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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

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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

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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

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	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.

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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

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Attachment A

Report: Hawaii Engineering Group, Inc.

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ENGINEERING & INSPECTIONS HAWAII, INC.

Attachment B

T-min Calculations
Provided by; Enterprise Engineering Inc.

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Attachment C

Report: TesTex Data and Mapping

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Attachment D

Spread sheet of data findings and repair recommendations

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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)

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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

Consulting Civil Engineers, Structural Engineers & Land Surveyors
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Photo #1: *Visible slippage of the bolt connection*

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

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

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

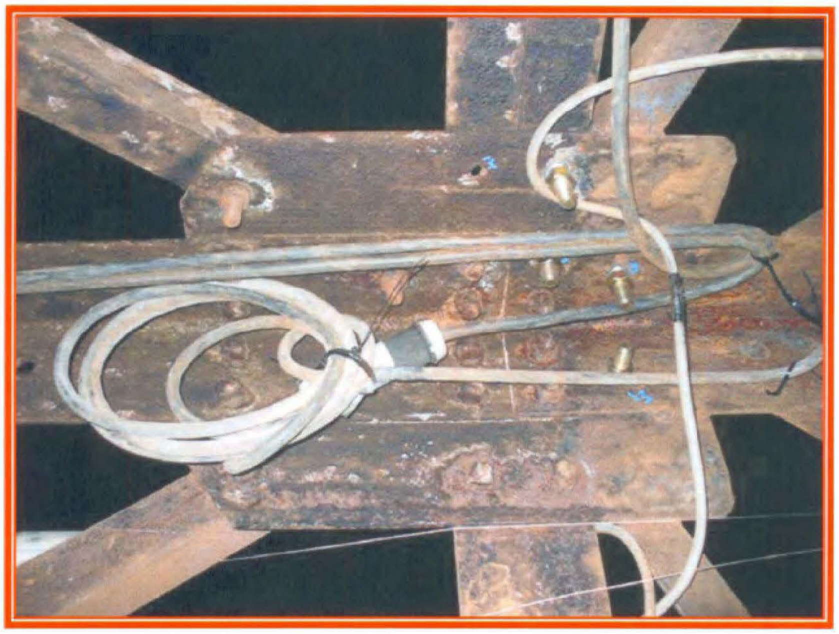

Photo #5: *Missing bolts*

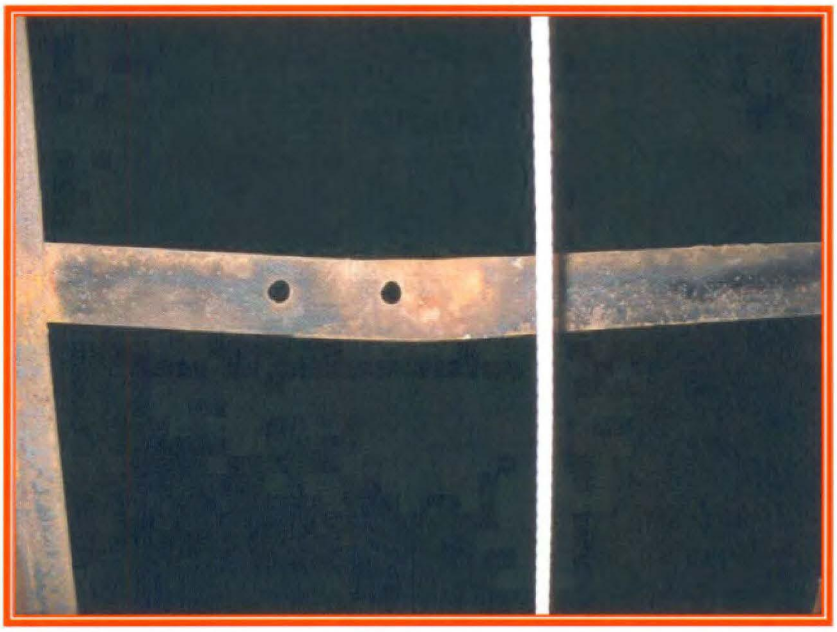

Photo #6: *Bent framing member*

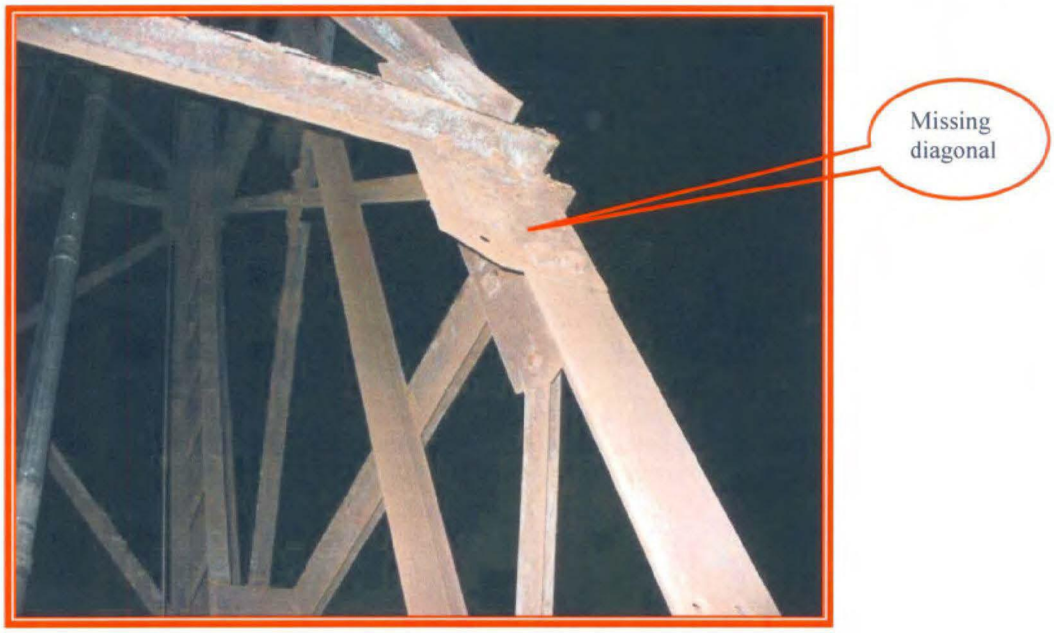

Photo #7: *Missing diagonal.*

Photo #8: *Missing diagonal*

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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*

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Email: heg@hawaiiengineering.net

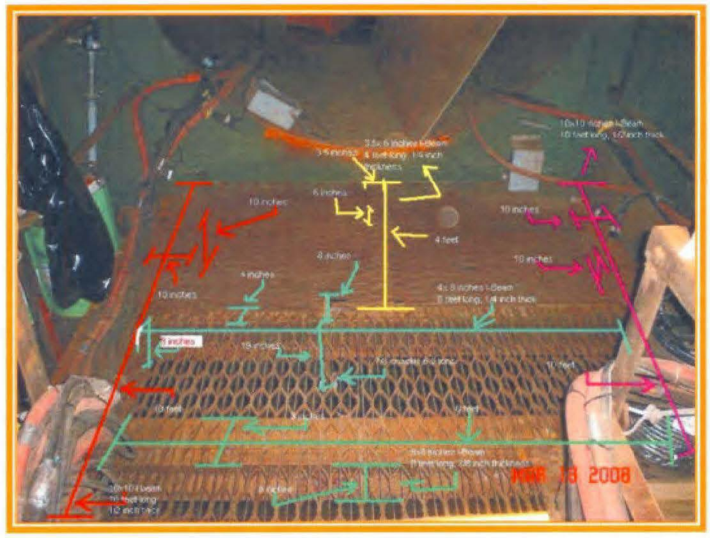

Photo #2: *Cat walk framing members and connections in good condition*

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

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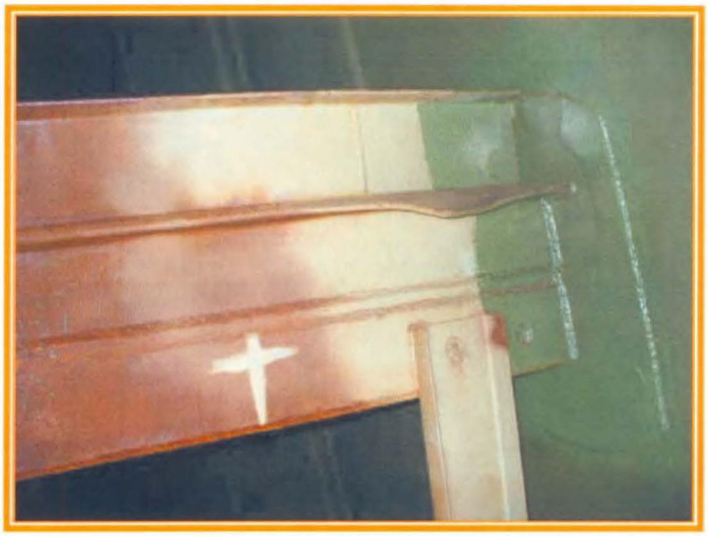

Photo #4: *Weld of the major I-beam is in good condition*

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*

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

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ENGINEERING & INSPECTIONS HAWAII, INC.

Attachment B

T-min Calculations
Provided by; Enterprise Engineering Inc.

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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.
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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

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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

ENGINEERING & INSPECTIONS HAWAII, INC.

Attachment C

Report: TesTex Data and Mapping

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TesTex

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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

[signature]

Sr. Field Engineer

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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

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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

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

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

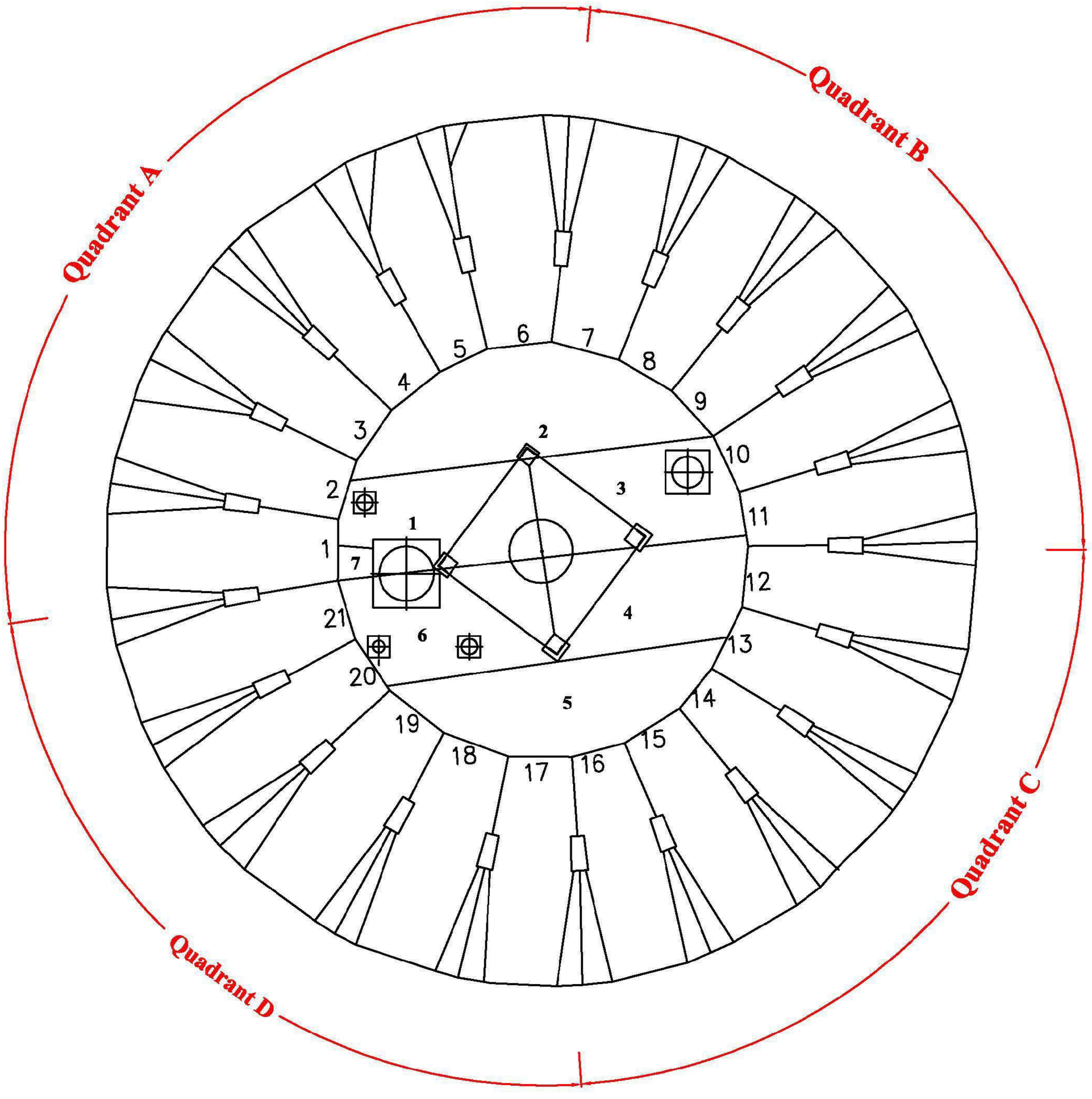
Test Equipment:

