ENGINEERING & INSPECTIONS
HAWAII, INC.

MODIFIED API-653 OUT-OF-SERVICE
TANK 20
RED HILL

From:

ENGINEERING & INSPECTIONS
HAWAII, INC.

P.O. Box 700217
Kapolei, HI. 96709-0217

"Providing Excellence in NDE and Quality Inspection Services to Industries Worldwide"

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.

December 5, 2008

Mr. Bruce Huddleston M.S.
Shaw Environmental, Inc.
590-B Paiea St.
Honolulu, HI 96819

Subject: Tank No. 20 Red Hill Fuel Facility

SYNOPSIS

During September and October 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. 20
Year Built: 1943 - 1945
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 20 is located at the Red Hill fuel storage facility located underground in a ridgeline between Halawa Valley and Moanalua Valley.
Tank 20 was built in 1943 (completed in 1945). 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. No documented inspection of the recommended repairs has been performed.

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.

Approximately 600 1½" tank piping penetrations were noted throughout the tank. The piping was removed by mechanically cutting at the interior re-pad interface. Based on information provided to Engineering & Inspections Hawaii, Inc., this condition will be addressed for repair recommendations by Engineering consultant; Enterprise Engineering, Inc.

Hammer testing of the lower dome revealed numerous voids behind the liner plate in the lower dome area. Of the 44 lower dome plates, approximately 22 were hammer tested with all 22 showing some degree of voids behind the plate. The smallest areas were noted to be six to eight square inches, the larger areas, specifically plates 23 and 24 have areas large enough that when hit with the hammer a visible deflecting of the plate was noticed.

Numerous lap welded patches were noted throughout the entire tank. Due to this being the first known out-of-service inspection of tank number 20, 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. Numerous areas of positive corrosion blooms were also noticed during this inspection. Some of the corrosion blooms were 1½" in diameter with visible pitting beneath the corrosion. The entire lower dome is affected by active corrosion holidays or coating holidays making proper inspection difficult. The area referenced as the tank lower dome has approximately 40% coating failure with exposure of the tank steel liner. The area known as the tank Barrel section was noted to have smaller areas of coating failure. 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
32" Pipeline	Acceptable
6" Slop line	Failed
6" Steam Line	Failed
8" Steam 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. Perform visual and magnetic particle inspection of the internal structural tower and catwalk where additional structural members or repairs have been made by welding; as outlined in the Hawaii Engineering Group, Inc. report
2. Evaluate the internal coating system by a certified NACE Inspector.
3. Perform engineering evaluation of large voids noted behind the liner plate in the lower dome.

Based on the inspection findings provided by TesTex, Inc. and as referenced by the TesTex, Inc. Flaw Log for Tank No. 20. And further defined by remaining T-min thickness calculations as provided by Enterprise Engineering, Inc.

Flaw #47A-C	Lack of Fusion in weld; Lower Dome; Repair by Welding
Flaw #50	Lack of Fusion in weld; Lower Dome; Repair by Welding
Flaw #51	Lack of Fusion in weld; Lower Dome; Repair by Welding
Flaw #146	Lack of Fusion in weld; Barrel; Repair by Welding
Flaw #166	Mechanical Gouge; Barrel; Repair by Welding
Flaw #173	Mechanical Gouge; Barrel; Repair by Welding
Flaw #174A/B	Lack of Fusion in weld; Barrel; Repair by welding
Flaw #212	Lack of Fusion in weld; Expansion Joint; Repair by welding
Flaw #215	Mechanical Gouge; Expansion Joint; Repair by Welding
Flaw #219	Lack of Fusion in weld; Barrel; Repair by welding
Flaw #221	Mechanical Gouge; Expansion Joint; Repair by Welding
Flaw #227	Mechanical Gouge; Expansion Joint; Repair by Welding
Flaw #258	Lack of Fusion in weld; Expansion Joint; Repair by welding

