loss on the heads of rivets and bolts.
d	NA	Inspect shell-to-bottom riveted lap joints.
e	X	Inspect for vertical grooving damage from seal assembly protrusions.
f	X	Inspect existing protective coatings for damage, deterioration, and disbonding.
g	X	Check for areas of rubbing (indicating too much pressure by the seal assembly shoes or inadequate annular space).
h	X	Visually inspect the shell plates and seams for indications of leakage.
i	NA	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.
j	X	Measure annular space at 40-foot intervals.
k	X	Survey the shell to check for roundness and plumb.

C.2.5 Shell-Mounted Overflows

a	X	Inspect overflow for corrosion and adequate screening.
b	X	Check location of overflow that it is not above any tank valves or equipment.

C.2.6 Roof Interior Surface

C.2.6.1 General

a	X	Visually inspect the underside surface of the roof plates for holes, scale buildup and pitting.
b	X	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.
c	X	Check all clips, brackets, braces, etc., welded to the roof deck plate for welded reinforcing pads and see that they have not broken free.
d	NA	If no pad is present, penetrant test for cracking of the weld or deck plate.
e	X	Inspect the protective coating for breaks, disbondment, and deterioration.
f	NA	Spark test the interior surface coating if recoating is not planned.

C.2.6.2 Fixed Roof Support Structure

a	NA	Inspect the support columns for thinning in the upper two feet.
b	NA	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.
c	NA	Check that the reinforcing pad on the bottom is seal welded to the tank bottom with horizontal movement restraining clips welded to the pad.
d	NA	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.
e	NA	Inspect and gauge rafters for thinning, particularly near the center of the roof. Report metal loss.
f	X	Check for loose or twisted rafters.
g	NA	Inspect girders for thinning and check that they are attached securely to the top of the columns.
h	NA	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).
i	NA	Inspect and report the presence of any roof-mounted swing line bumpers.
j	X	Photograph the roof structure if no rafter layout drawing exists.

Table C-2 Tank Out-of-Service Inspection Checklist

C.2.7 Fixed Roof Appurtenances

C.2.7.1 Inspection and Light Hatches

a NA Inspect the hatches for corrosion, paint and coating failures, holes, and cover sealing.
b NA On loose covers, check for a safety chain in good condition.
c NA On light hatches over 30 inches across, check for safety rods.
d NA Inspect the condition of the gaskets on bolted or latched down hatch covers.

C.2.7.2 Staging Support Connection

a X Inspect the condition of the staging support for corrosion.

C.2.7.3 Breathers and Vents

a X Inspect and service the breather.
b X Inspect screens on vents and breathers.

C.2.7.4 Emergency P/V Hatches

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

C.2.7.5 Sample Hatch

a NA Inspect sample hatch for corrosion.
b NA Check that the cover operates properly.
c NA If the tank has no gauge well, check for a hold off distance marker and check measurement.

C.2.8 Floating Roof

C.2.8.1 Roof Deck

a NA 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.)
b NA In sour water service, clean and test all deck plate weld seams for cracking unless the lower laps have been seal welded.
c NA Check that either the roof drain is open or the drain plug in the roof is open in case of unexpected rain.
d NA On flat bottomed and cone down 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.

C.2.8.2 Floating Roof Pontoons

a NA Visually inspect each pontoon for liquid leakage.
b NA Run a light wire through the gooseneck vents on locked down inspection hatch covers to make sure they are open.
c NA Inspect lockdown latches on each cover.
d NA Check and report if each pontoon is:
- [ ] Vapor tight (bulkhead seal welded on one side on bottom, sides, and top)
- [ ] Liquid tight (seal welded on bottom and sides only)
- [ ] Unacceptable (minimum acceptable condition is liquid tight)

C.2.8.3 Floating Roof Cutouts

a NA Inspect underside of cutouts for mechanical damage.
b NA Inspect welds for cracks.
c NA Inspect plate for thinning, pitting, and erosion.
d NA Measure mixer cutouts and record plate thickness for future mixer installation or replacement. Plate thickness _______________.

Table C-2 Tank Out-of-Service Inspection Checklist

C.2.8.4 Floating Roof Supports

a [X] Inspect fixed low and removable high floating roof legs for thinning.
b [X] Inspect for notching at bottom of legs for drainage.
c [X] Inspect for leg buckling or felling at bottom.
d [NA] Inspect pin hole in roof guide for tears.
e [X] Check plumb of all legs.
f [X] Inspect for adequate reinforcing gussets on all legs through a single portion of the roof.
g [X] 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.
h [X] Inspect the sealing system on the two-position legs and the vapor plugs in the fixed low leg for deterioration of the gaskets.
i [X] On all 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.

C.2.9 Floating Roof Seal Assemblies

C.2.9.1 Primary Shoe Assembly

a [NA] Remove four sections of foam log (foam filled seals) for inspection on 90 degree locations.
b [NA] Inspect hanger attachment to roof rim for thinning, bending, broken welds, and wear of pin holes.
c [NA] Inspect clips welded to roof rim for thinning.
d [NA] Shoes: Inspect for thinning and holes in shoes.
e [NA] Inspect for bit-metal bolts, clips, and attachments.
f [NA] Seal fabric: Inspect for deterioration, stiffening, holes, and tears in fabric.
g [NA] Measure length of fabric from top of shoe to roof rim, and check against maximum anticipated annular space as roof operates.
h [NA] Inspect any modification of shoes over shell nozzles, mixers, etc., for clearance.
i [NA] Inspect shoes for damage caused by striking shell nozzles, mixers, etc.

C.2.9.2 Primary Toroidal Assembly

a [NA] Inspect seal fabric for wear, deterioration, holes, and tears.
b [NA] Inspect hold down system for buckling or bending.
c [NA] Inspect foam for liquid absorption and deterioration.

C.2.9.3 Rim Mounted Secondaries

a [NA] Inspect the rim-mounted bolting bar for corrosion and broken welds.
b [NA] Measure and chart seal-to-shell gaps.
c [NA] Visually inspect seal from below, looking for holes as evident by light.
d [NA] Inspect fabric for deterioration and stiffness.
e [NA] Inspect for mechanical damage, corrosion, and wear on tip in contact with shell.
f [NA] Inspect for contact with obstructions above top of shell.

C.2.10 Floating Roof Appurtenances

C.2.10.1 Roof Manways

a [NA] Inspect walls of manways for pitting and thinning.
b [NA] On tanks with interface autogauges, check seal around gauge tape cable and guide wires through manway cover.
c [NA] Inspect cover gasket and bolts.

C.2.10.2 Rim Vent

a [NA] Check rim vent for pitting and holes.
b [NA] Check vent for condition of screen.
c [NA] 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.

C.2.10.3 Vacuum Breaker, Breather Type

a [X] Service and check operation of breather valve.
b [X] Check that nozzle pipe projects no more than 1/2 inch below roof deck.

Table C-2 Tank Out-of-Service Inspection Checklist

C.2.10.4 Vacuum Breaker, Mechanical Type

a NA 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.
- On high legs: __________.
- On low legs:__________.

C.2.10.5 Roof Drains: Open Systems, Including Emergency Drains

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

C.2.10.6 Closed Drain Systems: Drain Basins

a NA Inspect for thinning and pitting.
b NA Inspect protective coating (topside).
c NA Inspect basin cover or screen for corrosion.
d NA Test operation of check valve.
e NA Check for presence of check valve where bottom of basin is below product level.
f NA Inspect drain basin(s) to roof deck welds for cracking.
g NA Check drain basin(s) outlet pipe for adequate reinforcement to roof deck (including reinforcing pad).

C.2.10.7 Closed Drain Systems: Fixed Drain Line on Tank Bottom

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

C.2.10.8 Closed Drain Systems: Flexible Pipe Drain

a NA Inspect for damage to exterior of pipe.
b NA Check for obstructions that pipe could catch on.
c NA Inspect shields to protect pipe from snagging.
d NA Inspect results of hydrotest on flexible roof drain system.

C.2.10.9 Closed Drain Systems: Articulated Joint Drain

a NA Hammer test rigid pipe in flexible joint system for thinning and scale/debris plugging.
b NA Inspect system for signs of bending or strain.
c NA Inspect results of system hydrotest.
d NA Inspect landing leg and pad.

C.2.10.10 Autogauge System and Alarms

a X Check freedom of movement of tape through autogauge tape guide.
b X Inspect sheaves for freedom of movement.
c X Test operation checker.
d X Inspect tape and tape cable for twisting and fraying.
e X Test the tape's freedom of movement through guide sheaves and tape guide pipe.
f NA On open-top tanks, check that gate tapes with cables have no more than one foot of tape exposed with float at lowest point.
g NA Check float for leakage.
h NA Test float guide wire anchors for spring action by pulling on wire and releasing.
i NA Inspect floatwells in floating roofs for thinning and pitting of walls just above the liquid level.
j X Check that the autogauge tape is firmly attached to the float.
k NA Inspect the tape cable and float guide wire fabric seals through the float well cover.
l NA Inspect the bottom guide wire attachment clip. Inspect for a temporary weighted bar instead of a permanent welded down clip.
m NA Inspect board-type autogauge indicators for legibility and freedom of movement of indicator.
n NA Measure and record these distances to determine if seal damage will occur if tank is run over:
- From shell top angle to underside of tape guide system.
- From liquid level on floating top to top of secondary seal.

o X Identify floating roofs where the tape is connected directly to the roof.
p X Overfill alarm: Inspect tank overfill prevention alarm switches for proper operation.

Table C-2 Tank Out-of-Service Inspection Checklist

C.2.11 Common Tank Appurtenances

C.2.11.1 Gauge Well

a	X	Inspect gauge well pipe for thinning at about two-thirds distance above the bottom: look for thinning at the edge of the slots.
b	X	Check for corrosion on the pipe joint. Check that sample cords, weights, thermometers, etc.; have been removed from the pipe.
c	NA	Check for cone at bottom end of pipe about one foot above the bottom.
d	NA	Check condition of well washer pipe and that its flared end is directed at the near side of the hold off pad.
e	X	Check that supports for gauge well are welded to pad or to shell and not directly to bottom plate.
f	X	Check operation of gauge well cover.
g	NA	Check presence of a hold-off distance marker in well pipe and record hold-off distance. Hold-off Distance:__________.
h	X	Identify and report size and pipe schedule, and whether pipe is solid or slotted. Report slot size.
i	NA	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.
j	NA	Inspect vapor control float and cable.
k	NA	Check for presence and condition of gauge well washer.
l	NA	Check for bull plug or plate blind on gauge well washer valve.
m	NA	Inspect gage well guide in floating roof for pitting and thinning.
n	NA	Inspect the guide rollers and sliding plates for freedom of movement.
o	NA	Inspect condition of gauge well pipe seal system.
p	NA	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.
q	X	Visually inspect inside of pipe for pipe weld protrusions which could catch or damage vapor control float.

C.2.11.2 Sampling Systems: Roof Sample Hatches

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

C.2.11.3 Shell Nozzles

a	X	Inspect shell nozzles for thinning and pitting.
b	NA	Inspect hot tap nozzles for trimming of holes.
c	X	Identify type of shell nozzles.
d	X	Identify and describe internal piping, including elbow up and elbow down types.

C.2.11.4 For Nozzles Extended Into the Tank

a	X	Inspect pipe support pads welded to tank bottom.
b	X	Inspect to see that pipe is free to move along support without strain or tearing action on bottom plate.
c	X	Inspect nozzle valves for packing leaks and damaged flange faces.
d	NA	Inspect heater steam nozzle flanges and valves for wire cutting.
e	X	Report which nozzles have thermal pressure relief bosses and valves.
f	NA	In internal elbow-down fill line nozzles, inspect the wear plate on the tank bottom.
g	NA	On elbow-up fill lines in floating roof tanks, check that opening is directed against underside of roof, not against vapor space. Inspect impact area for erosion.

