ENTERPRISE
ENGINEERING, INC.

REPORT ADDENDA

REPAIR TANK 19, RED HILL
FISC PEARL HARBOR, HAWAII
DESC PROJECT PRL 98-9

Under Contract to
Pacific Division
Naval Facilities Engineering Command
Honolulu, Hawaii

A/E Contract N62724-98-C-0002
EEI Project No.: 98-2325

August 1998

PREPARED BY:

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MEETING REPORT AND REPORT ADDENDA
REPAIR TANK 19, RED HILL
FISC PEARL HARBOR HI
DESC PROJECT PRL 98-9

SUMMARY

A project review meeting was held in the FISC offices on June 30, 1998, to review the May 1998 project report prepared by Enterprise Engineering Inc. The purpose of the meeting was to address government comments, develop an Option Screening Method and plan for follow-on action.

Of the three major repair options previously presented, the following conclusions or issues were presented by EEI and FISC:

- If long term life extension renewal is the FISC goal, the Composite Tank Option would be favored (EEI opinion).
- Based on cost, the major Repair/Recoat Option is not favorable when compared to the Composite Tank Repair Option, as little cost would be saved (EEI opinion).
- Extrapolation of Tank 19 repairs to all tanks at Red Hill was considered. If all tanks required the expensive repairs, it was questionable that funds would be available from DESC (FISC comment).
- The Bladder Concept was considered to have merit, particularly if the long term need for tankage at Red Hill could not be confirmed (EEI opinion).

Although not considered in the present life extension tank repair evaluation effort (by earlier direction), a fourth option, of repairing only identified defects, and relying on the present coating systems, was discussed at length. The reason for considering this option is the expected lower costs for immediate repairs and extrapolated costs for all Red Hill tanks.

EEI presented a project selection matrix (weighted average criteria) as a means of determining the favored repair option. The matrix was developed based on several discussions with FISC staff prior to the formal review meeting. EEI expressed concern that any selection of option must be based on establishing the "goal" or "criteria" for selection. A variety of goals and criteria could be established, resulting in entirely different repair option selections. Steve Brooks and Steve DiGregorio both utilized the selection spreadsheet. Our perspective (i.e., "criteria") was long term (20 year plus) life extension, which resulted in selecting the Composite Tank Repair Option.

DETAILED DISCUSSIONS OF NOTE

1. Much of the discussion centered around how much backside corrosion presently exists in Tank 19, or other tanks. Little information is currently available to draw conclusions. Most shell integrity breaches being experienced are from spot backside corrosion, primarily located in the upper dome area. Breaches in the barrel, although limited, have been attributed to foreign objects behind the shell. With little objective information available on the presence or degree of possible backside corrosion, FISC was unwilling to make a selection of any of the three original, or one added option.

2. It was agreed that EEI would prepare a concept document for specific shell integrity evaluation of Tank 19. This will consist of the following investigative techniques:

   - Strip scanning (vertical) of the lower dome, barrel, and upper dome, to determine if backside corrosion can be found.
   - UT or other method of scanning, at selected locations, to see if backside corrosion is evident where the construction of the shell/anchor angle may result in a water pocket.
   - UT scanning to see if there are vertical anchors at the vertical butt welds of the barrel shell course plates.
   - One or more concrete cores through the shell into the concrete, and chemical testing to determine if the concrete contains chlorides.
   - Limited experimentation with helium injection, to see how much the tracer gas migrates around imbedded angles, particularly in the lower dome.

3. Much discussion was held on just how much shell scanning should be accomplished at this time, to obtain sufficient information to develop a conclusion. EEI felt that partial scanning would confirm or deny the presence of "pervasive" backside corrosion, and that 100% scanning was not necessary except for options that would rely on the present steel shell for hydraulic integrity. Some government representatives believe that nothing less than 100% scanning was needed to determine the option selected.

4. It was agreed that the strip scanning could proceed, but should include an option to extend the scanning to a 100% basis.

5. FISC advised that EEI would be responsible for recertifying the hoists, operating hoists, etc, as required for the testing. Several names were provided of suitable local contractors.

6. FISC advised that funding for the scanning would not be available until after October 1.

A/E RESPONSE TO COMMENTS

EEI Project No: 98-2325

Submission Status: 10% Concept Design Report

Response Date: 7/12/98

Reviewer/Code: Ron Tanaka, Code 403

Submission Date: 5/27/98

Constr. Contract: N/A

Project Title/Location: Repair Tank 19, Red Hill, FISC Pearl Harbor, Hawaii DESC Project PRL 98-9

EEI Response By: Stephen DiGregorio, P.E. and Stephen Brooks, P.E.