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)

TANK # 2 - LOWER DOME - COURSE 1

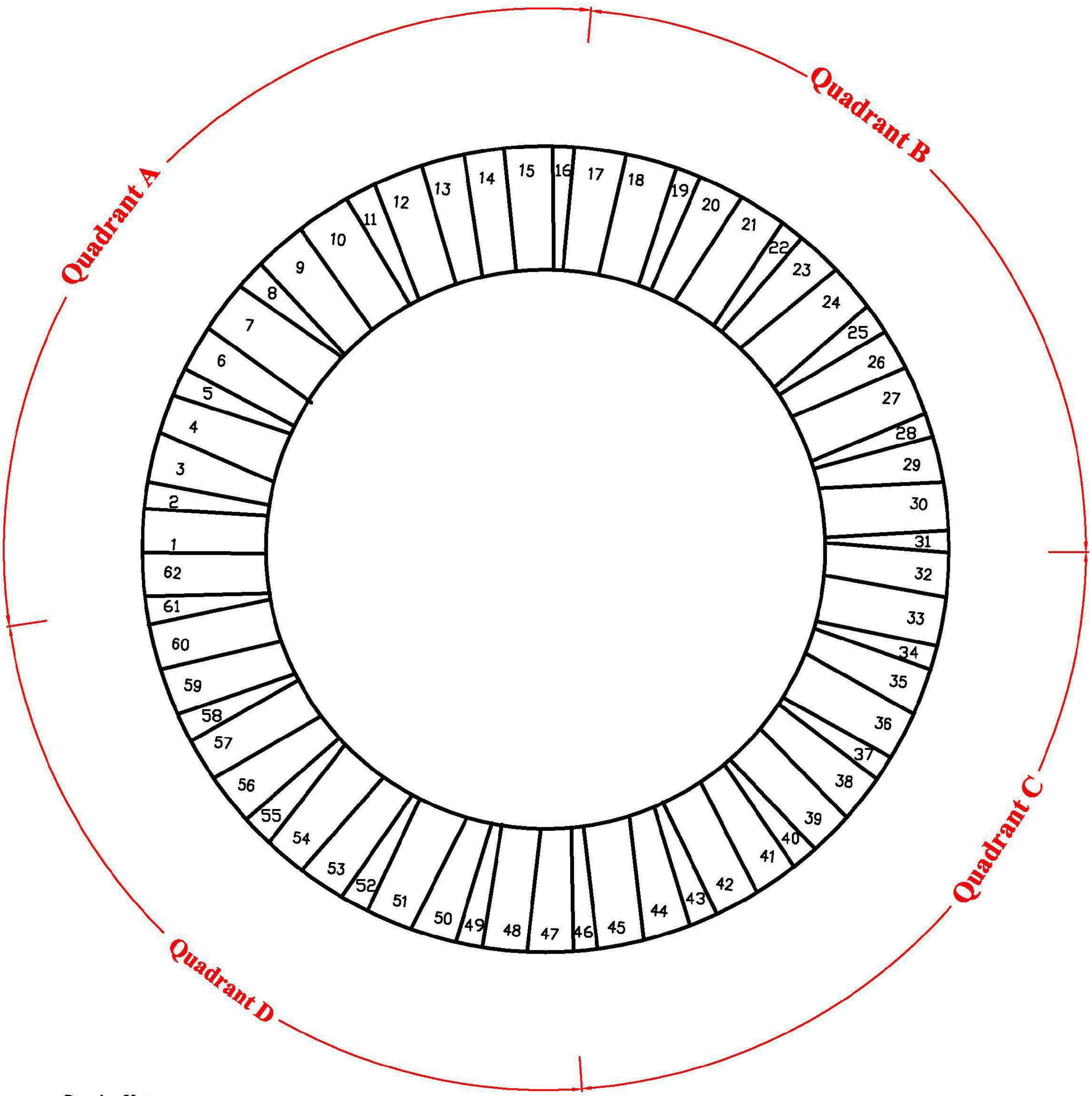


Drawing Notes:

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

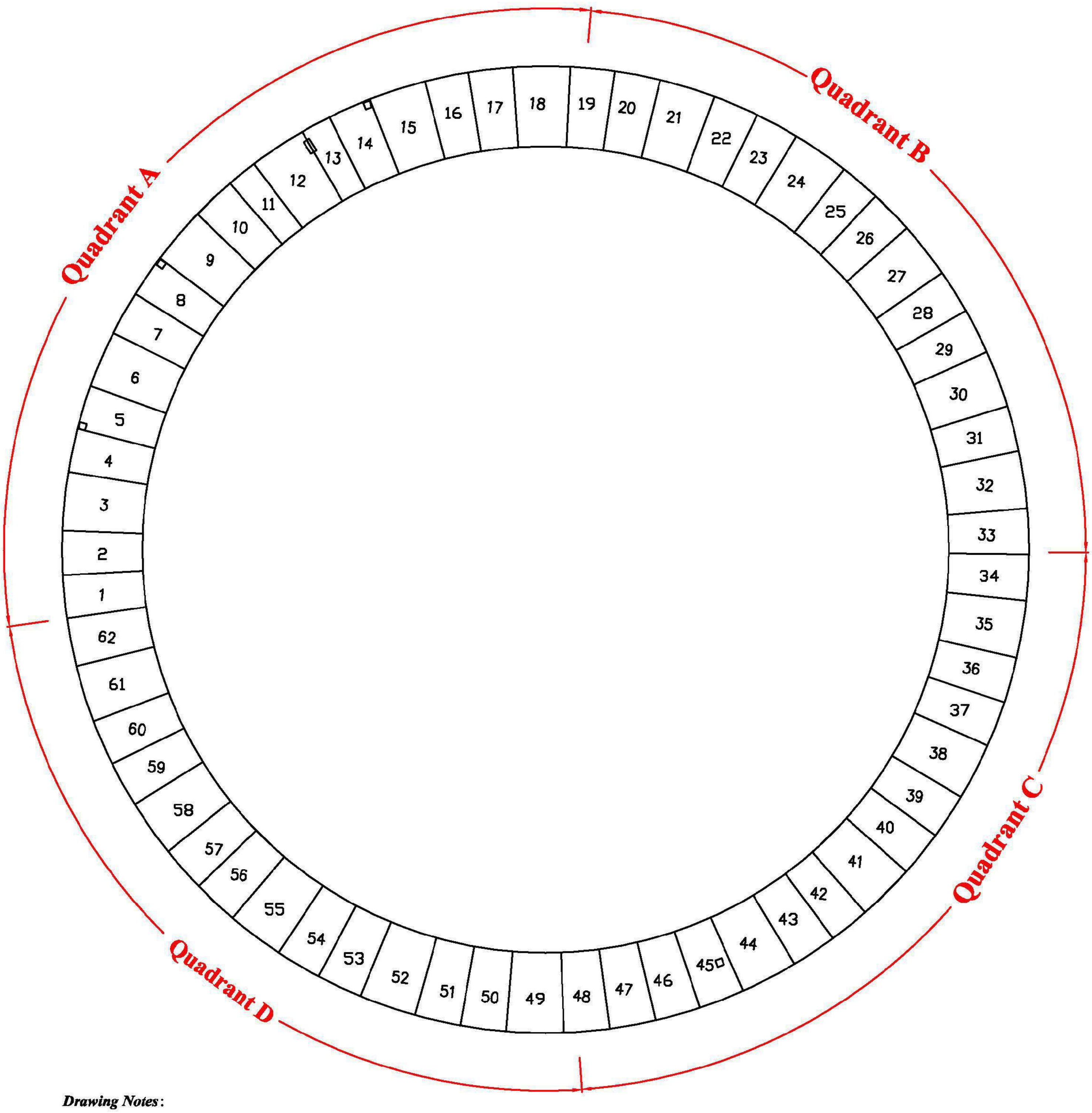


***Drawing Notes*:**

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



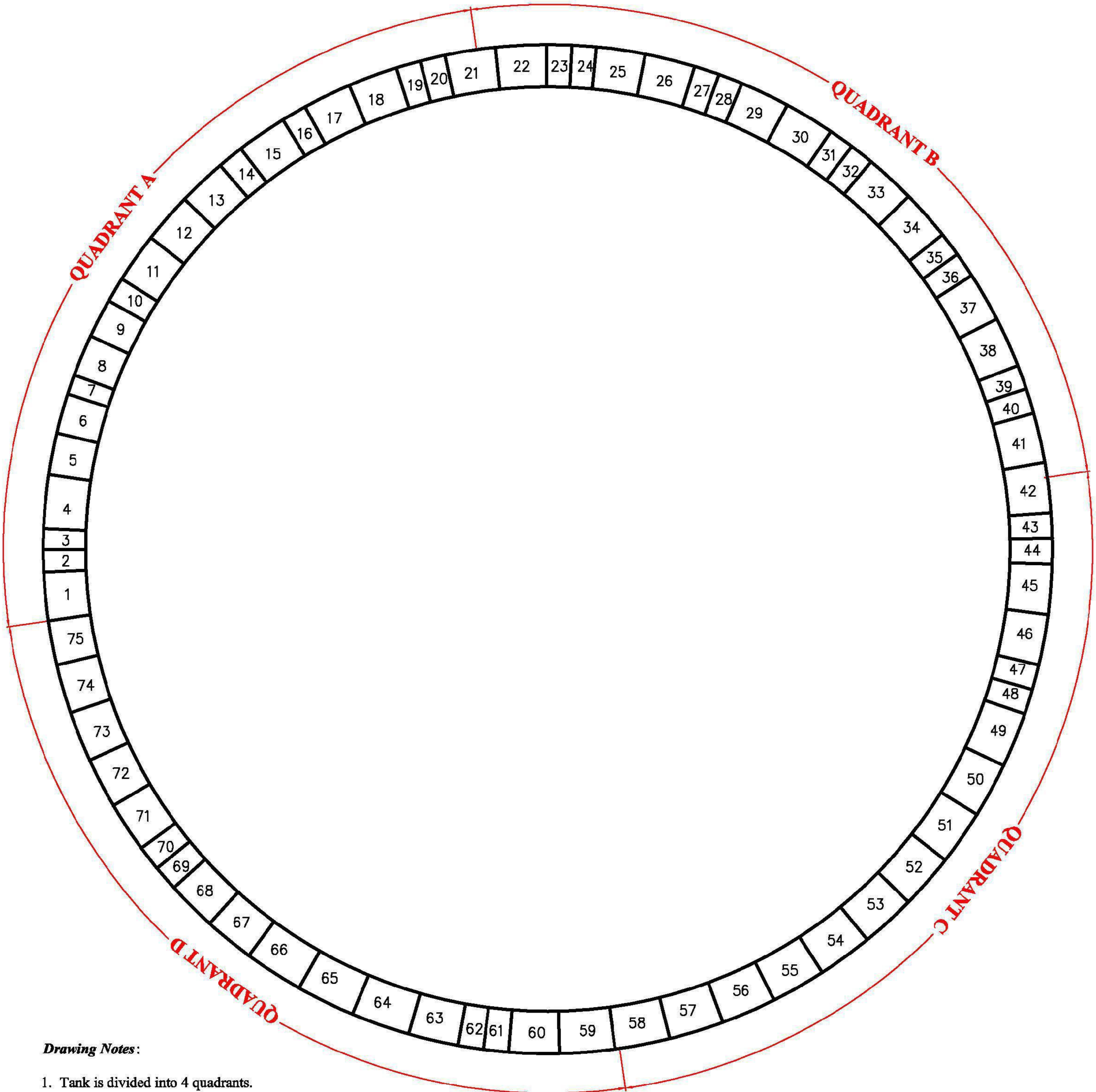
Drawing Notes:

