NFESC CONTRACT N47408-04-D-8503, DELIVERY ORDER 0031

TANK 2
ENGINEERING REVIEW AND SUITABILITY FOR SERVICE EVALUATION
API 653 OUT-OF-SERVICE TANK INSPECTION BY OTHERS

FISC PEARL HARBOR
RED HILL COMPLEX, HAWAII

Final Report October 2008

Prepared For:

Naval Facilities Engineering Command
Engineering Service Center
1100 23rd Avenue, Code 232
Port Hueneme, California 93043-4370

Presented By:

Shaw Environmental Inc.
590 Paiea Street
Honolulu, Hawaii 96819-1835

Prepared By:

ENTERPRISE ENGINEERING, INC.

Stephen J. DiGregorio, P.E.
Structural Engineer, API 653 Certificate No. 1113

Submitted By:

Stephen S. Brooks, P.E.
Principal, API 653 Certificate No. 17
2525 Gambell Street, Suite 200, Anchorage, AK 99503

EEI Project 08-4895

RED HILL TANK 2
FISC PEARL HARBOR, HAWAII

SUITABILITY FOR SERVICE EVALUATION
(API 653 TANK INSPECTION BY OTHERS)

ABSTRACT

The API 653 out-of-service inspection of Tank 2 at FISC Pearl Harbor, Red Hill was performed by Engineering & Inspections Hawaii, Inc. (E&I) during April 2008 under contract to Shaw. Non-destructive examination of Tank 2 was performed by TesTex. Enterprise Engineering, Inc. (EEI) has reviewed the documentation on Tank 2 prepared by E&I and TesTex and has prepared this engineering evaluation of Tank 2. The engineering evaluation was performed in accordance with the applicable sections of API Standard 653 Third Edition December 2001, Addendum 3 February 2008 and is solely based on the items presented in E&I's inspection report and follow-up correspondence and discussions. Information not presented by E&I, but possibly relevant to the integrity of the tank, has not been considered in this evaluation. This report only provides a review of relevant inspection findings by others, plus an evaluation of tank suitability for service completed by EEI, and should be read in conjunction with the formal report prepared by E&I. The E&I recommendations for repair prior to returning the tank to service are discussed herein as necessary from an engineering and repair requirements perspective.

Based on information presented in E&I's report and information provided by TesTex, our evaluation determined there are conditions that affect the hydraulic and structural integrity of Tank 2. Mandatory repairs are required prior to placing the tank back in-service.

EEI recommends the next API 653 out-of-service internal inspection be scheduled for no later than April 2028 (i.e. 20 years from the date of the inspection). The next out-of-service internal inspection should be performed sooner than April 2028 if a change in condition or a change in service occurs. EEI also recommends the condition of the interior coating be inspected and assessed at every fuel quality inspection.

In accordance with API Standard 653, this report satisfies the requirement for an out-of-service integrity evaluation and as such, must be kept permanently available for the life of the tank as a historical record for future reference.

STATE OF MAINE
STEPHEN DIGREGORIO
5224
10/13/08
LICENSED PROFESSIONAL ENGINEER

Stephen DiGregorio

I hereby acknowledge that being familiar with the provisions of API Standard 653, the engineering evaluation was performed in accordance with the provisions of API Standard 653 and good engineering practices, and with the exercise of usual and customary care.

This tank inspection determined that mandatory repairs are required. Based on the extent of the out-of-service inspection, Tank 2 is considered suitable for service after mandatory repairs are completed.

Stephen J. DiGregorio, P.E.
Chief Structural Engineer
ANSI/API 653 Aboveground Storage Tank Inspector No. 1113

TABLE OF CONTENTS

APPENDICES

RED HILL TANK 2
FISC PEARL HARBOR, HAWAII

ENGINEERING REVIEW AND SUITABILITY FOR SERVICE EVALUATION

SUMMARY

Enterprise Engineering, Inc. (EEI) performed an engineering review and suitability for service evaluation of Tank 2 based on the API 653 out-of-service inspection report prepared by Engineering & Inspections Hawaii, Inc (E&I) and follow-up correspondence and discussions. Additionally, EEI performed a visit to Tank 2 on June 17, 2008 to observe the condition of the joint between the barrel and upper dome, the joint between the barrel and lower dome, and conditions in the lower dome. The engineering evaluation was performed in accordance with the applicable sections of API Standard 653 Third Edition December 2001, Addendum 3 February 2008. API 653 has only limited application to this highly custom designed concrete tank with a steel liner.

This report provides an engineering review of the E&I report with additional suitability for service assessment comments as appropriate. Information not presented by E&I, but possibly relevant to the integrity of the tank, has not been considered in this evaluation.

REPAIR ITEMS

Repair Categories

The recommendations for repair were categorized by E&I based on paragraph 4.6.2.6 in the NFESC Statement of Work. The categorization is a practical time line basis, not necessarily considering whether a repair recommendation is considered a mandatory repair to meet the strict provisions of API 653, or a compelling recommendation based on life extension and preservation or military criteria.

Repairs - Standard of Care

All repairs shall strictly meet the requirements of API 650 and API 653 regarding material, welding procedures and qualification of welders, non destructive examination (NDE) of welding, and testing requirements.

Mandatory Repairs

Mandatory repairs are repairs that are required prior to placing the tank in service as either compelling under API 653, for hydraulic and structural integrity, or from a practical consideration as the only opportunity to complete the work is prior to filling the tank. The following repairs are listed in the E&I report as mandatory.

1. Tank Access Structure: Clean the additional structural members welded to the central tower and inspect by visual and magnetic particle inspection.

   EEI Comments:

   - No exception taken to E&I's recommendation.
   - Paragraph "Access Structure" of E&I's report states the welding to the central tower was noted to be covered by slag deposits and could not be inspected. EEI suggests the following clarification to E&I's recommendation: Remove slag deposits and inspect the welds of the additional structural members recommended by Hawaii Engineering Group.
   - As the internal tower and access walkway was inspected by Hawaii Engineering Group, EEI is excluding review and comment of their findings and recommendations from our review of Tank 2 inspection.

2. Internal Coating: Evaluate the Internal Coating by a certified NACE inspector.

   EEI Comments:

   - It is EEI's understanding that NFESC had a coating inspector inspect the interior coating; another inspection by a NACE coating inspector provided by Shaw is not be necessary.
   - As EEI has not received a copy of the NFESC coating inspection report, we can not make any comment regarding inspecting or repairing the interior coating.
   - During EEI's site visit to Tank 2 on June 17, 2008, EEI noted that the coating in the lower dome has failed. Coating failures are also present at spot locations on the barrel and to a lesser degree, on the upper dome.
   - Based on discussions with Shaw, the government has decided to re-coat the lower dome.

3. Steel Liner Repairs: E&I's report recommends repair of flaws in the steel liner plates and welds based on findings provided by TesTex.

   EEI Comments:

   - No exception taken to the list of liner repairs identified in E&I's report.
   - TesTex NDE data lists a 31" long x 18" high bulge in the barrel (flaw #44). The remaining wall thickness is reported as 0.230". This bulge is relatively small and does not require repair.
   - Repair the flaws listed in E&I's report. See the discussion that follows for EEI recommendations on repair requirements.
   - Before performing any repairs of the steel liner, EEI recommends a Marine Chemist evaluate conditions at the area of repair for hot work and prepare hot work

requirements. Past history on Red Hill has found some areas safe for hot work and some areas not safe unless special purging requirements are followed. EEI recommends the Marine Chemist prepare a series of procedures for conditions found.

Steel Liner Repair Requirements

1. Cracks in Welds
   - Remove cracks by grinding.
   - Perform magnetic particle or ultrasonic inspection to verify that the cracks have been removed.
   - Provide welds passes to restore the full thickness of the weld. Control heat input and rate of cooling to prevent new cracks from forming.
   - Perform magnetic particle or ultrasonic inspection of the completed repair. Inspect for cracks, lack of fusion, porosity, and slag inclusions. Repair all rejectable defects found.
   - NOTE: It may be necessary to weld a doubler plate over the repaired welds to reinforce the joint.
2. Incomplete Penetration in Welds
   - Remove lack of fusion by grinding.
   - Perform magnetic particle or ultrasonic inspection to verify that the lack of fusion has been removed.
   - Provide welds passes to restore the full thickness of the weld.
   - Perform magnetic particle or ultrasonic inspection of the completed repair. Inspect for cracks, lack of fusion, porosity, and slag inclusions. Repair all rejectable defects found.
3. Porosity in Welds
   - Remove porosity by grinding.
   - Perform magnetic particle or ultrasonic inspection to verify that the porosity has been removed.
   - Provide welds passes to restore the full thickness of the weld.
   - Perform magnetic particle or ultrasonic inspection of the completed repair. Inspect for cracks, lack of fusion, porosity, and slag inclusions. Repair all rejectable defects found.
4. Slag Inclusions
   - Remove slag inclusions by grinding.
   - Perform magnetic particle or ultrasonic inspection to verify that the slag inclusions have been removed.
   - Provide welds passes to restore the full thickness of the weld.
   - Perform magnetic particle or ultrasonic inspection of the completed repair. Inspect for cracks, lack of fusion, porosity, and slag inclusions. Repair all rejectable defects found.

5. Arc Strikes
   - Remove arc strikes by grinding.
   - Perform magnetic particle inspection to verify that the arc strike has been removed and that there are no cracks in the base metal.
   - Repair areas having a remaining metal thickness less than 0.200" by welding to restore the thickness of the liner plate.
   - Perform magnetic particle or ultrasonic inspection of the weld repair. Inspect for cracks, lack of fusion, porosity, and slag inclusions. Repair all rejectable defects found.
6. Backside Corrosion
   - Repair by welding a 1/4" thick patch plate over the area.
   - Perform magnetic particle inspection and vacuum box testing of the patch plate weld. Inspect for cracks, lack, of fusion, porosity, and leak indications. Repair all rejectable defects found.
7. Through Wall Hole
   - Repair by welding a 1/4" thick patch plate over the area.
   - Perform magnetic particle inspection and vacuum box testing of the patch plate weld. Inspect for cracks, lack, of fusion, porosity, and leak indications. Repair all rejectable defects found.

EEI Added Mandatory Repairs

1. Repair Topside Pitting in Floor of Lower Dome
   - TesTex's NDE report lists two locations of topside pitting in the floor of the lower dome (Flaws #82 and #83). The pitting is located in the 1/2" thick floor plate adjacent to the welded joint that joins the bottom course of the lower dome to the floor plate. As the pitting is close to the weld, EEI recommends the pitted areas be repaired by welding to fill the pits.
2. Repair Bulges in Lower Dome
   - TesTex's NDE report identifies a large bulge in plates 1 and 2 of the lower dome. EEI performed spot hammer testing of the bulges on June 17, 2008 and detected voids below the bulges.
   - EEI recommends voids behind the bulges be filled with grout.
3. Repair cracked welds of the sampling line penetrations in the welded plate on the end of the casing in the lower tunnel.
   - Lightly grind the welds to remove the cracks.

- Perform magnetic particle (MT) or liquid penetrant (PT) inspection of the areas to verify that the cracks have been removed.
- Repair the areas by welding additional passes.
- Perform magnetic particle (MT) or liquid penetrant (PT) inspection of the weld repairs. Inspect for cracks, lack of fusion, porosity, and other detectable leak paths.

Near Future Recommended Repairs (Non-Mandatory)

Near future recommended repairs are repairs not mandatory per API 653 or for structural and hydraulic integrity of the tank but should be performed if approved by the government in conjunction with the mandatory repairs, or within a 2-3 year period to preserve the integrity of the tank.

1. The E&I report does not list any recommended near future repairs.

   EEI Comment: No exception taken.

Recommended Repairs for Long Term Serviceability

Long term repairs are repairs that are not critical to the hydraulic and structural integrity of the tank and are not required prior to placing Tank 2 in service. Long term repairs consist of items that should be deferred to the next out of service inspection cycle.

1. Program the tank for the next out-of-service inspection in 20 years (April 2028).

ADDITIONAL COMMENTS AND RECOMMENDATIONS

Inspection of Steel Liner Plates

Per EEI discussions with TesTex not all areas of the steel liner plates could be inspected by L.F.E.T. (Low Frequency Electromagnetic Technique). TesTex reported that courses D, E, and F of the upper dome were not tested with L.F.E.T. due to accessibility issues. Per TesTex, courses D and E were 100% inspected using a specially designed UT shoe which traversed the entire surface of the plates. Course F is the top of the upper dome and is located directly above the central tower. Ultrasonic testing was performed on course F as far as could be reached from the penthouse platform.

EEI Comment: No exception taken to the extent of inspection performed.

Inspection of Steel Liner Welds

Per EEI discussions with TesTex the welds in the floor, lower dome, and barrel were inspected using Balanced Field Electromagnetic Technique (B.F.E.T.). TesTex's NDE report lists several locations of intermittent cracks in the welds of the lower dome. Per EEI discussion with TesTex, the cracks appear to be from a combination of overstressing and corrosion, since they originate in the center of the welds. E&I has recommended that the cracks be repaired.

EEI Comments:

- Cracks in welded joints are a concern as they are located on the in the lower dome which is subject to high fluid pressure.
- EEI concurs that the cracked welds be repaired. The method of repairing the cracks must be carefully considered to prevent new cracks from forming. Refer discussion on Steel Liner Repair Requirements for EEI recommendations on repairing cracked welds.

Existing Lap Welded Patch Plates

E&I's report states there are numerous lap-welded patch plates throughout the entire tank and that patch plates were noted that do not have radius corners and are smaller than the 6-inch minimum size required by API 653. Per EEI discussions with TesTex, UT readings were taken on all patch plates. Additionally TesTex reported that all patch plate welds were inspected by L.F.E.T.

EEI Comments:

- No exception taken to the extent of inspection performed.
- As TesTex did not report any flaws in the patch plates welds, no repairs are required.
- Patch plates having non-radius corners and patch plates smaller than 6-inch minimum size required by API 653 do not need to be replaced with new patch plates.

Channels in the Upper Dome

The upper dome has channels covering the original welds. TesTex's NDE report stated that spot ultrasonic testing was performed at 6" intervals on the channels; the welds attaching the channels to the upper dome, however, were not inspected. As the welds attaching the channels to the dome are a potential leak path, EEI recommended these welds be inspected for detectable leak paths (i.e. cracks, lack of fusion, and porosity). See "Addendum to TesTex Inspection" for additional discussion.

Barrel to Upper Dome Junction

EEI observed the condition of the barrel to upper dome joint during a site visit on June 17, 2008. The joint is an expansion joint as shown on record drawings of the Red Hill tanks. The expansion joint consists of two 1/4" thick horizontal plates (one on top of the other) that project into the tank. The top plate is welded to the upper dome and lower plate is welded to the barrel. The plates are welded to each other with plug welds at 24" on center and a fillet weld along the inner edge to form a hinge. EEI's observations found no indication of distortion, overstress, or movement.

Per EEI discussions with TesTex, the weld attaching the top plate to the upper dome and the weld attaching the lower plate to the barrel was inspected with B.F.E.T. The plates, plug welds, and fillet weld along the edge of the plates were not inspected. As the expansion joint plates, plug welds, and fillet weld are a potential leak path, EEI recommended the plates of the expansion joint including the plug welds joining the plates and fillet weld along the edge (hinge side) of the joint be inspected as these areas are a potential leak path. EEI recommended the plates be inspected for metal loss and areas having a remaining thickness less than 0.170" be repaired. EEI also recommended the plug welds and the fillet welds be inspected for cracks, lack of fusion, and porosity. See "Addendum to TesTex Inspection for additional discussion.

Addendum to TesTex Inspection

An addendum dated September 24, 2008 to TesTex's inspection states that inspection of Tank 2 resumed on September 8, 2008 to inspect the welds of the channels in the upper dome, the barrel / upper dome expansion joint, and the plates in the top course (course F) of the upper dome. The addendum states all of the channels in the upper dome and welds of the barrel / upper dome were inspected. TesTex reported the following findings:

- No reportable defects were found in the channel welds.
- No reportable defects were found in the welds of the barrel / upper dome expansion joint.
- Two defects in Upper Dome Course F: A 0.500" diameter through wall hole in plate 12 (32" from the manhole) and a dent in plate 21 (5 feet from the manhole).

EEI Comments and Recommendations

- Channels in the Upper Dome: As the inspection found no reportable defects in the welds, no repairs are required.
- Barrel / Upper Dome Expansion Joint: As the inspection found no reportable defects in the welds, no repairs are required. TesTex's addendum, however, makes no mention of the condition of the plates of the expansion joint. EEI's visual observation of the upper and lower plates of the expansion joint on June 17, 2008 found no indication of distortion, overstress, or movement.
- Upper Dome Course F: Repair the hole in upper dome plate 12 by welding a patch plate over the hole. Refer to "Steel Liner Repair Requirements" item 7 for requirements for repair of through wall holes. The dent in upper dome plate 21 does not need to be repaired.

Barrel to Lower Dome Junction

Per EEI discussions with TesTex, the welds of the joint were inspected with B.F.E.T.

EEI Comments:

- No exceptions taken.
- EEI observed the condition of the barrel to lower dome joint during a site visit on June 17, 2008. The joint consists of a 1/2" thick horizontal plate between the barrel and lower dome as shown on record drawings of the Red Hill tanks. EEI's observations found no indication of distortion, overstress, or movement.

Existing Grout Ports

Per EEI discussions with TesTex all grout ports were previously removed from Tank 2 and the openings in the liner have been closed with cover plates. TesTex reported that all cover plates were inspected by UT.

EEI Comment: No exceptions taken.

Piping Penetrations in Liner Plates

Per EEI discussions with TesTex, the welds in the floor of the lower dome around piping penetrations and reinforcing plate welds were tested by B.F.E.T.

EEI Comment: No exceptions taken.

Interior Coatings

Coating repairs and coating repair systems are being address by others.

Hydrostatic Testing of Tank 2 Piping

Information provided by Shaw (and included in E&I's inspection report) indicate the following piping was hydrotested: sampling lines (4 total), 6" slop line, 16" fuel line, and 20" fuel line (32" inside the tank). The hydrotest records state the piping was hydrotested at 150 psig for 4 hours and observed for leaks. The hydrotest records indicate that the 6" slop line failed the hydrotest; the sampling lines, 16" fuel pipe and 20" fuel pipe passed hydrostatic testing. Per discussions with Shaw, the 6" slop line will be repaired using a repair that was approved by NAVFAC for other Red Hill tanks by inserting a stainless steel flexible braided hose into the slop line.

The four sampling lines enter the tank through an old steam line (referred to as "casing" in the hydrotest record). The casing is located in the lower tunnel and extends in into the tank. The end of the casing in the lower tunnel is sealed with a blind flange. A plate is welded to the blind flange and the sampling lines enter the casing through the welded plate and blind flange. Hydrotest records indicate the casing was hydrotested and passed the hydrotest. The hydrotest record also indicates "slight" cracks were detected in the welds of the sampling line penetrations in the welded plate on the blind flange at the end of the casing in the lower tunnel.

EEI Comments:

- Shaw reported that the hydrotests were conducted in accordance Shaw's Work Plan, performed by Dunkin & Bush, and certified and monitored under NFESC, FISC, and Shaw. E&I was not present during the hydrotest procedure.
- EEI's review of the hydrotest records of the sample line found the pressure dropped 14 psi in the 200 ft long sample line, 10 psi in the 70 ft long sample line, and 3.5 psi in the 10 ft sample line. The hydrotest records indicate the drop in pressure was due to a leak through a ball valve at the sample stations and that the cause of the pressure drop was confirmed by manually releasing test water from the sample lines and measuring the amount of liquid captured and pressure drop. EEI has no exceptions taken to the results of the hydrotest.
- EEI recommends the cracked welds of the sampling line penetrations in the welded plate of the casing be repaired.

SUITABILITY FOR SERVICE EVALUATION

Hydraulic and Structural Integrity

The following table provides an assessment of the hydraulic and structural integrity of Tank 2 based on the E&I inspection data provided to EEI for review and assessment.

HYDRAULIC AND STRUCTURAL INTEGRITY		
Evaluation Item	**Findings**	**Comment**
Lower Dome	Intermittent cracks are present in the lower dome welds. The cracks are predominantly located in the weld junction between the plates of the lower dome and the floor plate. E&I's inspection report also lists other flaws in the lower dome that require repair.	Repair the cracked welds in lower dome. Repair flaws in the lower dome listed in E&I's inspection report. Repair bulges in plates 1 and 2 of the lower dome.
Barrel/Lower Dome Junction	TesTex's inspection found no defects in the welds. EEI's observations found no indication of distortion, overstress, or movement.	No concerns noted.
Barrel	E&I's inspection report lists flaws in the barrel that require repair.	Repair flaws in the barrel listed in E&I's inspection report.
Barrel/Upper Dome Junction	The barrel to upper dome joint is an expansion joint as shown on record drawings of the Red Hill tanks. EEI's observations found no indication of distortion, overstress, or movement. Inspection of the plug welds and fillet welds of the expansion joint found no reportable defects.	No concerns noted
Upper Dome	The upper dome has channels covering the original welds. Inspection of the welds attaching the channels to the dome found no reportable defects. Inspection of course F found a through-hole in plate 12 and a dent in plate 21.	Repair the hole in plate 12.
Hydrostatic Test of Piping	Hydrotest records indicate that the 6" slop line failed the hydrotest; the sampling lines, 16" fuel pipe, 20" fuel pipe, and casing containing the sample lines passed hydrostatic testing. Hydrotest records indicates "slight" cracks were detected in the welds of the sampling line penetrations in the welded plate on the blind flange at the end of the casing in the lower tunnel.	No exceptions taken to the results of the hydrotests. Provide repair of the 6" slop line. Repair cracked welds of the sampling line penetrations in the welded plate of the casing.

STEEL LINER PLATE MINIMUM THICKNESS ASSESSMENT

EEI performed a calculation of corrosion rate and the minimum required thickness of the 1/4" thick steel liner plates. This minimum thickness served as the criteria for determining the need to repair thin areas and pits in the steel liner plates for another 20-year interval until the next inspection.

EEI recommended a Tmin = 0.170" be used as the criteria for determining whether thin and pitted areas in the 1/4-inch thick steel liner plates in the upper dome, barrel, and lower dome require repair. This recommendation was reviewed and accepted by the government. The calculation of corrosion rate and Tmin = 0.170" is based on the following:

- Year Tank Constructed: 1942
- Original Thickness of Liner Plates: 0.250"
- Age of tank in 2028 = 2028 - 1942 = 86 years
- Remaining Thickness at the Next Inspection: 0.10" based on the tank having no means to contain a leak
- Interval until the Next Inspection: 20 years maximum

Corrosion Rate and Minimum Thickness Discussion

It is not possible calculate an actual corrosion rate for the Red Hill Tanks because the time interval during which corrosion occurred is unknown and can not be determined. Depending on the time interval that is assumed, the corrosion rate can be higher or lower compared to the actual corrosion rate. It is possible that conditions causing external corrosion can change over time. Additionally, the rock stratum surrounding the Red Hill tanks varies in type and porosity, thus the water content and corrosivity of the rock can vary from one location to another. Because of these highly variable conditions, selecting areas of the steel liner and measuring the remaining thickness to determine actual corrosion rates would not necessarily be representative of external corrosion conditions throughout the tank. It is possible that more severe corrosion could exist at areas that are not measured.

For a 20-year service interval starting in 2008, the next inspection would be in 2028. Using the API 653 straight-line method of calculating corrosion rates and a 0.10" remaining thickness at the next inspection in 2028, the external corrosion rate is calculated as follows:

> Maximum permissible metal loss = 0.250" – 0.10" = 0.150"
> Age of tank in 2028 = 2028 - 1942 = 86 years
>
> Considering the 0.150" of metal loss occurs over the life of the tank, the hypothetical external corrosion rate is: 0.150" / 86 years = 0.001744 in / year

EEI's calculation of the external corrosion rate follows the procedure outlined in API 653 section 4.4.5, which assumes a linear (i.e. constant) corrosion rate based on the age of the tank. The external corrosion rate was calculated based on the age of the tank in 20-years (i.e. 86 years old in 2028). EEI acknowledges that this calculated corrosion rate is not based on thickness data of the steel liner plates; however as stated above, selecting areas of the steel liner and measuring the remaining thickness to determine actual corrosion rates would not necessarily be representative of external corrosion conditions throughout the tank.

Following the guidance of API 570 which uses 2 times the corrosion rate to determine the interval until the next inspection, 2 times the corrosion rate results in a Tmin = 0.170 inches as follows:

Two times corrosion rate = (2) (0.001744 in / yr) = 0.003488 in /yr

A two times the corrosion rate, the metal loss that is expected to occur during the next 20 years = (0.003488 in / year) (20 years) = 0.070"

The minimum thickness required in 2008 to have 0.1" remaining thickness in 2028 at twice the corrosion rate of 0.001744 in / yr is:

Tmin = 0.070" + 0.100" = 0.170"

CONCLUSIONS

Based upon our evaluation of the inspection results presented by E&I and inspection addendum provided by TesTex, Tank 2 is considered suitable for service after mandatory repairs are completed.

APPENDIX A

STEEL LINER PLATE THICKNESS ASSESSMENT

Stephen J. DiGregorio

From: Stephen J. DiGregorio [sjd@eeiteam.com]

Sent: Tuesday, April 22, 2008 8:06 PM

To: Wilfred Chun

Cc: 'Weese, Todd'; 'Dygart, Aaron'; 'Phillips, David'; Steve Brooks; Stacy Kaplan-McMillan

Subject: Red Hill Tank 2 and 20 Tmin Calculation

Wilfred,

My responses to Incheol's comments are provided below. Due to the uncertainty in calculating corrosion rates, applying a factor of safety to Tmin has merit. You will see in the calculations and recommendations that follow, I have recommended a revised Tmin = 0.170 inches. I will revise EEI's formal Steel Liner Plate Minimum Thickness Assessment to reflect the new Tmin calculations and recommendations.

EEI Response to Comments

1. It is not possible calculate an actual corrosion rate for the Red Hill Tanks because the time interval during which corrosion occurred is unknown and can not be determined. Depending on the time interval that is assumed, the corrosion rate can be higher or lower compared to the actual corrosion rate. Additionally, it is possible that conditions causing external corrosion can change over time. Available record drawings indicate the rock face of the barrel of the tanks is lined with gunite and coated with either asphalt paint or "red dirt" paint; and that the space between the gunite lining and the steel liner plates is filled with reinforced concrete. It is known that cracks or other conditions have developed in the gunite or reinforced concrete allowing water to migrate to the steel liner plates and corrode steel liner plates that previously had no indication of external corrosion. This has been going on probably for the entire life of the tank, so it is not new.
2. The rock stratum surrounding the Red Hill tanks varies in type and porosity, thus the water content and corrosivity of the rock can vary from one location to another. Because of these highly variable conditions, selecting areas of the steel liner and measuring the remaining thickness to determine actual corrosion rates would not necessarily be representative of external corrosion conditions throughout the tank. It is possible that more severe corrosion could exist at areas that are not measured.
3. EEI's calculation of the external corrosion rate (0.001744 inches per year) and Tmin =0.140 inches follows the procedure outlined in API 653 section 4.4.7.1, which assumes a linear (i.e. constant) corrosion rate based on the age of the tank. For Tanks 2 and 20, the external corrosion rate was calculated based on the age of the tank in 20-years (i.e. 86 years old in 2028). EEI acknowledges that this calculated corrosion rate is not based on thickness data of the steel liner plates; however as stated above, selecting areas of the steel liner and measuring the remaining thickness to determine actual corrosion rates would not necessarily be representative of external corrosion conditions throughout the tank. On the other hand, there may not be any location on the tank that would have a more aggressive corrosion rate than that determined by our method of calculation, unless there has been a drastic change in conditions. Should areas be present that have a higher corrosion rate than our calculated corrosion rate, the remaining thickness will have a Tmin less than 0.140 inches and would be repaired.
4. EEI has not established a 20-year interval until the next inspection. A 20-year interval was used to calculate Tmin. A shorter interval until the next inspection could be used.

Summary and Conclusions

1. It is not possible calculate an actual corrosion rate for the Red Hill Tanks because the time interval during which corrosion occurred is unknown and can not be determined.
2. Selecting areas of the steel liner and measuring the remaining thickness to determine actual corrosion rates would not necessarily be representative of external corrosion conditions throughout the tank because the rock stratum surrounding the Red Hill tanks varies in type and porosity.
3. EEI's calculated Tmin = 0.140 inches is based on the age of the tank in 20-years (i.e. 86 years old in 2028). As stated in EEI's Steel Liner Plate Thickness Assessment, a Tmin = 0.140 inches has no safety factor. If a more conservative approach is desired, a shorter interval until the next inspection (i.e. 10 years) or Tmin based on higher external corrosion rate or both could be used. Given the uncertainty in calculating a

corrosion rate, using factor of safety for Tmin has merit.

Recommendations

1. As it is not possible to establish actual corrosion rates, a factory of safety applied to the previously recommended Tmin = 0.140 inches may have merit. Considering the guidance of API 570, which uses twice the corrosion rate in any remaining life, or pressure capability calculations, the new Tmin, at twice the corrosion rate, would be 0.170 inches. This new Tmin takes into consideration the uncertainty of calculating a corrosion rate and the potential for internal corrosion given the reported condition of the interior coating.
2. EEI, therefore recommends Tmin = 0.170" be used as the criteria for determining whether thin and pitted areas in the 1/4-inch thick steel liner plates in the, barrel, and lower dome require repair.
3. Tmin = 0.170 inches does not apply to the 1/2-inch thick floor (base plate) of the lower dome.
4. As the steel liner plates are not structural elements and should not be relied upon as a structural element to resist hoop and tensile stresses in the barrel and lower dome or compressive stress in the upper dome, consult EEI when voids are found behind liner plates.

Revised Tmin Calculations

Following the guidance of API 570 which uses twice the corrosion rate in any remaining life, or pressure capability calculations, a revised corrosion rate and Tmin is calculated as follows:

Parameters

- Original Thickness of Liner Plates: 0.250"
- Remaining Thickness at the Next Inspection: 0.10" based on the tank having no means to contain a leak
- Interval until the Next Inspection: 20 years maximum
- Year Tank Constructed: 1942

Revised Corrosion Rate and Minimum Thickness

For a 20-year service interval starting in 2008, the next inspection would be in 2028. Using the API 653 straight-line method of calculating corrosion rates and a 0.10" remaining thickness at the next inspection in 2028, the external corrosion rate is as follows:

Maximum permissible metal loss = 0.250" – 0.10" = 0.150"
Age of tank in 2028 = 2028 - 1942 = 86 years

Considering the 0.150" of metal loss occurs over the life of the tank, the external corrosion rate is:

External corrosion rate = 0.150" / 86 years = 0.001744 in / year

Following the guidance of API 570, using 2 times the corrosion rate results in a Tmin = 0.170 inches as follows:

Two times corrosion rate = (2) (0.001744 in / yr) = 0.003488 in /yr

A two times the corrosion rate, the metal loss that is expected to occur during the next 20 years is:

Metal loss during next 20 years = (0.003488 in / year) (20 years) = 0.0.70"

The minimum thickness required in 2008 to have 0.1" remaining thickness in 2028 at twice the corrosion rate of 0.001744 in / yr is:

Tmin = 0.070" + 0.100" = 0.170"

Steve

Stephen J. DiGregorio, P.E.
Chief Civil / Structural Engineer
Enterprise Engineering, Inc.
5 Depot Street
Freeport, ME 04032
TEL: (207) 869-8006

ENTERPRISE ENGINEERING, INC.

RED HILL TANKS 2 AND 20
FISC PEARL HARBOR, HAWAII

Steel Liner Plate Minimum Thickness Assessment
April 15, 2008

EEI Project No. 08-4895

GENERAL

Shaw is providing cleaning, inspection, and repair services for Tanks 2 and 20 at FISC Pearl Harbor Red Hill, Hawaii. Shaw has requested Enterprise Engineering, Inc. (EEI) calculate corrosion rates and the minimum thickness of the steel liner plates which will be used as the criteria for determining the need for repair based on a 20-year interval until the next inspection.

Record drawings of the Red Hill tanks indicate the steel liner plates in the upper dome, barrel, and lower dome in all of the tanks are 1/4" thick plate nominal. The floor (referred to as "base plate" on record drawings) of the lower dome in all of the tanks is indicated as 1/2" thick plate. This document prepared by EEI provides a calculation of corrosion rates and minimum required thickness of the 1/4" thick steel liner plates. This minimum thickness will serve as the criteria for determining the need to repair thin areas and pits for another 20-year interval until the next inspection.

RECOMMENDED REPAIR CRITERIA: STEEL LINER MINIMUM THICKNESS

It is reported that a Tmin of 0.19 inches was used on previous projects at Red Hill. EEI is not able to determine how this value was established. EEI recommends the following:

1. A minimum thickness (Tmin) of 0.140 inches be used as the criteria for determining whether thin and pitted areas in the 1/4-inch thick steel liner plates in the, barrel, and lower dome require repair. The upper dome area, with increased potential for atmospheric corrosion on the inside, can also use this Tmin criteria of 0.140 inches if it is determined the coating system is sound, there is no present internal corrosion, and the coating system has a remaining life of 20 years. Note: the Tmin value of 0.140 inches does not include any safety factor that the thickness of the steel liner plates will not be less than a minimum thickness of 0.10 inches at the end of another 20-year service interval. The justification for not using a safety factor is:

   a. API 653 does not use a safety factor.

   b. Tmin is based on a constant rate of corrosion (i.e. corrosion is assumed to not vary over time). Using a constant rate of corrosion is in accordance with API 653 and is considered conservative in that corrosion rates generally decrease over time unless conditions change.

c. A safety factor could be added to Tmin; however, this will involve more repairs and is not justified unless desired by the government or conditions are found indicating corrosion rates are higher than calculated.

2. Repair thin and pitted areas in the 1/4-inch thick steel liner plates in the upper dome, barrel, and lower dome having a minimum thickness (Tmin) less than 0.140 inches. Areas having Tmin equal to or greater than 0.140 inches do not require repair for a 20-year interval until the next inspection.

3. Tmin = 0.140 inches does not apply to the floor (base plate) of the lower dome.

4. EEI also calculated Tmin for a 10-year interval until the next inspection and determined Tmin in this case would be 0.120 inches. EEI can evaluate this alternative if desired.

5. Using Tmin = 0.140 inches as determined for 20-year interval until the next inspection and applying this criteria for a 10-year interval is an option as it is conservative and provides a factor of safety.

COMMENTS AND CLARIFICATIONS

EEI's calculation of Tmin is based on the following:

1. A 20-year interval until the next inspection in 2028 as indicated in Shaw's Work Plan.

2. An original plate thickness of 0.250 inches. Our calculation of Tmin does not take into account the original thickness of the plates may be thinner due to plate fabrication tolerances or other conditions. EEI recommends Shaw's inspector obtain ultrasonic thickness measurements of each plate (6 measurements minimum per plate). Submit for EEI review and assessment thickness measurements of plates having an average thickness less than 0.240". The 0.240 thickness is the ASTM A 6/A6M minimum thickness tolerance for 1/4-inch thick plates.

3. The rate of external corrosion was calculated using the API 653 straight line method and assuming metal loss occurring over the life of the tank (86 years) from tank construction in 1942 to the next inspection in 2028. The calculated rate of external corrosion does not take into consideration potential areas of concentrated corrosion caused by artifacts, welding rods, debris, rocks, microbial induced corrosion (MIC) in the form of small "worm-like" corrosion trails, or other conditions on the exterior of the liner plates the would cause concentrated corrosion. If these conditions are found, contact EEI for interpretation.

4. The rate of external corrosion and Tmin does not apply to the heat-affect zone of liner plates adjacent to welds (within 1 inch of the weld). As the corrosion rate in the heat-affected zone can be higher than areas outside the heat-affected zone, a higher Tmin value may be needed for the heat-affected zone. Information on plate thickness in the heat affected zone is needed to determine corrosion rates and Tmin of the heat affected zones of the steel liner plates. EEI

recommends Shaw's inspector obtain ultrasonic thickness measurements in the heat-affected zone in random areas in each quadrant of the upper dome, barrel, and lower dome for EEI assessment. Given the large quantity of welds in the liner plate joints, EEI recommends 20 UT thickness measurements be obtained in the heat-affected zones in each quadrant. Additional UT measurements may necessary if results are not consistent. Additionally, EEI recommends that we be notified when the remaining thickness in the heat-affected zone is less than 0.200 inches as additional assessment may be necessary.

5. The corrosion rate of product side corrosion is assumed to be 0.00 inches per year. This assumption is only valid if the existing interior coating is in serviceable condition and its service life is equal to or greater than the 20-year interval until the next inspection. If the interior coating is not expected to last another 20 years, product side corrosion may occur and thus the Tmin will need to be recalculated and increased. It should be noted that product side corrosion is not of concern when the tank is filled as areas are covered by product except at a water bottom in the lower dome. The 0.00 inches per year product side corrosion rate also does not take into consideration potential atmospheric corrosion of the steel liner plates if the coating is failing and not repaired and liner plates are exposed to atmosphere. Additional information is needed on the condition of the interior coating and whether atmospheric corrosion is present. This additional information may result in a greater Tmin of the upper dome, where atmospheric corrosion, and or degraded coatings is present.

6. A minimum thickness of 0.10 inches at the next inspection is used in the calculation of Tmin. A 0.10 inch minimum thickness is used as the steel liner plates are a hydraulic barrier and are not relied upon as a structural element to resist hoop and tensile stresses in the barrel and lower dome or compressive stress in the upper dome. The 0.10-inch criteria is similar to API 653 criteria for tank floors that have no means for containment of a leak.

7. As the steel liner plates are not structural elements and should not be relied upon as a structural element to resist hoop and tensile stresses in the barrel and lower dome or compressive stress in the upper dome, consult EEI when voids are found behind liner plates.

8. Our calculation of Tmin does not include any safety factor. A safety factor could be added to Tmin; however, this will involve more repairs and is not justified unless desired by the government or conditions are found indicating corrosion rates are higher than calculated.

9. Consult EEI when areas of thinning or pitting are found that exceed 12" in diameter.

CALCULATIONS

Parameters

- Original Thickness of Liner Plates: 0.250”
- Remaining Thickness at the Next Inspection: 0.10” based on the tank having no means to contain a leak
- Interval until the Next Inspection: 20 years maximum
- Year Tank Constructed: 1942
- Product Side Corrosion Rate: Assumed to be 0.00” per year based on the tank interior being coated and the life of the coating expected to exceed the interval until the next inspection

Corrosion Rate and Minimum Thickness

For a 20-year service interval starting in 2008, the next inspection would be in 2028. Using the API 653 straight-line method of calculating corrosion rates and a 0.10” remaining thickness at the next inspection in 2028, the external corrosion rate is as follows:

Maximum permissible metal loss = 0.250” – 0.10” = 0.150”
Age of tank in 2028 = 2028 - 1942 = 86 years

Considering the 0.150” of metal loss occurs over the life of the tank, the external corrosion rate is:

External corrosion rate = 0.150” / 86 years = 0.001744 in / year

Using this external corrosion rate, the expected metal loss that would have occurred thus far, (1942 to 2008) is:

Number of years from 1942 to 2008 = 66 years
Metal loss over 66 years = (0.001744 in / year) (66 years) = 0.115”

The minimum thickness required in 2008 to have 0.1” remaining thickness in 2028 at a corrosion rate of 0.001744 in / year is:

Tmin = 0.250” – 0.115” = 0.135”

Thus if Tmin = 0.135” in 2008; using an external corrosion rate of 0.001744” / year, the remaining thickness in 20 years (2028) is:

Metal loss occurring over the next 20 years = (0.001744” / yr) (20 years) = 0.035”
Remaining thickness at the end of the next 20 years = 0.135” – 0.035” = 0.10”
Use Tmin = 0.140” (0.135” rounded to 0.140”)

Prepared by:
//signed/
Stephen J. DiGregorio, P.E.
Chief Structural Engineer
ANSI/API 653 Certified Aboveground Tank Inspector, Certificate No. 1113

Quality • Integrity • Reliability

E&I ENGINEERING & INSPECTIONS HAWAII. INC.

May 30, 2008
Revised; September 29, 2008

Mr. Wilfred Chun P.E.
Shaw Environmental, Inc.
590-B Paiea St.
Honolulu, HI 96819

Subject: Tank No. 2 Red Hill Fuel Facility

SYNOPSIS

During April 2008, Engineering & Inspections Hawaii, Inc. performed a modified Out-of Service inspection on Tank **2** at the Red Hill fuel storage facility. This inspection was performed in accordance with the Clients requirements and the latest edition of API Standard 653, Tank Inspection, Repair, Alteration, and Reconstruction by a certified API 653 inspector. All personnel performing nondestructive examinations are certified to at least SNT-TC-1A level II.
Red Hill tanks are a design engineered underground storage tank and therefore do not fall under the requirements of API-653. The API-653 document was utilized as a guide for the evaluation of findings and recommendation of repairs, where necessary, during this inspection.

Tank Data

Tank No. 2
Year Built: 1942 - 1943
Design: Engineered Underground Storage Tank
Constructed: Morrison Knudsen
Product: JP-8
Capacity: 302,000 Bbls.
Size 100' Dia. x 250' High

P. O. Box 700217 • Kapolei, HI 96709-0217 • Tel: (808) 682-1667 • Fax: (808) 682-1834 • E-Mail: E I Hawaii@aol.com

Background

Tank 2 is located at the Red Hill fuel storage facility located underground in a ridgeline between Halawa Valley and Moanalua Valley.
Tank 2 was built in 1942 (completed in 1943). Its nominal capacity is 302,000 barrels. The tank, like the others in Red Hill, is a concrete tank with a steel liner. The configuration is a vertical cylinder measuring 100 feet in diameter and 250 feet in height. The tank is domed on the lower and upper ends. The primary access point to the tank is from the upper tunnel which is at the 200 foot level of the tank. The tank has a center tower extending from the top to the bottom that is connected to the access point by a catwalk.

Surrounding Area:

Red Hill Facility is located completely underground

Foundation:

Engineered high pressure grouting with steel liner underground storage tank.

Access Structure

The tank internal is accessed by an upper manway with a catwalk to a central structural tower which extends from the tank bottom to the tank top. This access structure contains two boom lifts and an air operated central lift for inspecting the internal of the tank. The structure was inspected by Hawaii Engineering Group, Inc., Certified structural engineers. Recommendations, based on their findings, to repair or replace hardware was performed by contractor Dunkin and Bush as safety precautions prior to the inspection of this tank.
Welding to the central tower was completed by a certified welder, however the welds were noted to be covered by slag deposits from the welding process limiting any post inspection of these welds.

Tank Internal

100% of the tank internal was inspected by the L.F.E.T (Low Frequency Electromagnetic Technique) by contractor TesTex Inc. Anomalies in the liner plate were identified by TesTex, Inc. and further evaluated as necessary. All areas below the nominal .250" for the liner plate were identified and mapped on TesTex reports, contained in the appendices of this report. Areas that were identified at or below .170" were evaluated and will be required to be repaired. Enterprise Engineering Inc. was contracted for calculating a T-min thickness threshold of which repairs would be required.

Numerous lap welded patches were noted throughout the entire tank.

Due to this being the first known out-of-service inspection of tank number 2, no known history exists as to the reason for these patches. The patches vary in size and shape with numerous patches noted not to meet the requirements of API-653. Patches were noted with non-radius corners and smaller than the minimum required six inch circular dimension.

Coating

The tank has numerous areas of coating failure. The area referenced as the tank lower dome has approximately 90% coating failure with exposure of the tank steel liner. The area known as the tank Barrel section was noted to have large areas of coating failure covering several square feet. The tank upper dome was noted to have the best areas of coating with only minimal failure.

Hydrostatic Testing of Piping

Contractors Dunkin & Bush and Shaw Environmental Inc. performed the hydrostatic testing of the tank piping as defined in the work plan. Engineering and Inspection, Inc. did not witness these test but did review the final test data. Based on the information supplied, the following lines were tested with the results listed below; Copies of the data reports are included in the appendices of this report.

16" Pipeline	Acceptable
20" Pipeline	Acceptable
6" Slop line	Failed
10' Sample Line	Acceptable
70' Sample Line	Acceptable
135' Sample Line	Acceptable
200' Sample Line	Acceptable.

Settlement Survey

This is an underground storage tank; settlement surveys could not be performed.

Recommendations

Mandatory Repairs:

Repairs that affect the overall operability and integrity of the tank; and must be performed in the immediate near future.

1. Clean by mechanical means the additional structural members welded to the central tower as recommended in the Hawaii Engineering Group, Inc. report and inspect by visual and magnetic particle inspection methods.
2. Evaluate the internal coating system by a certified NACE Inspector.

Mandatory Repairs (Cont'd):

Based on the inspection findings provided by TesTex, Inc. and as referenced by the TesTex, Inc. Flaw Log for Tank No. 2. And further defined by remaining T-min thickness calculations as provided by Enterprise Engineering, Inc.

Flaw #2A&B	Cracks in weld; Lower Dome; Repair by Welding
Flaw #3	Crack in weld; Lower Dome; Repair by Welding
Flaw #4A	Incomplete Penetration in weld; Lower Dome; Repair by welding
Flaw #4B	Arc Strike at weld; Lower Dome; Repair by welding
Flaw #5A	Backside corrosion; Lower Dome; Repair by use of lap welded patch .250" thick 14" x 14" with radius corners.
Flaw #5B	Incomplete Penetration in weld; Lower Dome; Repair by welding
Flaw #7	Lack of Fusion in weld; Lower Dome; Repair by welding
Flaw #14	Lack of Fusion in weld; Barrel; Repair by welding
Flaw #17A	Lack of Fusion in weld; Barrel; Repair by welding
Flaw #24	Porosity in weld; Barrel; Repair by welding
Flaw #25	Arc Strikes at weld; Barrel; Repair by welding
Flaw #26	Porosity in weld; Barrel; Repair by welding
Flaw #29A-D	Lack of Fusion in weld; Barrel; Repair by welding
Flaw #33	Tack weld resulting in liner plate metal loss; Barrel; Repair by use of lap welded patch, .250" thick x 6-inch circular
Flaw #47A-D	Lack of Fusion in weld; Barrel; Repair by welding
Flaw #49 A	Slag Inclusion in weld; Barrel; Repair by welding

ENGINEERING & INSPECTIONS HAWAII. INC.

Flaw #49B	Lack of Fusion in weld; Barrel; Repair by welding
Flaw #50	Lack of Fusion in weld; Barrel; Repair by welding
Flaw #52A&B	Lack of Fusion in weld; Barrel; Repair by welding
Flaw #54	Lack of Fusion in weld; Barrel; Repair by welding
Flaw #67A&B	Existing patch plate @ .141", and area of original liner plate at .185"; Upper Dome; Remove existing patch plate and repair entire area by use of lap patch plate .250" thick, 16" x 16" with radius corners
Flaw #76	Through Wall Pit 3/16" dia.; Upper dome; Repair by use of lap welded patch, .250" thick x 6-inch circular
Flaw #105A-C	Lack of Fusion in weld; Lower Dome; Repair by welding
Flaw #106A&B	Lack of Fusion in weld; Lower Dome; Repair by welding
Flaw #107A	Lack of Fusion in weld; Lower Dome; Repair by welding
Flaw #107B	Crack in weld; Lower Dome; Repair by Welding
Flaw #108A,C, D	Lack of Fusion in weld; Lower Dome; Repair by welding
Flaw #108B	Crack in weld; Lower Dome; Repair by Welding
Flaw #109A-E	Lack of Fusion in weld; Lower Dome; Repair by welding
Flaw #110A-D	Lack of Fusion in weld; Lower Dome; Repair by welding
Flaw #111A-D	Lack of Fusion in weld; Lower Dome; Repair by welding
Flaw #112A-E	Cracks in weld; Lower Dome; Repair by Welding
Flaw #113A-C	Lack of Fusion in weld; Lower Dome; Repair by welding
Flaw #114 A&B	Lack of Fusion in weld; Lower Dome; Repair by welding
Flaw #115A&B	Lack of Fusion in weld; Lower Dome; Repair by welding
Flaw #116A&B	Lack of Fusion in weld; Lower Dome; Repair by welding
Flaw #117A&B	Lack of Fusion in weld; Lower Dome; Repair by welding
Flaw #118A&B	Lack of Fusion in weld; Lower Dome; Repair by welding
Flaw #119	Lack of Fusion in weld; Lower Dome; Repair by welding
Flaw #120A&B	Lack of Fusion in weld; Lower Dome; Repair by welding

P. O. Box 700217 • Kapolei, HI 96709-0217 • Tel: (808) 682-1667 • Fax: (808) 682-1834 • E-Mail: E I Hawaii@aol.com

	Flaw #121A&B	Cracks in weld; Lower Dome; Repair by Welding
	Flaw #122	Lack of Fusion in weld; Lower Dome; Repair by welding
	Flaw #83	Pitting in floor plate with remaining thickness of .336"; Engineering Evaluation Required due to unknown stresses on the tank floor.
9/29	Flaw, Course "F"	Through hole approximately ½" diameter on plate 12**;** Repair by the use of a 6" circular ¼" thick lap welded patch.

Note: All of the above repairs will require welding by a certified welder to approved welding procedures. All welds are required to be inspected by visual, magnetic particle and vacuum box inspection methods. Additionally, all welding defects identified by the ultrasonic shearwave inspection method, should be re-inspected by this method upon completion of the repairs.

Recommended Near Future Repairs:

Repairs that do not adversely affect the operability or integrity of the tank for continued service.

Continued service will be determined by Enterprise Engineering, Inc upon review of all data and T-min calculations.

If you have any questions regarding this matter or require any additional information, please do not hesitate to contact Ken McNamara at (808) 682-1667 or by fax at (808) 682-1834.

Respectively submitted,

Ken McNamara
Certified API-653 Inspector No. 873

Reviewed By:
Brian McKenna; Project Manager

Attachments

A. Report; Hawaii Engineering Group, Inc.
B. Enterprise Engineering, Inc. T-min Calculations
C. Report; TesTex, Inc. Data mapping
D. Excel spread sheet of data findings and repair recommendations
E. Pressure test data sheets

P. O. Box 700217 • Kapolei, HI 96709-0217 • Tel: (808) 682-1667 • Fax: (808) 682-1834 • E-Mail: E I Hawaii@aol.com

ENGINEERING & INSPECTIONS HAWAII, INC.

Attachment A

Report: Hawaii Engineering Group, Inc.

P. O. Box 700217 • Kapolei, HI 96709-0217 • Tel: (808) 682-1667 • Fax: (808) 682-1834 • E-Mail: E I Hawaii@aol.com

Attachment B

T-min Calculations
Provided by; Enterprise Engineering Inc.

P. O. Box 700217 • Kapolei, HI 96709-0217 • Tel: (808) 682-1667 • Fax: (808) 682-1834 • E-Mail: E I Hawaii@aol.com

ENGINEERING & INSPECTIONS HAWAII, INC.

Attachment C

Report: TesTex Data and Mapping

P. O. Box 700217 • Kapolei, HI 96709-0217 • Tel: (808) 682-1667 • Fax: (808) 682-1834 • E-Mail: E I Hawaii@aol.com

ENGINEERING & INSPECTIONS HAWAII, INC.

Attachment D

Spread sheet of data findings and repair recommendations

P. O. Box 700217 • Kapolei, HI 96709-0217 • Tel: (808) 682-1667 • Fax: (808) 682-1834 • E-Mail: E I Hawaii@aol.com

ENGINEERING & INSPECTIONS HAWAII, INC.

Attachment E

Pressure test data

P. O. Box 700217 • Kapolei, HI 96709-0217 • Tel: (808) 682-1667 • Fax: (808) 682-1834 • E-Mail: E I Hawaii@aol.com

ENGINEERING & INSPECTIONS HAWAII. INC.

Attachment A

Report: Hawaii Engineering Group, Inc.

P. O. Box 700217 • Kapolei, HI 96709-0217 • Tel: (808) 682-1667 • Fax: (808) 682-1834 • E-Mail: E I Hawaii@aol.com

HAWAII
ENGINEERING
GROUP, INC.

Consulting Civil Engineers, Structural Engineers & Land Surveyors
US (SBA), 8(a) & SDB Certified

February 14, 2008

Mr. Steve Skeel, Project Manager
Dunkin & Bush, Inc.
4648 Pacific Highway, Bellingham
Washington 98226

Project: Red Hill Tanks

Subject: Tower framing Inspection Tank #2

Dear Mr. Skeel

A site visit was held to inspect the tower framing of Red Hill Tank #2 on January 28, 2008. The inspection involved the top connection, the bottom connection, the bolts, the framing members.

No calculations or testing of any kind was performed. Architectural, Mechanical, Electrical, and other nonstructural aspects were not addressed. Compliance of design with the current building codes or the building code it was designed under was not checked.

The tower framing was visually observed. The existing steel framing members and connections were physically observed to be in good condition except those listed below.

Observations:

1. Hoist Connection at Top: visible slippages were typically observed on bolt connection. Proper sized washers are recommended to be added. (photo #1, #2)

2. Unused Hoist Connection: Large holes in the vertical legs of the tower which had been drilled for some connection should be covered and welded with plate of same thickness as the tower leg (photo #3 and #4)

3. Missing bolts were observed. Should be installed. (photo #5)

1088 Bishop St., Suite 2506, Honolulu, Hawaii 96813 – Tel: (808) 533-2092 Fax: (808) 533-2059
Email: heg@hawaiiengineering.net

4. Bent framing members were observed. Should be fixed by adding a straight member adjacent to the existing bent member. (photo #6)

5. Missing diagonals were observed. Should be installed. (photo #7)

This report does not address portions of the structure other than those areas mentioned, nor does it provide any warranty either expressed or implied for any portion of the existing structure. If there are any comments or questions on any items above, please do not hesitate in calling.

Please call me if you have any questions.

Sincerely,

Hawaii Engineering Group, Inc.

Ather R. Dar, P.E.
President

Photo #1: *Visible slippage of the bolt connection*

Photo #2: *Visible slippage of the bolt connection*

Consulting Civil Engineers, Structural Engineers & Land Surveyors
1088 Bishop St., Suite 2506. Honolulu, Hawaii 96813 – Tel: (808) 533-2092 Fax: (808) 533-2059
Email: heg@hawaiiengineering.net

Photo #3: *Big holes on the framing members*

Photo #4: *Big holes on the framing members*

Consulting Civil Engineers, Structural Engineers & Land Surveyors
1088 Bishop St., Suite 2506. Honolulu, Hawaii 96813 – Tel: (808) 533-2092 Fax: (808) 533-2059
Email: heg@hawaiiengineering.net

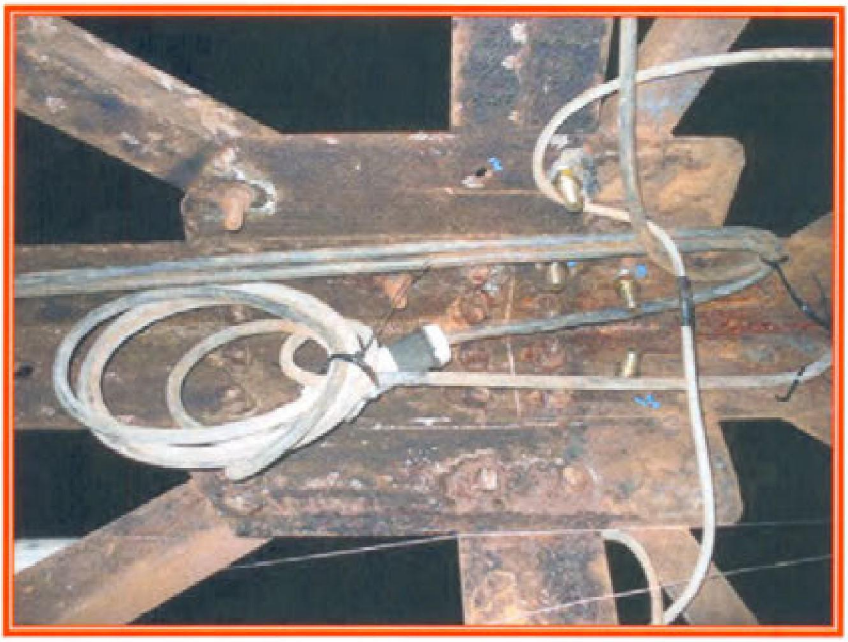


Photo #5: *Missing bolts*

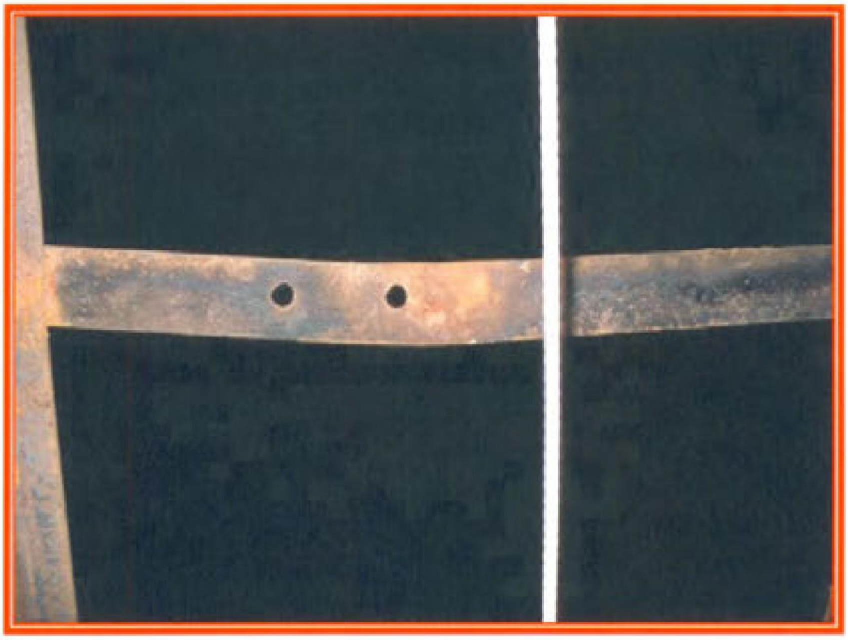


Photo #6: *Bent framing member*

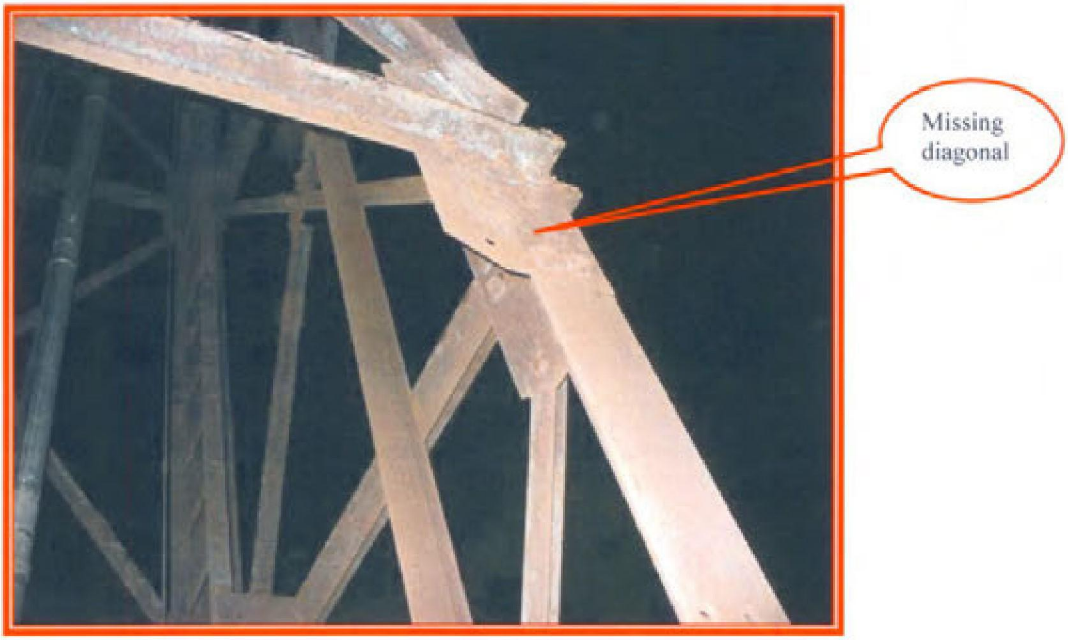


Photo #7: *Missing diagonal.*

Photo #8: *Missing diagonal*

Consulting Civil Engineers, Structural Engineers & Land Surveyors
1088 Bishop St., Suite 2506. Honolulu, Hawaii 96813 – Tel: (808) 533-2092 Fax: (808) 533-2059
Email: heg@hawaiiengineering.net

HAWAII ENGINEERING GROUP, INC.

Consulting Civil Engineers, Structural Engineers & Land Surveyors
US (SBA), 8(a) & SDB Certified

April 2, 2008

Mr. Steve Skeel, Project Manager
Dunkin & Bush, Inc.
4648 Pacific Highway, Bellingham
Washington 98226

Project: Red Hill Tanks

Subject: Review of Cat Walk Framing - Tank #2

Dear Mr. Skeel

A site visit was made on March 19, 2008 to check the framing of the cat walk inside Tank #2. Our visual observations involved observing physical condition of the framing members and measuring them for analysis. The boom crane and basket was used to observe conditions of members from bottom.

All framing members of the cat walk are in good condition (see photo #1 and #2). The welding of the major framing members to the tower steel wall are all in good condition (see photo #3 and #4) and are capable of providing fixed condition.

Photo #1: *Cat walk framing by the tank entrance*

1088 Bishop St., Suite 2506, Honolulu, Hawaii 96813 – Tel: (808) 533-2092 Fax: (808) 533-2059
Email: heg@hawaiiengineering.net

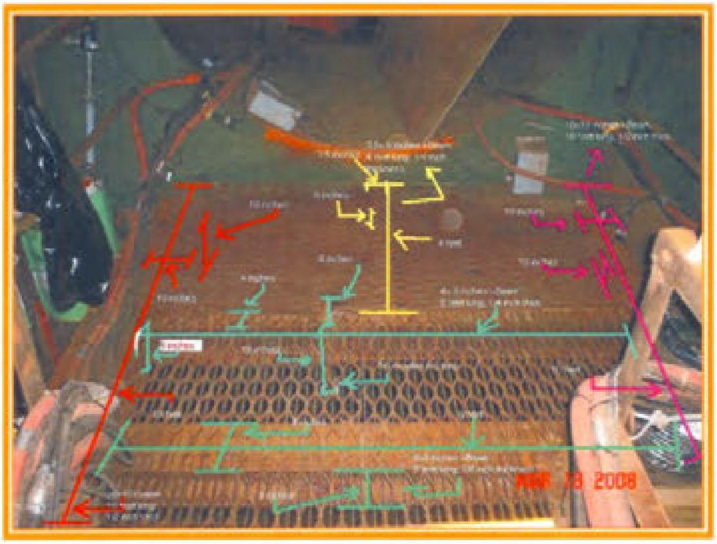


Photo #2: *Cat walk framing members and connections in good condition*

Photo #3: *Weld of the major I-beam is in good condition*

Consulting Civil Engineers, Structural Engineers & Land Surveyors
1088 Bishop St., Suite 2506, Honolulu, Hawaii 96813 – Tel: (808) 533-2092 Fax: (808) 533-2059
Email: heg@hawaiiengineering.net

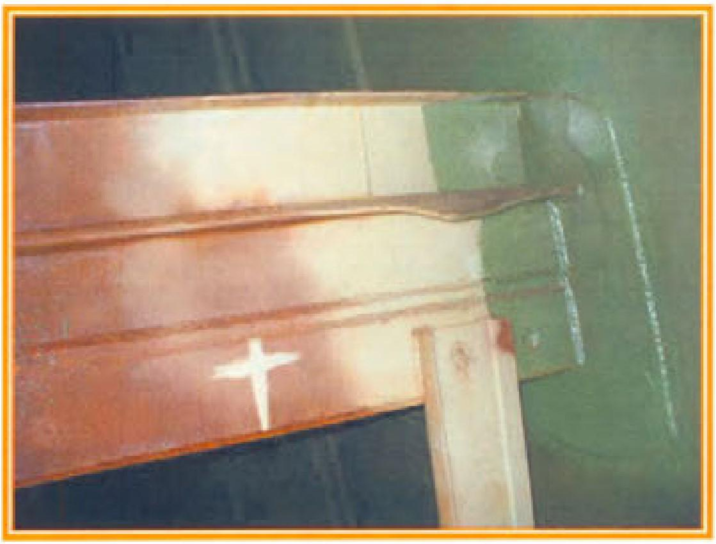


Photo #4: *Weld of the major I-beam is in good condition*

Our analysis indicates that the framing of the cat walk is able to support a live load of 200psf, and also to support the scaffold load of 2000lbs hung on the two points shown in photo #3.

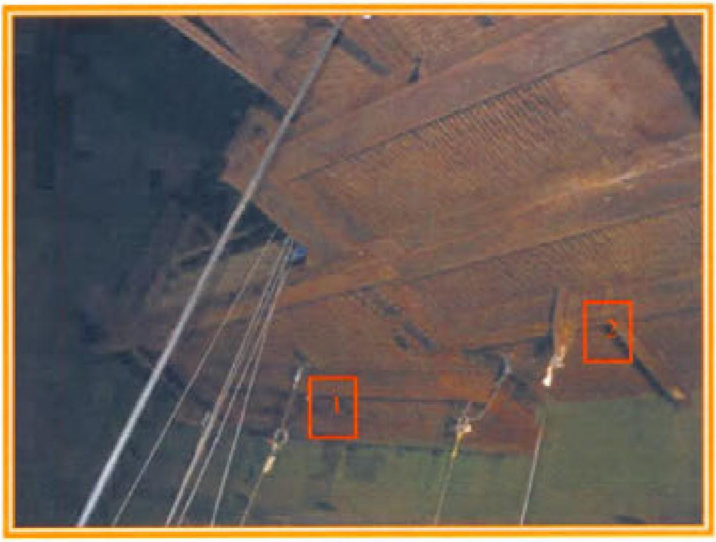


Photo #5: *Proposed scaffold will be hung on points 1 & 2*

Consulting Civil Engineers, Structural Engineers & Land Surveyors
1088 Bishop St., Suite 2506, Honolulu, Hawaii 96813 – Tel: (808) 533-2092 Fax: (808) 533-2059
Email: heg@hawaiiengineering.net

However, we suggest that loading of the cat walk framing be limited to no more than 4 persons at any one time while the scaffold is hung from the cat walk framing and is in use. We also recommend that loading of the scaffold hung on this platform framing be limited to 2000lbs and no more than 2 persons at any one time.

This report does not address portions of the structure other than those areas mentioned, nor does it provide any warranty either expressed or implied for any portion of the existing structure. If there are any comments or questions on any items above, please do not hesitate in calling.

Please call me if you have any questions.

Sincerely,

Hawaii Engineering Group, Inc.

Licensed Professional Engineer 7808-S

Ather R. Dar, P.E.
President

Consulting Civil Engineers, Structural Engineers & Land Surveyors
1088 Bishop St., Suite 2506. Honolulu, Hawaii 96813 – Tel: (808) 533-2092 Fax: (808) 533-2059
Email: heg@hawaiiengineering.net

Attachment B

T-min Calculations
Provided by; Enterprise Engineering Inc.

P. O. Box 700217 • Kapolei, HI 96709-0217 • Tel: (808) 682-1667 • Fax: (808) 682-1834 • E-Mail: E I Hawaii@aol.com

Ken McNamara

From: Chun, Wilfred [wilfred.chun@shawgrp.com]

Sent: Tuesday, April 22, 2008 5:09 PM

To: Pang, Incheol (NFESC)

Cc: Dygart, Aaron; Phillips, David; Weese, Todd; kenm.eihawaii@hawaiiantel.net; Barry.eihawaii@hawaiiantel.net; l.mcdougal@testex-ndt.com; Steve Brooks; Steve DiGregorio

Subject: FW: Red Hill Tank 2 and 20 Tmin Calculation

Incheol – Forwarded for your info and use.

Rgds,

Wilfred Chun, P.E.
Project Manager
Shaw Environmental & Infrastructure, Inc.
590 B Paiea St.
Honolulu, HI 96819-1835
808.840-2015 direct
808.388-6878 cell
808.839-0339 fax
wilfred.chun@shawgrp.com

From: Stephen J. DiGregorio [mailto:sjd@eeiteam.com]
Sent: Tuesday, April 22, 2008 2:06 PM
To: Chun, Wilfred
Cc: Weese, Todd; Dygart, Aaron; Phillips, David; Steve Brooks; Stacy Kaplan-McMillan
Subject: Red Hill Tank 2 and 20 Tmin Calculation

Wilfred,

My responses to Incheol's comments are provided below. Due to the uncertainty in calculating corrosion rates, applying a factor of safety to Tmin has merit. You will see in the calculations and recommendations that follow, I have recommended a revised Tmin = 0.170 inches. I will revise EEI's formal Steel Liner Plate Minimum Thickness Assessment to reflect the new Tmin calculations and recommendations.

EEI Response to Comments

1. It is not possible calculate an actual corrosion rate for the Red Hill Tanks because the time interval during which corrosion occurred is unknown and can not be determined. Depending on the time interval that is assumed, the corrosion rate can be higher or lower compared to the actual corrosion rate. Additionally, it is possible that conditions causing external corrosion can change over time. Available record drawings indicate the rock face of the barrel of the tanks is lined with gunite and coated with either asphalt paint or "red dirt" paint; and that the space between the gunite lining and the steel liner plates is filled with reinforced concrete. It is known that cracks or other conditions have developed in the gunite or reinforced concrete allowing water to migrate to the steel liner plates and corrode steel liner plates that previously had no indication of external corrosion. This has been going on probably for the entire life of the tank, so it is not new.

2. The rock stratum surrounding the Red Hill tanks varies in type and porosity, thus the water content and corrosivity of the rock can vary from one location to another. Because of these highly variable conditions, selecting areas of the steel liner and measuring the remaining thickness to determine actual corrosion rates would not necessarily be representative of external corrosion conditions throughout the tank. It is possible that more severe corrosion could exist at areas that are not measured.

3. EEI's calculation of the external corrosion rate (0.001744 inches per year) and Tmin =0.140 inches follows the procedure outlined in API 653 section 4.4.7.1, which assumes a linear (i.e. constant) corrosion rate based on the age of the tank. For Tanks 2 and 20, the external corrosion rate was calculated based on the age of

the tank in 20-years (i.e. 86 years old in 2028). EEI acknowledges that this calculated corrosion rate is not based on thickness data of the steel liner plates; however as stated above, selecting areas of the steel liner and measuring the remaining thickness to determine actual corrosion rates would not necessarily be representative of external corrosion conditions throughout the tank. On the other hand, there may not be any location on the tank that would have a more aggressive corrosion rate than that determined by our method of calculation, unless there has been a drastic change in conditions. Should areas be present that have a higher corrosion rate than our calculated corrosion rate, the remaining thickness will have a Tmin less than 0.140 inches and would be repaired.

4. EEI has not established a 20-year interval until the next inspection. A 20-year interval was used to calculate Tmin. A shorter interval until the next inspection could be used.

Summary and Conclusions

1. It is not possible calculate an actual corrosion rate for the Red Hill Tanks because the time interval during which corrosion occurred is unknown and can not be determined.
2. Selecting areas of the steel liner and measuring the remaining thickness to determine actual corrosion rates would not necessarily be representative of external corrosion conditions throughout the tank because the rock stratum surrounding the Red Hill tanks varies in type and porosity.
3. EEI's calculated Tmin = 0.140 inches is based on the age of the tank in 20-years (i.e. 86 years old in 2028). As stated in EEI's Steel Liner Plate Thickness Assessment, a Tmin = 0.140 inches has no safety factor. If a more conservative approach is desired, a shorter interval until the next inspection (i.e. 10 years) or Tmin based on higher external corrosion rate or both could be used. Given the uncertainty in calculating a corrosion rate, using factor of safety for Tmin has merit.

Recommendations

1. As it is not possible to establish actual corrosion rates, a factory of safety applied to the previously recommended Tmin = 0.140 inches may have merit. Considering the guidance of API 570, which uses twice the corrosion rate in any remaining life, or pressure capability calculations, the new Tmin, at twice the corrosion rate, would be 0.170 inches. This new Tmin takes into consideration the uncertainty of calculating a corrosion rate and the potential for internal corrosion given the reported condition of the interior coating.
2. EEI, therefore recommends Tmin = 0.170" be used as the criteria for determining whether thin and pitted areas in the 1/4-inch thick steel liner plates in the, barrel, and lower dome require repair.
3. Tmin = 0.170 inches does not apply to the 1/2-inch thick floor (base plate) of the lower dome.
4. As the steel liner plates are not structural elements and should not be relied upon as a structural element to resist hoop and tensile stresses in the barrel and lower dome or compressive stress in the upper dome, consult EEI when voids are found behind liner plates.