ITEM	REFERENCE	A/E RESPONSE
1 (a)	10% Concept Design Report Page 16: Effectiveness of pipe testing	The piping connected to the bottom of Tank 19 is embedded in concrete and includes a DN 800 fill/issue pipe, a DN 450 slop pipe, and a DN 200 water pipe. Pipe inspection methods include: 1. Remote TV inspection 2. Pressure testing 3. MFL inspection 4. Ultrasonic inspection 5. Tracer gas or Helium leak testing Given the unique construction of the Red Hill Tanks, the above pipe inspection methods are either not practical or will have limited effectiveness. A precision pressure test may provide information about whether a leak is present but we are not confident that the test will be effective with piping that is embedded in concrete as the concrete could possibly prevent the detection of small leaks. Thus, it would be accomplished during construction. MIL and UT inspection have limited application as record drawings indicate that the lines have bends that prevent pigging. MFL inspection, due to cost and mitered elbows, is not recommended. Some hand UT inspection, particularly of the DN 800 pipe, is possible and is recommended to generalize possible external corrosion. Tracer gas or helium leak testing is also not practical as the piping is embedded in concrete which prevents the installation of external probes to monitor for leakage of the tracer gas.

ITEM	REFERENCE	A/E RESPONSE
		TV inspection offers the most effective (but limited) method of inspection for Tank 19 piping and is recommended to be performed. TV inspection can provide valuable visual information about the interior of the piping. This would be particularly valuable investigating on the slop line as it would be expected to have the greatest interior corrosion. TV inspection , however, can not provide information about the thickness of the piping wall or external condition of the piping. As none of the investigative techniques is fool proof, we have recommended lining the pipes.
1 (a) cont.	10% Concept Design Report Page 16: Cured-in-Place Pipe Liner	A cured-in-place pipe liner is a lining material that is formed into a tube and saturated with epoxy resin. The tube is inserted into the pipe and is expanded into position using air or water. Air or water pressure forces the tube against the inside of the pipe and bonds the liner tube to the pipe wall. A woven polyester material can be used to provide additional reinforcement of the internal lining. The polyester reinforcement is formed into a tube and is inserted into the pipe. The liner tube and epoxy resin is then inserted inside the reinforcement tube and forced against the interior of the reinforcement and pipe using air or water. A TV inspection is normally indicated, as a part of construction, to confirm interior conditions and pipe bends. Pipe wall surface prep is provided by sandblasting or high pressure water cleaning.
1 (b)	10% Concept Design Report Page 23: Tank Bottom - Composite Tank Concept	In the Composite Tank concept, the tank bottom area around the center tower will have be provided with a new sump with leak detection piping to the lower tunnel (Refer to Tab B, SK-1). One concept to provide a composite liner of steel plate and grout fill below the tower would be to cut the tower legs and provide a new steel plate liner as follows:

A/E RESPONSE TO COMMENTS

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EEI Response By: Stephen DiGregorio, P.E. and Stephen Brooks, P.E.

ITEM	REFERENCE	A/E RESPONSE
		1. Temporarily support the tower legs with welded steel outriggers and blocking. 2. Cut and remove the bottom 100 mm (4 inches) of the tower legs that presently is supported on the bottom of the tank. 3. Shim below the tower legs with 100 mm (4 inches) thick solid steel shims. (An alternative to steel shims would be cast in place concrete.) 5. Place new steel plate liner between the steel shim and tower leg. 6. Provide WT 100 steel tees on the bottom of the lower dome radial from the center of the tank and new steel plate liner. 7. Fill space between existing steel liner and new steel liner with grout. Another concept would be to place 100 to 150 mm thick concrete on the flat area of the bottom dome around the tower (embedding the tower legs in the concrete) and place a new steel around the tower legs, welded to the tower legs. It was also discussed in the FACD to forego installing a double bottom over the flat center plate as it is 0.5 inches thick. Thus, through corrosion is much less likely to occur. If the Composite Tank Concept is selected, final design of the tank bottom will be determined during the design phase.
1 (c)	10% Concept Design Report Page 34: Results of chromium and lead testing	Analytical testing for total lead and total chromium was performed on three coating samples coating obtained from Tank 19. Total lead content ranged from 49.7 mg/kg (0.00497% by weight) to 140 mg/kg (0.014% by weight). Total chromium content ranged from 4920 mg/kg (0.49% by weight) to 20,900 mg/kg (2.09% by weight).