C.2.11.5 Diffusers and Air Rolling Systems

a	X	Inspect diffuser pipe for erosion and thinning.
b	NA	Check holes in diffuser for excessive wear and enlargement.
c	X	Inspect diffuser supports for damage and corrosion.
d	X	Check that diffuser supports restrain, not anchor, longitudinal line movement.
e	NA	Inspect air spiders on bottom of lube oil tanks for plugging and damaged or broken threaded joints.

Table C-2 Tank Out-of-Service Inspection Checklist

C.2.11.6 Swing Lines

a	NA	Inspect flexible joint for cracks and leaks.
b	NA	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.
c	NA	Check that flexible joints over six inches are supported.
d	NA	Inspect the swing pipe for deep pitting and weld corrosion.
e	NA	Loosen the vent plugs in the pontoons and listen for a vacuum. Lack of a vacuum indicates a leaking pontoon.
f	NA	Check the results of air tests on pontoons during repairs.
g	NA	Inspect the pontoons for pitting.
h	NA	Inspect the pull-down cable connections to the swing.
i	NA	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.
j	NA	Inspect safety hold-down chain for corrosion and weak links.
k	NA	Check that there is a welded reinforcing pad where the chain connects to the bottom.
l	NA	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, recommend installation of a limiting bracket.)
m	NA	Inspect pull down cable for fraying.
n	NA	Inspect for three cable clamps where cable attaches to end of swingline (single-reeved) or to roof assembly (double-reeved). Inspect sheaves for freedom of movement.
o	NA	Inspect winch operation and check the height indicator for legibility and accuracy.
p	NA	Inspect bottom-mounted sheave assembly at end of pontoon for freedom of rotation of sheave.
q	NA	Inspect shell-mounted lower sheave assembly for freedom of rotation of sheave, corrosion thinning and pitting of sheave housing.
r	NA	Inspect upper sheave assembly for freedom of movement of sheave.
s	NA	Inspect the cable counterbalance assembly for corrosion and freedom of operation.

C.2.11.7 Manway Heater Racks

a	NA	Inspect the manway heater racks for heater welds and bending of the sliding rails.
b	NA	Measure and record the length of the heater and length of the rack.

C.2.11.8 Mixer Wear Plates

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

Appendix E
Photographs

E.1 Tank Overview

E.2 Secondary Containment View

E.3 Drain

E.4 Secondary Containment Drain Hydrostatic Test

E.5 Leak Detection(Not Sealed)

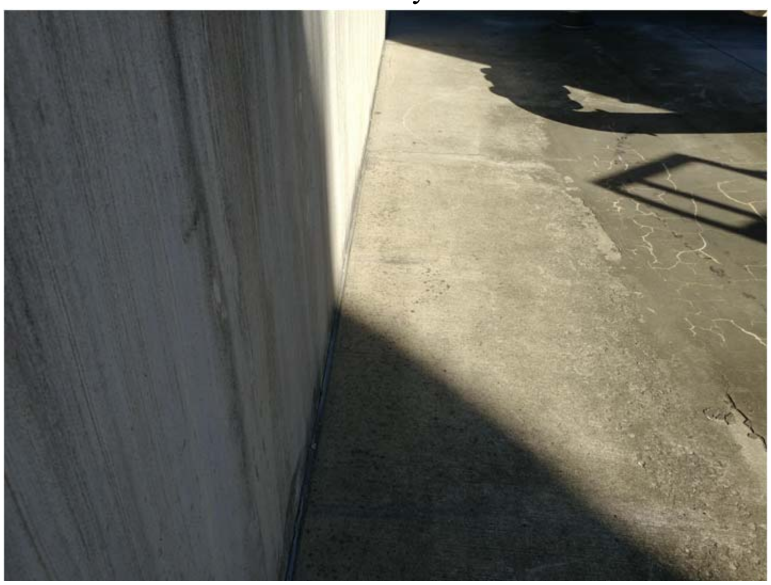
E.6 Issue/Receipt Line Not Sealed

E.7 Secondary Containment Floor

E.8 Vegetation in Secondary Containment Floor

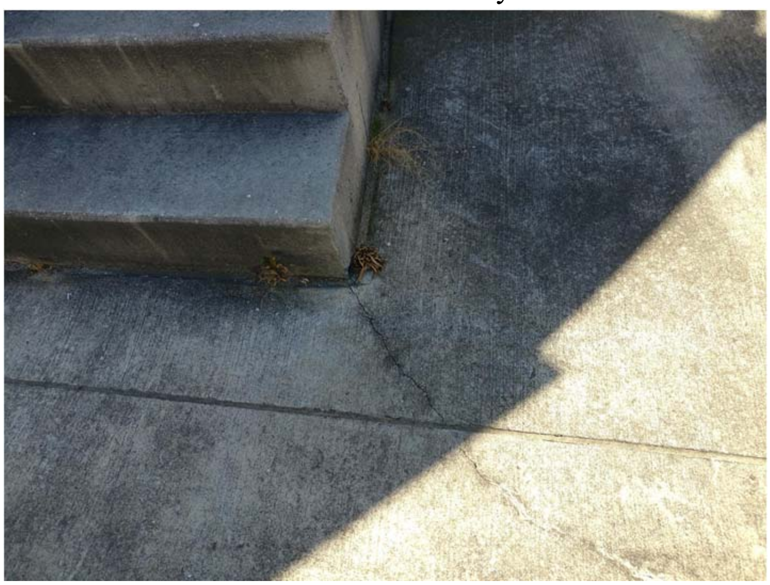
E.9 Vegetation in Secondary Containment


E.10 Crack in Secondary Containment Wall


E.11 Failed Secondary Containment Wall to Floor Sealant.