Flaw #266A/B	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #267	Pitting in weld; Expansion Joint; Repair by welding
Flaw #276	Mechanical Gouge; Expansion Joint; Repair by Welding
Flaw #277	Lack of Fusion in weld; Expansion Joint; Repair by welding
Flaw #278	Lack of Fusion in weld; Expansion Joint; Repair by welding
Flaw #302A/B	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #303	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #304	Loss of Wall @ .165"; Upper Dome; Repair by use of lap patch plate .250" thick, 16" x 16" with radius corners
Flaw #305	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #312	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #313A/C	Pitting in Weld; Upper Dome; Repair by welding
Flaw #313B/D	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #314A/B	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #325	Loss of Wall @ .137"; Upper Dome; Repair by use of Tombstone shaped lap patch plate .250" thick, 10" x 10" with radius top to cover Flaws 325 and 326
Flaw #329	Base Metal Arc Gouge; Expansion Joint; Repair by welding
Flaw #330	Base Metal Arc Gouge; Expansion Joint; Repair by welding
Flaw #334	Loss of Wall @ .137"; Expansion Joint; Repair by use of lap patch plate .250" thick, 16" x 16" with radius corners
Flaw #337	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #341A/C	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #345	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #346A/B	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #347	Through Hole on Strap; Upper Dome; Repair by welding
Flaw #351	Base Metal Arc Gouge; Upper Dome; Repair by welding

Flaw #352	Base Metal Arc Gouge; Upper Dome; Repair by welding
Flaw #353	Base Metal Arc Gouge; Upper Dome; Repair by welding
Flaw #358/477	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #359A-E	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #360	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #362	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #363	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #364	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #365	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #366	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #367	Mechanical Gouge; Upper Dome; Repair by Welding
Flaw #369	Weld Pit .125"; Upper Dome; Repair by welding
Flaw #375	Lack of Fusion in Weld; Upper Dome; Repair by Welding
Flaw #377	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #378	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #379A-C	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #380	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #381	Weld Pit .063"; Upper Dome; Repair by welding
Flaw #382A/B	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #383A/B	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #384	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #385	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #389	Mechanical Gouge; Upper Dome; Repair by Welding
Flaw #392	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #393	Lack of Fusion in weld; Upper Dome; Repair by welding

Flaw #394A-F	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #395	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #397	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #401	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #406	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #407	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #408A/B	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #409	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #413A/B	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #414A/B	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #415	Mechanical Gouge; Barrel; Repair by Welding
Flaw #416	Weld Pit .125"; Upper Dome; Repair by welding
Flaw #417A/C-E	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #417B/F	Weld Gouge; Upper Dome; Repair by Welding
Flaw #421	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #423	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #426	Mechanical Gouge; Upper Dome; Repair by welding
Flaw #432	Lack of Fusion in tack weld; Upper Dome; Repair by welding
Flaw #433	Lack of Fusion in tack weld; Upper Dome; Repair by welding
Flaw #434	Lack of Fusion in tack weld; Upper Dome; Repair by welding
Flaw #435	Lack of Fusion in tack weld; Upper Dome; Repair by welding
Flaw #436	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #437A/B	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #439	Lack of Fusion in weld; Upper Dome; Repair by welding

Flaw #441	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #442	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #447A/B	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #449	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #451	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #452	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #453A/B	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #455A/B	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #463A/B	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #467A/B	Lack of Fusion in weld; Barrel; Repair by welding
Flaw #468	Lack of Fusion in weld; Under Catwalk; Repair by welding
Flaw #469A/B	Lack of Fusion in weld; Manway; Repair by welding
Flaw #470	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #471	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #472	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #473A/B	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #474A/B	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #475	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #476	Lack of Fusion in weld; Extension; Repair by welding
Flaw #477/358	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #478	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #479	Weld Gouge .085"; Upper Dome; Repair by welding
Flaw #480A/B	Lack of Fusion in weld; Upper Dome; Repair by welding
Flaw #481A-C	Lack of Fusion in weld; Upper Dome; Repair by welding

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Flaw #482 Crack in weld; Lower Dome; Repair by Welding

Note: All of the above repairs will require welding by a certified welder to approved welding procedures. All repairs to existing welds requiring weld excavation are required to be inspected by magnetic particle or liquid Penetrant after excavation to ensure defect removal. Final welds are required to be inspected by visual, magnetic particle or liquid penetrant methods. Addition of lap welded patch plates where required will also require inspection by the vacuum box inspection method.

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

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