A/E RESPONSE TO COMMENTS

EEI Project No: 98-2325

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Response Date: 7/12/98

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Constr. Contract: N/A

Project Title/Location: Repair Tank 19, Red Hill, FISC Pearl Harbor, Hawaii DESC Project PRL 98-9

EEI Response By: Stephen DiGregorio, P.E. and Stephen Brooks, P.E.

ITEM	REFERENCE	A/E RESPONSE
		The significance of the coating test results are: 1. Test results of the amount of total lead and total chromium in the existing coating indicates that worker exposure to airborne contaminants during coating removal must be considered. a. Worker exposure to airborne contaminants is dependent upon contractor methods to remove, collect, handle, and dispose of the removed coating. No conclusion, however, can be made to relate total lead content and total chromium content in coatings to concentrations of airborne contamination. 29 CFR 1926 provides threshold limit values for airborne chromium (II and III), and chromates, and action levels for air borne concentration of lead. 29 CFR 1926 also provides requirements for exposure assessment and requirements to keep the exposure of employees to air contaminants within prescribed limits. b. The amount of total chromium (0.49% to 2.09% by weight) is considered sufficiently high to warrant contractor precautions for worker safety. From discussions with our testing lab, coating contractors, and a CIH, EEI has learned that early formulations of NRL coatings may contain Hexavalent Chromium (Cr+6) which is a carcinogen. Unfortunately, testing form Cr+6 is extremely difficult and not always conclusive. c. Due to the unique ventilation conditions at Red Hill, air inside Tank 19 is vented to the lower tunnel. Thus, persons outside Tank 19, within the Red Hill tunnel system and other Red Hill tanks are also at risk of exposure to any airborne contaminants resulting from construction activities in Tank 19. As no correlation can

A/E RESPONSE TO COMMENTS

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Response Date: 7/12/98

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Constr. Contract: N/A

Project Title/Location: Repair Tank 19, Red Hill, FISC Pearl Harbor, Hawaii DESC Project PRL 98-9

EEI Response By: Stephen DiGregorio, P.E. and Stephen Brooks, P.E.

ITEM	REFERENCE	A/E RESPONSE
		be to relate total lead content and total chromium content to concentrations of airborne contamination, administrative or engineering controls must be implemented to protect persons outside Tank 19 from airborne contaminants. 2. Test results also indicate that TCLP testing is recommended prior to waste disposal to determine whether wastes generated during coating removal are a hazardous waste under 40 CFR 261.10 based on the characteristic of toxicity. Protecting workers and utilizing waste minimization techniques usually go hand in hand. This also tends to generate small quantities of concentrated hazardous waste. 3. EEI recently received a draft copy of a new coating removal specification from SOUTHDIV which addresses the lead and chromates found in earlier versions of the NRL coating system. 4. Several innovative techniques for safe removal of these coatings have been developed. Once of the most promising is a remotely controlled high pressure water method inside a vacuum chamber.
1 (d)	10% Concept Design Report Page 44: Funding Categories	There may be some areas where the work may be classified either repair or maintenance. The funding classifications provided in the Cost Estimates for Tank 19 are similar to other tank repair projects prepared by EEI. In our experience, projects having a high portion of coating removal, plus recoating, clearly fall into the "maintenance" funding category.
1 (e)	10% Concept Design Report	For a 10% Concept Design effort, the cost estimate for each concept is within 10% to 15% (approximately $500K). Considerable thought was given to developing the estimate.

A/E RESPONSE TO COMMENTS

EEI Project No: 98-2325

Submission Status: 10% Concept Design Report

Response Date: 7/12/98

Reviewer/Code: Ron Tanaka, Code 403

Submission Date: 5/27/98

Constr. Contract: N/A

Project Title/Location: Repair Tank 19, Red Hill, FISC Pearl Harbor, Hawaii
DESC Project PRL 98-9

EEI Response By: Stephen DiGregorio, P.E. and Stephen Brooks, P.E.