E.12 Cracks in Secondary Containment Floor

E.13 Failed Joint Sealant in Secondary Containment Floor

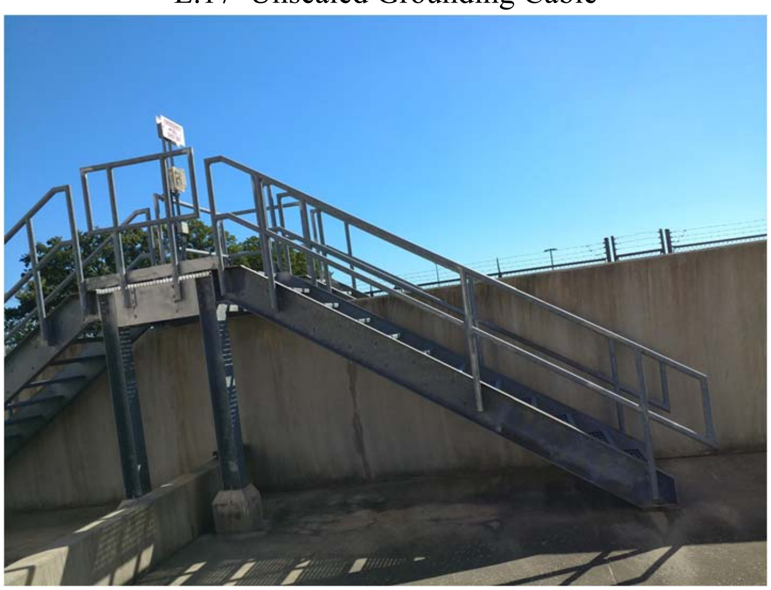


E.14 Cracks and Vegetation in Secondary Containment Floor

E.15 Failed Ringwall Joint Sealant

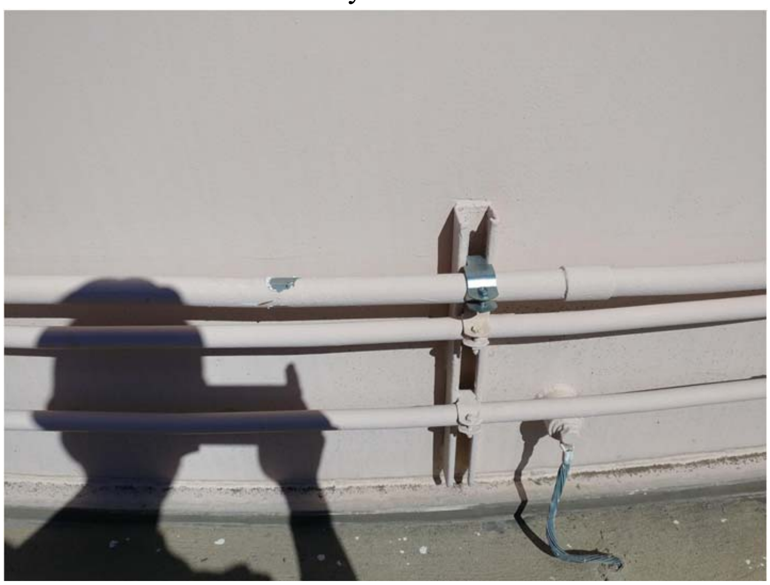
E.16 Ringwall Seal Failure

E.17 Unsealed Grounding Cable

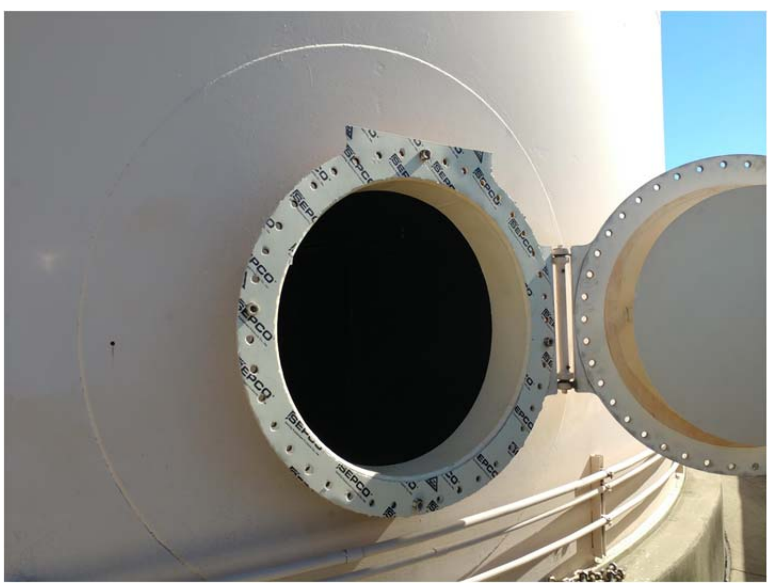


E.18 Secondary Containment Stairs

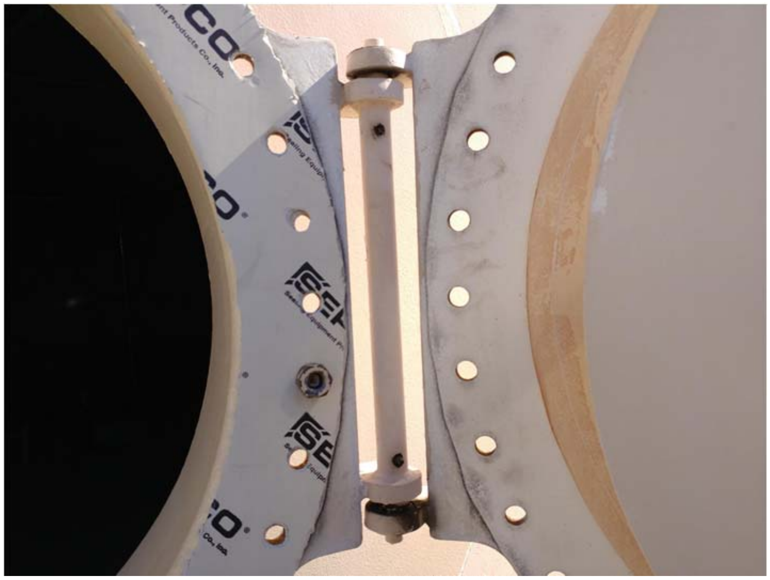
E.19 Secondary Containment Stairs



E.20 Corrosion on Conduit



E.21 Nozzle A, 36" Manhole with 74" Repad



E.22 Manhole Missing Grease Fitting on Hinge

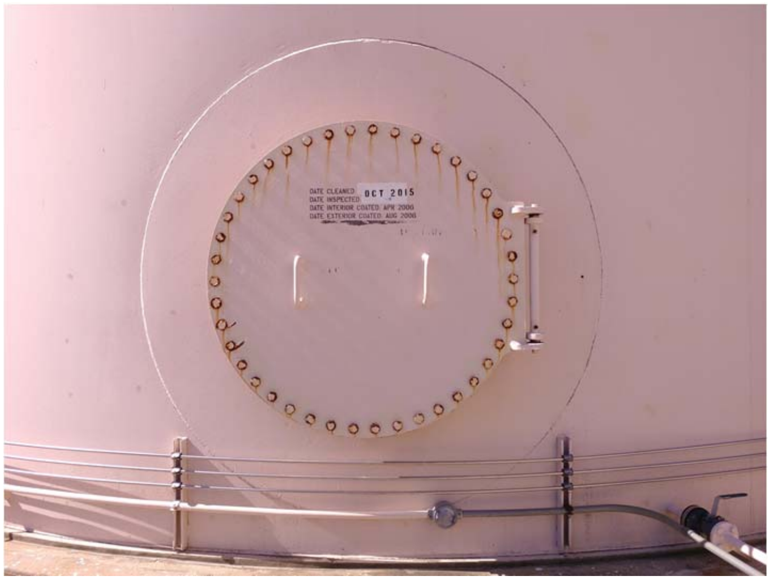
E.23 Nozzles B, C, D, E

E.24 Coating Failure on Low and High Level Alarms

E.25 Nozzles F and G

E.26 Junction Box not Properly Sealed

E.27 Coating Failure on Low Level Alarm



E.28 Nozzle H, 36" Manhole with 74" Repad

E.29 Nozzle I, 1" Water Draw

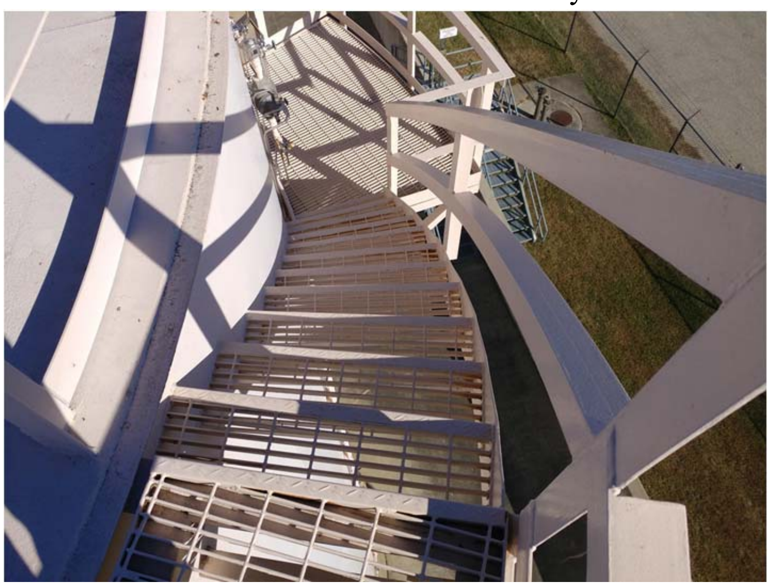
E.30 Water Draw-Off Piping Galvanic Corrosion

E.31 Product Saver Tank System

E.32 Nozzle J, 8" Receipt with 18" Repad

E.33 Coating Failure on 8" Receipt

E.34 Circumferential Stairway



E.35 Circumferential Stairway

E.36 Underneath View of Platform

E.37 Nozzle K, 36" Internal Floating Roof Manhole

E.38 Tank Shell

E.39 Mechanical Tape Gauge

E.40 Mechanical Tape Gauge

E.41 Nozzle L, 12" Issue with 26" Repad

E.42 Coating Failure on 12" Issue

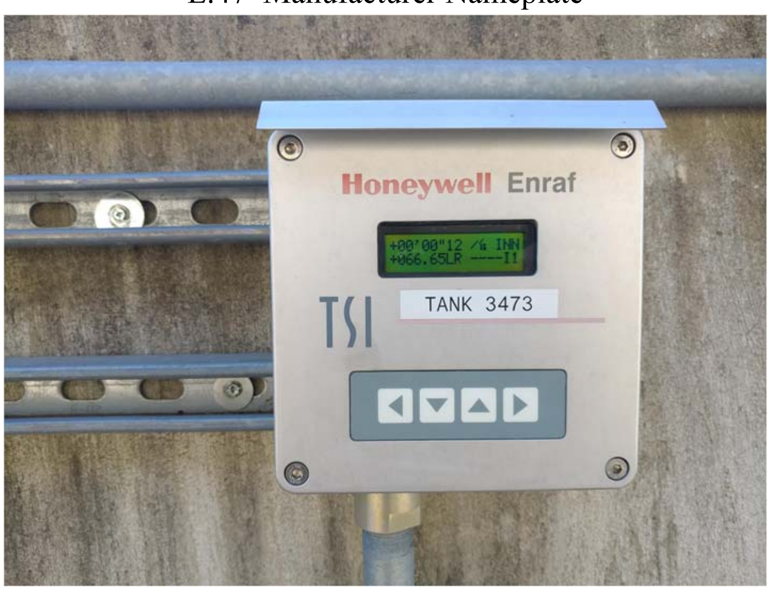

E.43 Nozzle M, 4" Low Suction with 12" Repad


E.44 Coating Failure on Low Suction Flange


E.45 Overflow Vent

E.46 Overflow Vent

E.47 Manufacturer Nameplate



E.48 Enraf

E.49 Cathodic Protection

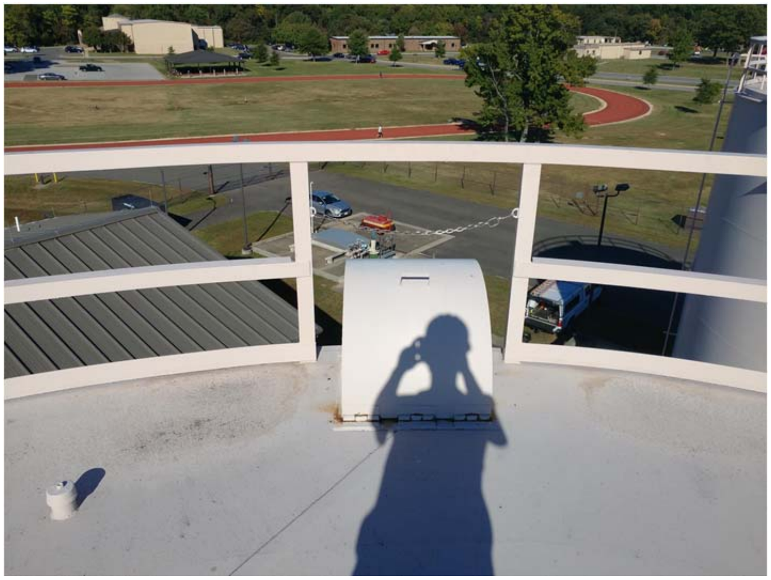
E.50 Cathodic Protection Rectifier

E.51 Cathodic Protection Rectifier

E.52 Cathodic Protection Rectifier Monitor

E.53 Emergency Shutoff


E.54 Roof Overall View



E.55 Low Spots on Roof

E.56 Roof Nozzles

E.57 Roof Vent

E.58 Coating Failure/Corrosion on Hood

E.59 Inspection Hatch Screen

E.60 Coating Failure on Hood Hinge

E.61 Roof Nozzle A, 6" Enraf/Vito Stilling Well

E.62 Roof Nozzle A, 6" Enraf/Vito Stilling Well

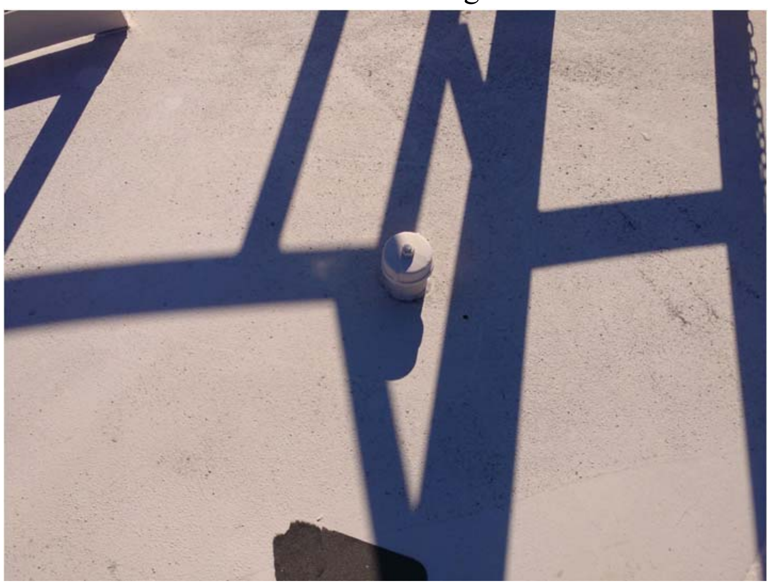
E.63 Roof Nozzle A, 6" Enraf/Vito Stilling Well

E.64 Roof Nozzle A, 6" Enraf/Vito Stilling Well

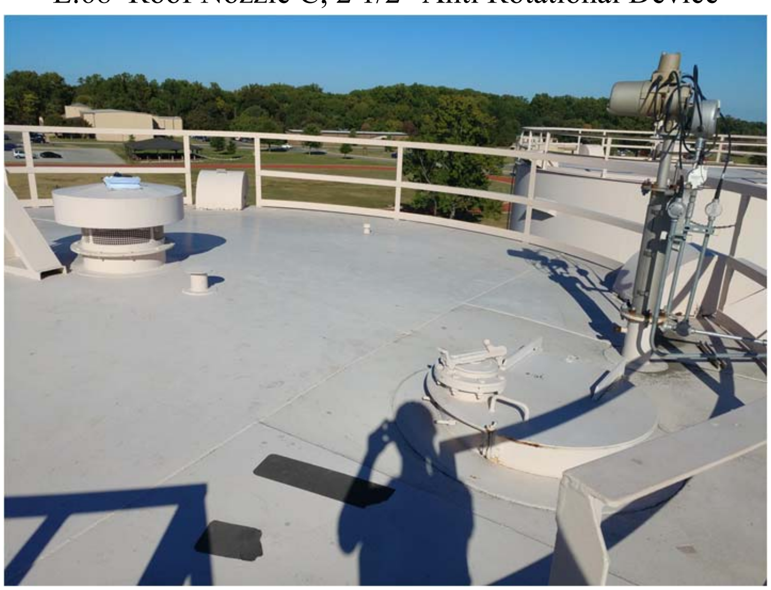
E.65 Roof Nozzle A, 6" Enraf/Vito Stilling Well

E.66 Roof Nozzle B, 36" Manhole with 8" Manual Gauge Hatch(Not Bolted)

E.67 8" Manual Gauge Hatch



E.68 Roof Nozzle C, 2 1/2" Anti Rotational Device



E.69 Roof Nozzle D, 2 1/2" Cap

E.70 Roof Nozzle E, 24" Vent

E.71 Roof Nozzle E, 24" Vent

E.72 Roof Nozzle F, 30" x 72" Pan Installation Hatch, Nozzle G, 2 1/2" Cap

E.73 Roof Nozzle H, 3" Tie-Off

E.74 Roof Nozzle J, 1 1/2" Mechanical Tape Gauge

E.75 Tank Bottom

E.76 Tank Bottom

E.77 Bottom Nozzle A, 6" Enraf/Vito Stilling Well

E.78 Bottom Nozzle B, 8" Manual Gauge with Ladder

E.79 Foam Seal Saturated and Dripping Fuel

E.80 Penetration Seal Deteriorated

E.81 Minor Coating Failure on Manual Gauge Well Reinforcement Pad

E.82 Anti-Rotational Device

E.83 Anti-Rotational Device

E.84 IFR Leg

E.85 IFR Leg

E.86 4" Low Suction

E.87 12" Issue


E.88 12" Issue Not Fully Resting on Support


E.89 8" Receipt


E.90 8" Receipt

E.91 Carbon Steel Connected to Stainless Steel Flange

E.92 1" Water Draw

E.93 Bottom Nozzle C, 30" Sump

E.94 IFR Ladder

E.95 IFR Roof Rafter Layout

E.96 IFR Ladder Penetration Deteriorated

E.97 IFR

E.98 IFR Seal

E.99 Anti-Rotation Device (ARD)

E.100 Leica 3D Disto

E.101 IFR

E.102 IFR

E.103 IFR Leg

E.104 Vacuum Vent (IFR)

Appendix F

Verticality Study

Shell Plumbness and Roundness Evaluation

The purpose of this study is to determine the tank shell out-of-roundness, locations of buckled areas, flat spots, and peaking and banding at weld joints. Shell distortion can be caused by many conditions, such as foundation settlement, over- or under-pressuring, high wind, poor shell fabrication, or various repair techniques or tank modifications.