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

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

TANK # 2 - LOWER DOME - COURSE 4

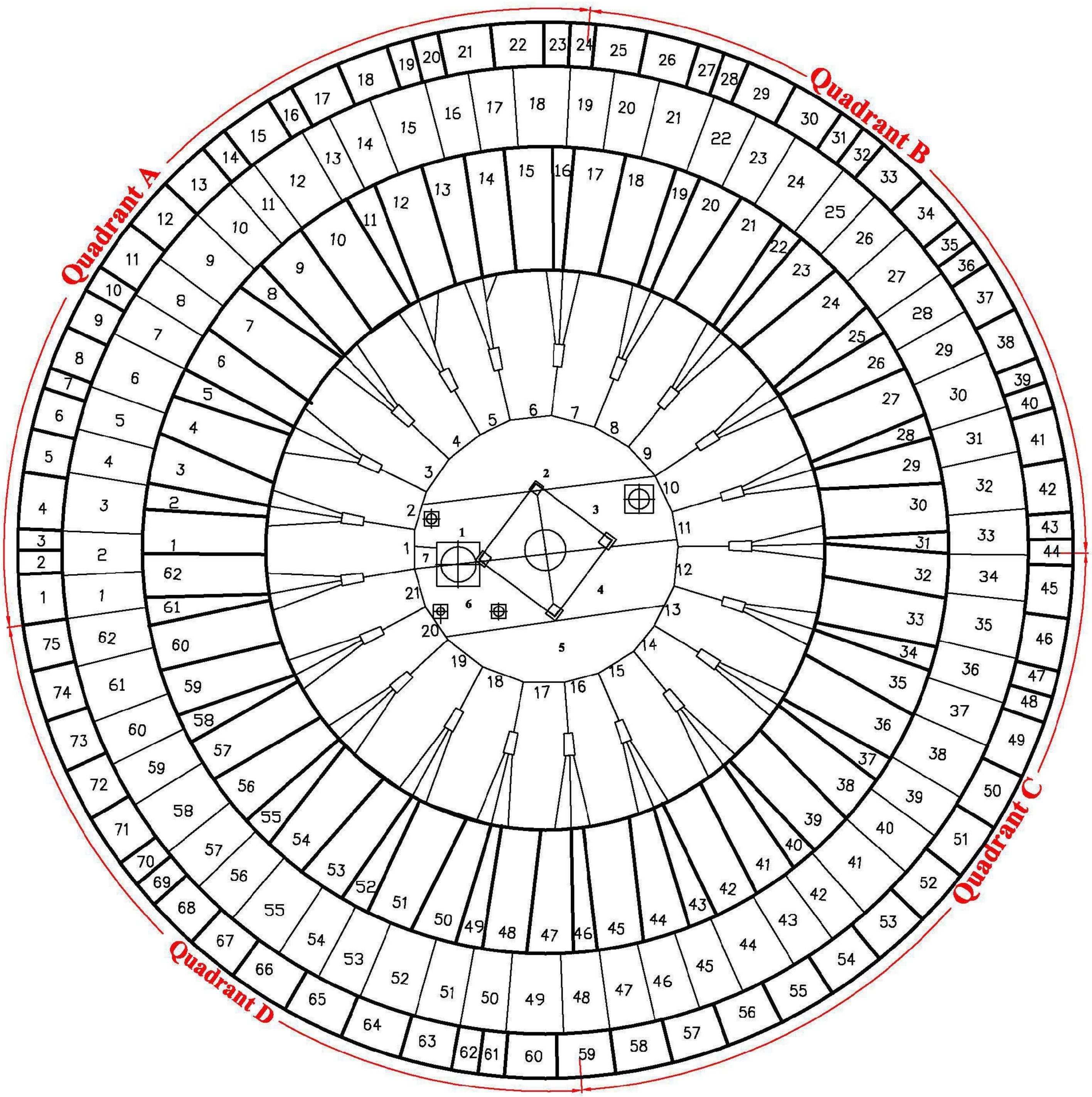


***Drawing Notes*:**

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



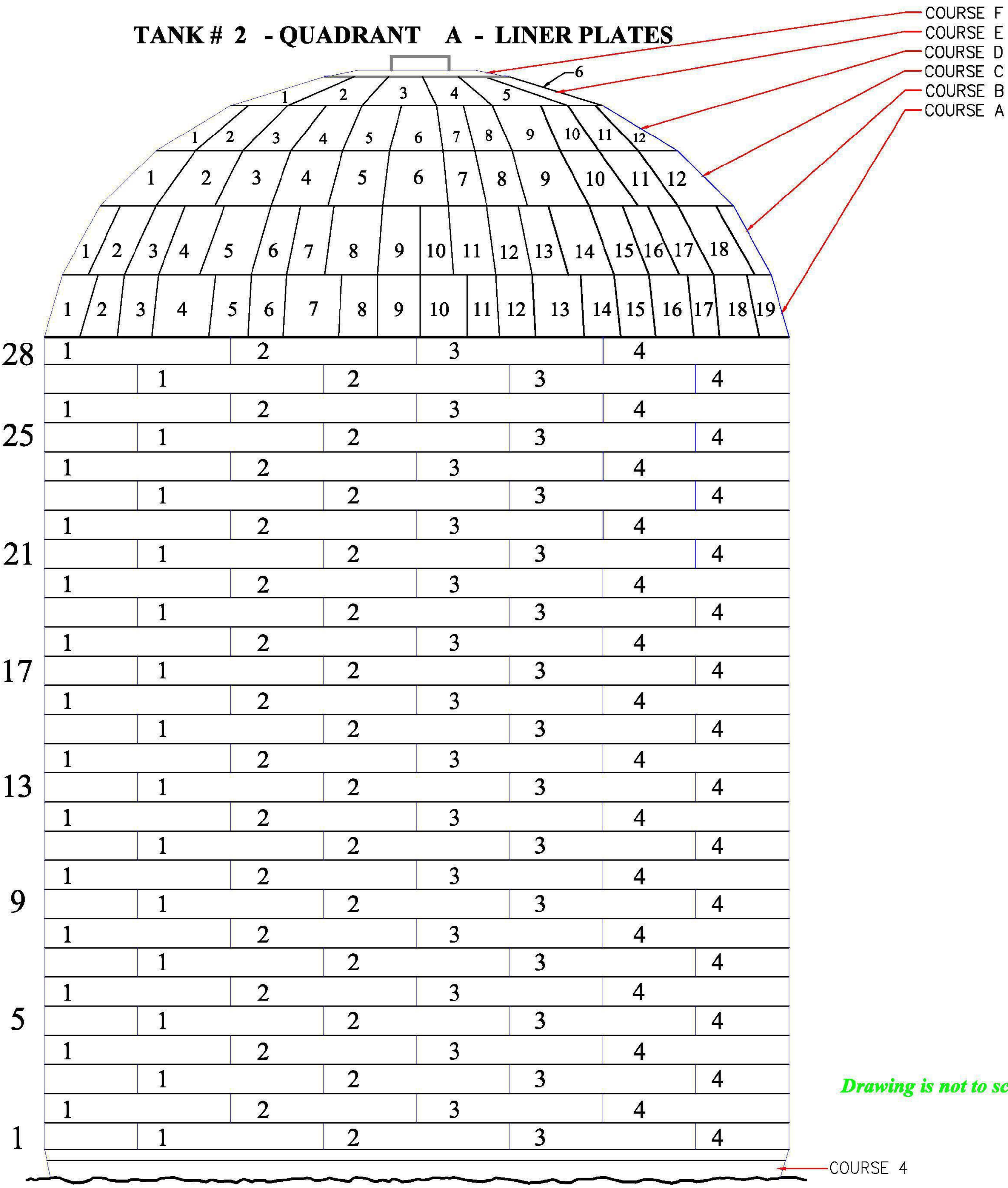
Drawing Notes:

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

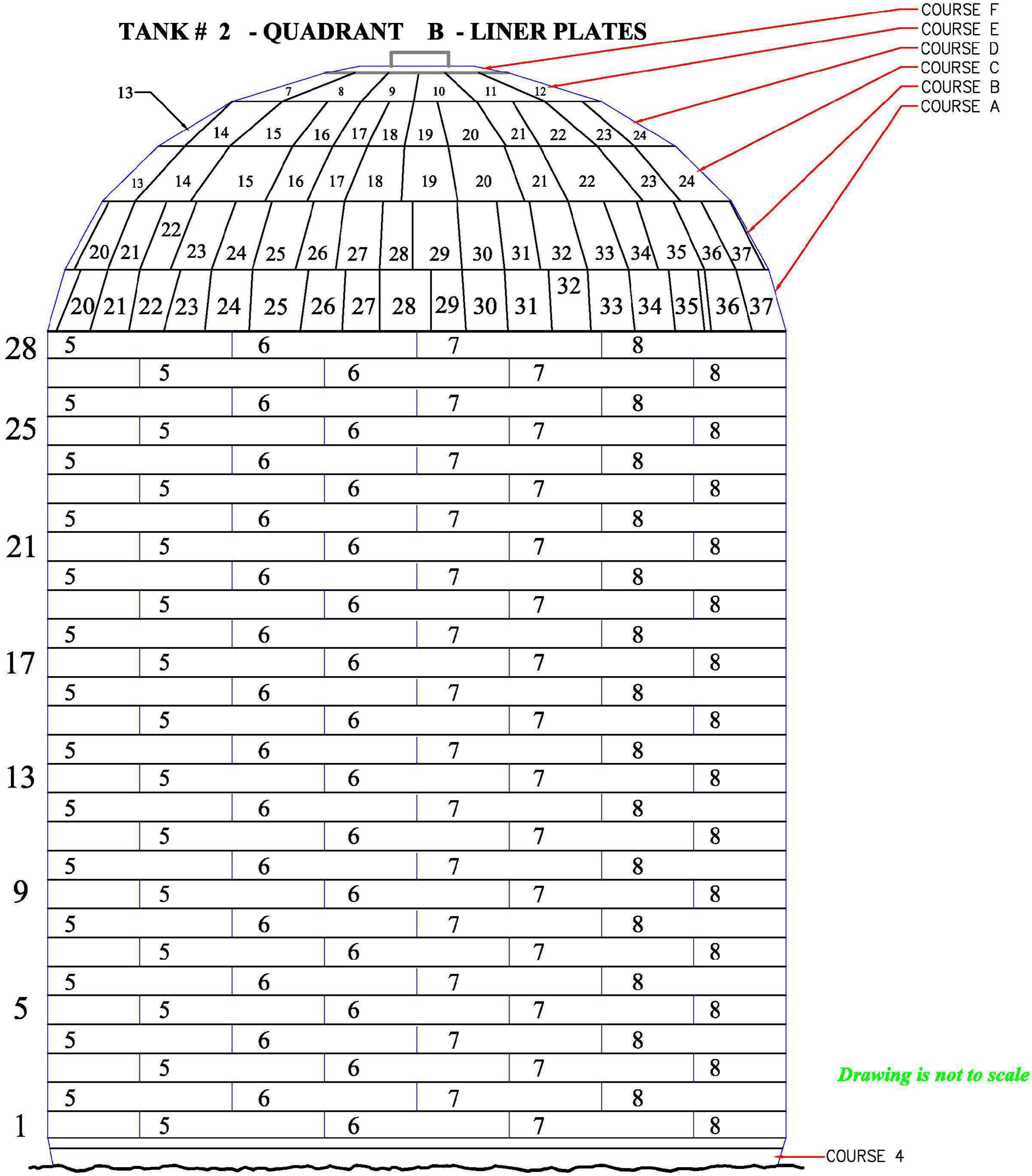
Dunkin & Bush, Inc.
Honolulu, HI

TANK # 2 - QUADRANT A - LINER PLATES

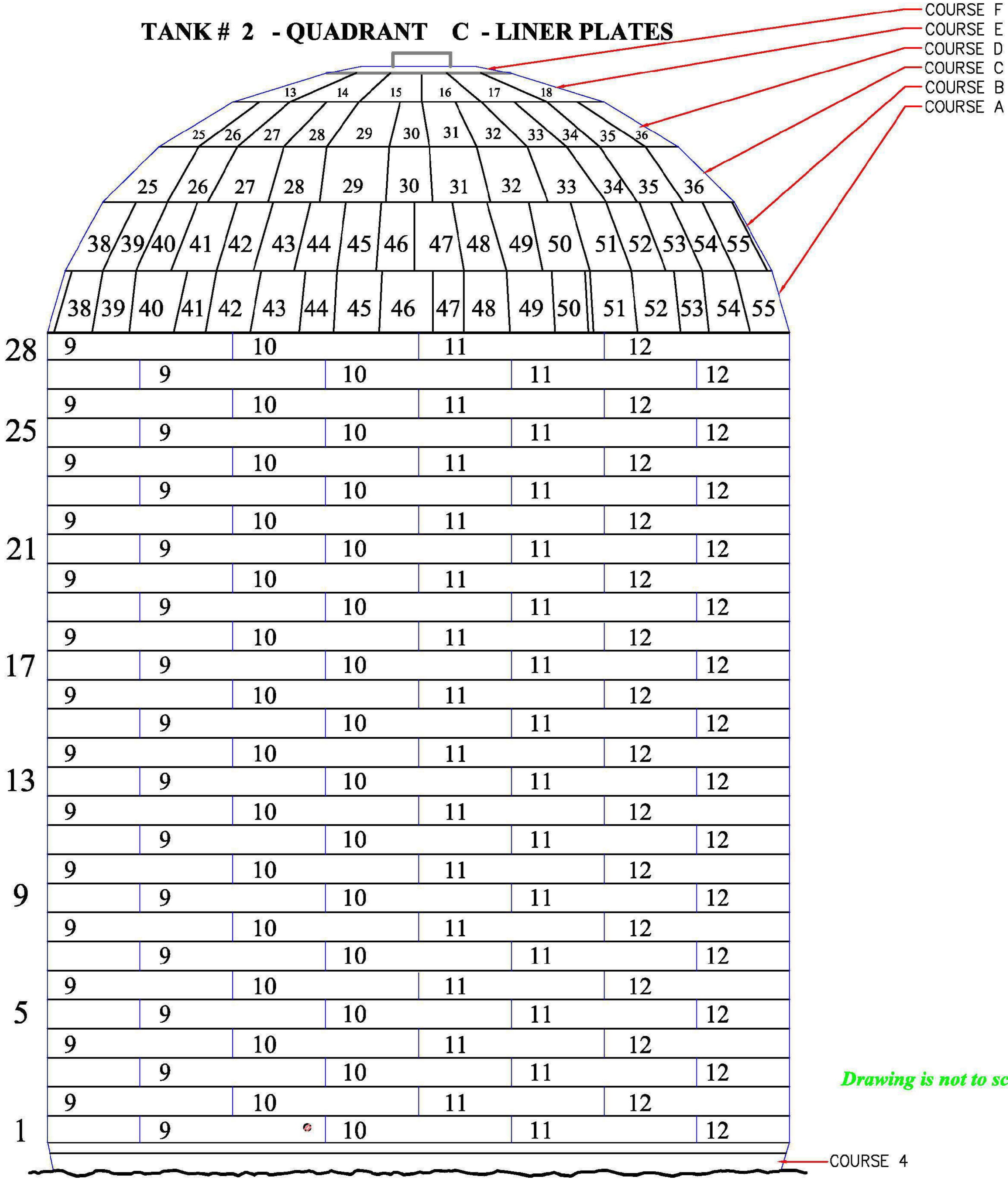


Drawing is not to scale

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



TANK # 2 - QUADRANT C - LINER PLATES

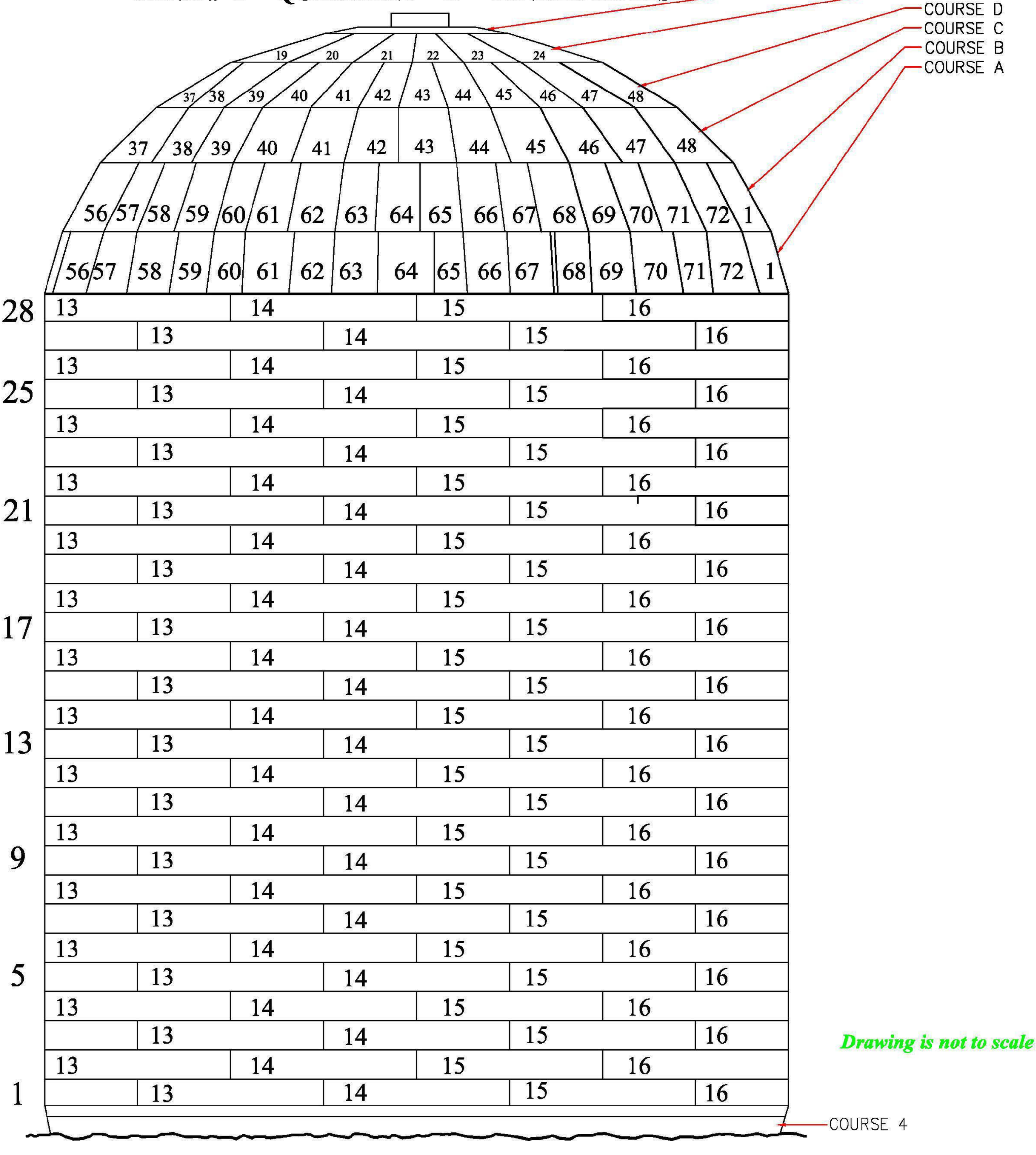


Drawing is not to scale

3.0TANK MAPS

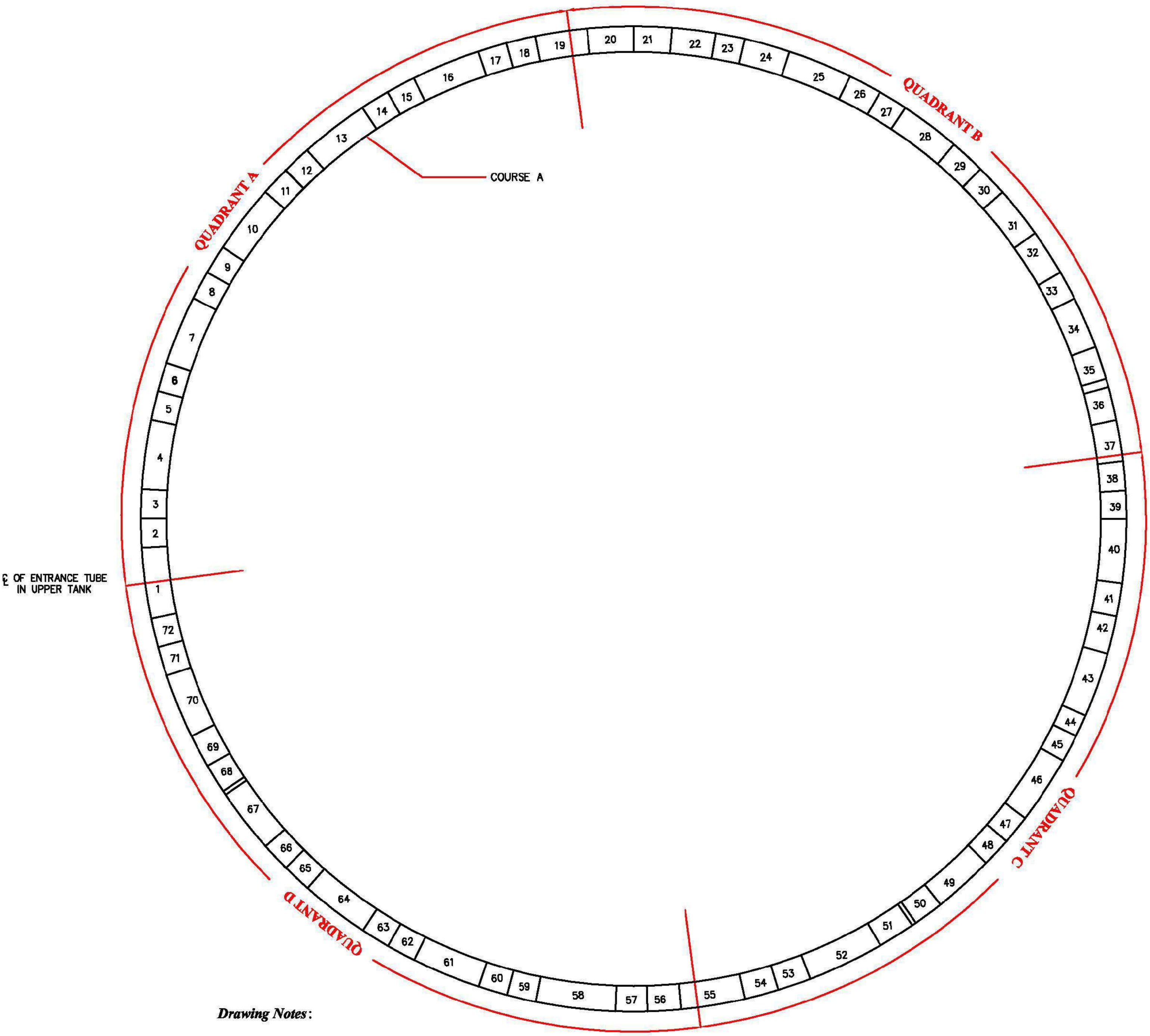
Dunkin & Bush, Inc.
Honolulu, HI

TANK # 2 - QUADRANT D - LINER PLATES



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

TANK # 2 - UPPER DOME COURSE A



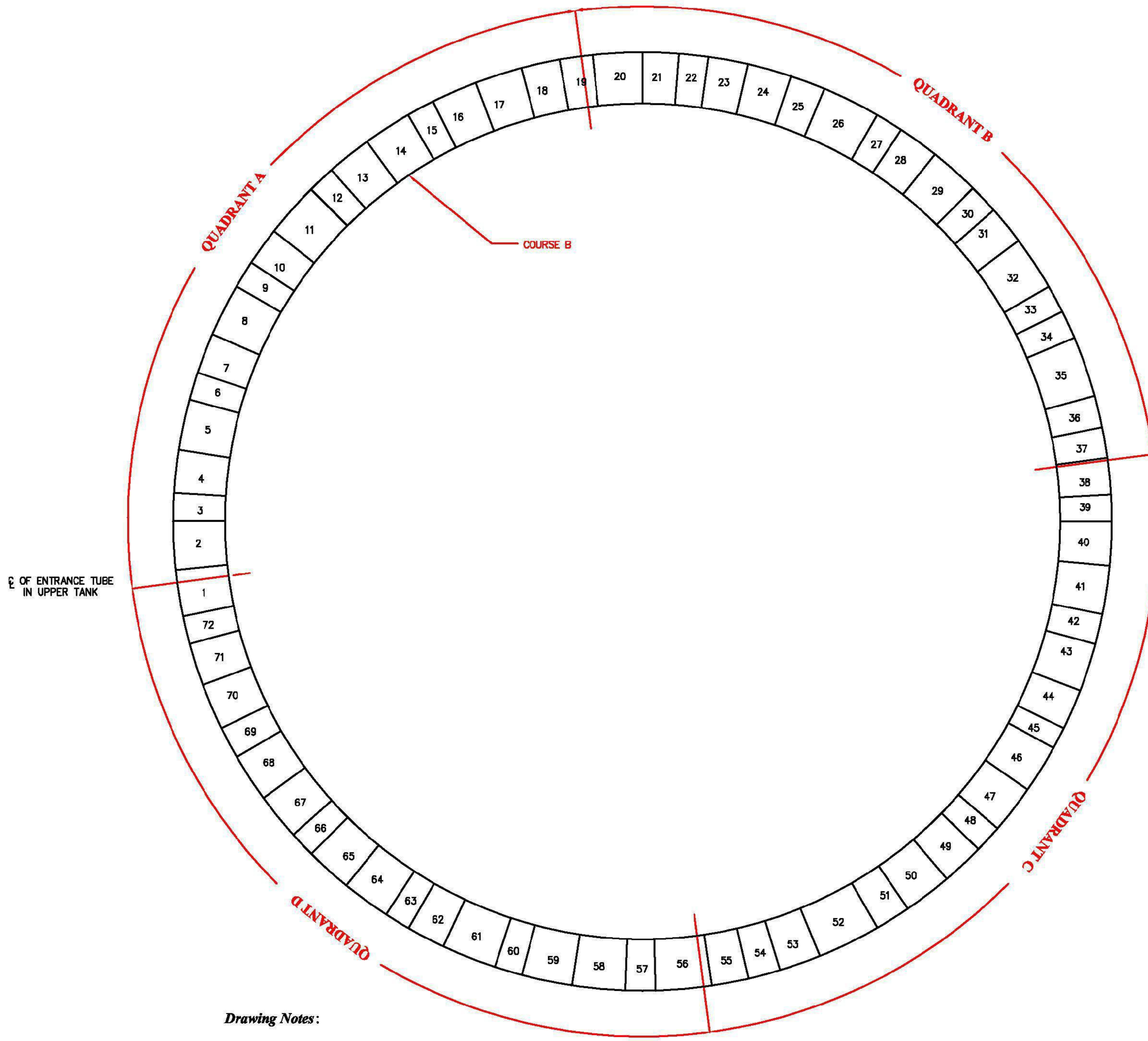