ITEM	REFERENCE	A/E RESPONSE
	Accuracy of Cost Estimates	Many actual quotations were solicited, and general conditions/overhead were carefully addressed. We have given cost estimating our highest professional effort. Our track record on tank repair projects is good. Our estimate is usually within the lowest 3 bidders.
2.	Enclosure (1): Review comments from cost estimating branch	A/E response to cost estimating branch review comments are provided in a separate A/E response form.
3	Review comments from environmental planning branch	Waiting for comments, if any.
4	Review meeting	Review meeting was completed, July 1998.

A/E RESPONSE TO COMMENTS

EEI Project No: 98-2325

Submission Status: 10% Concept Design Report

Response Date: 7/12/98

Reviewer/Code: Cost Estimating Branch, 40601

Submission Date: 5/27/98

Constr. Contract: N/A

Project Title/Location: Repair Tank 19, Red Hill, FISC Pearl Harbor, Hawaii
DESC Project PRL 98-9

EEI Response By: Stephen DiGregorio, P.E. and Stephen S. Brooks, P.E.

ITEM	REFERENCE	A/E RESPONSE
1	10% Concept Design Report Cost of Petro Gard X bladder	A direct cost of $12.90/sm direct for a 30 mil thick Petro Gard X bladder (material only) was developed using a material cost of $1.20/SF based on conversations with MPC Containment Systems, Ltd. and Seamen Corporation on May 8, 1998. Both companies reported material costs of $1.20/SF to $1.50/SF and installed costs of $2.00/SF to $3.00/SF. A budget quote from MPC Containment Systems, Ltd. dated May 8, 1998 (Refer to Tab G of the 10% Concept Design report) provides cost to line Tank 19 barrel and bottom dome with Petro Gard X as follows: Item / Total Cost (Installed) / Quantity / Unit Cost Line Barrel / $230,000 / 4400 sm (47,124 SF) / $52.27 / $4.88 Line Bottom / $80,000 / 1460 sm (15,707 SF) / $54.79 / $5.90 Costs provided in Bladder System Cost Estimate were developed from vender quotes and are as follows: Item / Total Cost (Subcontractor) / Quantity / Unit Cost Line Barrel Direct / $209,321 Sub Mark-up / $ 41,346 Subtotal / $250,667 / 4400 sm / $56.97

RDHLCC0027427
BWS030967

A/E RESPONSE TO COMMENTS

EEI Project No: 98-2325

Submission Status: 10% Concept Design Report

Response Date: 7/12/98

Reviewer/Code: Cost Estimating Branch, 40601

Submission Date: 5/27/98

Constr. Contract: N/A

Project Title/Location: Repair Tank 19, Red Hill, FISC Pearl Harbor, Hawaii
DESC Project PRL 98-9

EEI Response By: Stephen DiGregorio, P.E. and Stephen S. Brooks, P.E.

ITEM	REFERENCE	A/E RESPONSE
		Line Bottom Direct $ 56,820 Sub Mark-up $ 10,841 Subtotal $ 67,661 1460 sm $46.34 **Conclusion:** We have made every effort to provide accurate cost estimate information. Our estimate is based on vendor quotes specifically for Tank 19. We do not have sufficient information to explain why a quote for Petro Gard 6 for a previous project was $28/sm.
2.	10% Concept Design Report Cost of tank barrel steel plate work	Cost estimate for the composite tank barrel work was developed using direct unit costs as follows: Steel Plate: $1.1/kg WT 100: $1.1/kg Welding: $20/m The costs used were developed from other EEI projects and calls made to contractors in Alaska.

RDHLCC0027428
BWS030968

REPAIR TANK 19, RED HILL
FISC PEARL HARBOR, HI

EXISTING COATING IN TANK 19

SUMMARY AND CONCLUSIONS

1. EEI observations on May 4, 1998 found the original 1960-63 applied NRL coating system (green surface color) was evident throughout the tank. The observable condition of the coating on the barrel was excellent, with no particular areas exhibiting failure. The coating on the flat floor of the lower dome was failing in most areas. There was no metalizing below the coating. The barrel portion of the tank, and lower dome was covered with sediment (dirt) on the coating that easily came off by wiping with a rag. The coating thickness averaged 10 to 12 mils thick.

2. Analytical testing for total lead and total chromium was performed on three coating samples coating obtained from Tank 19. Total lead content ranged from 49.7 mg/kg (0.00497% by weight) to 140 mg/kg (0.014% by weight). Total chromium content ranged from 4920 mg/kg (0.49% by weight) to 20,900 mg/kg (2.09% by weight).

3. TCLP testing was not performed. Thus, it is not possible to report if the samples as considered a hazardous waste by 40 CFR 261.10.