Methodology

The vertical shell profiles were obtained externally at equally spaced planes arround the circumference of the tank with measurements recorded at 6-inch intervals along each vertical profile. The roundness of the shell was obtained internally with measurements recorded at 12-inch intervals above and below the floating roof. All measurements were recorded using an aoutomatic laser scanning surveying instrument, Lieca® 3D DISTO.

Plumbness Evaluation

The maximum allowable out-of-plumbness for this tank is 4.915 inches in accordance with API Standard 653, paragraph 10.5.2. The maximum calculated out-of-plumbness for this tank is 1.5582 inches.

-The tank shell out-of-plumbness is within the limits of API Standard 653.

Roundness Evaluation

The maximum allowable out-of-roundness for this tank is 1.5 inches in accordance with API Standard 653, paragraph 10.5.3. The maximum calculated out-of-roundness for this tank is 1.1485 inches.

-The shell out-of-roundness is within the limits of API Standard 653.

Shell Plumbness and Roundness Evaluation

(Shell Plumbness Evaluation)

Height from Bottom (feet)	Vertical Profile #1 ΔRadius (inches)	Vertical Profile #2 ΔRadius (inches)	Vertical Profile #3 ΔRadius (inches)	Vertical Profile #4 ΔRadius (inches)	Vertical Profile #5 ΔRadius (inches)	Vertical Profile #6 ΔRadius (inches)	Vertical Profile #7 ΔRadius (inches)	Vertical Profile #8 ΔRadius (inches)
0.0								
0.5		-0.179	0.010	0.011	-0.012	-0.039	0.038	-0.004
1.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.5	-0.023	0.047	0.028	0.035	-0.016	0.004	-0.009	-0.068
2.0	-0.032	0.008	0.056	0.084	-0.010	0.008	-0.003	-0.115
2.5	-0.003	-0.006	0.052	0.116	-0.020	-0.065	-0.015	-0.110
3.0	0.023	-0.044	0.092	0.143	0.024	-0.109	-0.032	-0.127
3.5	0.057	-0.087	0.131	0.160	0.071	-0.146	-0.041	-0.105
4.0	0.081	-0.112	0.147	0.171	0.079	-0.174	-0.047	-0.098
4.5	0.107	-0.084	0.175	0.180	0.102	-0.174	-0.073	-0.065
5.0	0.120	-0.090	0.201	0.197	0.148	-0.182	-0.067	-0.057
5.5	0.143	-0.169	0.262	0.207	0.179	-0.173	-0.068	-0.018
6.0	0.175	-0.233	0.304	0.223	0.248	-0.158	-0.077	0.017
6.5								
7.0								
7.5			0.313					0.024
8.0	0.229	-0.303	0.349	0.213		-0.122	-0.058	0.057
8.5	0.319	-0.298	0.408	0.216	0.395	-0.072	-0.052	-0.052
9.0	0.399	-0.328	0.402	0.203	0.501	-0.008	-0.029	-0.195
9.5	0.389	-0.367	0.417	0.193	0.542	0.020	-0.113	-0.280
10.0	0.311	-0.398	0.434	0.196	0.560	0.056	-0.104	-0.283
10.5	0.258	-0.401	0.423	0.201	0.694	0.094	-0.135	-0.238
11.0	0.212	-0.409	0.440	0.205	0.638	0.108	-0.154	-0.191
11.5	0.152	-0.415	0.436	0.210	0.650	0.124	-0.142	-0.163
12.0	0.087	-0.412	0.429	0.209	0.588	0.139	-0.196	-0.143
12.5	0.049	-0.403	0.429	0.211	0.544	0.171	-0.207	-0.126
13.0	0.019	-0.379	0.430	0.212	0.501	0.164	-0.194	-0.095
13.5	-0.032	-0.315	0.420	0.212	0.506	0.180	-0.233	-0.089
14.0	-0.089	-0.224	0.390	0.223	0.479	0.184	-0.196	-0.065
14.5	-0.137	-0.167	0.368	0.230	0.472	0.200	-0.200	-0.042
15.0	-0.198	-0.167	0.352	0.235	0.406	0.193	-0.220	-0.033
15.5	-0.275	-0.195	0.340	0.240	0.402	0.207	-0.245	-0.021
16.0	-0.326	-0.233	0.302	0.250	0.407	0.276	-0.223	0.003
16.5	-0.373	-0.282	0.279	0.254	0.377	0.266	-0.214	0.048
17.0	-0.429	-0.344	0.222	0.243	0.392	0.298	-0.236	0.054
17.5	-0.485	-0.378	0.188	0.241	0.367	0.316	-0.278	0.036
18.0	-0.528	-0.398	0.149	0.227	0.384	0.361	-0.281	-0.011
18.5	-0.555	-0.397	0.141	0.216	0.408	0.437	-0.293	-0.025
19.0	-0.581	-0.393	0.137	0.216	0.423	0.449	-0.263	-0.032
19.5	-0.627	-0.399	0.114	0.200	0.390	0.489	-0.299	-0.063
20.0	-0.670	-0.409	0.098	0.188	0.410	0.521	-0.299	-0.067
20.5	-0.689	-0.423	0.073	0.181	0.409	0.596	-0.295	-0.066
21.0	-0.715	-0.421	0.082	0.173	0.431	0.626	-0.342	-0.070
21.5	-0.737	-0.408	0.073	0.166	0.454	0.664	-0.343	-0.060
22.0	-0.776	-0.397	0.060	0.162	0.456	0.716	-0.356	-0.080
22.5	-0.813	-0.373	0.050	0.151	0.474	0.774	-0.346	-0.090
23.0	-0.862	-0.362	0.042	0.147	0.470	0.876	-0.316	-0.097
23.5	-0.909	-0.344	0.025	0.139	0.572	0.963	-0.309	-0.119
24.0	-0.918	-0.341	0.042	0.140	0.559	1.060	-0.290	-0.111
24.5	-0.946	-0.365	0.044	0.133	0.566	1.138	-0.192	-0.052
25.0	-0.978	-0.370	0.081	0.133	0.664	1.296	-0.080	0.039
25.5	-0.992	-0.385	0.075	0.130	0.742	1.442	-0.108	0.122
26.0	-0.997	-0.394	0.076	0.125	0.801	1.525	-0.168	0.143

Shell Plumbness and Roundness Evaluation

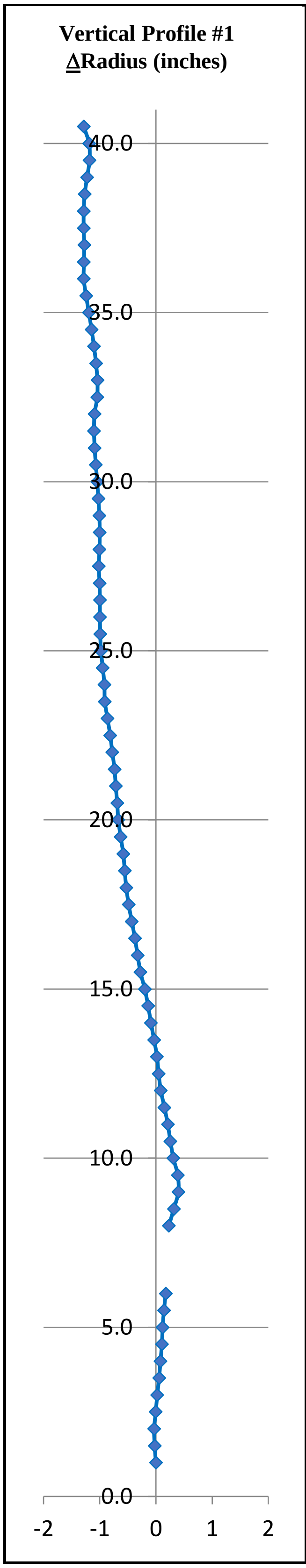
(Shell Plumbness Evaluation)

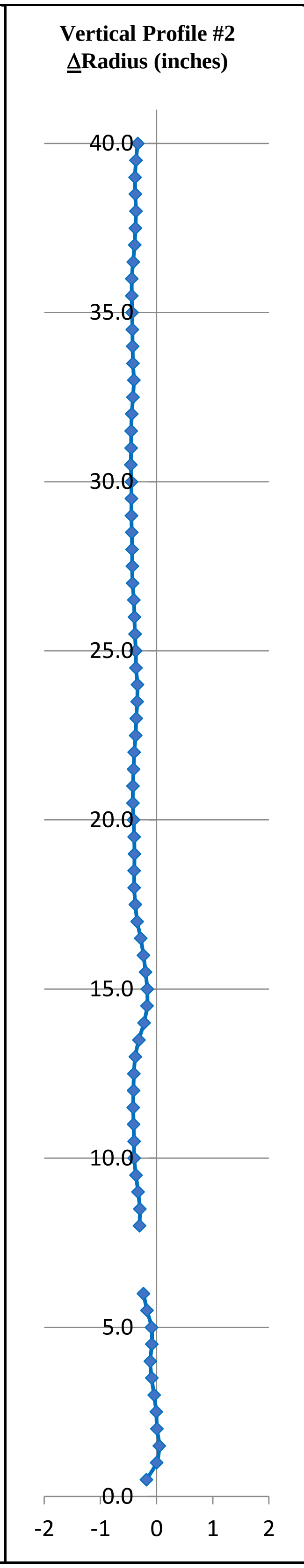
Height from Bottom (feet)	Vertical Profile #1 ΔRadius (inches)	Vertical Profile #2 ΔRadius (inches)	Vertical Profile #3 ΔRadius (inches)	Vertical Profile #4 ΔRadius (inches)	Vertical Profile #5 ΔRadius (inches)	Vertical Profile #6 ΔRadius (inches)	Vertical Profile #7 ΔRadius (inches)	Vertical Profile #8 ΔRadius (inches)
26.5	-0.998	-0.403	0.087	0.124	0.833	1.458	-0.151	0.140
27.0	-1.003	-0.427	0.085	0.116	0.862	1.394	-0.213	0.118
27.5	-1.017	-0.434	0.080	0.112	0.872	1.260	-0.282	0.105
28.0	-1.004	-0.435	0.090	0.104	0.884	1.216	-0.299	0.105
28.5	-1.001	-0.440	0.082	0.103	0.779	1.178	-0.346	0.127
29.0	-1.007	-0.449	0.092	0.095	0.854	1.168	-0.368	0.133
29.5	-1.025	-0.446	0.097	0.091	0.873	1.194	-0.422	0.124
30.0	-1.045	-0.449	0.114	0.089	0.886	1.209	-0.410	0.082
30.5	-1.069	-0.456	0.119	0.089	0.928	1.252	-0.440	0.052
31.0	-1.090	-0.453	0.131	0.078	0.926	1.288	-0.440	0.053
31.5	-1.102	-0.451	0.136	0.073	0.853	1.293	-0.483	0.044
32.0	-1.092	-0.441	0.161	0.072	0.754	1.270	-0.497	-0.008
32.5	-1.044	-0.419	0.200	0.064	0.663	1.242	-0.491	-0.065
33.0	-1.041	-0.405	0.229	0.056	0.653	1.216	-0.500	-0.147
33.5	-1.067	-0.419	0.212	0.048	0.652	1.212	-0.579	-0.186
34.0	-1.102	-0.427	0.190	0.037	0.632	1.215	-0.611	-0.178
34.5	-1.146	-0.429	0.160	0.027	0.632	1.217	-0.686	-0.168
35.0	-1.193	-0.436	0.174	0.018	0.619	1.206	-0.783	-0.151
35.5	-1.243	-0.441	0.196	0.009	0.616	1.208	-0.804	-0.162
36.0	-1.285	-0.440	0.252	-0.003	0.618	1.219	-0.879	-0.176
36.5	-1.281	-0.418	0.260	-0.008	0.650	1.239	-0.886	-0.166
37.0	-1.276	-0.391	0.206	-0.013	0.675	1.256	-0.888	-0.160
37.5	-1.286	-0.377	0.123	-0.015	0.712	1.295	-0.882	-0.157
38.0	-1.285	-0.367	0.061	-0.019	0.731	1.334	-0.819	-0.120
38.5	-1.268	-0.379	0.021	-0.018	0.719	1.377	-0.751	-0.089
39.0	-1.226	-0.383	-0.017	-0.015	0.732	1.406	-0.714	-0.077
39.5	-1.181	-0.366	-0.004	-0.016	0.775	1.500	-0.678	-0.064
40.0	-1.190	-0.336	0.014	-0.016	0.937	1.558	-0.583	-0.023
40.5	-1.284			-0.008				