***Drawing Notes*:**

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



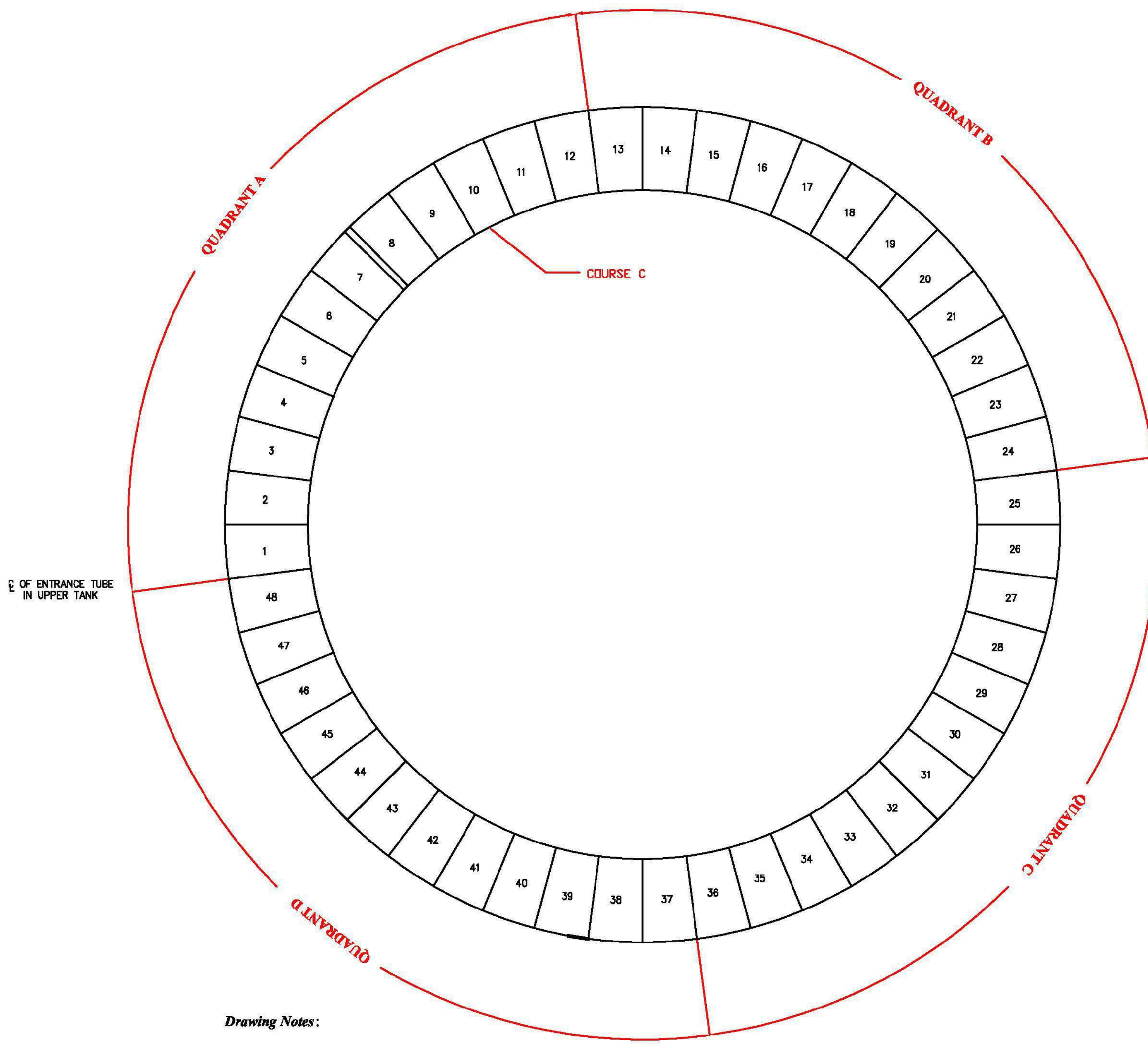
***Drawing Notes*:**

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



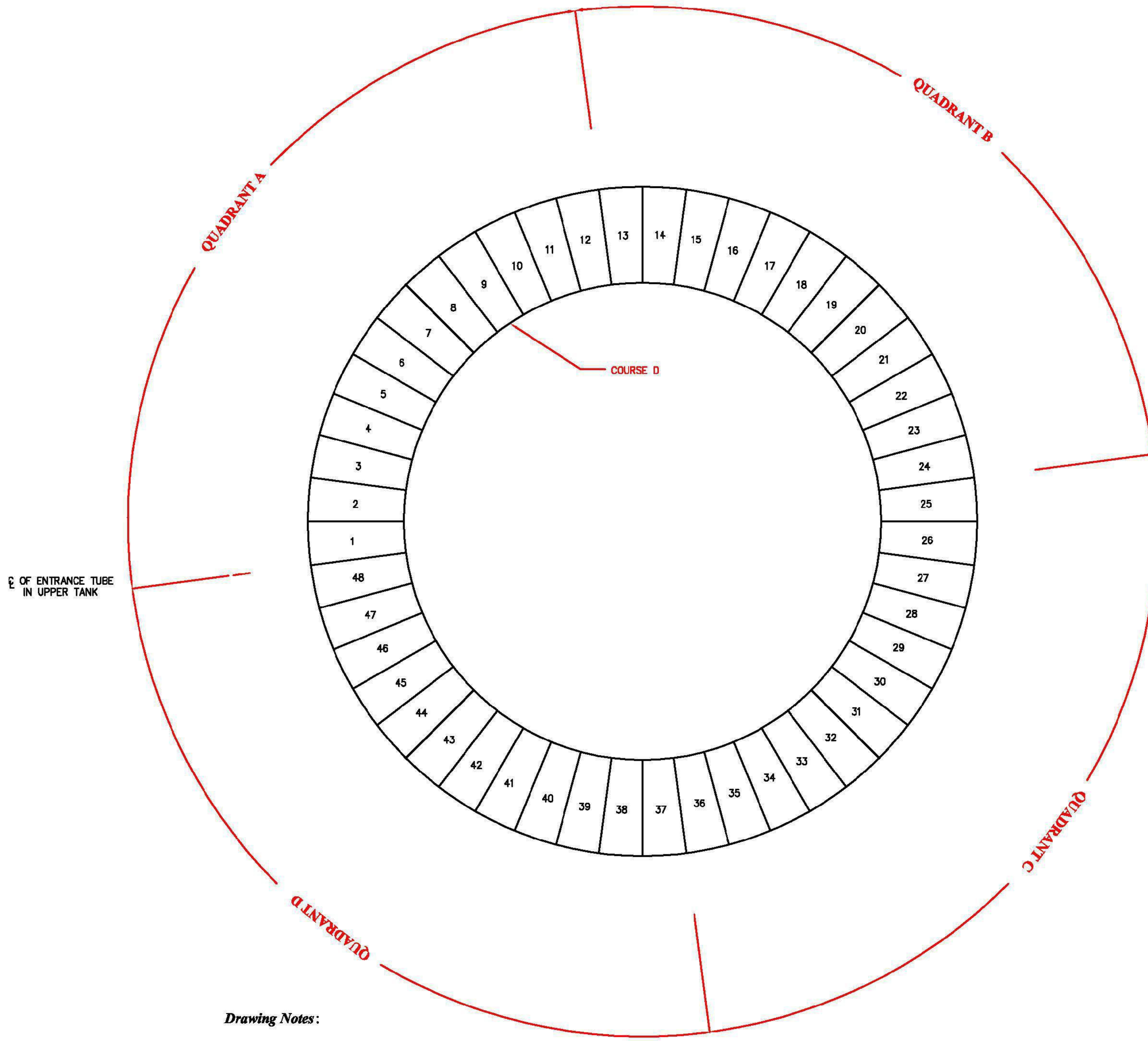
***Drawing Notes*:**

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



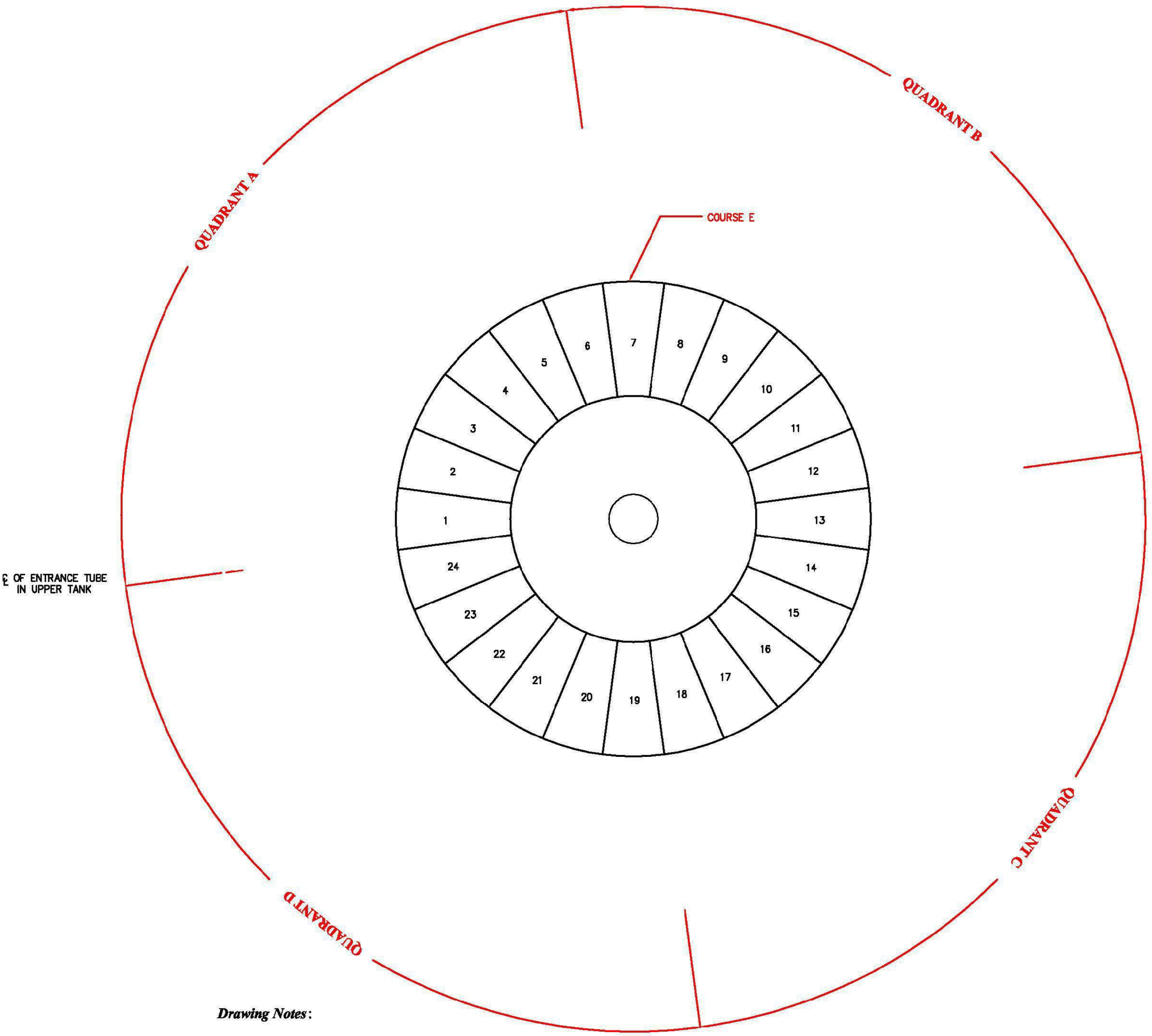
***Drawing Notes*:**

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



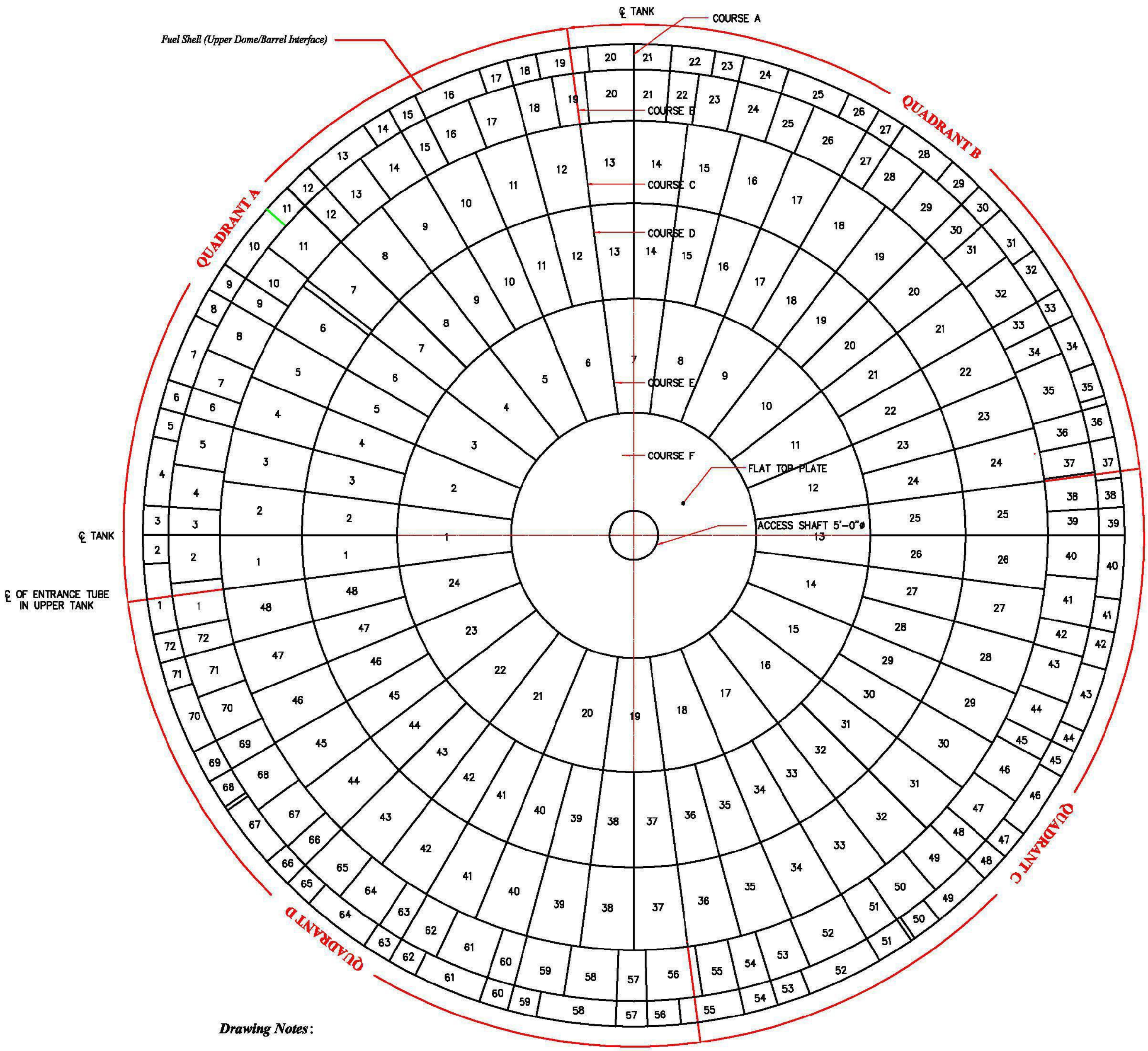
***Drawing Notes*:**

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*:**

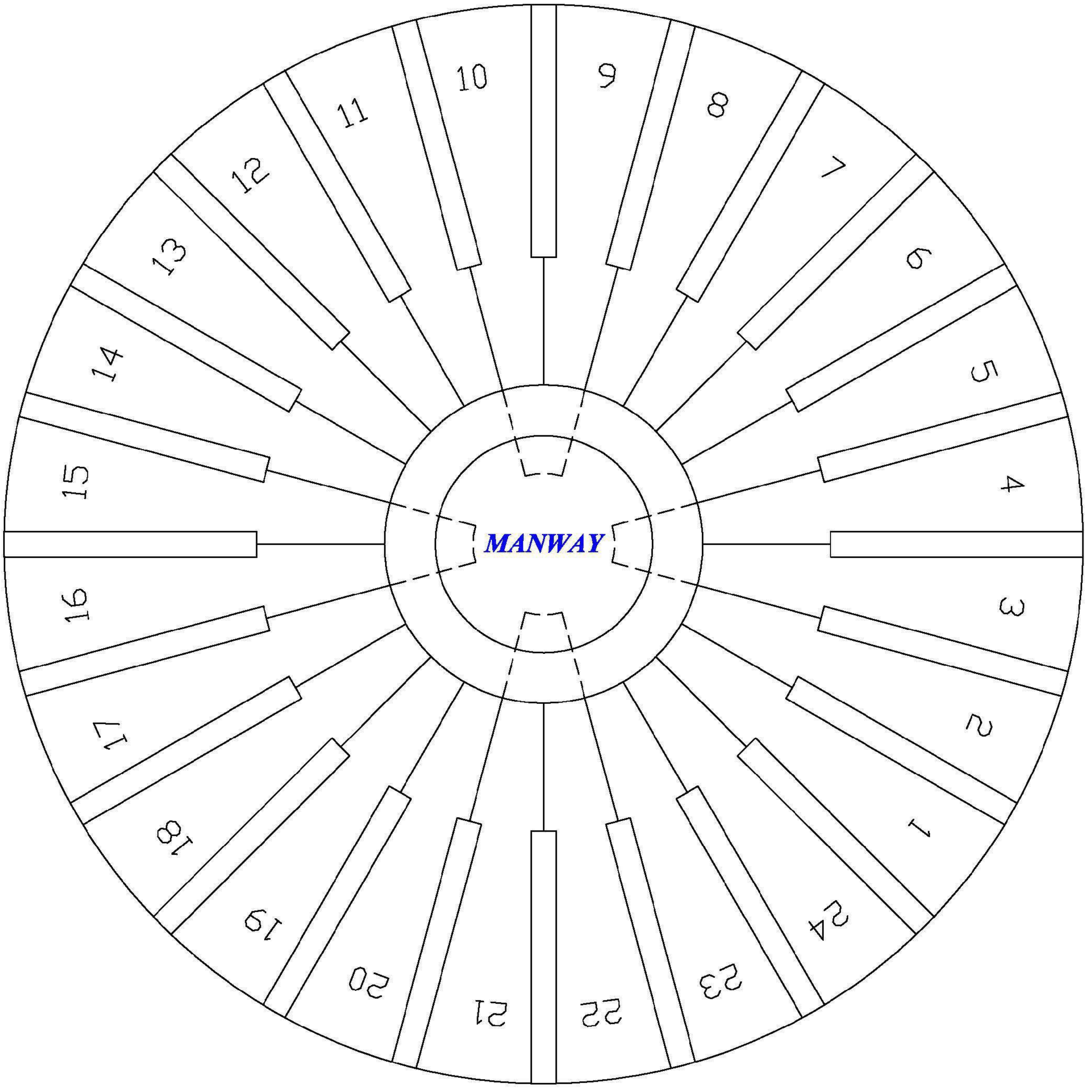
1. Tank is divided into 4 quadrants (A-D).
2. Course A is comprised of 72 total plates.