4. Testing for Cr+6, Hexavalent Chromium was also not performed. NIOSH methods 7600 and 7604 indicate the capability to recover Cr+6, Hexavalent Chromium in its insoluble form. Testing for Cr+6, Hexavalent Chromium, however, is difficult to perform and may be susceptible to interference from iron and other colored species.

5. Worker exposure to airborne contaminants is dependent upon contractor methods to remove, collect, handle, and dispose of the removed coating. No conclusion can be made to relate total lead content and total chromium content in coatings to concentrations of airborne contamination. 29 CFR 1926 provides threshold limit values for airborne chromium (II and III), and chromates, and action levels for air borne concentration of lead. 29 CFR 1926 also provides requirements for exposure assessment and requirements to keep the exposure of employees to air contaminants within prescribed limits.

6. Due to the unique ventilation conditions at Red Hill, air inside Tank 19 is vented to the lower tunnel. Thus, persons outside Tank 19, within the Red Hill tunnel system and other Red Hill tanks are also at risk of exposure to any airborne contaminants resulting from construction activities in Tank 19. As no correlation can be to relate total lead content and total chromium content to concentrations of airborne contamination, administrative or engineering controls must be implemented to protect persons outside Tank 19 from airborne contaminants.

7. Prior to removing the existing the contractor should:
   a. Perform additional testing to determine TCLP Toxicity characteristics for chromium and lead;
   b. Perform additional testing to determine the concentration of hexavalent chromium;
   c. Obtain a CIH to develop a Health and Safety Plan and monitor conditions, and
   d. Perform all work in accordance with OSHA.

Laboratory results of coating samples from the tank barrel and lower dome are as follows:

Sample Location	Laboratory Reference No.	Total Chromium Content mg/kg	Total Lead Content mg/kg
Barrel Wall (near manhole)	982157001	20900	49.7
Barrel Wall (near upper dome spring line)	982157002	4920	140
Lower Dome	982157003	7150	102

Analytical testing for chromium was performed using EPA method SW846-7191. Analytical testing for lead was performed using EPA method SW846-7421.

OSHA THRESHOLD LIMIT VALUES OF AIRBORNE CONTAMINANTS FOR CONSTRUCTION

Airborne Contaminants for Construction (29 CFR 1926.55)

OSHA threshold limit values of airborne contaminants for construction are:

Substance	mg/m^3 (milligram of substance per cubic meter of air)
Chromates (as CrO3)	0.1
Chromium (II) compounds (as Cr)	0.5
Chromium (III) compounds (as Cr)	0.5
Chromium metal and insol. salts (as Cr)	1
Chromium (VI) insoluble	0.01*
Chromium (VI) soluble	0.05*

*Information provided by M. Finkel, CIH.

Section 1926.55 provides the following requirements:

(a) Exposure of employees to inhalation, ingestion, skin absorption, or contact with contact with any material or substance at a concentration above those specified in the "Threshold Limit Values of Airborne Contaminants for 1970" of the American Conference of Governmental Industrial Hygienists, shall be avoided.

(b) To achieve compliance the paragraph (a), administrative or engineering controls must first be implemented whenever feasible. When such controls are not feasible to achieve full compliance, protective equipment or other protective measures shall be used to keep the exposure of employees to air contaminants within the limits prescribed. Any equipment and technical measures used for this purpose must first be approved for each particular use by a competent industrial hygienist or other technically qualified person.

<u>Lead</u>

29 CFR Section 1926.62 provides requirements where an employee may be occupationally exposed to lead. The following are excerpts from Section 1926.62 regarding action levels and permissible exposure limits:

Exposure Assessment

If lead is present in the workplace in any quantity, the employer is required to an initial determination of whether any employee's exposure to lead exceeds the action level. Employee exposure is that exposure which would occur if the employee were not using a respirator

Action Level

Action Level means employee exposure without regard to the use of respirators, to an airborne concentration of lead of 30 microgram per cubic meter of air (30 ug/m^3) calculated as an 8-hour time-weighted average (TWA).

Permissible Exposure Limit

1. The employer shall assure that no employee is exposed to lead at concentration greater than 50 microgram per cubic meter (50 ug/m^3) averaged over an 8-hour period.