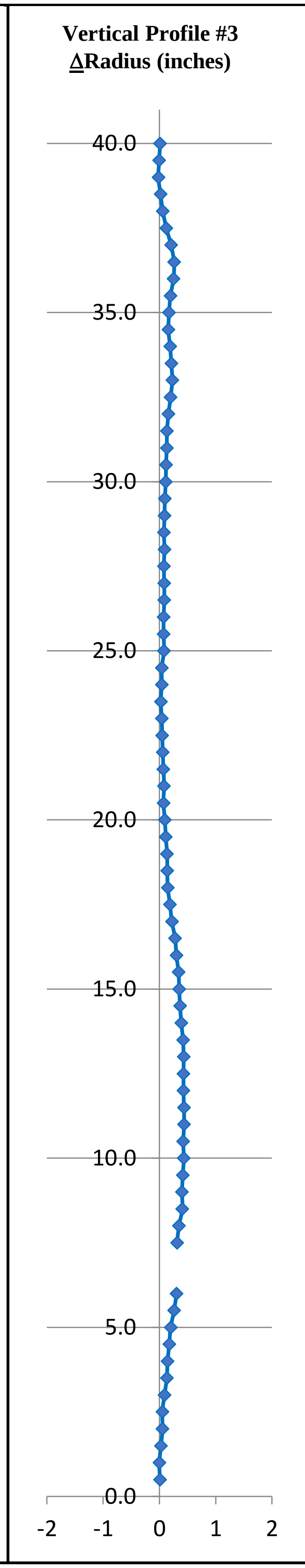
Minimum:	-1.286	-0.456	-0.017	-0.019	-0.020	-0.182	-0.888	-0.283
Maximum:	0.399	0.047	0.440	0.254	0.937	1.558	0.038	0.143
ΔPlumbness:	1.685	0.504	0.457	0.273	0.957	1.740	0.926	0.425
ΔAllowed:	4.915	4.915	4.915	4.915	4.915	4.915	4.915	4.915
Condition:	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**

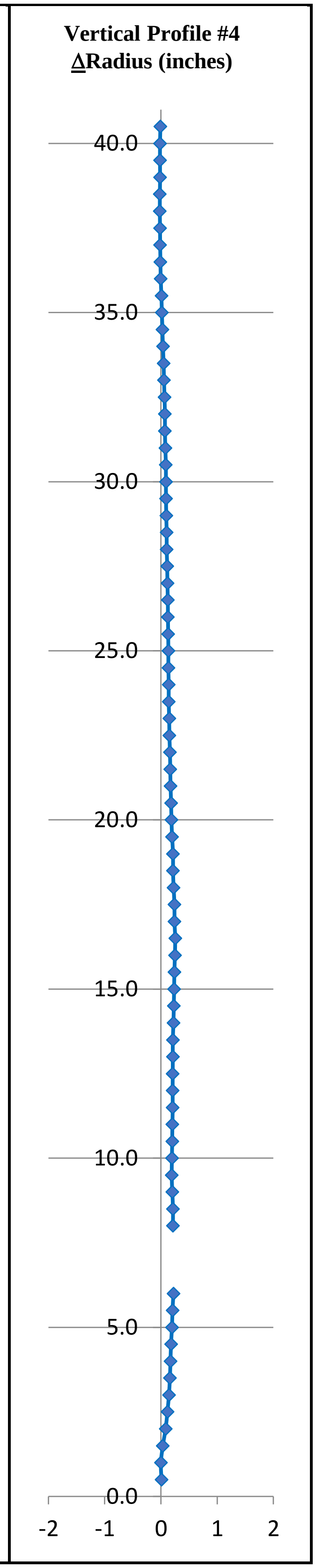
Shell Plumbness and Roundness Evaluation

(Shell Plumbness Evaluation)



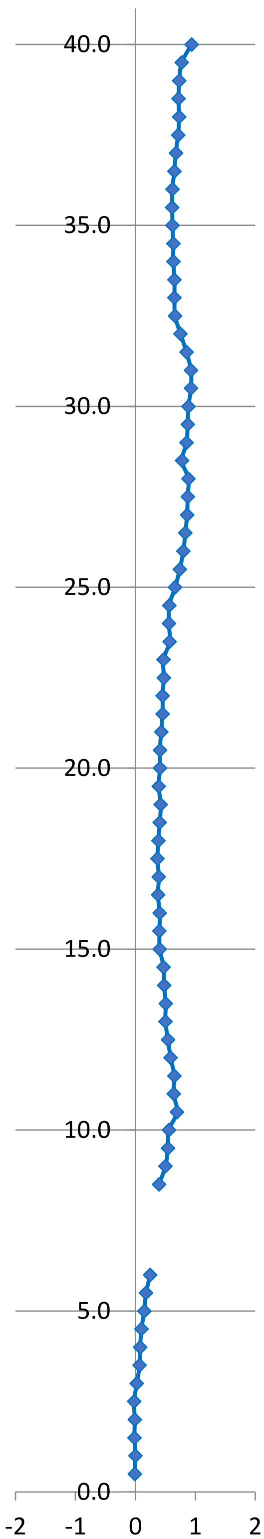
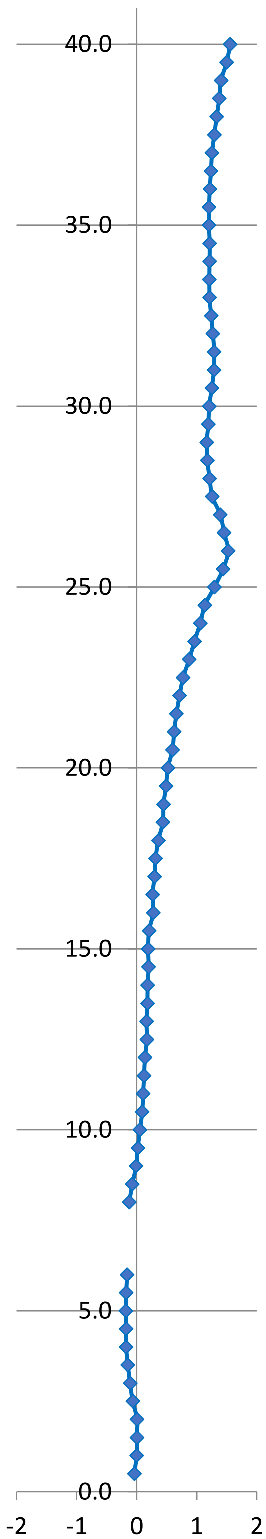
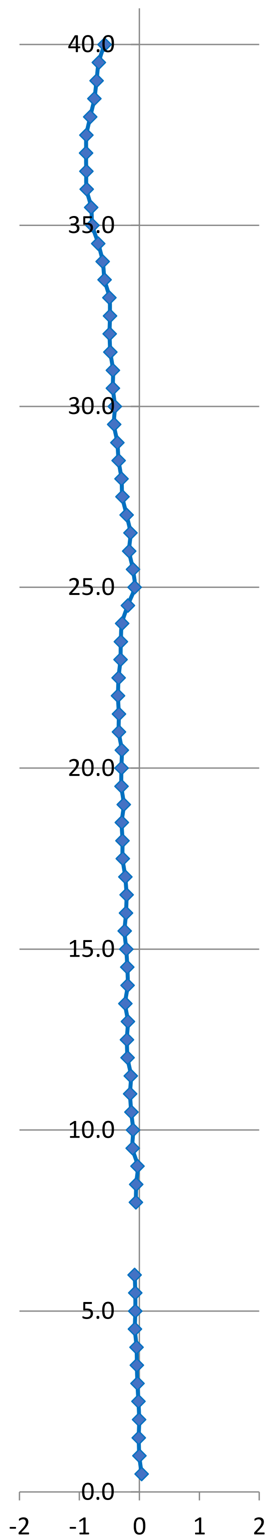
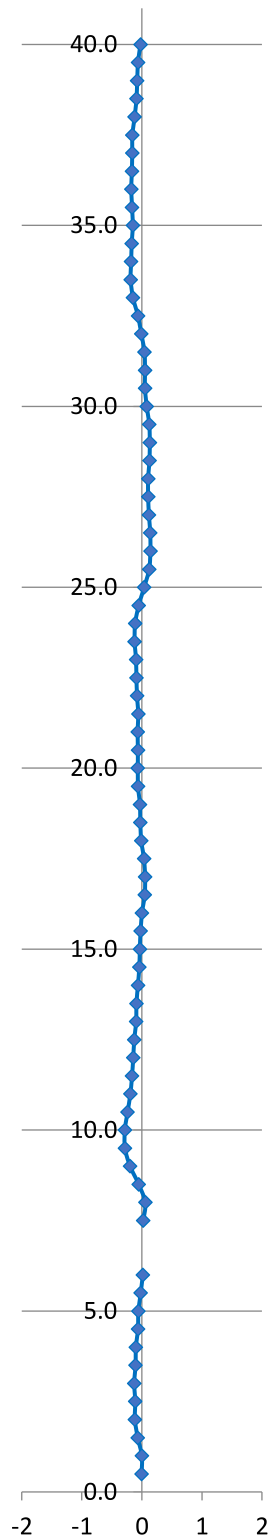






Shell Plumbness and Roundness Evaluation

(Shell Plumbness Evaluation)

Vertical Profile #5 ΔRadius (inches)	Vertical Profile #6 ΔRadius (inches)	Vertical Profile #7 ΔRadius (inches)	Vertical Profile #8 ΔRadius (inches)
			

Shell Plumbness and Roundness Evaluation
(Shell Roundness Evaluation)