Revised Tmin Calculations

Following the guidance of API 570 which uses twice the corrosion rate in any remaining life, or pressure capability calculations, a revised corrosion rate and Tmin is calculated as follows:

Parameters

- Original Thickness of Liner Plates: 0.250"
- Remaining Thickness at the Next Inspection: 0.10" based on the tank having no means to contain a leak
- Interval until the Next Inspection: 20 years maximum
- Year Tank Constructed: 1942

Revised Corrosion Rate and Minimum Thickness

For a 20-year service interval starting in 2008, the next inspection would be in 2028. Using the API 653 straight-line method of calculating corrosion rates and a 0.10" remaining thickness at the next inspection in 2028, the external corrosion rate is as follows:

Maximum permissible metal loss = 0.250" – 0.10" = 0.150"

Age of tank in 2028 = 2028 - 1942 = 86 years

Considering the 0.150" of metal loss occurs over the life of the tank, the external corrosion rate is:

External corrosion rate = 0.150" / 86 years = 0.001744 in / year

Following the guidance of API 570, using 2 times the corrosion rate results in a Tmin = 0.170 inches as follows:

Two times corrosion rate = (2) (0.001744 in / yr) = 0.003488 in /yr

A two times the corrosion rate, the metal loss that is expected to occur during the next 20 years is:

Metal loss during next 20 years = (0.003488 in / year) (20 years) = 0.0.70"

The minimum thickness required in 2008 to have 0.1" remaining thickness in 2028 at twice the corrosion rate of 0.001744 in / yr is:

Tmin = 0.070" + 0.100" = 0.170"

Steve

Stephen J. DiGregorio, P.E.
Chief Civil / Structural Engineer
Enterprise Engineering, Inc.
5 Depot Street
Freeport, ME 04032
TEL: (207) 869-8006

Original Message-----
From: Chun, Wilfred [mailto:wilfred.chun@shawgrp.com]
Sent: Thursday, April 17, 2008 1:08 PM
To: Steve DiGregorio ; Steve Brooks
Cc: Weese, Todd; Dygart, Aaron; Phillips, David
Subject: FW: Red Hill Tank 2 and Tmin Calculations

Steve - Request comment on Incheol's Tmin of 0.14 based on coating inspection below and serviceable for next 20 years.

Thks,

Wilfred Chun, P.E.
Project Manager
Shaw Environmental & Infrastructure, Inc.
590 B Paiea St.
Honolulu, HI 96819-1835
808.840-2015 direct
808.388-6878 cell
808.839-0339 fax
wilfred.chun@shawgrp.com
-----Original Message-----
From: Pang, Incheol (NFESC) [mailto:incheol.pang@navy.mil]
Sent: Wednesday, April 16, 2008 4:15 PM
To: Chun, Wilfred; Dygart, Aaron; Weese, Todd; Phillips, David
Cc: Pierce, William (NFESC); Oberst, Casey (NFESC); Rocha, Mike (NFESC); Moore, Terry L CIV NFELC, AQ01
Subject: RE: Red Hill Tank 2 and Tmin Calculations

Wilfred and Todd,

Thanks for forwarding the EEI's Tmin calculation for Tank 2 & 20. What does Shaw propose on this?

Here is my thoughts. Now EEI recommends 0.14" as minimum plate thickness based on two facts; 1/4" original plate & corrosion rate based on 0.1" minimum remaining thickness at the end of year 2028. I can understand how Stephen calculates Tmin for 20 year inspection cycle. However, here is my questions for this calculation and Tmin. The same question that I had on Tank 1405 (Tank 54) inspection interval. In normal API 653 inspection, a corrosion rate is established, and remaining life gets calculated to determine the next inspection date. On this calculation, Stephen established 20 year cycle, and calculate the corrosion rate. I guess it would be ok for 20 year long stand point. However, this would not give you a truly or close to real 'established corrosion rate'. Can this method be considered proper way to establish corrosion rate? This is exactly why I asked Shaw as part of Work Plan comments to justify 0.19" as Tmin for the inspection.

Also, Stephen assumed internal coating is serviceable for next 20 years as well to use 0.14" as Tmin. Recent coating inspection of Tank 2 by NAVFAC coating expert revealed that the existing coating was applied without any proper surface preparation in the 80's. And the current condition shows delaminating at substantial area of the interior. Under the consideration of tank age and condition, the coating expert recommended no coating repair. Repair attempt would do more harm than good. The bottom dome would be recoated after tank inspection, but no coating repair is considered on any part of the shell or upper dome area. If this information would make this calculation any different, please let Stephen know and recalculate Tmin based on current coating condition.

v/r,

Incheol

incheol.pang@navy.mil
805-331-2148

-----Original Message-----
From: Chun, Wilfred [mailto:wilfred.chun@shawgrp.com]
Sent: Wednesday, April 16, 2008 11:16
To: Pang, Incheol (NFESC); kenm.eihawaii@hawaiiantel.net
Cc: Barry.eihawaii@hawaiiantel.net; Dygart, Aaron; l.mcdougal@testex-ndt.com; Weese, Todd
Subject: FW: Red Hill Tank 2 and Tmin Calculations

Incheol - Attached is the Tmin by Enterprise.

Thks,

Wilfred Chun, P.E.

Project Manager

Shaw Environmental & Infrastructure, Inc.

590 B Paiea St.

Honolulu, HI 96819-1835

808.840-2015 direct

808.388-6878 cell

808.839-0339 fax

wilfred.chun@shawgrp.com

From: Stephen J. DiGregorio [mailto:sjd@eeiteam.com]
Sent: Wednesday, April 16, 2008 7:52 AM
To: Chun, Wilfred
Cc: Weese, Todd; Steve Brooks; Stacy Kaplan-McMillan
Subject: Red Hill Tank 2 and Tmin Calculations

Wilfred,

Enclosed are my calculations of Tmin for Red Hill Tanks 2 and 20. Let me know if you or the government have questions.

Steve

Stephen J. DiGregorio, P.E.

Chief Civil / Structural Engineer

Enterprise Engineering, Inc.

5 Depot Street

Freeport, ME 04032

TEL: (207) 869-8006

RED HILL TANKS 2 AND 20
FISC PEARL HARBOR, HAWAII

Steel Liner Plate Minimum Thickness Assessment
April 15, 2008

EEI Project No. 08-4895

GENERAL

Shaw is providing cleaning, inspection, and repair services for Tanks 2 and 20 at FISC Pearl Harbor Red Hill, Hawaii. Shaw has requested Enterprise Engineering, Inc. (EEI) calculate corrosion rates and the minimum thickness of the steel liner plates which will be used as the criteria for determining the need for repair based on a 20-year interval until the next inspection.

Record drawings of the Red Hill tanks indicate the steel liner plates in the upper dome, barrel, and lower dome in all of the tanks are 1/4" thick plate nominal. The floor (referred to as "base plate" on record drawings) of the lower dome in all of the tanks is indicated as 1/2" thick plate. This document prepared by EEI provides a calculation of corrosion rates and minimum required thickness of the 1/4" thick steel liner plates. This minimum thickness will serve as the criteria for determining the need to repair thin areas and pits for another 20-year interval until the next inspection.

RECOMMENDED REPAIR CRITERIA: STEEL LINER MINIMUM THICKNESS

It is reported that a Tmin of 0.19 inches was used on previous projects at Red Hill. EEI is not able to determine how this value was established. EEI recommends the following:

1. A minimum thickness (Tmin) of 0.140 inches be used as the criteria for determining whether thin and pitted areas in the 1/4-inch thick steel liner plates in the, barrel, and lower dome require repair. The upper dome area, with increased potential for atmospheric corrosion on the inside, can also use this Tmin criteria of 0.140 inches if it is determined the coating system is sound, there is no present internal corrosion, and the coating system has a remaining life of 20 years. Note: the Tmin value of 0.140 inches does not include any safety factor that the thickness of the steel liner plates will not be less than a minimum thickness of 0.10 inches at the end of another 20-year service interval. The justification for not using a safety factor is:

   a. API 653 does not use a safety factor.

   b. Tmin is based on a constant rate of corrosion (i.e. corrosion is assumed to not vary over time). Using a constant rate of corrosion is in accordance with API 653 and is considered conservative in that corrosion rates generally decrease over time unless conditions change.

c. A safety factor could be added to Tmin; however, this will involve more repairs and is not justified unless desired by the government or conditions are found indicating corrosion rates are higher than calculated.

2. Repair thin and pitted areas in the 1/4-inch thick steel liner plates in the upper dome, barrel, and lower dome having a minimum thickness (Tmin) less than 0.140 inches. Areas having Tmin equal to or greater than 0.140 inches do not require repair for a 20-year interval until the next inspection.

3. Tmin = 0.140 inches does not apply to the floor (base plate) of the lower dome.

4. EEI also calculated Tmin for a 10-year interval until the next inspection and determined Tmin in this case would be 0.120 inches. EEI can evaluate this alternative if desired.

5. Using Tmin = 0.140 inches as determined for 20-year interval until the next inspection and applying this criteria for a 10-year interval is an option as it is conservative and provides a factor of safety.

COMMENTS AND CLARIFICATIONS

EEI's calculation of Tmin is based on the following:

1. A 20-year interval until the next inspection in 2028 as indicated in Shaw's Work Plan.

2. An original plate thickness of 0.250 inches. Our calculation of Tmin does not take into account the original thickness of the plates may be thinner due to plate fabrication tolerances or other conditions. EEI recommends Shaw's inspector obtain ultrasonic thickness measurements of each plate (6 measurements minimum per plate). Submit for EEI review and assessment thickness measurements of plates having an average thickness less than 0.240". The 0.240 thickness is the ASTM A 6/A6M minimum thickness tolerance for 1/4-inch thick plates.

3. The rate of external corrosion was calculated using the API 653 straight line method and assuming metal loss occurring over the life of the tank (86 years) from tank construction in 1942 to the next inspection in 2028. The calculated rate of external corrosion does not take into consideration potential areas of concentrated corrosion caused by artifacts, welding rods, debris, rocks, microbial induced corrosion (MIC) in the form of small "worm-like" corrosion trails, or other conditions on the exterior of the liner plates the would cause concentrated corrosion. If these conditions are found, contact EEI for interpretation.

4. The rate of external corrosion and Tmin does not apply to the heat-affect zone of liner plates adjacent to welds (within 1 inch of the weld). As the corrosion rate in the heat-affected zone can be higher than areas outside the heat-affected zone, a higher Tmin value may be needed for the heat-affected zone. Information on plate thickness in the heat affected zone is needed to determine corrosion rates and Tmin of the heat affected zones of the steel liner plates. EEI

recommends Shaw's inspector obtain ultrasonic thickness measurements in the heat-affected zone in random areas in each quadrant of the upper dome, barrel, and lower dome for EEI assessment. Given the large quantity of welds in the liner plate joints, EEI recommends 20 UT thickness measurements be obtained in the heat-affected zones in each quadrant. Additional UT measurements may necessary if results are not consistent. Additionally, EEI recommends that we be notified when the remaining thickness in the heat-affected zone is less than 0.200 inches as additional assessment may be necessary.

5. The corrosion rate of product side corrosion is assumed to be 0.00 inches per year. This assumption is only valid if the existing interior coating is in serviceable condition and its service life is equal to or greater than the 20-year interval until the next inspection. If the interior coating is not expected to last another 20 years, product side corrosion may occur and thus the Tmin will need to be recalculated and increased. It should be noted that product side corrosion is not of concern when the tank is filled as areas are covered by product except at a water bottom in the lower dome. The 0.00 inches per year product side corrosion rate also does not take into consideration potential atmospheric corrosion of the steel liner plates if the coating is failing and not repaired and liner plates are exposed to atmosphere. Additional information is needed on the condition of the interior coating and whether atmospheric corrosion is present. This additional information may result in a greater Tmin of the upper dome, where atmospheric corrosion, and or degraded coatings is present.

6. A minimum thickness of 0.10 inches at the next inspection is used in the calculation of Tmin. A 0.10 inch minimum thickness is used as the steel liner plates are a hydraulic barrier and are not relied upon as a structural element to resist hoop and tensile stresses in the barrel and lower dome or compressive stress in the upper dome. The 0.10-inch criteria is similar to API 653 criteria for tank floors that have no means for containment of a leak.

7. As the steel liner plates are not structural elements and should not be relied upon as a structural element to resist hoop and tensile stresses in the barrel and lower dome or compressive stress in the upper dome, consult EEI when voids are found behind liner plates.

8. Our calculation of Tmin does not include any safety factor. A safety factor could be added to Tmin; however, this will involve more repairs and is not justified unless desired by the government or conditions are found indicating corrosion rates are higher than calculated.

9. Consult EEI when areas of thinning or pitting are found that exceed 12" in diameter.

CALCULATIONS

Parameters

- Original Thickness of Liner Plates: 0.250"
- Remaining Thickness at the Next Inspection: 0.10" based on the tank having no means to contain a leak
- Interval until the Next Inspection: 20 years maximum
- Year Tank Constructed: 1942
- Product Side Corrosion Rate: Assumed to be 0.00" per year based on the tank interior being coated and the life of the coating expected to exceed the interval until the next inspection

Corrosion Rate and Minimum Thickness

For a 20-year service interval starting in 2008, the next inspection would be in 2028. Using the API 653 straight-line method of calculating corrosion rates and a 0.10" remaining thickness at the next inspection in 2028, the external corrosion rate is as follows:

Maximum permissible metal loss = 0.250" – 0.10" = 0.150"
Age of tank in 2028 = 2028 - 1942 = 86 years

Considering the 0.150" of metal loss occurs over the life of the tank, the external corrosion rate is:

External corrosion rate = 0.150" / 86 years = 0.001744 in / year

Using this external corrosion rate, the expected metal loss that would have occurred thus far, (1942 to 2008) is:

Number of years from 1942 to 2008 = 66 years
Metal loss over 66 years = (0.001744 in / year) (66 years) = 0.115"

The minimum thickness required in 2008 to have 0.1" remaining thickness in 2028 at a corrosion rate of 0.001744 in / year is:

Tmin = 0.250" – 0.115" = 0.135"

Thus if Tmin = 0.135" in 2008; using an external corrosion rate of 0.001744" / year, the remaining thickness in 20 years (2028) is:

Metal loss occurring over the next 20 years = (0.001744" / yr) (20 years) = 0.035"
Remaining thickness at the end of the next 20 years = 0.135" – 0.035" = 0.10"
Use Tmin = 0.140" (0.135" rounded to 0.140")

Prepared by:

Stephen DiGregorio

Stephen J. DiGregorio, P.E.
Chief Structural Engineer
ANSI/API 653 Certified Aboveground Tank Inspector, Certificate No. 1113

<u>Attachment C</u>

Report: TesTex Data and Mapping

P. O. Box 700217 • Kapolei, HI 96709-0217 • Tel: (808) 682-1667 • Fax: (808) 682-1834 • E-Mail: E I Hawaii@aol.com

TesTex

STATE OF THE ART PRODUCTS AND SERVICES FOR NON-DESTRUCTIVE TESTING

535 Old Frankstown Road
Pittsburgh, PA 15239

E-mail: testex-ndt@verizon.net
Website: www.testex-ndt.com

Wednesday, September 24, 2008

Addendum to Tank 2 final report

Expansion Joint, Upper Dome U-Channel Welds, Course F Scanning

On September 8th 2008 work resumed in tank 2 at the Red Hill facility. This work consisted of scanning the welds associated with the Expansion joint and all U-channels of the upper dome and additionally, the surface area of course F. The following is the total linear footage of welds and surface area scanned:

1) Expansion joint welds: 4 different welds at approximately 314 linear feet each **(1,256 linear feet total)**

2) Upper dome U-channel welds: Course A, approximately 2,788 linear feet
Course B, approximately 2,756 linear feet
Course C, approximately 1,970 linear feet
Course D, approximately 1,864 linear feet
Course E, approximately 1,180 linear feet
Course F, approximately 512 linear feet
(11,070 linear feet)

3) Course F surface area: approximately **491 square feet**

The scanning concluded on September 11th 2008 with **no reportable defects found in the 12,326 linear feet of welds** that was scanned. However, **two defects were found in the surface area of course F.** One defect was approximately a **0.500" diameter through hole** on plate 12, 32 inches from the manway and 6 inches from the plate 12/13 intersection. The other defect was a **dent** in plate 21, 5 foot from the manway and 4 inches from the plate 21/22 intersection.

Jason Tonini

Jason T

Sr. Field Engineer.

France
Tel: 011 33 4 74 82 72 23
Fax: 011 33 4 74 82 75 41
testexfrance@yahoo.com

India (Mumbai)
Tel: 011 91 22 67978015
Fax: 011 91 22 25510788
testex@vsnl.net

Japan
Tel: 011 81 82 2896770
Fax: 011 81 82 2896769
kimoto@testex-j.com

United Kingdom
Tel: 011 44 1469 541586
Fax 011 44 1469 541587
Testexuk@aol.com

Pittsburgh (HQ) Tel: 412-798-8990
Atlanta Tel: 770-323-8903
Bakersfield Tel: 661-396-9167
Houston Tel: 713-680-
New Orleans Tel: 504-393-0968
Philadelphia Tel: 215-638-4233
South Bend Tel: 574-254-9953

TesTex

STATE OF THE ART PRODUCTS & SERVICES
FOR NON-DESTRUCTIVE TESTING

LOW FREQUENCY ELECTROMAGNETIC TECHNIQUE

INSPECTION REPORT

OF

TANK # 2

AT

RED HILL

IN

HONOLULU, HI

BY

TESTEX, INC.

TESTED: 3/31 - 5/12, 2008

AUTHOR: LARRY McDOUGAL

REVIEWED BY: SID RAMCHANDRAN

PITTSBURGH (H.Q.)
Tel: (412) 798-8990
Fax: (412) 798-8995
www.testex-ndt.com
testex@adelphia.net

HOUSTON
Tel: (713) 680-8604
Fax: (713) 680-9469

CHI/SOUTH BEND
Tel: (574) 254-9953
Fax: (574) 254-9961

ATLANTA
Tel: (770) 323-8903
Fax: (770) 323-8603

PHILADELPHIA
Tel: (215) 638-4233
Fax: (215) 638-4237

NEW ORLEANS
Tel: (504) 393-0968
Fax: (504) 393-0762

JAPAN
Tel: 082-289-6770
Fax: 082-289-6769

INDIA
Tel: 91-22-55978015
Fax: 91-22-25510788

UNITED KINGDOM
Tel: 1469-541586
Fax: 1469-541587

TABLE OF CONTENTS

1.0 RESULTS AND CONCLUSIONS
Dunkin and Bush, Inc.
Honolulu, HI
Tank #2

INTRODUCTION

An NDT inspection was conducted on Tank #2 at Red Hill in Honolulu, HI on March 31st – May 13th, 2008. This inspection focused on 100% testing of the floor, lower dome, barrel, and upper dome areas. The inspection was performed with the TesTex developed *TS-2000 NDT Multi-channel System* (for plate scanning using the principles of the *Low Frequency Electromagnetic Technique*) and the *Hawkeye 2000 System* (for weld testing focusing on surface and subsurface cracking and pinholes). All defected areas found with the above-mentioned TesTex equipment were backed up and sized using regular *Ultrasonic Technique* and *Ultrasonic Shear wave Technique*. The *Ultrasonic Shear wave Technique* was an additional service used which measured the depth of detected pinholes, provided they were oriented in a position that could be tested. The results of this inspection are detailed in the following report.

RESULTS

In beginning this inspection (March 31, 2008), TesTex started scanning the floor plates (7 plates totaling 25 ft. in diameter) of tank #2. By day two (April. 1st), scanning was complete on the floor (491 sq ft) and moved to course 1 of the lower dome. Day 3 saw the completion of course 1 (2,695 sq ft) and the first 3' of course 2. In addition, scanning of the welds was performed by a fifth TesTex person using the Hawkeye on the floor (and around all pipe entry points), course 1, and the first 3' of course 2 during the first three days. It is to be mentioned that all scanning to this point could be reached from standing on either the floor or course 1 of the lower dome. The end of the week saw work starting from the baskets on the remainder of course 2. Now, both types of scanning (LFET for liner plates and BFET for welds) were performed together by the basket crews. The course was finished by day's end (4,573 sq ft). In beginning the week of April 7th, 2008, TesTex personnel was back to four. The first day consisted of scanning course 3. This course (5,797 sq ft) was finished by both baskets by days end. The next day (April 8th) started with scanning course 4 and ended with its completion (5,634 sq ft). Day three (April 9th) saw the start of barrel scanning. The scans consisted of 8 ft. wide (the width of the basket) drops from the upper dome/barrel interface down to the lower dome/barrel interface. By the end of day four (April, 10th), approximately 15% of the barrel was completed. The third week picked back up with Barrel scanning and by the end of the first day (April 14th), 25% of the barrel was complete. Over the course of the next 3 days, the total finished barrel percentage rose to 50% to end the week (April 17th). The fourth week would see the completion of barrel (41,598 sq ft) scanning at the end of the third day (April 23rd). On the last day of the week (April 24th), Scanning began on course A of the upper dome. Week 5 started with the completion of course A (4,437 sq ft) at the end of the first day (April 28th). Course B was started on day two (April 29th) and finished (4,082 sq ft) halfway through the next day (April 30th). The second half of the day three saw the starting of course C and its completion (3,458 sq ft) at the end of day four (May 1st). The last week of the inspection, week six, marked the return of the fifth TesTex person and an ultrasonic technician. The ultrasonic technician began using Shear Wave technology (May 5th) on the lower dome/floor interface and shear wave prove-up on any possible weld defects found in the tank. The first day also saw the beginning of inspection, with one team, of the barrel under the catwalk. On the second day (May 6th), the second team began scanning course D and E using ultrasonic trolleys in quadrants C and D. In addition, the team under the catwalk finished their scanning (2,895 sq ft). The third day of the week (May 7th) consisted of finishing courses D and E in Quadrant C and D (2,148 sq ft) and starting the same for quadrants A and B for one team and the other team worked in the lower tunnel on U.T. spot checks inside of the 32-inch and 18-inch lines. These spot checks were done on the 32-inch line from the inside and consisted of a group of 8 circumferential readings taken every 3 feet across the approximate 40-foot span. The 18-inch line was too small to access internally, so readings could only be taken at 8 and 18 inches from the end. On the fourth day (May 8th), scanning was completed on courses D and E in quadrants A and B (2,148 sq ft). Also, course F was U.T spot-checked from the gallery and the inside of the manway was scanned using the LFET scanner. In wrapping up the day, both teams covered the tank to confirm all defect locations and documentation. This marked the end of the inspection for the two TesTex teams who were there for the entire inspection. The following day (May 9th) was used to finish shear wave scans of the remaining welds. All of the gathered data was examined over the weekend and a preliminary report was given on Monday May 12th, which outlined all defects found in the tank. This report characterized type, size, location, etc. for each.

In addition to the above-mentioned scanning, all weld cover channels in the scanned areas of the upper dome were U.T. spot-checked on their faces in 6" increments. This was done in accordance to specifications established for tanks 15, 16, and 6.

CONCLUSIONS

As a result of this inspection, TesTex found 172 flaw indications most of which were either proved up with ultrasonic thickness measurements or sized using Ultrasonic Shear Wave Technique. All defects including their respective depth or other flaw characterization may be found in Section 4.0, **PLATE TEST SUMMARY**.

Section 3.0 is **TANK MAPS,** which clarifies the numbering system and tank layout. Section 5.0 shows typical waveforms collected from these sections. Printouts of waveforms collected from this unit are included in **APPENDIX A** and are correlated to each plate where the original flaw indication(s) was observed.

2.0 UNIT DETAILS
Dunkin and Bush, Inc.
Honolulu, HI
Tank #2

	Totals
Orientation	**Vertical**
Plate Thickness	
Upper Dome	**0.250”**
Lower Dome	**0.250”**
Barrel	**0.250”**
Floor	**0.500”**
Plate Material	**Carbon Steel**
Total Surface Area of Tank #2	**≈ 79,621 sq ft (plates)**
Upper Dome	**≈ 16,763 sq ft (plates)**
Barrel	**≈ 43,668 sq ft (plates)**
Lower Dome	**≈ 19,190 sq ft (plates)**
Total Surface Area Scanned by TesTex	**≈ 79,135 sq ft (plates)**
	≈ 16,968 linear ft (welds)
Upper Dome	**≈ 16,277 sq ft (plates)**
course A	**≈ 4,437 sq ft (plates)**
course B	**≈ 4,082 sq ft (plates)**
course C	**≈ 3,458 sq ft (plates)**
course D	**≈ 2,632 sq ft (plates)**
course E	**≈ 1,664 sq ft (plates)**
course F: (U.T. spot checks)	**≈ 5 sq ft (plates)**
Barrel	**≈ 43,668 sq ft (plates)**
	≈ 11,346 linear ft (welds)
Lower Dome	**≈ 19,190 sq ft (plates)**
	≈ 5,622 linear ft (welds)
course 4	**≈ 5,634 sq ft (plates)**
	≈ 1,439 linear ft (welds)
course 3	**≈ 5,797 sq ft (plates)**
	≈ 1,507 linear ft (welds)
course 2	**≈ 4,573 sq ft (plates)**
	≈ 1,500 linear ft (welds)
course 1	**≈ 2,695 sq ft (plates)**
	≈ 1,007 linear ft (welds)
base:	**≈ 491 sq ft (plates)**
	≈ 169 linear ft (welds2

2.0 UNIT DETAILS

Dunkin and Bush, Inc.
Honolulu, HI
Tank #2

Percent surface area of Tank #2 inspected	**≈ 99.4%**
Surface area of Upper Dome inspected	**≈ 97%**
Surface area of Barrel inspected	**≈ 100%**
Surface area of Lower Dome inspected	**≈ 100%**

Tank Numbering System See **3.0 TANK MAP**

	Totals
Defect distribution	
Tank #2	172
Area	
Upper Dome	28
Barrel	58
Lower Dome	84
Floor	2
Type	
Underside corrosion	48
Through holes	1
Topside (pits gouges)	24
Dents/bulges	28
Weld: LOF/IP	53
Weld: Cracking	12
Weld: Porosity	2
Weld: Misc.(AS, SL, TW, etc.)	4

Test Equipment:

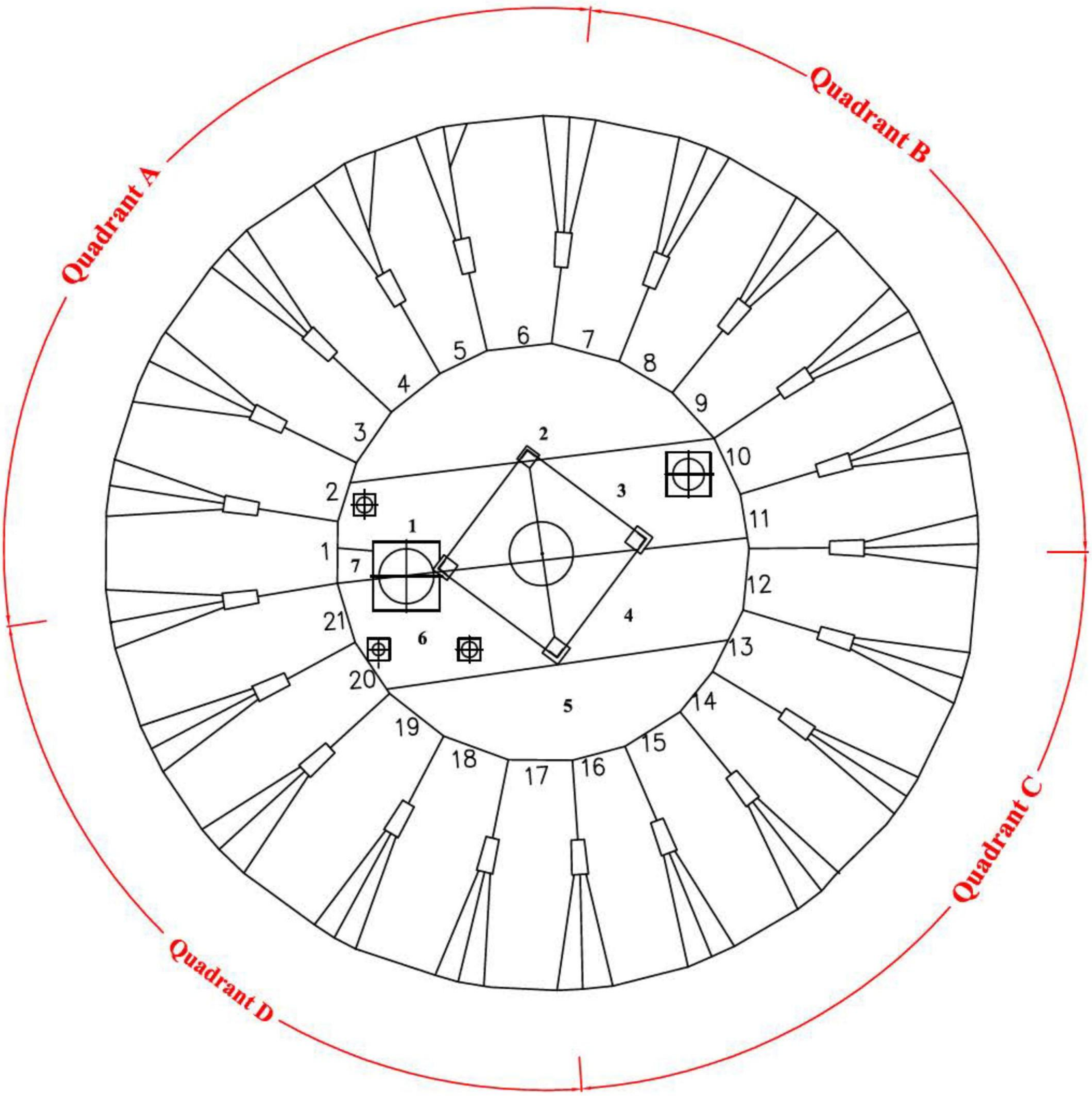
Electronics:
TS-2000, 8 Channel Plate Scanner
Hawkeye, Single Channel Pencil Probe Weld Scanner

Hardware:
U.T. Viper (Magnetic manual Crawler)

Ultrasonic Thickness Meter:
DMS-2 Krautkramer (with A-Scan Display)

3.0 Tank Maps
Dunkin & Bush, Inc.
Honolulu, HI
Tank # 2 - Lower Dome

TANK # 2 - LOWER DOME - COURSE 1

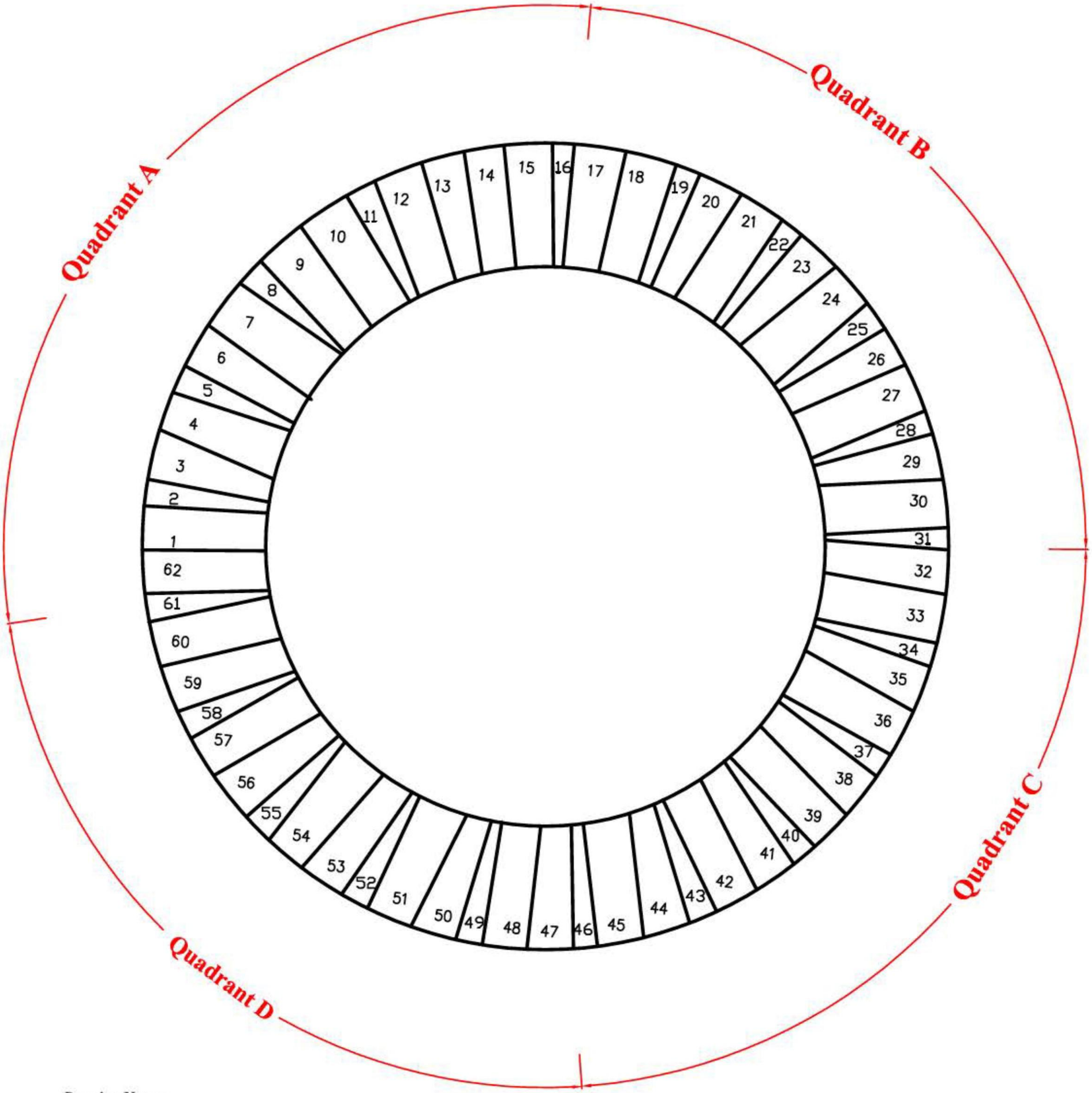


Drawing Notes:

1. Tank is divided into 4 quadrants (A-D).
2. Course 1 is comprised of 21 total plates.
3. Quadrant A is comprised of 6 plates (1-6).
4. Quadrant B is comprised of 5 plates (7-11).
5. Quadrant C is comprised of 5 plates (12-16).
6. Quadrant D is comprised of 11 plates (17-21).
7. This numbering convention begins with plate #1 being the first plate of quadrant A.

Drawing is not to scale

TANK # 2 - LOWER DOME - COURSE 2

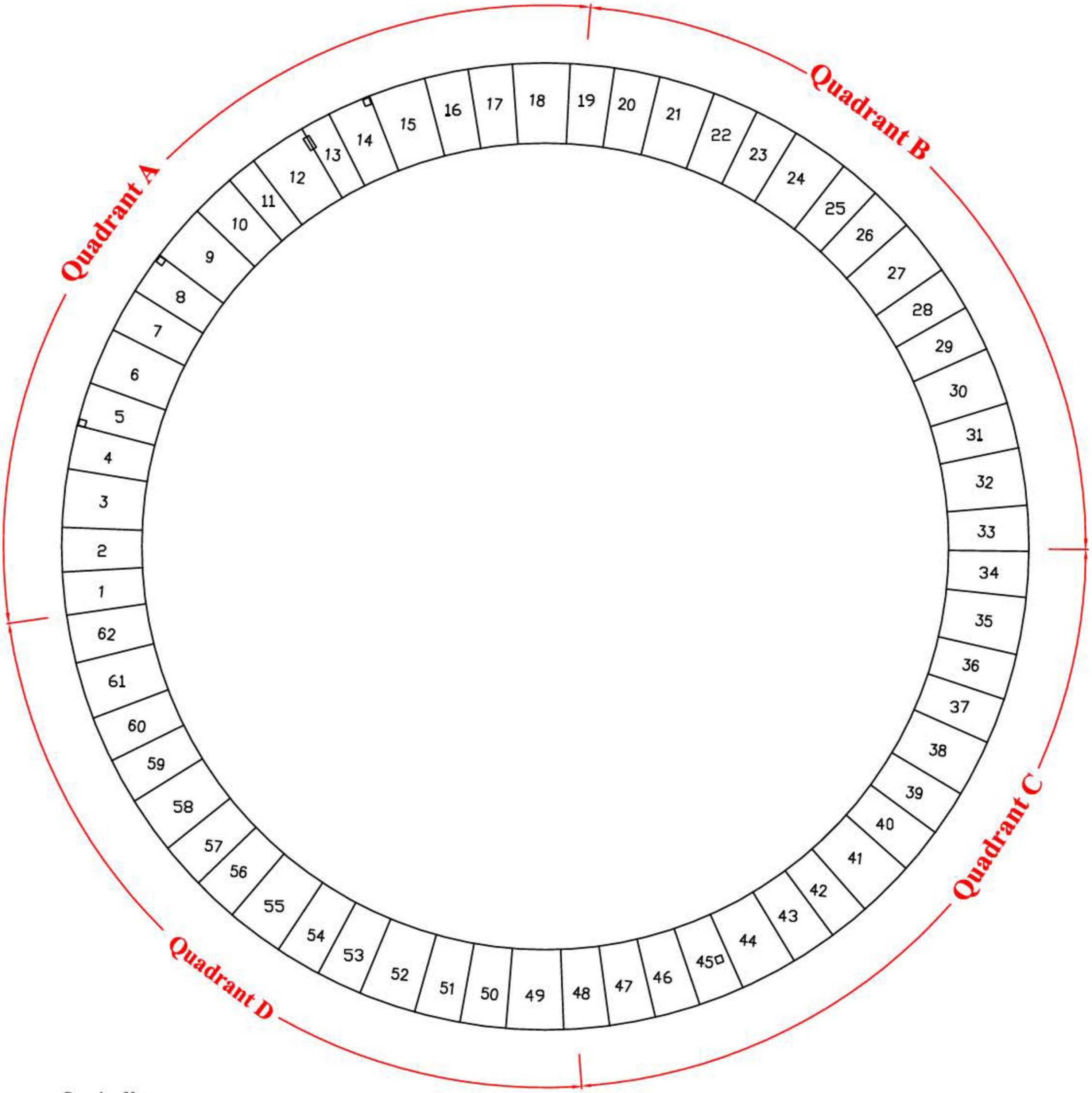


***Drawing Notes*:**

1. Tank is divided into 4 quadrants (A-D).
2. Quadrant A is comprised of 17 plates.(62 - 16)
3. Quadrant B is comprised of 15 plates.(17 - 31)
4. Quadrant C is comprised of 15 plates.(32 - 46)
5. Quadrant D is comprised of 15 plates.(47 - 61)
6. This numbering convention begins with plate #1 being the first plate of quadrant A.

Drawing is not to scale

TANK # 2 - LOWER DOME - COURSE 3

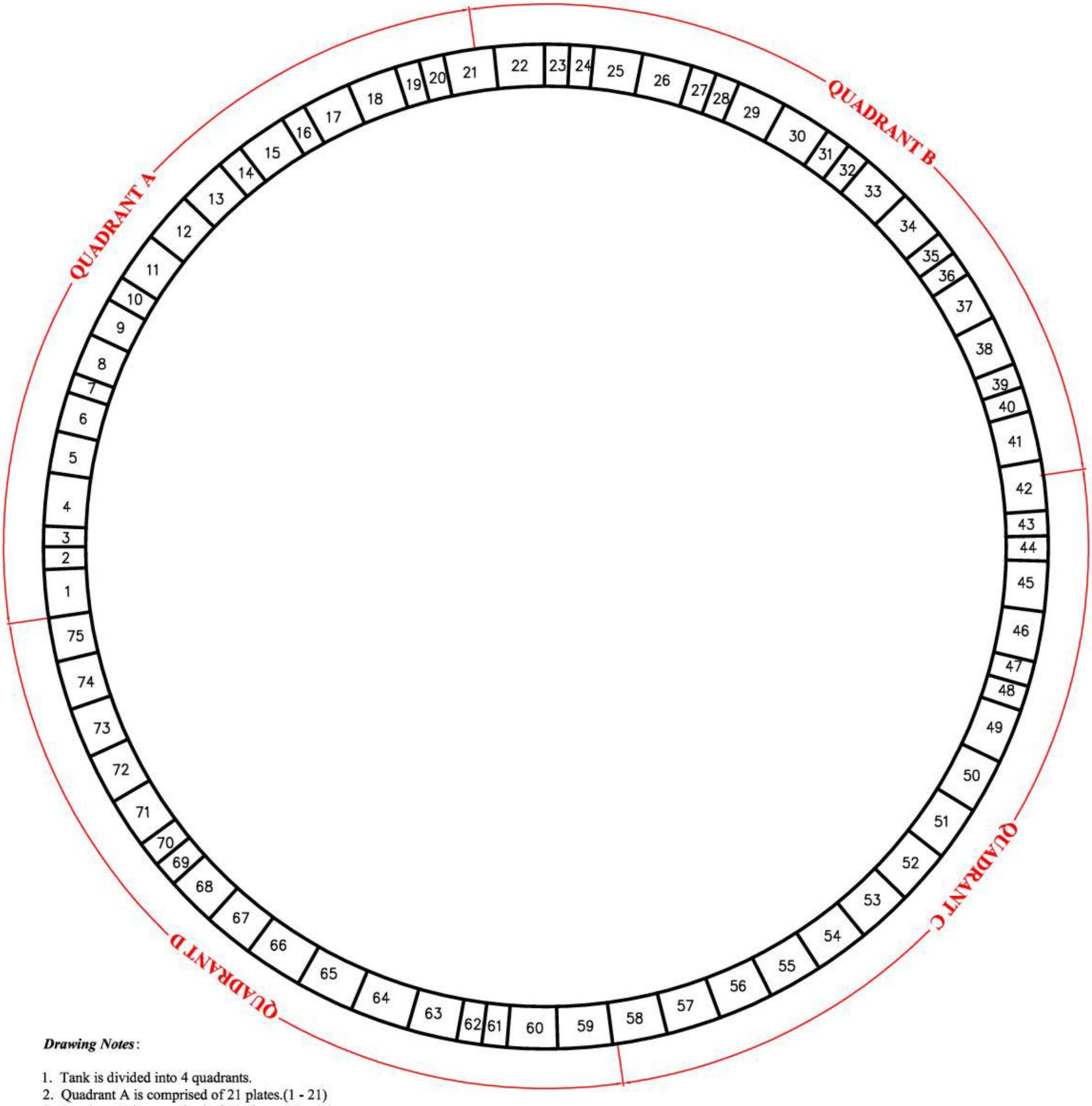


Drawing Notes:

1. Tank is divided into 4 quadrants (A-D).
2. Quadrant A is comprised of 19 plates.(1 - 18)
3. Quadrant B is comprised of 15 plates.(19 - 33)
4. Quadrant C is comprised of 15 plates.(34 - 48)
5. Quadrant D is comprised of 14 plates.(49 - 62)
6. This numbering convention begins with plate #1 being the first plate of quadrant A.

Drawing is not to scale

TANK # 2 - LOWER DOME - COURSE 4

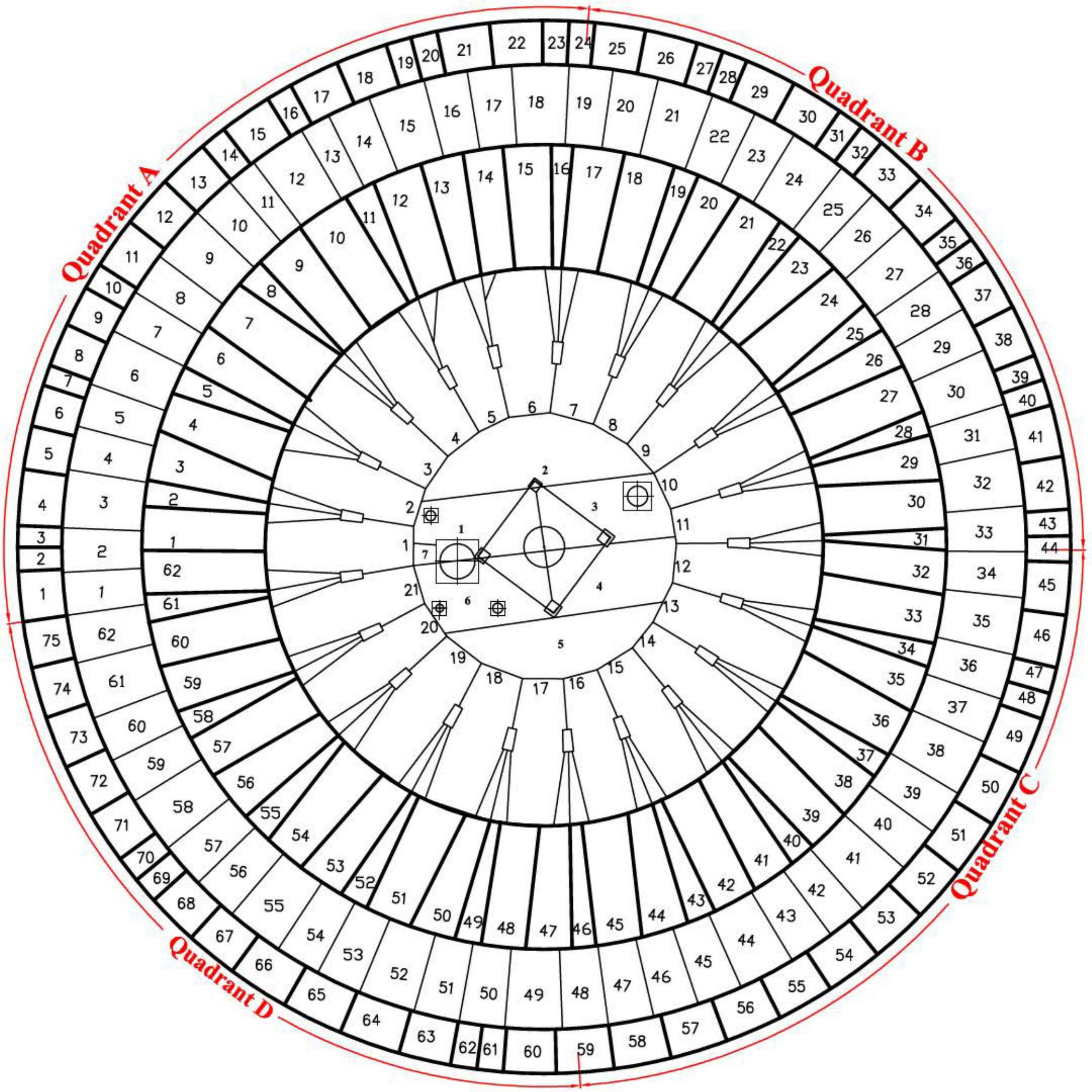


Drawing Notes:

1. Tank is divided into 4 quadrants.
2. Quadrant A is comprised of 21 plates.(1 - 21)
3. Quadrant B is comprised of 20 plates.(22 - 41)
4. Quadrant C is comprised of 17 plates.(42 - 58)
5. Quadrant D is comprised of 17 plates.(59 - 75)
6. This numbering convention begins with plate #1 being the first plate of quadrant A.

Drawing is not to scale

TANK # 2 - LOWER DOME - LINER PLATES



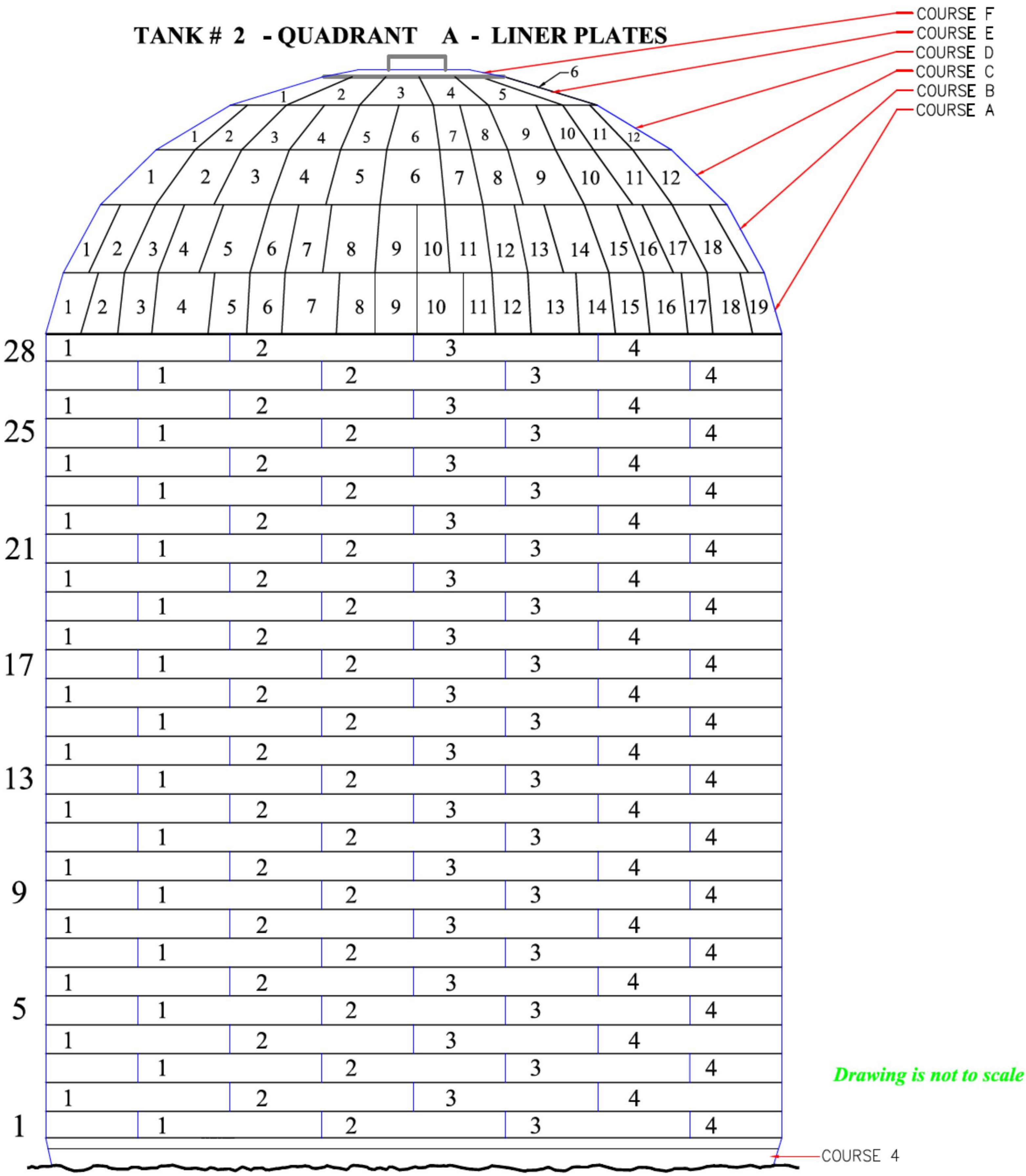
Drawing Notes:

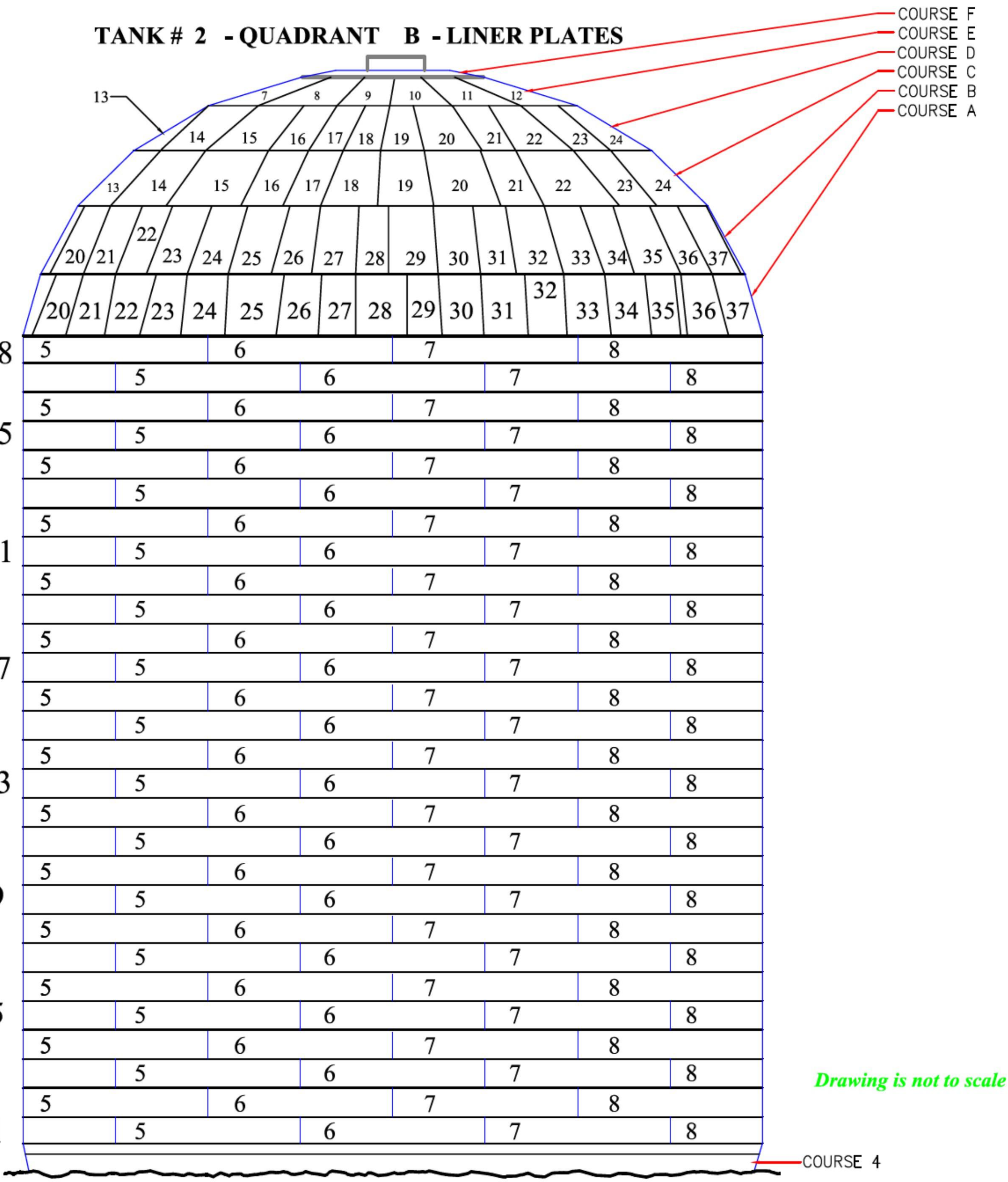
1. Tank is divided into 4 quadrants .
2. Course 1 is comprised of 21 plates.
3. Course 2 is comprised of 62 plates .
4. Course 3 is comprised of 62 plates .
5. Course 4 is comprised of 75 plates .
6. This numbering convention begins with plate #1 being the first plate of quadrant A.

Drawing is not to scale

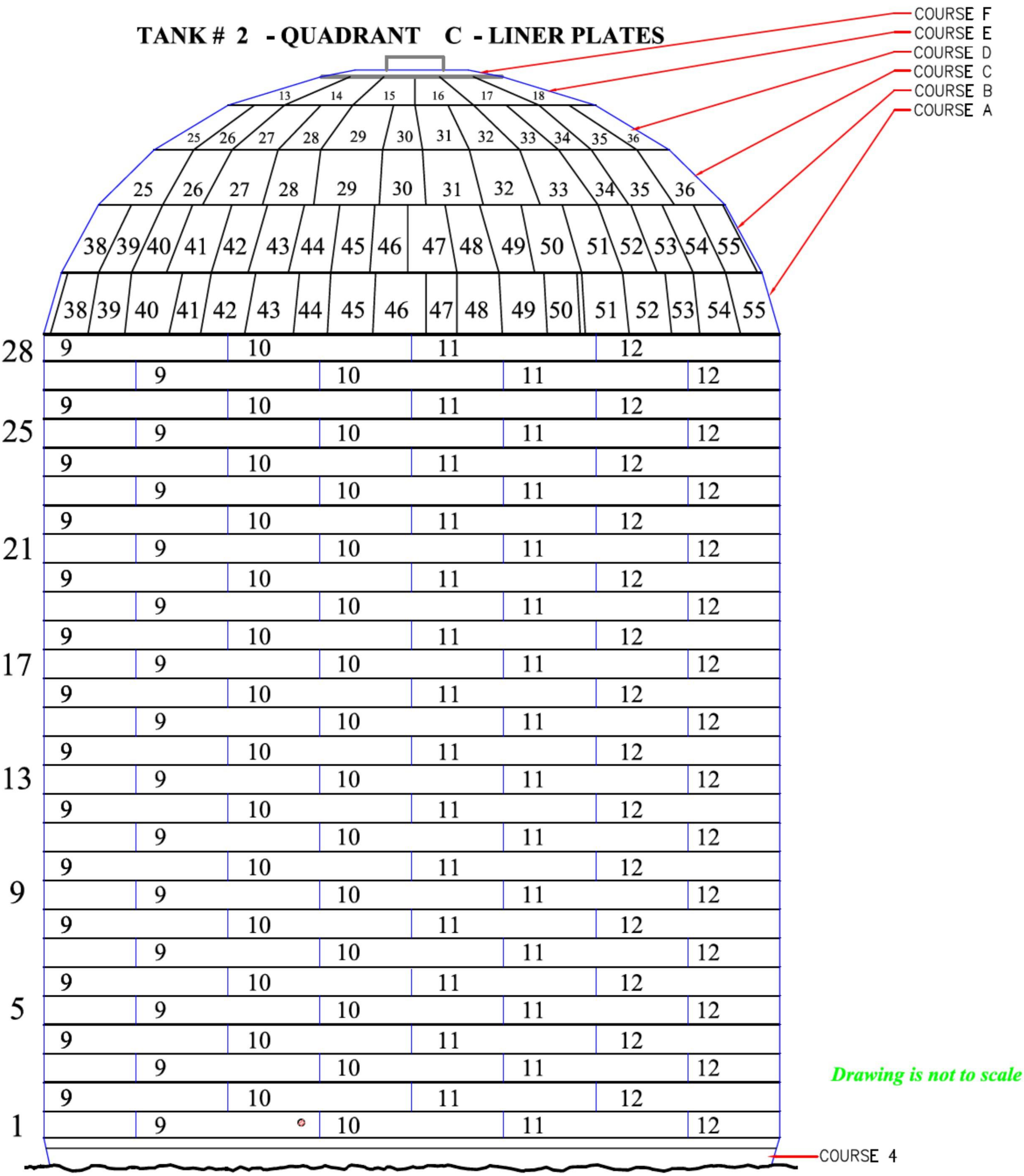
3.0 TANK MAPS

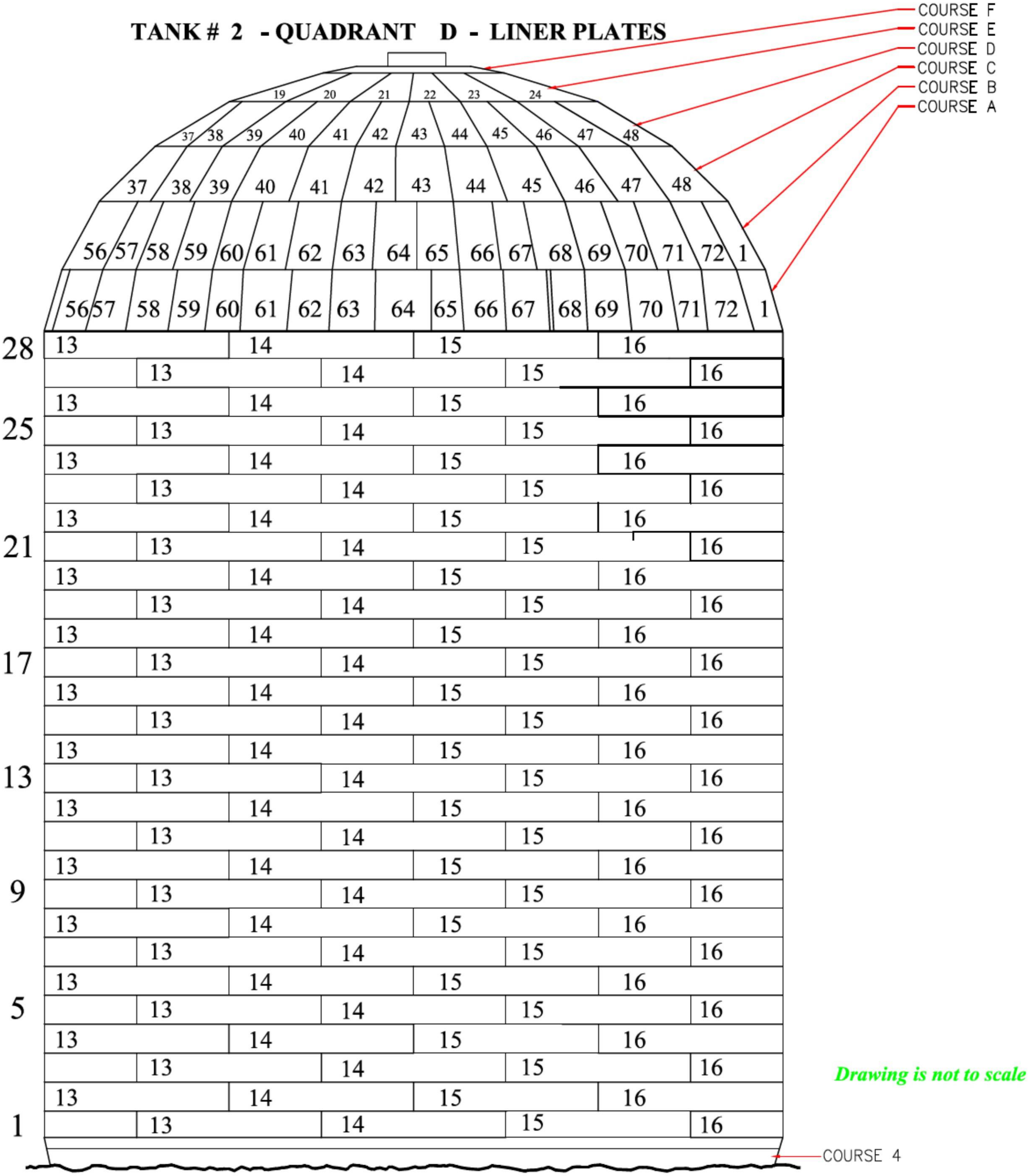
Dunkin & Bush, Inc.
Honolulu, HI




TANK # 2 - QUADRANT B - LINER PLATES
COURSE F
COURSE E
COURSE D
COURSE C
COURSE B
COURSE A
COURSE 4
28
25
21
17
13
9
5
1
Drawing is not to scale

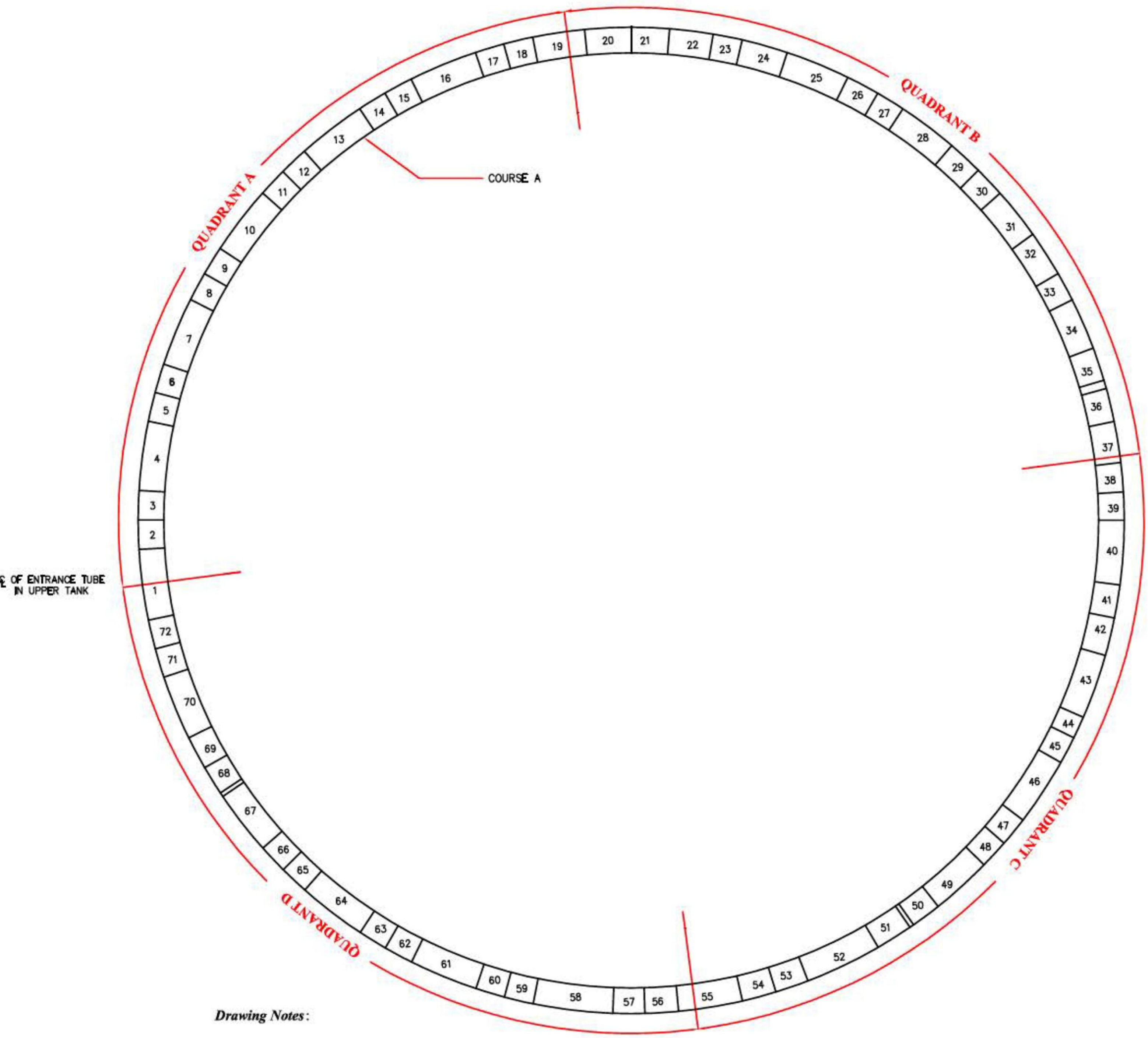
TANK # 2 - QUADRANT C - LINER PLATES




TANK # 2 - QUADRANT D - LINER PLATES
COURSE F
COURSE E
COURSE D
COURSE C
COURSE B
COURSE A
28
25
21
17
13
9
5
1
COURSE 4
Drawing is not to scale

3.0 Tank Maps
Dunkin & Bush, Inc.
Honolulu, HI
Tank # 2 - Upper Dome Liner Plates

TANK # 2 - UPPER DOME COURSE A



Drawing Notes:

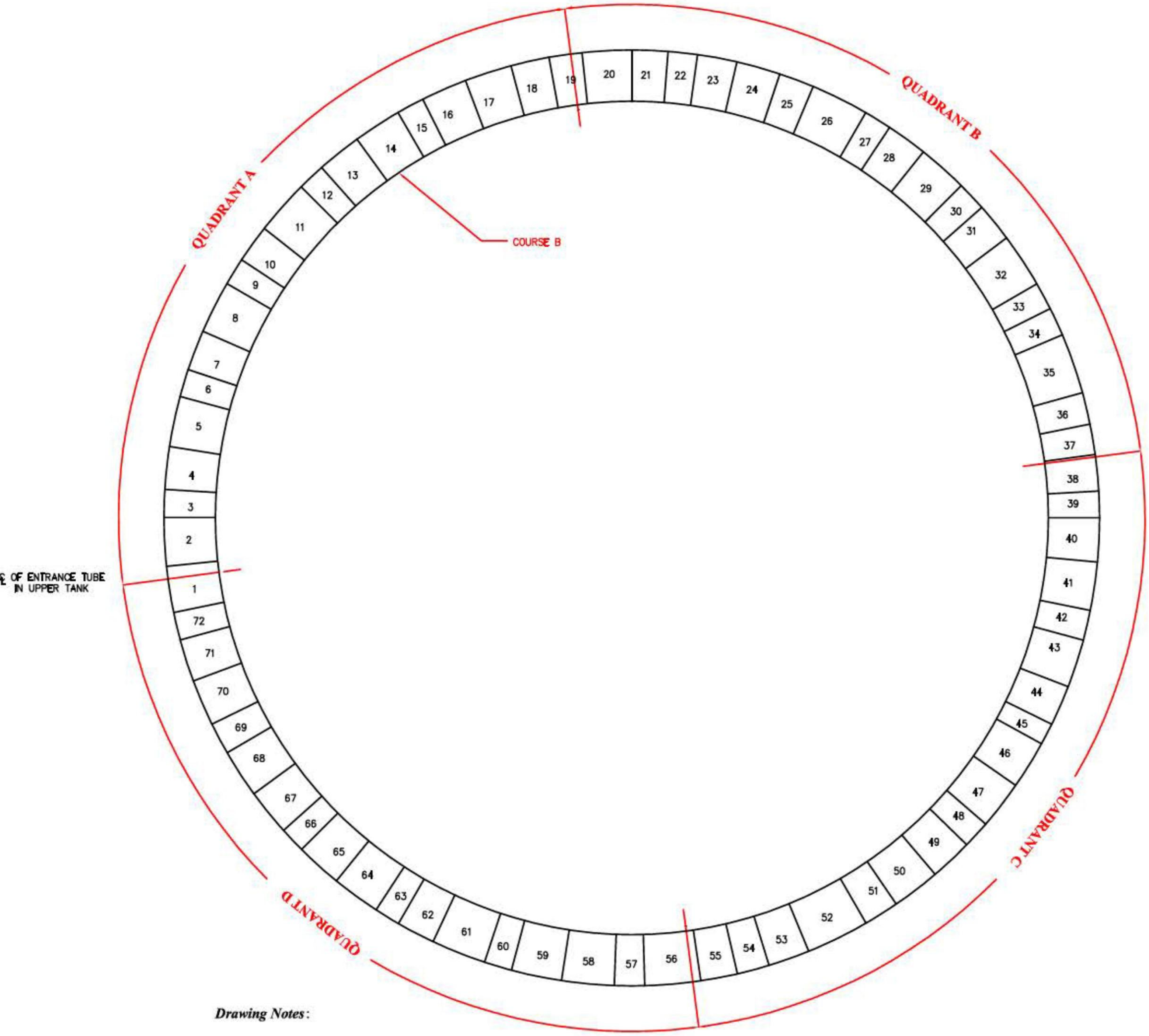
1. Tank is divided into 4 quadrants (A-D).
2. Course A is comprised of 72 total plates.
3. Quadrant A is comprised of 19 plates (1-19).
4. Quadrant B is comprised of 18 plates (20-37).
5. Quadrant C is comprised of 18 plates (38-55).
6. Quadrant D is comprised of 17 plates (56-72).
7. This numbering convention begins with plate #1 being the first full plate to the left of the manway in plan view.
8. All Plate intersection welds are covered with 3" wide channels.

Drawing is not to scale

3.0 Tank Maps

Dunkin & Bush, Inc..
Honolulu, HI
Tank # 2 - Upper Dome Liner Plates

TANK # 2 - UPPER DOME COURSE B



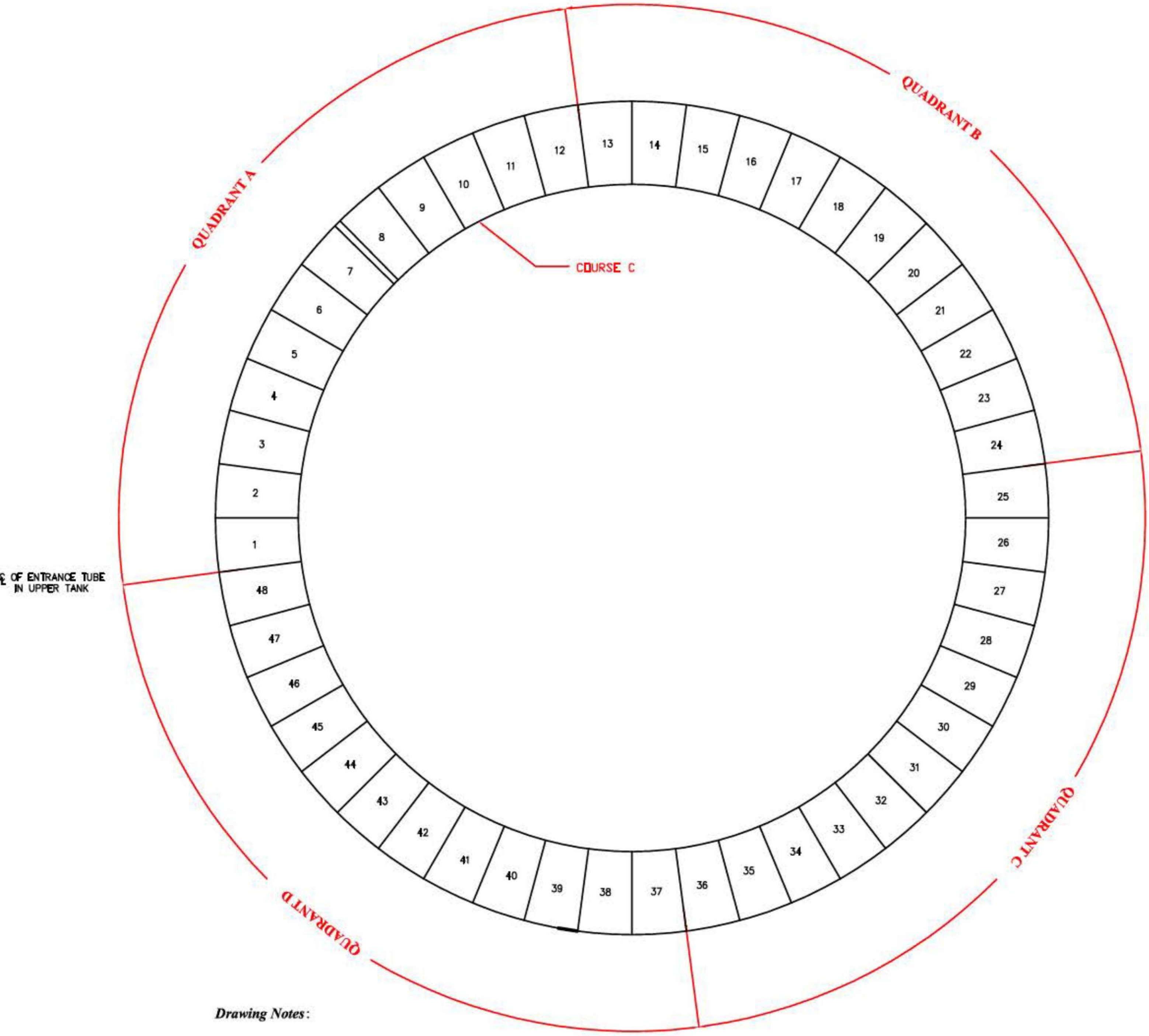
***Drawing Notes*:**

1. Tank is divided into 4 quadrants (A-D).
2. Course B is comprised of 72 total plates.
3. Quadrant A is comprised of 19 plates (1-19).
4. Quadrant B is comprised of 18 plates (20-37).
5. Quadrant C is comprised of 18 plates (38-55).
6. Quadrant D is comprised of 17 plates (56-72).
7. This numbering convention begins with plate #1 being the first full plate to the left of the manway in plan view.
8. All Plate intersection welds are covered with 3" wide channels.