2. If an employee is exposed to lead for more than 8 hours in any work day the employee's allowable exposure, as a time weighted average (TWA) for that day, shall be reduced according to the following formula:

   Allowable employee exposure (in ug/m^3) = 400 divided by hours worked in the day

HEXAVALENT CHROMIUM IN PAINT AND PAINT DUST

The following information was provided by Stephen C. Ede, Technical Director, CT&E Environmental Services (the laboratory that performed analytical testing of the Tank 19 coating samples):

Both NIOSH methods 7600 and 7604 indicate the capability to recover Cr+6, Hexavalent Chromium in its insoluble form by an Alkaline digestion using sodium hydroxide and sodium carbonate while purging the headspace over the digestion with Nitrogen gas to minimize oxidation of Cr+3. This method is a colorimetric determination and may be susceptible to interference from iron and other colored species.

This method is similar to the one that the EPA had dropped as not being accurate. It is the required method for air samples but may not apply to the bulk paint samples. CT & E Environmental Services cannot perform this method.

WASTE DISPOSAL

40 CFR 261.20 Subpart C defines the characteristics of hazardous waste. TCLP testing is used to determine whether a solid waste exhibits the characteristic of toxicity. Table 1 of Section 261.24 provides maximum concentration of contaminants for toxicity characteristic. Concentrations for lead and for chromium are listed as follows:

Contaminant	Regulatory Toxicity Level (mg/L)
Chromium	5.0
Lead	5.0

TCLP testing was not performed. Thus, it is not possible to report if the samples as considered a hazardous waste by 40 CFR 261.10.

CONTACTS

Person	Organization	Telephone No.
Tom Snyder, CIH	NORTHDIV - Industrial Hygiene	(610) 595-0567
Gordon Yamamoto	PACDIV - Industrial Hygiene	(808) 474-5989

ATTACHMENT A
ENGINEERING SCOPE OF SERVICES
AUGUST 18, 1998

INSPECT TANK 19, RED HILL
FISC PEARL HARBOR, HI

A/E CONTRACT NO. N62742-98-C-0002
EEI Project No. 98P-0789

INTRODUCTION

Enterprise Engineering, Inc. was commissioned to provide a 10% Concept Design Solution to repair Red Hill Tank 19, Special Project PRL 98-9. The Concept Design was prepared on site during May 4, 1998, through May 12, 1998, using a modified Functional Analysis Concept Development (FACD) process. Three options to repair Tank 19 were developed: Composite Tank, Internal Bladder Type Lining, and Repair Existing Tank. A final review meeting, held on June 30, 1998, discussed an additional option of providing limited repairs and utilizing the existing coating system.

FISC has requested this project to inspect Tank 19 to collect further data on the condition of the tank before selecting one of the repair options.

PROJECT GOAL

The goal of this Tank 19 inspection project is to determine the condition of the exterior (that is, backside) of the existing steel liner and determine if there is pervasive backside corrosion of the steel liner.

TANK INFORMATION

Tank 19, as well as the other 19 bulk storage tanks at Red Hill, is a 55 year old underground storage tank constructed inside a rock excavation. The tank is a cylinder, 250 feet tall x 100 feet in diameter with a dome bottom and top. The domes are a 50 foot radius hemisphere. The barrel and domes are constructed of 1/4 inch thick steel plate with concrete fill on the exterior, between the rock face and steel plate.

SCOPE OF SERVICES

To accomplish the project goal we propose to perform a selective inspection of areas of the tank and collect detailed information on the following:

- Backside condition of the steel lining

- Condition of the shell at selected anchor points
- Condition of the interior surface of the steel lining
- Quality of welds
- Testing and analysis of the concrete behind the steel lining
- Ability to helium test the lower dome and barrel

Upon considering initial selective inspection findings, our tank inspection can be expanded to include 100% scanning of the tank steel lining. We propose to provide inspection efforts beyond the selective inspection on a priced option basis.

BASIC SERVICES

MFE Scanning

General

MFE scanning will be performed to look for backside corrosion of the steel liner. MFE scanning will be performed on a selective (partial) basis by scanning strips up the barrel, lower dome, and upper dome.

Indications detected by MFE scanning will be examined using manual ultrasonic A-scan to determine if the indication is backside corrosion, an inclusion within the plate such as slag, or a lamination. Metal thickness will be recorded at locations determined to be backside corrosion.

It will not be necessary to remove the existing NRL coating for scanning as it will not prevent scanning.

We have provided estimates of the time required to perform MFE scanning. The actual time required to perform the scanning and UT follow-up, however, is highly dependent upon the number of MFE indications found.