Point Number	Shell Course #1		Shell Course #2		Shell Course #3		Shell Course #4	
	ΔRadius (inches)	Condition	ΔRadius (inches)	Condition	ΔRadius (inches)	Condition	ΔRadius (inches)	Condition
1	-0.045	PASS	0.025	PASS	-0.186	PASS	-0.489	PASS
2	-0.993	PASS	-0.237	PASS	-0.461	PASS	-0.538	PASS
3	-1.043	PASS	-0.534	PASS	-0.598	PASS	-0.599	PASS
4	-0.237	PASS	-0.686	PASS	-0.556	PASS	-0.553	PASS
5	0.296	PASS	-0.733	PASS	-0.368	PASS	-0.464	PASS
6	0.452	PASS	-0.536	PASS	-0.112	PASS	-0.238	PASS
7	0.294	PASS	-0.270	PASS	0.110	PASS	-0.079	PASS
8	0.053	PASS	0.007	PASS	0.235	PASS	0.177	PASS
9	-0.092	PASS	0.231	PASS	0.299	PASS	0.115	PASS
10	-0.120	PASS	0.137	PASS	0.233	PASS	0.028	PASS
11	-0.059	PASS	0.148	PASS	0.095	PASS	-0.018	PASS
12	0.061	PASS	0.057	PASS	0.012	PASS	-0.001	PASS
13	0.210	PASS	-0.145	PASS	0.009	PASS	0.128	PASS
14	0.215	PASS	-0.303	PASS	0.034	PASS	0.267	PASS
15	0.151	PASS	-0.280	PASS	-0.038	PASS	0.400	PASS
16	0.016	PASS	-0.084	PASS	0.023	PASS	0.505	PASS
17	-0.035	PASS	0.226	PASS	0.110	PASS	0.650	PASS
18	-0.133	PASS	0.460	PASS	0.291	PASS	0.643	PASS
19	-0.207	PASS	0.612	PASS	0.559	PASS	0.564	PASS
20	-0.164	PASS	0.682	PASS	0.581	PASS	0.496	PASS
21	-0.177	PASS	0.650	PASS	0.505	PASS	0.224	PASS
22	-0.140	PASS	0.464	PASS	0.384	PASS	-0.086	PASS
23	-0.014	PASS	0.168	PASS	0.248	PASS	-0.290	PASS
24	0.067	PASS	-0.118	PASS	0.137	PASS	-0.304	PASS
25	0.122	PASS	-0.256	PASS	-0.040	PASS	-0.074	PASS
26	0.120	PASS	-0.168	PASS	-0.133	PASS	0.088	PASS
27	0.151	PASS	-0.090	PASS	-0.202	PASS	0.027	PASS
28	0.164	PASS	-0.118	PASS	-0.300	PASS	-0.135	PASS
29	0.091	PASS	-0.157	PASS	-0.334	PASS	-0.243	PASS
30	0.099	PASS	-0.236	PASS	-0.273	PASS	-0.162	PASS
31	0.178	PASS	-0.371	PASS	-0.096	PASS	0.017	PASS
32	0.344	PASS	-0.392	PASS	0.074	PASS	0.142	PASS
33	-0.055	PASS	-0.127	PASS	0.213	PASS	0.089	PASS
34	-0.219	PASS	-0.261	PASS	0.250	PASS	-0.005	PASS
35	-0.160	PASS	-0.158	PASS	0.334	PASS	-0.022	PASS
36	-0.071	PASS	0.081	PASS	0.464	PASS	0.064	PASS
37	-0.024	PASS	0.334	PASS	0.595	PASS	0.620	PASS
38	-0.113	PASS	0.686	PASS	-0.017	PASS	0.694	PASS
39	-0.152	PASS	0.734	PASS	-0.235	PASS	0.760	PASS
40	-0.016	PASS	0.588	PASS	-0.135	PASS	0.698	PASS
41	0.253	PASS	0.310	PASS	-0.049	PASS	0.472	PASS
42	0.446	PASS	-0.009	PASS	-0.117	PASS	-0.164	PASS
43	0.373	PASS	-0.282	PASS	-0.150	PASS	-0.660	PASS
44	-0.196	PASS	-0.285	PASS	-0.191	PASS	-0.797	PASS
45	-0.481	PASS	-0.251	PASS	-0.242	PASS	-0.909	PASS
46	-0.156	PASS	-0.131	PASS	-0.481	PASS	-0.969	PASS
47	0.323	PASS	0.033	PASS	-0.703	PASS	-0.879	PASS
48	0.491	PASS	0.101	PASS	-0.802	PASS	-0.742	PASS
49	0.207	PASS	-0.005	PASS	-0.958	PASS	-0.679	PASS
50	-0.170	PASS	-0.146	PASS	-1.010	PASS	-0.619	PASS

Shell Plumbness and Roundness Evaluation

(Shell Roundness Evaluation)

Point Number	Shell Course #1 ΔRadius (inches)	Shell Course #1 Condition	Shell Course #2 ΔRadius (inches)	Shell Course #2 Condition	Shell Course #3 ΔRadius (inches)	Shell Course #3 Condition	Shell Course #4 ΔRadius (inches)	Shell Course #4 Condition
51	-0.591	PASS	-0.366	PASS	-0.632	PASS	-0.542	PASS
52	-0.630	PASS	-0.449	PASS	-0.200	PASS	-0.370	PASS
53	-0.490	PASS	-0.509	PASS	0.137	PASS	-0.113	PASS
54	-0.412	PASS	-0.508	PASS	0.237	PASS	0.099	PASS
55	-0.243	PASS	-0.189	PASS	0.266	PASS	0.148	PASS
56	-0.012	PASS	0.080	PASS	0.198	PASS	0.192	PASS
57	0.224	PASS	0.076	PASS	0.023	PASS	0.239	PASS
58	0.325	PASS	0.159	PASS	0.276	PASS	0.360	PASS
59	0.328	PASS	-0.088	PASS	0.454	PASS	0.466	PASS
60	0.243	PASS	-0.454	PASS	0.400	PASS	0.549	PASS
61	0.055	PASS	-0.249	PASS	0.290	PASS	0.549	PASS
62	-0.050	PASS	-0.115	PASS	0.279	PASS	0.563	PASS
63	-0.123	PASS	-0.049	PASS	0.210	PASS	0.399	PASS
64	-0.064	PASS	0.101	PASS	0.267	PASS	0.391	PASS
65	0.082	PASS	0.251	PASS	0.351	PASS	0.270	PASS
66	0.162	PASS	0.320	PASS	0.329	PASS	0.104	PASS
67	-0.062	PASS	0.382	PASS	0.255	PASS	-0.046	PASS
68	0.098	PASS	0.346	PASS	0.196	PASS	-0.182	PASS
69	0.275	PASS	0.276	PASS	0.148	PASS	-0.343	PASS
70	0.274	PASS	0.078	PASS	0.268	PASS	-0.335	PASS
71	0.172	PASS	-0.056	PASS	0.050	PASS	-0.222	PASS
72	0.085	PASS	-0.146	PASS	-0.002	PASS	0.018	PASS
73	-0.047	PASS	-0.122	PASS	0.033	PASS	0.238	PASS
74	-0.199	PASS	0.040	PASS	0.136	PASS	0.322	PASS
75	-0.278	PASS	0.358	PASS	0.271	PASS	0.329	PASS
76	-0.216	PASS	0.692	PASS	0.351	PASS	0.332	PASS
77	-0.025	PASS	0.835	PASS	0.315	PASS	0.307	PASS
78	0.118	PASS	0.673	PASS	0.233	PASS	0.197	PASS
79	0.169	PASS	0.255	PASS	0.220	PASS	0.188	PASS
80	0.202	PASS	-0.142	PASS	0.169	PASS	0.154	PASS
81	0.168	PASS	-0.358	PASS	-0.048	PASS	0.035	PASS
82	0.080	PASS	-0.360	PASS	-0.245	PASS	-0.124	PASS
83	0.093	PASS	-0.308	PASS	-0.459	PASS	-0.293	PASS
84	0.108	PASS	-0.383	PASS	-0.636	PASS	-0.295	PASS
85	0.106	PASS	-0.453	PASS	-0.834	PASS	-0.258	PASS
86	0.065	PASS	-0.521	PASS	-0.831	PASS	-0.133	PASS
87	0.034	PASS	-0.462	PASS	-0.761	PASS	0.039	PASS
88	0.074	PASS	-0.354	PASS	-0.497	PASS	0.150	PASS
89			-0.167	PASS	-0.088	PASS	0.193	PASS
90			0.083	PASS	0.196	PASS	0.163	PASS
91			0.329	PASS	0.411	PASS	0.098	PASS
92			0.504	PASS	0.494	PASS	0.063	PASS
93			0.564	PASS	0.507	PASS	-0.024	PASS
94			0.534	PASS	0.304	PASS	-0.247	PASS
95			0.384	PASS	-0.048	PASS	-0.365	PASS
96			0.126	PASS			-0.410	PASS

Shell Plumbness and Roundness Evaluation
(Shell Roundness Evaluation)

Point Number	Shell Course #5 ΔRadius (inches)	Condition
1	-0.464	PASS
2	-0.524	PASS
3	-0.480	PASS
4	-0.350	PASS
5	-0.180	PASS
6	0.025	PASS
7	0.156	PASS
8	0.173	PASS
9	0.176	PASS
10	0.093	PASS
11	0.066	PASS
12	0.129	PASS
13	0.255	PASS
14	0.362	PASS
15	0.471	PASS
16	0.418	PASS
17	0.439	PASS
18	0.418	PASS
19	0.394	PASS
20	0.327	PASS
21	0.258	PASS
22	0.188	PASS
23	0.149	PASS
24	0.088	PASS
25	-0.003	PASS
26	-0.058	PASS
27	-0.104	PASS
28	-0.121	PASS
29	-0.097	PASS
30	-0.205	PASS
31	0.049	PASS
32	0.144	PASS
33	0.074	PASS
34	0.013	PASS
35	-0.079	PASS
36	-0.051	PASS
37	0.014	PASS
38	0.093	PASS
39	0.221	PASS
40	0.332	PASS
41	0.297	PASS
42	0.176	PASS
43	-0.093	PASS
44	-0.407	PASS
45	-0.595	PASS
46	-0.781	PASS
47	-1.019	PASS
48	-1.128	PASS
49	-1.148	PASS
50	-1.008	PASS

Shell Plumbness and Roundness Evaluation

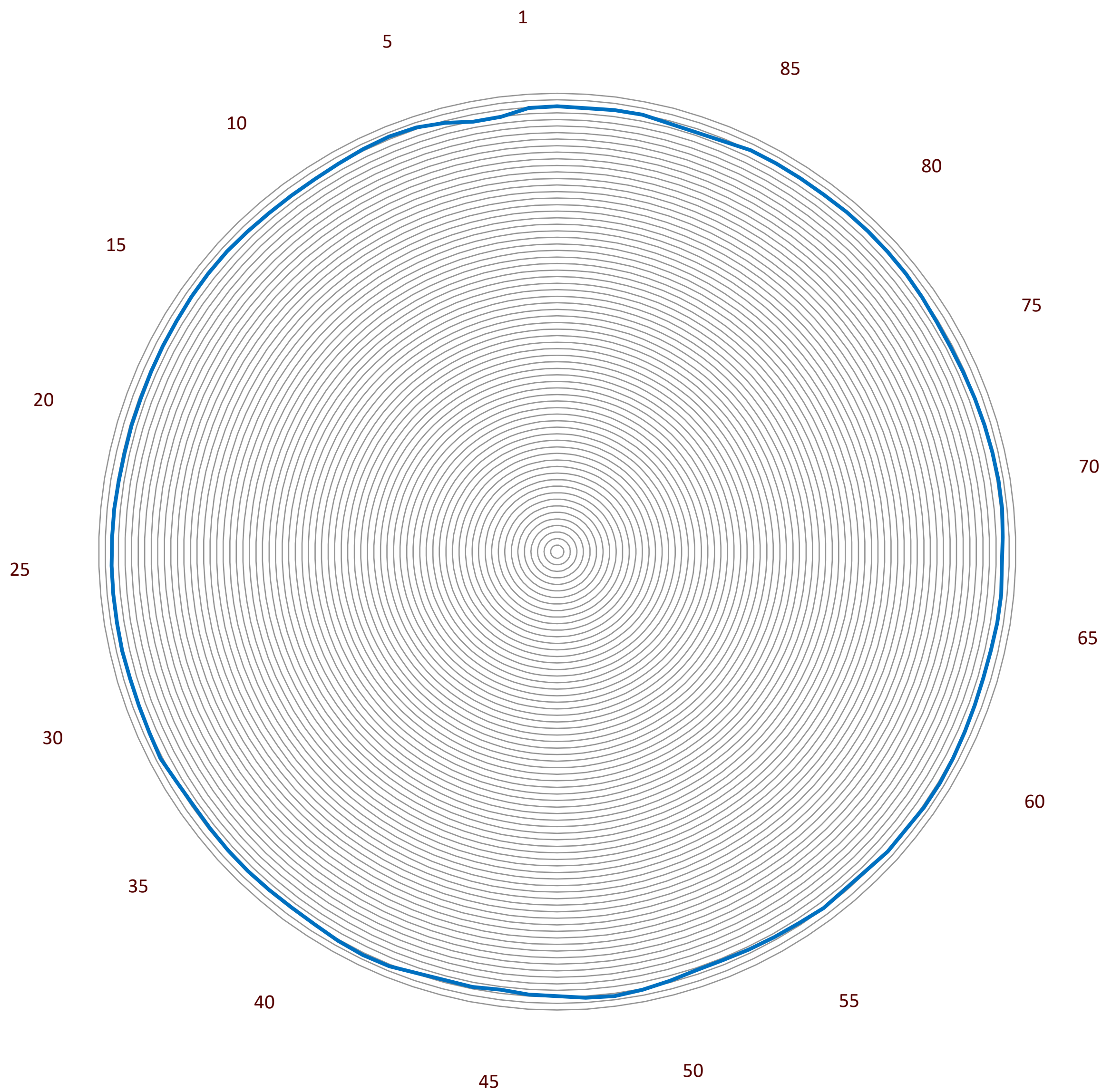
(Shell Roundness Evaluation)