Drawing is not to scale

3.0 Tank Maps
Dunkin & Bush, Inc..
Honolulu, HI
Tank # 2 - Upper Dome Liner Plates

TANK # 2 - UPPER DOME COURSE C



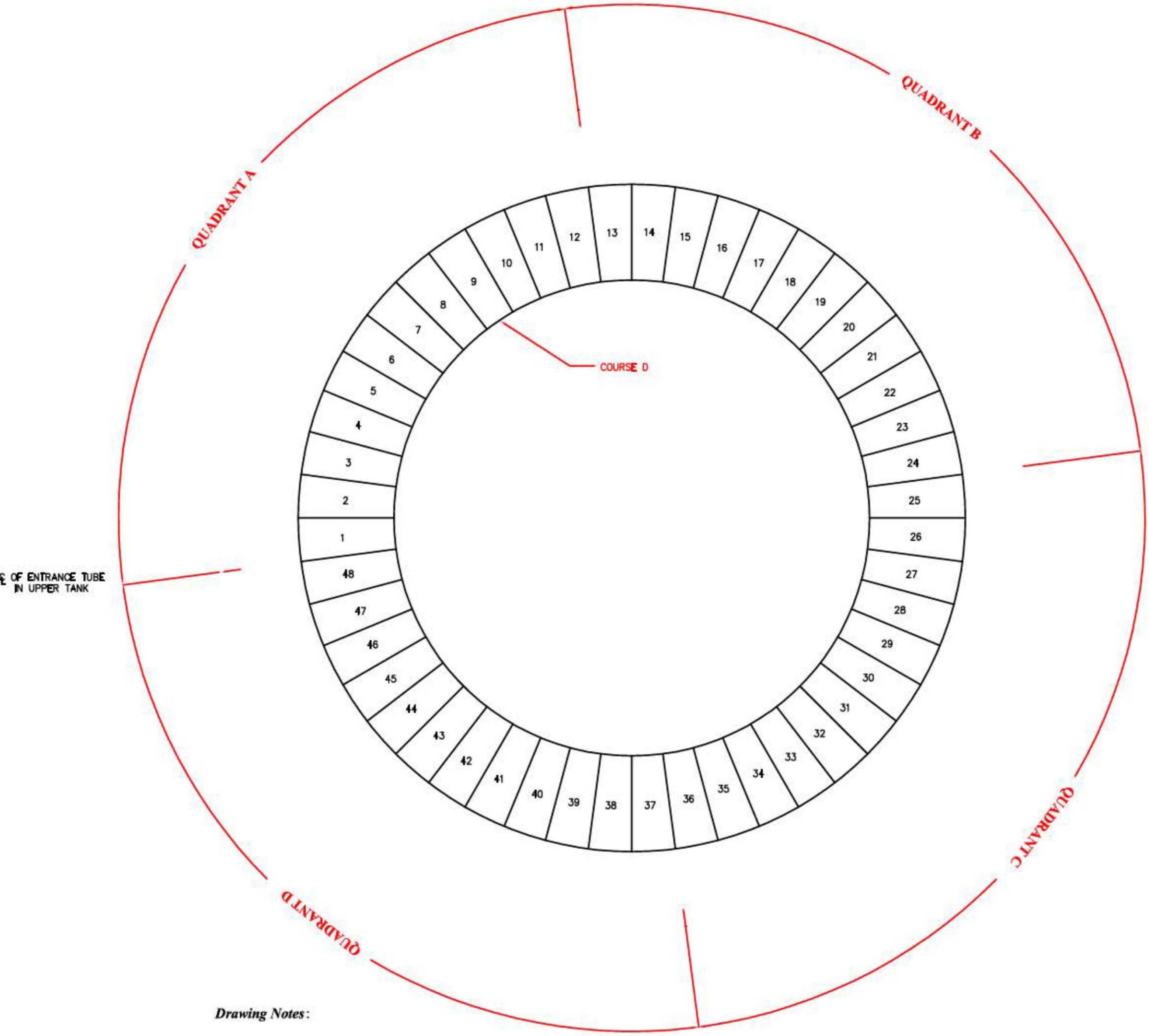
***Drawing Notes*:**

1. Tank is divided into 4 quadrants (A-D).
2. Course C is comprised of 48 total plates.
3. Quadrant A is comprised of 12 plates (1-12).
4. Quadrant B is comprised of 12 plates (13-24).
5. Quadrant C is comprised of 12 plates (25-36).
6. Quadrant D is comprised of 12 plates (37-48).
7. This numbering convention begins with plate #1 being the first full plate to the left of the manway in plan view.
8. All Plate intersection welds are covered with 3" wide channels.

Drawing is not to scale

3.0 Tank Maps
Dunkin & Bush, Inc..
Honolulu, HI
Tank #   - Upper Dome Liner Plates

TANK # 2 - UPPER DOME COURSE D



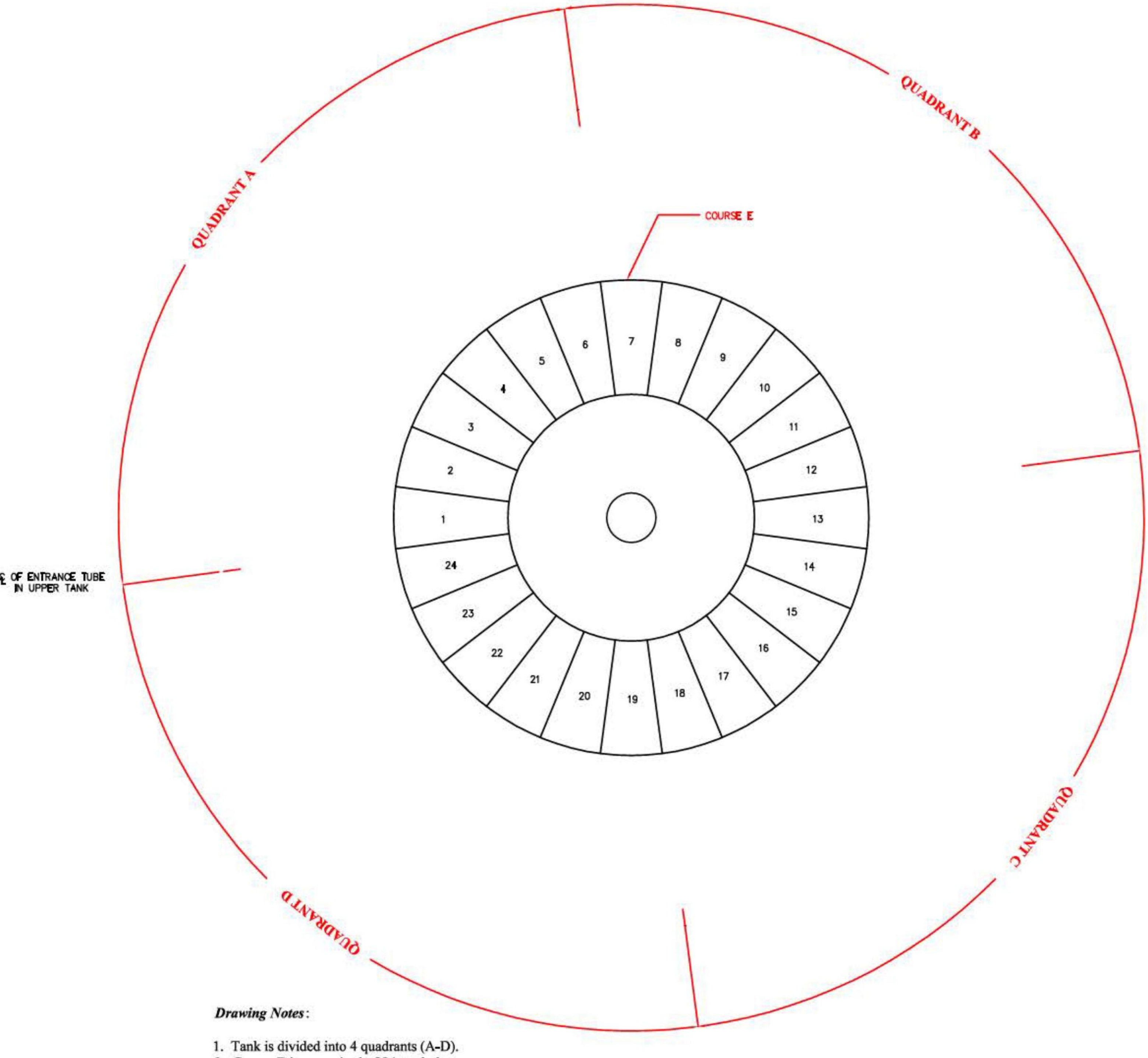
***Drawing Notes*:**

1. Tank is divided into 4 quadrants (A-D).
2. Course D is comprised of 48 total plates.
3. Quadrant A is comprised of 12 plates (1-12).
4. Quadrant B is comprised of 12 plates (13-24).
5. Quadrant C is comprised of 12 plates (25-36).
6. Quadrant D is comprised of 12 plates (37-48).
7. This numbering convention begins with plate #1 being the first full plate to the left of the manway in plan view.
8. All Plate intersection welds are covered with 3" wide channels

Drawing is not to scale

3.0 Tank Maps
Dunkin & Bush, Inc..
Honolulu, HI
Tank # 2 - Upper Dome Liner Plates

TANK # 2 - UPPER DOME COURSE E



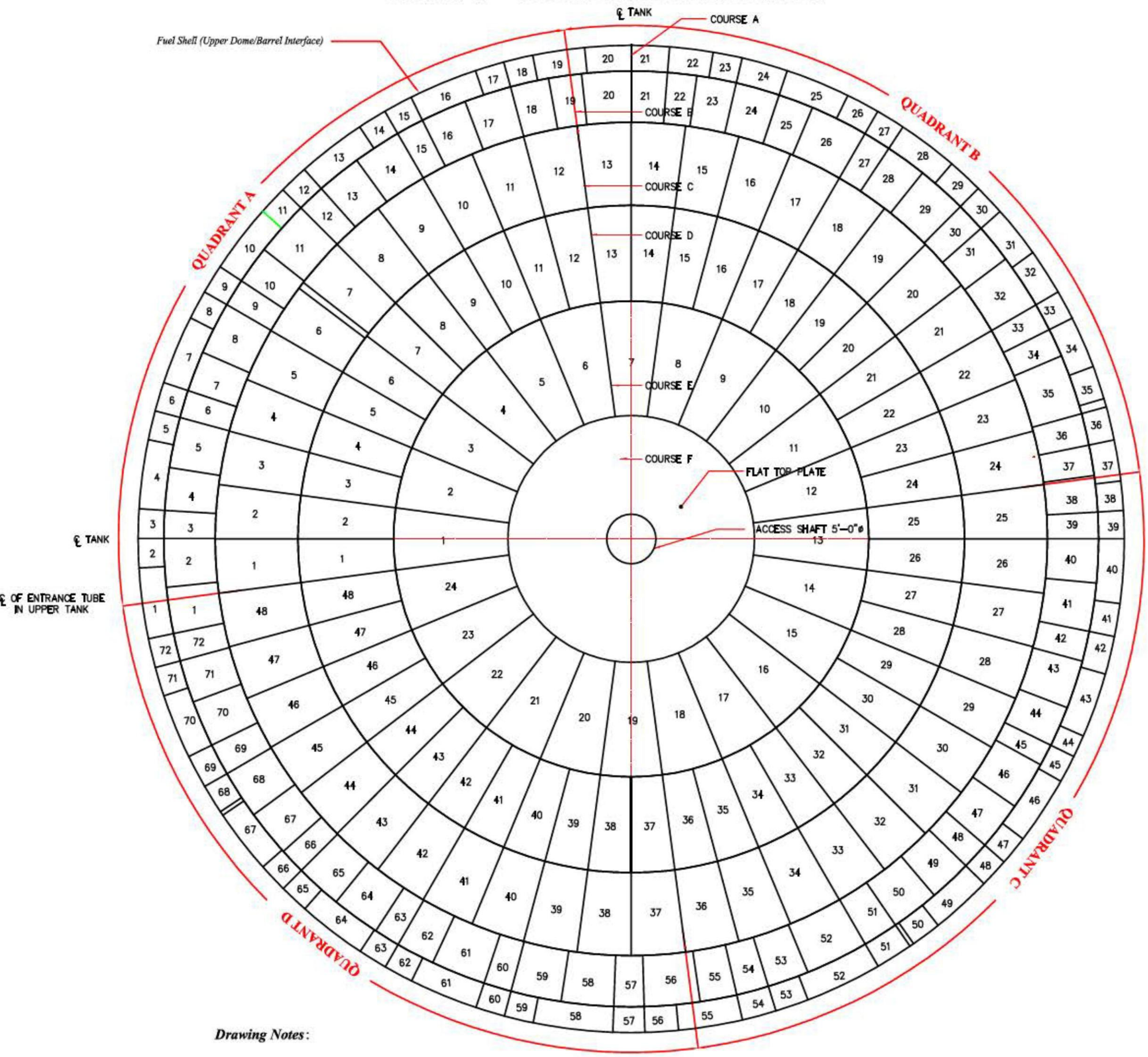
Drawing Notes:

1. Tank is divided into 4 quadrants (A-D).
2. Course E is comprised of 24 total plates.
3. Quadrant A is comprised of 6 plates (1-6).
4. Quadrant B is comprised of 6 plates (7-12).
5. Quadrant C is comprised of 6 plates (13-18).
6. Quadrant D is comprised of 6 plates (19-24).
7. This numbering convention begins with plate #1 being the first full plate to the left of the manway in plan view.
8. All Plate intersection welds are covered with 3" wide channels.

Drawing is not to scale

3.0 Tank Maps
Dunkin & Bush, Inc..
Honolulu, HI
Tank # 2 - Upper Dome Liner Plates

TANK # 2 - UPPER DOME LINER PLATES



***Drawing Notes*:**

1. Tank is divided into 4 quadrants (A-D).
2. Course A is comprised of 72 total plates.
3. Course B is comprised of 72 total plates.
4. Course C is comprised of 48 total plates.
5. Course D is comprised of 48 total plates.
6. Course E is comprised of 24 total plates.
7. This numbering convention begins with plate #1 being the first full plate to the left of the manway in plan view.
8. All Plate intersection welds are covered with 3" wide channels.

Drawing is not to scale

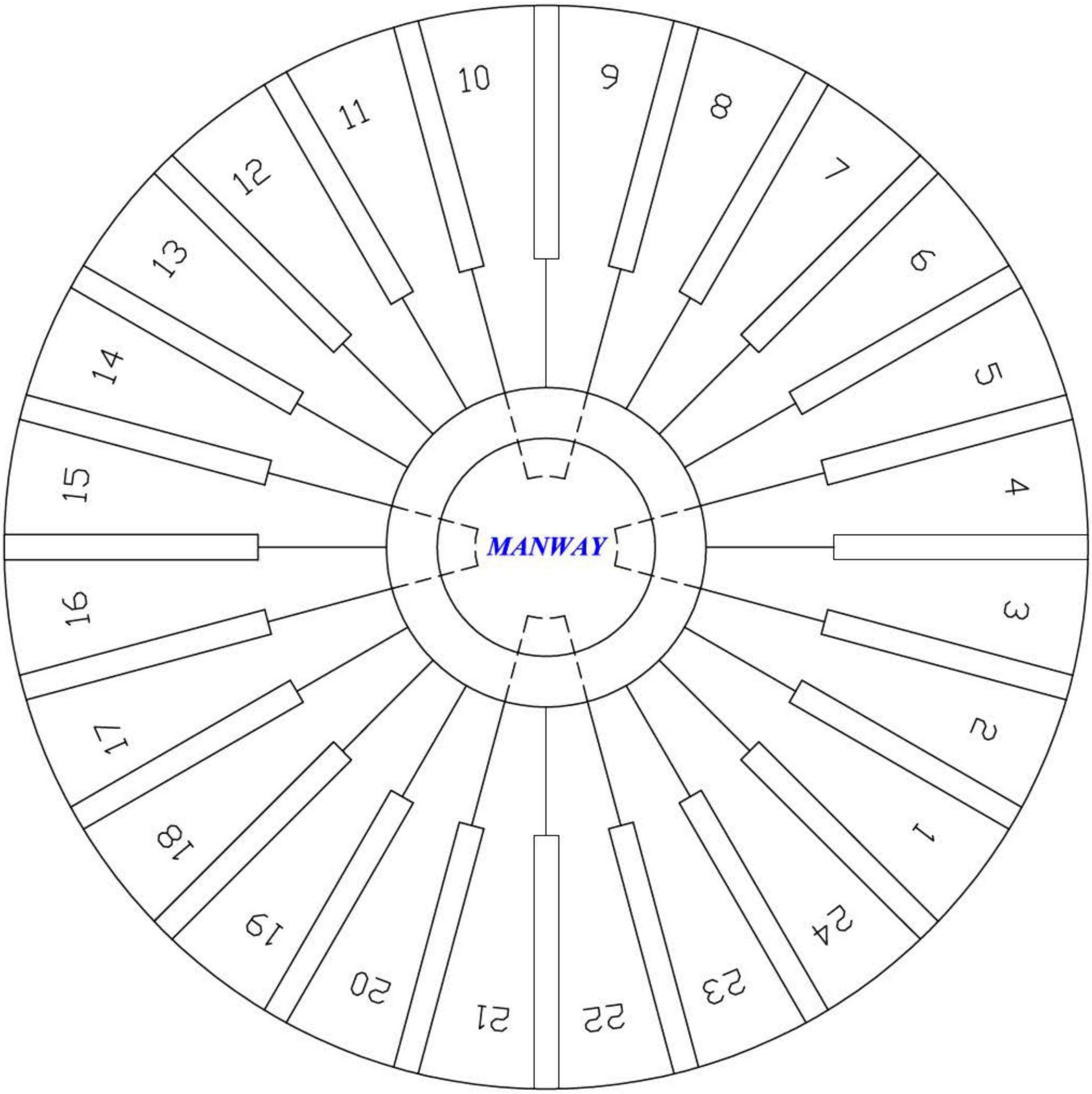
3.0 TANK MAPS

Dunkin and Bush, Inc.
Honolulu, HI
Tank #2 - Upper Dome Course F

Date Inspected/Confirmed: 5/6/2008

Tank Section: Upper Dome
Quadrant: A, B, C, D
Course: F

TANK #2 - Upper Dome Course F



Drawing is not to scale

TANK #2 - QUADRANT A

***Nominal Plate Thickness: 0.250"**

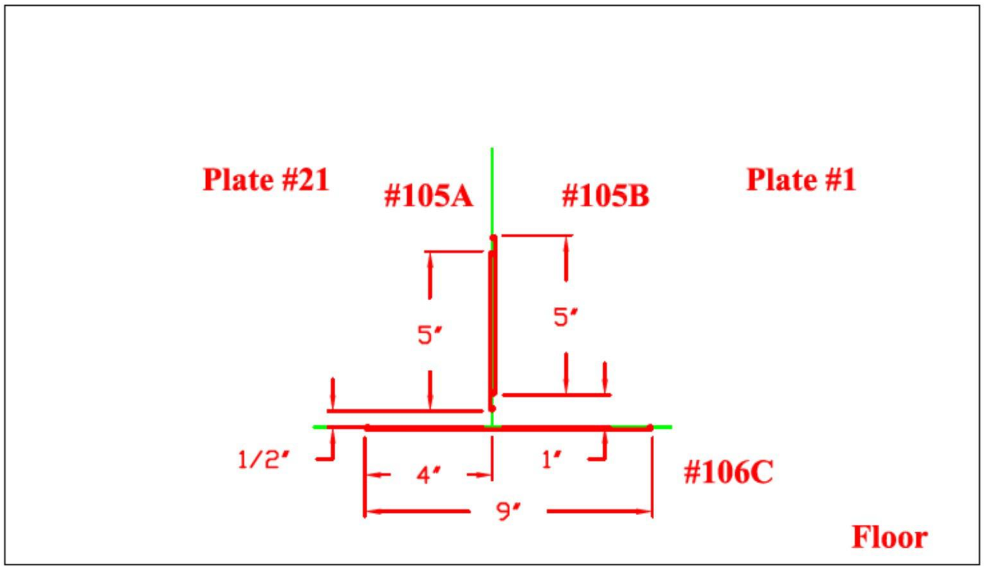
Date Inspected/Confirmed: 05/08/2008

Tank Section: Floor/Shell
Quadrant: A
Course:
Plate: # 21 - 1

Flaw # 105A - Lack of fusion .094 depth 5" long (left)

Flaw # 105B - Lack of fusion .081 depth 5" long (right)

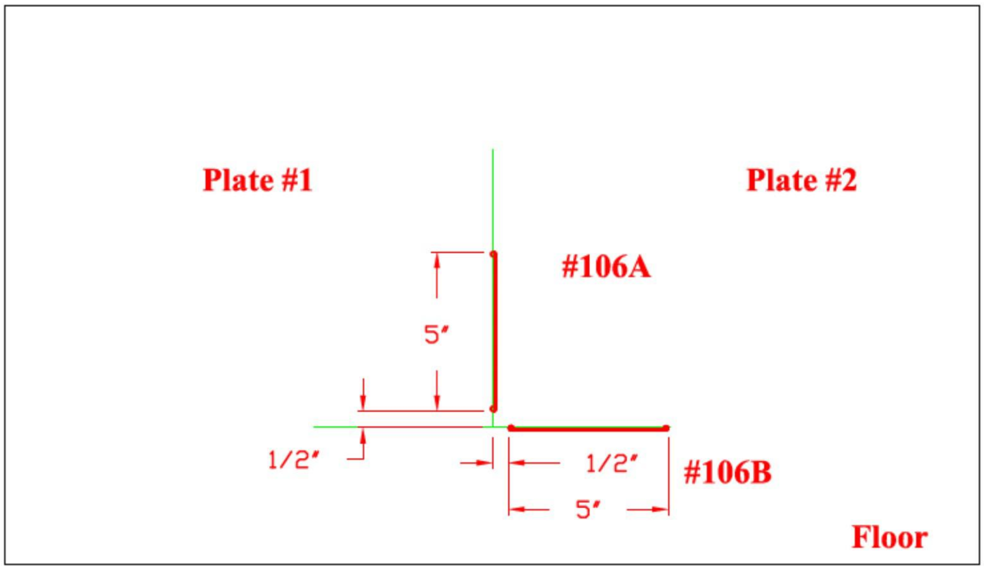
Flaw # 105C - Lack of fusion .100 depth 9" long (bottom)



Tank Section: Floor/Shell
Quadrant: A
Course:
Plate: # 1 - 2

Flaw # 106A - Lack of fusion .086 depth 5" long (right)

Flaw # 106B - Lack of fusion .084 depth 5" long (bottom)



Drawing is not to scale

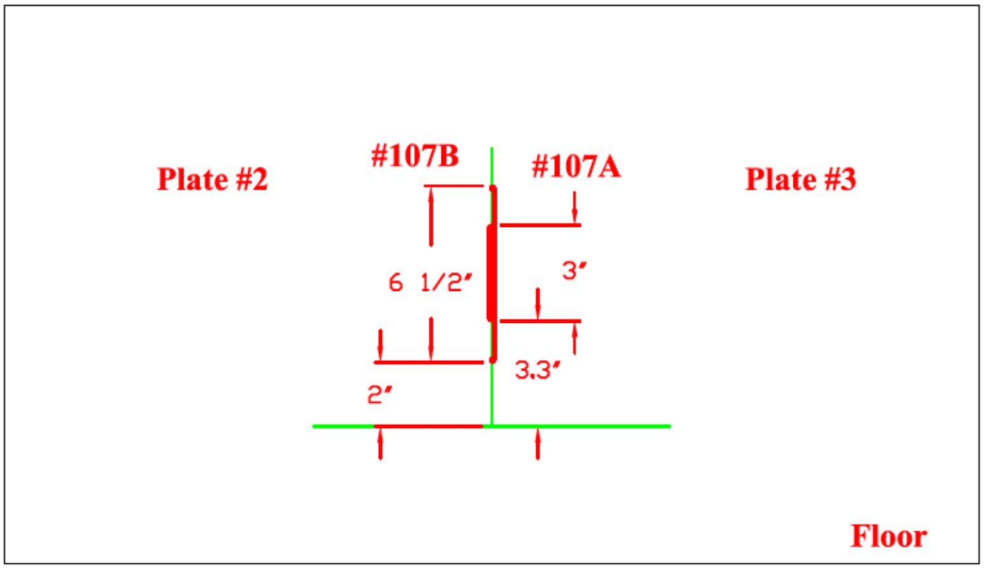
TANK #2 - QUADRANT A
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/08/2008

Tank Section: Floor/Shell
Quadrant: A
Course:
Plate: # 2 - 3

Flaw #107A - Lack of fusion .201 depth 6 ½" long (right)

Flaw #107B - Lack of fusion .217 depth 3" long (left)



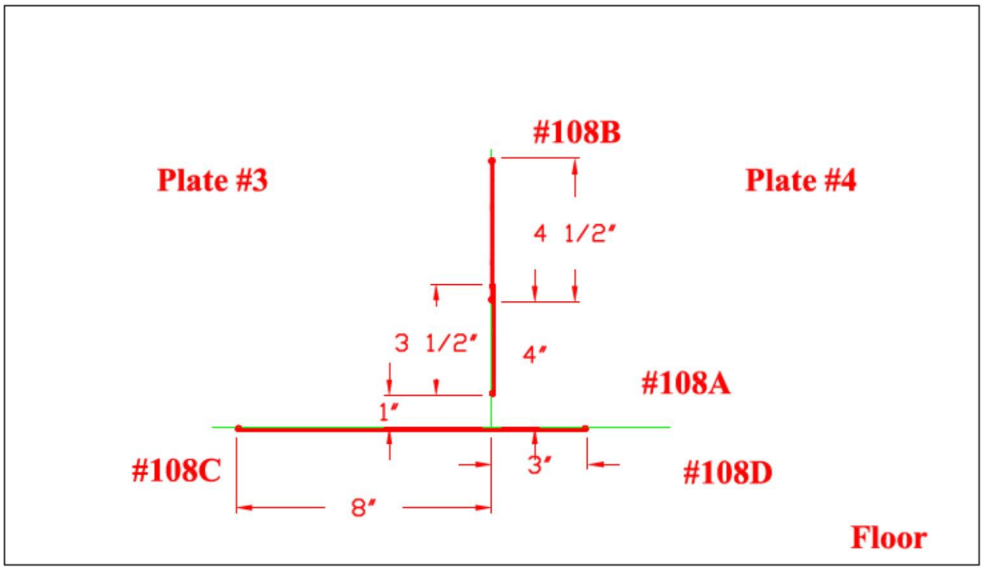
Tank Section: Floor/Shell
Quadrant: A
Course:
Plate: # 3 - 4

Flaw #108A - Lack of fusion .206 depth 3 ½" long (right)

Flaw #108B - Lack of fusion .200 depth 4 ½" long (center)

Flaw #108C - Lack of fusion .080 depth 8" long (bottom)

Flaw #108D - Lack of fusion .135 depth 3" long (bottom)



Drawing is not to scale

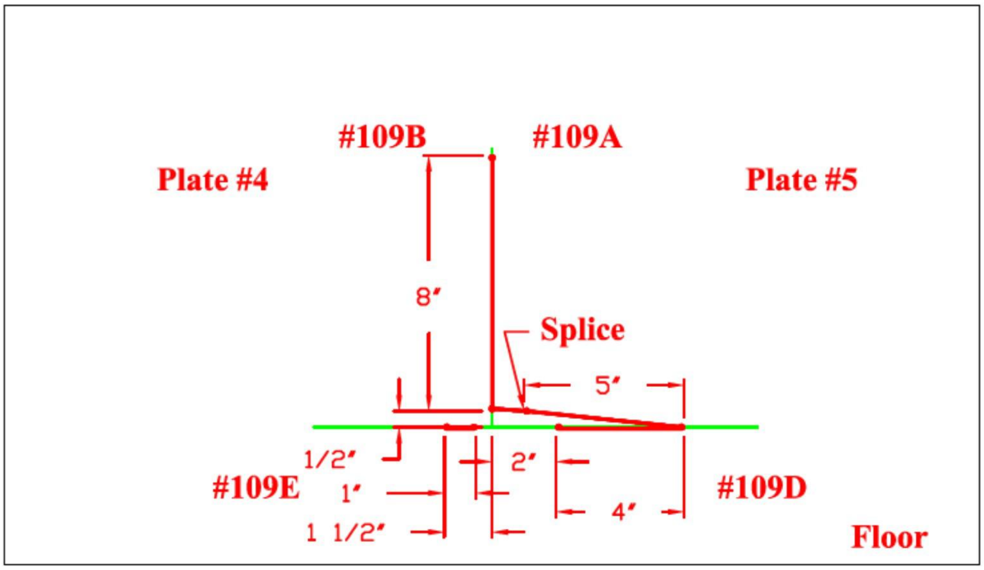
TANK #2 - QUADRANT A

Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/09/2008

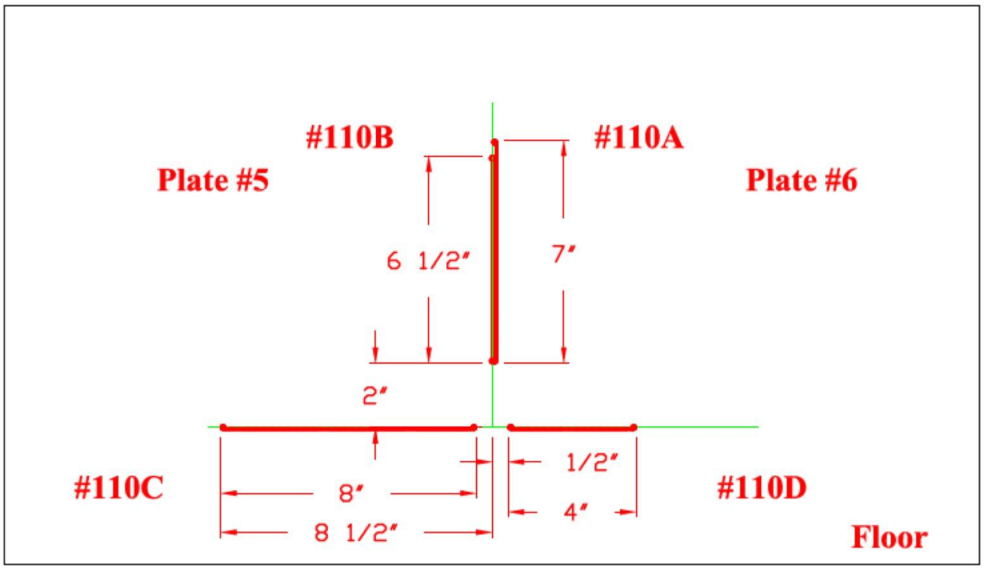
Tank Section: Floor/Shell
Quadrant: A
Course:
Plate: # 4 - 5

Flaw #109A,B - Lack of fusion
.201 depth 8" long (right)
.212 depth 8" long (left)
Flaw #109C - Lack of fusion
.201 depth 5" long (center)
Flaw #109D,E - Lack of fusion
.086 depth 4" long (bottom)
.162 depth 1" long (bottom)



Tank Section: Floor/Shell
Quadrant: A
Course:
Plate: # 5 - 6

Flaw #110A - Lack of fusion
.193 depth 7" long (right)
Flaw #110B - Lack of fusion
.198 depth 6 1/2" long (left)
Flaw #110C - Lack of fusion
.065 depth 8" long (bottom)
Flaw #110D - Lack of fusion
.148 depth 4" long (bottom)



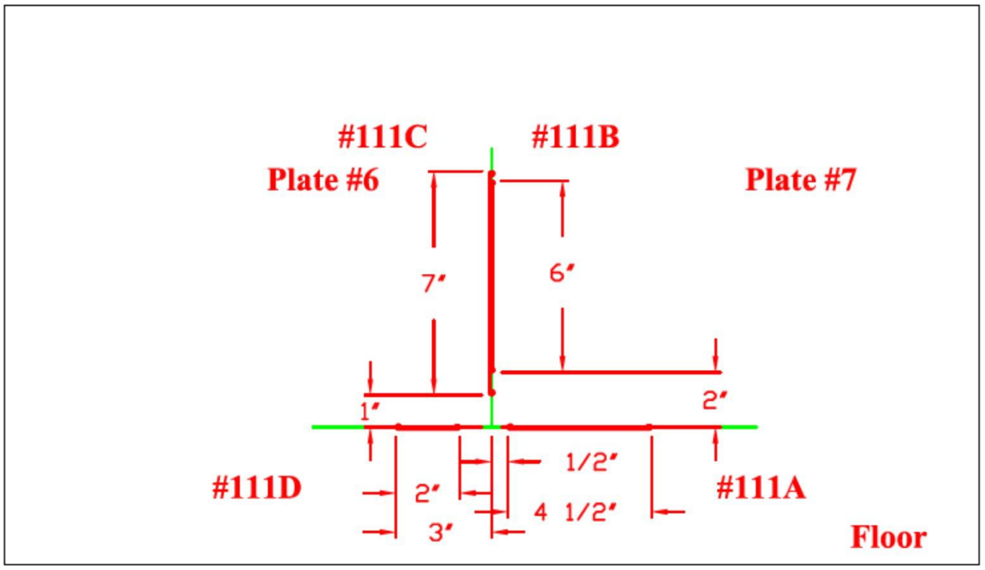
Drawing is not to scale

TANK #2 - QUADRANT AB
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/09/2008

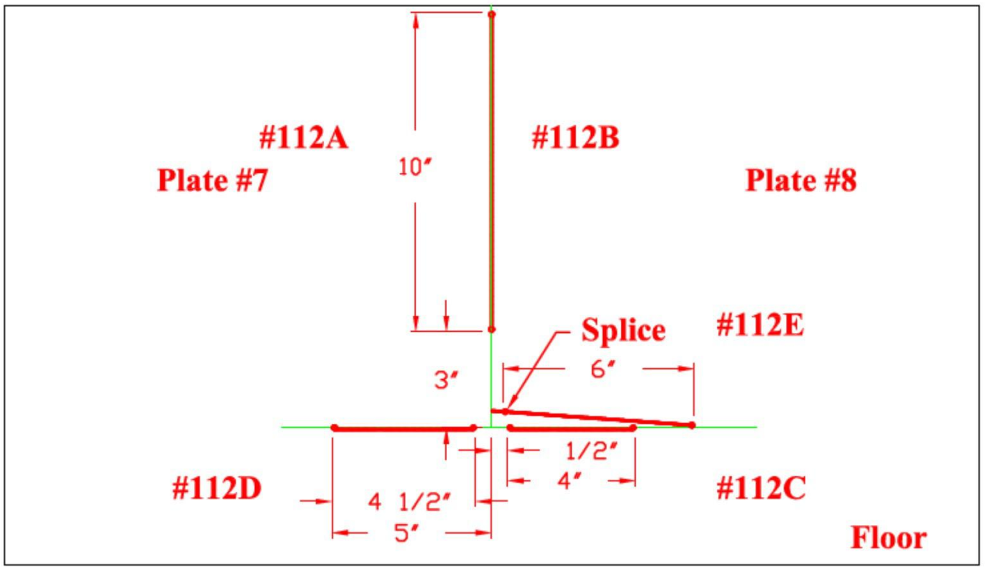
Tank Section: Floor/Shell
Quadrant: AB
Course:
Plate: # 6 - 7

Flaw #111A - Lcak of fusion
.185" depth 4 ½" long (bottom)
Flaw #111 B,C - Lcak of fusion
.157" depth 6" long (right)
.197" depth 7" long (left)
Flaw #111 D - Lcak of fusion
.195" depth 2" long (bottom)



Tank Section: Floor/Shell
Quadrant: AB
Course:
Plate: # 7 - 8

Flaw #112A,B - Intermittent crack
.145" depth 10" long (left)
.222" depth 10" long (right)
Flaw #112C - Intermittent crack
.188" depth 4" long (top)
Flaw #112D - Intermittent crack
.182" depth 4 1/2" long (bottom)
Flaw #112E - Splice -Intermittent crack
.218" depth 6" long (center)



Drawing is not to scale

TANK #2 - QUADRANT B

Nominal Plate Thickness: 0.250"

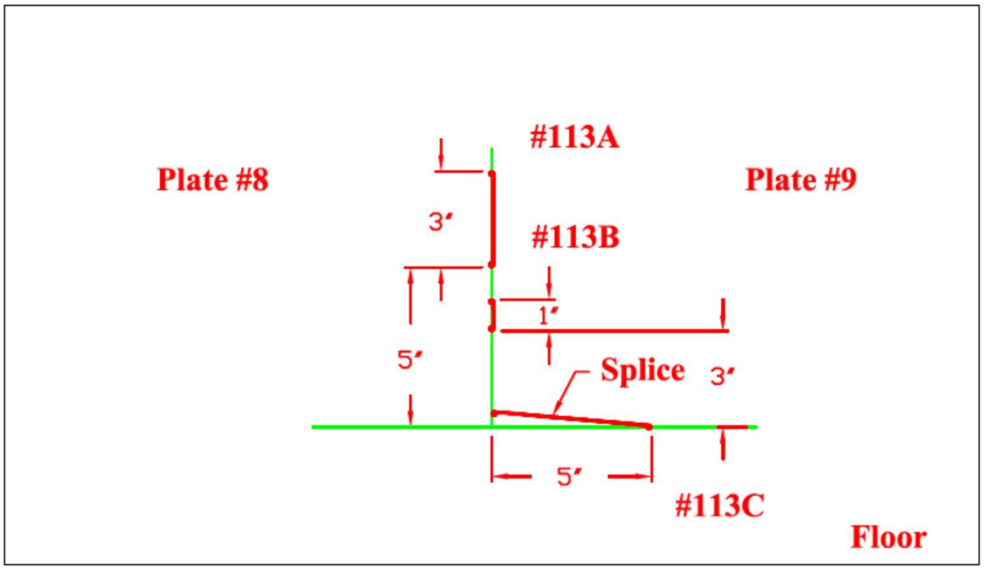
Date Inspected/Confirmed: 05/08/2008

Tank Section: Floor/Shell
Quadrant: B
Course:
Plate: # 8 - 9

Flaw #113A - Lack of fusion .079" depth 3" long (right)

Flaw #113B - Lack of fusion .207" depth 1" long (right)

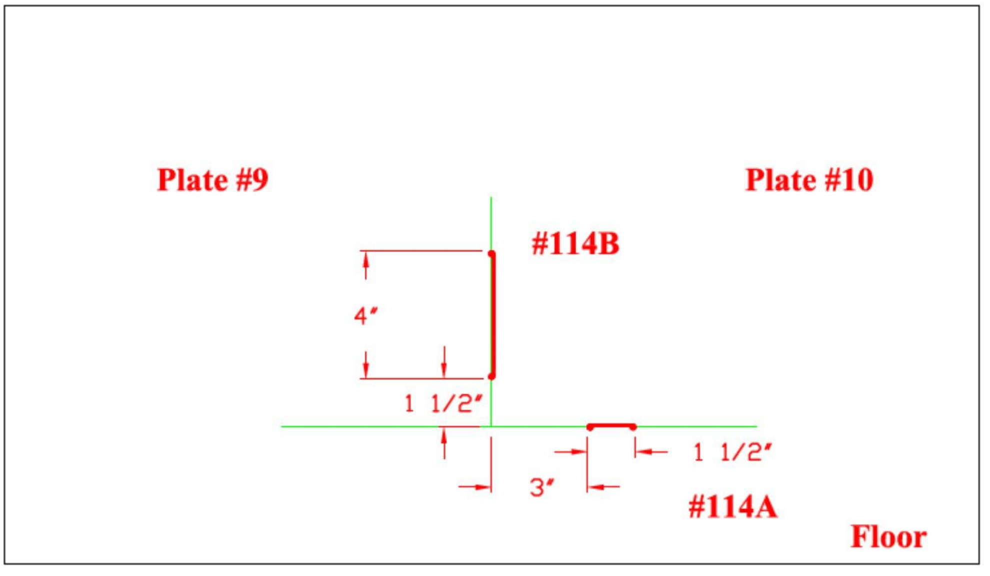
Flaw #113C - Lack of fusion .086" depth 5" long (top)



Tank Section: Floor/Shell
Quadrant: B
Course:
Plate: # 9 - 10

Flaw #114A - Lack of fusion .133" depth 1 1/2" long (top)

Flaw #114B - Lack of fusion .216" depth 4" long (right)



Drawing is not to scale

TANK #2 - QUADRANT BC

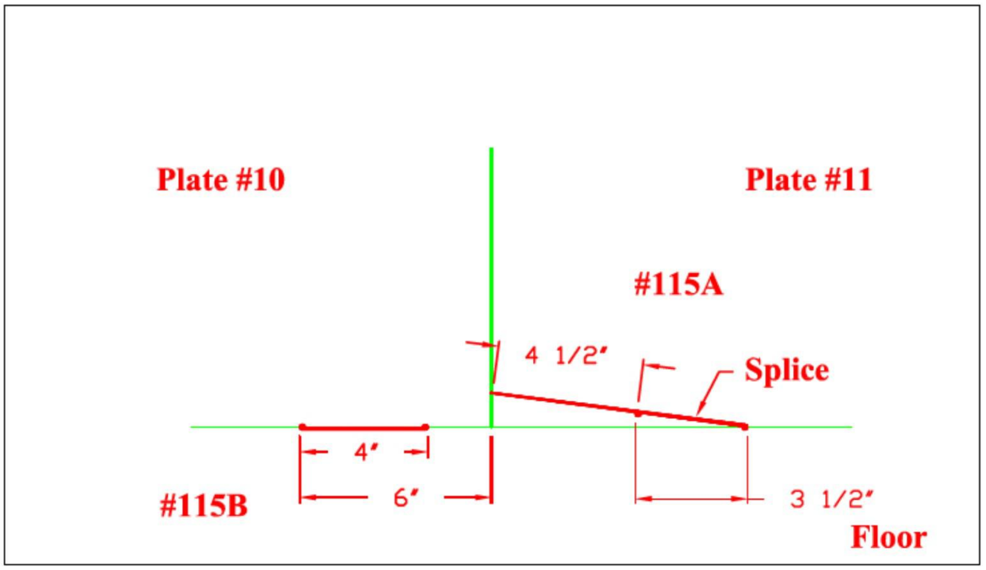
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/08/2008

Tank Section: Floor/Shell
Quadrant: B
Course:
Plate: # 10 - 11

Flaw # 115A - Splice - LOF
.082" depth 3 1/2" long (top)

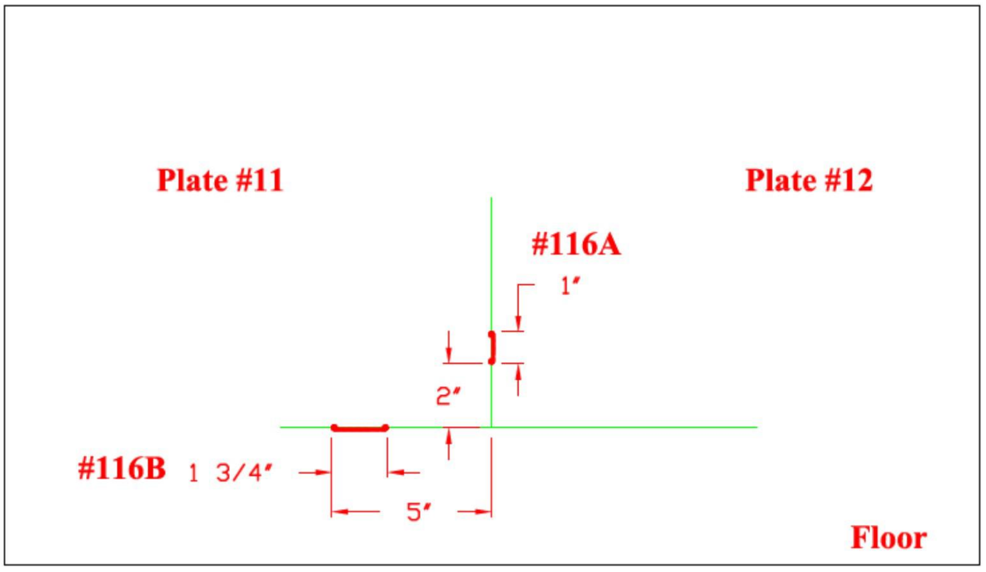
Flaw # 115B - Lack of fusion
.080" depth 4" long (bottom)



Tank Section: Floor/Shell
Quadrant: BC
Course:
Plate: # 11 -12

Flaw # 116A - Lack of fusion
.216" depth 1" long (right)

Flaw # 116B - Lack of fusion
.071" depth 1 3/4" long (bottom)



Drawing is not to scale

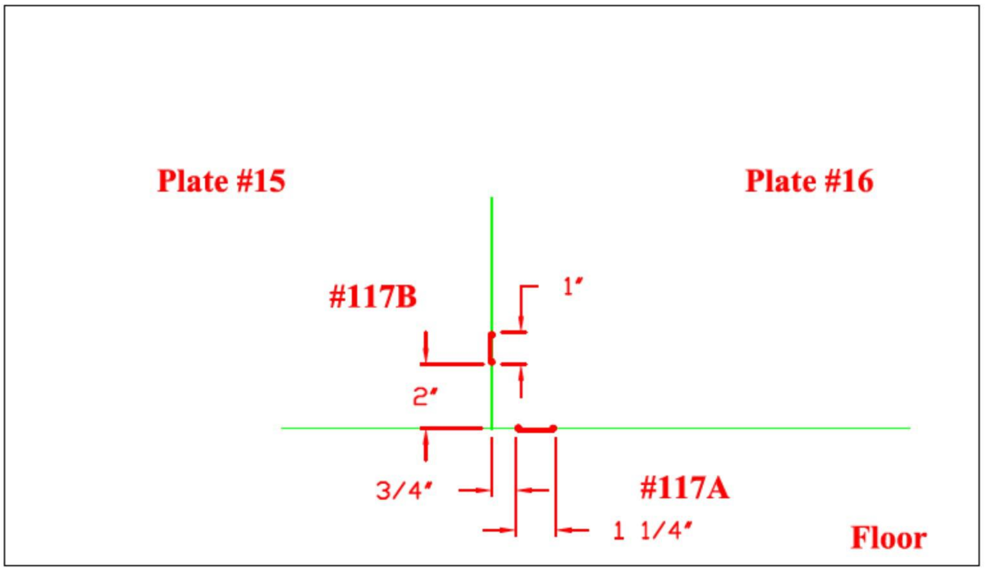
TANK #2 - QUADRANT CD

Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/08/2008

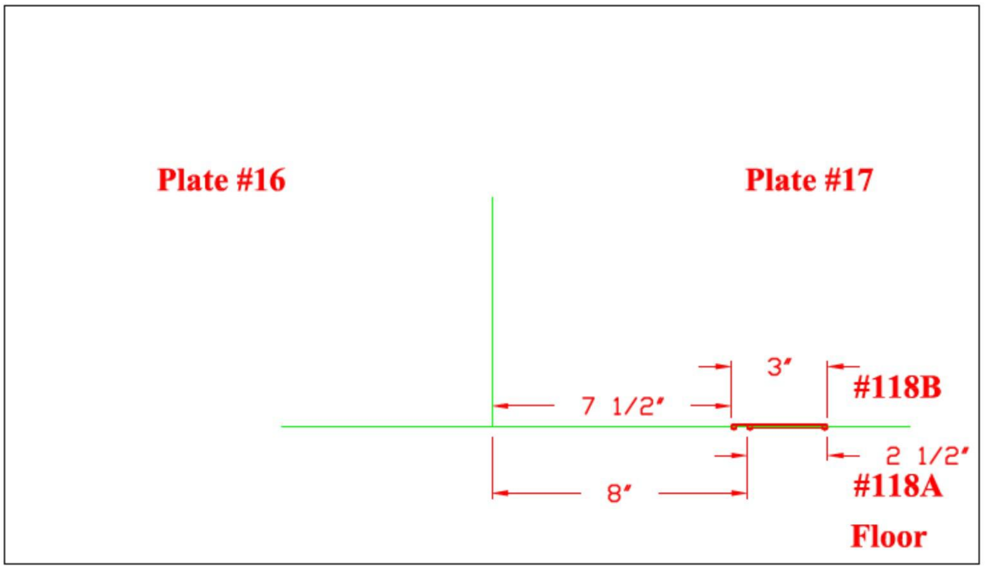
Tank Section: Floor/Shell
Quadrant: C
Course:
Plate: # 15 - 16

Flaw #117A - Lack of fusion
.102" depth 1 1/4" long (bottom)
Flaw #117B - Lack of fusion
.197" depth 1" long (left)



Tank Section: Floor/Shell
Quadrant: CD
Course:
Plate: # 16 - 17

Flaw #118A - Lack of fusion
.080" depth 2 1/2" long (bottom)
Flaw # 118B - Lack of fusion
.085" depth 3" long (top)



Drawing is not to scale

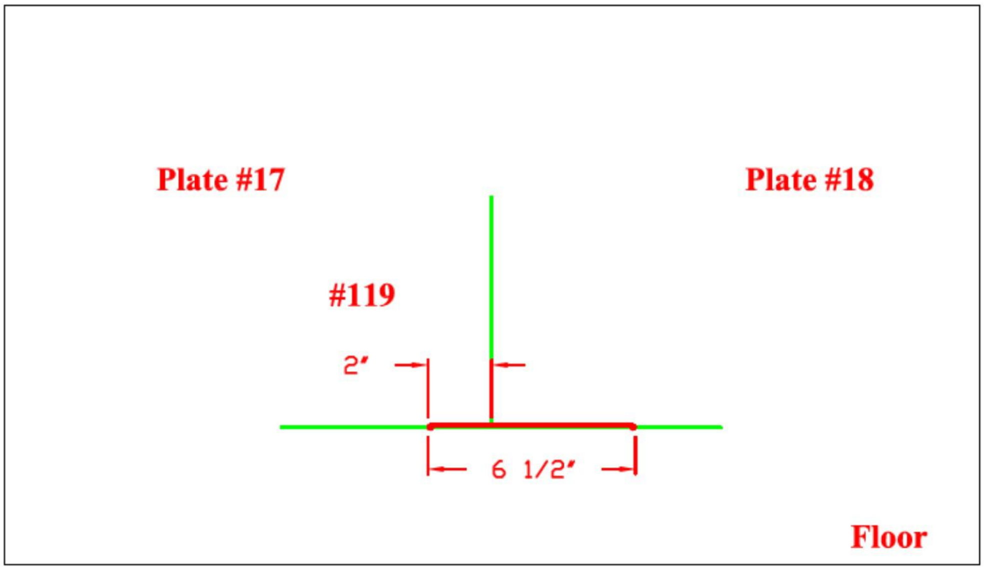
TANK #2 - QUADRANT D

Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/05/2008

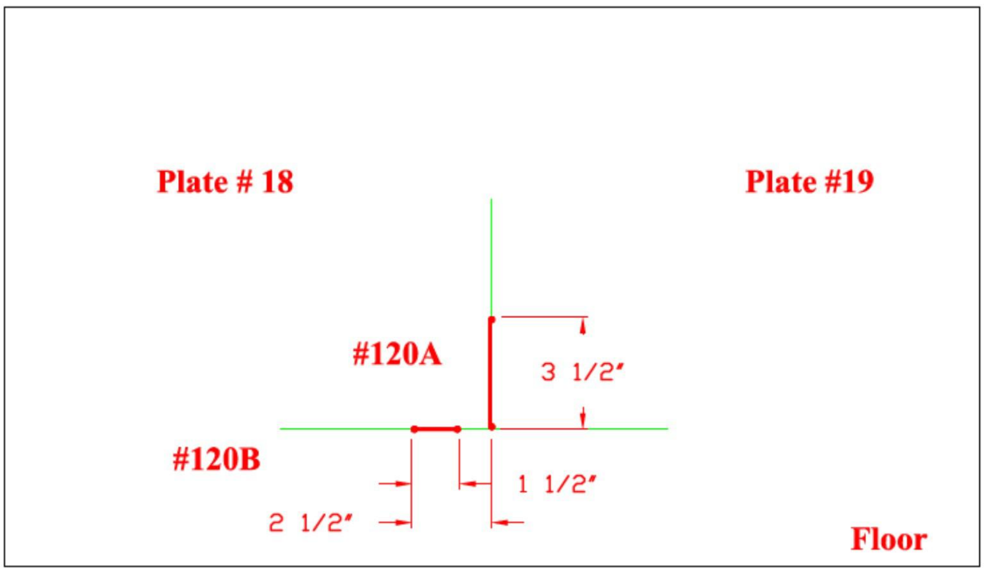
Tank Section: Floor/Shell
Quadrant: D
Course:
Plate: # 17 - 18

Flaw #119 - Lack of fusion
.211" depth 6 ½" long (top)



Tank Section: Floor/Shell
Quadrant: D
Course:
Plate: # 18 - 19

Flaw #120A - Lack of fusion
.088" depth 3 ½" long (left)
Flaw #120B - Incomplete pen.
.228" depth 1 ½" long (center)



Drawing is not to scale

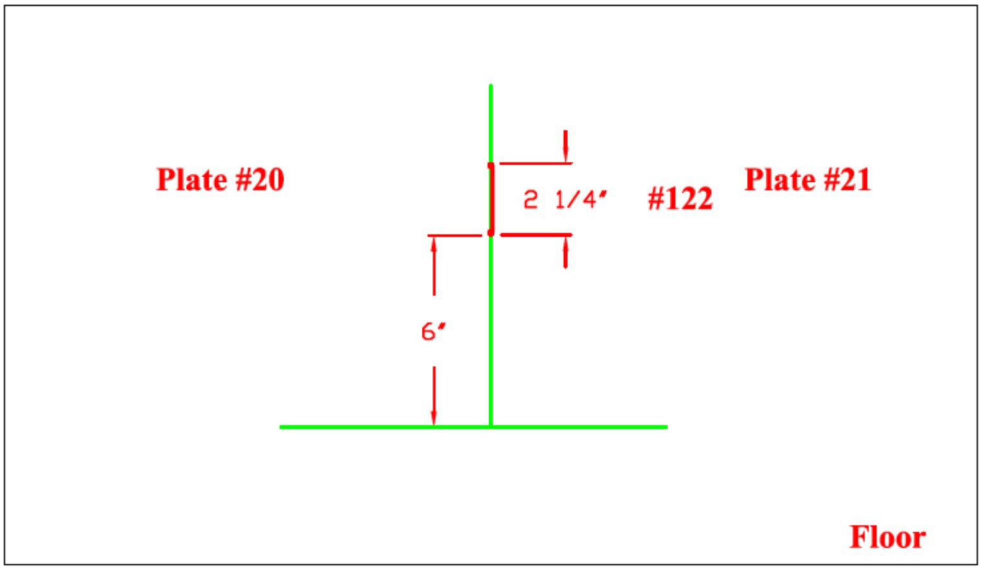
3.0 TANK MAPS
Dunkin & Bush, Inc.
Honolulu, HI
Tank # -2 Quadrant D

TANK #2 - QUADRANT D
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/08/2008

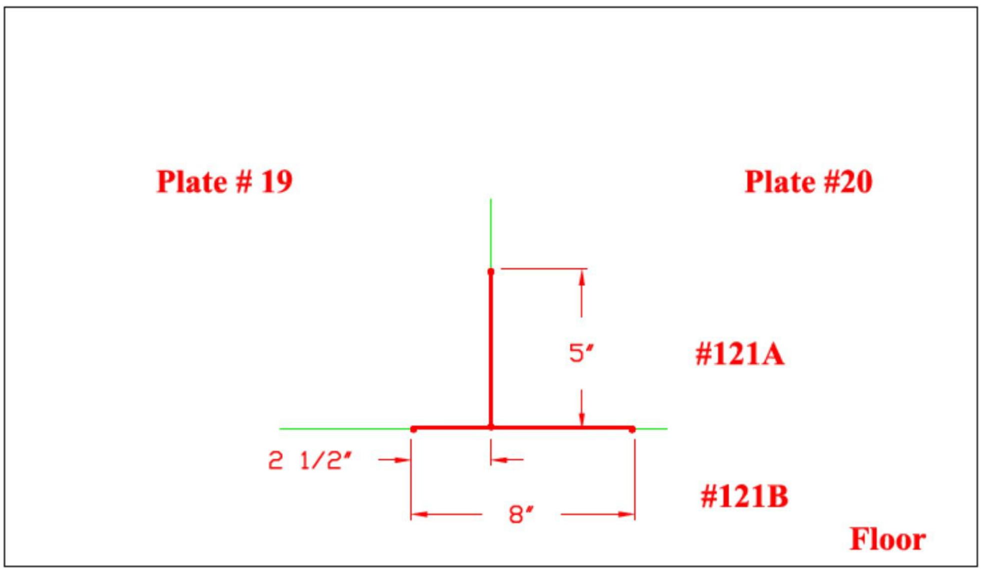
Tank Section: Floor/Shell
Quadrant: D
Course:
Plate: # 20 - 21

Flaw #122 - Lack of fusion
.192 depth 2 ¼" long (Right)



Tank Section: Floor/Shell
Quadrant: D
Course:
Plate: # 19 - 20

Flaw #121A - Intermittent crack
.238 depth 5" long (center)
Flaw #121B - Intermittent crack
.231 depth 8" long (top)



Drawing is not to scale

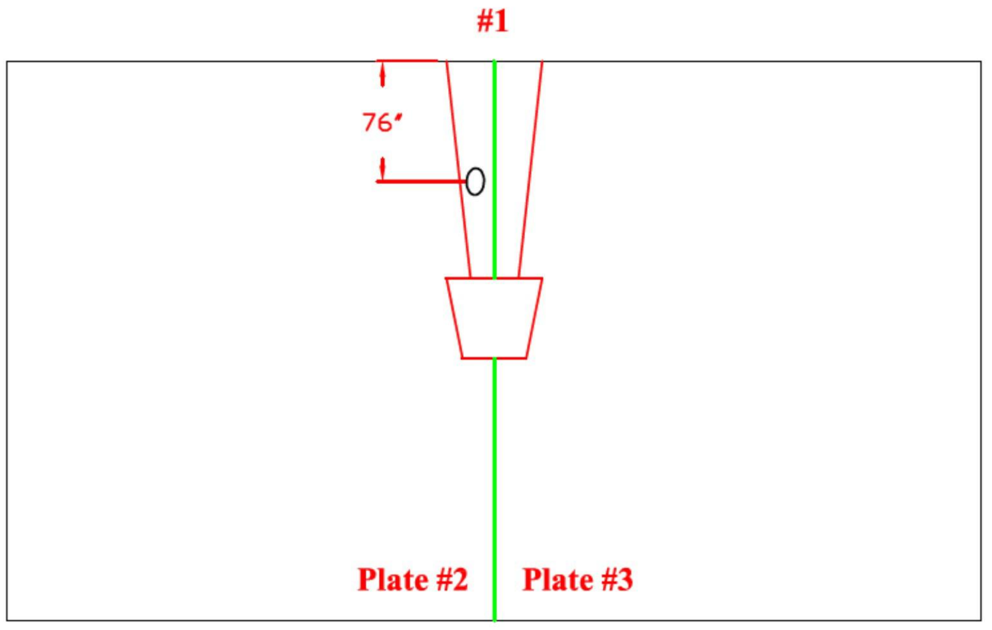
TANK #2 - QUADRANT A-B

Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/06/2008

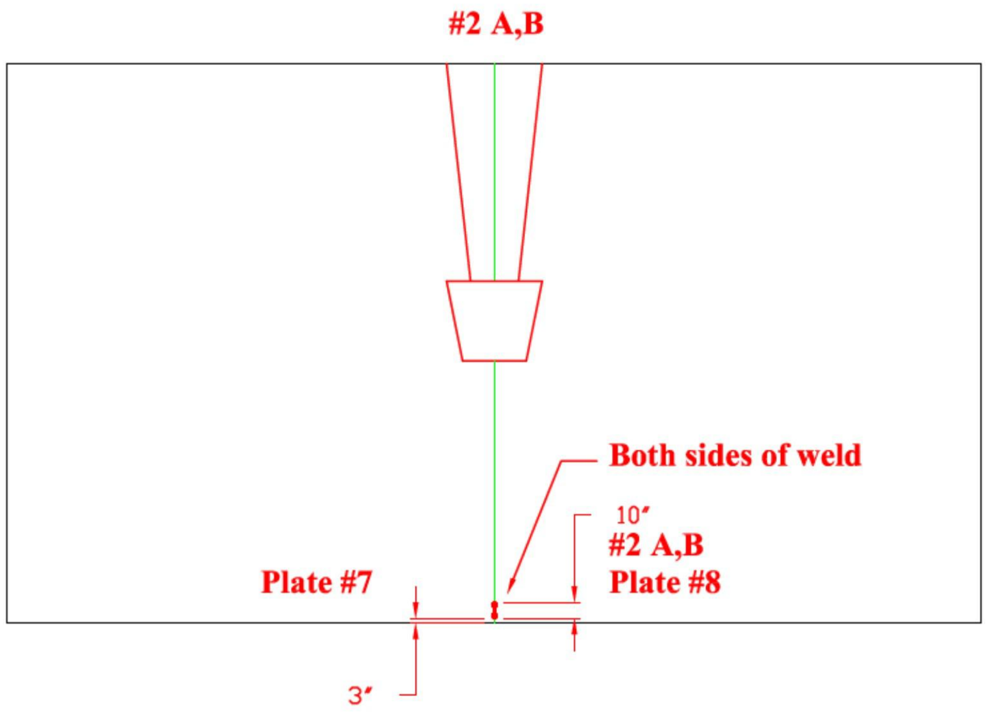
Tank Section: Lower dome
Quadrant: A
Course: 1
Plate: # 2 - 3

Flaw #1 - Dent
⅜" deep
1" dia



Tank Section: Lower dome
Quadrant: B
Course: 1
Plate: # 7 - 8

Flaw #2 - Intermittent crack
2A - .229" depth 10" long (right side)
2B - .154" depth 10" long (left side)



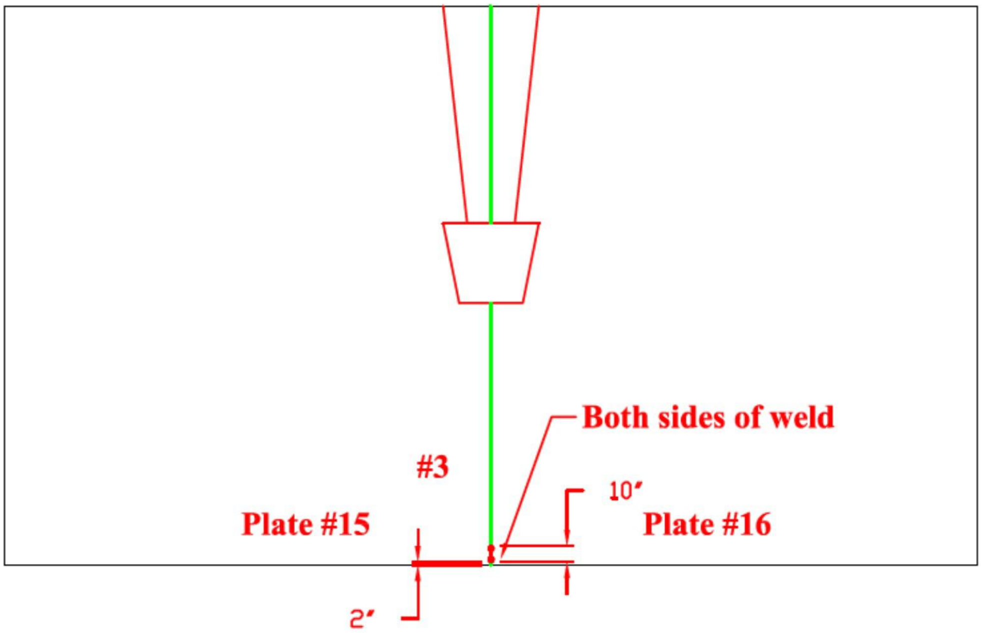
Drawing is not to scale

TANK #2 - QUADRANT C-D
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/06/2008

Tank Section: Lower dome
Quadrant: C
Cours: 1
Plate: # 15 - 16

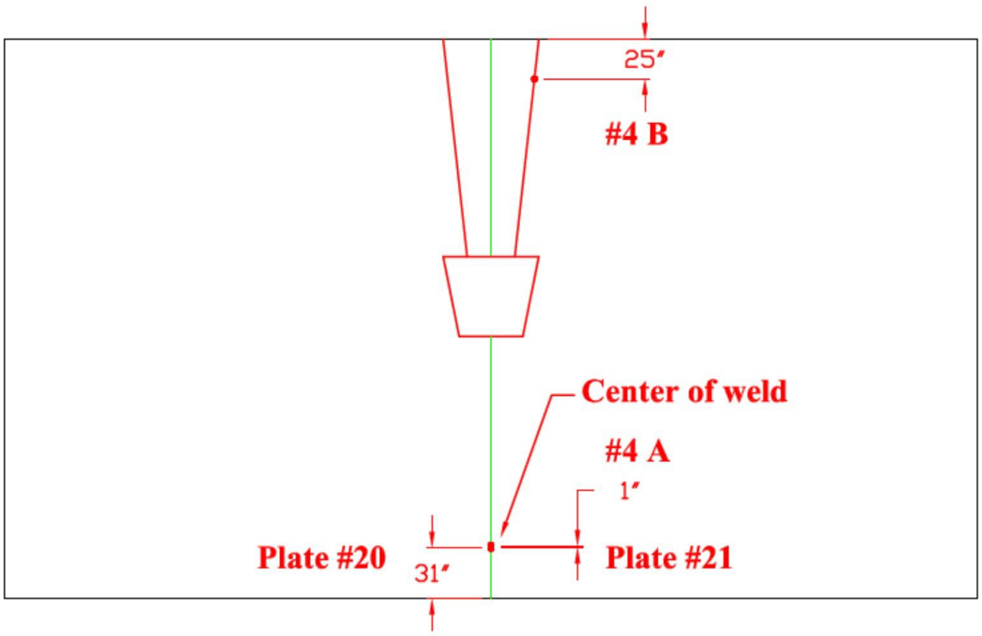
Flaw #3 - Intermittent crack
3A - .223" depth 10" long (left side)
3B - .214" depth 10" long (right side)



Tank Section: Lower dome
Quadrant: D
Course: 1
Plate: # 20 - 21

Flaw #4A - Incomplete .222" depth 1" long

Flaw #4B - Arc strike at toe .069" depth 2" long



Drawing is not to scale

3.0 TANK MAPS
Dunkin & Bush, Inc.
Honolulu, HI
Tank # -2 Quadrant D-C

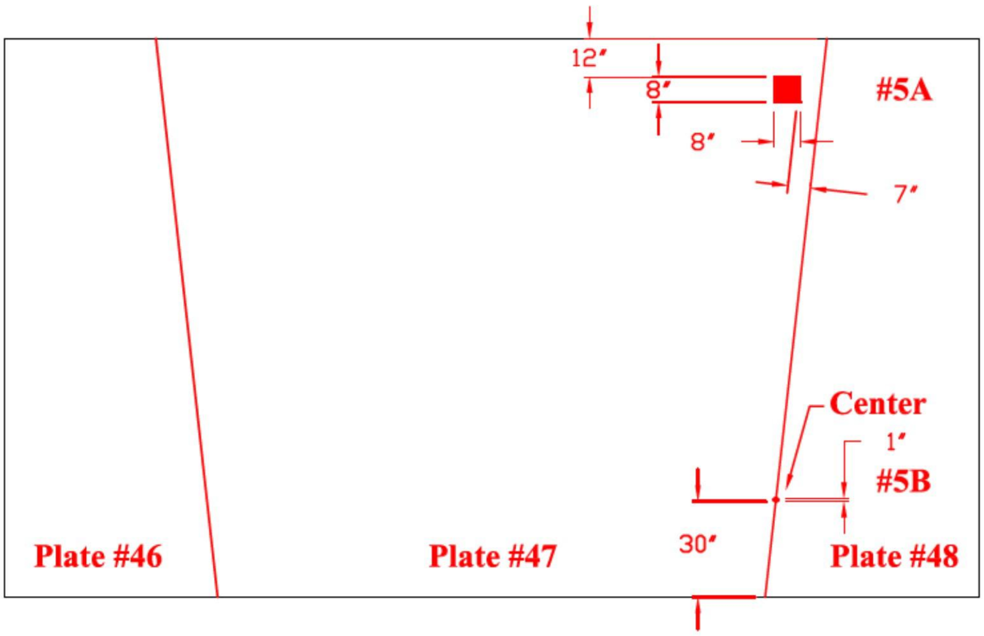
TANK #2 - QUADRANT D-C
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/06/2008

Tank Section: Lower dome
Quadrant: D
Course: 2
Plate: # 47

Flaw # 5A - W.L.
.147" - .210" Remaining

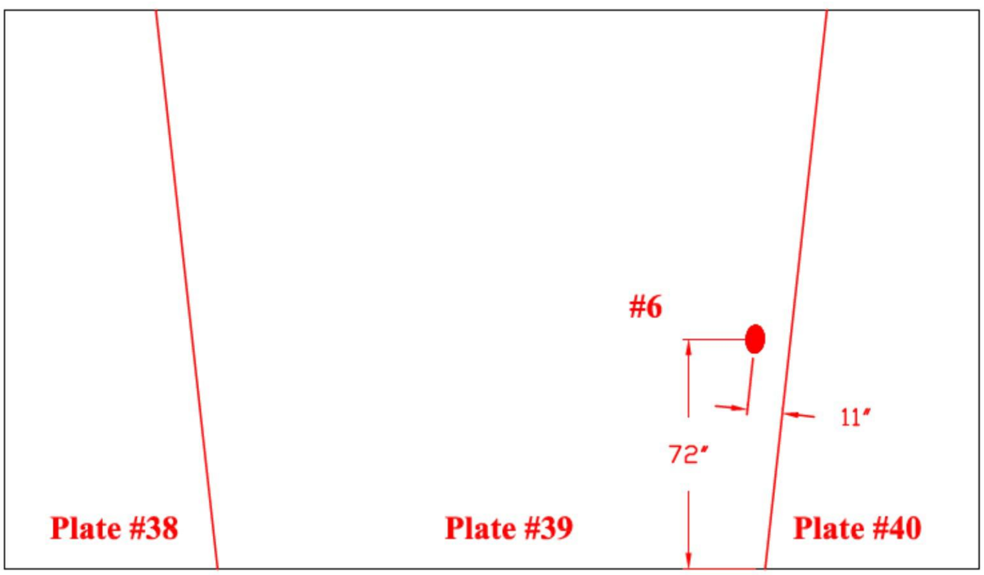
Flaw # 5B - Incomplete Pen.
.215" depth 1" long



Tank Section: Lower dome
Quadrant: C
Course: 2
Plate: # 39

Flaw # 6 - Dent

N.S.W.L.