3. Course B is comprised of 72 total plates.
4. Course C is comprised of 48 total plates.
5. Course D is comprised of 48 total plates.
6. Course E is comprised of 24 total plates.
7. This numbering convention begins 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

Date Inspected/Confirmed: 5/6/2008

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

TANK #2 - Upper Dome Course F



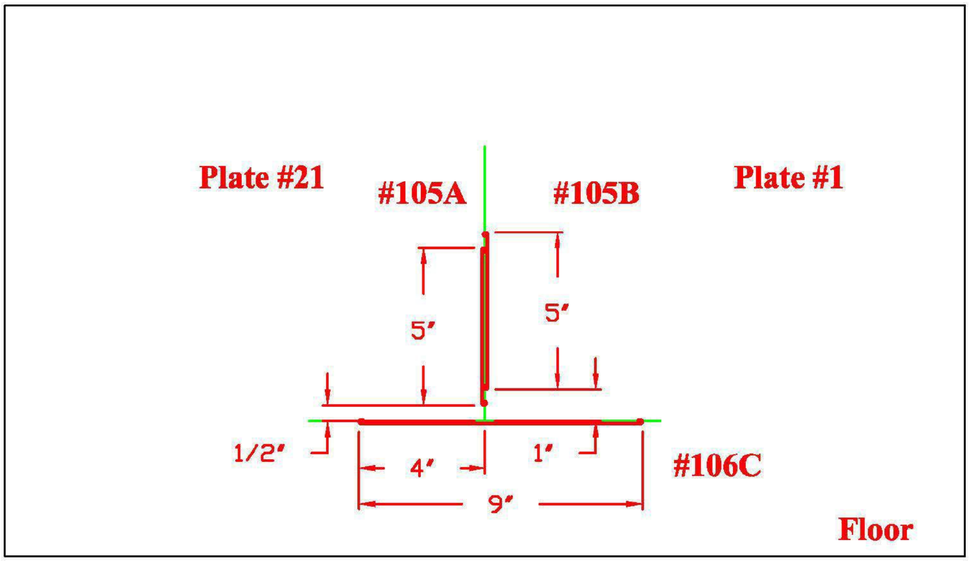
Drawing is not to scale

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

Date Inspected/Confirmed: 05/08/2008

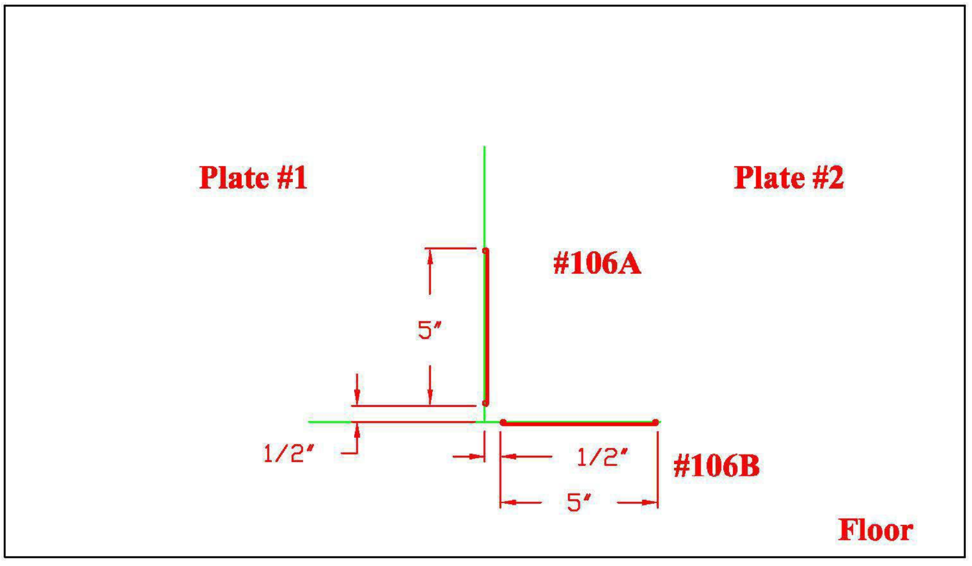
Tank Section: Floor/Shell
Quadrant: A
Course:
Plate: # 21 - 1