Point Number	Shell Course #5	
	ΔRadius (inches)	Condition
51	-0.730	PASS
52	-0.468	PASS
53	-0.285	PASS
54	0.153	PASS
55	0.425	PASS
56	0.490	PASS
57	0.570	PASS
58	0.598	PASS
59	0.654	PASS
60	0.660	PASS
61	0.572	PASS
62	0.513	PASS
63	0.458	PASS
64	0.367	PASS
65	0.248	PASS
66	0.264	PASS
67	0.131	PASS
68	0.131	PASS
69	0.120	PASS
70	0.154	PASS
71	0.151	PASS
72	0.114	PASS
73	0.101	PASS
74	0.074	PASS
75	0.141	PASS
76	0.163	PASS
77	0.173	PASS
78	0.044	PASS
79	-0.078	PASS
80	-0.149	PASS
81	-0.222	PASS
82	-0.387	PASS
83	-0.535	PASS
84	-0.485	PASS
85	-0.314	PASS
86	-0.140	PASS
87	0.003	PASS
88	0.121	PASS
89	0.175	PASS
90	0.160	PASS
91	0.196	PASS
92	-0.058	PASS
93	-0.228	PASS
94	-0.338	PASS
95	-0.353	PASS
96	-0.458	PASS

Shell Plumbness and Roundness Evaluation

(Shell Roundness Evaluation)

Shell Course #1
(12x Radius, in inches)

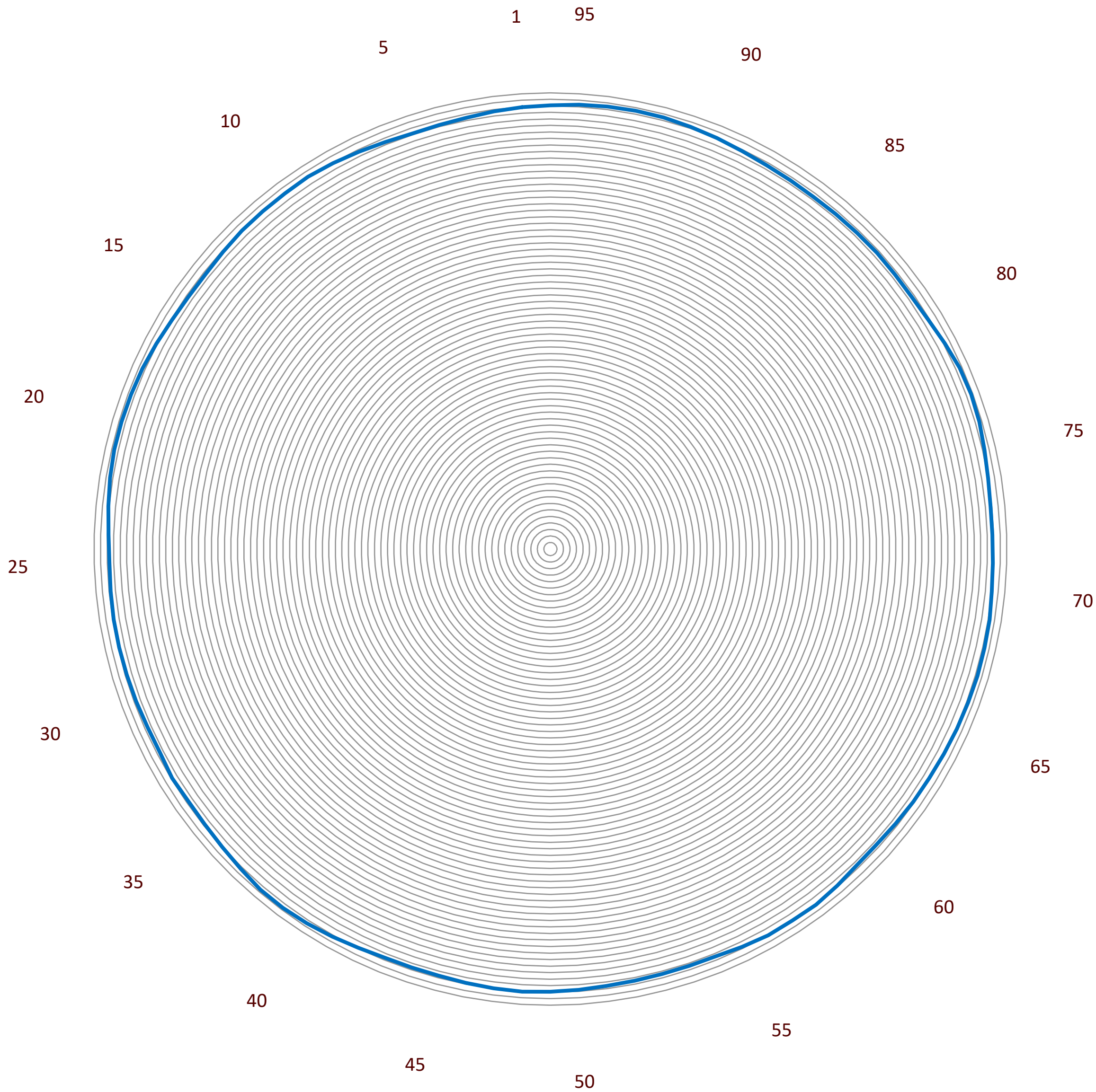


Note: Point #1 is at Shell Vertical Seam #1.

Shell Plumbness and Roundness Evaluation

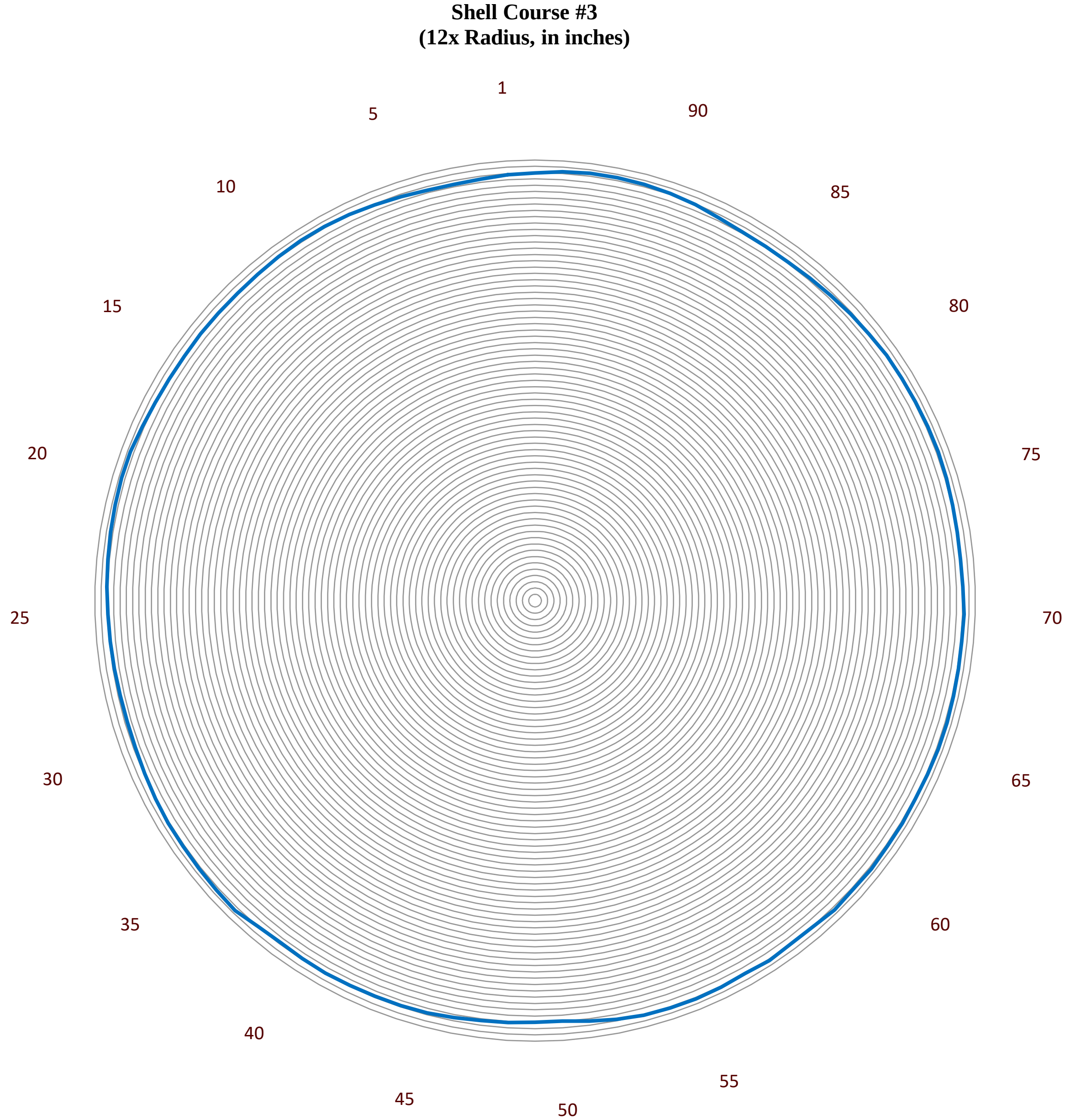
(Shell Roundness Evaluation)

Shell Course #2
(12x Radius, in inches)



Note: Point #1 is above Shell Vertical Seam #1.