Drawing is not to scale

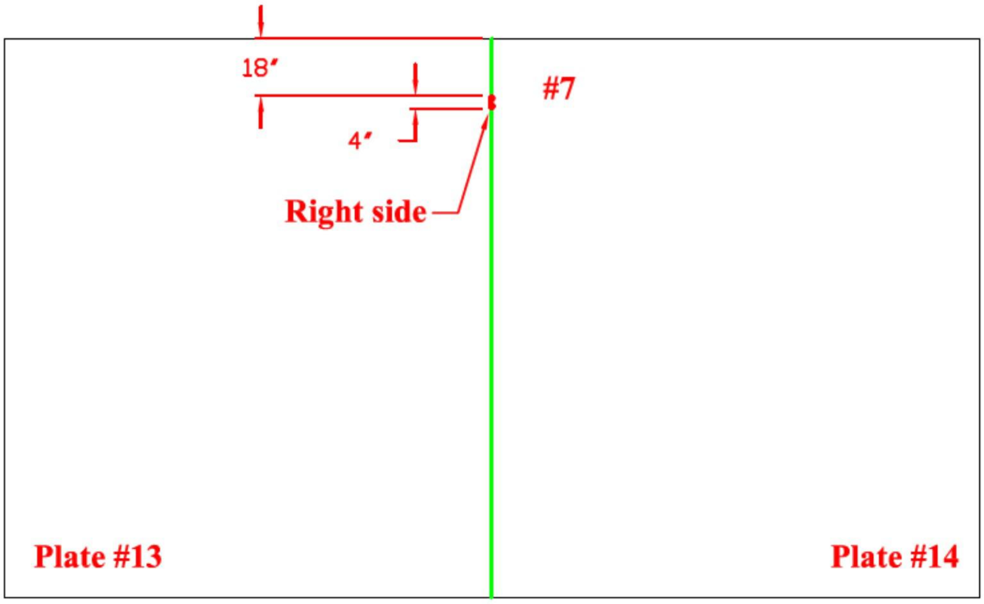
TANK #2 - QUADRANT A

Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 04/07/2008

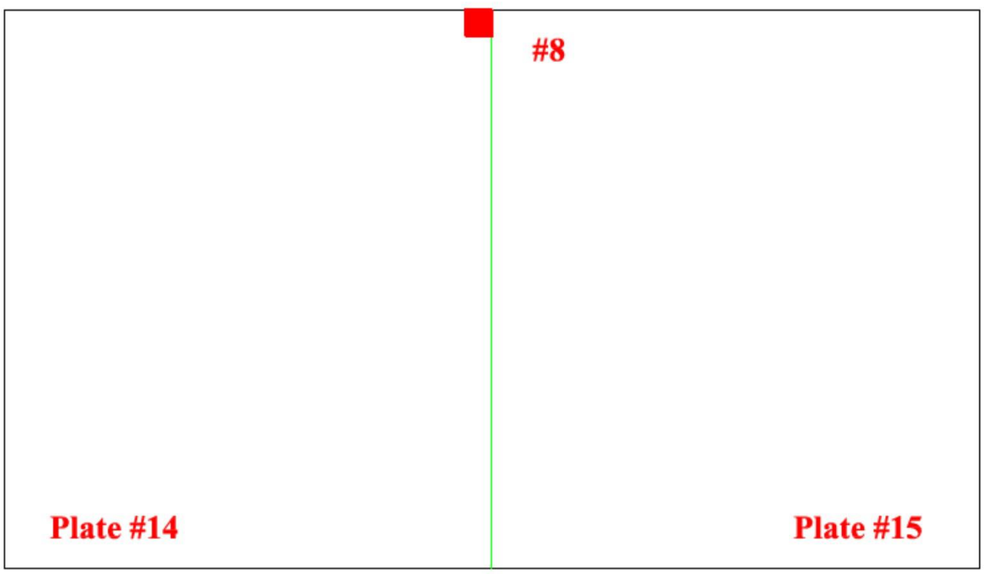
Tank Section: Lower dome
Quadrant: A
Course: 3
Plate: #13 - 14

Flaw #7 - Lack of fusion
.195" depth 4" long
(right side)



Tank Section: Lower dome
Quadrant: A
Course: 3
Plate: #14 - 15

Flaw #8 - W.L.
.223" Remaining



Drawing is not to scale

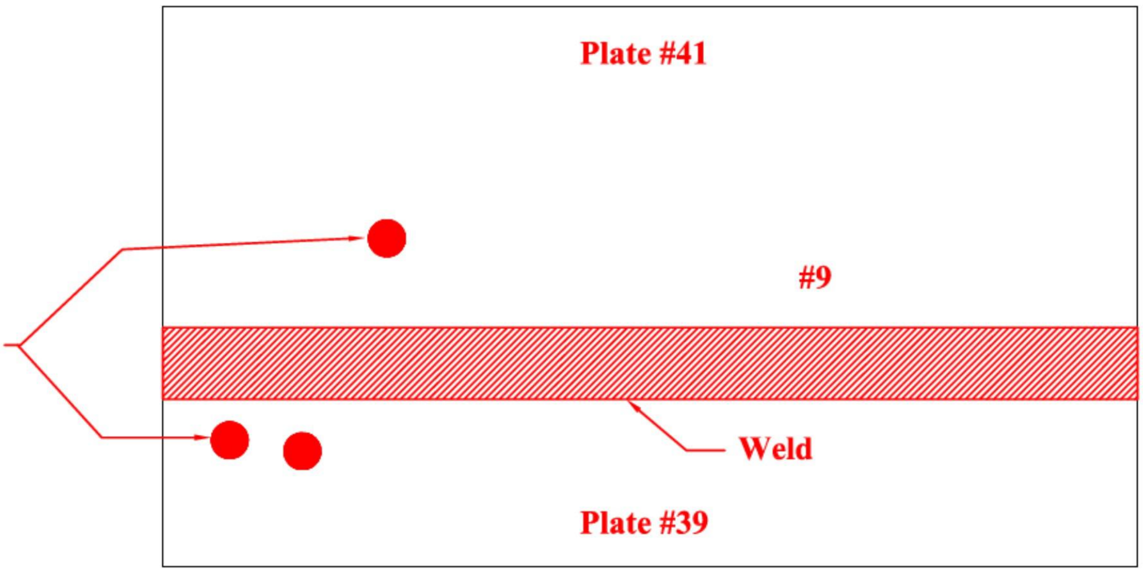
TANK #2 - QUADRANT C

Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 04/03/2008

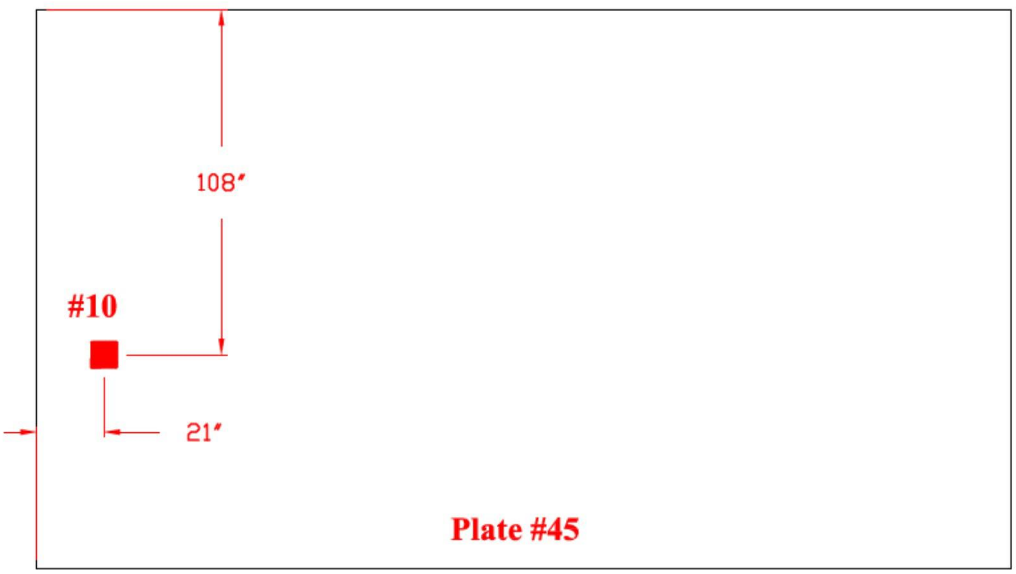
Tank Section: Lower dome
Quadrant: C
Course: 3
Plate: #41

Flaw #9 - W.L.
.230 Remaining



Tank Section: Lower dome
Quadrant: C
Course: 3
Plate: #45

Flaw #10 - W.L./Pit
.219 Remaining



Drawing is not to scale

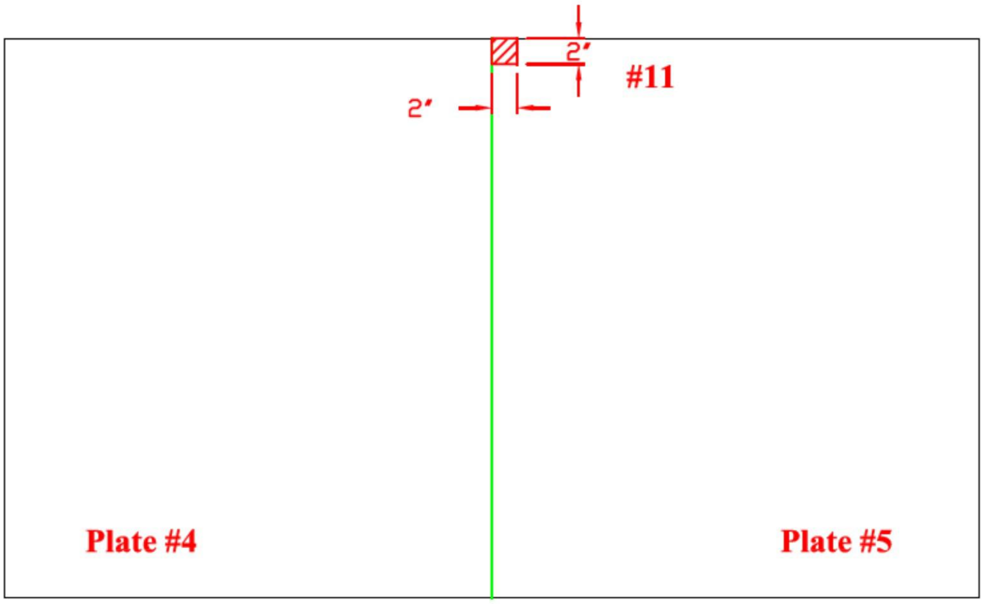
TANK #2 - QUADRANT A

Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 04/08/2008

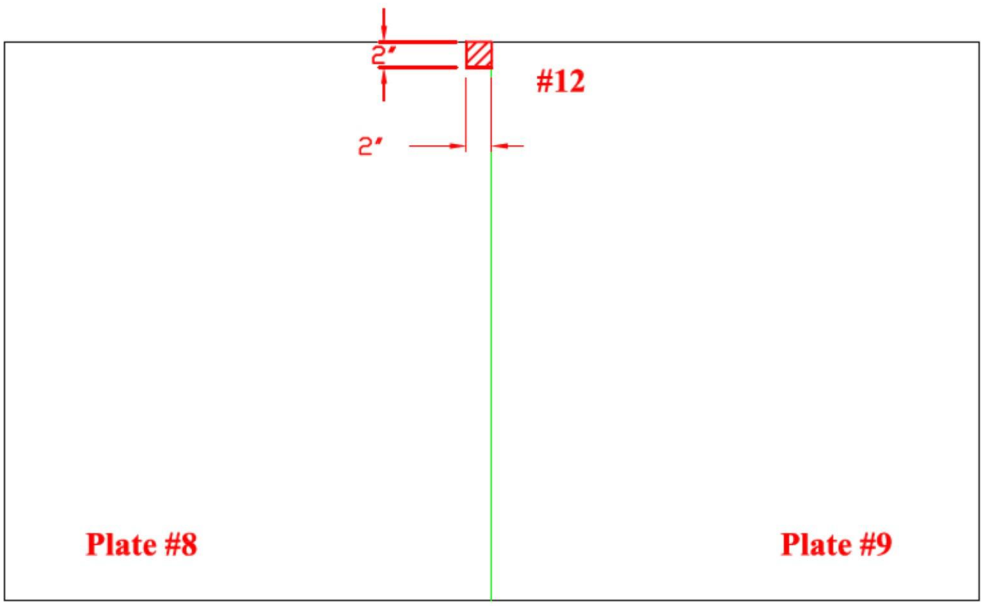
Tank Section: Lower dome
Quadrant: A
Course: 3
Plate: # 5

Flaw #11 - W.L.
.226" Remaining



Tank Section: Lower dome
Quadrant: A
Course: 3
Plate: # 8

Flaw #12 - W.L.
.233" Remaining



Drawing is not to scale

TANK # 2 - QUADRANT A
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 04/09/2008

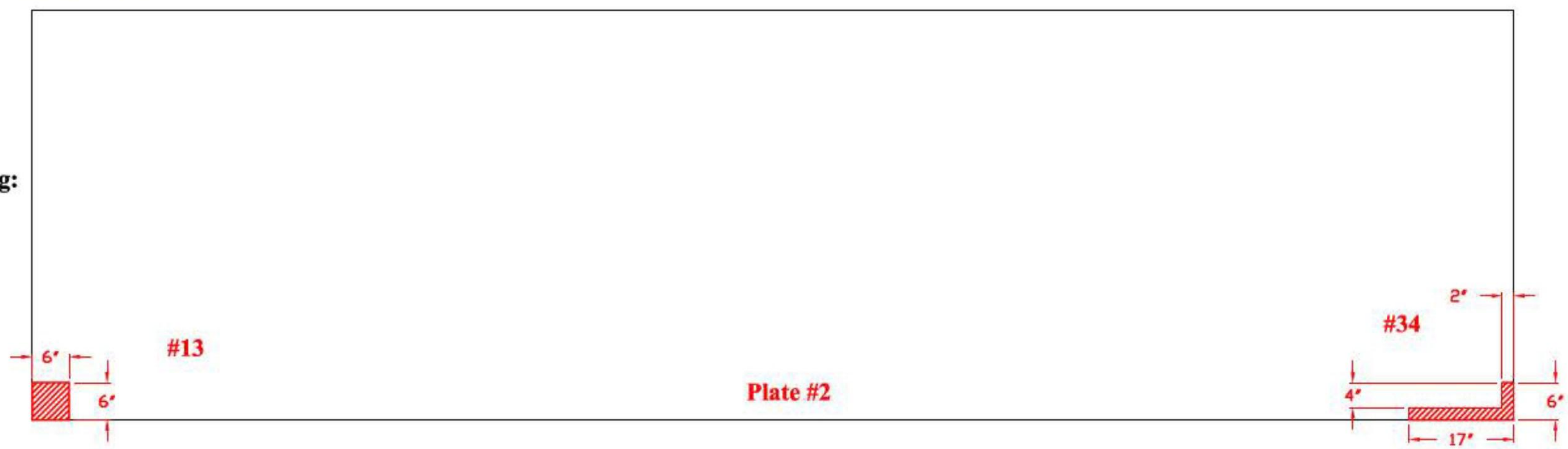
Tank Section: Barrel

Course: 25
Plate #: 2

Flaw # - Type - Remaining:

#13 - W.L. - .231"

#34 - W.L. - .219"



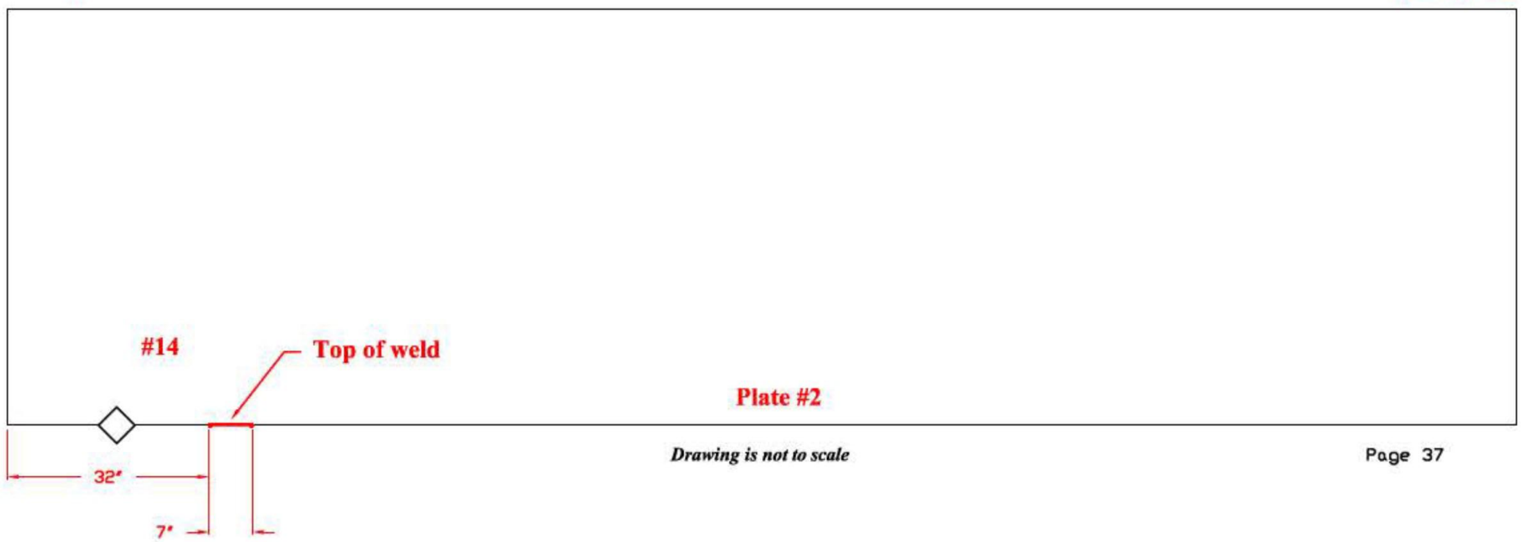
Tank Section: Barrel

Course: 2
Plate #: 2

Flaw # - Type - Remaining:

#14 - Lack of fusion

.125" depth 7" long
Top of weld



Drawing is not to scale

TANK # 2 - QUADRANT A
Nominal Plate Thickness: 0.250"

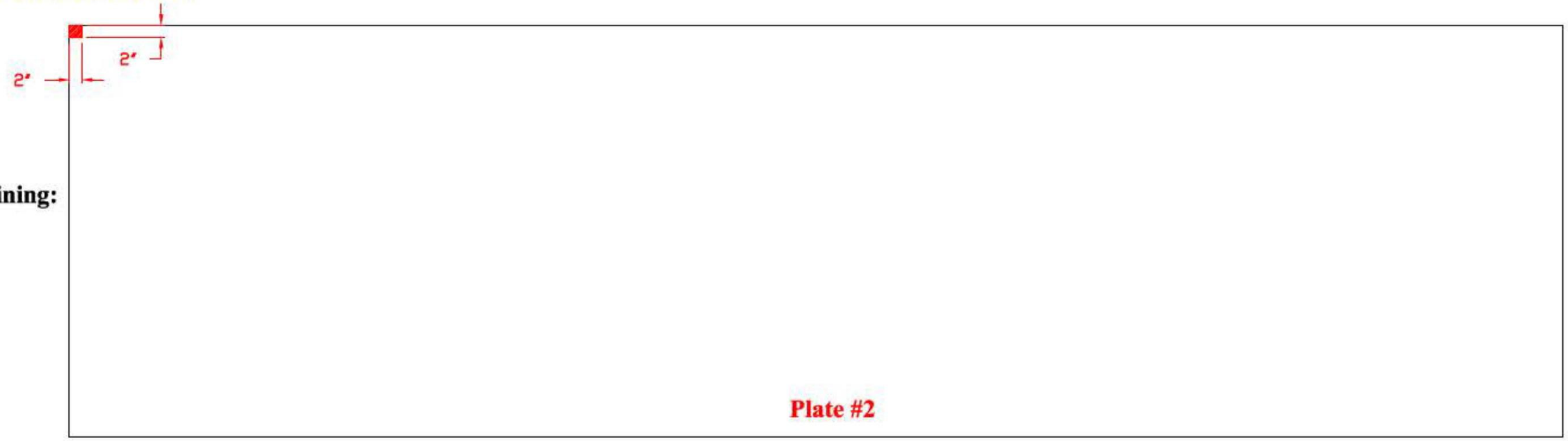
Date Inspected/Confirmed: 04/09/2008

Tank Section: Barrel

Course: 21
Plate #: 2

Flaw # - Type - Remaining:

#15 - W.L. - .233"



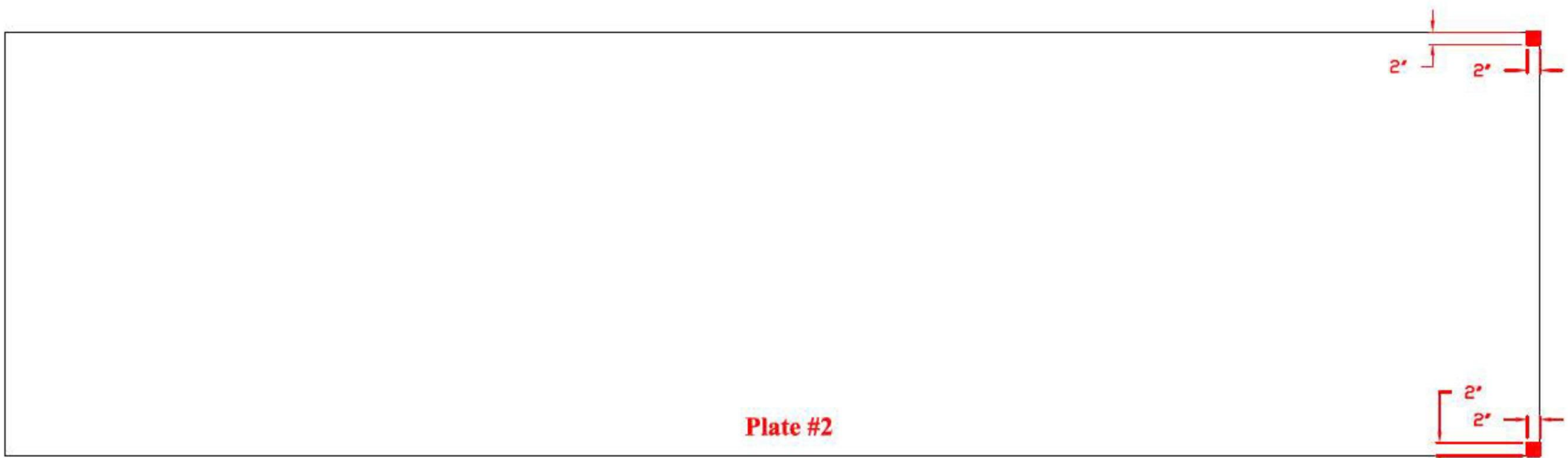
Tank Section: Barrel

Course: 25
Plate #: 1

Flaw # - Type - Remaining:

#16A - W.L. - .232"

#16B - W.L. - .227"



Drawing is not to scale

TANK # 2 - QUADRANT A
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 04/10/2008

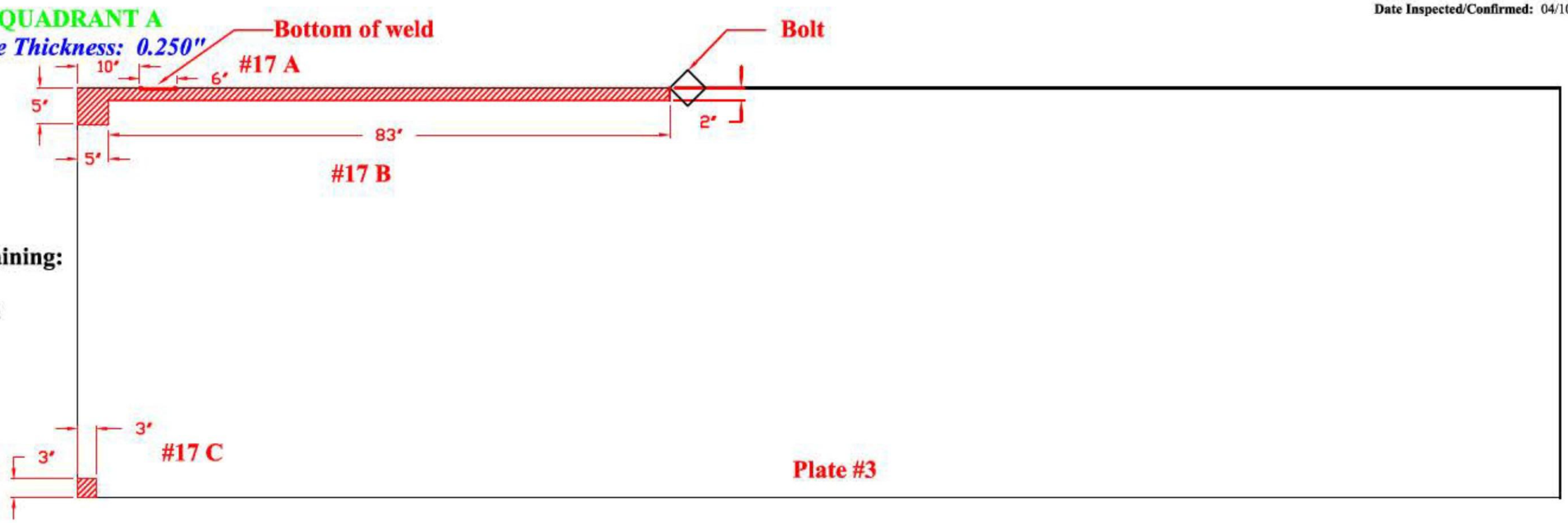
Tank Section: Barrel

Course: 21
Plate #: 3

Flaw # - Type - Remaining:

#17A - Lack of fusion
.173" depth 6" long
(bottom of weld)

#17B - W.L. - .224"
#17C - W.L. - .234"

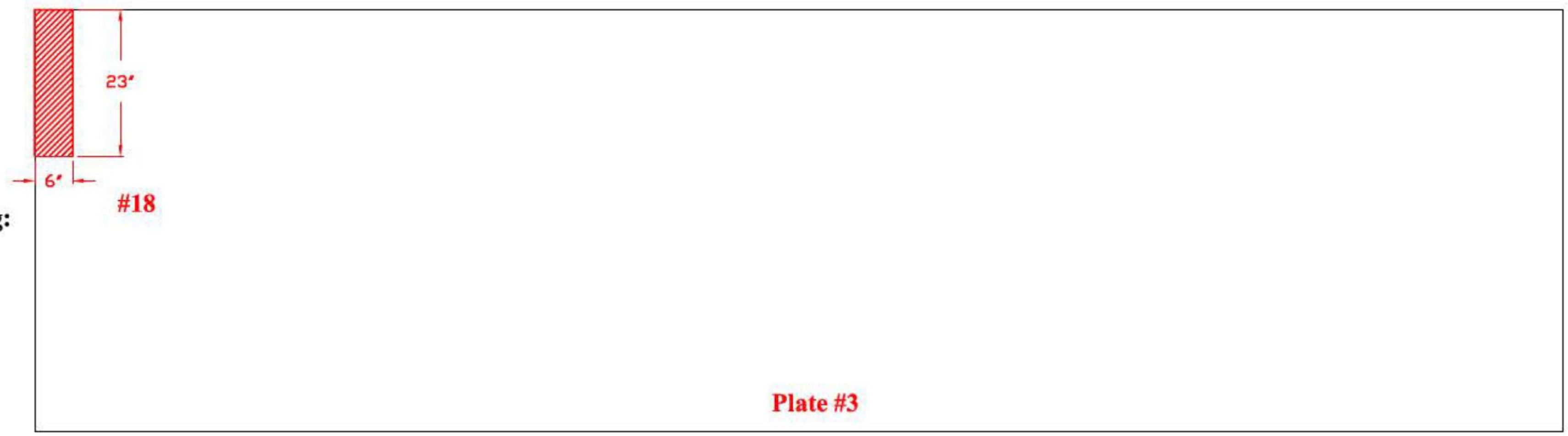


Tank Section: Barrel

Course: 7
Plate #: 3

Flaw # - Type - Remaining:

#18 - W.L. - .228"



Drawing is not to scale

TANK # 2 - QUADRANT D
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 04/10/2008

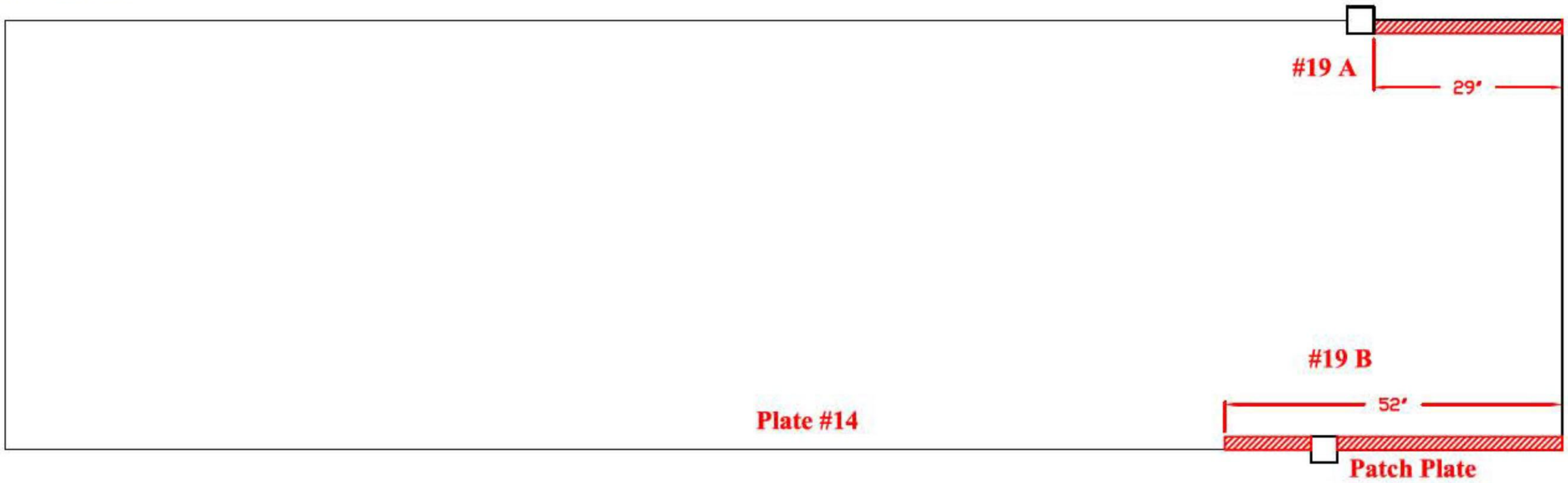
Tank Section: Barrel

Course: 24
Plate #: 14

Flaw # - Type - Remaining:

#19A - W.L. - .227"

#19B - W.L. - .232"

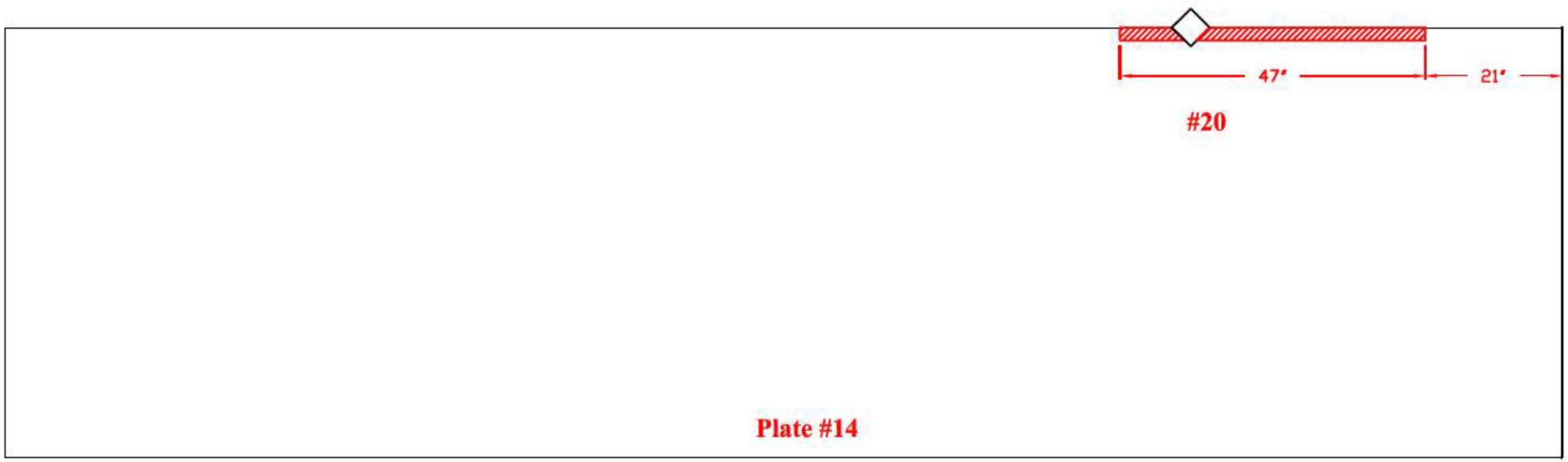


Tank Section: Barrel

Course: 22
Plate #: 14

Flaw # - Type - Remaining:

#20 - W.L. - .234"



Drawing is not to scale

TANK # 2 - QUADRANT D
***Nominal Plate Thickness: 0.250"**

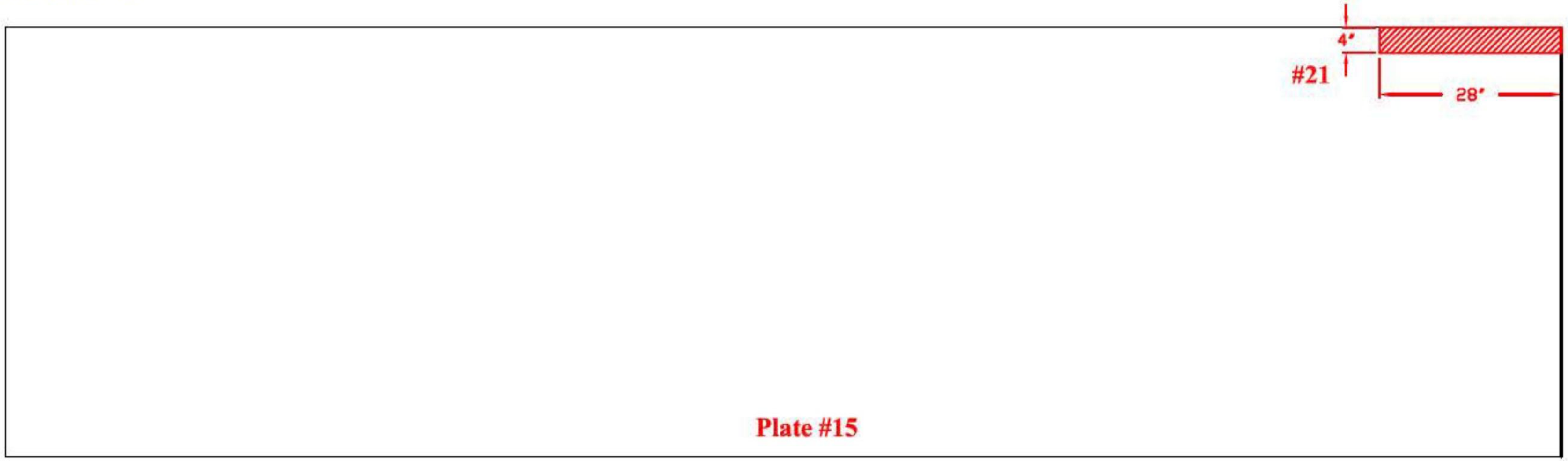
Date Inspected/Confirmed: 04/10/2008

Tank Section: Barrel

Course: 4
Plate #: 15

Flaw # - Type - Remaining:

#21 - W.L. - .235"

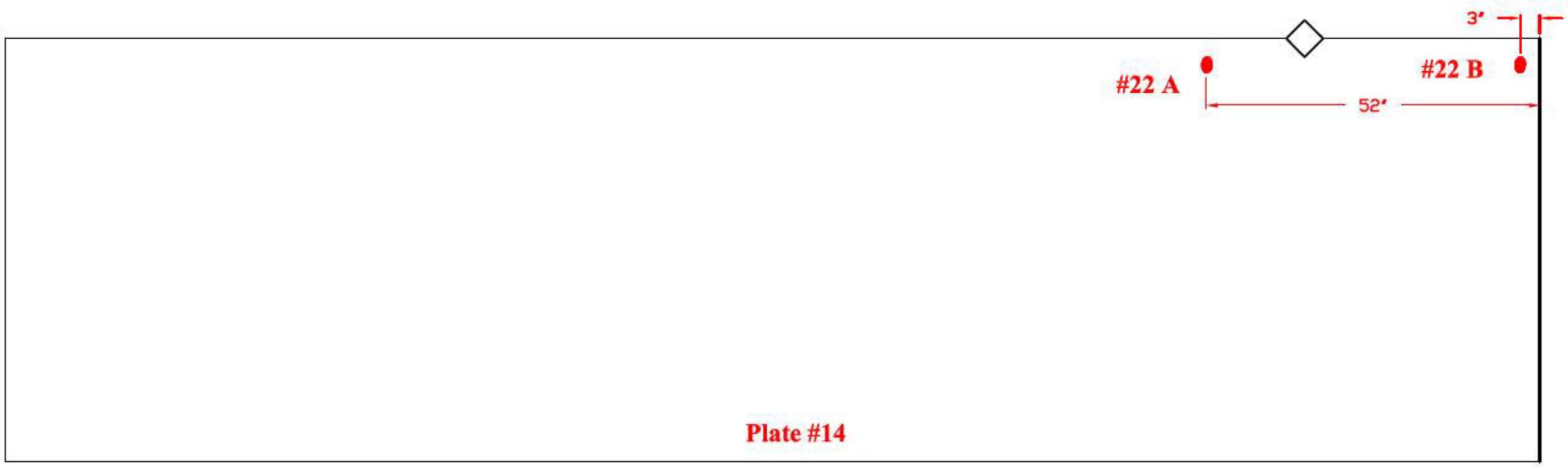


Tank Section: Barrel

Course: 8
Plate #: 14

Flaw # - Type - Remaining:

#22A - W.L./Pit - .230"
#22B - W.L./Pit - .221"



Drawing is not to scale

TANK # 2 - QUADRANT A
Nominal Plate Thickness: 0.250"

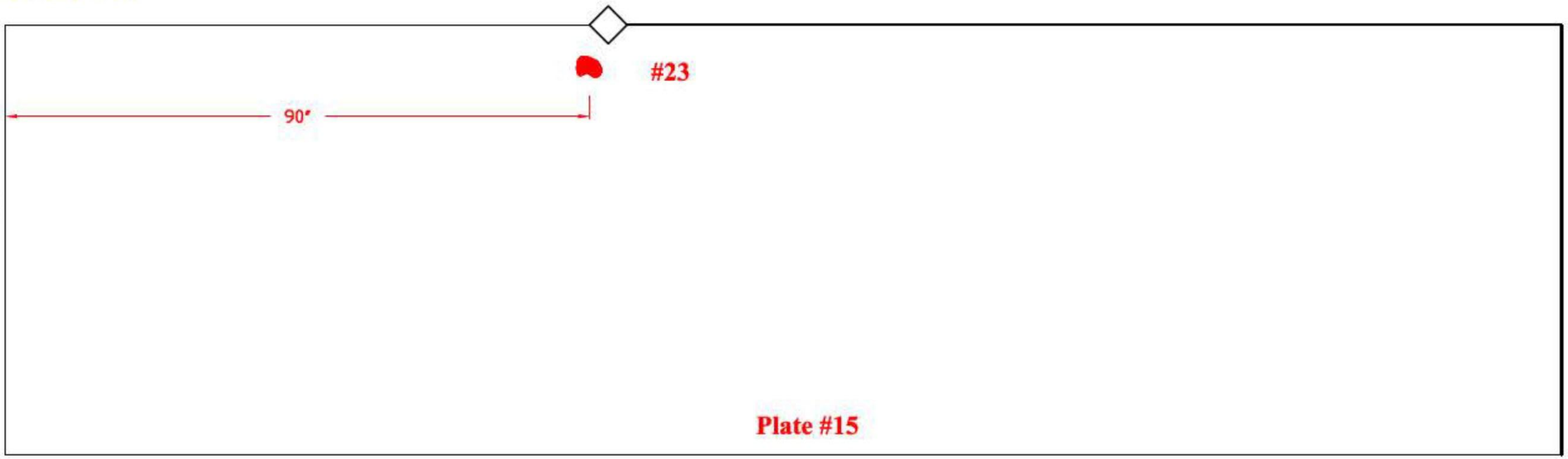
Date Inspected/Confirmed: 04/14/2008

Tank Section: Barrel

Course: 8
Plate #: 15

Flaw # - Type - Remaining:

#23 - W.L./Pit - .228"



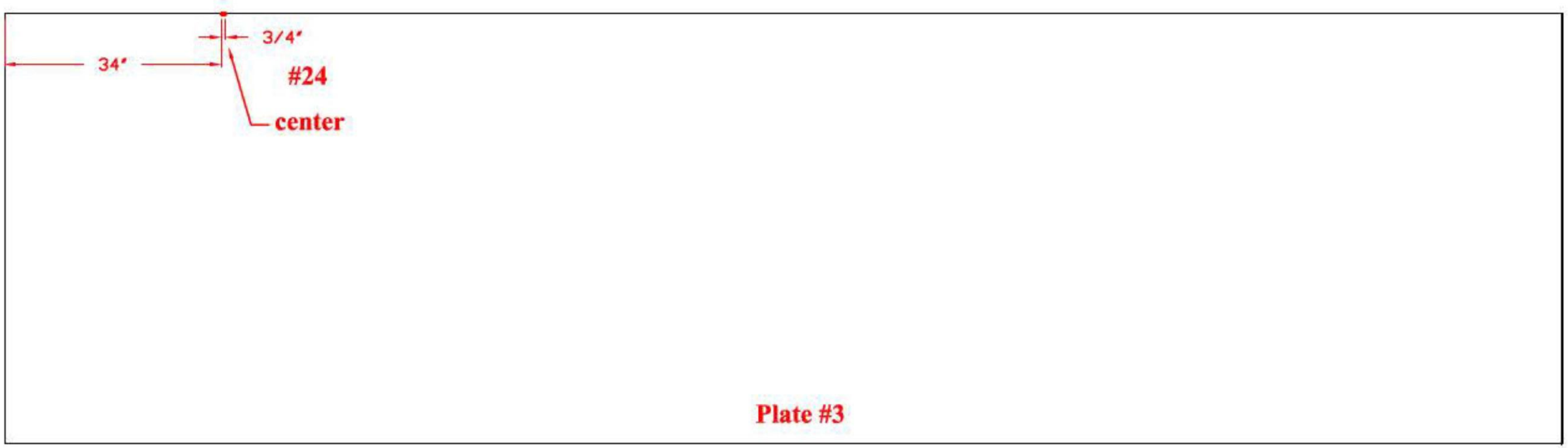
Tank Section: Barrel

Course: 26
Plate #: 3

Flaw # - Type - Remaining:

#24 - Porosity

.210" depth ¾" long
(center of weld)



Drawing is not to scale

TANK # 2 - QUADRANT A
***Nominal Plate Thickness: 0.250"**

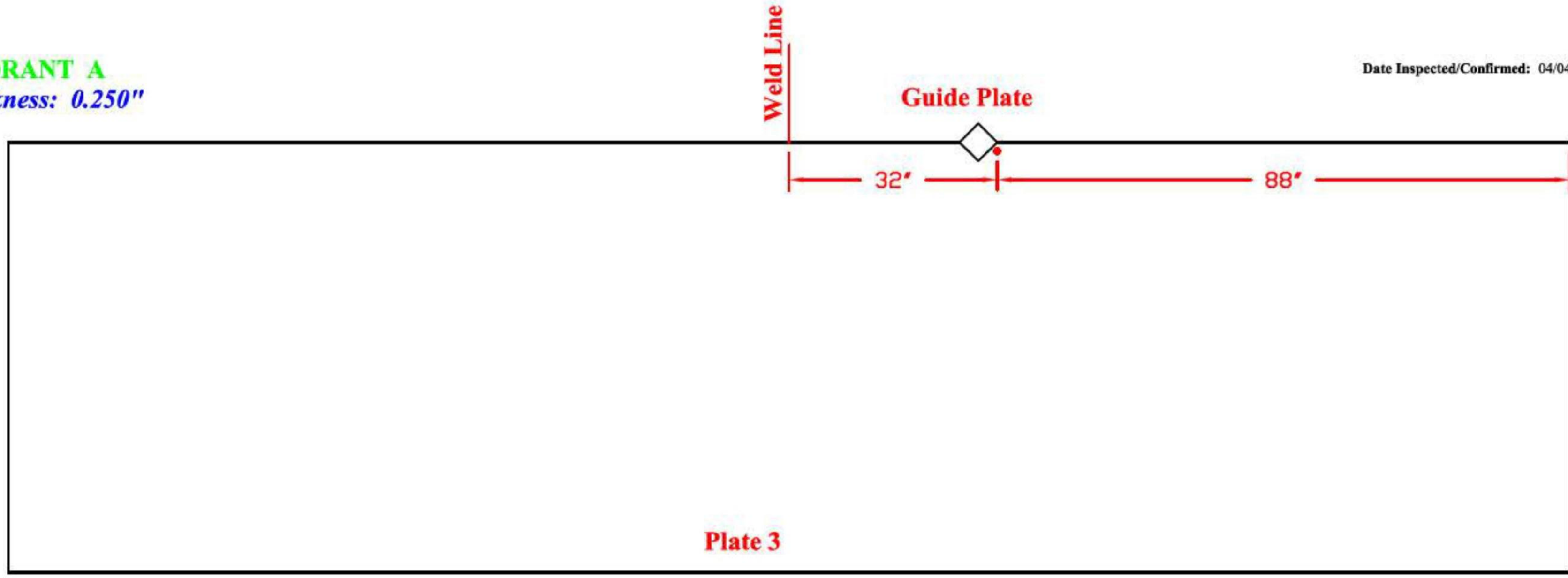
Date Inspected/Confirmed: 04/04/2008

Tank Section: Barrel

Course: 17
Plate #: 3

Flaw # - Type - Remaining:

#25 - Toe Arc Strikes
.063" depth
5½" L x 3" W

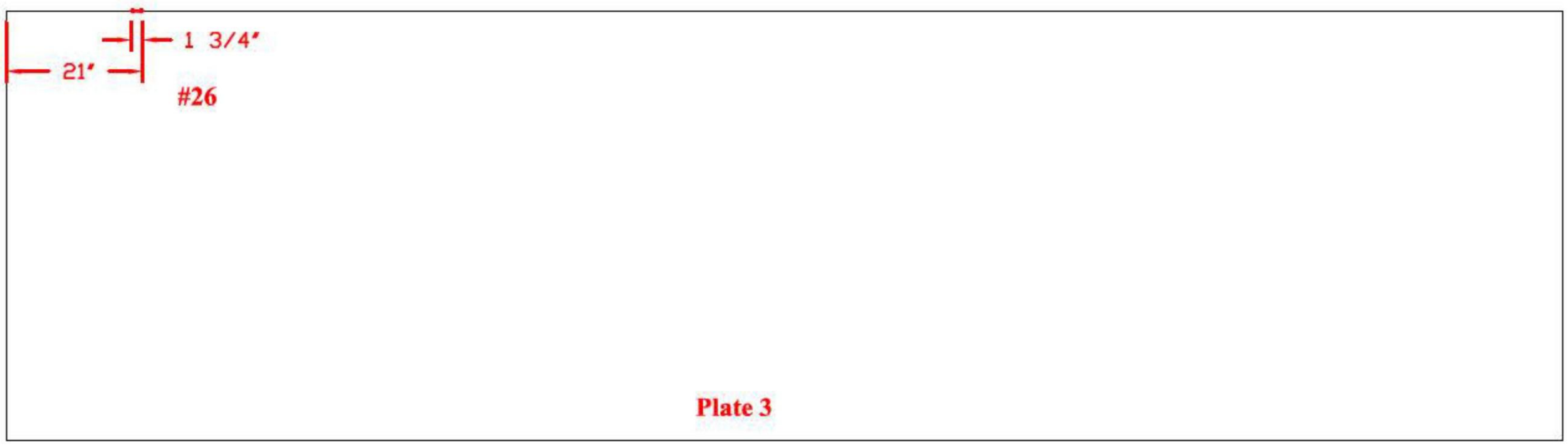


Tank Section: Barrel

Course: 20
Plate #: 3

Flaw # - Type - Remaining:

#26 - Porosity
.181" depth 1¾" long
(bottom of weld)



Drawing is not to scale

TANK # 2 - QUADRANT A
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 04/14/2008

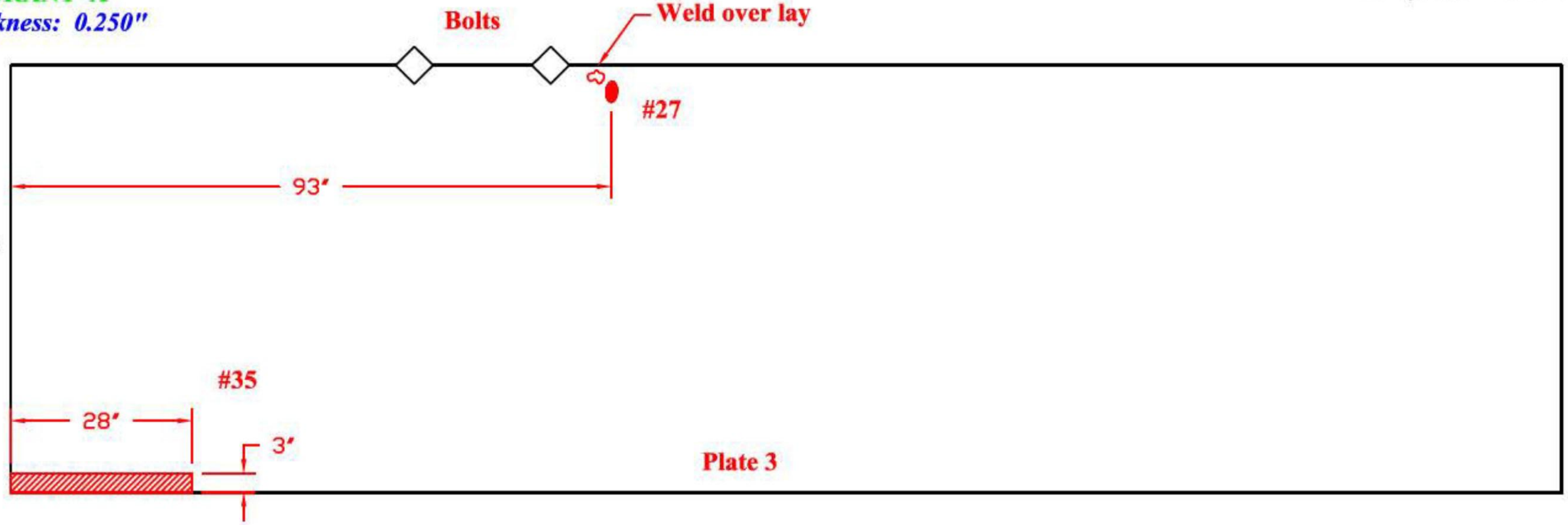
Tank Section: Barrel

Course: 25
Plate #: 3

Flaw # - Type - Remaining:

#27 - Pit - .234"

#35 - W.L. - .221"

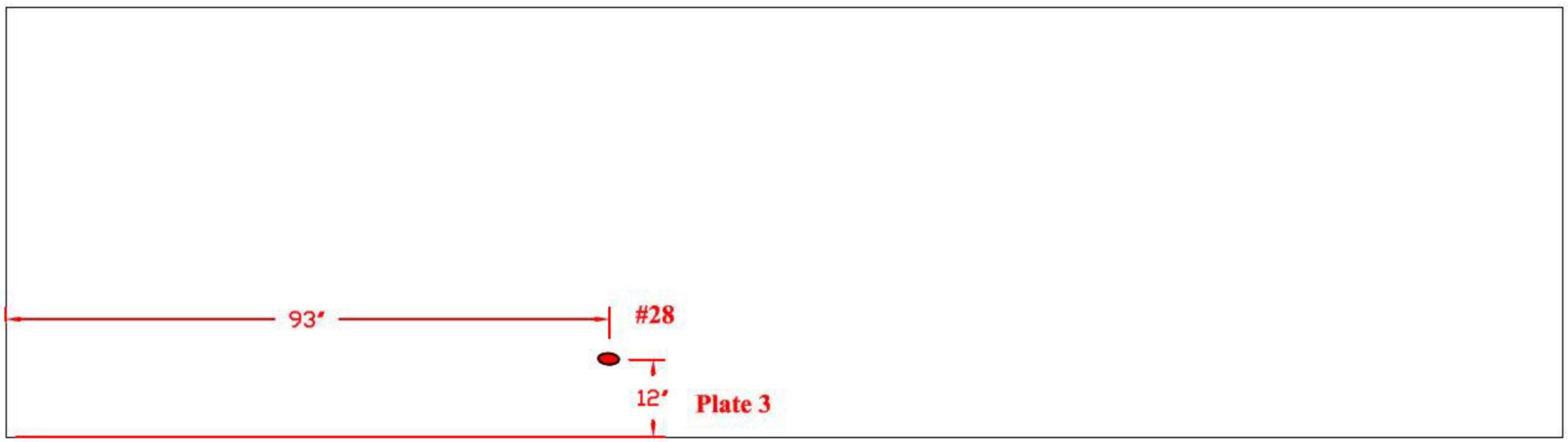


Tank Section: Barrel

Course: 8
Plate #: 3

Flaw # - Type - Remaining:

#28 - Pit - .220"



Drawing is not to scale

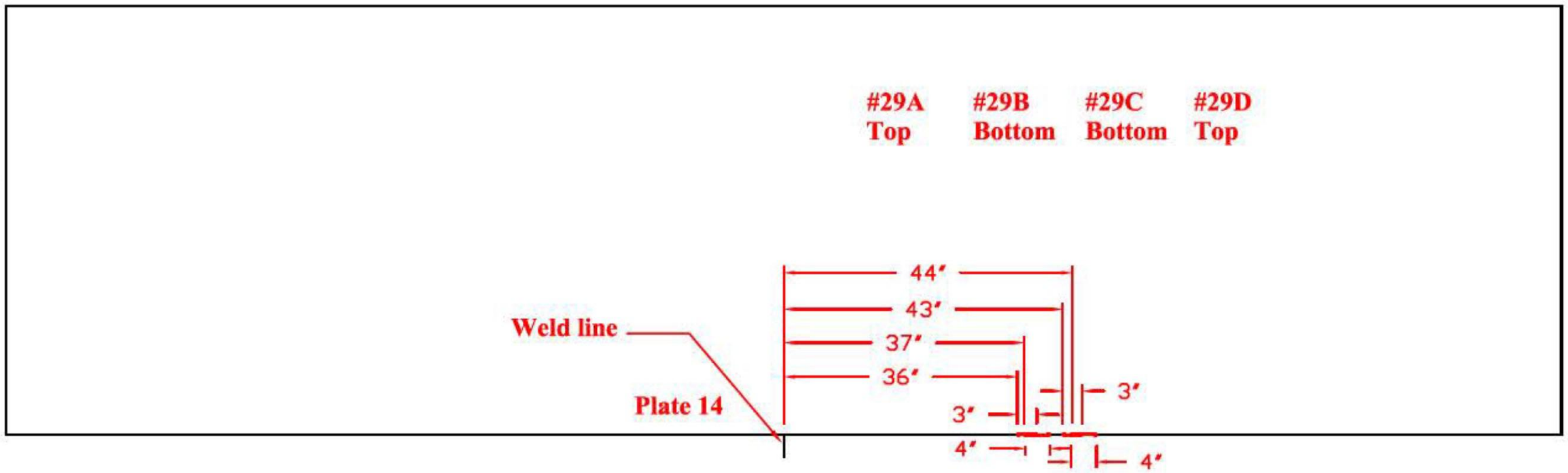
TANK # 2 - QUADRANT D
***Nominal Plate Thickness: 0.250"**

Date Inspected/Confirmed: 04/14/2008

Tank Section: Barrel

Course: 13
Plate #: 14

Flaw # - Type - Remaining:
#29 - Lack of fusion
A- .173" depth 3" long (top)
B- .112" depth 4" long (bottom)
C- .205" depth 3" long (bottom)
C- .206" depth 4" long (top)

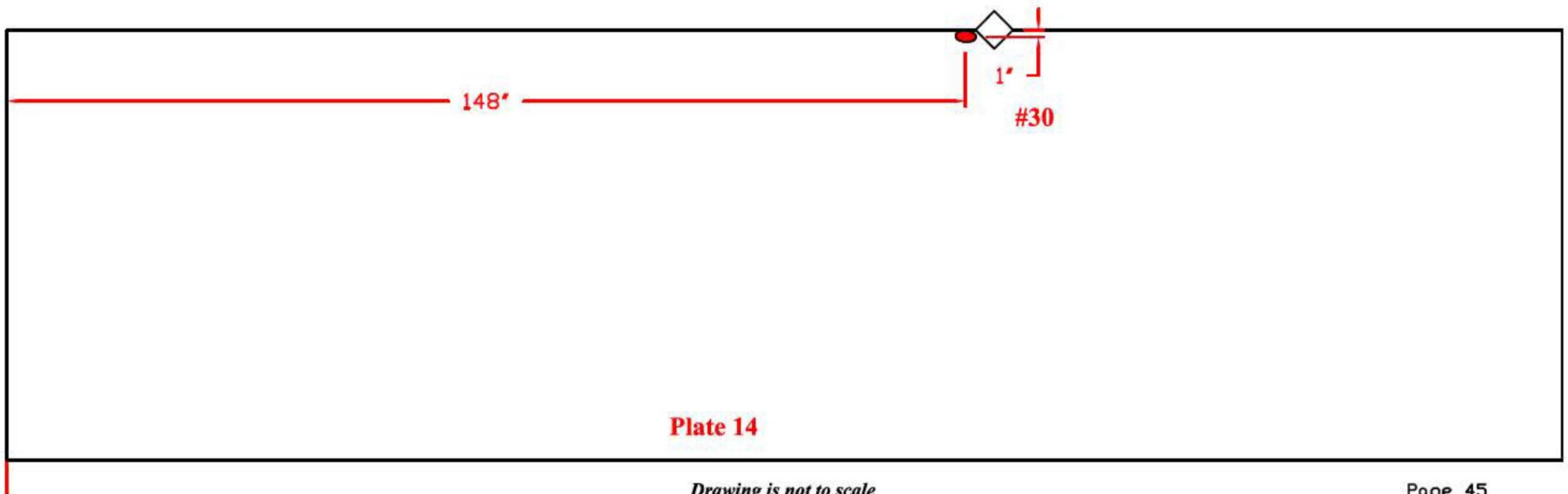


Tank Section: Barrel

Course: 4
Plate #: 14

Flaw # - Type - Remaining:

#30 - Pit -.226"



Drawing is not to scale

TANK # 2 - QUADRANT D

***Nominal Plate Thickness: 0.250"**

Date Inspected/Confirmed: 04/10/2008

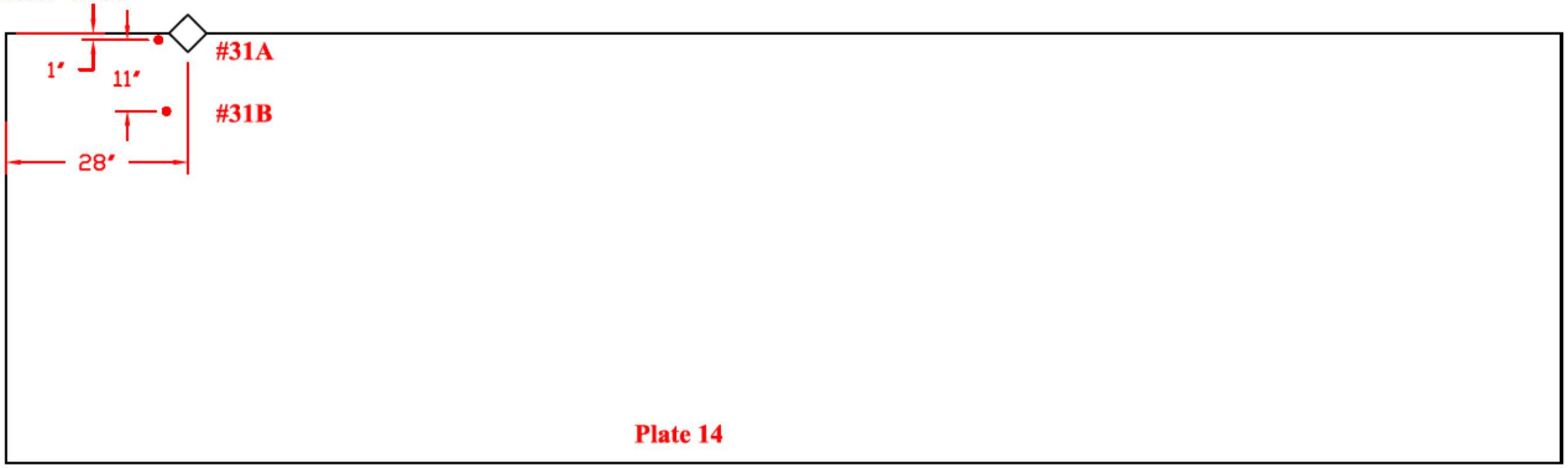
Tank Section: Barrel

Course: 5
Plate #: 14

Flaw # - Type - Remaining:

#31A - W.L./Pit - .235"

#31B - W.L./Pit - .235"



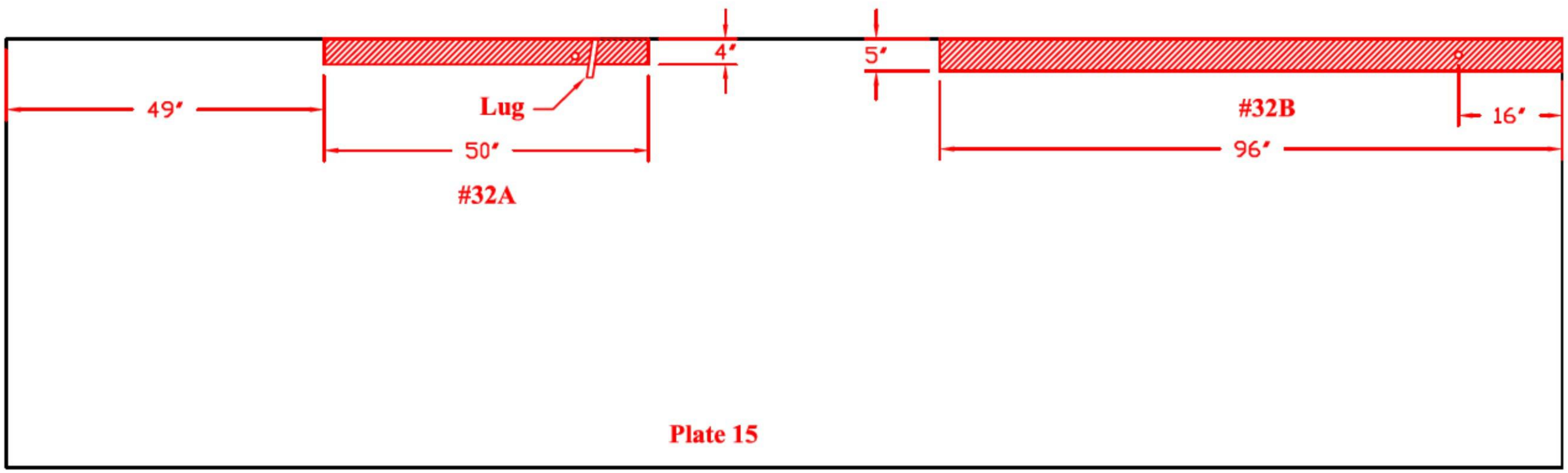
Tank Section: Barrel

Course: 21
Plate #: 15

Flaw # - Type - Remaining:

#32A - W.L. - .230"

#32B - W.L. - .219"



Drawing is not to scale

3.0 TANK MAPS
Dunkin & Bush, Inc.
Honolulu, HI

TANK # 2 - QUADRANT D - A
***Nominal Plate Thickness: 0.250"**

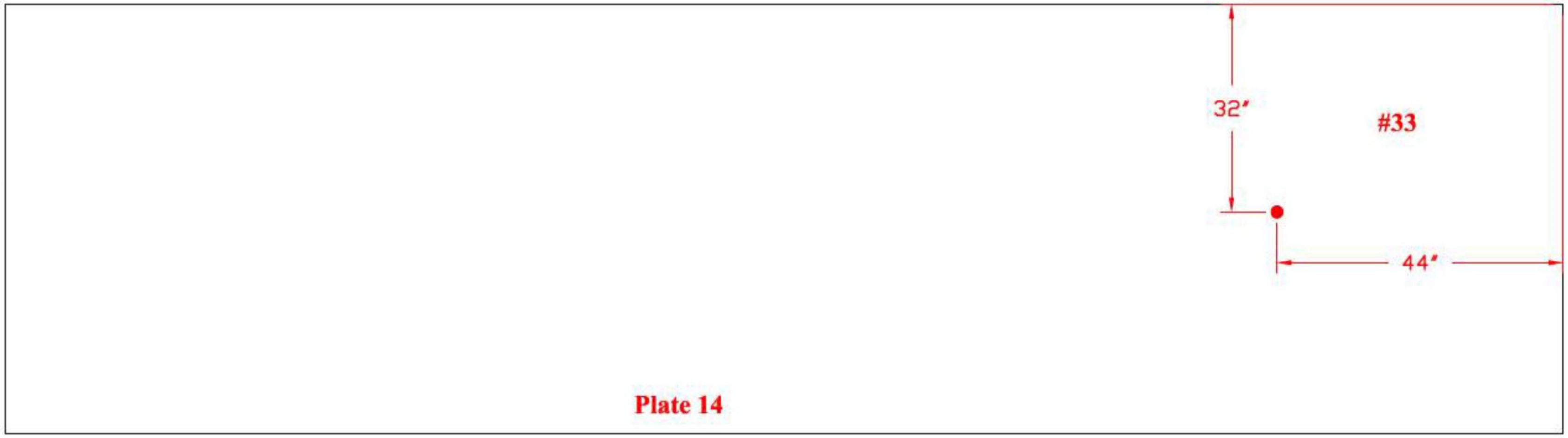
Date Inspected/Confirmed: 04/10/2008

Tank Section: Barrel

Course: 20
Plate #: 14

Flaw # - Type - Remaining:

#33 - Tack weld
.082" depth
1½" L x ¼" W

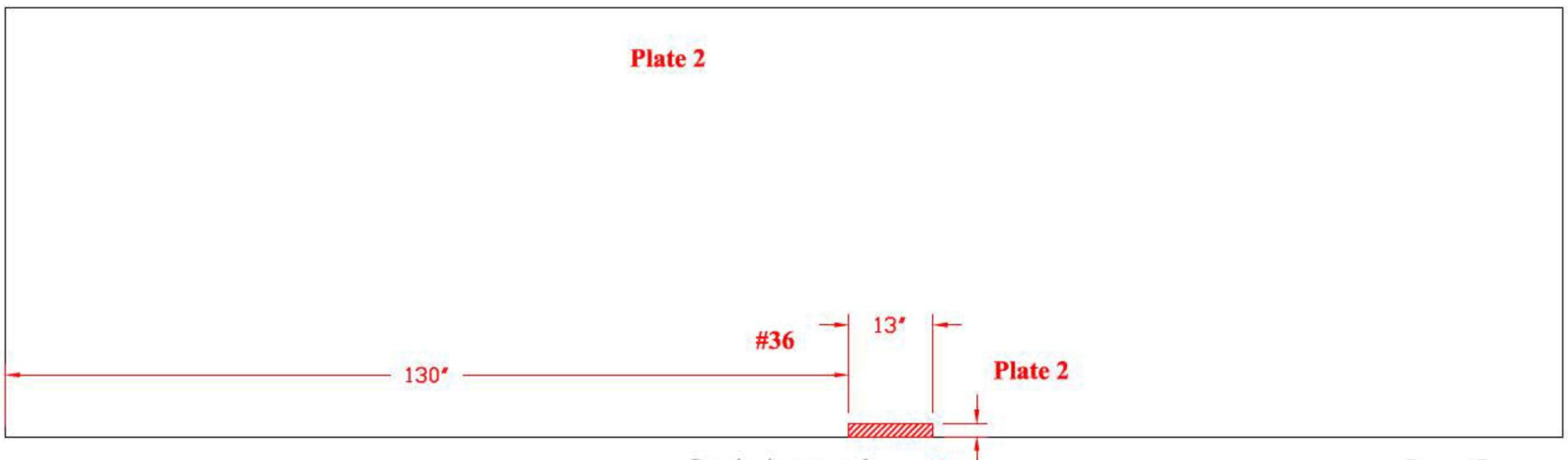


Tank Section: Barrel

Course: 10
Plate #: 2

Flaw # - Type - Remaining:

#36 - W.L. - .218"



Drawing is not to scale

TANK # 2 - QUADRANT D
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 04/10/2008

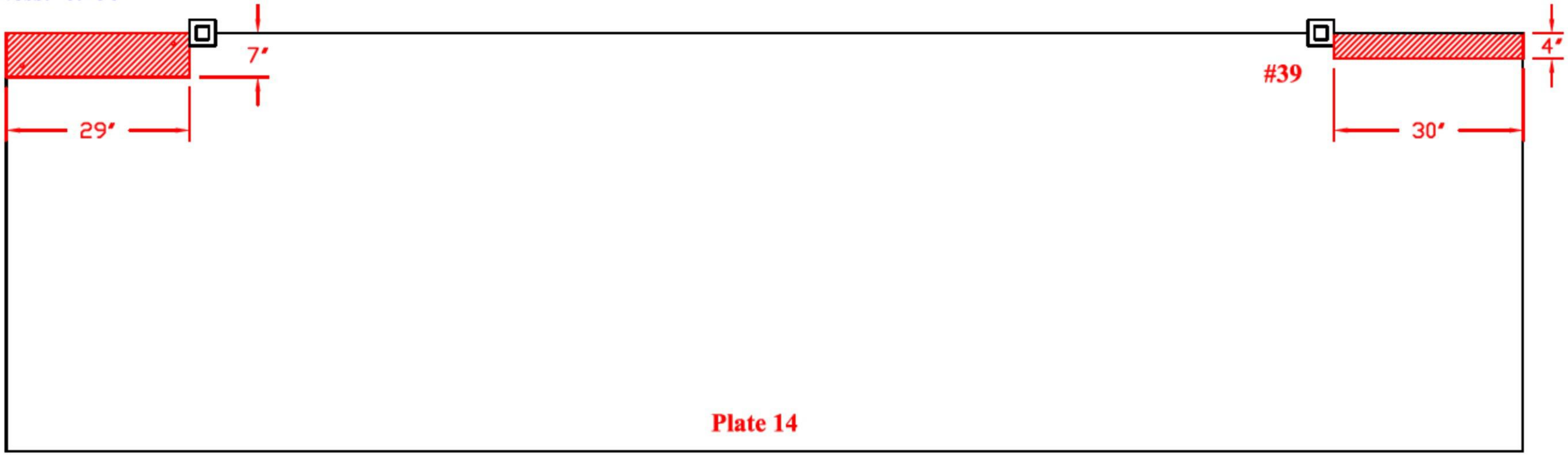
Tank Section: Barrel

Course: 25
Plate #: 14

Flaw # - Type - Remaining:

#39 - W.L. - .230"

#42 - W.L. - .234" A
.223" B

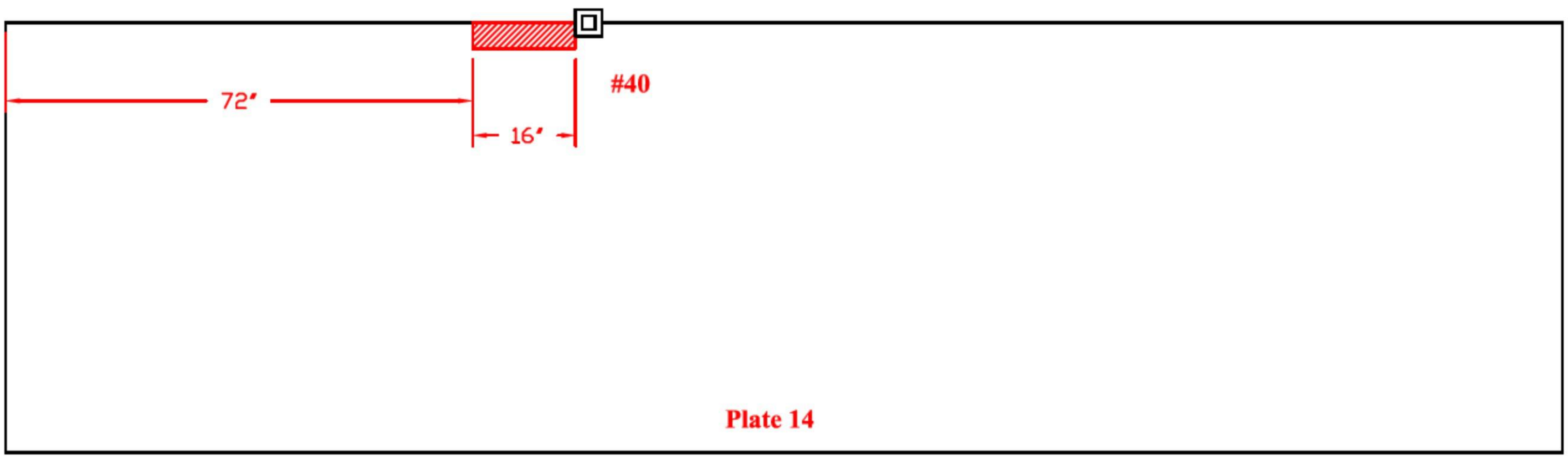


Tank Section: Barrel

Course: 26
Plate #: 14

Flaw # - Type - Remaining:

#40 - W.L. - .214"



Drawing is not to scale

TANK # 2 - QUADRANT D - A
***Nominal Plate Thickness: 0.250"**

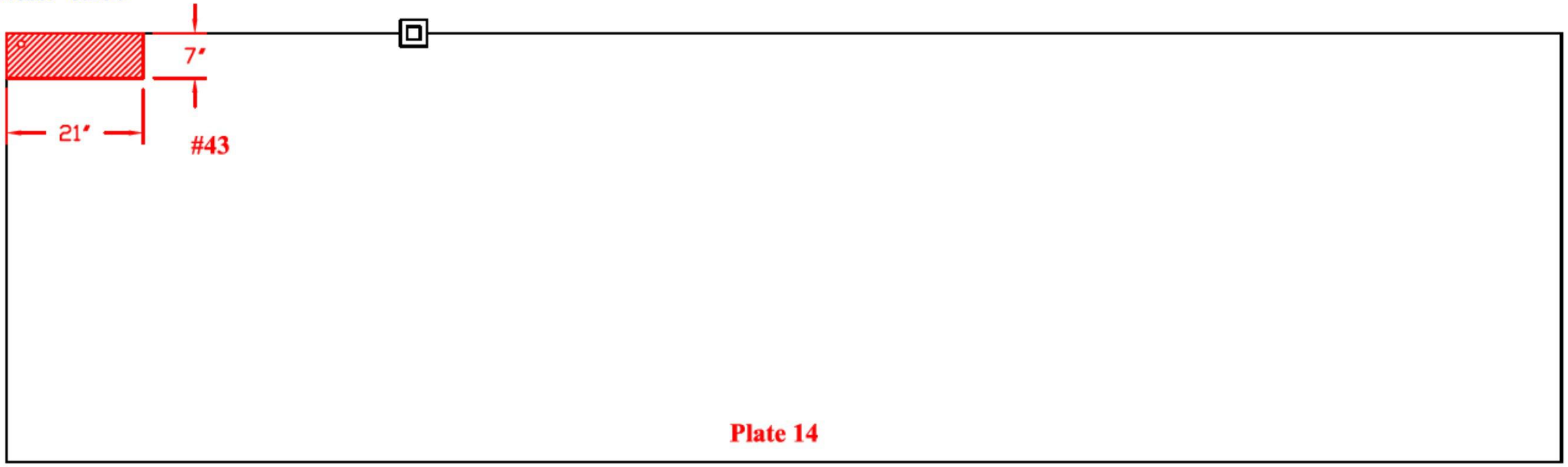
Date Inspected/Confirmed: 04/15/2008

Tank Section: Barrel

Course: 27
Plate #: 14

Flaw # - Type - Remaining:

#43 - W.L. - .229"

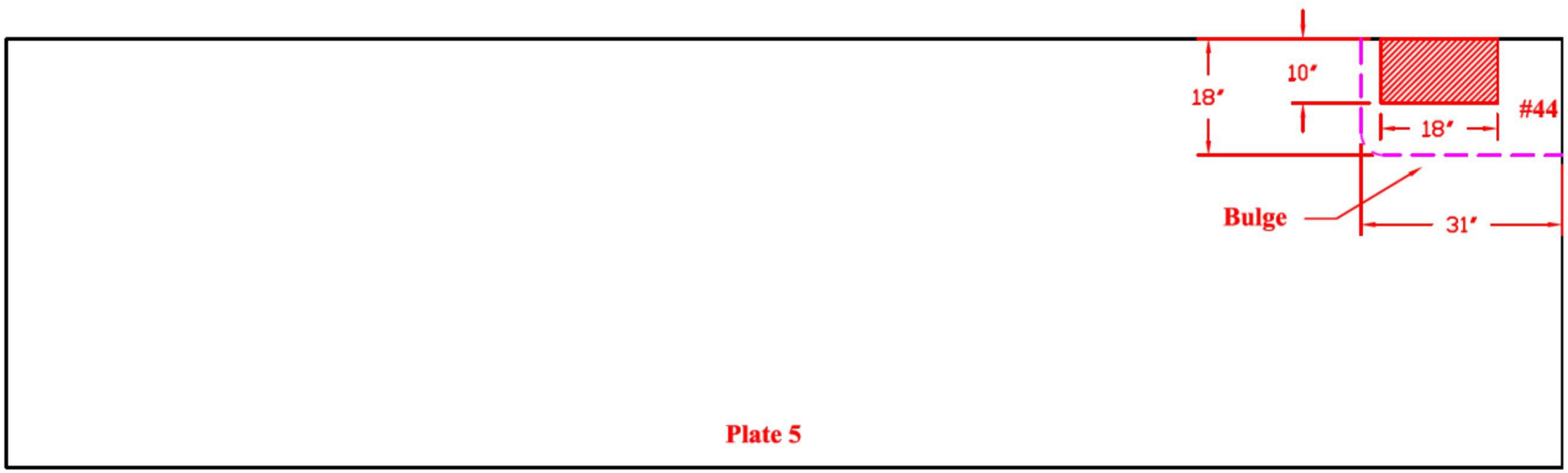


Tank Section: Barrel

Course: 27
Plate #: 15

Flaw # - Type - Remaining:

#44 - W.L. - .230"



Drawing is not to scale

TANK # 2 - QUADRANT B - D
Nominal Plate Thickness: 0.250"

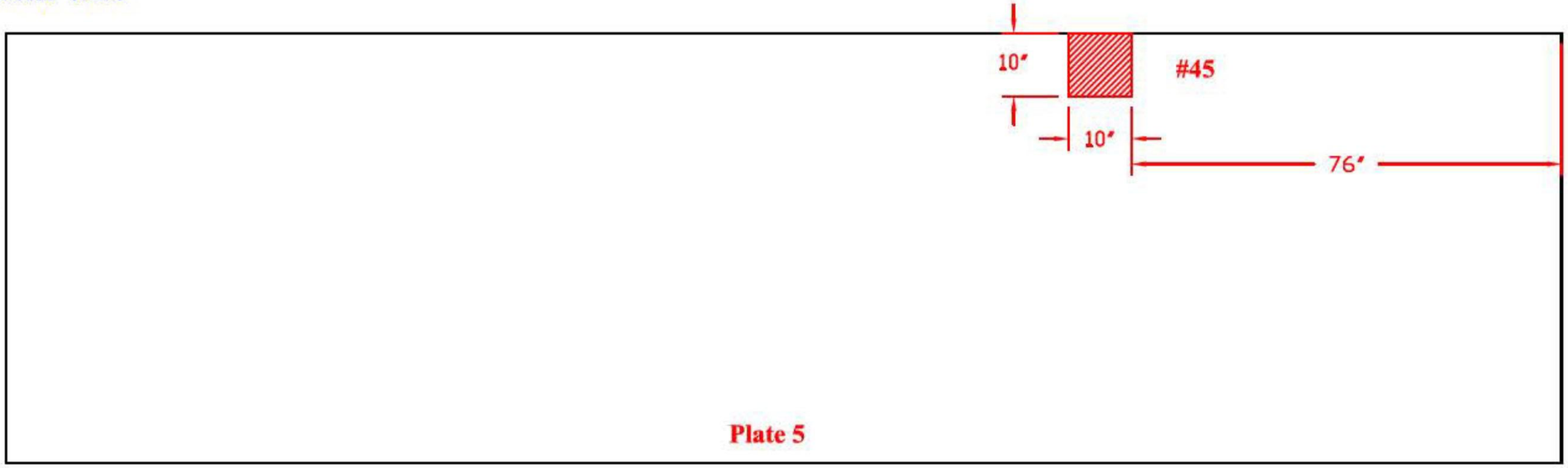
Date Inspected/Confirmed: 04/16/2008

Tank Section: Barrel

Course: 2
Plate #: 5

Flaw # - Type - Remaining:

#45 - W.L. - .225"

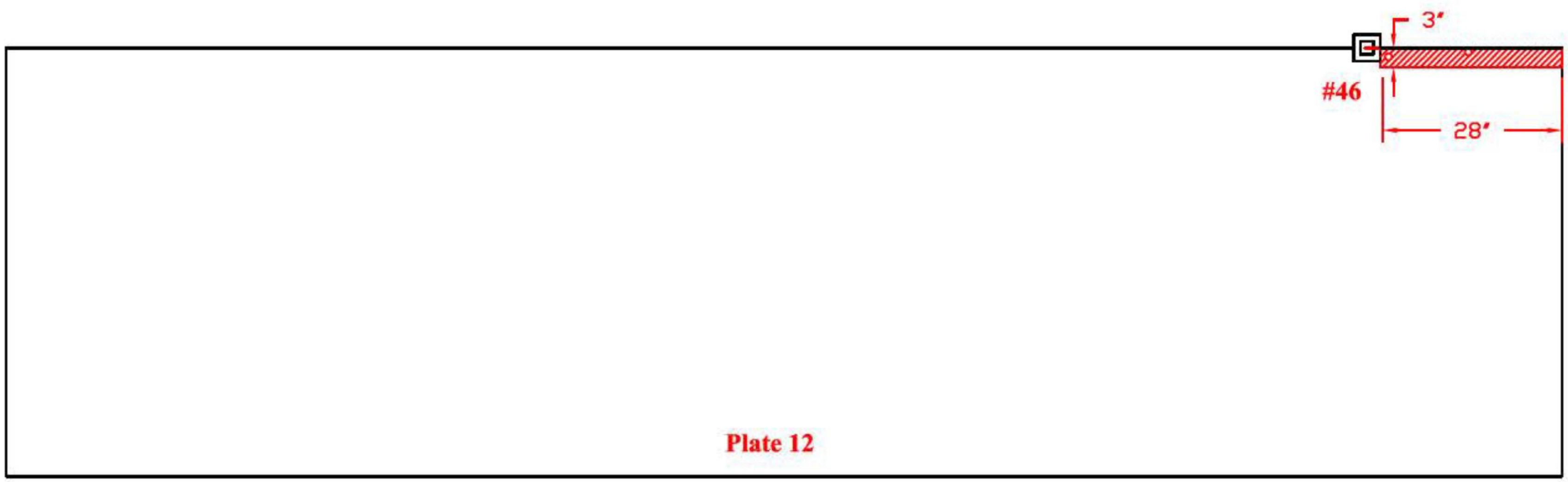


Tank Section: Barrel

Course: 25
Plate #: 12

Flaw # - Type - Remaining:

#46 - W.L. - .230"



Drawing is not to scale

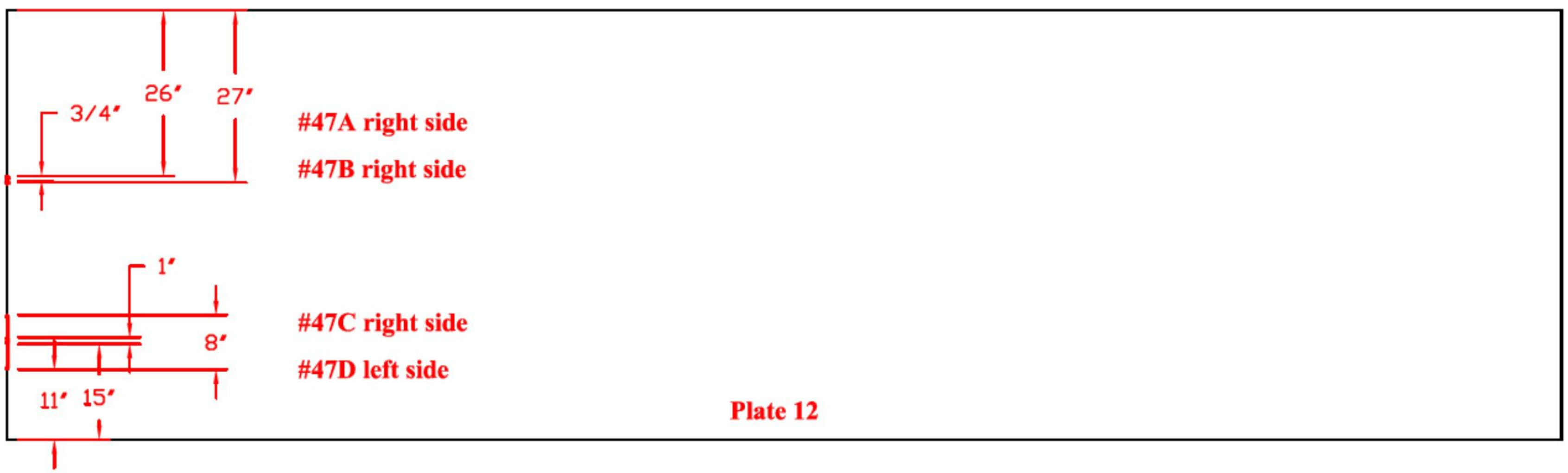
TANK # 2 - QUADRANT D - B
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 04/16/2008

Tank Section: Barrel

Course: 20
Plate #: 12

Flaw # - Type - Remaining:
#47A - Lack of fusion
.211" depth ¾"long (right)
#47B - Pin hole
.088" depth ⅛"dia (right)
#47C - Lack of fusion
.219" depth 8"long (right)
#47C - Lack of fusion
.221" depth 1"long (left)

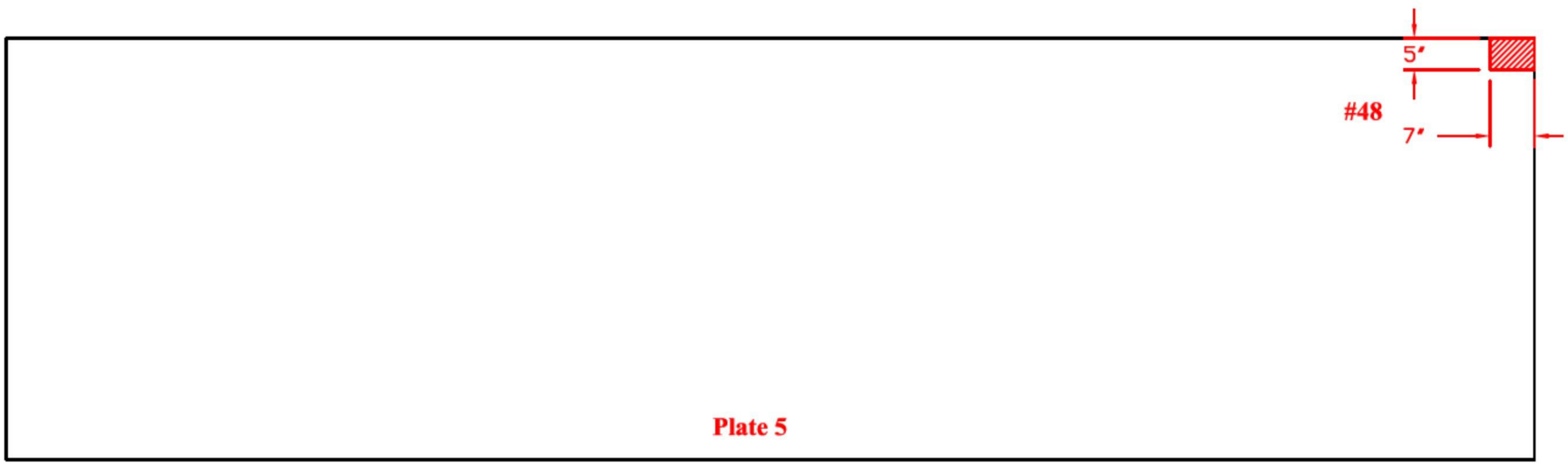


Tank Section: Barrel

Course: 17
Plate #: 5

Flaw # - Type - Remaining:

#48 - W.L. - .232"



Drawing is not to scale

TANK # 2 - QUADRANT B
***Nominal Plate Thickness: 0.250"**

Date Inspected/Confirmed: 04/17/2008

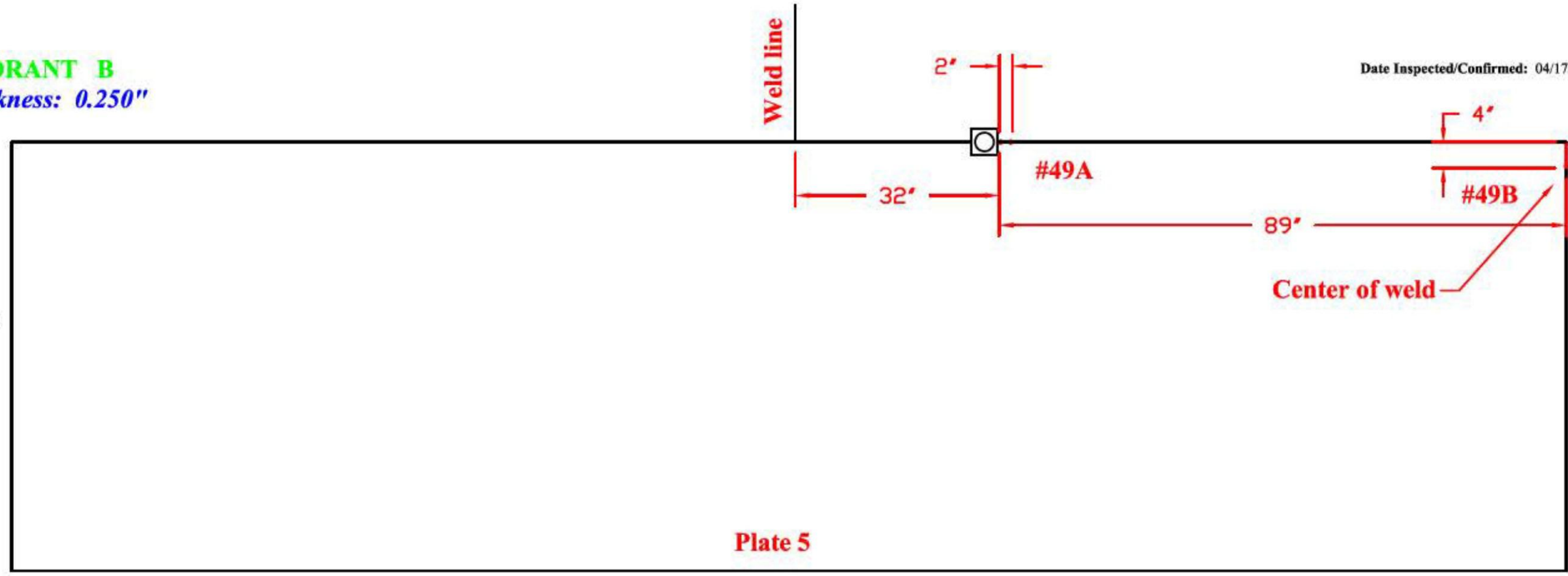
Tank Section: Barrel

Course: 26
Plate #: 5

Flaw # - Type - Remaining:

#49A - Slag line
.114" depth 2"long

#49B - Lack of fusion
.083" depth 4" long

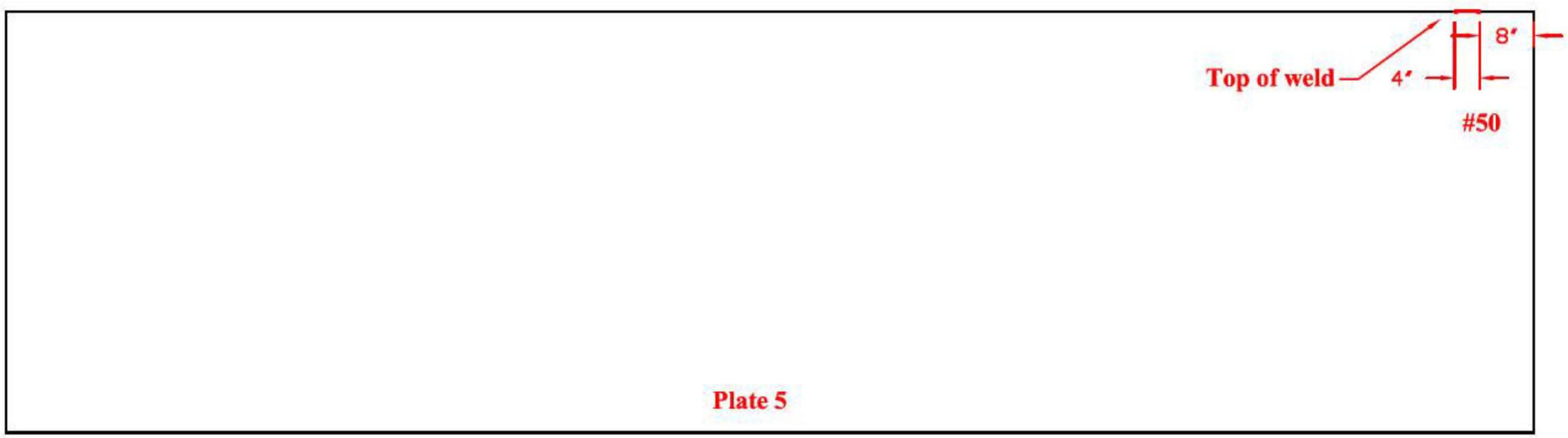


Tank Section: Barrel

Course: 28
Plate #: 5

Flaw # - Type - Remaining:

#50 - Lack of fusion
.104" depth 4" long



Drawing is not to scale

TANK # 2 - QUADRANT B
Nominal Plate Thickness: 0.250"

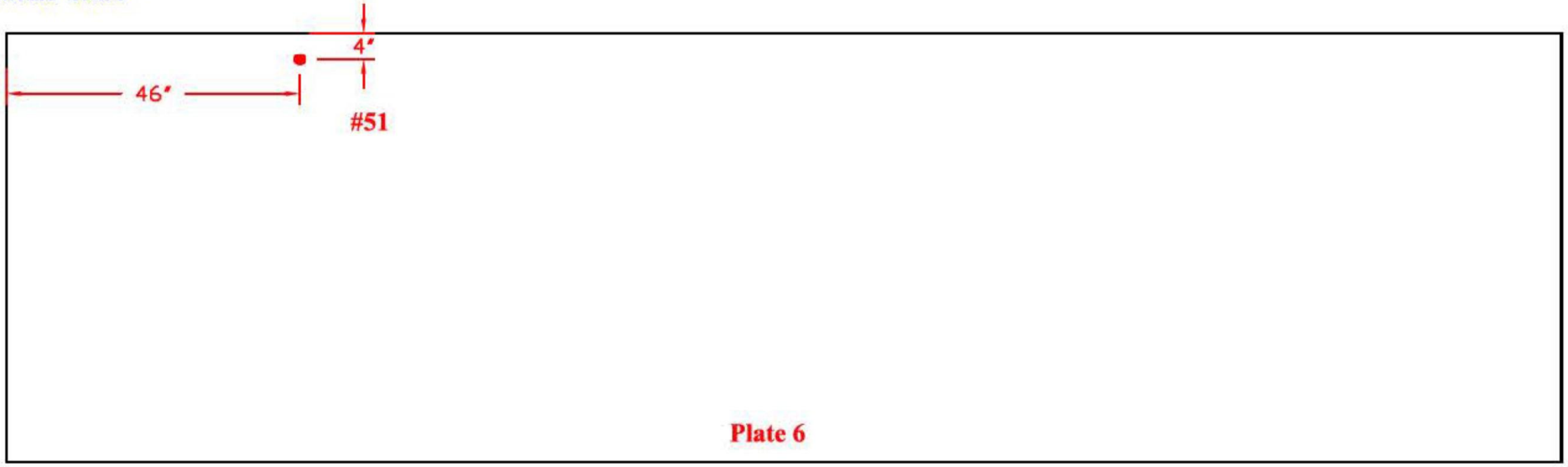
Date Inspected/Confirmed: 04/17/2008

Tank Section: Barrel

Course: 26
Plate #: 6

Flaw # - Type - Remaining:

#51 - W.L./Pit - .220"

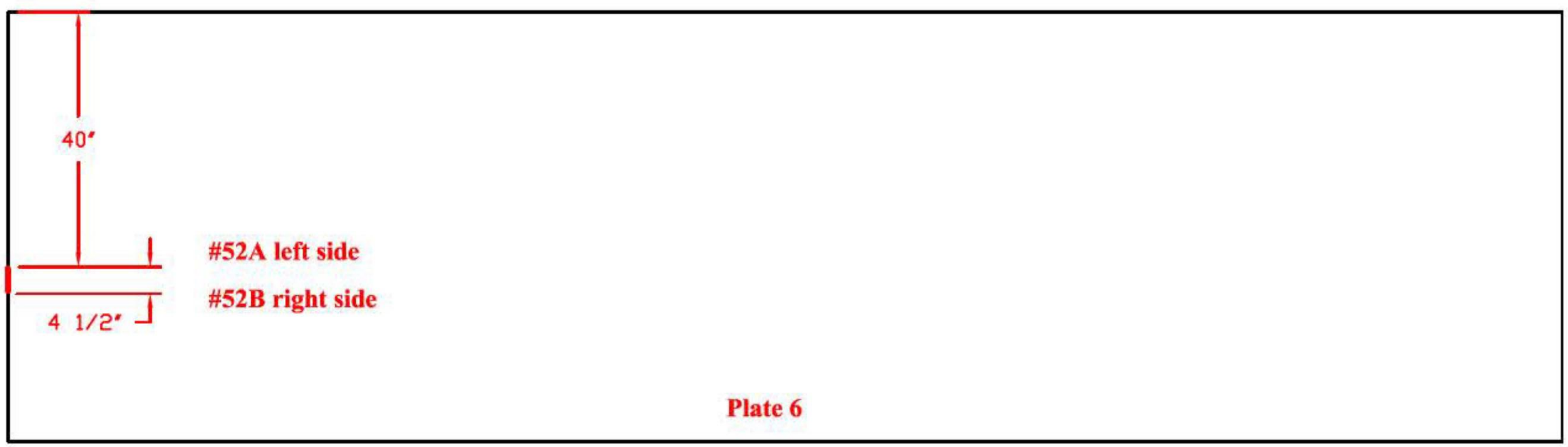


Tank Section: Barrel

Course: 22
Plate #: 6

Flaw # - Type - Remaining:

#52A - Lack of fusion
.169" depth 4 1/2" long
(left side)
#52B - Lack of fusion
.154" depth 4 1/2" long
(right side)



Drawing is not to scale

TANK # 2 - QUADRANT B
Nominal Plate Thickness: 0.250"

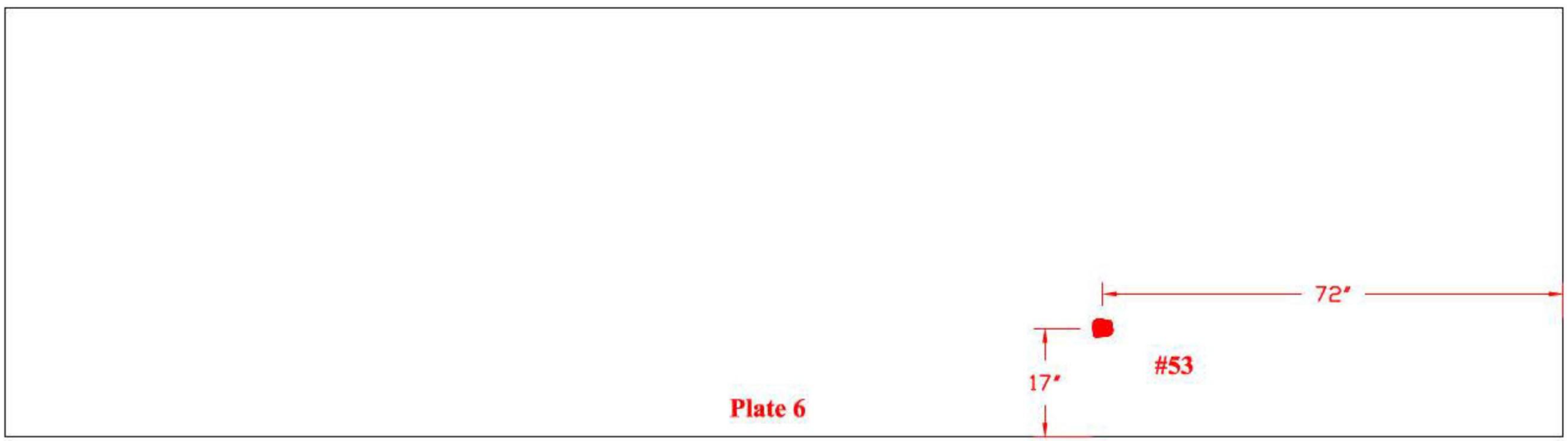
Date Inspected/Confirmed: 04/17/2008

Tank Section: Barrel

Course: 19
Plate #: 6

Flaw # - Type - Remaining:

#53 - W.L./Pit - .220"

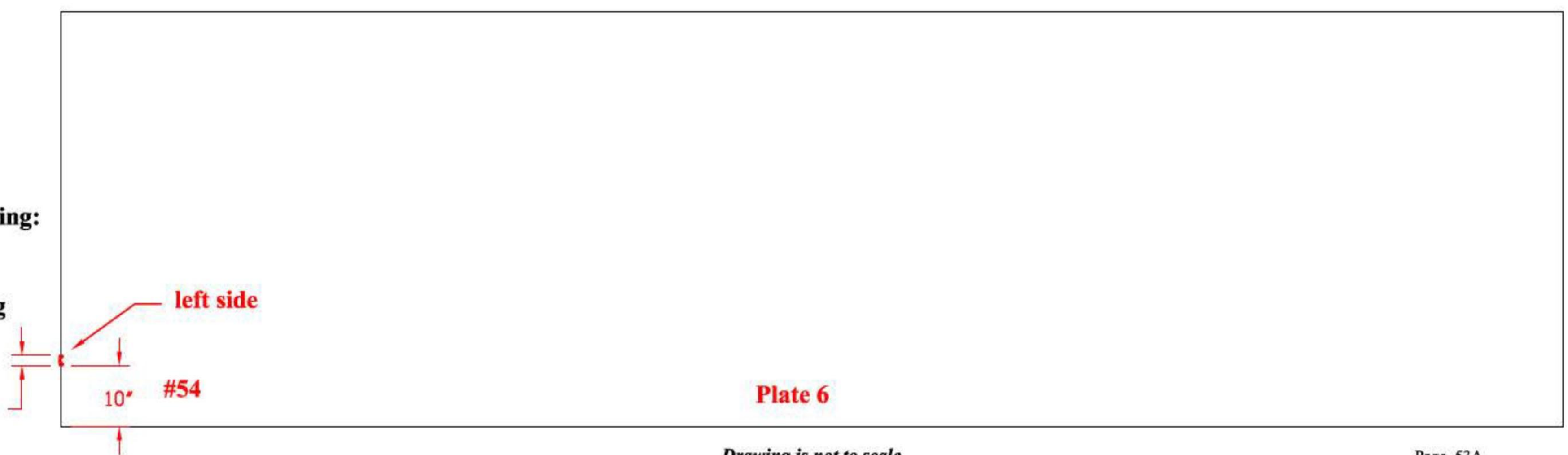


Tank Section: Barrel

Course: 2
Plate #: 6

Flaw # - Type - Remaining:

#54 - Lack of fusion
.219" depth 1 3/4" long
(left side)



Drawing is not to scale

TANK # 2 - QUADRANT C
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 04/17/2008

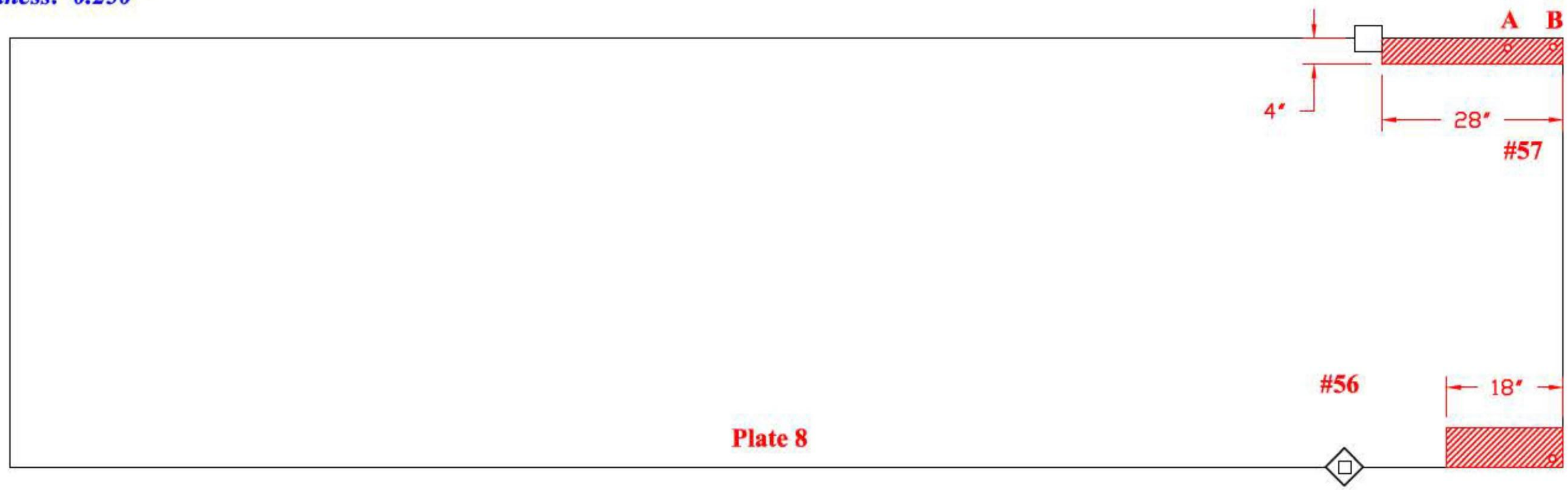
Tank Section: Barrel

Course: 6
Plate #: 8

Flaw # - Type - Remaining:

#56 - W.L. - .225"

#57 - W.L. - .229" A
.231" B

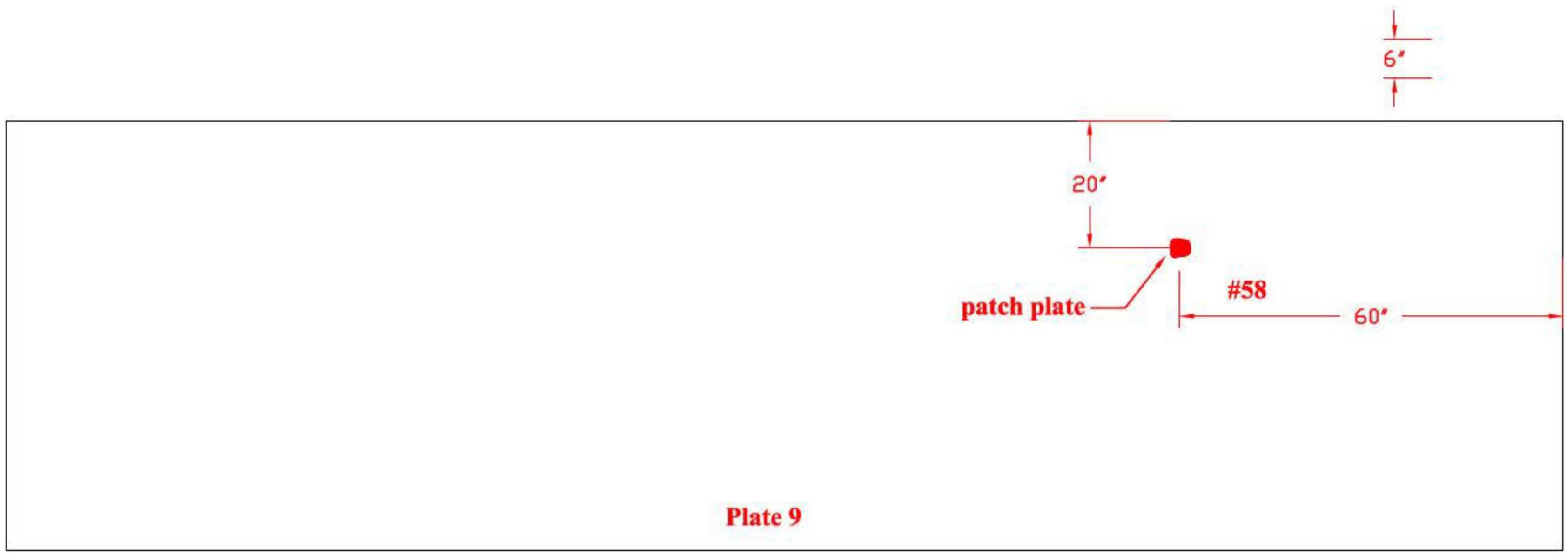


Tank Section: Barrel

Course: 1
Plate #: 9

Flaw # - Type - Remaining:

#58 - W.L. - .200"
on patch plate



Drawing is not to scale

TANK # 2 - QUADRANT C
Nominal Plate Thickness: 0.250"

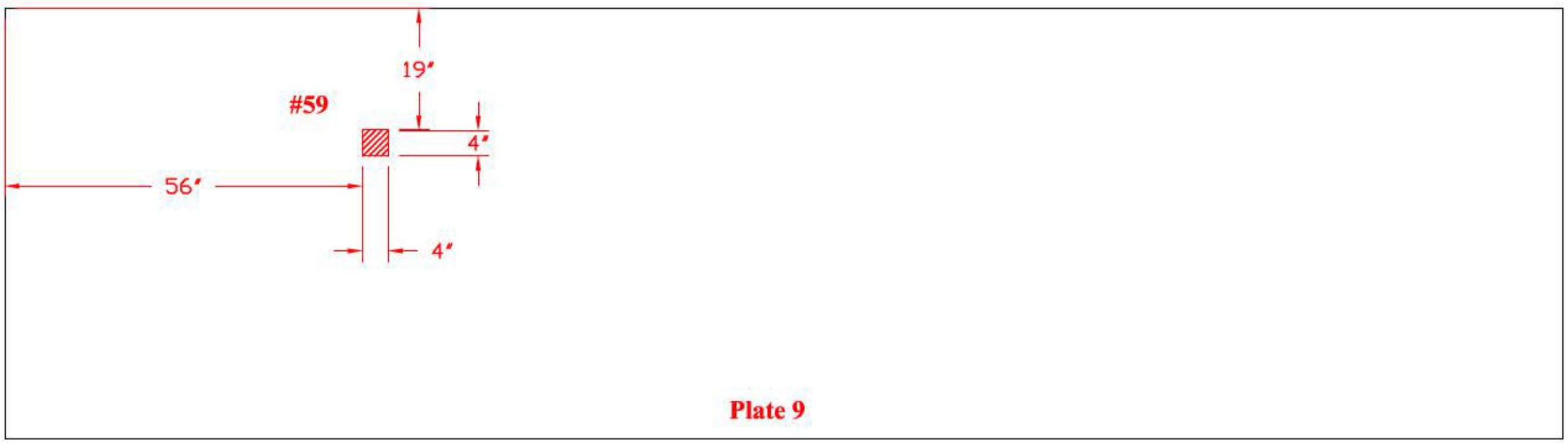
Date Inspected/Confirmed: 04/23/2008

Tank Section: Barrel

Course: 22
Plate #: 9

Flaw # - Type - Remaining:

#59 - W.L. - .186"

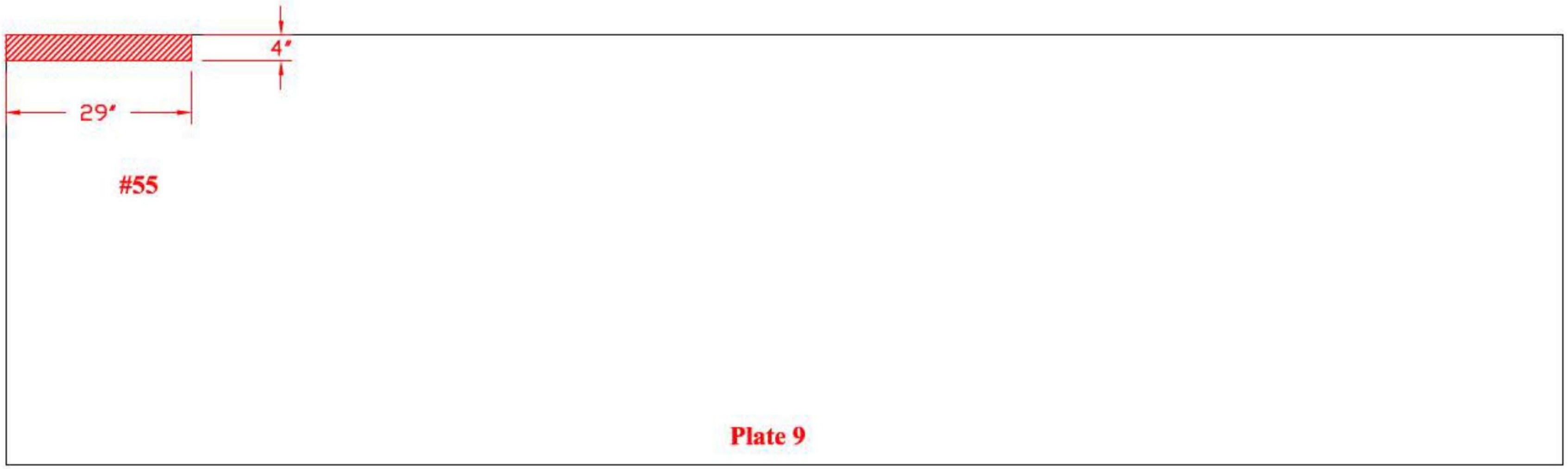


Tank Section: Barrel

Course: 23
Plate #: 9

Flaw # - Type - Remaining:

#55 - W.L. - .228"



Drawing is not to scale

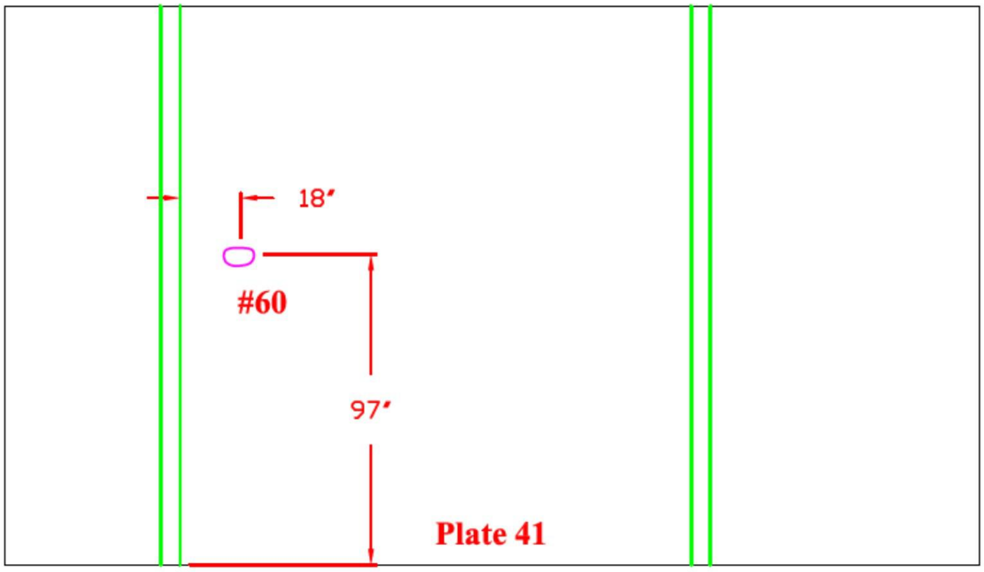
3.0 TANK MAPS
Dunkin & Bush, Inc.
Honolulu, HI
Tank #2 - Quadrant C

TANK #2 - QUADRANT C
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 04/24/2008

Tank Section: Upper dome
Quadrant: C
Course: A
Plate: # 41

Flaw # 60 - Dent
.165 deep 1½" dia N.S.W.L.

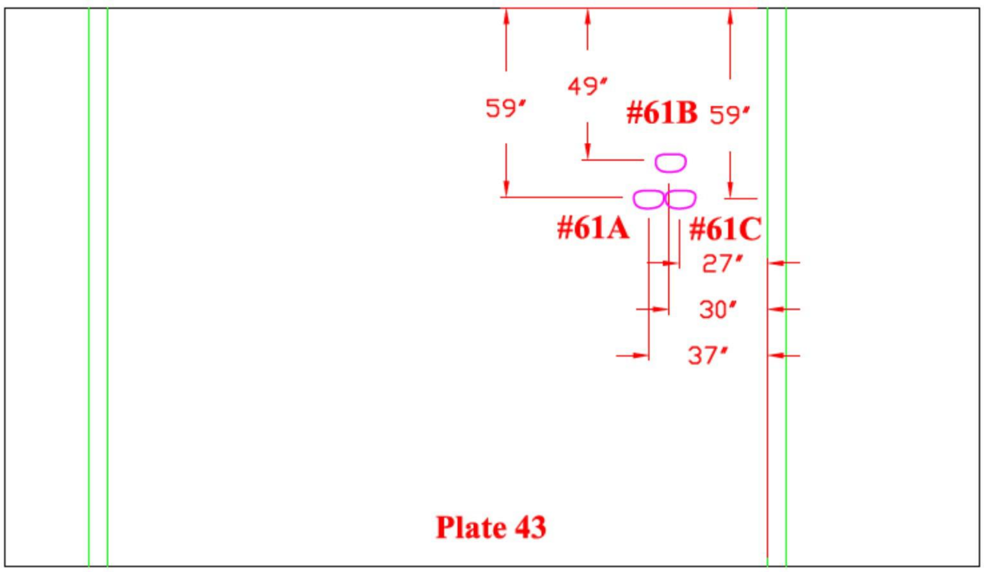


Tank Section: Upper dome
Quadrant: C
Course: A
Plate: # 46

Flaw # 61A - Dent
.215 deep 1½"-2" dia N.S.W.L.

Flaw # 61B - Dent
.095 deep 1½"-2" dia N.S.W.L.

Flaw # 61C - Dent
.265 deep 1½"-2" dia N.S.W.L.



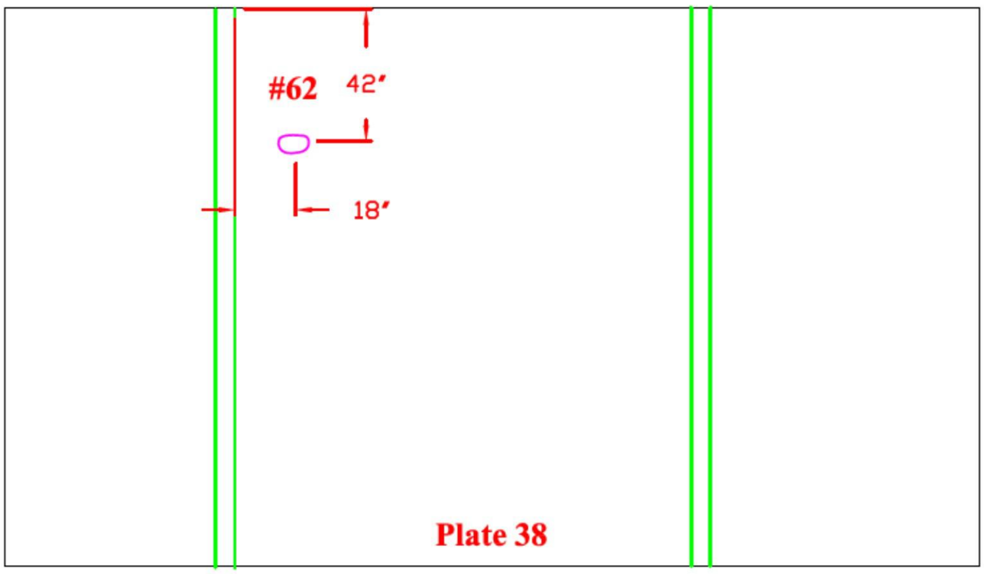
Drawing is not to scale

TANK #2 - QUADRANT C
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 04/24/2008

Tank Section: Upper dome
Quadrant: C
Course: A
Plate: # 38

Flaw # 62 - Dent
.480 deep 2" dia N.S.W.L.

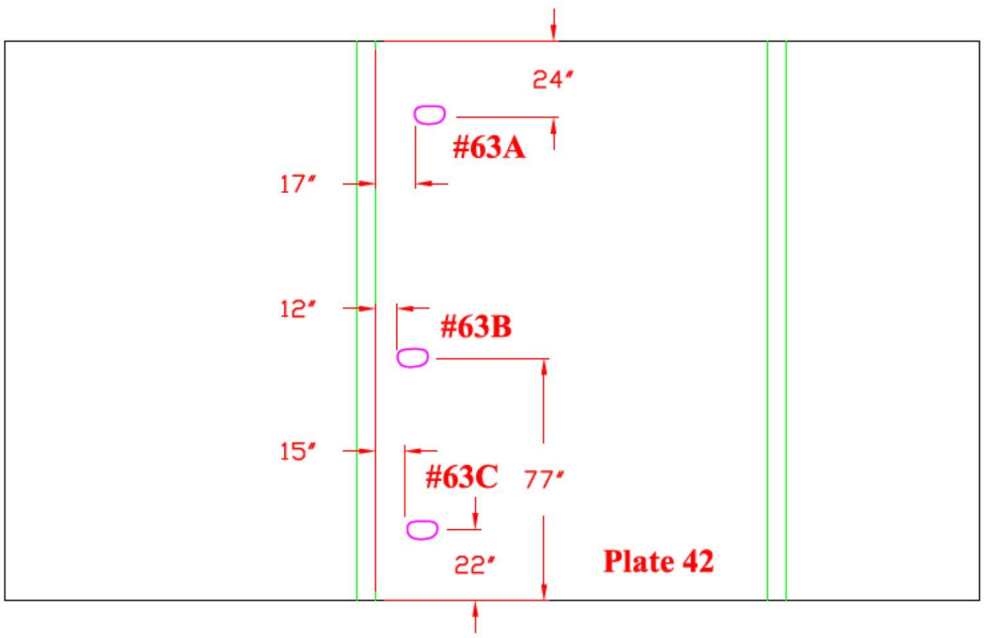


Tank Section: Upper dome
Quadrant: C
Course: A
Plate: # 42

Flaw # 63A - Dent
.130 deep 1½"-2" dia N.S.W.L.

Flaw # 63B - Dent
.170 deep 1½"-2" dia N.S.W.L.

Flaw # 63C - Dent
.155 deep 1½"-2" dia N.S.W.L.



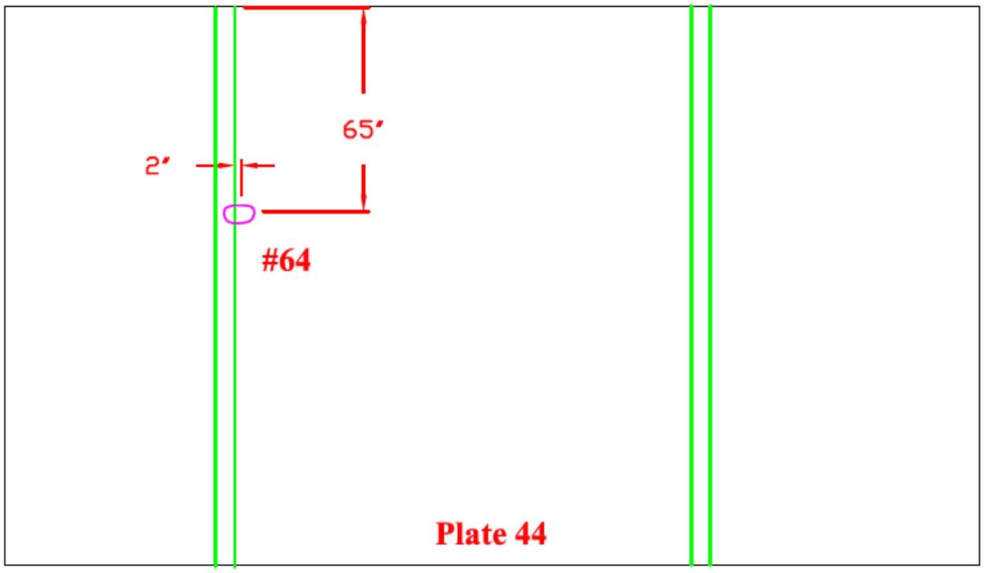
Drawing is not to scale

TANK #2 - QUADRANT C
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 04/24/2008

Tank Section: Upper dome
Quadrant: C
Course: A
Plate: # 44

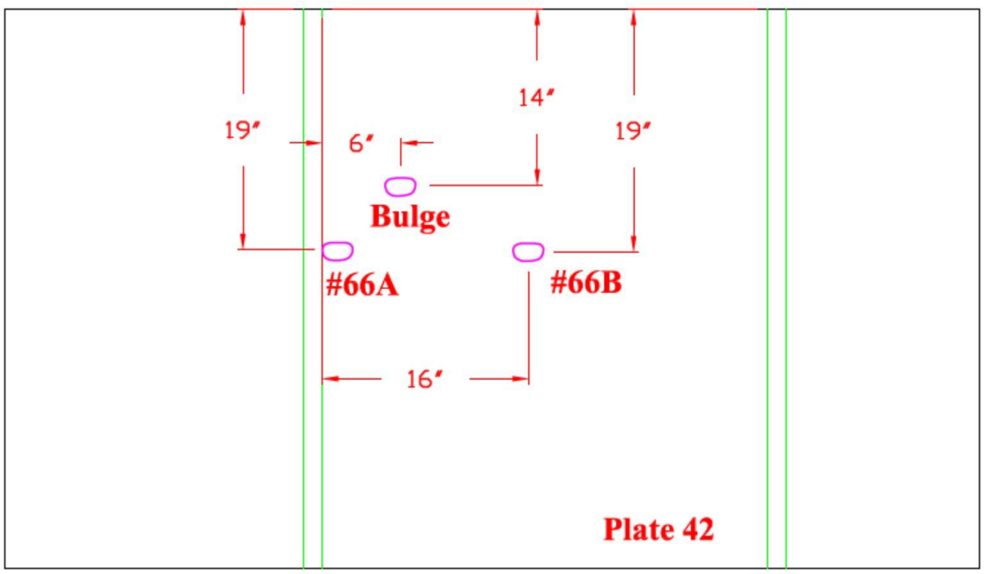
Flaw # 64 - Dent
.115 deep 2" dia N.S.W.L.



Tank Section: Upper dome
Quadrant: C
Course: B
Plate: # 41

Flaw # 66A - Dent
.065 deep 1½" dia N.S.W.L.

Flaw # 66B - Dent
.025 deep 1½" dia N.S.W.L.



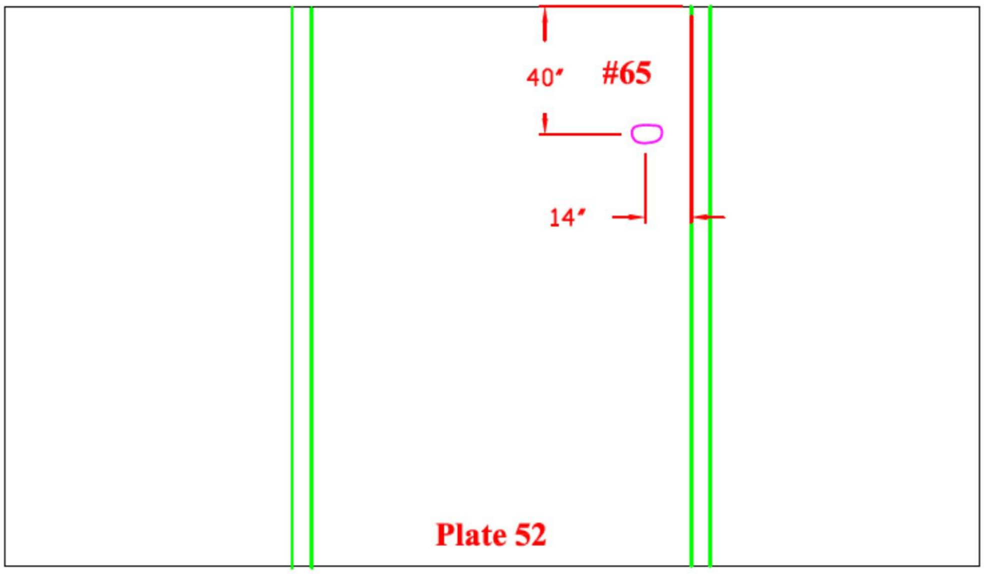
Drawing is not to scale

TANK #2 - QUADRANT C - B
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 04/28/2008

Tank Section: Upper dome
Quadrant: C
Course: A
Plate: # 52

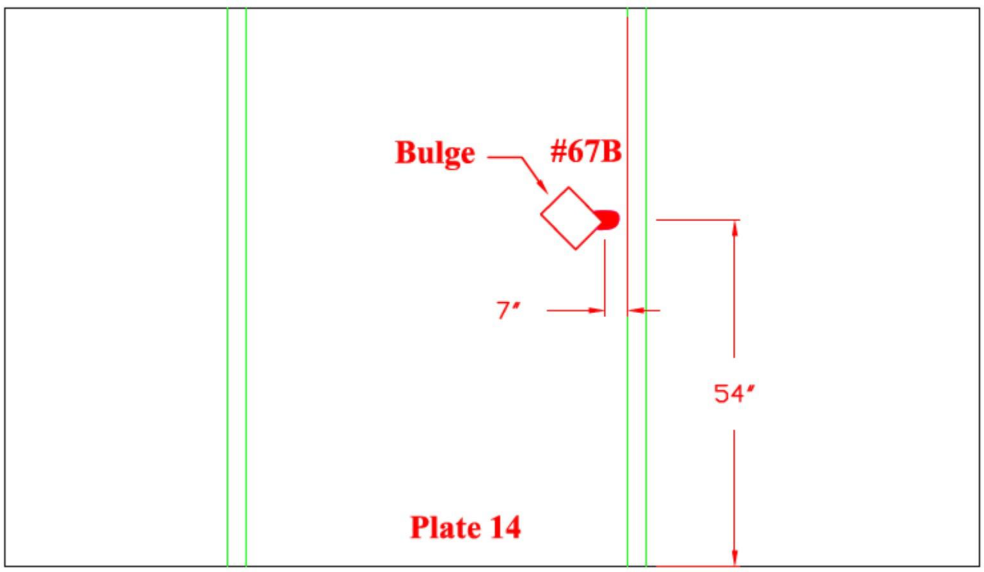
Flaw # 65 - Dent
.085 deep 1 1/2" dia N.S.W.L.



Tank Section: Upper dome
Quadrant: B
Course: C
Plate: # 14

Flaw # 67A - Patch
.141 Remaining

Flaw # 67B - W.L.
.185 Remaining



Drawing is not to scale

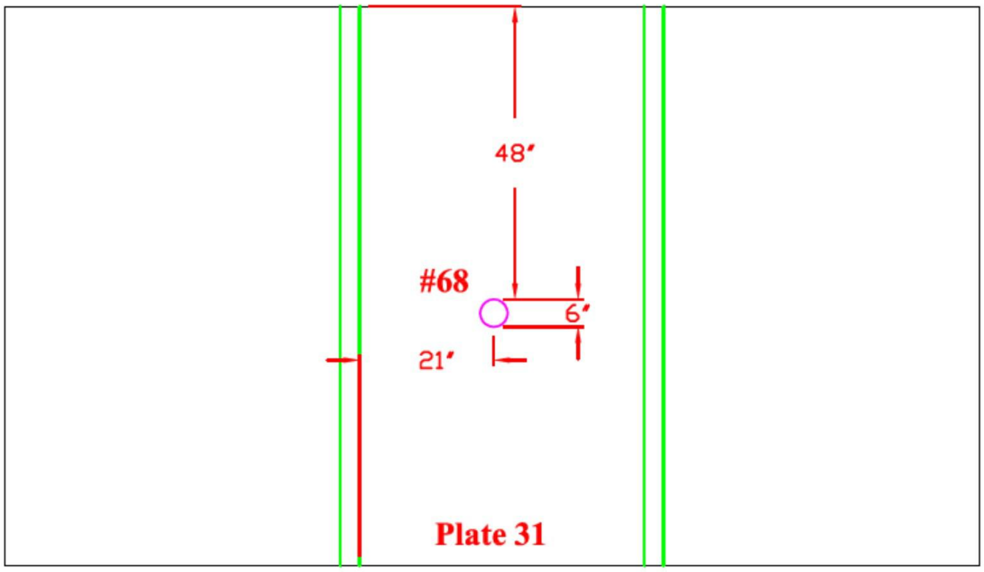
TANK #2 - QUADRANT B

Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/01/2008

Tank Section: Upper dome
Quadrant: B
Course: B
Plate: # 31

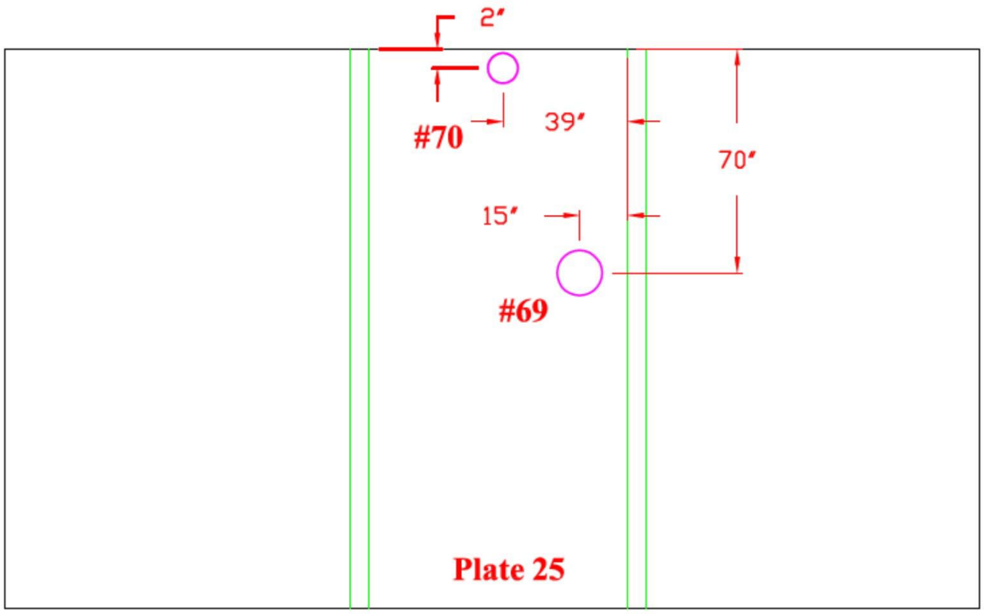
Flaw # 68 - Dent
.300 deep 6" dia N.S.W.L.



Tank Section: Upper dome
Quadrant: B
Course: A
Plate: # 25

Flaw # 69 - Patch
.120 deep 1 ½" dia N.S.W.L.

Flaw # 70 - Dent
.200 deep 2 ½" dia N.S.W.L.



Drawing is not to scale

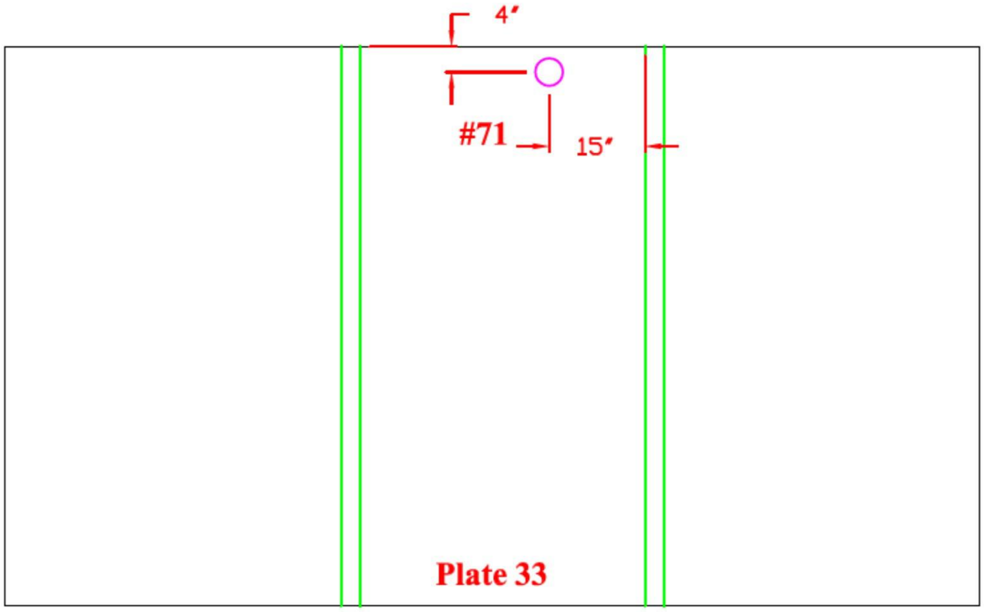
TANK #2 - QUADRANT B

Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/01/2008

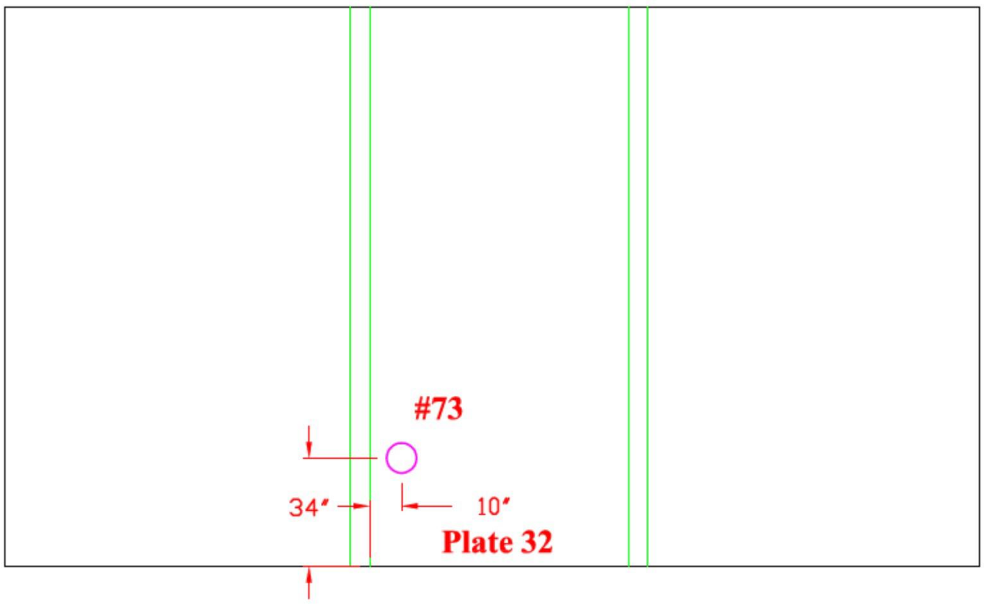
Tank Section: Upper dome
Quadrant: B
Course: A
Plate: # 33

Flaw # 71 - Dent
.320 deep 3" dia N.S.W.L.



Tank Section: Upper dome
Quadrant: B
Course: A
Plate: # 32

Flaw # 73 - Dent
.170 deep 2" dia N.S.W.L.



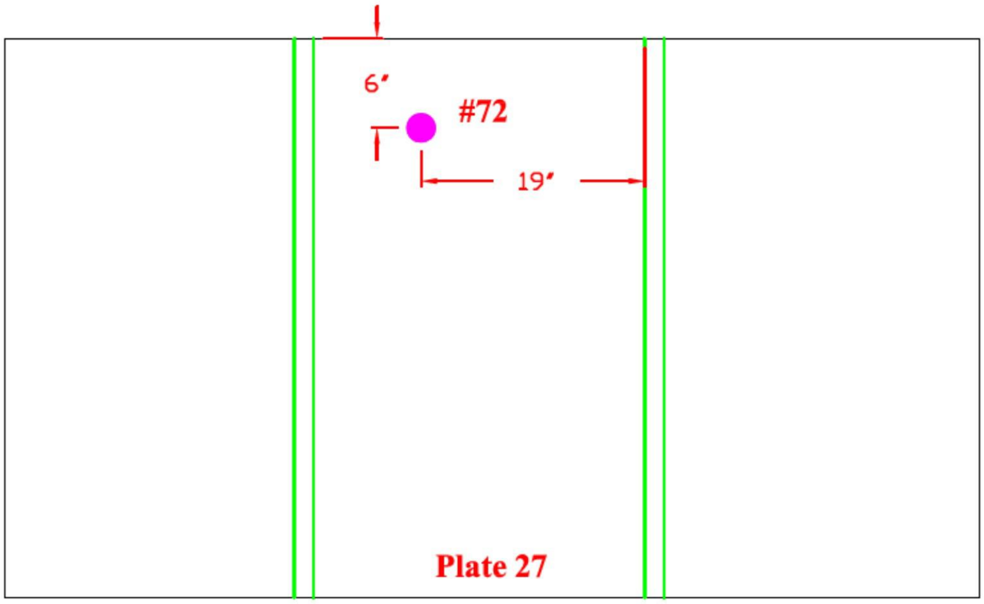
Drawing is not to scale

TANK #2 - QUADRANT B
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/01/2008

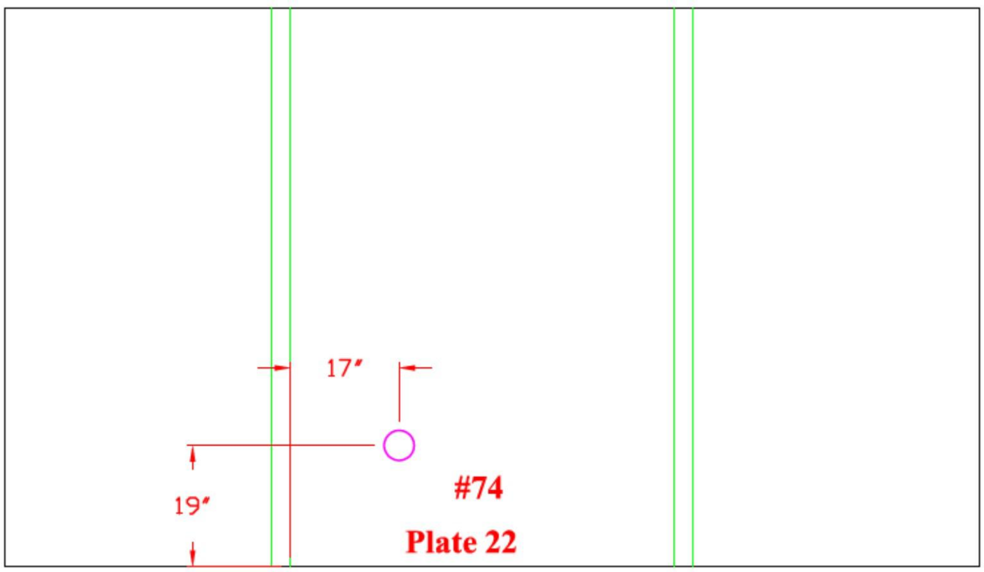
Tank Section: Upper dome
Quadrant: B
Course: A
Plate: # 27

Flaw # 72 - T.S. Pit
.210" Remaining



Tank Section: Upper dome
Quadrant: B
Course: B
Plate: # 22

Flaw # 74 - Dent
.260 deep 3" dia N.S.W.L.



Drawing is not to scale

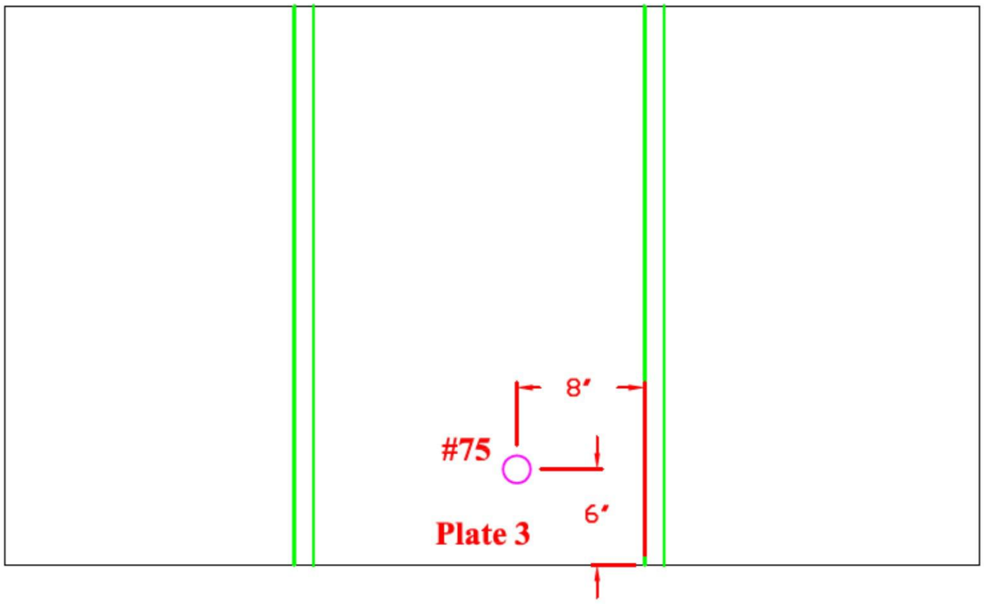
TANK #2 - QUADRANT A

Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/01/2008

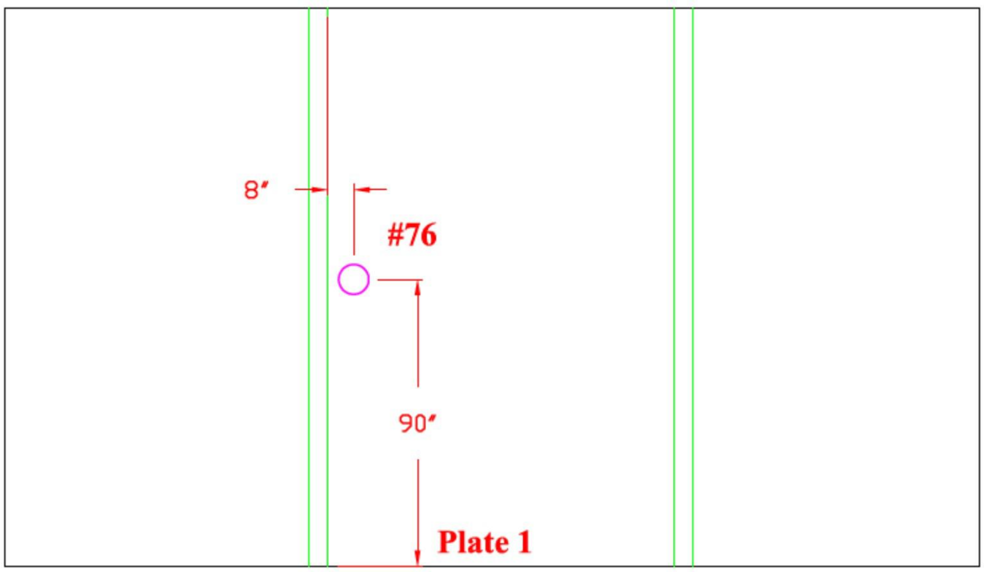
Tank Section: Upper dome
Quadrant: A
Course: B
Plate: # 3

Flaw # 75 - Dent
.250" deep 1½"-2" dia
N.S.W.L.