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

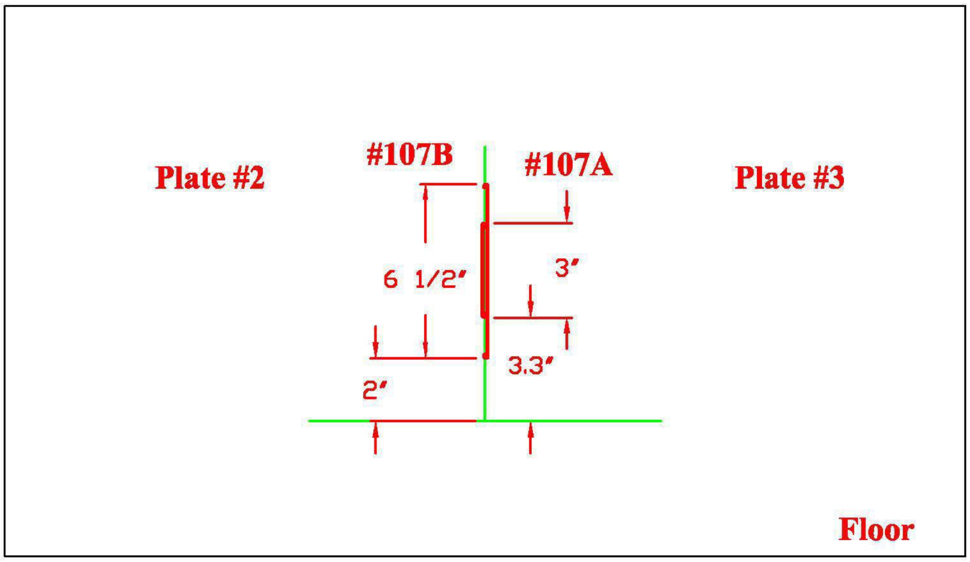
TANK #2 - QUADRANT A
Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/08/2008

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

Flaw #107A - Lack of fusion
.201 depth 6 $\frac{1}{2}$" long (right)

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



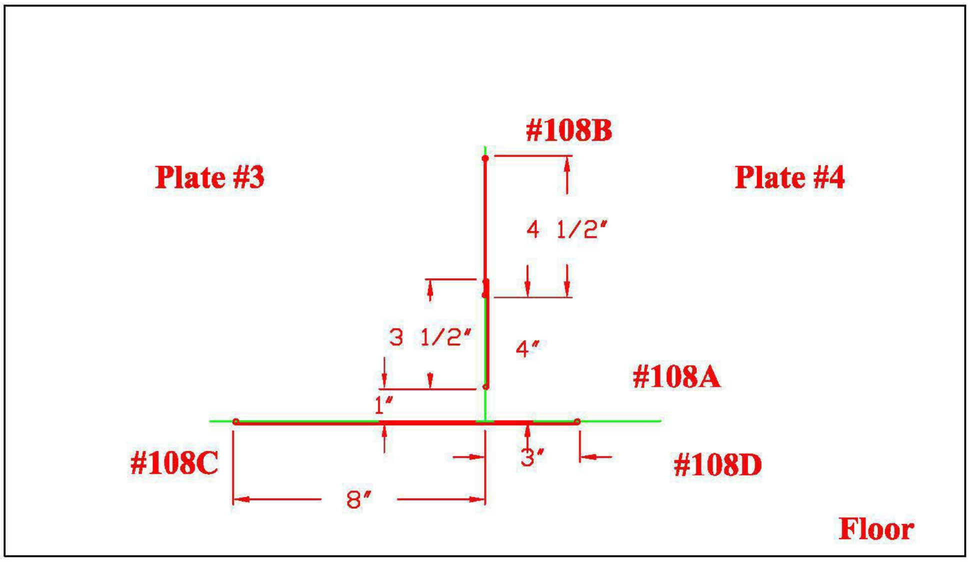
Tank Section: Floor/Shell
Quadrant: A
Course:
Plate: # 3 - 4

Flaw #108A - Lack of fusion
.206 depth 3 $\frac{1}{2}$" long (right)

Flaw #108B - Lack of fusion
.200 depth 4 $\frac{1}{2}$" 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

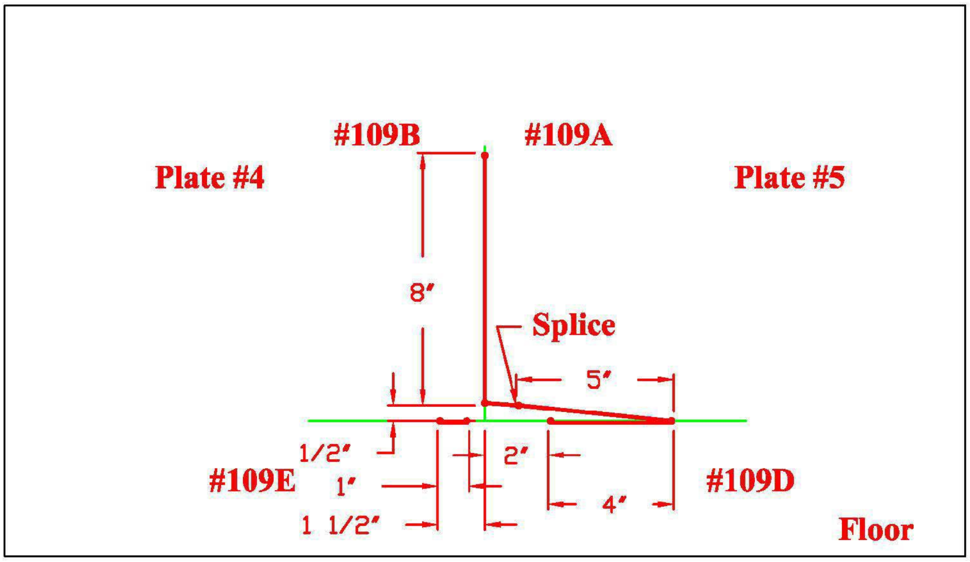
3.0 TANK MAPS
Dunkin & Bush, Inc.
Honolulu, HI
Tank #2 - Quadrant A

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

Date Inspected/Confirmed: 05/09/2008

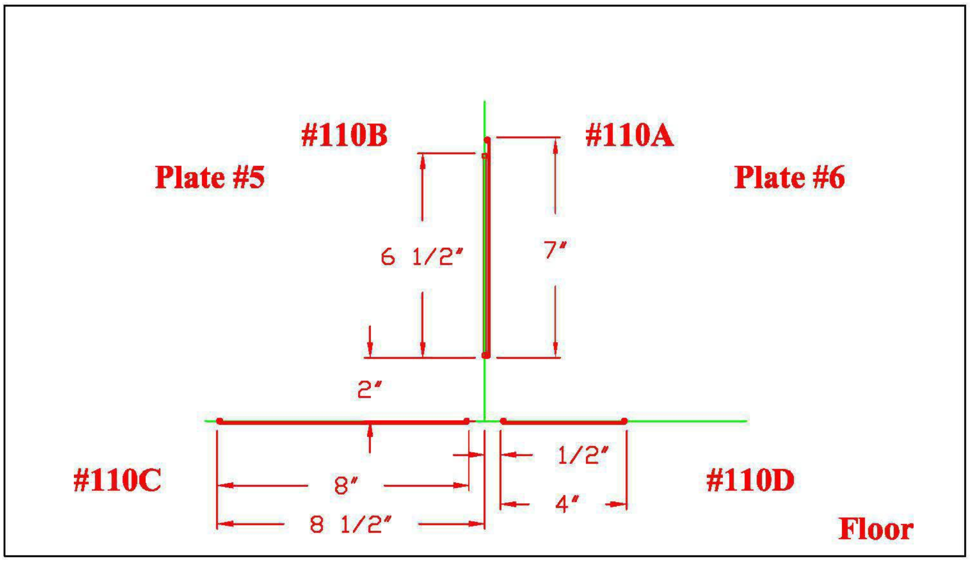
Tank Section: Floor/Shell
Quadrant: A
Course:
Plate: # 4 - 5

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)



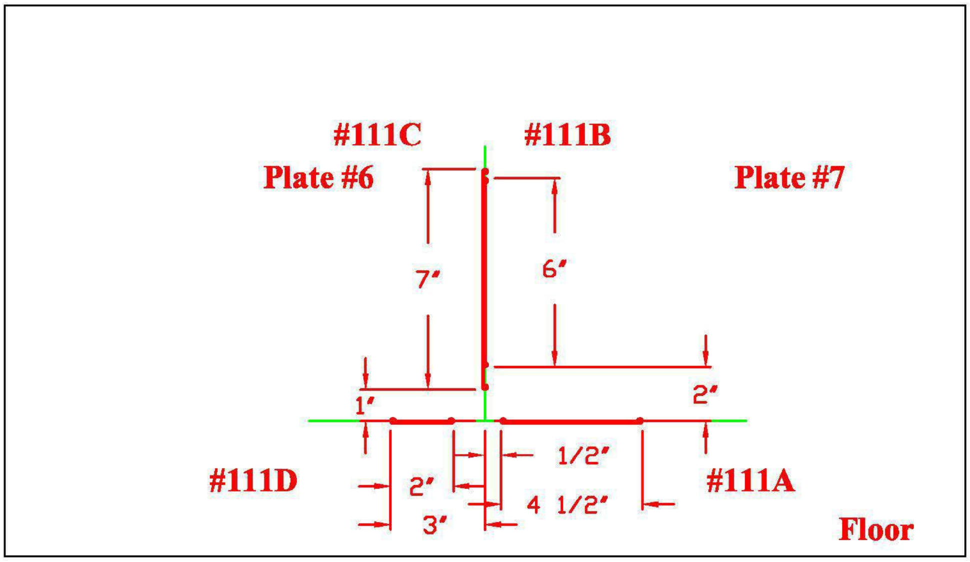
Drawing is not to scale

TANK #2 - QUADRANT AB

Nominal Plate Thickness: 0.250"