Shell Plumbness and Roundness Evaluation
(Shell Roundness Evaluation)

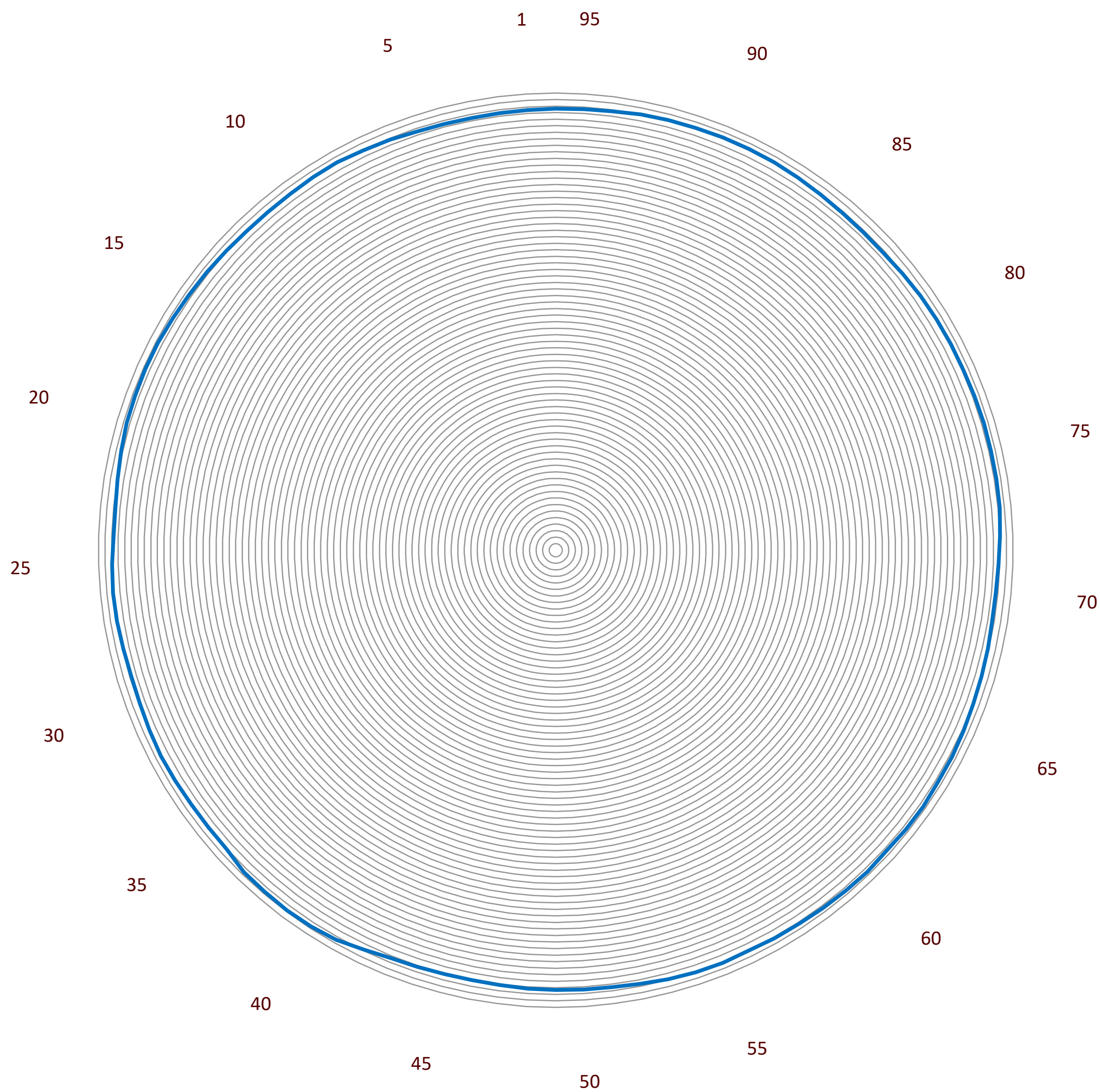


Note: Point #1 is above Shell Vertical Seam #1.

Shell Plumbness and Roundness Evaluation

(Shell Roundness Evaluation)

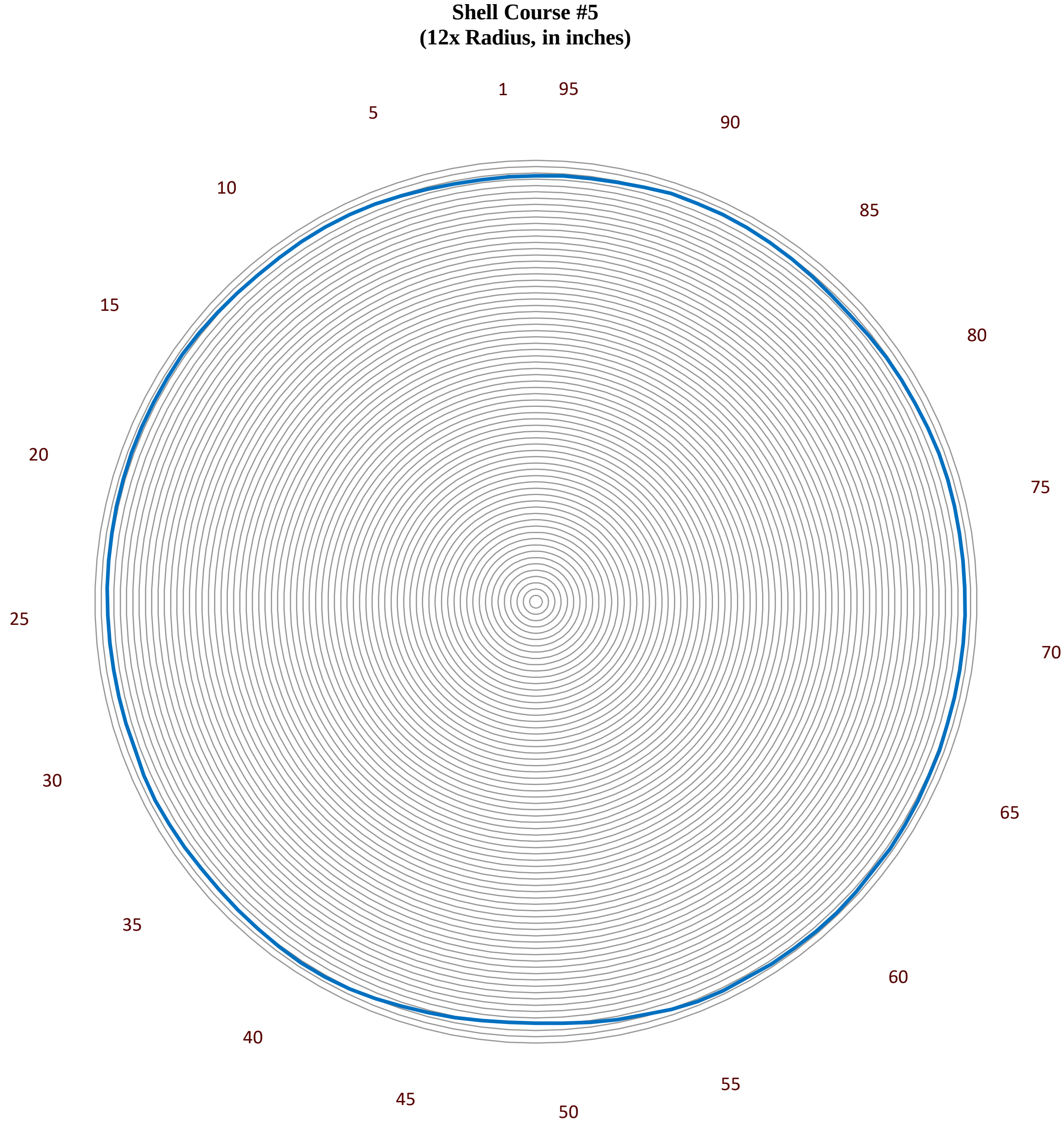
Shell Course #4
(12x Radius, in inches)



Note: Point #1 is above Shell Vertical Seam #1.

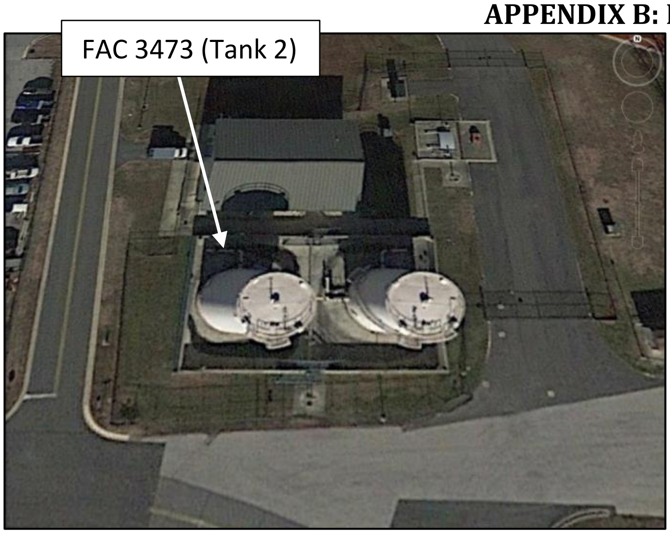
Shell Plumbness and Roundness Evaluation

(Shell Roundness Evaluation)



Note: Point #1 is above Shell Vertical Seam #1.

APPENDIX B: PHOTOGRAPHS



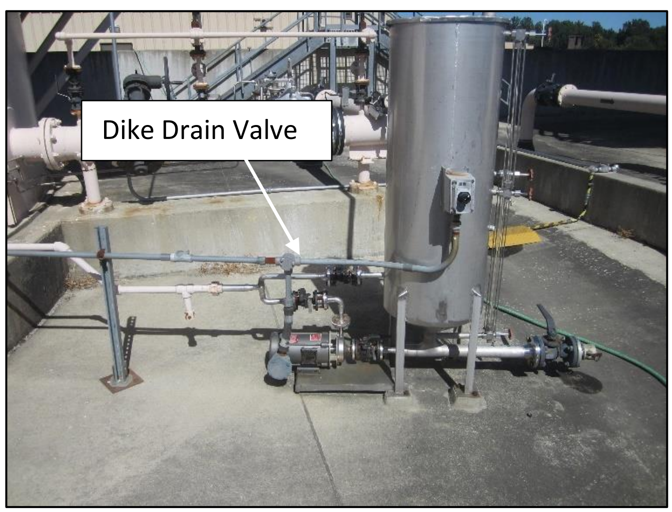
B.1: Google Earth View

B.2: View of Tank from the Northeast

B.3: View of Tank from the Southeast

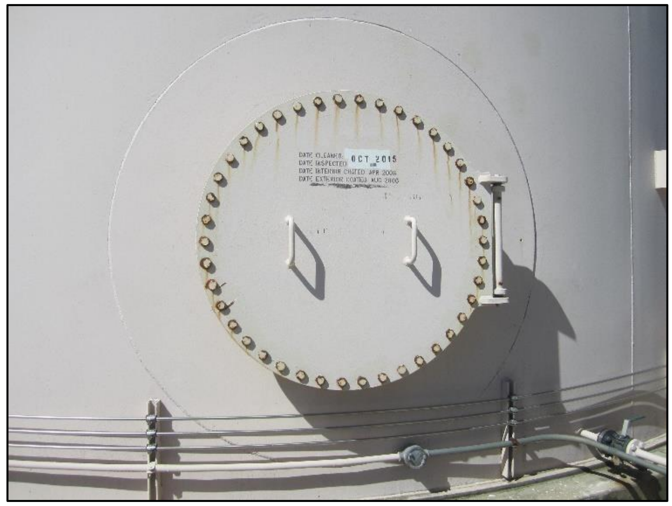
B.4: Issue Piping at top of Swale

B.5: Receipt Piping Over Swale and Near Drain

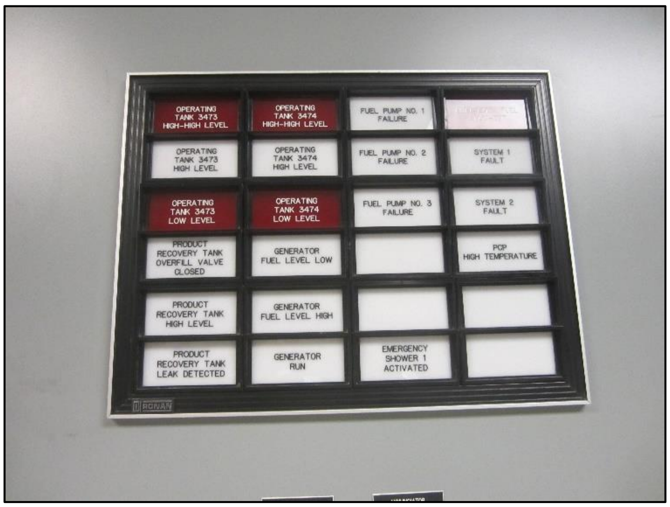


B.6: Product Saver Tank over Swale

B.7: Low Level Alarm and Leak Detection Well



B.8: Southeast Shell Manhole



B.9: Level Alarm Panel

B.10: Mold/Mildew Under Manhole Neck

B.11: High Level Alarms and Controls

B.12: Shell Overflow, Stairway Landing, and Alarms


B.13: Roof Center Vent and Scaffold Cable Support


B.14: Underside of Roof Center Vent


B.15: Roof Perimeter Vent Opening Frame Corrosion


B.16: Coating Failure on Roof at Roof Perimeter Vent


B.17: ATG/Water Bottom Sensor and Well


B.18: Receipt Diffuser