Tank Section: Upper dome
Quadrant: A
Course: B
Plate: # 1

Flaw # 76 - Thru Wall Pit
.232 depth 3/16" dia



Drawing is not to scale

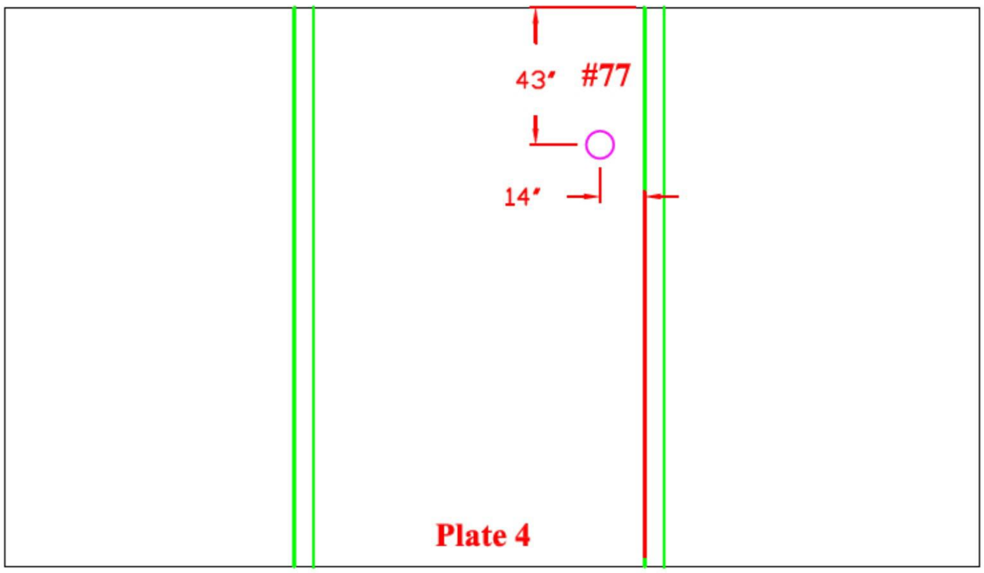
TANK #2 - QUADRANT A

Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/01/2008

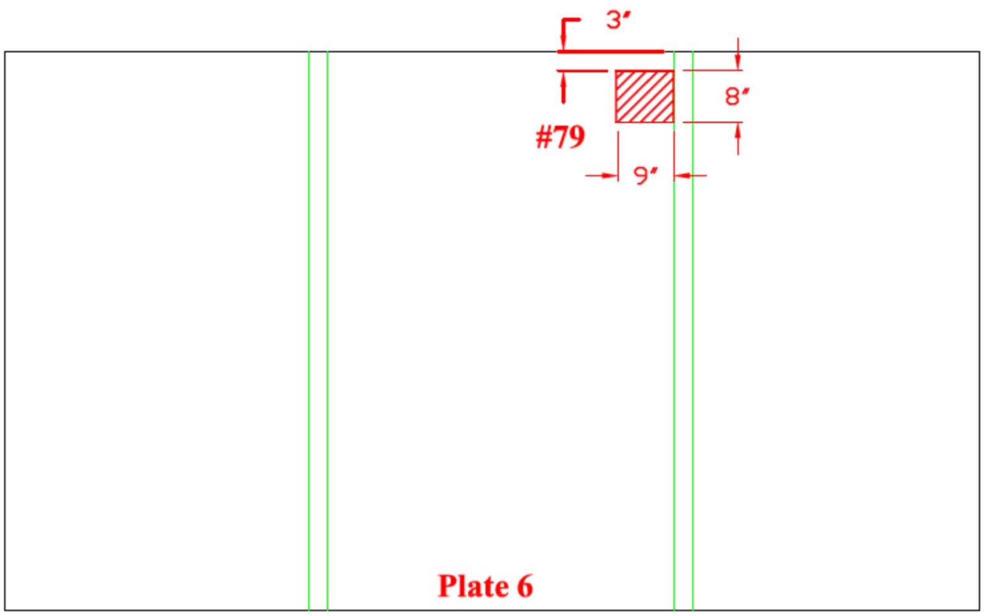
Tank Section: Upper dome
Quadrant: A
Course: A
Plate: # 4

Flaw # 77 - Dent
.165" deep 3" dia
N.S.W.L.



Tank Section: Upper dome
Quadrant: A
Course: C
Plate: # 6

Flaw # 79 - W.L.
.210 Remaining



Drawing is not to scale

TANK #2 - QUADRANT C

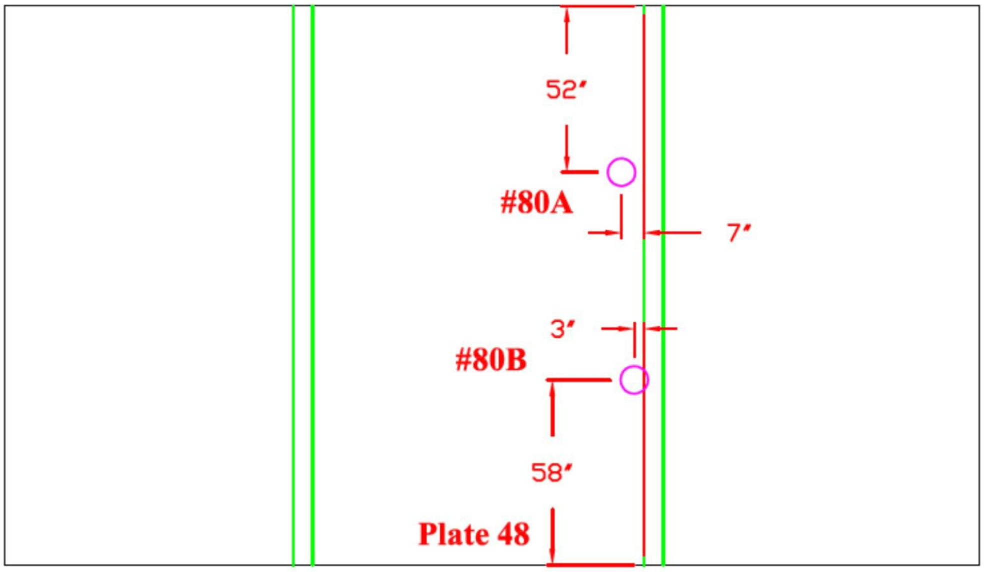
***Nominal Plate Thickness: 0.250"**

Date Inspected/Confirmed: 04/24/2008

Tank Section: Upper dome
Quadrant: C
Course: A
Plate: # 48

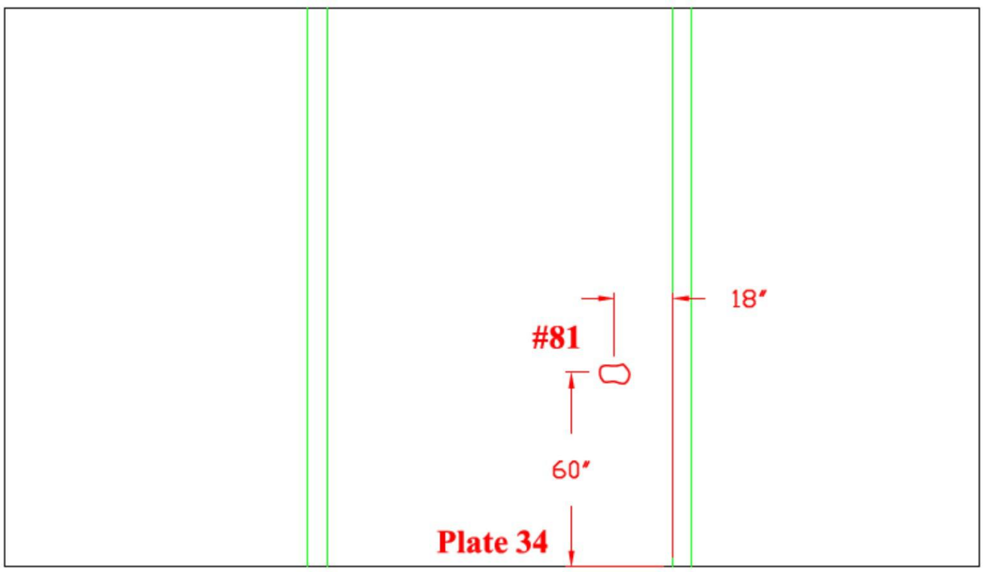
Flaw # 80A - Dent
.255" deep 1 1/2" - 2" dia
N.S.W.L.

Flaw # 80B - Dent
.140" deep 1 1/2" - 2" dia
N.S.W.L.



Tank Section: Upper dome
Quadrant: C
Course: C
Plate: # 34

Flaw # 81 - T.S. Pit
.055 deep



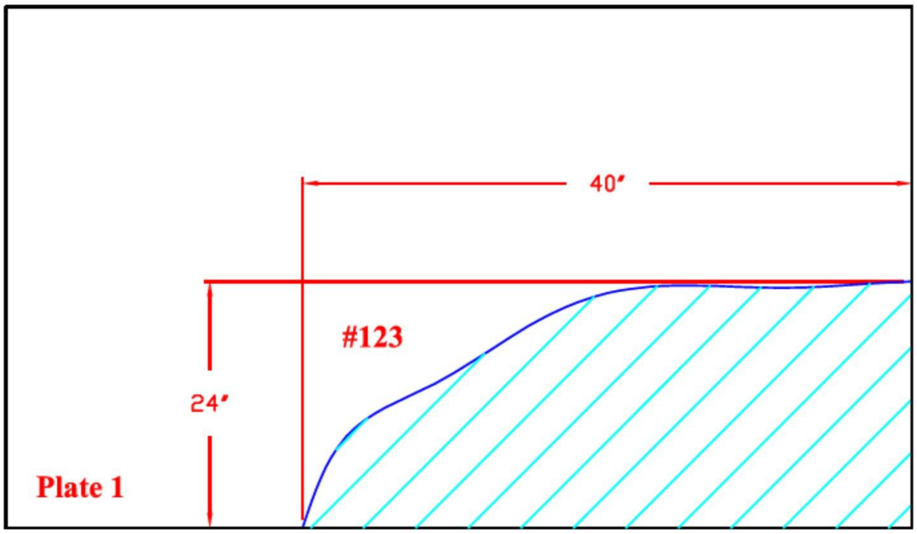
Drawing is not to scale

TANK #2 - QUADRANT A -D
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/08/2008

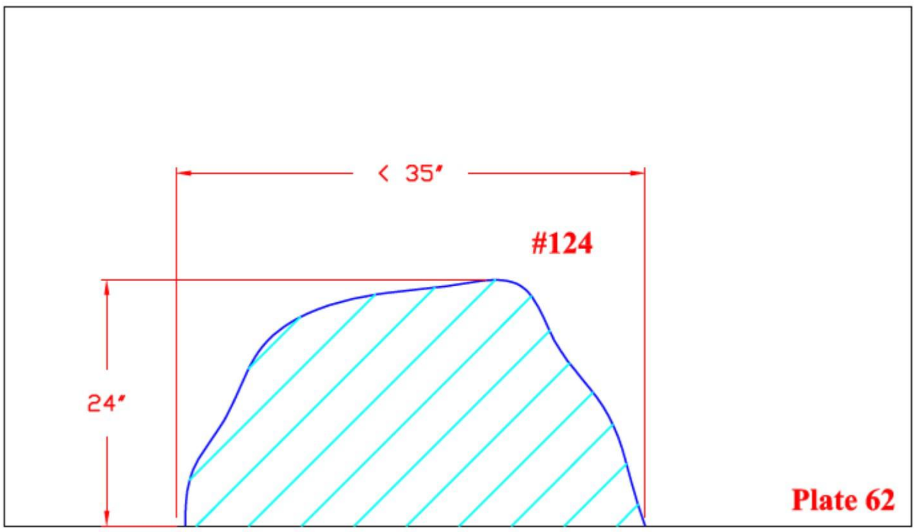
Tank Section: Lower Dome
Quadrant: A
Course: 2
Plate: # 1

Flaw # 123 - Bulge - N.S.W.L.
Shear wave technique was performed on all welds in bulge area.



Tank Section: Lower Dome
Quadrant: D
Course: 2
Plate: # 62

Flaw # 124 - Bulge - N.S.W.L.
Shear wave technique was performed on all welds in bulge area.



Drawing is not to scale

TANK #2 - QUADRANT A

Nominal Plate Thickness: 0.250"

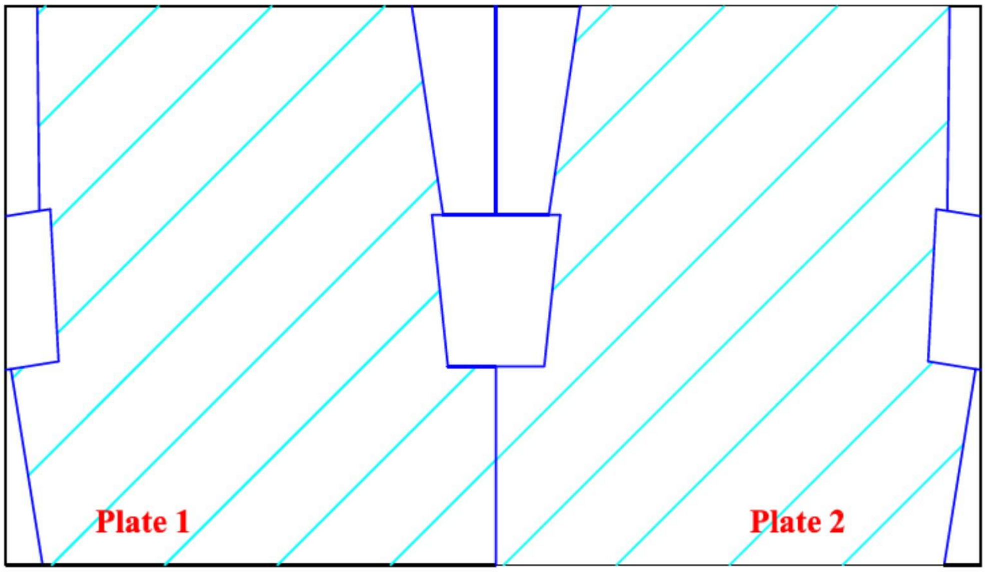
Date Inspected/Confirmed: 05/08/2008

Tank Section: Lower Dome
Quadrant: A
Course: 1
Plate: # 1-2

Flaw # 125 - Bulge - N.S.W.L.
Shear wave technique was performed on all welds in bulge area.

*** Note: This bulge encompassed both plates thru entire lengths.**

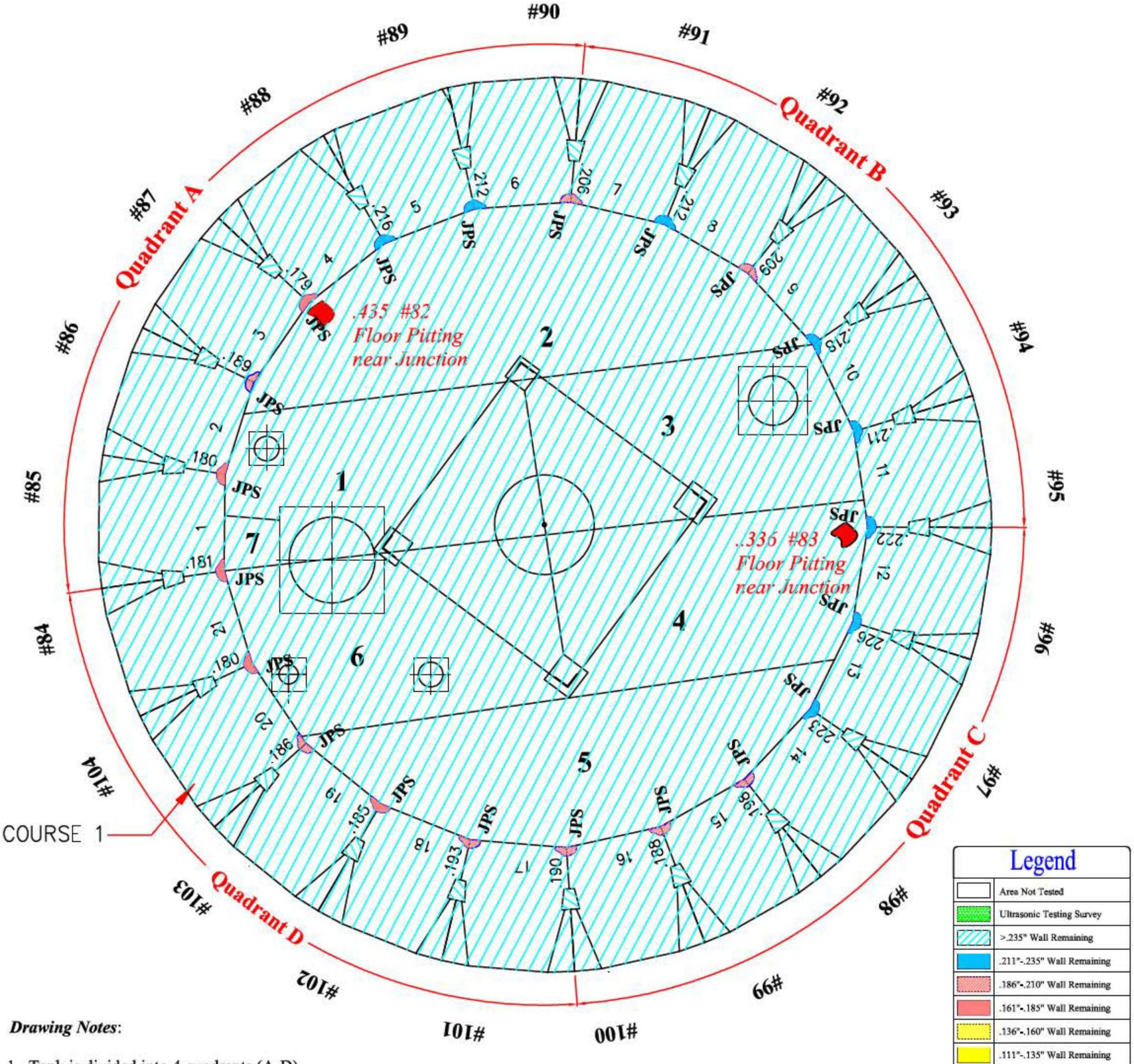
#125



Drawing is not to scale

3.0 Tank Maps
Dunkin & Bush, Inc.
Honolulu, HI
Tank # 2 - Lower Dome

TANK # 2 - LOWER DOME - PITTING - FLOOR , COURSE 1



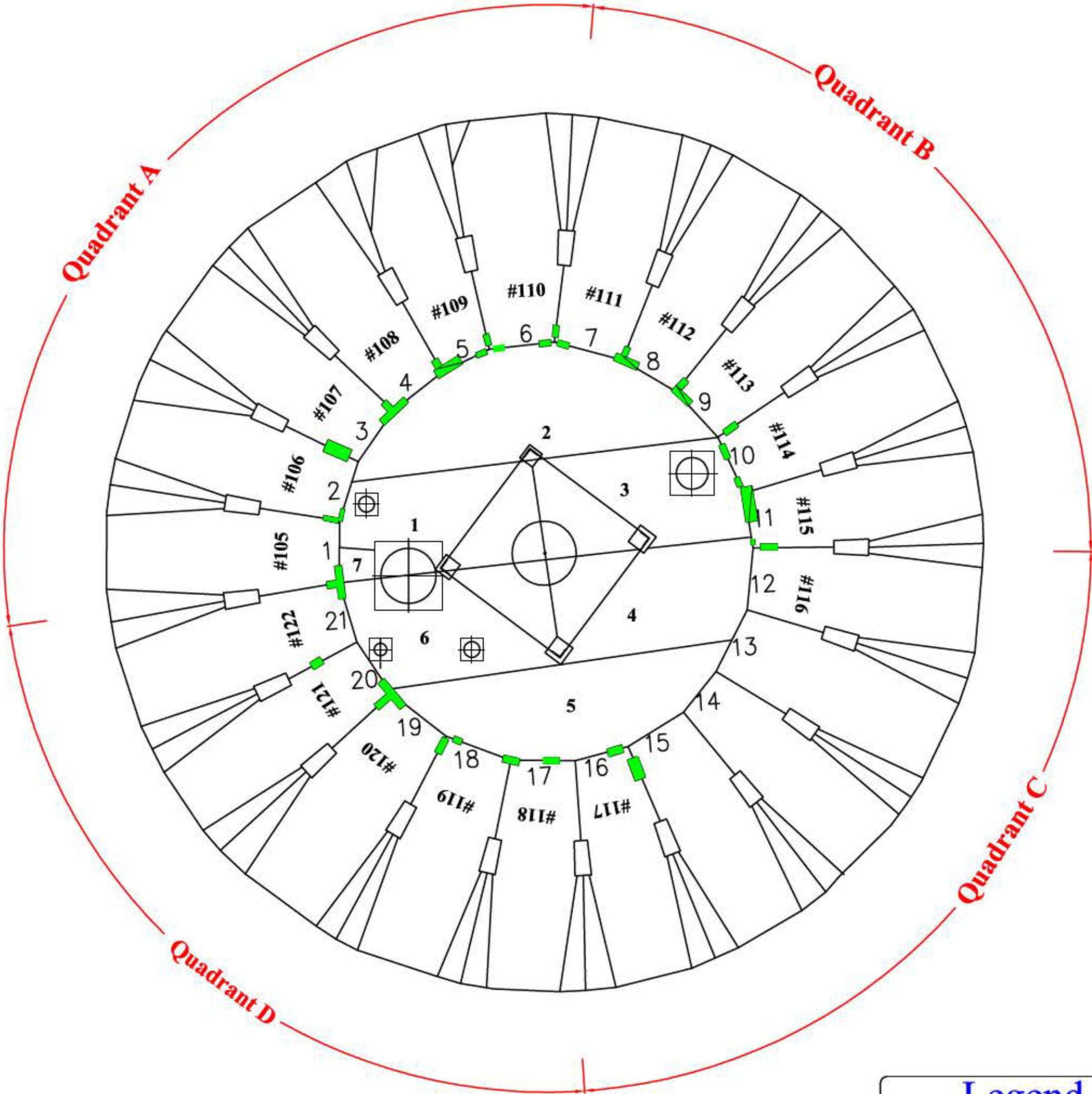
Drawing Notes:

1. Tank is divided into 4 quadrants (A-D).
2. Course 1 is comprised of 21 total plates.
3. Quadrant A is comprised of 6 plates (1-6).
4. Quadrant B is comprised of 5 plates (7-11).
5. Quadrant C is comprised of 5 plates (12-16).
6. Quadrant D is comprised of 5 plates (17-21).
7. This numbering convention begins with plate #1 being the first plate of quadrant A.

Drawing is not to scale

3.0 Tank Maps
Dunkin & Bush, Inc.
Honolulu, HI
Tank # 2 - Lower Dome

TANK # 2 - LOWER DOME - COURSE 1- WELD DEFECTS



Legend
Weld Defects

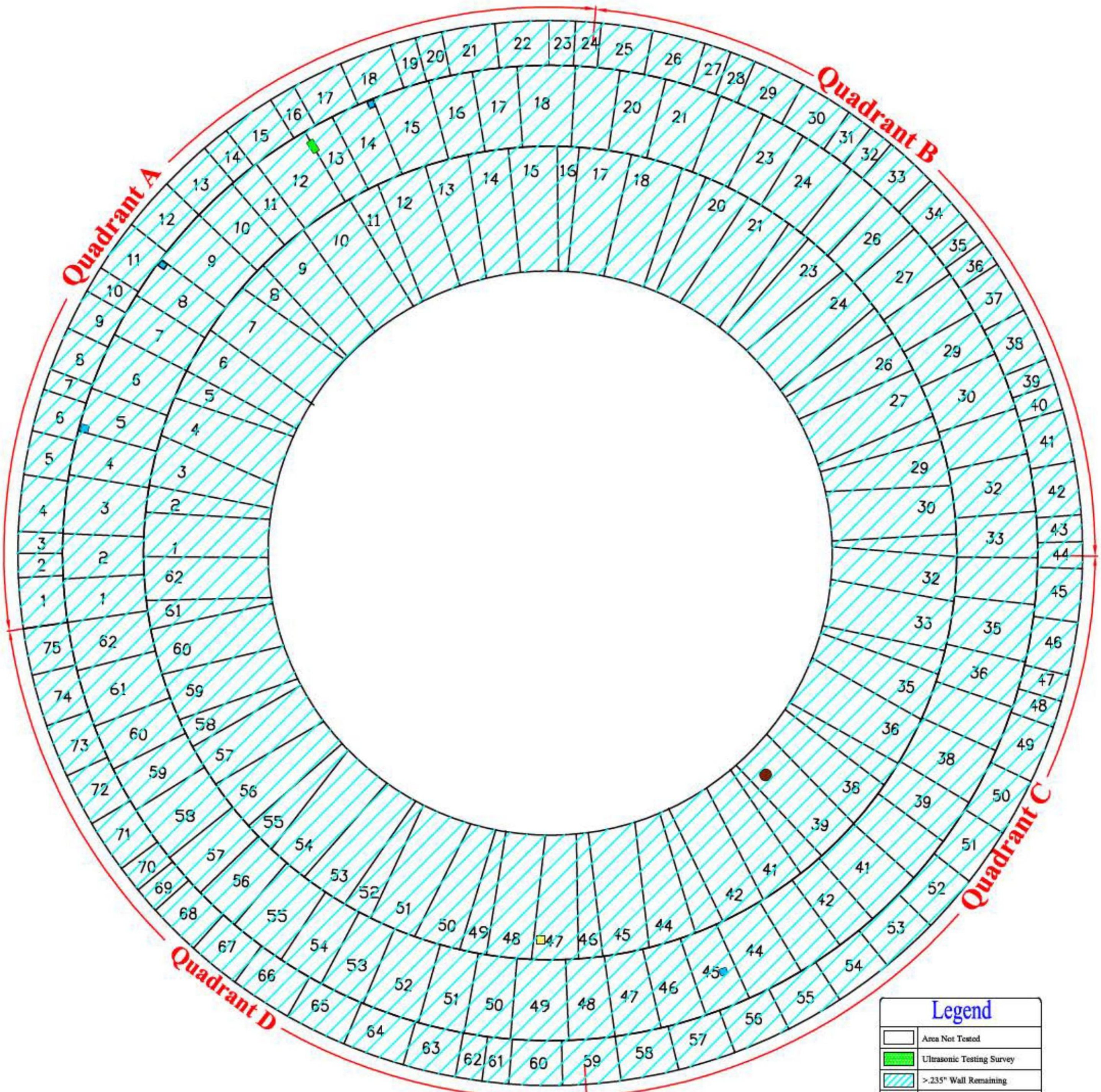
Drawing Notes:

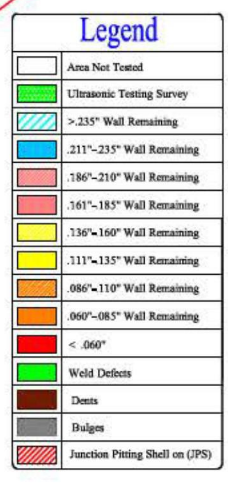
1. Tank is divided into 4 quadrants (A-D).
2. Course 1 is comprised of 21 total plates.
3. This numbering convention begins with plate #1 being the first plate of quadrant A.

Drawing is not to scale

3.0Tank Maps
Dunkin & Bush, Inc.
Honolulu, HI
Tank # 2 - Lower Dome

TANK # 2 - LOWER DOME - COURSE 2, 3 AND 4



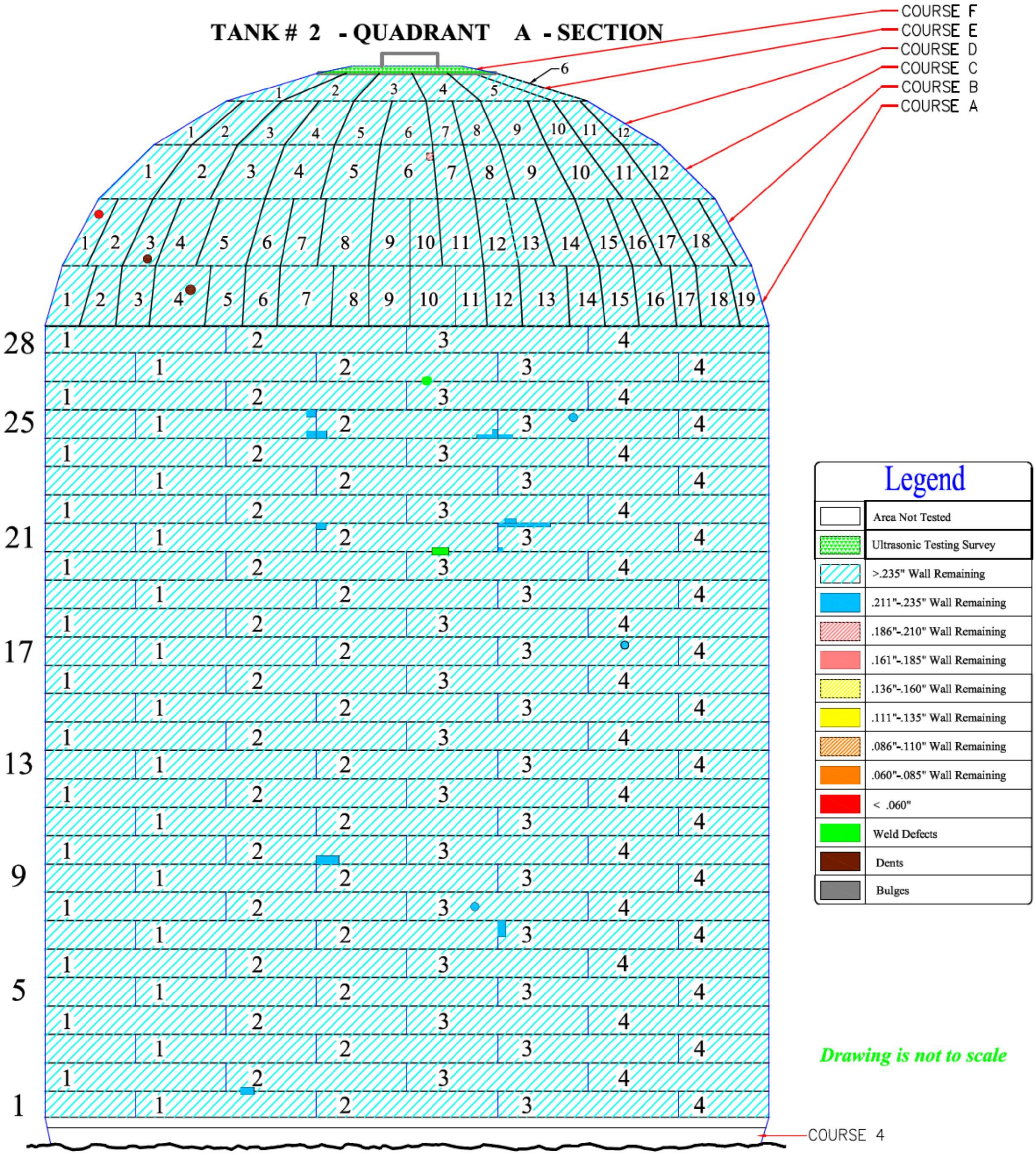


Drawing Notes:

1. Tank is divided into 4 quadrants .
2. Course 2 is comprised of 62 plates .
3. Course 3 is comprised of 62 plates .
4. Course 4 is comprised of 75 plates .
5. This numbering convention begins with plate #1 being the first plate of quadrant A.

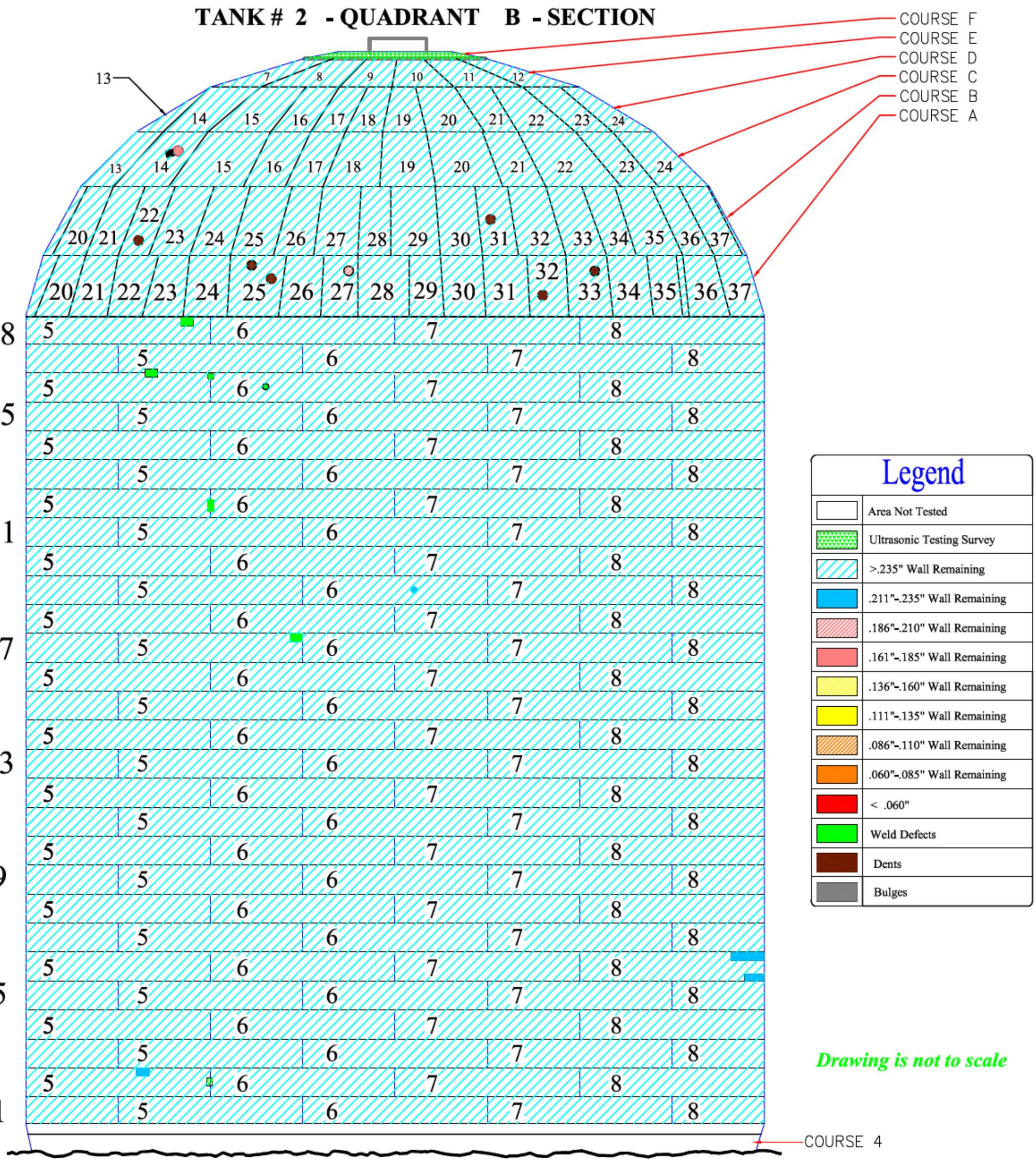
Drawing is not to scale

3.0 TANK MAPS
Dunkin & Bush, Inc.
Honolulu, HI



3.0 TANK MAPS

Dunkin & Bush, Inc.
Honolulu, HI

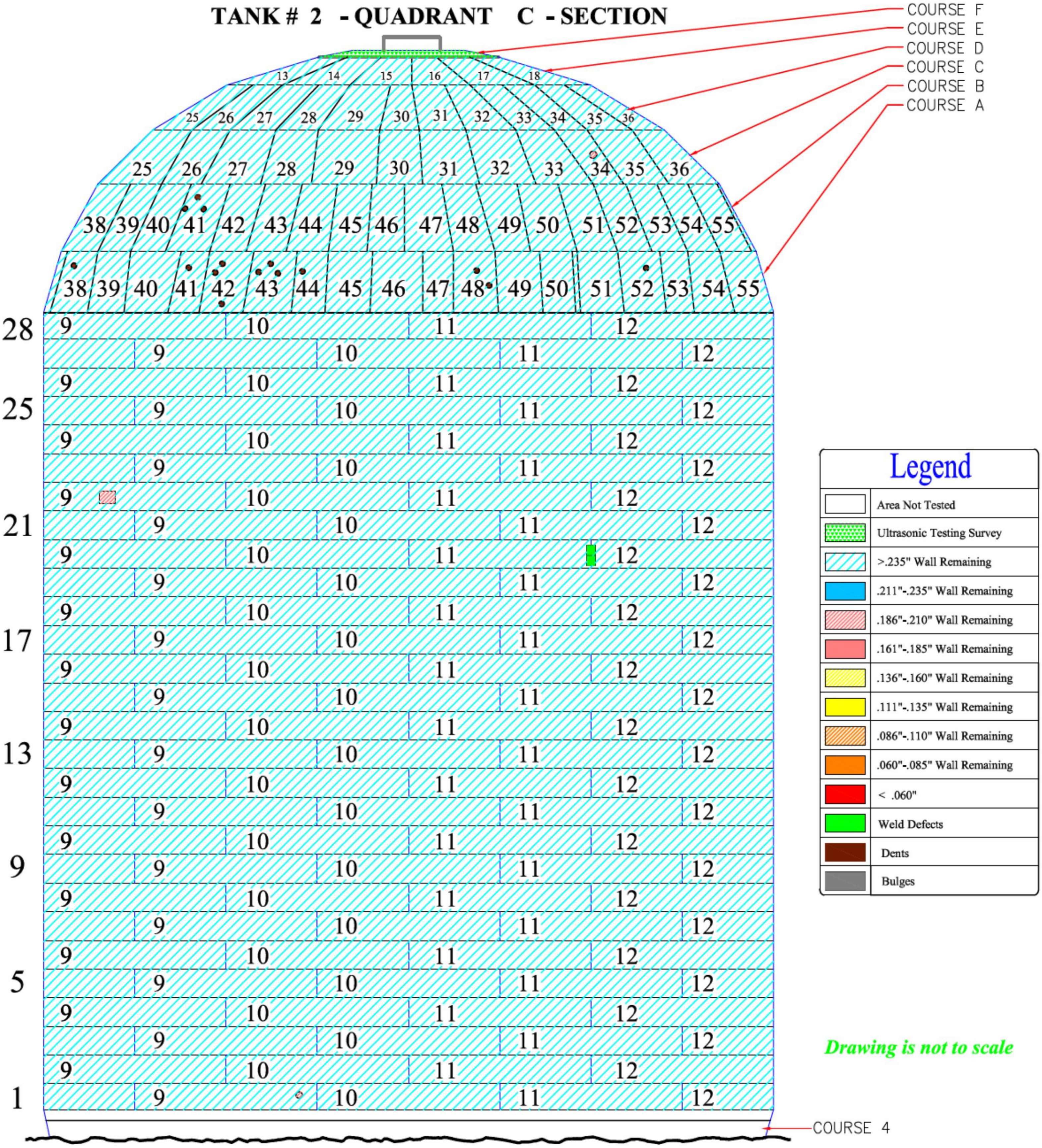


Page 71

BWS020639

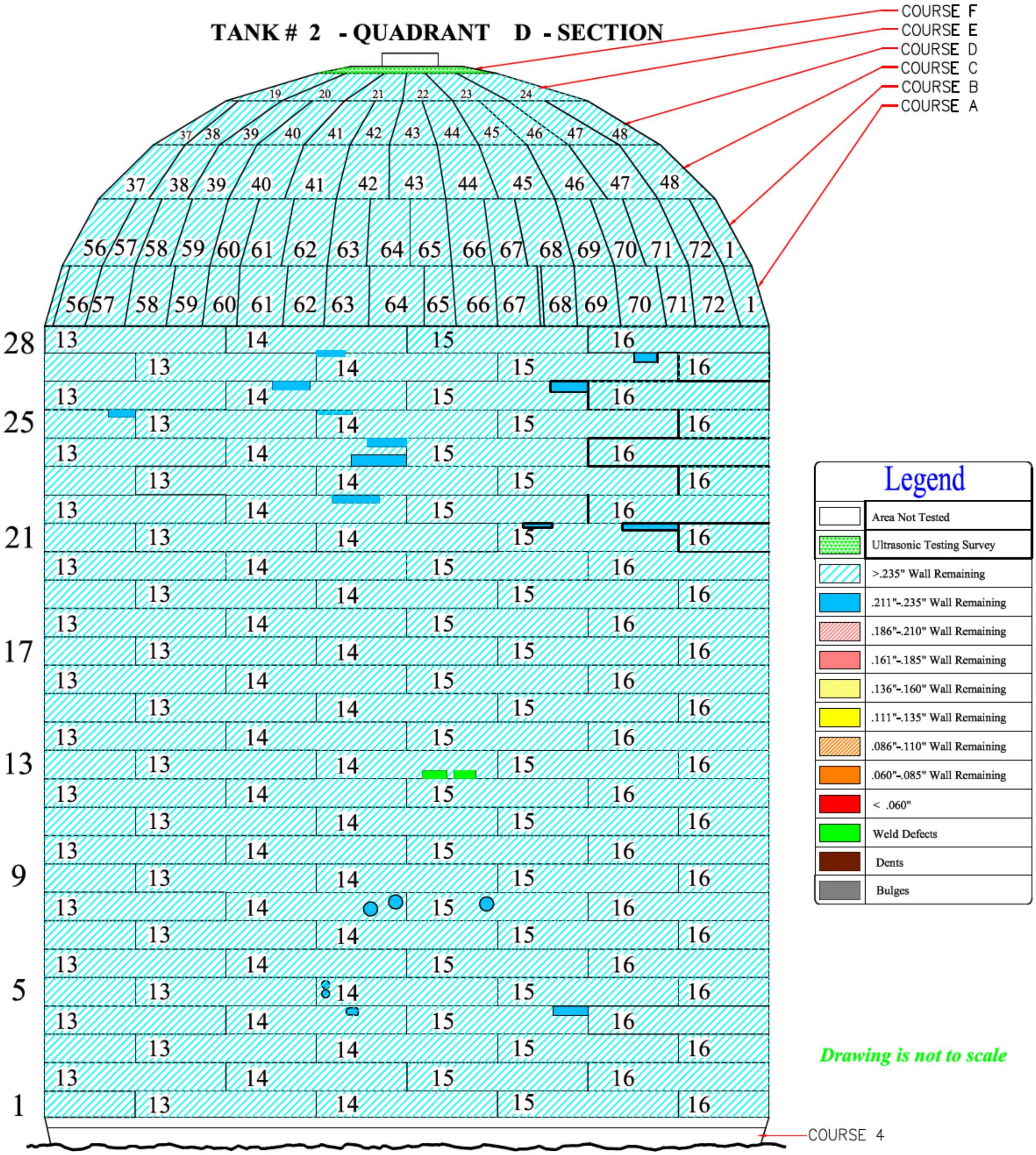
3.0
TANK MAPS
Dunkin & Bush, Inc.
Honolulu, HI

TANK # 2 - QUADRANT C - SECTION

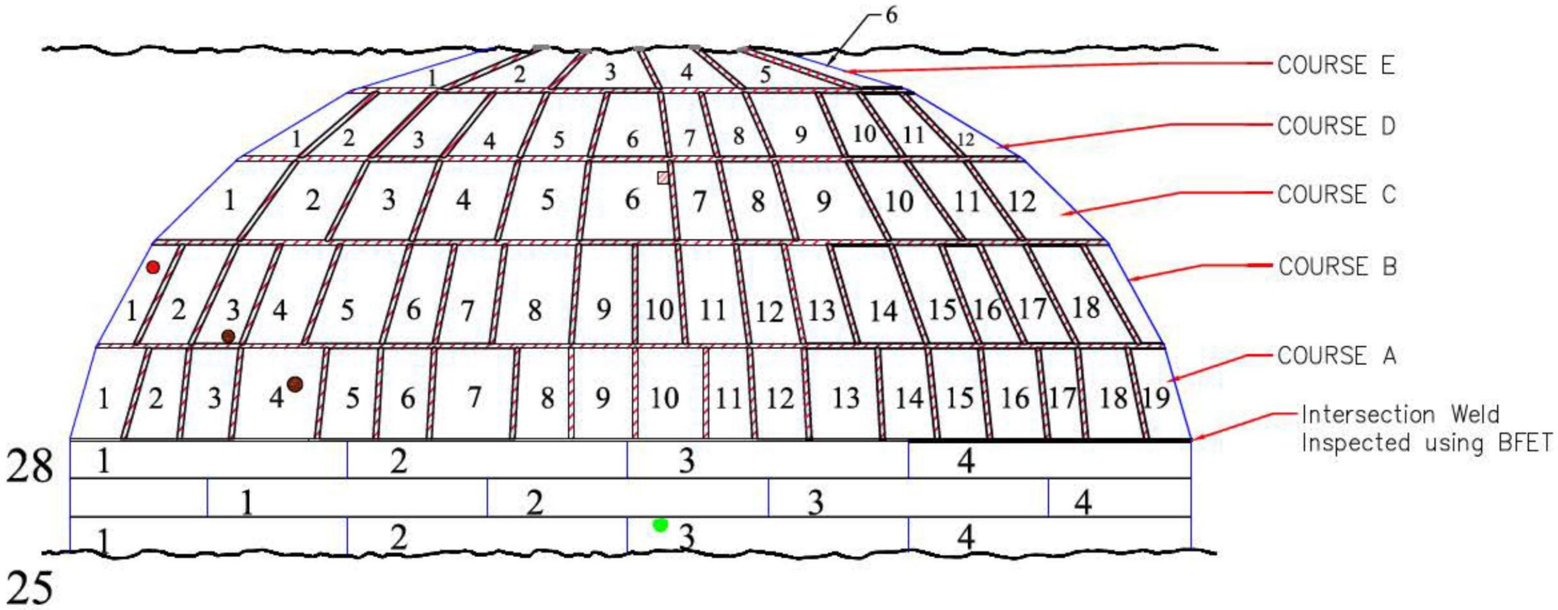


3.0TANK MAPS

Dunkin & Bush, Inc.
Honolulu, HI

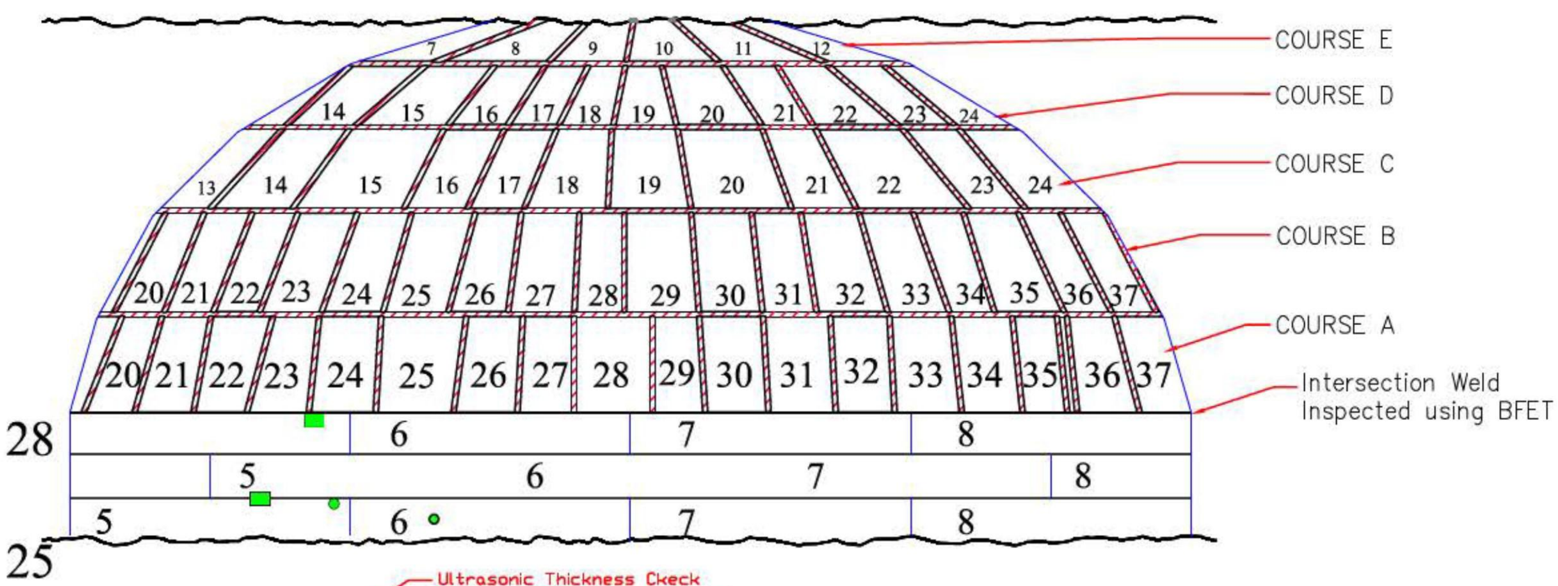


TANK # 2 - QUADRANT - A UPPER DOME (SECTIONS)

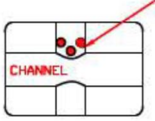


U.T. Range for All Channels tested: 0.135 - 0.150

TANK # 2 - QUADRANT - B UPPER DOME (SECTIONS)



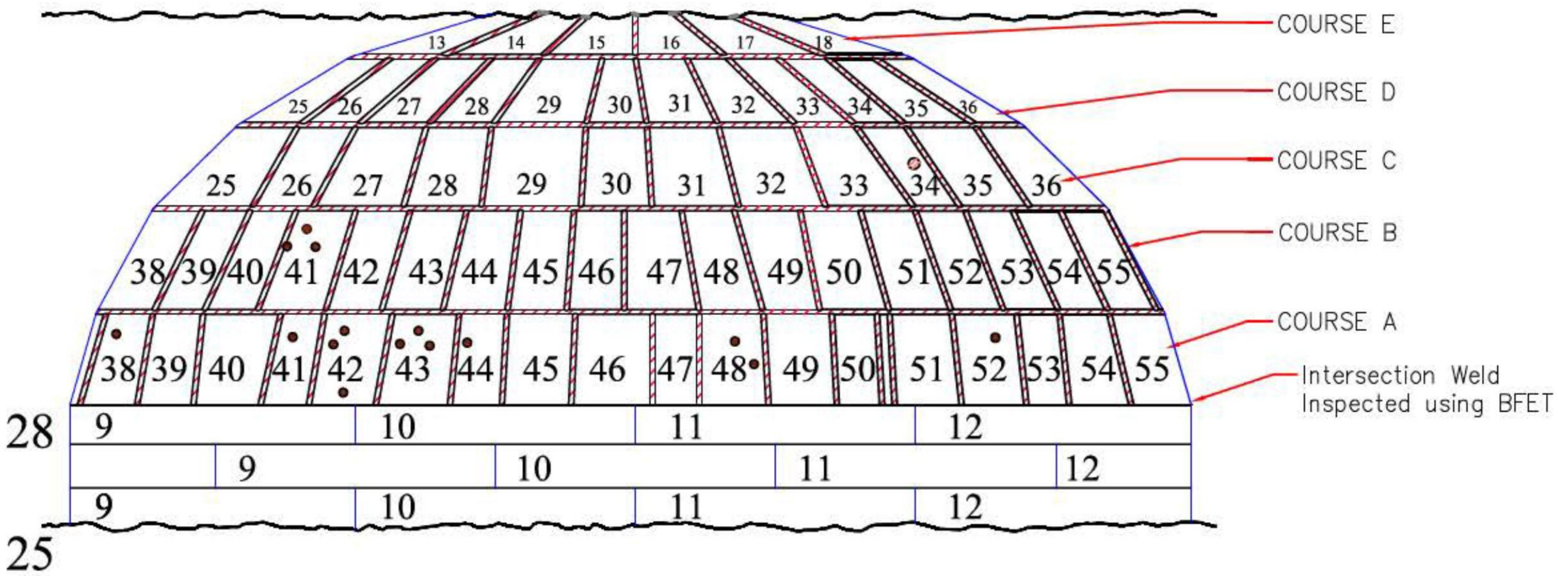
Ultrasonic Thickness Check Point Pattern carried out on all channels in Tank # 2 at every 6"



Drawing is not to scale

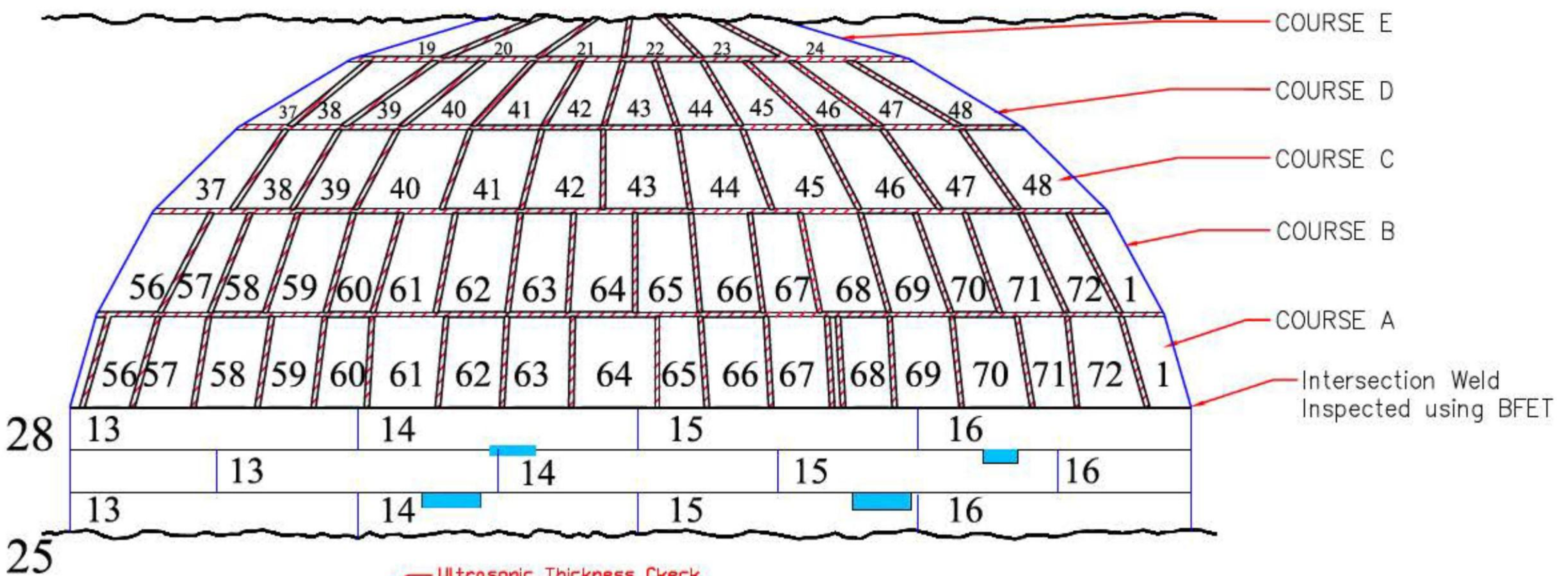
Legend
U.T. Spot Checked

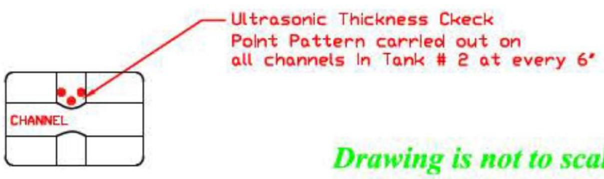
TANK # 2 - QUADRANT - C UPPER DOME (SECTIONS)



U.T. Range for All Channels tested: 0.135 - 0.150

TANK # 2 - QUADRANT - D UPPER DOME (SECTIONS)





Drawing is not to scale

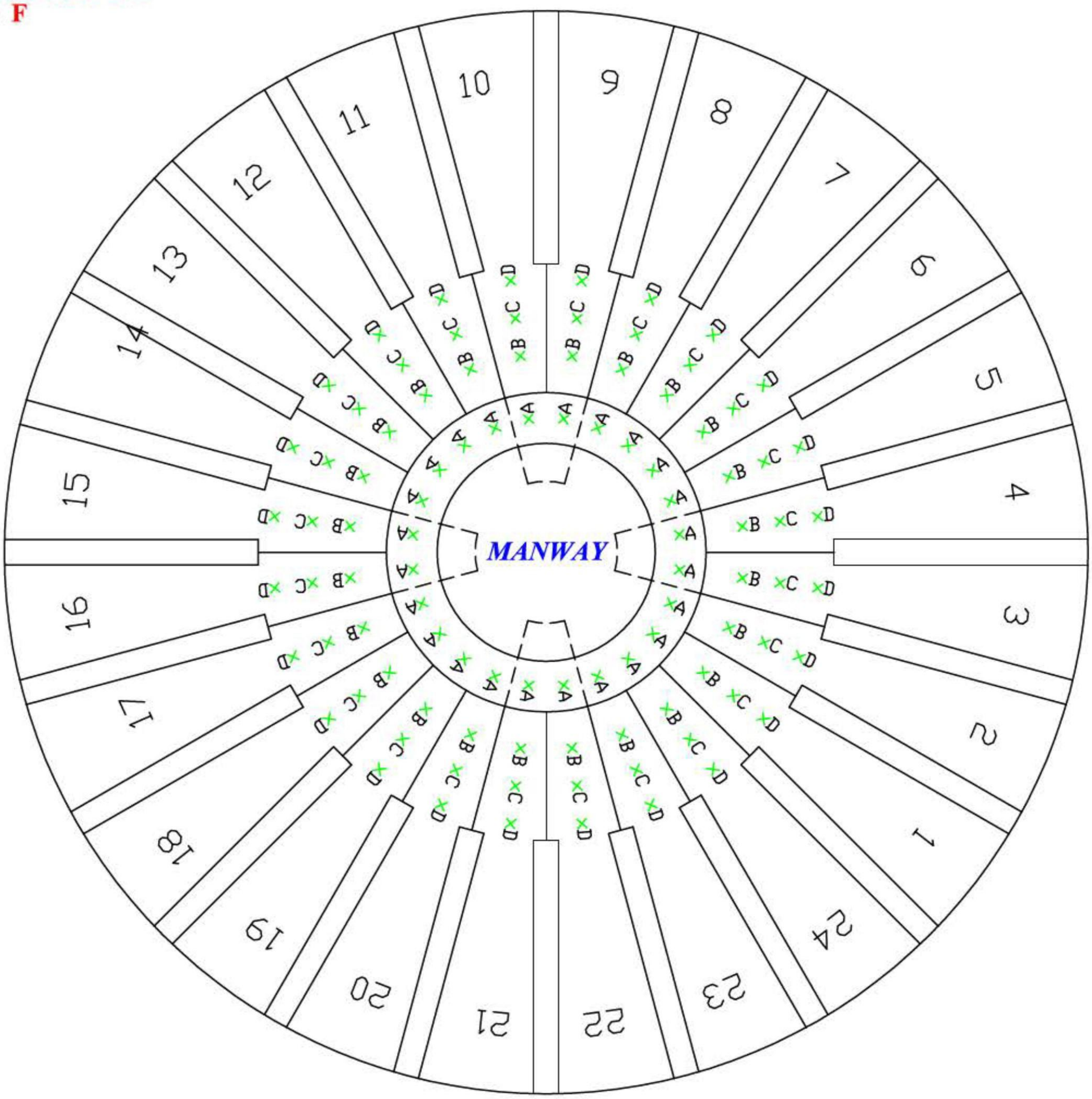
3.0 TANK MAPS

Dunkin and Bush, Inc.
Honolulu, HI
Tank #2 - Upper Dome Course F
Ultrasonic Testing Survey

Date Inspected/Confirmed: 5/6/2008

Tank Section: Upper Dome
Quadrant: A, B, C, D
Course: F

TANK #2 - Upper Dome Course F (U.T. Survey)
Nominal Plate Thickness: 0.250"



**Note: The U.T. Survey points on each plate in Course F of the Upper Dome were reachable from the gallery and are consequently close to the inside edge of each plate even though the pictorial representation above exaggerates the distance from the manway for illustration purposes.*

LEGEND	
×	*Ultrasonic Testing Survey Point*

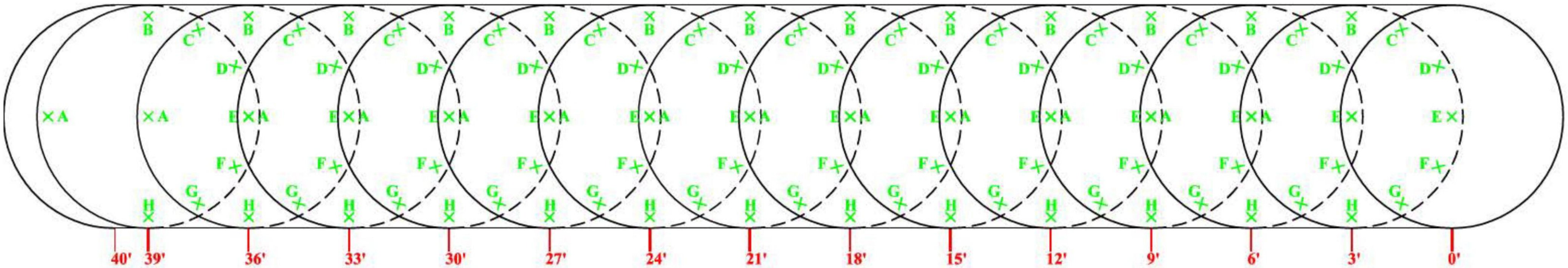
Drawing is not to scale

U.T. Thickness Measurements of Upper Dome Course F

Plate #	A	B	C	D
1	0.257"	0.273"	0.280"	0.280"
2	0.256"	0.259"	0.271"	0.259"
3	0.262"	0.244"	0.251"	0.246"
4	0.255"	0.257"	0.253"	0.261"
5	0.270"	0.277"	0.246"	0.253"
6	0.265"	0.259"	0.274"	0.275"
7	0.250"	0.293"	0.267"	0.270"
8	0.260"	0.262"	0.267"	0.277"
9	0.273"	0.252"	0.263"	0.268"
10	0.281"	0.258"	0.257"	0.262"
11	0.285"	0.268"	0.286"	0.280"
12	0.272"	0.282"	0.270"	0.278"
13	0.236"	0.263"	0.267"	0.269"
14	0.266"	0.263"	0.295"	0.274"
15	0.278"	0.288"	0.269"	0.270"
16	0.328"	0.287"	0.270"	0.288"
17	0.265"	0.284"	0.280"	0.286"
18	0.253"	0.269"	0.290"	0.288"
19	0.248"	0.271"	0.250"	0.261"
20	0.260"	0.270"	0.266"	0.266"
21	0.269"	0.261"	0.292"	0.266"
22	0.266"	0.277"	0.299"	0.277"
23	0.253"	0.262"	0.283"	0.273"
24	0.261"	0.249"	0.252"	0.282"

TANK MAPS
Dunkin and Bush, Inc.
Honolulu, HI
Tank #2 - 32" Fuel Pipe Nozzle
Ultrasonic Testing Survey

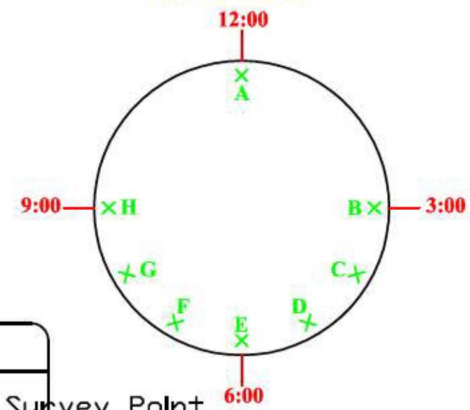
TANK #2 - 32" FUEL PIPE NOZZLE (U.T. Survey)



U.T. Thickness Measurements

	B	C	D	E	F	G	H	A
3'	0.385"	0.382"	0.390"	0.381"	0.380"	0.380"	0.383"	0.380"
6'	0.390"	0.388"	0.380"	0.387"	0.390"	0.390"	0.390"	0.400"
9'	0.399"	0.395"	0.380"	0.380"	0.390"	0.390"	0.390"	0.404"
12'	0.400"	0.420"	0.410"	0.379"	0.393"	0.410"	0.398"	0.408"
15'	0.403"	0.388"	0.399"	0.397"	0.390"	0.400"	0.393"	0.400"
18'	0.405"	0.400"	0.385"	0.399"	0.390"	0.385"	0.395"	0.405"
21'	0.394"	0.387"	0.385"	0.363"	0.368"	0.382"	0.393"	0.406"
24'	0.406"	0.420"	0.420"	0.400"	0.420"	0.400"	0.392"	0.373"
27'	0.400"	0.397"	0.409"	0.420"	0.400"	0.399"	0.396"	0.377"
30'	0.391"	0.391"	0.395"	0.420"	0.430"	0.389"	0.384"	0.370"
33'	0.374"	0.369"	0.370"	0.365"	0.369"	0.369"	0.366"	0.391"
36'	0.370"	0.395"	0.372"	0.373"	0.377"	0.385"	0.372"	0.400"
39'	0.390"	0.402"	0.400"	0.388"	0.406"	0.390"	0.400"	0.413"

Orientation



LEGEND

× Ultrasonic Testing Survey Point

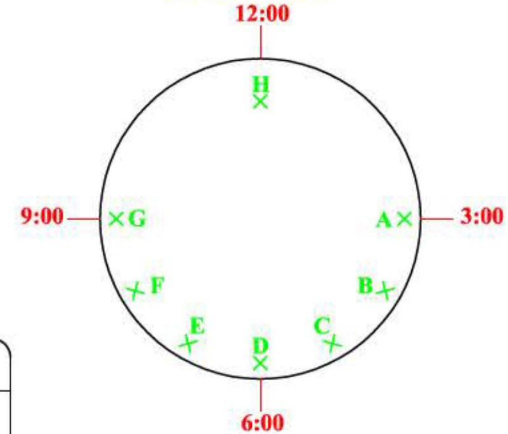
Drawing is not to scale

TANK #2 - 18" FUEL PIPE NOZZLE (U.T. Survey)

U.T. Thickness Measurements

	A	B	C	D	E	F	G	H
8"	0.380"	0.387"	0.390"	0.400"	0.386"	0.389"	0.380"	0.384"
18"	0.416"	0.402"	0.412"	0.380"	0.408"	0.390"	0.379"	0.388"

Orientation



LEGEND

× *Iltrasonic Testing Survey Point*

Drawing is not to scale

4.0 PLATE TEST SUMMARY
Dunkin and Bush, Inc.
Honolulu, HI
Tank #2

Flaw No.	Tank Section	Quad	Row / Course	Plate / Vertical Drop	Description of Flaw / Defect	Remaining Thickness/ Depth
1	Lower Dome	A	1	2 & 3	Dent	NSWL
2	Lower Dome	B	1	7 & 8	WD-IMC	0.229
3	Lower Dome	C	1	15 & 16	WD-IMC, IMC	.223, .214
4	Lower Dome	D	1	20 & 21	WD-IP, AS	.222, .069
5	Lower Dome	D	2	47	WL, WD	0.147-.210, .215
6	Lower Dome	C	2	39	Dent	NSWL
7	Lower Dome	A	3	13 & 14	WD-LOF	0.195
8	Lower Dome	A	3	14 & 15	WL	0.233
9	Lower Dome	C	3	41	WL	0.230
10	Lower Dome	C	3	45	WL/PIT	0.219
11	Lower Dome	A	3	5	WL	0.226
12	Lower Dome	A	3	8	WL	0.233
13	Barrel	A	25	2	WL	0.231
14	Barrel	A	2	2	WD-LOF	0.125
15	Barrel	A	21	2	WL	0.233
16	Barrel	A	25	1	WL	0.232, 0.227
17	Barrel	A	21	3	WD-LOF, WL, WL	.173, 0.224, 0.234
18	Barrel	A	7	3	WL	0.228
19	Barrel	D	24	14	WL, WL	0.227, 0.232
20	Barrel	D	22	14	WL	0.234
21	Barrel	D	4	15	WL	0.235
22	Barrel	D	8	14	WL, WL	.230, .221
23	Barrel	D	8	15	WL	0.228
24	Barrel	A	26	3	WD-Porosity	0.210
25	Barrel	A	17	3	WD-AS	0.063
26	Barrel	A	20	3	WD-Porosity	0.181
27	Barrel	A	25	3	Pitting	0.234
28	Barrel	A	8	3	Pitting	0.220
29	Barrel	D	13	14	WD-LOF,LOF,LOF,LOF	.173, .112, .205, .206
30	Barrel	D	4	14	Pitting	0.226
31	Barrel	D	5	14	Pitting, Pitting	0.235, .235
32	Barrel	D	21	15	WL, WL	.230, 0.219
33	Barrel	D	20	14	WD-Tack weld	0.082
34	Barrel	A	25	2	WL	0.219
35	Barrel	A	25	3	WL	0.221
36	Barrel	A	10	2	WL	0.218
39	Barrel	D	25	14	WL	0.230
40	Barrel	D	26	14	WL	0.214
42	Barrel	D	25	14	WL	0.223/0.234
43	Barrel	D	27	14	WL	0.229
44	Barrel	A	27	5	WL/Bulge	0.230
45	Barrel	A	2	5	WL	0.225
46	Barrel	D	25	12	WL	0.230
47	Barrel	D	20	12	WD-LOF, PH, LOF,LOF	.211, .088, .219, .221

4.0 PLATE TEST SUMMARY
Dunkin and Bush, Inc.
Honolulu, HI
Tank #2

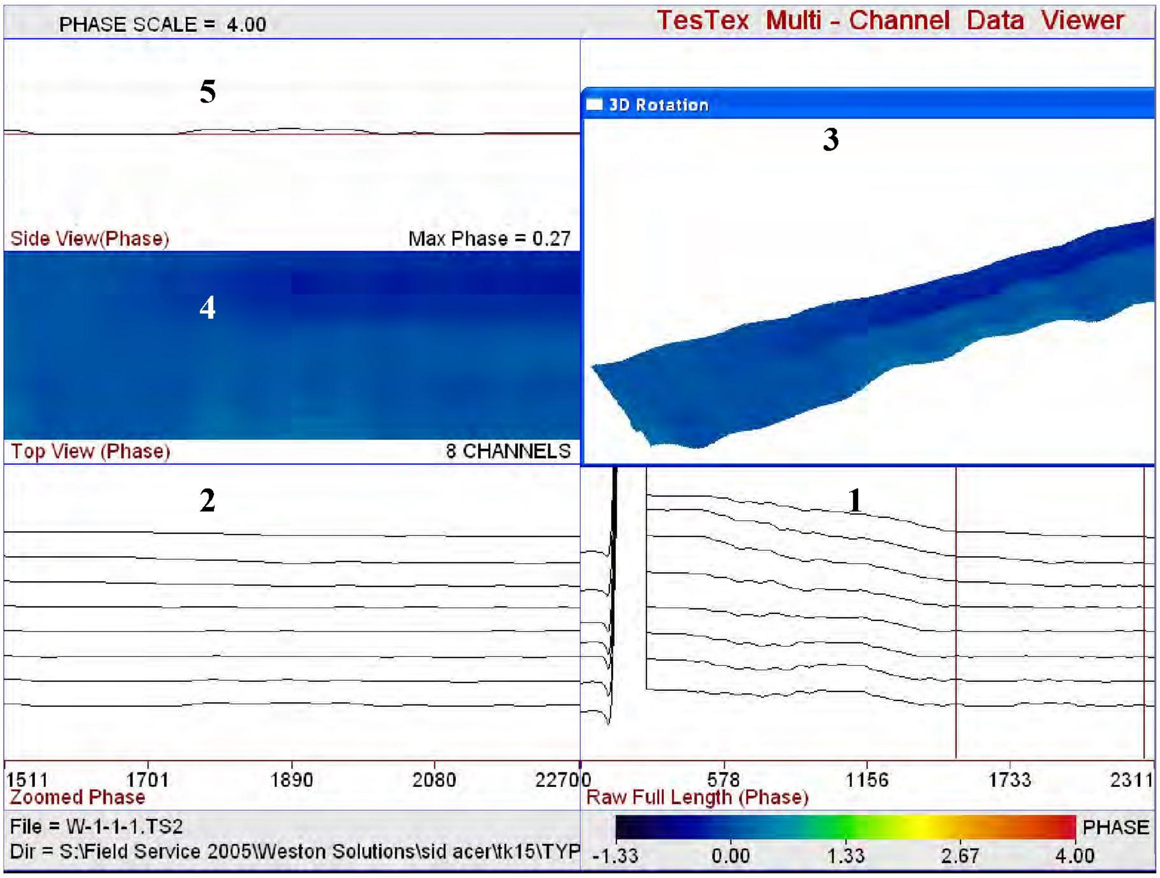
Flaw No.	Tank Section	Quad	Row / Course	Plate / Vertical Drop	Description of Flaw / Defect	Remaining Thickness/ Depth
48	Barrel	B	17	5	WL	0.232
49	Barrel	B	26	5	WD-SL, LOF	.114, .083
50	Barrel	B	28	5	WD-LOF	0.104
51	Barrel	B	26	6	Pitting	0.220
52	Barrel	B	22	6	WD-LOF, LOF	.169, .154
53	Barrel	B	19	6	Pitting	0.220
54	Barrel	B	2	6	WD-LOF	0.219
55	Barrel	C	23	11	WL	0.228
56	Barrel	C	6	8	WL	0.225
57	Barrel	C	6	8	WL	0.229/0.231
58	Barrel	C	1	9	WL on PP	0.200
59	Barrel	C	22	9	WL	0.186
60	Upper Dome	C	A	41	Dent	NSWL
61	Upper Dome	C	A	43	Dent, Dent, Dent	NSWL
62	Upper Dome	C	A	38	Dent	NSWL
63	Upper Dome	C	A	42	Dent, Dent, Dent	NSWL
64	Upper Dome	C	A	44	Dent	NSWL
65	Upper Dome	C	A	52	Dent	NSWL
66	Upper Dome	C	B	41	Bulge, Dent, Dent	NSWL
67	Upper Dome	B	C	14	WL-PP, WL	0.141, 0.185
68	Upper Dome	B	B	31	Dent	NSWL
69	Upper Dome	B	A	25	Dent	NSWL
70	Upper Dome	B	A	25	Dent	NSWL
71	Upper Dome	B	A	33	Dent	NSWL
72	Upper Dome	B	A	27	Pitting	0.210
73	Upper Dome	B	A	32	Dent	NSWL
74	Upper Dome	B	B	22	Dent	NSWL
75	Upper Dome	A	B	3	Dent	NSWL
76	Upper Dome	A	B	1	Pitting	THRU/.018
77	Upper Dome	A	A	4	Dent	NSWL
79	Upper Dome	A	C	6	WL	0.210
80	Upper Dome	A	A	48	Dent, Dent	NSWL
81	Upper Dome	C	C	34	TS Pitting	0.055
82	Floor	A		2	TS pitting	0.435
83	Floor	B		4	TS pitting	0.336
84	Lower Dome	DA	1	21 & 1	Junction Pitting Shell	0.181
85	Lower Dome	A	1	1 & 2	JPS	0.180
86	Lower Dome	A	1	2 & 3	JPS	0.189
87	Lower Dome	A	1	3 & 4	JPS	0.179
88	Lower Dome	A	1	4 & 5	JPS	0.216
98	Lower Dome	A	1	5 & 6	JPS	0.212
90	Lower Dome	AB	1	6 & 7	JPS	0.206
91	Lower Dome	B	1	7 & 8	JPS	0.212
92	Lower Dome	B	1	8 & 9	JPS	0.209

4.0 PLATE TEST SUMMARY
Dunkin and Bush, Inc.
Honolulu, HI
Tank #2

Flaw No.	Tank Section	Quad	Row / Course	Plate / Vertical Drop	Description of Flaw / Defect	Remaining Thickness/ Depth
93	Lower Dome	B	1	9 & 10	JPS	0.218
94	Lower Dome	B	1	10 & 11	JPS	0.211
95	Lower Dome	BC	1	11 & 12	JPS	0.222
96	Lower Dome	C	1	12 & 13	JPS	0.226
97	Lower Dome	C	1	13 & 14	JPS	0.223
98	Lower Dome	C	1	14 & 15	JPS	0.198
99	Lower Dome	C	1	15 & 16	JPS	0.188
100	Lower Dome	CD	1	16 & 17	JPS	0.190
101	Lower Dome	D	1	17 & 18	JPS	0.193
102	Lower Dome	D	1	18 & 19	JPS	0.185
103	Lower Dome	D	1	19 & 20	JPS	0.186
104	Lower Dome	D	1	20 & 21	JPS	0.180
105	Lower Dome	DA	1	21 & 1	WD-LOF	.094, .081, .100
106	Lower Dome	A	1	1 & 2	WD-LOF	.086, .084
107	Lower Dome	A	1	2 & 3	WD-LOF, Crack	.201, .217
108	Lower Dome	A	1	3 & 4	WD-LOF, Crack, LOF, LOF	.206, .200, .080, .135
109	Lower Dome	A	1	4 & 5	WD-LOF, LOF, LOF, LOF, LOF	.201, .212, .201, .086, .162
110	Lower Dome	A	1	5 & 6	WD-LOF, LOF, LOF, LOF	.193, .198, .065, 148
111	Lower Dome	AB	1	6 & 7	WD-LOF, LOF, LOF, LOF	.185, .157, .197, .195
112	Lower Dome	B	1	7 & 8	WD-IMC, IMC, IMC, IMC, IMC	.145, .222, .188, .182, .218
113	Lower Dome	B	1	8 & 9	WD-LOF, LOF, LOF	.079, .207, .086
114	Lower Dome	B	1	9 & 10	WD-LOF, LOF	.133, .216
115	Lower Dome	B	1	10 & 11	WD-LOF, LOF	.082, .080
116	Lower Dome	BC	1	11 & 12	WD-LOF, LOF	.216, .071
117	Lower Dome	C	1	15 & 16	WD-LOF, LOF	.102, .197
118	Lower Dome	CD	1	16 & 17	WD-LOF, LOF	.080, .085
119	Lower Dome	D	1	17 & 18	WD-LOF	0.211
120	Lower Dome	D	1	18 & 19	WD-LOF, IP	.088, .288
121	Lower Dome	D	1	19 & 20	WD-IMC, IMC	.238, .231
122	Lower Dome	D	1	20 & 21	WD-LOF	0.192
123	Lower Dome	A	2	1	Bulge	NSWL
124	Lower Dome	D	2	62	Bulge	NSWL
125	Lower Dome	A	1	1 & 2	Bulge (both plates entirely)	NSWL

* Note: Flaws in "Red" are shown in depth, not remaining. All others in "Black" are in remaining. Abbreviations are as follows; WD (weld defect), LOF (lack of fusion), IMC (intermittent cracking), IP (incomplete Penetration), AS (arc strike), PH (pin hole), SL (slag line), PP (patch plate), WL (wall loss), TS (topside), NSWL (no significant wall loss), JPS (junction pitting on shell).