Upper Dome

The upper done has been an area of greatest past corrosion leakage. Thus, FISC has requested scanning of the upper dome be included in the basic inspection.

Working over head will be serious challenge. It is not known whether conventional MFE scanners and robotic crawler can be operated in an over head position. Access to the dome surface is also difficult, as the existing booms inside the tank can not access top 8 ft of the upper dome.

We propose to perform scanning of the upper dome as follows:

1. Selective (partial) scanning of 10% of the dome surface area will be performed. Selective scanning will consist of 10 vertical strips, 2 ft ± wide from the dome spring line to within 8 ft of the top of the dome, as close as the boom and basket hoist can reach. The inspection will be performed by a 2 person team.

2. Scanning of the upper dome plates between the dome spring line to approximately 45 degrees above the dome spring line will be performed from a basket hoist using a combination of an MFE scanner and ultrasonic robotic crawlers.

3. Scanning of the upper dome plates higher than 45 degrees above the spring line will be performed from a basket hoist using ultrasonic robotic crawlers.

4. Scanning of the upper dome will be performed utilizing a subcontractor specializing in MFE scanning and robotic crawler ultrasonic inspection. We estimate 7 to 10 days will be required to perform selective scanning of the upper dome.

Barrel

1. Selective (partial) scanning of 10% of the barrel surface area will be performed. Selective scanning will consist of 16 vertical strips, 2 ft ± wide, full height of the barrel.

2. Scanning will be performed using two 2-person crews from basket hoists using a conventional MFE scanner. We estimate 12 to 14 days will be required to selectively scan the barrel.

Lower Dome

1. Selective (partial) scanning of 10% of the dome surface area will be performed. Selective scanning will consist of 10 vertical strips, 2 ft ± wide from the dome spring line to the bottom of the dome.

2. The inspection will be performed by a 2 person team. A 40 ft long extension ladder will be used to enhance ability to inspect the lower dome

3. Scanning 10 vertical strips will take approximately 2 to 3 days to complete.

Corrosion At Steel Liner Anchor Locations

The steel liner is anchored to the concrete fill on the exterior of tank with embedded steel angles. The steel plates of the liner are welded to the embedded angles. A concern regarding the anchors is that water on the exterior of the tank may be trapped behind the liner at the embedded angles and may be causing corrosion of the liner.

1. The condition of the backside of the steel liner at anchors locations will be assessed for backside corrosion using longitudinal wave ultrasonic (UT) scanning equipment. The liner welds and liner plate within 3 inches of the welds will be scanned. Scanning the liner welds will require grinding the crown of the weld flat for UT signal transmission. The quality of the welds will have an effect on the ability to scan; as porosity, slag inclusions, lack of fusion can interfere with the UT sound transmission.

2. The MFE scanning of the barrel will give indications of the location of the underlying embedded angle anchors but can not scan the welds and adjacent plate for backside corrosion.

3. Laboratory testing of coating samples obtained during the 10% Concept Design project determined that the existing NRL coating contains lead and chromium. To prevent worker exposure to lead in air contamination and chromium in air contamination from grinding welds, the existing coating will be removed from areas to be scanned before any grinding is performed. The existing coating will be removed using paint removal tools and grinders with negative pressure containment (vacuum hood) for grinding or a chemical stripper.

4. Coating removal work and grinding work will be accomplished using a subcontractor.

5. We propose to scan 100 LF of welds at random locations in the barrel using a two person team and the existing basket hoist. Once removal of the existing coating and grinding of the welds is complete, we estimate random scanning of 100 LF of barrel welds will require 2 to 3 days to complete.

Helium Leak Testing

Several past leaks have been attributed to through-plate pin-hole corrosion. The pin-hole corrosion observed in several coupons taken from other Red Hill tanks closely resembles typical chloride corrosion.

The purpose of helium leak testing is to look for pinholes in the steel liner plate and welds. Helium leak testing is not intended to inspect for backside corrosion. The intent of performing helium leak testing is to evaluate if helium will be an effective testing method for detecting small leaks but not to actually look for leaks. The main purpose of the test is determine if helium can migrate behind the steel lining plates. The test will hopefully demonstrate how effective helium leak testing is for the Red Hill tanks and whether it would be effective on a large scale basis.