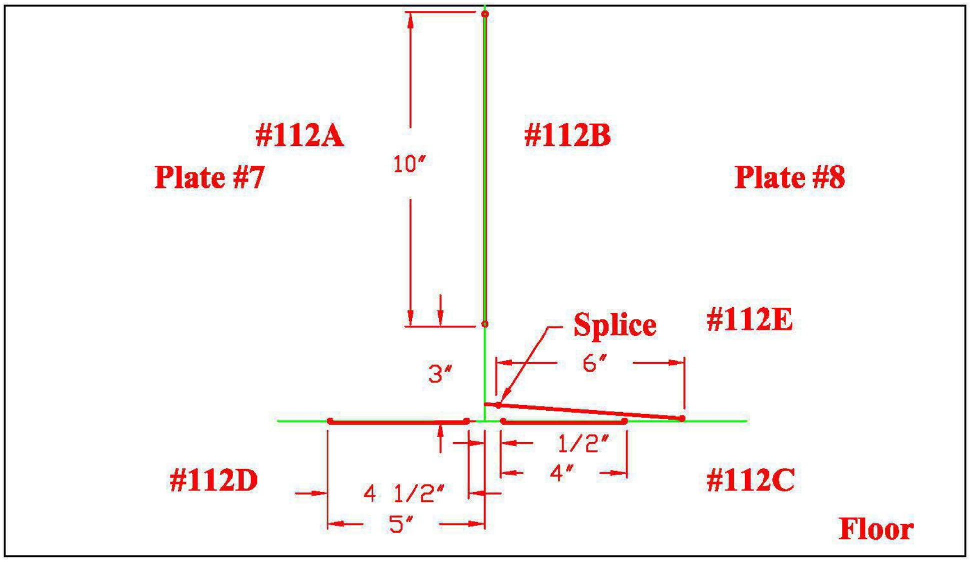
Date Inspected/Confirmed: 05/09/2008

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

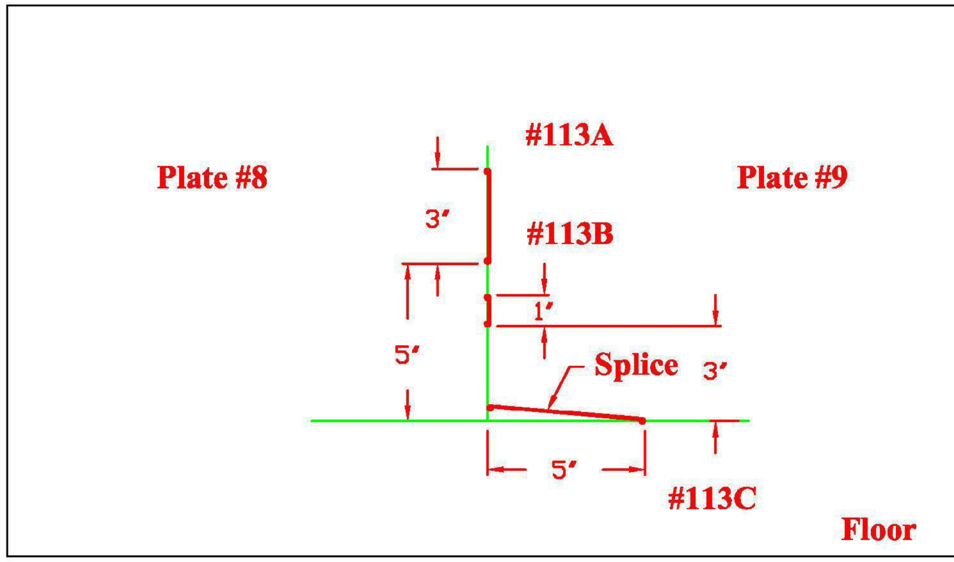
TANK #2 - QUADRANT B

Nominal Plate Thickness: 0.250"

Date Inspected/Confirmed: 05/08/2008

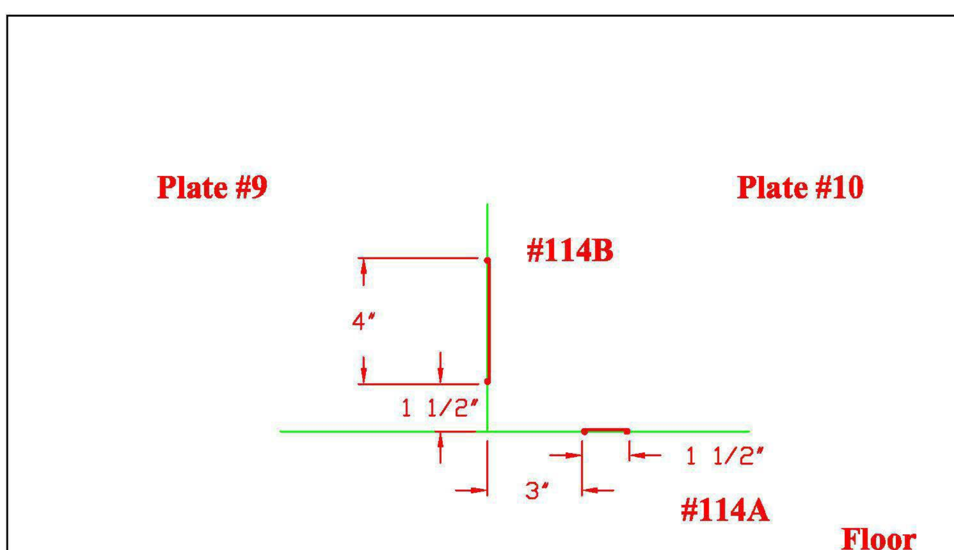
Tank Section: Floor/Shell
Quadrant: B
Course:
Plate: # 8 - 9

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

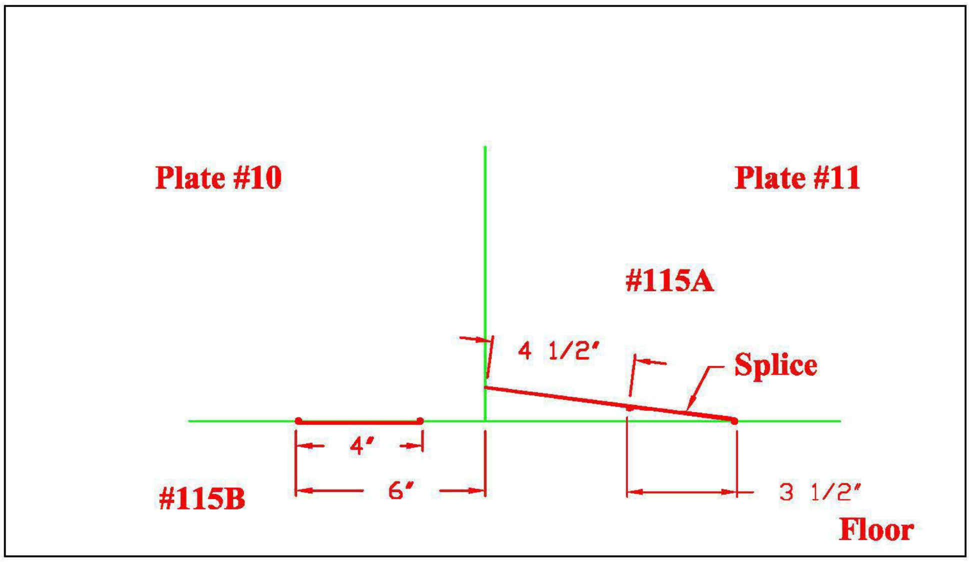
3.0 TANK MAPS
Dunkin & Bush, Inc.
Honolulu, HI
Tank # -2 Quadrant BC

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

Date Inspected/Confirmed: 05/08/2008

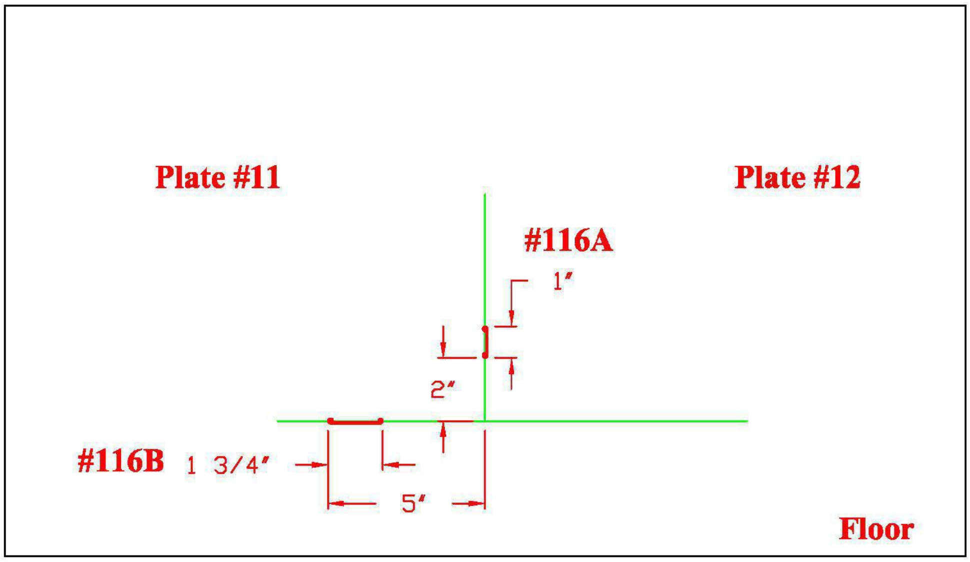
Tank Section: Floor/Shell
Quadrant: B
Course:
Plate: # 10 - 11

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

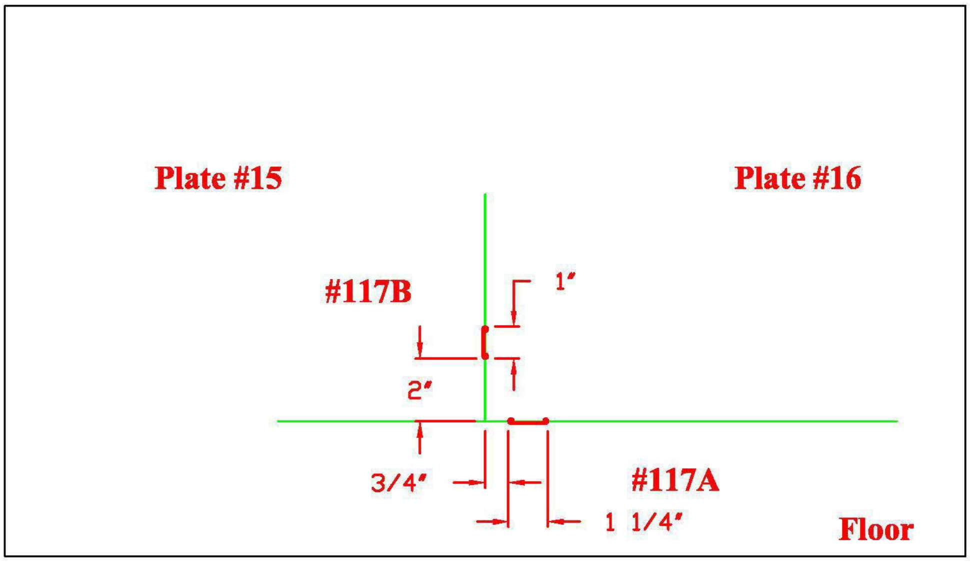
3.0 TANK MAPS
Dunkin & Bush, Inc.
Honolulu, HI
Tank # -2 Quadrant CD

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

Date Inspected/Confirmed: 05/08/2008

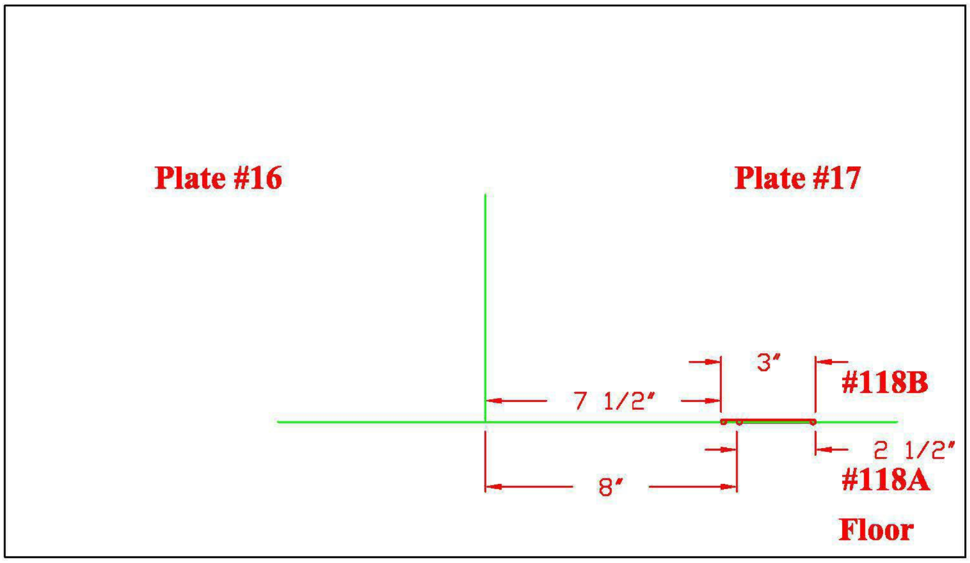
Tank Section: Floor/Shell
Quadrant: C
Course:
Plate: # 15 - 16

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