5.0 TYPICAL WAVEFORMS
Dunkin and Bush, Inc.
Honolulu, HI
Tank #15



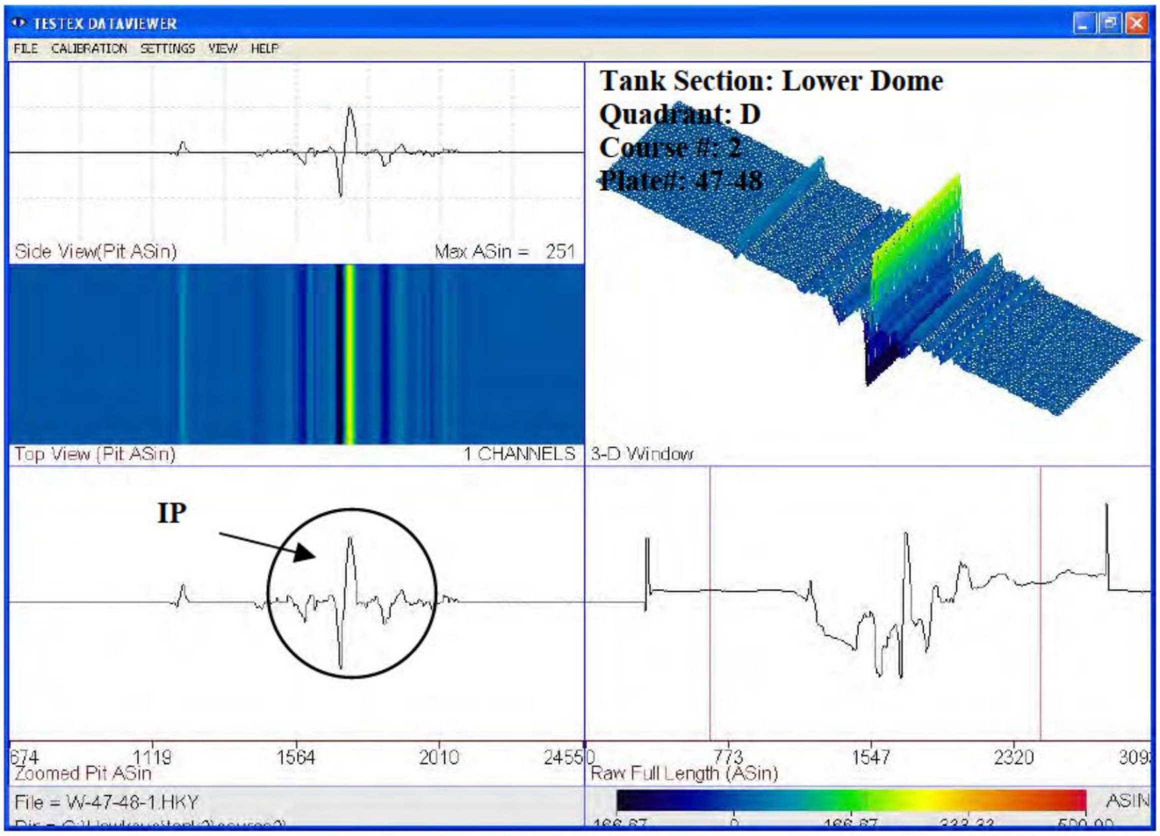
Shown above is a typical **TS-2000** waveform collected from the Barrel of Tank #15. This particular plate exhibits nominal wall thickness.

The **TS-2000** display has 5 windows to facilitate the interpretation of each plate. Window 1 shows raw data from the scanner before the signal is processed or filtered. The 2nd window shows the raw data filtered and processed. The 3rd window shows a 3-D view of the plate. The 4th window shows a topside view of the plate. The 5th window shows the highest and lowest points of the plate baseline.

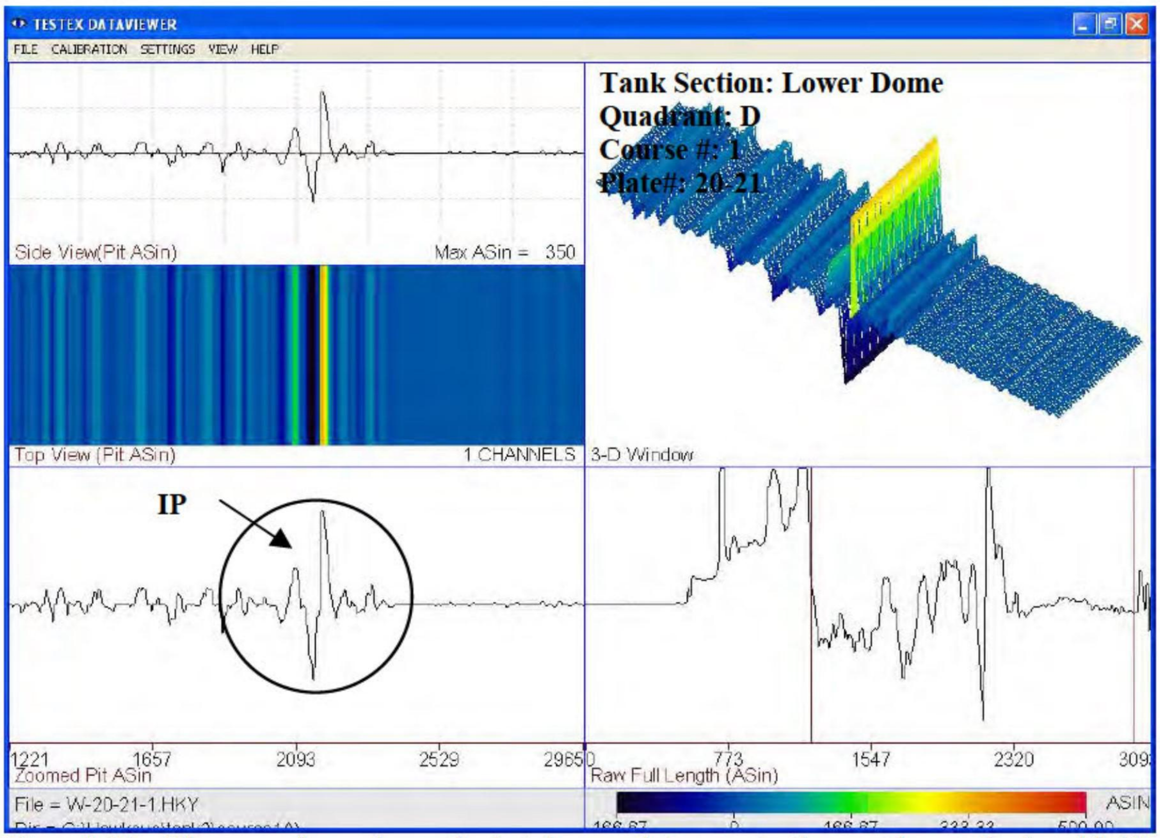
The **TS-2000** scanner is comprised of 8 sensors, which gives more sensitivity to pitting and cracking. Each sensor is individually represented by a line in windows 1, 2, and 3. The 4th window shows each sensor and is color marked as it detects wall loss. Any rise in the waveform indicates wall loss. The magnitude of the response is given by a color and is coded to the right of the waveform. From this color and comparing it to a calibration, a percent wall loss or wall remaining value can therefore be determined.

APPENDIX A – SAMPLE WAVEFORMS

APPENDIX A – SAMPLE WAVEFORMS

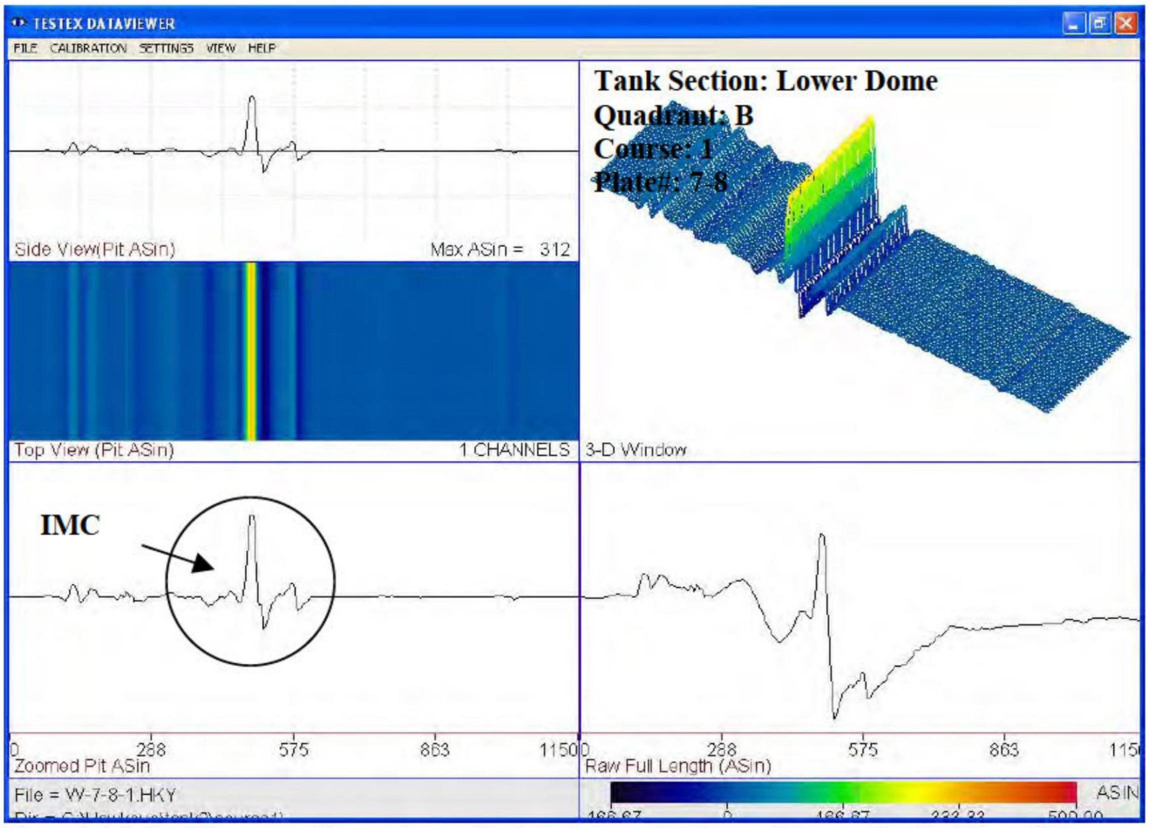


Flaw # 5B: The waveform above depicts incomplete penetration on the vertical weld, 1" long, at a depth of .215".

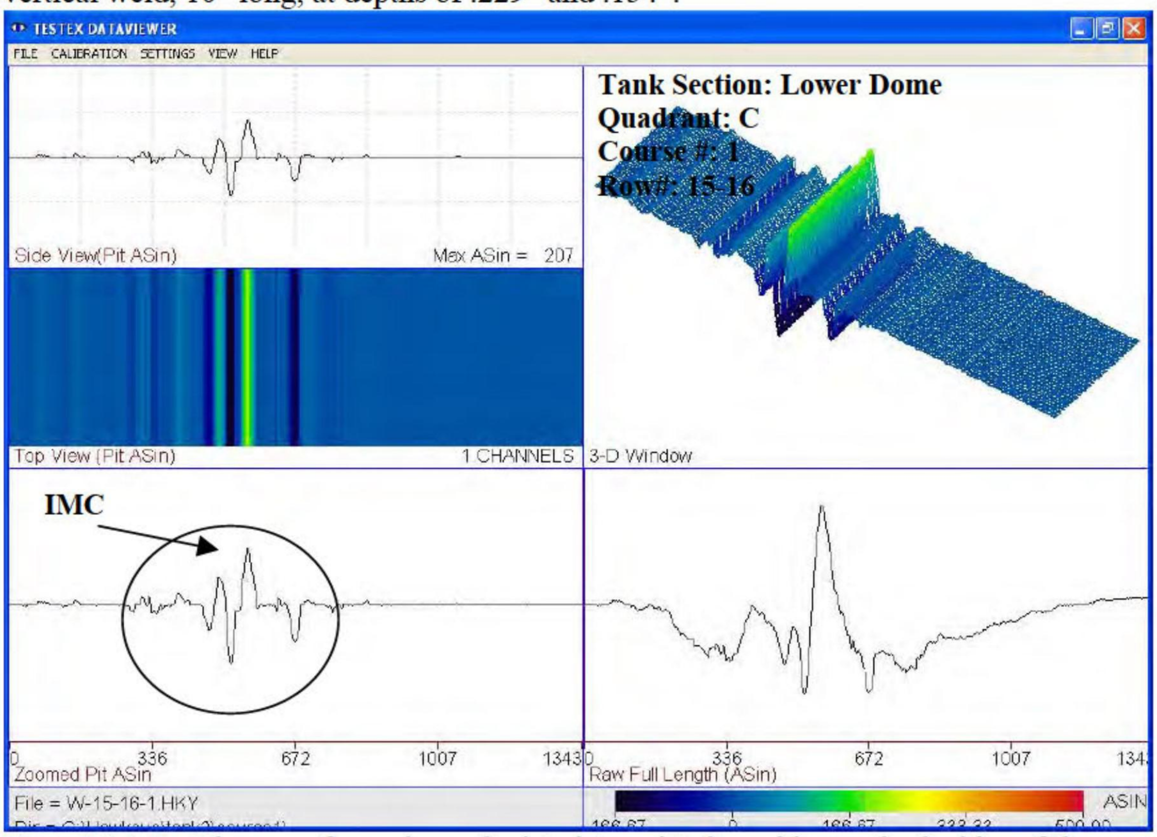


Flaw # 4A: The waveform above depicts incomplete penetration on the vertical weld, 1" long, at a depth of .222".

APPENDIX A – SAMPLE WAVEFORMS

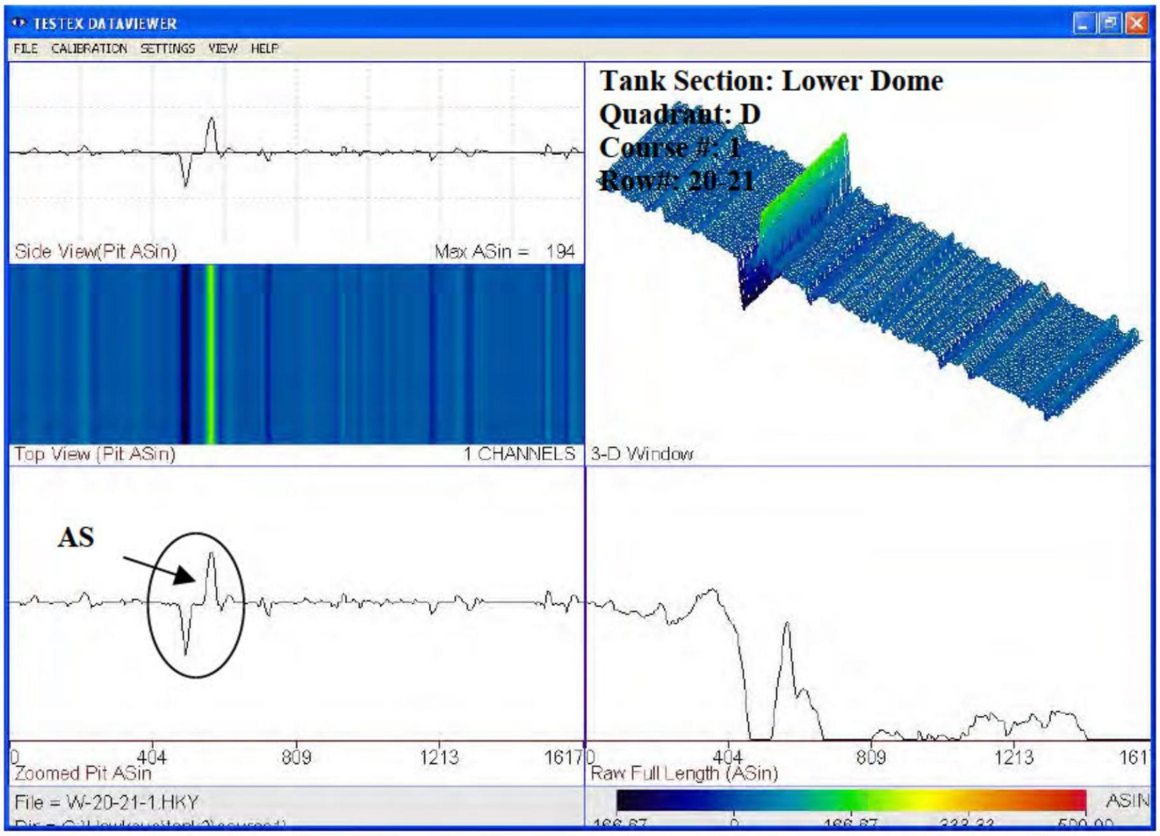


Flaw # 2A,B: The waveform above depicts intermitted cracking on both sides of the vertical weld, 10" long, at depths of .229" and .154".

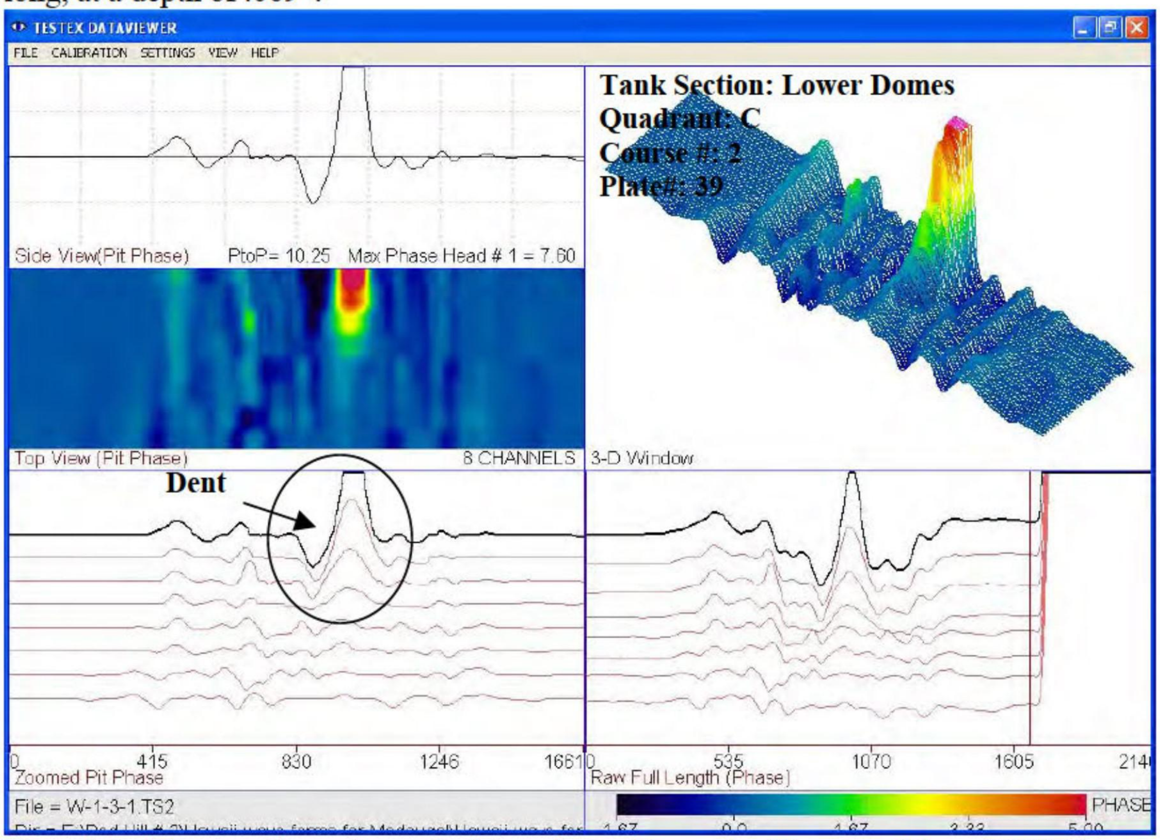


Flaw # 3A,B: The waveform above depicts intermitted cracking on both sides of the vertical weld, 10" long, at depths of .223" and .214".

APPENDIX A – SAMPLE WAVEFORMS

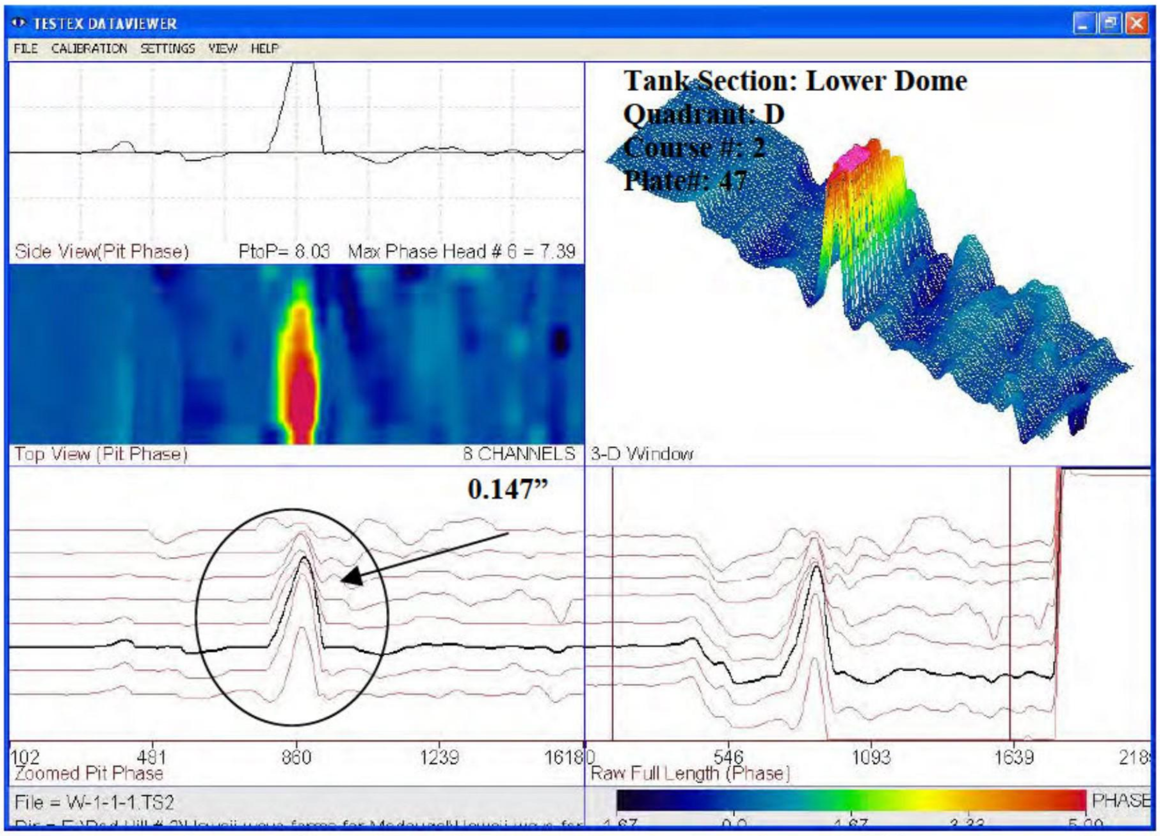


Flaw # 4B: The waveform above depicts arc strike at the toe on the vertical weld, 2" long, at a depth of .069".

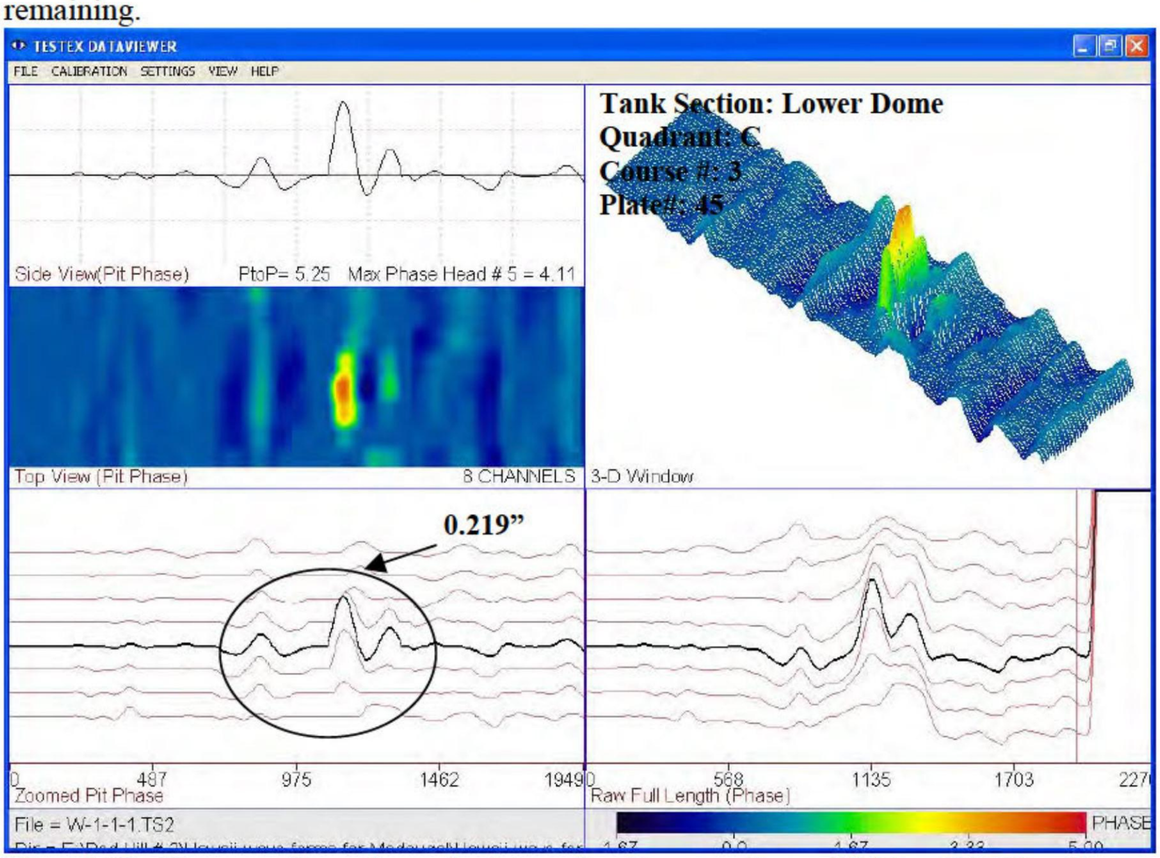


Flaw # 6: The waveform above depicts a dent with no significant wall loss (NSWL).

APPENDIX A – SAMPLE WAVEFORMS

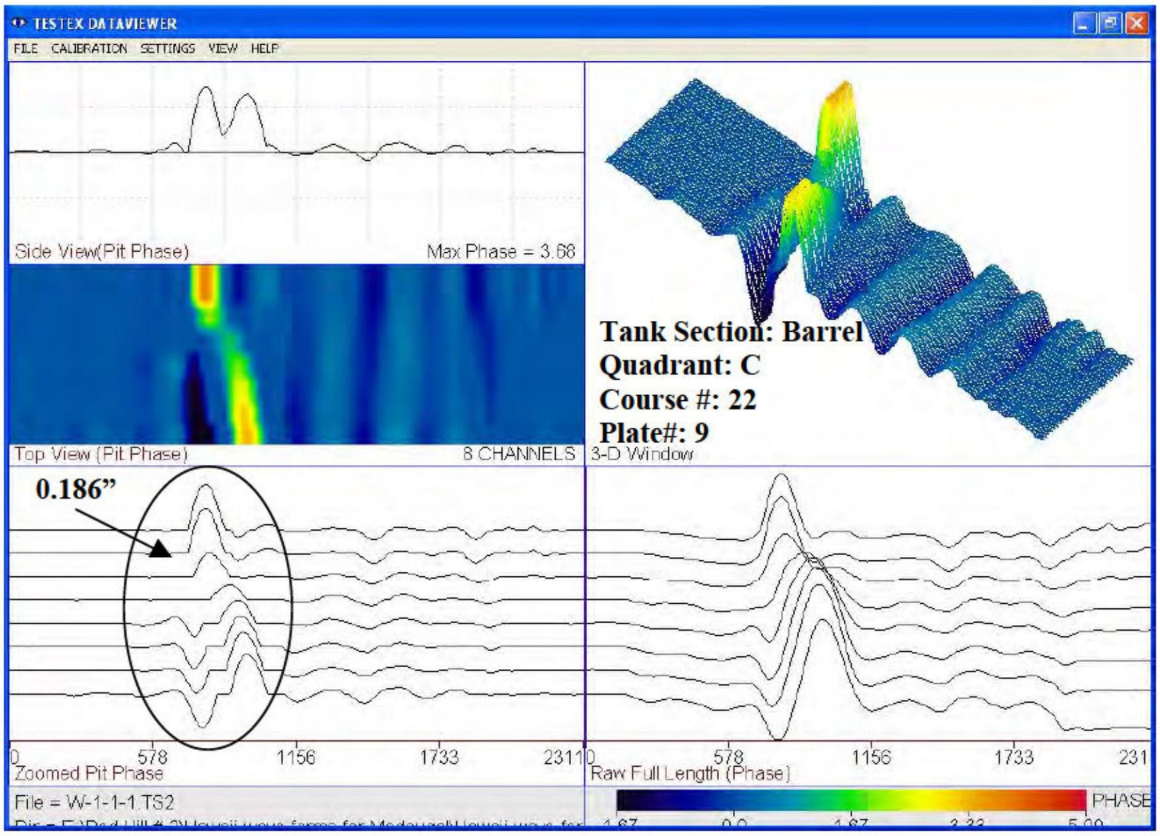


Flaw # 5A: The waveform above depicts underside corrosion exhibiting 0.147" wall remaining.



Flaw # 10: The waveform above depicts underside corrosion exhibiting 0.219" wall remaining.

APPENDIX A – SAMPLE WAVEFORMS

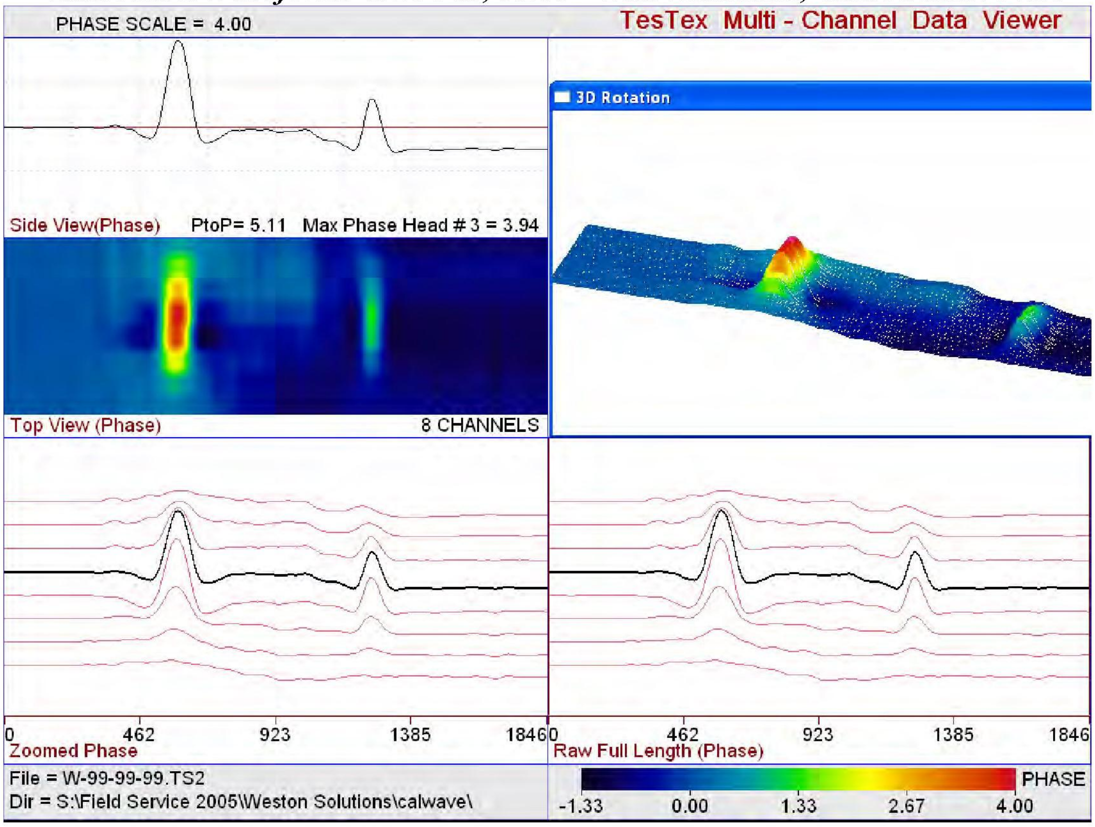


Flaw # 59: The waveform above depicts underside corrosion exhibiting 0.186" wall remaining.

APPENDIX B – CALIBRATION

APPENDIX B – CALIBRATION

Calibration Waveform: 5/16 Pits, 0.250" Wall Thickness, Carbon Steel Plate



Calibration Table: 5/16 Pits, 0.250" Wall Thickness, Carbon Steel Plate

5/16 Pits, 0.250" WALL THICKNESS, CARBON STEEL, FREQ. 10 HZ.
PROBE# 8.0" Scanner, FILE# 99-99-99, DATE 08/15/2005, UNIT# TS-2000
% WL 1 = 30.00, PHASE 1 = 0.91, AMP 1 = 0.10 | *
% WL 2 = 60.00, PHASE 2 = 1.96, AMP 2 = 0.10 | * [QUADRATIC FIT]

% WALL LOSS	DELTA PHASE	DELTA LNA	WALL REMAINING
5.0	0.14	0.03	0.238
10.0	0.29	0.05	0.225
15.0	0.44	0.06	0.213
20.0	0.59	0.08	0.200
25.0	0.75	0.09	0.188
30.0	0.91	0.10	0.175
35.0	1.08	0.11	0.163
40.0	1.25	0.11	0.150
45.0	1.42	0.11	0.138
50.0	1.60	0.11	0.125
55.0	1.78	0.11	0.113
60.0	1.96	0.10	0.100
65.0	2.15	0.09	0.088
70.0	2.34	0.08	0.075

APPENDIX C – TEST METHODS/PROCEDURES AND EQUIPMENT DESCRIPTION

APPENDIX C – TEST METHODS/PROCEDURES AND EQUIPMENT DESCRIPTION

Principles of LFET

Low Frequency Electromagnetic Technique (LFET) was developed out of further research of Remote Field Electromagnetic Technique (RFET). The main difference of LFET is the placement of the sensors between the two poles of an electromagnetic driver.

With a low frequency AC driver signal of 3 to 40 Hz for carbon steel (see Figure 1), the driver signal fully penetrates the material being tested. When the scanner passes over an area with no defects, the magnetic fields are not distorted.

When the test material has a defect and the sensors are located above that defect, distortions in the magnetic field indicate presence of the flaw. LFET instruments measure this distortion as changes in phase and amplitude. Depth of the flaw is proportional to these phase and amplitude changes. Diameter of the defect is related to the number of sensors affected.

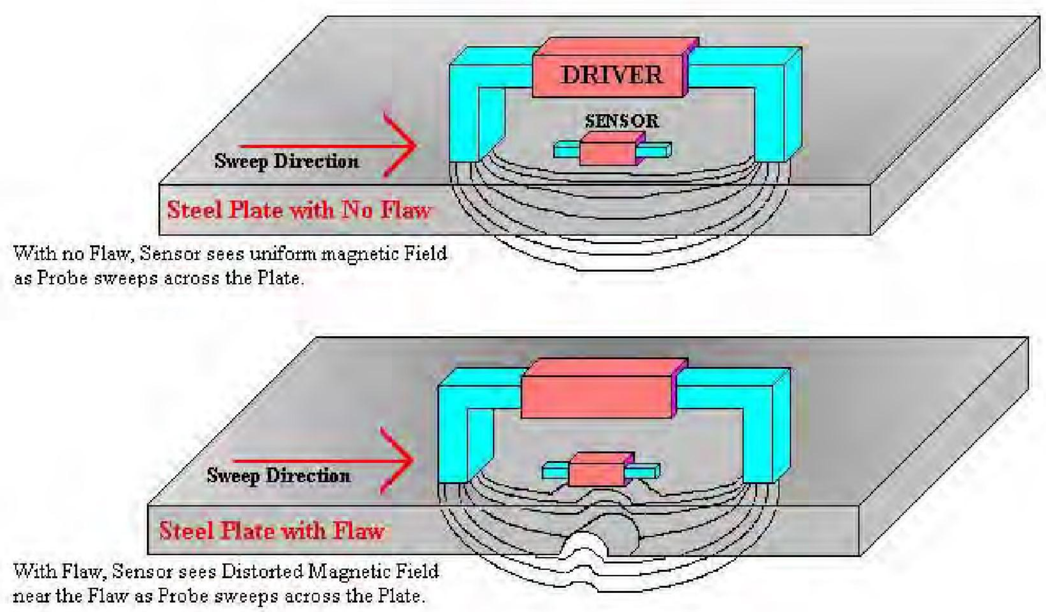


Figure 1.
Principles of Low Frequency Electromagnetic Technique (LFET)

APPENDIX C – TEST METHODS/PROCEDURES AND EQUIPMENT DESCRIPTION

Tank Floor Scanning Theory/Background

FALCON 2000 SYSTEM

The TesTex Tank Floor Inspection System consists of a sixteenth inch modular swath containing 32 probe heads. This configuration allows for a 100% coverage of the tank plate. The probe emits a very low frequency electromagnetic field which penetrates the tank floor. Any variation in the tank floor thickness will cause the electromagnetic field to change. These changes are very small, which makes it necessary to use digital signal processing to enhance the resulting signal. The resulting processed signal is in the form of phase and amplitude readings. Calibration tables are used to convert these signals into percentage wall loss values.

PROCEDURES

Each tank floor is mapped out by measuring the length, width, and orientation of the individual plates. The wall loss information for each plate is stored on a floppy disk.

SOFTWARE

The data acquisition module collects the plate data at a given sample rate. The menu-driven program provides for real-time display of phase, amplitude, and probe position across the plate. The x-y geometry of the plate, probe speed, and other details are also handled by the data acquisition module.

The data analysis and display module contain the calibration curves for wall thinning, volume losses, and pitting. His module correlates calibration standards information with the plant data for flaw sizing and evaluation. Several routines for digital the filtering, averaging techniques, background evaluation, curve fitting, and other useful signal processing techniques are also available. Up to 16 waveforms can be displayed simultaneously in the screen while "zooming" algorithms are used to easily examine small segments of the waveforms.

Plate Scanning Theory/Background

To test vertically/horizontally-oriented plates, the ***TS 2000*** scanner is placed on an unobstructed area on the topside of one of the plates. The equipment is then zeroed using the ***TS 2000 PLATE SCAN*** software's auto-set function. This action also selects the right time constant, sets the gains of the internal amplifiers, and ensures that the data is displayed on the screen as it is being collected.

After zeroing, the scanner is moved to the beginning of the scan sweep area. The scanner is then gradually moved across the surface of the tube and data is collected via magnetic medium on the PC. The processing of the data occurs real-time and the data is stored as several waveforms and stored as several signal responses. Among these are phase and amplitude for each individual channel.

APPENDIX C – TEST METHODS/PROCEDURES AND EQUIPMENT DESCRIPTION

SYSTEM DESCRIPTION

ELECTRONICS: The digital system consists of function generators, power amplifiers, difference amplifiers, phase rotators, auto-zero phase shifters, A-to-D converters, digital controllers, etc. One of the key design objectives was to achieve as low a noise as possible. We detect phase changes to an accuracy of 1/10 of a degree and amplitude signals of a fraction of a microvolt. The ***TS 2000*** contains all the electronics and software for data acquisition. It contains an internal A-to-D converter, which connects to the PC through a serial port.

SOFTWARE: Consists of two modules

The data acquisition module collects the tube data at a given sample rate. The menu driven, user-oriented program provides for real-time display of phase, amplitude, and probe position in the tube. The row and column of the tube, probe speed, and other bookkeeping details are also handled by the data acquisition module.

The data analysis and display module contains the calibration curves for plate thinning, volume losses, pits, vibration/fret wear, and correlates the calibration standard information with the actual plant data for flaw sizing and evaluation. It has routines for digital filtering, averaging techniques, background evaluation, curve fitting, and other useful signal processing techniques. Up to three waveforms can be displayed simultaneously on the screen and the "zooming" algorithm enables the user to easily examine small segments of the waveform.

DETECTION ACCURACY

The ***TesTex, Inc.*** developed lock-in amplifier is capable of measuring very low level signals in the microvolt range and can measure small phase angle changes of a fraction of a degree, even in the presence of a considerable amount of noise. This system, when used in conjunction with the calibration standards: partial and through-wall pitting, gradual wall thinning. Hydrogen damage, etc. and their respective calibration curves, allows us to measure small gradual wall losses on the order of 10%, pits of diameter 0.062" (1.57mm), and vibration/fret wear of five volume percent.

<u>Weld Scanning Theory/Background</u>

TesTex, Inc. has developed a special electromagnetic probe based on the principle of achieving a “balanced field” for the probe. This probe is also very sensitive to small changes in electromagnetic field and the noise is significantly reduced by appropriate phase rotation of the horizontal and vertical component of the signal. A single element probe of this type was used to detect “surface and subsurface cracking” This probe was called Hawkeye and it is successfully used for testing cracks, welds, pipes, plates, etc.

The system works by PHASE ROTATING liftoff noise into the ACOS signal while leaving the CRACK signal in the ASIN waveform. Processing is used to reduce gradual changes in the waveform to make detection easier.

APPENDIX C – TEST METHODS/PROCEDURES AND EQUIPMENT DESCRIPTION

Ultrasonic Shear Wave (Angle Beam) Testing Description

The instrument used for Shear Wave or Angle Beam Testing is a simple pulse-echo flaw detector with A-Scan, receiving, and transmitting capabilities in which the user can size the length, depth, and distance of the flaw.

The primary reason for using shear waves is for the detection of discontinuities with geometries and orientations non-parallel to the testing surface. The Angle Beam technique is extensively used for weld testing at ½ step and full step distances. The frequency range specifically for weld testing with angle beam transducers is 1MHz to 5MHz. The most common Angle Beam contact transducers are designed to produce shear waves of 45, 60, and 70° in steel.

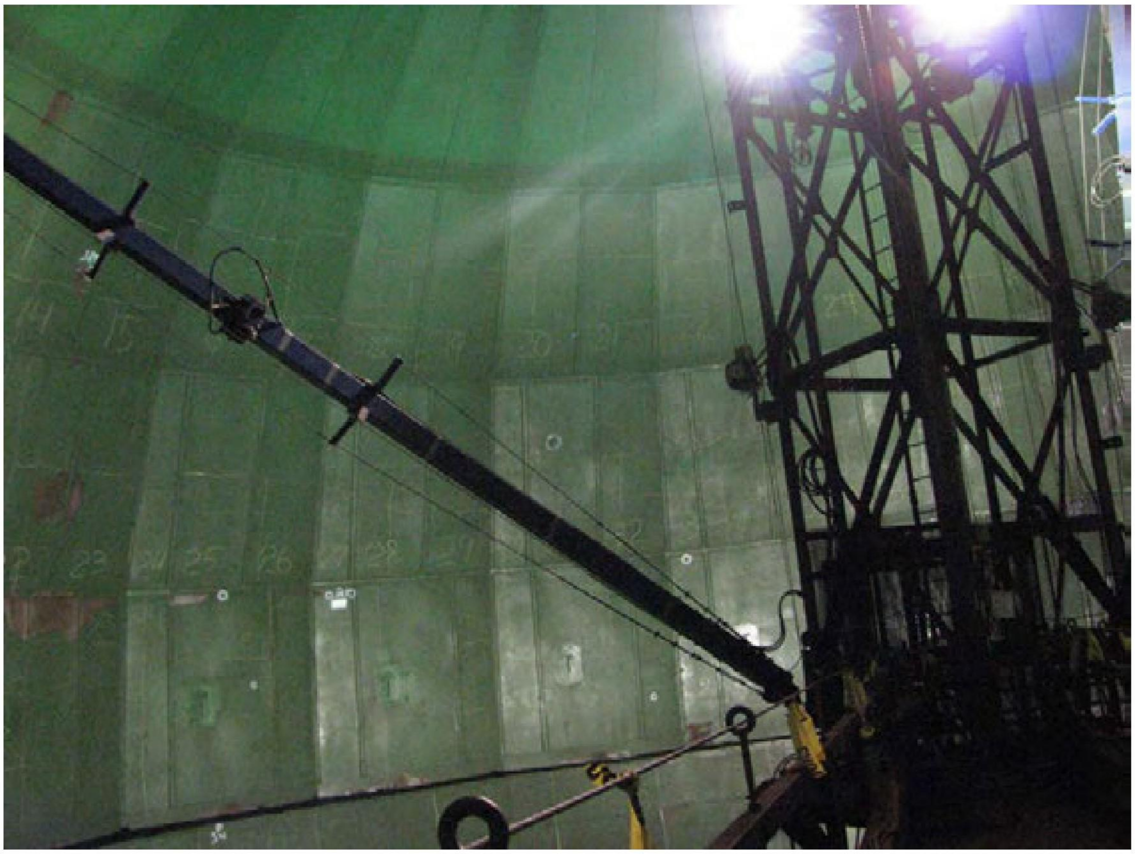
APPENDIX D – TANK INTERIOR PHOTOGRAPHS

APPENDIX D – TANK INTERIOR PHOTOGRAPHS

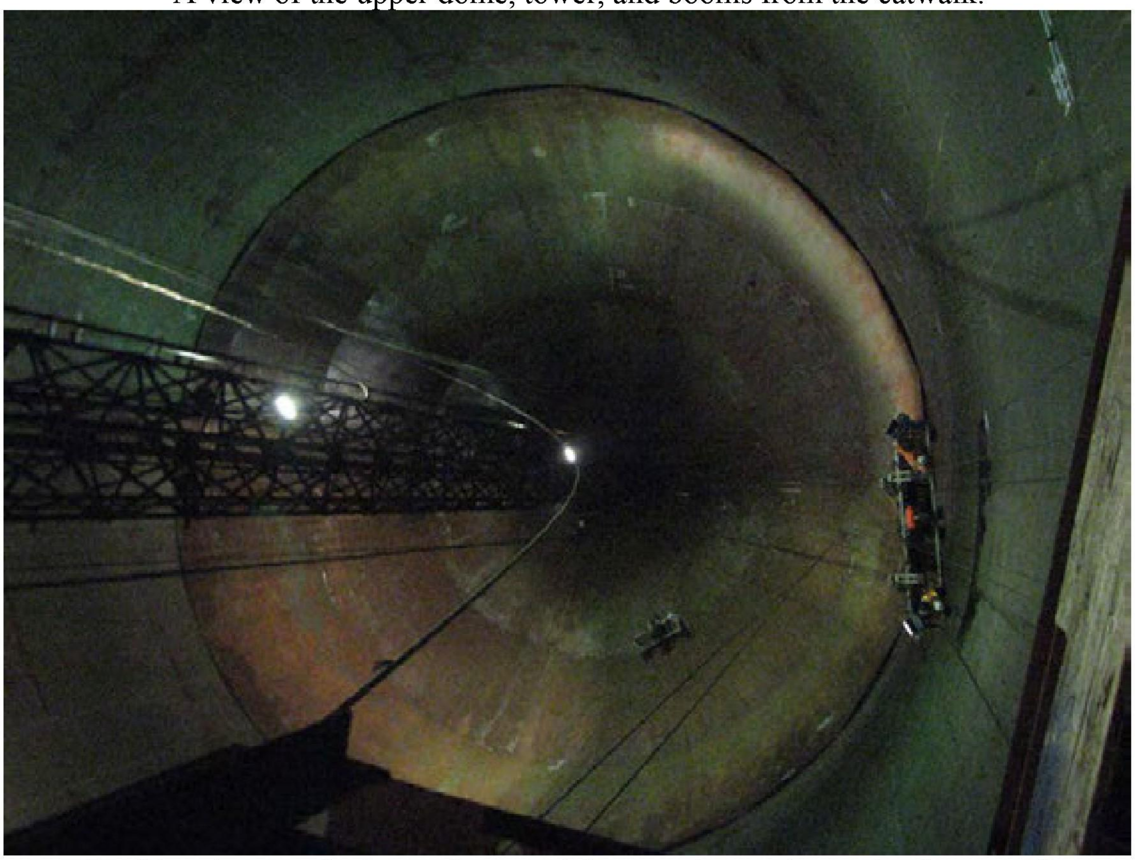
A view of the tunnel area around tank #2.

A view of the manway leading into tank #2.

APPENDIX D – TANK INTERIOR PHOTOGRAPHS

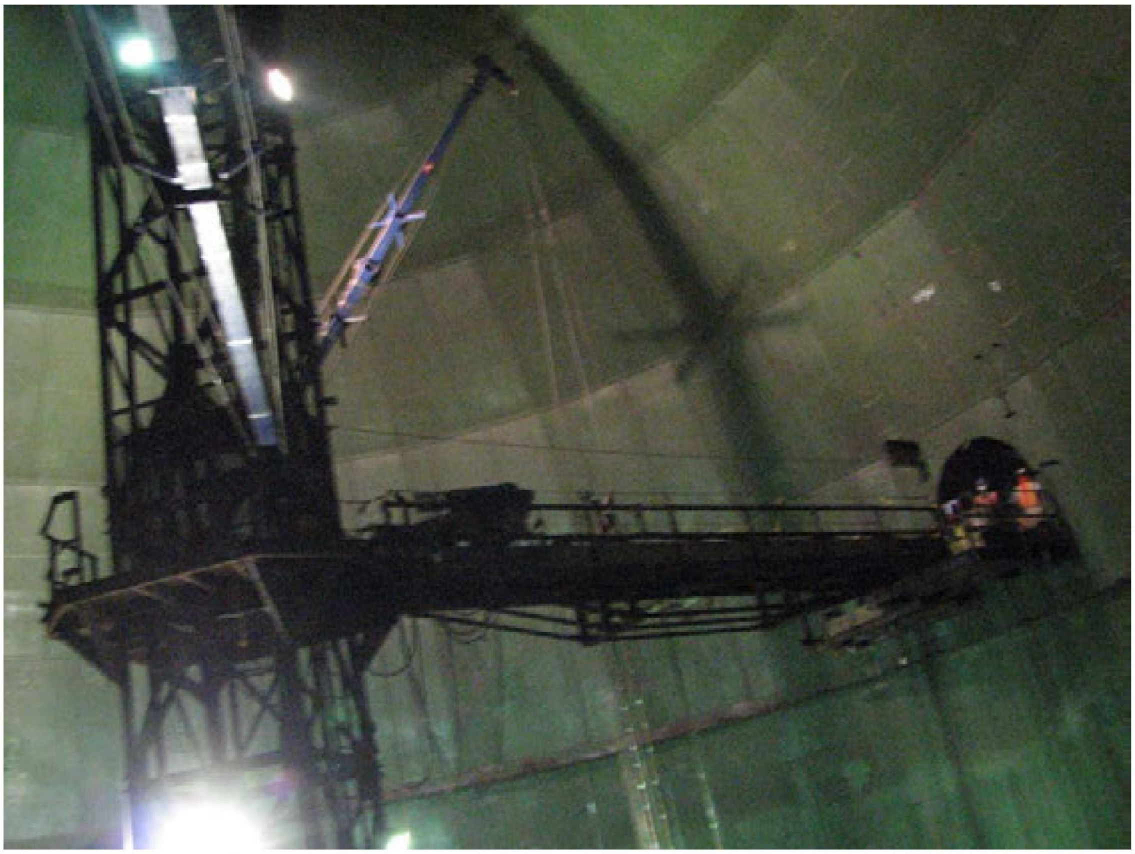


A view of the upper dome, tower, and booms from the catwalk.



Looking down at the lower dome and the crew inspecting under the catwalk.

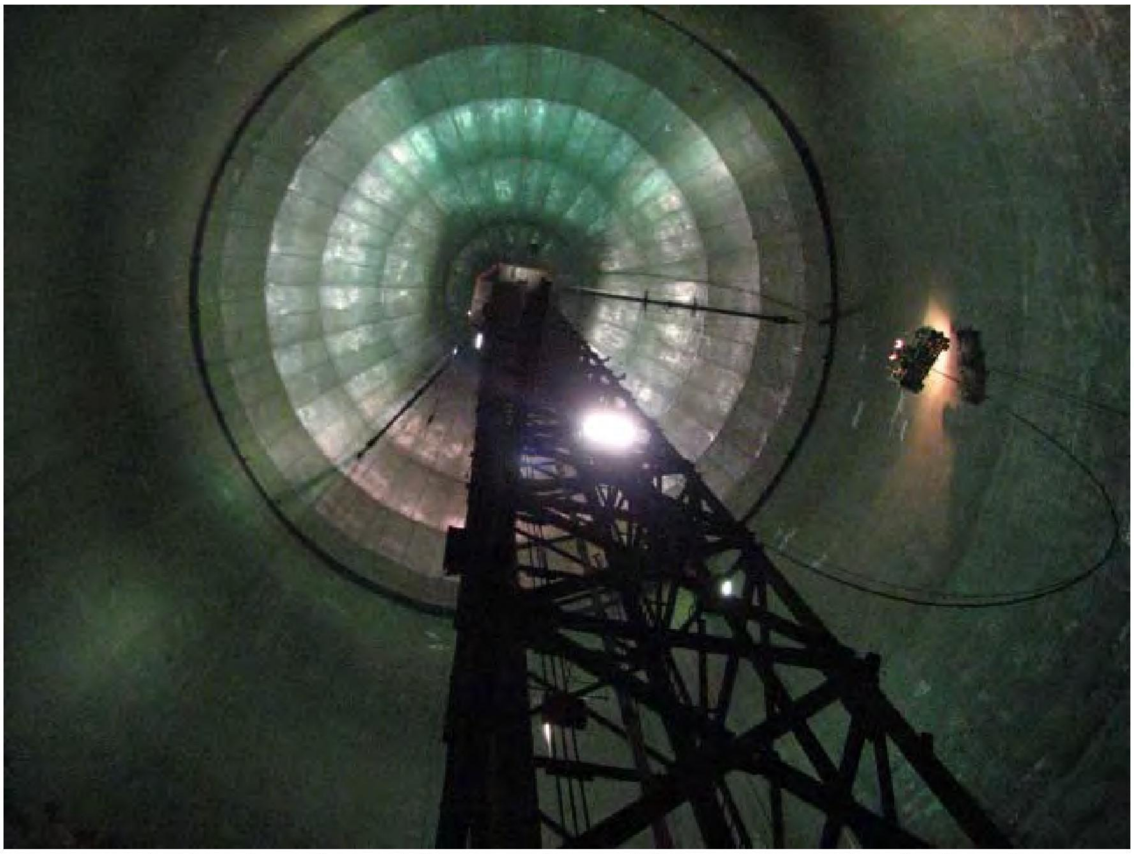
APPENDIX D – TANK INTERIOR PHOTOGRAPHS



Looking at the tower/catwalk structure while descending in one of the baskets.

Lower dome view from above showing extensive coating failure.

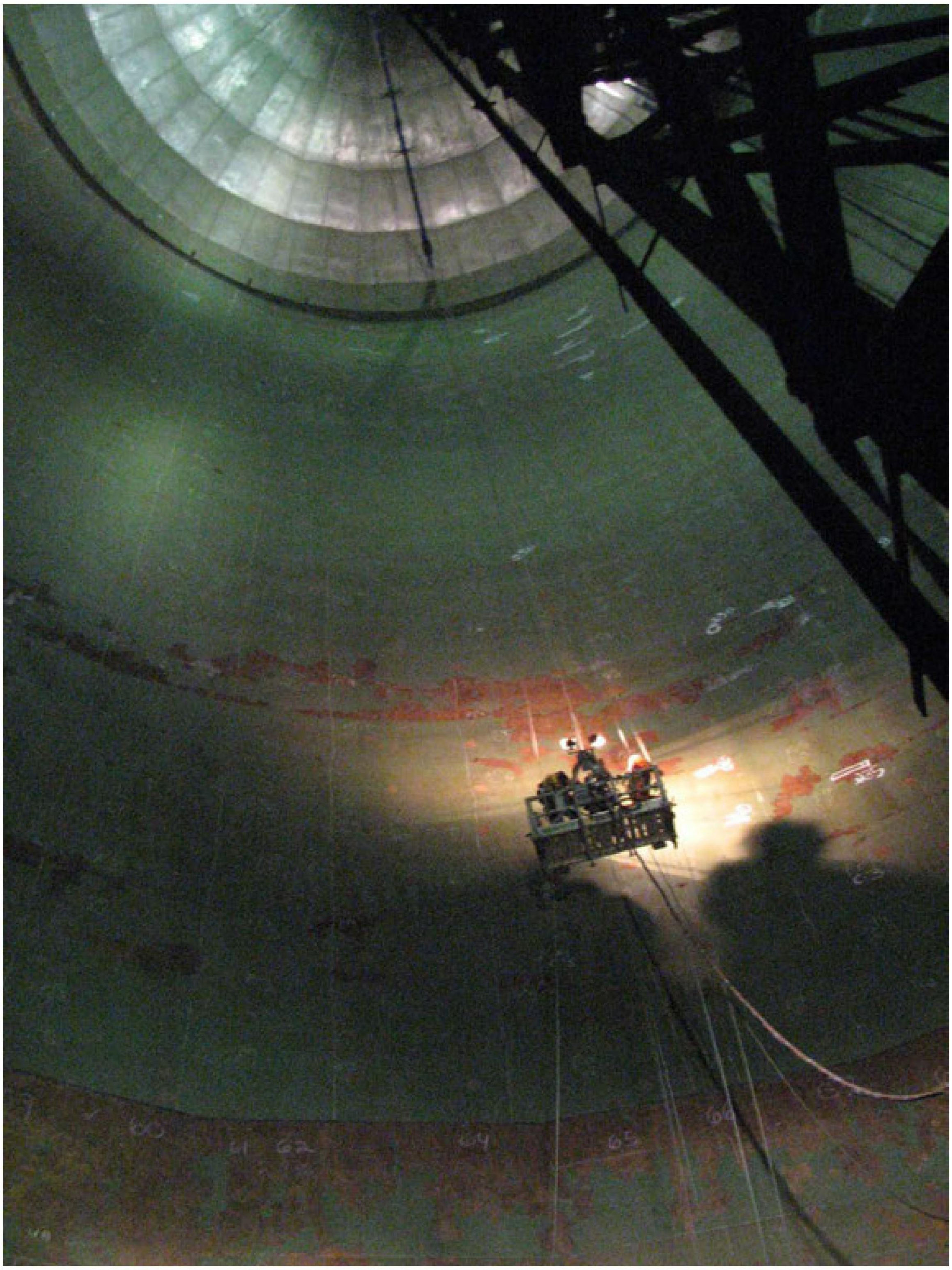
APPENDIX D – TANK INTERIOR PHOTOGRAPHS



A view from the tank bottom of one of the teams scanning the barrel

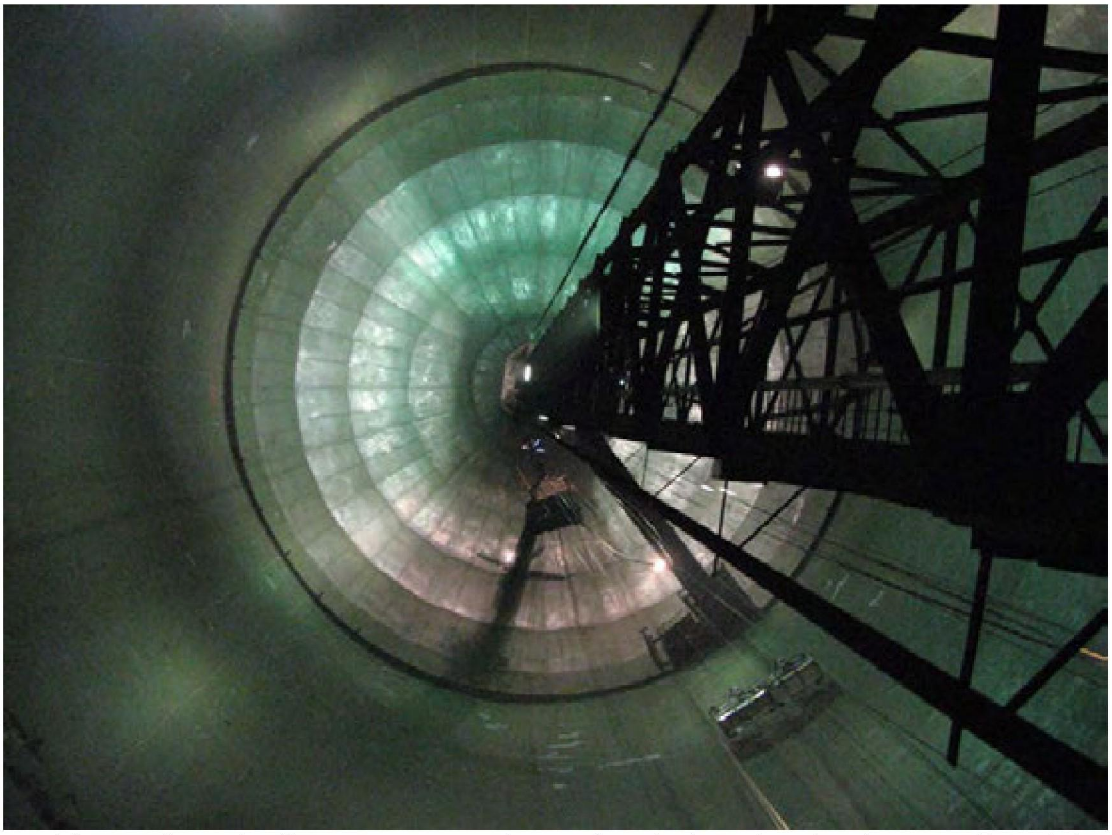
Picture showing part of the floor and lower dome

APPENDIX D – TANK INTERIOR PHOTOGRAPHS



Another view of one crew inspecting the barrel just above the lower dome.

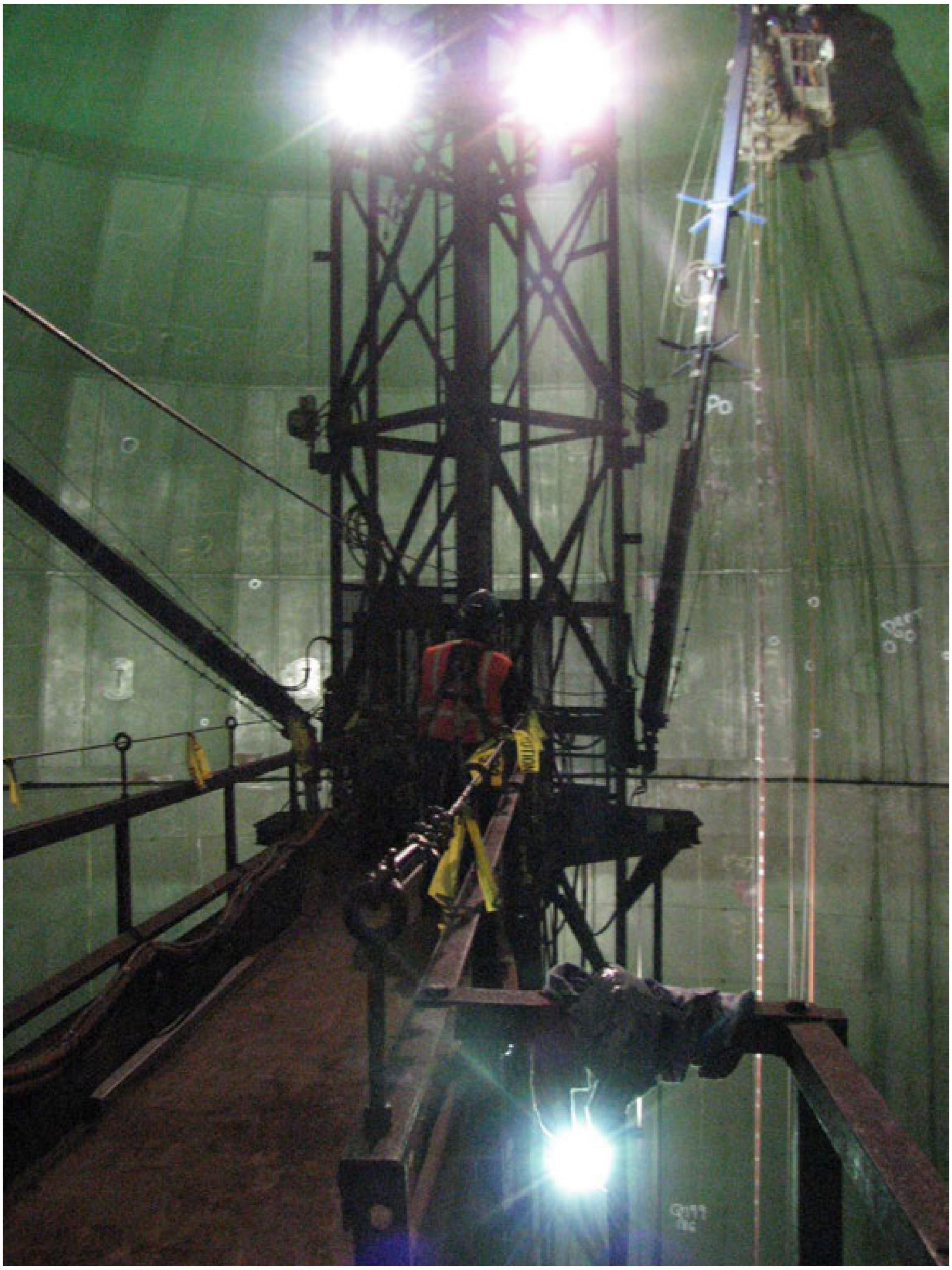
APPENDIX D – TANK INTERIOR PHOTOGRAPHS



Looking up from the floor at one crew inspecting the barrel under the catwalk and the other crew-inspecting course E of the upper dome.

A view of the very top of tank # 2 showing courses D, E, and F with a TesTex crew

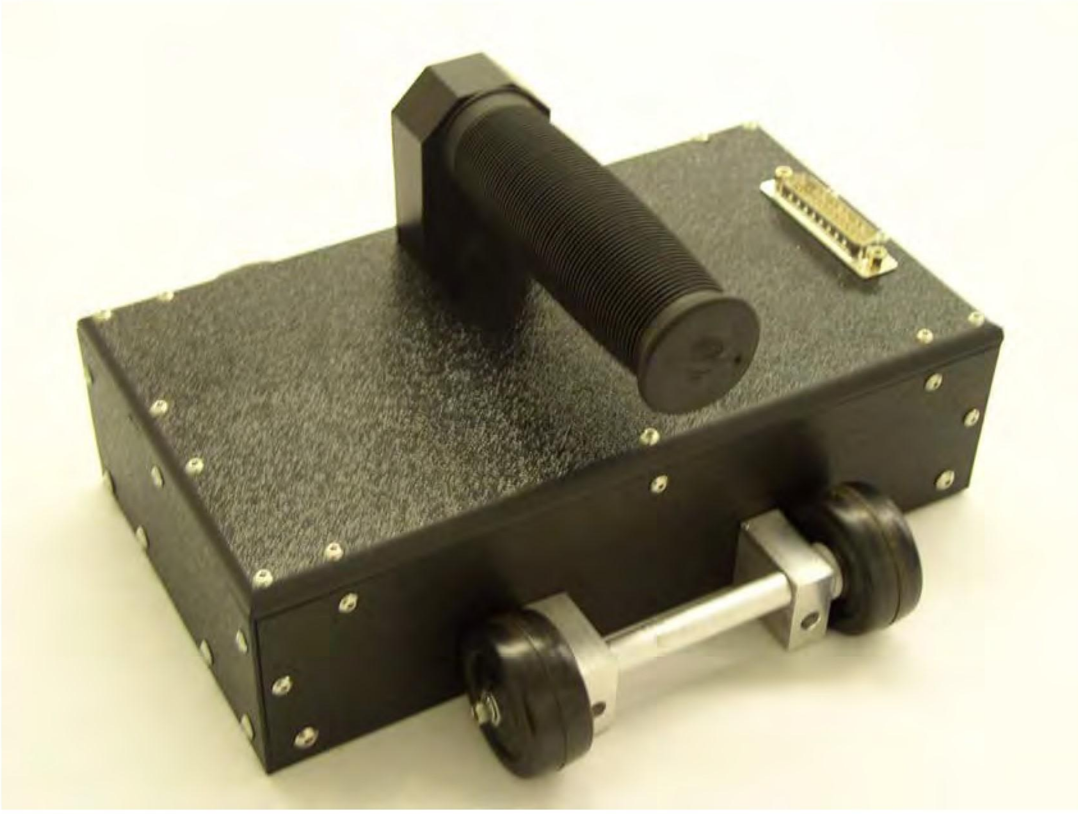
APPENDIX D – TANK INTERIOR PHOTOGRAPHS



A view just inside of tank #2 with a TesTex crew inspecting course D and E of the upper dome.

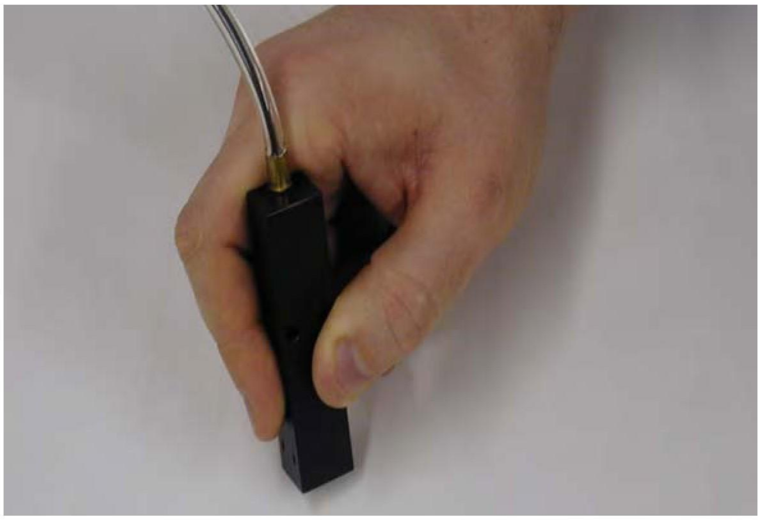
APPENDIX E – TESTEX EQUIPMENT

APPENDIX E – TESTEX EQUIPMENT



Above: A specially developed 8" wide hand scanner used for the majority of the surface scanning. Below: A TesTex crewmember using the hand scanner from one of the baskets.

APPENDIX E – TESTEX EQUIPMENT



Above: The Hawkeye Pencil Probe used for testing all welds in tank # 2. Below: A TesTex crewmember using the Hawkeye a weld from one of the baskets.

APPENDIX F – DEFECT AREA PHOTOGRAPHS

APPENDIX F – DEFECT AREA PHOTOGRAPHS

Intersecting welds between plates 21 and 1 of course 1 and the floor.


Intersecting welds between plates 1 and 2 of course 1 and the floor.

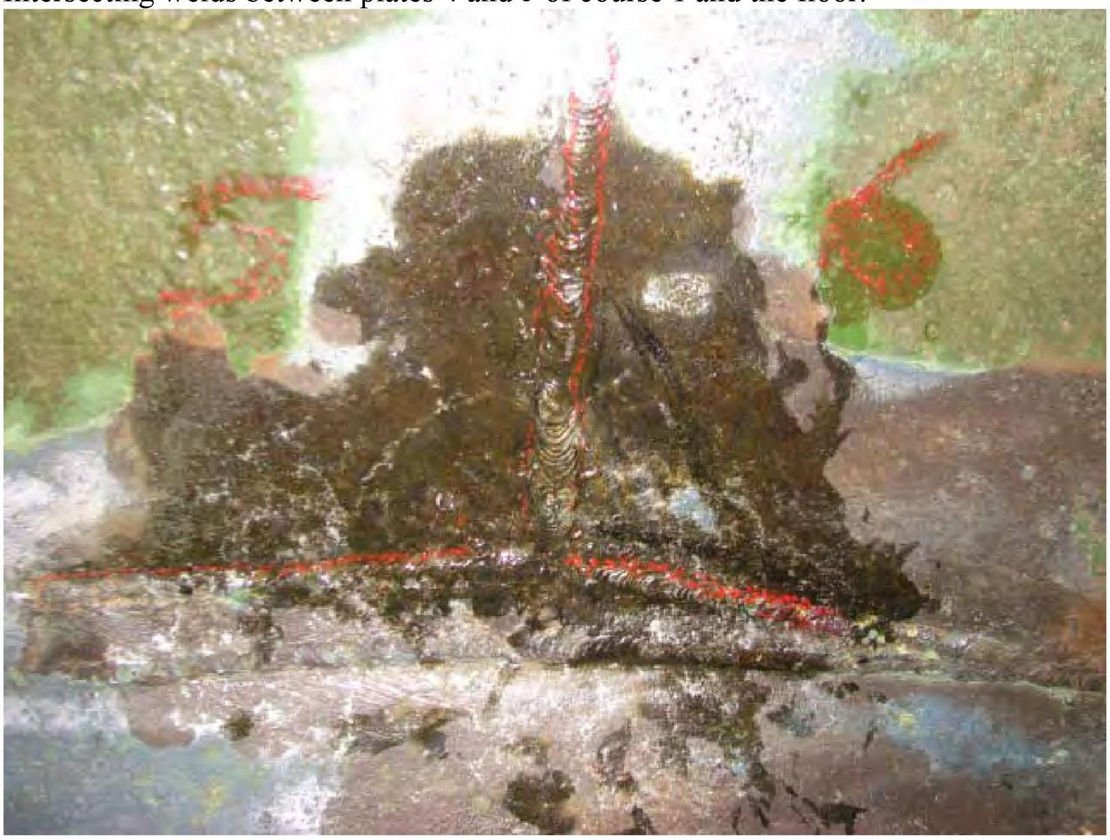
APPENDIX F – DEFECT AREA PHOTOGRAPHS

Intersecting welds between plates 2 and 3 of course 1 and the floor.

Intersecting welds between plates 3 and 4 of course 1 and the floor.

APPENDIX F – DEFECT AREA PHOTOGRAPHS

Intersecting welds between plates 4 and 5 of course 1 and the floor.



Intersecting welds between plates 5 and 6 of course 1 and the floor.

APPENDIX F – DEFECT AREA PHOTOGRAPHS

Intersecting welds between plates 6 and 7 of course 1 and the floor.

Intersecting welds between plates 7 and 8 of course 1 and the floor.

APPENDIX F – DEFECT AREA PHOTOGRAPHS

Intersecting welds between plates 8 and 9 of course 1 and the floor.

Intersecting welds between plates 9 and 10 of course 1 and the floor.

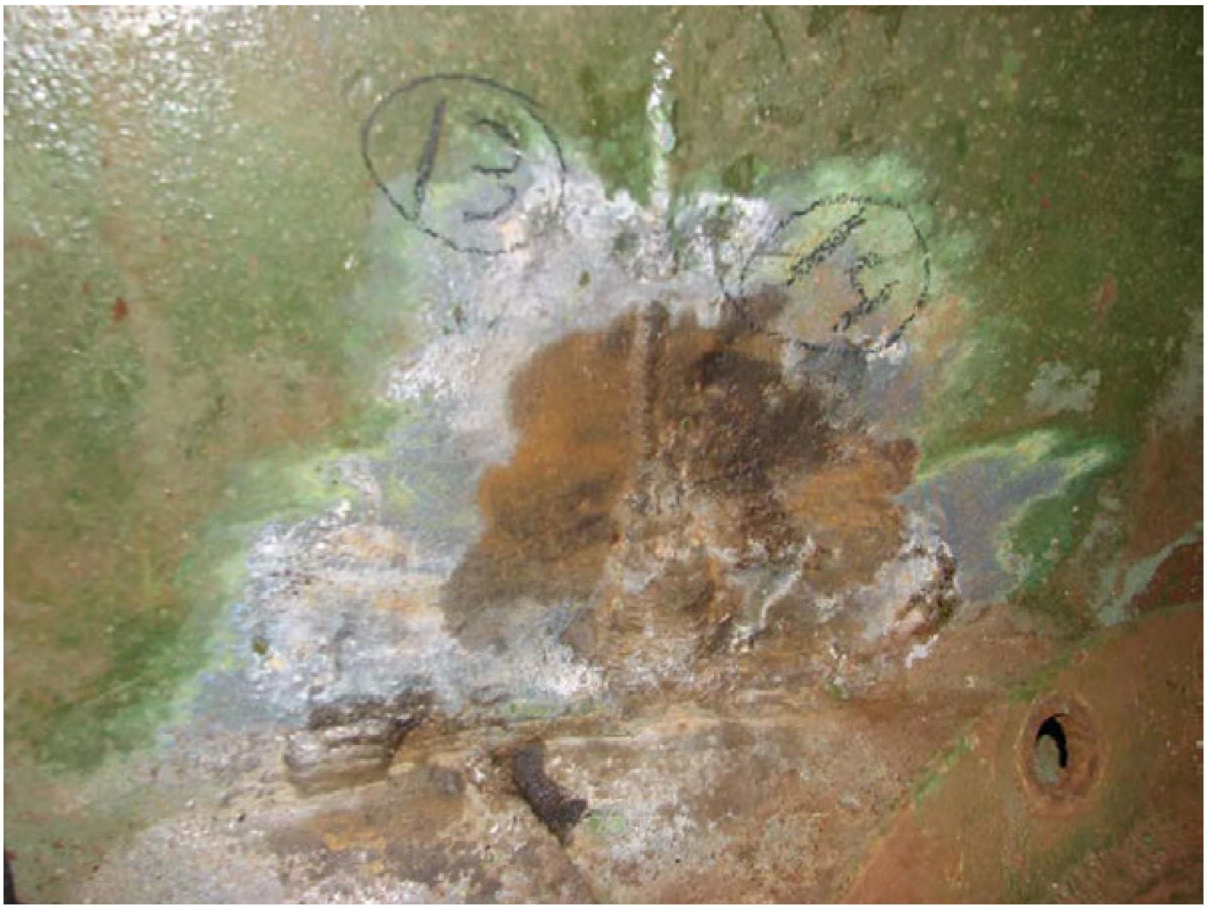
APPENDIX F – DEFECT AREA PHOTOGRAPHS

Intersecting welds between plates 10 and 11 of course 1 and the floor.

Intersecting welds between plates 11 and 12 of course 1 and the floor.

APPENDIX F – DEFECT AREA PHOTOGRAPHS

Intersecting welds between plates 12 and 13 of course 1 and the floor.



Intersecting welds between plates 13 and 14 of course 1 and the floor.

APPENDIX F – DEFECT AREA PHOTOGRAPHS

Intersecting welds between plates 14 and 15 of course 1 and the floor.

Intersecting welds between plates 15 and 16 of course 1 and the floor.

APPENDIX F – DEFECT AREA PHOTOGRAPHS

Intersecting welds between plates 17 and 18 of course 1 and the floor.

Intersecting welds between plates 19 and 20 of course 1 and the floor.

APPENDIX F – DEFECT AREA PHOTOGRAPHS

Intersecting welds between plates 20 and 21 of course 1 and the floor.

Flaw # 83, topside pitting on plate 4 of the floor, 0.336" remaining, near plates 11 and 12 of course 1

APPENDIX G – SHEAR WAVE REPORT AND CALIBRATIONS

Baker Inspection Group, LLC

ASME FLAW ULTRASONIC INSPECTION REPORT

REPORT NO. ____________ DATE: ____________

BAKER INSPECTION GROUP ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO OUR INTERPRETATION OF THE QUALITY OF MATERIAL SUBMITTED. ALL DATA IS HELD STRICTLY CONFIDENTIAL. (FORM No. 123R1-QA)

CLIENT: ____________ JOB LOCATION: ____________ JOB NO. ____________

CLIENT PO# ____________ CLIENT JOB NO: ____________ INSTRUMENT TYPE/SN# ____________

INST CAL. DATE ________ PROCEDURE ______ REV. ____ ACCEPTANCE STD. ____________ TEST SURFACE TEMP. ____ °F

MATERIAL ____________ THICKNESS ______ in. or SCHEDULE ______ DIAMETER ______ in.

COMPONENT DESCRIPTION ____________ TEST SURFACE ________ TIME START _____ TIME STOP _____

0 REFERENCE: X-Axis ____________ Y-Axis ____________

SURFACE CONDITION ____________

PART NO. OR WELD NO.	IND. NO.	MAX. % DAC	SOUND (BEAM) PATH (in.)	LOC. (X) (in.)	POS. (Y) (in.)	CAL. SHEET ID	ANGLE DEG. & (DIR.)	COMMENTS & STATUS

SKETCH:

COMPONENT DRAWING NO.

TECHNICIAN ____________ SNT-TC-1A LEVEL ________ DATE ____________

CLIENT REVIEW ____________ DATE ____________ PAGE ____ OF ____

Baker Inspection Group, LLC

ASME FLAW ULTRASONIC INSPECTION REPORT

REPORT NO. ____________ DATE: ____________

BAKER INSPECTION GROUP ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO OUR INTERPRETATION OF THE QUALITY OF MATERIAL SUBMITTED. ALL DATA IS HELD STRICTLY CONFIDENTIAL. (FORM No. 123R1-QA)

CLIENT: ____________ JOB LOCATION: ____________ JOB NO. ____________

CLIENT PO# ____________ CLIENT JOB NO: ____________ INSTRUMENT TYPE/SN# ____________

INST CAL. DATE ________ PROCEDURE ______ REV. ____ ACCEPTANCE STD. ____________ TEST SURFACE TEMP. ____ °F

MATERIAL ____________ THICKNESS ______ in. or SCHEDULE ______ DIAMETER ______ in.

COMPONENT DESCRIPTION ____________ TEST SURFACE ________ TIME START _____ TIME STOP _____

0 REFERENCE: X-Axis ____________ Y-Axis ____________

SURFACE CONDITION ____________

PART NO. OR WELD NO.	IND. NO.	MAX. % DAC	SOUND (BEAM) PATH (in.)	LOC. (X) (in.)	POS. (Y) (in.)	CAL. SHEET ID	ANGLE DEG. & (DIR.)	COMMENTS & STATUS

SKETCH:

COMPONENT DRAWING NO.

TECHNICIAN ____________ SNT-TC-1A LEVEL ________ DATE ____________

CLIENT REVIEW ____________ DATE ____________ PAGE ____ OF ____

Baker Inspection Group, LLC

ASME FLAW ULTRASONIC INSPECTION REPORT

REPORT NO. ____________ DATE: ____________

BAKER INSPECTION GROUP ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO OUR INTERPRETATION OF THE QUALITY OF MATERIAL SUBMITTED. ALL DATA IS HELD STRICTLY CONFIDENTIAL. (FORM No. 123R1-QA)

CLIENT: ____________ JOB LOCATION: ____________ JOB NO. ____________

CLIENT PO# ____________ CLIENT JOB NO: ____________ INSTRUMENT TYPE/SN# ____________

INST CAL. DATE ________ PROCEDURE ______ REV. ____ ACCEPTANCE STD. ____________ TEST SURFACE TEMP. ____ °F

MATERIAL ____________ THICKNESS ______ in. or SCHEDULE ______ DIAMETER ______ in.

COMPONENT DESCRIPTION ____________ TEST SURFACE ________ TIME START _____ TIME STOP _____

0 REFERENCE: X-Axis ____________ Y-Axis ____________

SURFACE CONDITION ____________

PART NO. OR WELD NO.	IND. NO.	MAX. % DAC	SOUND (BEAM) PATH (in.)	LOC. (X) (in.)	POS. (Y) (in.)	CAL. SHEET ID	ANGLE DEG. & (DIR.)	COMMENTS & STATUS

SKETCH:

COMPONENT DRAWING NO.

TECHNICIAN ____________ SNT-TC-1A LEVEL ________ DATE ____________

CLIENT REVIEW ____________ DATE ____________ PAGE ____ OF ____

Baker Inspection Group, LLC

ASME FLAW ULTRASONIC INSPECTION REPORT

REPORT NO. ____________ DATE: ____________

BAKER INSPECTION GROUP ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO OUR INTERPRETATION OF THE QUALITY OF MATERIAL SUBMITTED. ALL DATA IS HELD STRICTLY CONFIDENTIAL. (FORM No. 123R1-QA)

CLIENT: ____________ JOB LOCATION: ____________ JOB NO. ____________

CLIENT PO# ____________ CLIENT JOB NO: ____________ INSTRUMENT TYPE/SN# ____________

INST CAL. DATE ________ PROCEDURE ______ REV. ____ ACCEPTANCE STD. ____________ TEST SURFACE TEMP. ____ °F

MATERIAL ____________ THICKNESS ______ in. or SCHEDULE ______ DIAMETER ______ in.

COMPONENT DESCRIPTION ____________ TEST SURFACE ________ TIME START _____ TIME STOP _____

0 REFERENCE: X-Axis ____________ Y-Axis ____________

SURFACE CONDITION ____________

PART NO. OR WELD NO.	IND. NO.	MAX. % DAC	SOUND (BEAM) PATH (in.)	LOC. (X) (in.)	POS. (Y) (in.)	CAL. SHEET ID	ANGLE DEG. & (DIR.)	COMMENTS & STATUS

SKETCH:

COMPONENT DRAWING NO.

TECHNICIAN ____________ SNT-TC-1A LEVEL ________ DATE ________

CLIENT REVIEW ____________ DATE ________ PAGE ____ OF ____

Baker Inspection Group, LLC

ASME FLAW ULTRASONIC INSPECTION REPORT

REPORT NO. ____________ DATE: ____________

BAKER INSPECTION GROUP ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO OUR INTERPRETATION OF THE QUALITY OF MATERIAL SUBMITTED. ALL DATA IS HELD STRICTLY CONFIDENTIAL. (FORM No. 123R1-QA)

CLIENT: ____________ JOB LOCATION: ____________ JOB NO. ____________

CLIENT PO# ____________ CLIENT JOB NO: ____________ INSTRUMENT TYPE/SN# ____________

INST CAL. DATE ________ PROCEDURE ______ REV. ____ ACCEPTANCE STD. ____________ TEST SURFACE TEMP. ____ °F

MATERIAL ____________ THICKNESS ______ in. or SCHEDULE ______ DIAMETER ______ in.

COMPONENT DESCRIPTION ____________ TEST SURFACE ________ TIME START _____ TIME STOP _____

0 REFERENCE: X-Axis ____________ Y-Axis ____________

SURFACE CONDITION ____________

PART NO. OR WELD NO.	IND. NO.	MAX. % DAC	SOUND (BEAM) PATH (in.)	LOC. (X) (in.)	POS. (Y) (in.)	CAL. SHEET ID	ANGLE DEG. & (DIR.)	COMMENTS & STATUS

SKETCH:

COMPONENT DRAWING NO.

TECHNICIAN ____________ SNT-TC-1A LEVEL ________ DATE ____________

CLIENT REVIEW ____________ DATE ____________ PAGE ____ OF ____

Baker Inspection Group, LLC

ASME FLAW ULTRASONIC INSPECTION REPORT

REPORT NO. ____________ DATE: ____________

BAKER INSPECTION GROUP ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO OUR INTERPRETATION OF THE QUALITY OF MATERIAL SUBMITTED. ALL DATA IS HELD STRICTLY CONFIDENTIAL. (FORM No. 123R1-QA)

CLIENT: ____________ JOB LOCATION: ____________ JOB NO. ____________

CLIENT PO# ____________ CLIENT JOB NO: ____________ INSTRUMENT TYPE/SN# ____________

INST CAL. DATE ________ PROCEDURE ______ REV. ____ ACCEPTANCE STD. ____________ TEST SURFACE TEMP. ____ °F

MATERIAL ____________ THICKNESS ______ in. or SCHEDULE ______ DIAMETER ______ in.

COMPONENT DESCRIPTION ____________ TEST SURFACE ________ TIME START _____ TIME STOP _____

0 REFERENCE: X-Axis ____________ Y-Axis ____________

SURFACE CONDITION ____________

PART NO. OR WELD NO.	IND. NO.	MAX. % DAC	SOUND (BEAM) PATH (in.)	LOC. (X) (in.)	POS. (Y) (in.)	CAL. SHEET ID	ANGLE DEG. & (DIR.)	COMMENTS & STATUS

SKETCH:

COMPONENT DRAWING NO.

TECHNICIAN ____________ SNT-TC-1A LEVEL ________ DATE ____________

CLIENT REVIEW ____________ DATE ____________ PAGE ____ OF ____

Baker Inspection Group, LLC

ASME FLAW ULTRASONIC INSPECTION REPORT

REPORT NO. ____________ DATE: ____________

BAKER INSPECTION GROUP ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO OUR INTERPRETATION OF THE QUALITY OF MATERIAL SUBMITTED. ALL DATA IS HELD STRICTLY CONFIDENTIAL. (FORM No. 123R1-QA)

CLIENT: ____________ JOB LOCATION: ____________ JOB NO. ____________

CLIENT PO# ____________ CLIENT JOB NO: ____________ INSTRUMENT TYPE/SN# ____________

INST CAL. DATE ________ PROCEDURE ______ REV. ____ ACCEPTANCE STD. ________ TEST SURFACE TEMP. ____ °F

MATERIAL ____________ THICKNESS ______ in. or SCHEDULE ______ DIAMETER ______ in.

COMPONENT DESCRIPTION ____________ TEST SURFACE ________ TIME START _____ TIME STOP _____

0 REFERENCE: X-Axis ____________ Y-Axis ____________

SURFACE CONDITION ____________

PART NO. OR WELD NO.	IND. NO.	MAX. % DAC	SOUND (BEAM) PATH (in.)	LOC. (X) (in.)	POS. (Y) (in.)	CAL. SHEET ID	ANGLE DEG. & (DIR.)	COMMENTS & STATUS

SKETCH:

COMPONENT DRAWING NO.

TECHNICIAN ____________ SNT-TC-1A LEVEL ________ DATE ________

CLIENT REVIEW ____________ DATE ________ PAGE ____ OF ____

Baker Inspection Group, LLC

ASME FLAW ULTRASONIC INSPECTION REPORT

REPORT NO. ____________ DATE: ____________

BAKER INSPECTION GROUP ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO OUR INTERPRETATION OF THE QUALITY OF MATERIAL SUBMITTED. ALL DATA IS HELD STRICTLY CONFIDENTIAL. (FORM No. 123R1-QA)

CLIENT: ____________ JOB LOCATION: ____________ JOB NO. ____________

CLIENT PO# ____________ CLIENT JOB NO: ____________ INSTRUMENT TYPE/SN# ____________

INST CAL. DATE ______ PROCEDURE ______ REV. ____ ACCEPTANCE STD. ______ TEST SURFACE TEMP. ____ °F

MATERIAL ____________ THICKNESS ______ in. or SCHEDULE ______ DIAMETER ______ in.

COMPONENT DESCRIPTION ____________ TEST SURFACE ______ TIME START ______ TIME STOP ______

0 REFERENCE: X-Axis ____________ Y-Axis ____________

SURFACE CONDITION ____________

PART NO. OR WELD NO.	IND. NO.	MAX. % DAC	SOUND (BEAM) PATH (in.)	LOC. (X) (in.)	POS. (Y) (in.)	CAL. SHEET ID	ANGLE DEG. & (DIR.)	COMMENTS & STATUS

SKETCH:

COMPONENT DRAWING NO.

TECHNICIAN ____________ SNT-TC-1A LEVEL ______ DATE ______

CLIENT REVIEW ____________ DATE ______ PAGE ____ OF ____

Baker Inspection Group, LLC

ASME FLAW ULTRASONIC INSPECTION REPORT

REPORT NO. ____________ DATE: ____________

BAKER INSPECTION GROUP ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO OUR INTERPRETATION OF THE QUALITY OF MATERIAL SUBMITTED. ALL DATA IS HELD STRICTLY CONFIDENTIAL. (FORM No. 123R1-QA)

CLIENT: ____________ JOB LOCATION: ____________ JOB NO. ____________

CLIENT PO# ____________ CLIENT JOB NO: ____________ INSTRUMENT TYPE/SN# ____________

INST CAL. DATE ________ PROCEDURE ______ REV. ____ ACCEPTANCE STD. ____________ TEST SURFACE TEMP. ____ °F

MATERIAL ____________ THICKNESS ______ in. or SCHEDULE ______ DIAMETER ______ in.

COMPONENT DESCRIPTION ____________ TEST SURFACE ________ TIME START _____ TIME STOP _____

0 REFERENCE: X-Axis ____________ Y-Axis ____________

SURFACE CONDITION ____________

PART NO. OR WELD NO.	IND. NO.	MAX. % DAC	SOUND (BEAM) PATH (in.)	LOC. (X) (in.)	POS. (Y) (in.)	CAL. SHEET ID	ANGLE DEG. & (DIR.)	COMMENTS & STATUS

SKETCH:

COMPONENT DRAWING NO.

TECHNICIAN ____________ SNT-TC-1A LEVEL ________ DATE ____________

CLIENT REVIEW ____________ DATE ____________ PAGE ____ OF ____

Baker Inspection Group, LLC

ASME FLAW ULTRASONIC INSPECTION REPORT

REPORT NO. ____________ DATE: ____________

CLIENT: ____________ JOB LOCATION: ____________ JOB NO. ____________

CLIENT PO# ____________ CLIENT JOB NO: ____________ INSTRUMENT TYPE/SN# ____________

INST CAL. DATE ________ PROCEDURE ______ REV. ____ ACCEPTANCE STD. ________ TEST SURFACE TEMP. ____ °F

MATERIAL ____________ THICKNESS ______ in. or SCHEDULE ______ DIAMETER ______ in.

COMPONENT DESCRIPTION ____________ TEST SURFACE ________ TIME START _____ TIME STOP _____

0 REFERENCE: X-Axis ____________ Y-Axis ____________

SURFACE CONDITION ____________

PART NO. OR WELD NO.	IND. NO.	MAX. % DAC	SOUND (BEAM) PATH (in.)	LOC. (X) (in.)	POS. (Y) (in.)	CAL. SHEET ID	ANGLE DEG. & (DIR.)	COMMENTS & STATUS

SKETCH:

COMPONENT DRAWING NO.

TECHNICIAN ____________ SNT-TC-1A LEVEL ________ DATE ________

CLIENT REVIEW ____________ DATE ________ PAGE ____ OF ____

BAKER INSPECTION GROUP, LLC
UT CALIBRATION SHEET
CALIBRATION SHEET NUMBER ____

PLANT ______________________________ **DATE** ____________

JOB NUMBER ______________________________ **PROCEDURE** ______ **REV. NO.** _______

OPERATOR ______________________________ **LEVEL** _________
ASSISTANT ______________________________ **LEVEL** _________

ULTRASONIC INSTRUMENT MANUFACTURER AND MODEL ______________________________
SERIAL NO. ____________ FREQUENCY ____ MHz SWEEP RANGE _____ IN.
SOUND VEL. __________ GAIN: REFERENCE LEVEL _____ dB +14 dB SCANNING LEVEL _____ dB
DAMPING _______ REJECT _______ PROBE DELAY _____ μSEC DISPLAY DELAY _____ μSEC

SEARCH UNIT MANUFACTURER _______________________ TYPE ___________________
SERIAL NO. ____________ DIA. OR DIMENSIONS _____ IN. REFRACTED ANGLE ____ DEG.
FREQUENCY ____ MHz CABLE TYPE _________________ CABLE LENGTH _________ FEET

CALIBRATION STANDARD SERIAL NO. ____________ THICKNESS ___________ IN.
MATERIAL ________________ DIAMETER _____ IN. NOTCHES ___ SIDE DRILLED HOLES ___
PIPE ___ DIAMETER ___ IN. SCHEDULE ______ TEMPERATURE ___ DEG. F CRACKS ____
WELD EXAM ___ MATERIAL EXAM ___ NOZZLE INNER RADIUS ___

COUPLANT MANUFACTURER _____________ TYPE ________ BATCH NO. ___________

OTHER EQUIPMENT ____
____
____

SCREEN HEIGHT LINEARITY
% FSH AMPLITUDE

LARGER	SMALLER
______	______
______	______
80	______
______	______
______	______
______	______
______	______
______	______
______	______

AMPLITUDE CONTROL LINEARITY
Gain Control Setting (dB)
Low ____ Medium ____ High ____

% FSH	dB CHANGE	READING % FSH			INDICATION LIMITS (% FSH)
80	-6	____	____	____	32 to 48
80	-12	____	____	____	16 to 24
40	+6	____	____	____	64 to 96
20	+12	____	____	____	64 to 96

TECHNIQUE STRAIGHT BEAM _____ ANGLE BEAM _____
CONTACT _____ IMMERSION _____
SCAN DIRECTION _____ AXIAL _____ CIRCUMFERENTIAL
WELD _____ MATERIAL _____ INNER RADIUS _____

BP ___ or CAL. TIME > ______ ______ ______
DEPTH ____ DATA SHEET NO.> ______ ______ ______

NOTCH	HOLE	BP OR DEPTH (INCH)	SR	%FSH	SR	%FSH	SR	%FSH
1/2 VEE	1/4 t							
1 VEE	1/2 t							
3/2 VEE	3/4 t							
2 VEE	5/4 t							
5/2 VEE	6/4 t							
3 VEE	7/4 t							
NOTCH @1/2 VEE								
IR NOTCH	#1							
IR NOTCH	#2							
IR NOTCH	#3							

BP = Beam Path VEE = VEE Path SR = Sweep Reading FSH = Full Screen Height IR = Inner Radius Notch or Crack No.

BAKER INSPECTION GROUP, LLC
UT CALIBRATION SHEET
CALIBRATION SHEET NUMBER ____

PLANT ________________ **DATE** ________

JOB NUMBER ________________ **PROCEDURE** ______ **REV. NO.** _______

OPERATOR ________________ **LEVEL** ________
ASSISTANT ________________ **LEVEL** ________

ULTRASONIC INSTRUMENT MANUFACTURER AND MODEL ________________
SERIAL NO. __________ FREQUENCY ____ MHz SWEEP RANGE _____ IN.
SOUND VEL. __________ GAIN: REFERENCE LEVEL _____ dB +14 dB SCANNING LEVEL _____ dB
DAMPING ________ REJECT ________ PROBE DELAY _____ µSEC DISPLAY DELAY _____ µSEC

SEARCH UNIT MANUFACTURER ________________ TYPE ________________
SERIAL NO. __________ DIA. OR DIMENSIONS _____ IN. REFRACTED ANGLE ____ DEG.
FREQUENCY ____ MHz CABLE TYPE ________________ CABLE LENGTH _________ FEET

CALIBRATION STANDARD SERIAL NO. __________ THICKNESS __________ IN.
MATERIAL ______________ DIAMETER _____ IN. NOTCHES ___ SIDE DRILLED HOLES ___
PIPE ___ DIAMETER ___ IN. SCHEDULE ______ TEMPERATURE ___ DEG. F CRACKS _____
WELD EXAM ___ MATERIAL EXAM ___ NOZZLE INNER RADIUS ___

COUPLANT MANUFACTURER ____________ TYPE ________ BATCH NO. ___________

OTHER EQUIPMENT ________________________________

SCREEN HEIGHT LINEARITY % FSH AMPLITUDE

LARGER	SMALLER
80	

AMPLITUDE CONTROL LINEARITY
Gain Control Setting (dB)
Low ____ Medium ____ High ____

% FSH	dB CHANGE	READING % FSH			INDICATION LIMITS (% FSH)
80	-6	____	____	____	32 to 48
80	-12	____	____	____	16 to 24
40	+6	____	____	____	64 to 96
20	+12	____	____	____	64 to 96

TECHNIQUE STRAIGHT BEAM _____ ANGLE BEAM _____
CONTACT _____ IMMERSION _____
SCAN DIRECTION _____ AXIAL _____ CIRCUMFERENTIAL
WELD _____ MATERIAL _____ INNER RADIUS _____

BP ___ or CAL. TIME > ______ ______ ______
DEPTH ____ DATA SHEET NO.> ______ ______ ______

NOTCH	HOLE	BP OR DEPTH (INCH)	SR	%FSH	SR	%FSH	SR	%FSH
1/2 VEE	1/4 t							
1 VEE	1/2 t							
3/2 VEE	3/4 t							
2 VEE	5/4 t							
5/2 VEE	6/4 t							
3 VEE	7/4 t							
NOTCH @1/2 VEE								
IR NOTCH	#1							
IR NOTCH	#2							
IR NOTCH	#3							

BP = Beam Path VEE = VEE Path SR = Sweep Reading FSH = Full Screen Height IR = Inner Radius Notch or Crack No.

BAKER INSPECTION GROUP, LLC
UT CALIBRATION SHEET
CALIBRATION SHEET NUMBER ____

PLANT ______________________________ **DATE** ____________

JOB NUMBER ______________________ **PROCEDURE** _____ **REV. NO.** ______

OPERATOR ______________________________ **LEVEL** _________
ASSISTANT ______________________________ **LEVEL** _________

ULTRASONIC INSTRUMENT MANUFACTURER AND MODEL ______________________
SERIAL NO. __________ FREQUENCY ____ MHz SWEEP RANGE ____ IN.
SOUND VEL. _________ GAIN: REFERENCE LEVEL _____ dB +14 dB SCANNING LEVEL _____ dB
DAMPING _______ REJECT _______ PROBE DELAY _____ µSEC DISPLAY DELAY _____ µSEC

SEARCH UNIT MANUFACTURER ____________________ TYPE ________________
SERIAL NO. __________ DIA. OR DIMENSIONS _____ IN. REFRACTED ANGLE ____ DEG.
FREQUENCY ____ MHz CABLE TYPE _______________ CABLE LENGTH ________ FEET

CALIBRATION STANDARD SERIAL NO. __________ THICKNESS __________ IN.
MATERIAL _____________ DIAMETER _____ IN. NOTCHES ___ SIDE DRILLED HOLES ___
PIPE ___ DIAMETER ___ IN. SCHEDULE ______ TEMPERATURE ___ DEG. F CRACKS ____
WELD EXAM ___ MATERIAL EXAM ___ NOZZLE INNER RADIUS ___

COUPLANT MANUFACTURER ____________ TYPE ________ BATCH NO. ___________

OTHER EQUIPMENT ____
____
____

SCREEN HEIGHT LINEARITY
% FSH AMPLITUDE

LARGER	**SMALLER**
80	

AMPLITUDE CONTROL LINEARITY
Gain Control Setting (dB)
Low ____ Medium ____ High ____

% FSH	**dB CHANGE**	**READING % FSH**			**INDICATION LIMITS (% FSH)**
80	-6	____	____	____	32 to 48
80	-12	____	____	____	16 to 24
40	+6	____	____	____	64 to 96
20	+12	____	____	____	64 to 96

TECHNIQUE STRAIGHT BEAM ____ ANGLE BEAM ____
CONTACT ____ IMMERSION ____
SCAN DIRECTION ____ AXIAL ____ CIRCUMFERENTIAL
WELD ____ MATERIAL ____ INNER RADIUS ____

BP ___ or DEPTH ____

	CAL. TIME >		______		______		______	
	DATA SHEET NO.>		______		______		______	
NOTCH	HOLE	BP OR DEPTH (INCH)	SR	%FSH	SR	%FSH	SR	%FSH
1/2 VEE	1/4 t							
1 VEE	1/2 t							
3/2 VEE	3/4 t							
2 VEE	5/4 t							
5/2 VEE	6/4 t							
3 VEE	7/4 t							
NOTCH @1/2 VEE								
IR NOTCH	#1							
IR NOTCH	#2							
IR NOTCH	#3							

BP = Beam Path VEE = VEE Path SR = Sweep Reading FSH = Full Screen Height IR = Inner Radius Notch or Crack No.

BAKER INSPECTION GROUP, LLC
UT CALIBRATION SHEET
CALIBRATION SHEET NUMBER ____

PLANT ______________________________ **DATE** __________

JOB NUMBER ______________________ **PROCEDURE** ______ **REV. NO.** ______

OPERATOR ______________________________ **LEVEL** ________
ASSISTANT ______________________________ **LEVEL** ________

ULTRASONIC INSTRUMENT MANUFACTURER AND MODEL ______________________
SERIAL NO. __________ FREQUENCY ____ MHz SWEEP RANGE _____ IN.
SOUND VEL. __________ GAIN: REFERENCE LEVEL _____ dB +14 dB SCANNING LEVEL _____ dB
DAMPING _______ REJECT _______ PROBE DELAY _____ µSEC DISPLAY DELAY _____ µSEC

SEARCH UNIT MANUFACTURER __________________ TYPE _______________
SERIAL NO. __________ DIA. OR DIMENSIONS _____ IN. REFRACTED ANGLE ____ DEG.
FREQUENCY ____ MHz CABLE TYPE ______________ CABLE LENGTH ________ FEET

CALIBRATION STANDARD SERIAL NO. __________ THICKNESS __________ IN.
MATERIAL _____________ DIAMETER _____ IN. NOTCHES ___ SIDE DRILLED HOLES ___
PIPE ___ DIAMETER ___ IN. SCHEDULE ______ TEMPERATURE ___ DEG. F CRACKS ____
WELD EXAM ___ MATERIAL EXAM ___ NOZZLE INNER RADIUS ___

COUPLANT MANUFACTURER ____________ TYPE ________ BATCH NO. __________

OTHER EQUIPMENT ____
____
____

SCREEN HEIGHT LINEARITY % FSH AMPLITUDE

LARGER	**SMALLER**
80	

AMPLITUDE CONTROL LINEARITY
Gain Control Setting (dB)
Low ____ Medium ____ High ____

% FSH	**dB CHANGE**	**READING % FSH**			**INDICATION LIMITS (% FSH)**
80	-6	____	____	____	32 to 48
80	-12	____	____	____	16 to 24
40	+6	____	____	____	64 to 96
20	+12	____	____	____	64 to 96

TECHNIQUE STRAIGHT BEAM ____ ANGLE BEAM ____
CONTACT ____ IMMERSION ____
SCAN DIRECTION ____ AXIAL ____ CIRCUMFERENTIAL
WELD ____ MATERIAL ____ INNER RADIUS ____

BP ___ or CAL. TIME > ______ ______ ______
DEPTH ___ DATA SHEET NO.> ______ ______ ______

NOTCH	HOLE	BP OR DEPTH (INCH)	SR	%FSH	SR	%FSH	SR	%FSH
1/2 VEE	1/4 t							
1 VEE	1/2 t							
3/2 VEE	3/4 t							
2 VEE	5/4 t							
5/2 VEE	6/4 t							
3 VEE	7/4 t							
NOTCH @1/2 VEE								
IR NOTCH	#1							
IR NOTCH	#2							
IR NOTCH	#3							

BP = Beam Path VEE = VEE Path SR = Sweep Reading FSH = Full Screen Height IR = Inner Radius Notch or Crack No.

BAKER INSPECTION GROUP, LLC
UT CALIBRATION SHEET
CALIBRATION SHEET NUMBER ____

PLANT ______________________________ **DATE** __________

JOB NUMBER ______________________ **PROCEDURE** ______ **REV. NO.** _______

OPERATOR ______________________________ **LEVEL** _________
ASSISTANT ______________________________ **LEVEL** _________

ULTRASONIC INSTRUMENT MANUFACTURER AND MODEL __________________________
SERIAL NO. ___________ FREQUENCY ____ MHz SWEEP RANGE _____ IN.
SOUND VEL. __________ GAIN: REFERENCE LEVEL _____ dB +14 dB SCANNING LEVEL _____ dB
DAMPING _______ REJECT _______ PROBE DELAY _____ µSEC DISPLAY DELAY _____ µSEC

SEARCH UNIT MANUFACTURER ___________________ TYPE _______________
SERIAL NO. ___________ DIA. OR DIMENSIONS _____ IN. REFRACTED ANGLE ____ DEG.
FREQUENCY ____ MHz CABLE TYPE _______________ CABLE LENGTH _________ FEET

CALIBRATION STANDARD SERIAL NO. ___________ THICKNESS __________ IN.
MATERIAL ______________ DIAMETER _____ IN. NOTCHES ___ SIDE DRILLED HOLES ___
PIPE ___ DIAMETER ___ IN. SCHEDULE ______ TEMPERATURE ___ DEG. F CRACKS ____
WELD EXAM ___ MATERIAL EXAM ___ NOZZLE INNER RADIUS ___

COUPLANT MANUFACTURER ____________ TYPE ________ BATCH NO. ___________

OTHER EQUIPMENT ____
____
____

SCREEN HEIGHT LINEARITY
% FSH AMPLITUDE

LARGER	**SMALLER**
______	______
______	______
80	______
______	______
______	______
______	______
______	______
______	______
______	______

AMPLITUDE CONTROL LINEARITY
Gain Control Setting (dB)
Low ____ Medium ____ High ____

% FSH	**dB CHANGE**	**READING % FSH**			**INDICATION LIMITS (% FSH)**
80	-6	____	____	____	32 to 48
80	-12	____	____	____	16 to 24
40	+6	____	____	____	64 to 96
20	+12	____	____	____	64 to 96

TECHNIQUE STRAIGHT BEAM ____ ANGLE BEAM ____
CONTACT ____ IMMERSION ____
SCAN DIRECTION ____ AXIAL ____ CIRCUMFERENTIAL
WELD ____ MATERIAL ____ INNER RADIUS ____

BP ___ or CAL. TIME > ______ ______ ______
DEPTH ___ DATA SHEET NO.> ______ ______ ______

NOTCH	HOLE	BP OR DEPTH (INCH)	SR	%FSH	SR	%FSH	SR	%FSH
1/2 VEE	1/4 t							
1 VEE	1/2 t							
3/2 VEE	3/4 t							
2 VEE	5/4 t							
5/2 VEE	6/4 t							
3 VEE	7/4 t							
NOTCH @1/2 VEE								
IR NOTCH	#1							
IR NOTCH	#2							
IR NOTCH	#3							

BP = Beam Path VEE = VEE Path SR = Sweep Reading FSH = Full Screen Height IR = Inner Radius Notch or Crack No.

ENGINEERING & INSPECTIONS
HAWAII. INC.

Attachment D

Spread sheet of data findings and repair recommendations

P. O. Box 700217 • Kapolei, HI 96709-0217 • Tel: (808) 682-1667 • Fax: (808) 682-1834 • E-Mail: E I Hawaii@aol.com

Red Hill Fuel Facility
Tank No. 2

Flaw No.	Tank Section	Quad	Row/Course	Plate	Description of Flaw	R. Thickness	API-653 Repair Recommendation
1	Lower Dome	A	1	2 & 3	Dent 3/8"x 1"		Based on remaining thickness; No action is required
2A & B	Lower Dome	B	1	7 & 8	Weld Defect, Cracks		Repair by Welding (see note: 1)
3	Lower Dome	C	1	15 & 16	Weld Defect, Cracks		Repair by Welding (see note: 1)
4A & B	Lower Dome	D	1		Weld Defect, I P; Arc Strike		Repair by Welding (see note: 1)
5A	Lower Dome	D	2	47	Backside Defect	0.150	Repair by lap welded patch 14" x 14"; with radius corners (see note: 2)
5B	Lower Dome	D	2	47	Weld Defect, I P		Repair by Welding (see note: 1)
6	Lower Dome	C	2	39	Topside Dent (Shallow)		Based on remaining thickness; No action is required
7	Lower Dome	A	3	13 & 14	Weld Defect, LOF		Repair by Welding (see note: 1)
8	Lower Dome	A	3	14 & 15	Thickness	0 233	Based on remaining thickness; No action is required
9	Lower Dome	C	3	41	Thickness	0 230	Based on remaining thickness; No action is required
10	Lower Dome	C	3	45	Topside Pit	0 219	Based on remaining thickness; No action is required
11	Lower Dome	A	3	4 & 5	Thickness	0 226	Based on remaining thickness; No action is required
12	Barrel	A	4	8 & 9	Thickness	0 233	Based on remaining thickness; No action is required
13	Barrel	A	25	2	Thickness	0 227	Based on remaining thickness; No action is required
14	Barrel	A	C	2	Weld Defect, LOF		Repair by Welding (see note: 1)
15	Barrel	A	21	2	Thickness	0 233	Based on remaining thickness; No action is required
16A & B	Barrel	A	25	1	Thickness	0.232/0.229	Based on remaining thickness; No action is required
17A	Barrel	A	23	3	Weld Defect, LOF		Repair by Welding (see note: 1)
17B & C	Barrel	A	23	3	Thickness	0.224/0.234	Based on remaining thickness; No action is required
18	Barrel	A	7	3	Thickness	0.228	Based on remaining thickness; No action is required
19A & B	Barrel	D	24	14	Thickness	0.227/0.232	Based on remaining thickness; No action is required
20	Barrel	D	22	14	Thickness	0.234	Based on remaining thickness; No action is required
21	Barrel	D	4	15	Thickness	0.235	Based on remaining thickness; No action is required
22A & B	Barrel	D	18	14	Topside Pits	0.230/0.221	Based on remaining thickness; No action is required
23	Barrel	D	8	15	Topside Pit	0.228	Based on remaining thickness; No action is required
24	Barrel	A	26	3	Weld Defect; Porosity		Repair by Welding (see note: 1)
25	Barrel	A	17	3	Weld Defect, Arc Strikes		Repair by Welding (see note: 1)
26	Barrel	A	20	3	Weld Defect, Porosity		Repair by Welding (see note: 1)
27	Barrel	A	25	3	Topside Pit	0 234	Based on remaining thickness; No action is required
28	Barrel	A	8	3	Topside Pit	0 220	Based on remaining thickness; No action is required
29A-D	Barrel	D	13	14	Weld Defect, LOF		Repair by Welding (see note: 1)
30	Barrel	D	4	14	Topside Pit	0 226	Based on remaining thickness; No action is required
31A & B	Barrel	D	5	14	Topside Pits	0.235/0.235	Based on remaining thickness; No action is required
32A & B	Barrel	D	21	15	Thickness	0.230/0.219	Based on remaining thickness; No action is required
33	Barrel	D	20	14	Weld Defect, Tack Weld	0.168	Repair by Welding (see note: 1)
34	Barrel	A	25	2	Thickness	0 219	Based on remaining thickness; No action is required
35	Barrel	A	25	3	Thickness	0.221	Based on remaining thickness; No action is required
36	Barrel	A	10	2	Thickness	0.218	Based on remaining thickness; No action is required
37							Removed, Duplicated Item; See Flaw 34
38							Removed, Duplicated Item; See Flaw 35
39	Barrel	D	25	14	Thickness	0 230	Based on remaining thickness; No action is required
40	Barrel	D	26	14	Thickness	0 214	Based on remaining thickness; No action is required

1

Red Hill Fuel Facility
Tank No. 2

Flaw No.	Tank Section	Quad	Row/Course	Plate	Description of Flaw	R. Thickness	API-653 Repair Recommendation
41	Barrel	C	3	45	Topside Pit	0 222	Based on remaining thickness; No action is required
42A & B	Barrel	D	25	14	Thickness	0.223/0.234	Based on remaining thickness; No action is required
43	Barrel	D	27	14	Thickness	0 229	Based on remaining thickness; No action is required
44	Barrel	A	27	5	Thickness/Bulge	0 230	Based on remaining thickness; No action is required
45	Barrel	A	2	5	Thickness	0 225	Based on remaining thickness; No action is required
46	Barrel	D	25	12	Thickness	0 230	Based on remaining thickness; No action is required
47A, C-D	Barrel	D	20	12	Weld Defect, LOF		Repair by Welding (see note: 1)
47B	Barrel	D	20	12	Topside Pit	0.162	Repair by Welding (see note: 1)
48	Barrel	B	17	5	Thickness	0.232	Based on remaining thickness; No action is required
49A	Barrel	B	26	5	Weld Defect, Slag Inclusion		Repair by Welding (see note: 1)
49B	Barrel	B	26	5	Weld Defect, LOF		Repair by Welding (see note: 1)
50	Barrel	B	28	5	Weld Defect, LOF		Repair by Welding (see note: 1)
51	Barrel	B	26	6	Topside Pit	0.220	Based on remaining thickness; No action is required
52A & B	Barrel	B	22	6	Weld Defect, LOF		Repair by Welding (see note: 1)
53	Barrel	B	19	6	Topside Pit	0.220	Based on remaining thickness; No action is required
54	Barrel	B	2	6	Weld Defect, LOF		Repair by Welding (see note: 1)
55	Barrel	C	23	11	Thickness	0.228	Based on remaining thickness; No action is required
56	Barrel	C	6	8	Thickness	0 225	Based on remaining thickness; No action is required
57A & B	Barrel	C	6	8	Thickness	0.229/0.231	Based on remaining thickness; No action is required
58	Barrel	C	1	9	Thickness on Lap Patch	0 200	Based on remaining thickness; No action is required
59	Barrel	C	22	9	Thickness	0.186	Based on remaining thickness; No action is required
60	Upper Dome	C	1	41	Dent		Based on remaining thickness; No action is required
61A - C	Upper Dome	C	1	43	Dents 3 ea		Based on remaining thickness; No action is required
62	Upper Dome	C	1	38	Dent		Based on remaining thickness; No action is required
63A - C	Upper Dome	C	1	42	Dents 3 ea		Based on remaining thickness; No action is required
64	Upper Dome	C	1	44	Dent		Based on remaining thickness; No action is required
65	Upper Dome	C	1	52	Dent		Based on remaining thickness; No action is required
66A & B	Upper Dome	C	2	41	Dents		Based on remaining thickness; No action is required
67A & B	Upper Dome	B	3	14	Thickness	0.185/0.141	Existing patch plate @ .141",area of original liner plate at .185"; Remove existing patch plate and repair entire area by use of lap patch plate .250" thick, 16" x 16" with radius corners
68	Upper Dome	B	2	31	Dent		Based on remaining thickness; No action is required
69	Upper Dome	A	1	25	Dent		Based on remaining thickness; No action is required
70	Upper Dome	A	1	25	Dent		Based on remaining thickness; No action is required
71	Upper Dome	A	1	33	Dent		Based on remaining thickness; No action is required
72	Upper Dome	A	1	27	Topside Pit	0 210	Based on remaining thickness; No action is required
73	Upper Dome	A	1	32	Dent		Based on remaining thickness; No action is required
74	Upper Dome	B	2	22	Dent		Based on remaining thickness; No action is required
75	Upper Dome	B	2	3	Dent		Based on remaining thickness; No action is required
76	Upper Dome	B	2	1	Through Wall Pit	0.000	Through Wall Pit 3/16" dia.; Upper dome; Repair by use of lap welded patch, .250" hick x 6-inch circle
77	Upper Dome	A	1	4	Dent	0.165	Based on remaining thickness; No action is required
78							Removed, Duplicated Item; See Flaw 67
79	Upper Dome	C	3	6	Thickness	0 210	Based on remaining thickness; No action is required

Red Hill Fuel Facility
Tank No. 2

Flaw No.	Tank Section	Quad	Row/Course	Plate	Description of Flaw	R. Thickness	API-653 Repair Recommendation
80A & B	Upper Dome	A	1	48	Dent		Based on remaining thickness; No action is required
81	Upper Dome	C	3	81	Topside Pit	0.195	Based on remaining thickness; No action is required
82	**Lower Dome**	**A**	**0**	**Floor Plate 2**	**Topside Pitting**	**0.435**	**Engineering Evaluation by EEI Required, Due to Location**
83	**Lower Dome**	**B**	**0**	**Floor Plate 4**	**Topside Pitting**	**0.336**	**Engineering Evaluation by EEI Required, Due to Location**
84	Lower Dome	A	1	1	Topside Pit ing	0.181	Based on remaining thickness; No action is required
85	Lower Dome	A	1	2	Topside Pit ing	0.180	Based on remaining thickness; No action is required
86	Lower Dome	A	1	3	Topside Pit ing	0.189	Based on remaining thickness; No action is required
87	Lower Dome	A	1	4	Topside Pit ing	0.179	Based on remaining thickness; No action is required
88	Lower Dome	A	1	5	Topside Pit ing	0 216	Based on remaining thickness; No action is required
89	Lower Dome	A	1	6	Topside Pit ing	0 212	Based on remaining thickness; No action is required
90	Lower Dome	B	1	7	Topside Pit ing	0 206	Based on remaining thickness; No action is required
91	Lower Dome	B	1	8	Topside Pit ing	0 212	Based on remaining thickness; No action is required
92	Lower Dome	B	1	9	Topside Pit ing	0 209	Based on remaining thickness; No action is required
93	Lower Dome	B	1	10	Topside Pit ing	0 218	Based on remaining thickness; No action is required
94	Lower Dome	B	1	11	Topside Pit ing	0 211	Based on remaining thickness; No action is required
95	Lower Dome	C	1	12	Topside Pit ing	0 222	Based on remaining thickness; No action is required
96	Lower Dome	C	1	13	Topside Pit ing	0 226	Based on remaining thickness; No action is required
97	Lower Dome	C	1	14	Topside Pit ing	0 223	Based on remaining thickness; No action is required
98	Lower Dome	C	1	15	Topside Pit ing	0.198	Based on remaining thickness; No action is required
99	Lower Dome	C	1	16	Topside Pit ing	0.188	Based on remaining thickness; No action is required
100	Lower Dome	D	1	17	Topside Pit ing	0.190	Based on remaining thickness; No action is required
101	Lower Dome	D	1	18	Topside Pit ing	0.193	Based on remaining thickness; No action is required
102	Lower Dome	D	1	19	Topside Pit ing	0.185	Based on remaining thickness; No action is required
103	Lower Dome	D	1	20	Topside Pit ing	0.186	Based on remaining thickness; No action is required
104	Lower Dome	D	1	21	Topside Pit ing	0.180	Based on remaining thickness; No action is required
105 A - C	Lower Dome	A	Floor/Shell Jnct.	21/1	Welding Defects, LOF		Repair by Welding (see note: 1)
106 A & B	Lower Dome	A	Floor/Shell Jnct.	1/2	Welding Defects, LOF		Repair by Welding (see note: 1)
107A	Lower Dome	A	Floor/Shell Jnct.	2/3	Welding Defect, LOF		Repair by Welding (see note: 1)
107B	Lower Dome	A	Floor/Shell Jnct.	2/3	Welding Defect, Crack		Repair by Welding (see note: 1)
108A, C,D	Lower Dome	A	Floor/Shell Jnct.	3/4	Welding Defect, LOF		Repair by Welding (see note: 1)
108B	Lower Dome	A	Floor/Shell Jnct.	3/4	Welding Defect, Crack		Repair by Welding (see note: 1)
109A-E	Lower Dome	A	Floor/Shell Jnct.	4/5	Welding Defects, LOF		Repair by Welding (see note: 1)
110A-D	Lower Dome	A	Floor/Shell Jnct.	5/6	Welding Defects, LOF		Repair by Welding (see note: 1)
111A-D	Lower Dome	A/B	Floor/Shell Jnct.	6/7	Welding Defects, LOF		Repair by Welding (see note: 1)
112A-E	Lower Dome	B	Floor/Shell Jnct.	7/8	Welding Defects, Cracks		Repair by Welding (see note: 1)
113A-C	Lower Dome	B	Floor/Shell Jnct.	8/9	Welding Defects, LOF		Repair by Welding (see note: 1)
114A & B	Lower Dome	B	Floor/Shell Jnct.	9/10	Welding Defects, LOF		Repair by Welding (see note: 1)
115A & B	Lower Dome	B	Floor/Shell Jnct.	10/11	Welding Defects, LOF		Repair by Welding (see note: 1)
116A & B	Lower Dome	B/C	Floor/Shell Jnct.	11/12	Welding Defects, LOF		Repair by Welding (see note: 1)
117A & B	Lower Dome	C	Floor/Shell Jnct.	15/16	Welding Defects, LOF		Repair by Welding (see note: 1)
118A & B	Lower Dome	C/D	Floor/Shell Jnct.	16/17	Welding Defects, LOF		Repair by Welding (see note: 1)
119	Lower Dome	D	Floor/Shell Jnct.	17/18	Welding Defect, LOF		Repair by Welding (see note: 1)
120A	Lower Dome	D	Floor/Shell Jnct.	18/19	Welding Defect, LOF		Repair by Welding (see note: 1)
120B	Lower Dome	D	Floor/Shell Jnct.	18/19	Welding Defect, I P		Repair by Welding (see note: 1)
121A & B	Lower Dome	D	Floor/Shell Jnct.	19/20	Welding Defects, Cracks		Repair by Welding (see note: 1)
122	Lower Dome	D	Floor/Shell Jnct.	20/21	Welding Defects, LOF		Repair by Welding (see note: 1)
9/29/2008	Upper dome	F		12	Through Hole 1/2" Dia.		Repair by use of 6" circular lap welded patch

3

Note 1: All welding defects are to be removed after he location is deemed safe for Hot Work. Defects should be removed by grinding and verified by either the magnetic particle or liquid penetrant inspectin method for complete removal. Final weld pass should be examined by the liquid penetrant or magnetic particle test method with final weld acceptance by ultrasonic shear wave inspection method.

Attachment E

Pressure test data

P. O. Box 700217 • Kapolei, HI 96709-0217 • Tel: (808) 682-1667 • Fax: (808) 682-1834 • E-Mail: E I Hawaii@aol.com

Project No. N62472-03-C-1402
Pearl Harbor, Hawaii
Clean and Repair Red Hill Tanks 2 & 20

Cleaning Petroleum Tanks
Hydrostatic Test

Hydrostatic Test per ASME B31.3

Date: 3/27/08

Tank No. 2 Pipe Line: 135 FT SAMPLE TUBE

Portion of Line Tested: [illegible] SAMPLE TUBE

Pipe Material: Carbon Steel

Test Pressure: 150 psig

Test Time: 4 Hours

Test Results: Acceptable X Retest Required______

Procedure: Step (1) ensure all lines have been emptied, (2) Cap/Blind each line (3) Fill line with water (4) Bleed line of all excess air (5) Pressurize line to 150 psig (6) Inspect line/blinds/cap & joints for leakage (7) If leaks are present repair as necessary (8) If no leaks hold pressure for four hours (9) Record pressure and temperature readings every ten minutes on appropriate log.

Notes:

D&B Representative: [signature]

Shaw CQC: [signature]

Dunkin & Bush, Inc.

Project No. N62472-03-C-1402
Pearl Harbor, Hawaii
Clean and Repair Red Hill Tanks 2 & 20

Cleaning Petroleum Tanks
Hydrostatic Test

Test Log Per ASME B31.3

Tank No. 2 Pipe Line: 135' - SAMPLE TUBE

Date: 3/27/08

Start Time: 0825 Ambient Temperature: 76.8

Time	Pressure (psig)	Pipe Temp. (deg F)	Notes
Start of Test	153		
15 Minutes	154		
30 Minutes	154		
45 Minutes	155		77.4
60 Minutes	155		
75 Minutes	155		
90 Minutes	155		77.5
105 Minutes	155		
120 Minutes	155		
135 Minutes	156		77.4
150 Minutes	156		
165 Minutes	155		77.5
180 Minutes	154		77.4
195 Minutes	154		
210 Minutes	154		
225 Minutes	153.5		
240 Minutes	152.5		77.5

D&B Test Witnessed By: [signature]

Shaw/Govt. Test Witnessed By: [signature] / [signature]

Dunkin & Bush, Inc.

Project No. N62472-03-C-1402
Pearl Harbor, Hawaii
Clean and Repair Red Hill Tanks 2 & 20

Cleaning Petroleum Tanks
Hydrostatic Test

Hydrostatic Test per ASME B31.3

Date: 3/28/08

Tank No. 2 Pipe Line: 200' SAMPLES TUBE

Portion of Line Tested: BOTTOM SAMPLE

Pipe Material: Carbon Steel

Test Pressure: 150 psig

Test Time: 4 Hours

Test Results: Acceptable X Retest Required ______

Procedure: Step (1) ensure all lines have been emptied, (2) Cap/Blind each line (3) Fill line with water (4) Bleed line of all excess air (5) Pressurize line to 150 psig (6) Inspect line/blinds/cap & joints for leakage (7) If leaks are present repair as necessary (8) If no leaks hold pressure for four hours (9) Record pressure and temperature readings every ten minutes on appropriate log.

Notes:

D&B Representative: [signature]

Shaw CQC: [signature]

Dunkin & Bush, Inc.

Project No. N62472-03-C-1402
Pearl Harbor, Hawaii
Clean and Repair Red Hill Tanks 2 & 20

Cleaning Petroleum Tanks
Hydrostatic Test

Test Log Per ASME B31.3

Tank No. 2 **Pipe Line:** 200' Sample Tube

Date: 3/27/08

Start Time: 08 27 **Ambient Temperature:** 77

Time	Pressure (psig)	Pipe Temp. (deg F)	Notes
Start of Test	150		drip @ coupling
15 Minutes	150		
30 Minutes	150		
45 Minutes	150		AMB. 77.4
60 Minutes	150		
75 Minutes	148.5		
90 Minutes	148		AMB 77.5
105 Minutes	146		
120 Minutes	146		
135 Minutes	144		AMB 77.4
150 Minutes	143		
165 Minutes	141		77.5
180 Minutes	140		
195 Minutes	139		still dripping
210 Minutes	138		
225 Minutes	136.5		
240 Minutes	136		77.5

D&B Test Witnessed By: [illegible]

Shaw/Govt. Test Witnessed By: [illegible] / [illegible]

Dunkin & Bush, Inc.

Project No. N62472-03-C-1402
Pearl Harbor, Hawaii
Clean and Repair Red Hill Tanks 2 & 20

Cleaning Petroleum Tanks
Hydrostatic Test

Hydrostatic Test per ASME B31.3

Date: 3/27/08

Tank No. 2 Pipe Line: 16" PIPELINE

Portion of Line Tested: ENTIRE 16" P/L

Pipe Material: Carbon Steel

Test Pressure: 150 psig

Test Time: 4 Hours

Test Results: Acceptable X Retest Required

Procedure: Step (1) ensure all lines have been emptied, (2) Cap/Blind each line (3) Fill line with water (4) Bleed line of all excess air (5) Pressurize line to 150 psig (6) Inspect line/blinds/cap & joints for leakage (7) If leaks are present repair as necessary (8) If no leaks hold pressure for four hours (9) Record pressure and temperature readings every ten minutes on appropriate log.

Notes:

D&B Representative:

Shaw CQC:

Dunkin & Bush, Inc.

Project No. N62472-03-C-1402
Pearl Harbor, Hawaii
Clean and Repair Red Hill Tanks 2 & 20

Cleaning Petroleum Tanks
Hydrostatic Test

Test Log Per ASME B31.3

Tank No. 2 Pipe Line: 16" [illegible]

Date: 3/27/08

Start Time: 0835 Ambient Temperature: 77.2

Time	Pressure (psig)	Pipe Temp. (deg F)	Notes
Start of Test	150	79	
15 Minutes	150		
30 Minutes	150		
45 Minutes	150		AMB 77.4
60 Minutes	150		
75 Minutes	150		
90 Minutes	150		AMB 77.5
105 Minutes	150		
120 Minutes	150		
135 Minutes	150		AMB 77.4
150 Minutes	150		
165 Minutes	150		AMB 77.5
180 Minutes	150		
195 Minutes	150		AMB 77.4
210 Minutes	150		
225 Minutes	149+		
240 Minutes	150		77.5

D&B Test Witnessed By: [signature]

Shaw/Govt. Test Witnessed By: [signature] / [signature]

Dunkin & Bush, Inc.

Project No. N62472-03-C-1402
Pearl Harbor, Hawaii
Clean and Repair Red Hill Tanks 2 & 20

Cleaning Petroleum Tanks
Hydrostatic Test

Hydrostatic Test per ASME B31.3

Date: 3/27/08

Tank No. 2 Pipe Line: 20" 4HS

Portion of Line Tested: ENTIRE 20"

Pipe Material: Carbon Steel

Test Pressure: 150 psig

Test Time: 4 Hours

Test Results: Acceptable X Retest Required ______

__Procedure:__ Step (1) ensure all lines have been emptied, (2) Cap/Blind each line (3) Fill line with water (4) Bleed line of all excess air (5) Pressurize line to 150 psig (6) Inspect line/blinds/cap & joints for leakage (7) If leaks are present repair as necessary (8) If no leaks hold pressure for four hours (9) Record pressure and temperature readings every ten minutes on appropriate log.

Notes:

D&B Representative:

Shaw CQC:

Dunkin & Bush, Inc.

Project No. N62472-03-C-1402
Pearl Harbor, Hawaii
Clean and Repair Red Hill Tanks 2 & 20

Cleaning Petroleum Tanks
Hydrostatic Test

Test Log Per ASME B31.3

Tank No. 2 Pipe Line: 20" Lulo

Date: 3/27/08

Start Time: 0830 Ambient Temperature: 77.2

Time	Pressure (psig)	Pipe Temp. (deg F)	Notes
Start of Test	150	79	
15 Minutes	149½		
30 Minutes	149½		
45 Minutes	149½		AMB. 77.4
60 Minutes	149½		
75 Minutes	148		
90 Minutes	148		AMB 77.5
105 Minutes	148		
120 Minutes	148		
135 Minutes	148		AMB 77.4
150 Minutes	148		
165 Minutes	148		AMB 77.3
180 Minutes	148		AMB 77.4
195 Minutes	148		
210 Minutes	148		
225 Minutes	148		
240 Minutes	148		77.5

D&B Test Witnessed By: [signature]

Shaw/Govt. Test Witnessed By: [signature] / [signature]

Dunkin & Bush, Inc.

Project No. N62472-03-C-1402
Pearl Harbor, Hawaii
Clean and Repair Red Hill Tanks 2 & 20

Cleaning Petroleum Tanks
Hydrostatic Test

Hydrostatic Test per ASME B31.3

Date: 3/27/09

Tank No. 2 Pipe Line: SLOP LINE 6"

Portion of Line Tested: ENTIRE SLOP LINE

Pipe Material: Carbon Steel

Test Pressure: 150 psig

Test Time: 4 Hours

Test Results: Acceptable_______ Retest Required_______

Procedure: Step (1) ensure all lines have been emptied, (2) Cap/Blind each line (3) Fill line with water (4) Bleed line of all excess air (5) Pressurize line to 150 psig (6) Inspect line/blinds/cap & joints for leakage (7) If leaks are present repair as necessary (8) If no leaks hold pressure for four hours (9) Record pressure and temperature readings every ten minutes on appropriate log.

Notes:

Not acceptable - replace/repair

D&B Representative: [signature]

Shaw CQC: [signature]

Dunkin & Bush, Inc.

Project No. N62472-03-C-1402
Pearl Harbor, Hawaii
Clean and Repair Red Hill Tanks 2 & 20

Cleaning Petroleum Tanks
Hydrostatic Test

Test Log Per ASME B31.3

Tank No. 2 Pipe Line: 6" SLOP LINE

Date: 3/27/08

Start Time: 0830 Ambient Temperature: 77.2

STARTED @ 150 @ 8:15

Time	Pressure (psig)	Pipe Temp. (deg F)	Notes
Start of Test	146	79	
15 Minutes	141		
30 Minutes	139		
45 Minutes	135		AVG 77.4
60 Minutes	135.5		
75 Minutes	133.5		
90 Minutes	125		Avg 77.5
105 Minutes	122		
120 Minutes	120		
135 Minutes	118		Avg 77.4
150 Minutes	114		
165 Minutes	112		Avg 77.5
180 Minutes	111		Avg 77.4
195 Minutes	109		
210 Minutes	107		
225 Minutes	104.5		
240 Minutes	103.5		77.5

D&B Test Witnessed By: [signature]

Shaw/Govt. Test Witnessed By: [signature] / [signature]

Dunkin & Bush, Inc.

Project No. N62472-03-C-1402
Pearl Harbor, Hawaii
Clean and Repair Red Hill Tanks 2 & 20

Cleaning Petroleum Tanks
Hydrostatic Test

Hydrostatic Test per ASME B31.3

Date: 3/27/08

Tank No. 2 Pipe Line: 10' SAMPLING TUBES

Portion of Line Tested: EXISTING SAMPLING TUBES

Pipe Material: Carbon Steel

Test Pressure: 150 psig

Test Time: 4 Hours

Test Results: Acceptable X Retest Required______

Procedure: Step (1) ensure all lines have been emptied, (2) Cap/Blind each line (3) Fill line with water (4) Bleed line of all excess air (5) Pressurize line to 150 psig (6) Inspect line/blinds/cap & joints for leakage (7) If leaks are present repair as necessary (8) If no leaks hold pressure for four hours (9) Record pressure and temperature readings every ten minutes on appropriate log.

Notes:

D&B Representative: [signature]

Shaw CQC: [signature]

Dunkin & Bush, Inc.

Project No. N62472-03-C-1402
Pearl Harbor, Hawaii
Clean and Repair Red Hill Tanks 2 & 20

Cleaning Petroleum Tanks
Hydrostatic Test

Test Log Per ASME B31.3

Tank No. 2 Pipe Line: 10' SAMPLE 1040

Date: 3/27/08

Start Time: 820 Ambient Temperature: 76.8

Time	Pressure (psig)	Pipe Temp. (deg F)	Notes
Start of Test	150 / 0820	79	
15 Minutes	150		
30 Minutes	150		
45 Minutes	150		Amb. 77.4
60 Minutes	150		
75 Minutes	150		
90 Minutes	148		Amb 77.5 slight drop
105 Minutes	148		
120 Minutes	148		
135 Minutes	148		Amb 77.4
150 Minutes	148		
165 Minutes	148		77.5
180 Minutes	148		77.4
195 Minutes	147.5		
210 Minutes	147		
225 Minutes	147		
240 Minutes	146.5		77.5

D&B Test Witnessed By: [signature]

Shaw/Govt. Test Witnessed By: [signature] / [signature]

Dunkin & Bush, Inc.

Project No. N62472-03-C-1402
Pearl Harbor, Hawaii
Clean and Repair Red Hill Tanks 2 & 20

Cleaning Petroleum Tanks
Hydrostatic Test

Hydrostatic Test per ASME B31.3

Date: 3/27/08

Tank No. 2 Pipe Line: 70' SAMPLE TUBE

Portion of Line Tested: ENTIRE

Pipe Material: Carbon Steel

Test Pressure: 150 psig

Test Time: 4 Hours

Test Results: Acceptable X Retest Required______

Procedure: Step (1) ensure all lines have been emptied, (2) Cap/Blind each line (3) Fill line with water (4) Bleed line of all excess air (5) Pressurize line to 150 psig (6) Inspect line/blinds/cap & joints for leakage (7) If leaks are present repair as necessary (8) If no leaks hold pressure for four hours (9) Record pressure and temperature readings every ten minutes on appropriate log.

Notes:

D&B Representative: [signature]

Shaw CQC: [signature]

Dunkin & Bush, Inc.

BARRY

FINAL VERSION FOR RED HILL

I AM GOING TO BE WORKING

ON PRELIM FOR B-1

HOPE TO HAVE IT DONE

THIS AFTERNOON

KEN