Helium testing will involve drilling and tapping holes in the steel liner, injecting helium behind the liner, and testing to determine if the helium can pass around the embedded anchors and migrate upward to the barrel and upper dome. The concern is how far the helium will migrate. It is not known if helium will travel around the horizontal embedded angles. Water on the exterior of the steel lining can also affect the migration of helium and may even prevent helium migration.

One difficulty will be to determine the amount of helium present in the upper part of tank and the ability to maintain enough pressure for the gas to travel laterally to a leak location instead of diffusing upward. If there is enough resistance/lack of permeability of the material behind the tank shell there will be adequate pressure on the backside of the liner to perform the test.

1. Starting with the lower dome, holes will be drilled and tapped in selected courses for helium testing.

2. Valves or plugs will be installed at 4 circumferential locations in the selected courses. The installation of valves and pressure gauges in some tappings will enable us to verify if helium is present on the exterior of a plate at any time by opening the valve and checking for helium, without allowing large amounts of helium to flow into the tank. The valves will also be used to inject helium at locations where it is not detected. Tunnel ventilation is required at all times.

3. The holes and valves will be installed by a subcontractor.

4. To minimize the risk of an oxygen deficient atmosphere should a cylinder leak inside the tank, helium cylinders must remain outside the tank, in the upper tunnel. Cylinders will be manifolded in the upper tunnel with a regulator at the manifold. Low pressure flow regulators will be used on lines inside tank.

5. Clarification on use of helium cylinders in the upper tunnel is required from FISC.

6. As cylinders must remain in outside the tank, long supply hoses and a person to monitor the helium cylinders in the tunnel is required. A long supply hose will require at least one entire helium cylinder to displace air in the supply hose and manifold.

7. Air inside the tank will be continuously monitored for oxygen.

8. We estimate 2 to 4 days will be required to prepare the tank for helium leak testing, including set-up, drilling and tapping holes, and installing valves and pressure gauges.

9. We also propose to helium leak test several of the existing leak detection pipes in the tank. The piping has a threaded plug at the top of the tell tale riser at the upper dome spring line. These are accessible using the boom and basket.

Coupon Cutting and Concrete Cores

FISC has requested that one or more coupons be cut in Tank 19 shell and concrete core samples be obtained for testing to determine if the pin-hole corrosion observed in several coupons taken from other Red Hill tanks is caused by typical chloride corrosion.

1. Coupons and concrete cores will be obtained at several locations in the bottom dome, and from the platform near the main access manhole.

2. A local contractor will be obtained to cut the coupons and core concrete samples. Coupons and cores will be cold cut using a core drill.

3. Concrete core samples will be tested for chlorides and sulfates.

4. Coupons will be visually examined for backside corrosion.

Safety

The tank at the upper platform is not a permit required confined space as the tank manhole is 8 ft diameter. However, EEI considers the barrel and lower dome a confined space, due to access difficulties, but not from an air quality standpoint.

1. A full-time safety person will be provided on upper platform.

2. The safety person will communicate with the inspection team inside the tank via radios.

Boom and Hoist Recertification and Operation

1. EEI intends to use the existing booms and basket hoists in Tank 19 for inspection efforts.

2. Two booms and basket hoists and one hoist need rectification. EEI will utilize a specialty subcontractor to certify booms and hoists safe for operation and operate boom during inspection efforts.

Access, Electrical Power, and Lighting

1. We anticipate that Adit 5 and the upper tunnel will be available for personnel and equipment access to the tank.

2. The upper tunnel space is non-hazardous electrical class. However, most of the near-by power sources in the upper tunnel are explosion-proof receptacles. We assume power

will be made available for inspection but we may need to set up a temporary power panel in the upper tunnel near the tank manhole

3. Tank 19 is presently equipped with temporary lighting that is supported from the center tower. We assume that this lighting will be available and in working order for the inspection.

On-site API 653 Inspector

1. An API 653 certified tank inspector will be on site full time during the inspection to monitor inspection procedures and review initial inspection results.

Engineering Evaluation and Reporting

1. At the conclusion of inspection efforts we will provide the results of our testing and inspection in a tank inspection report.

2. The inspection report will be prepared by EEI's API 653 certified tank inspector and senior tank inspection engineer.

OVERALL TEAM REQUIREMENTS

Enterprise Engineering

- Prime Consultant
- API-653 Inspector on site
- Tank inspection logistics, safety program, safety watch
- Tank inspectors
- 1-MFE Industries scanner
- UT prove-up scanning
- Helium leak detection

Subconsultant Inspection Organization

- 1-MFE or UT scanner, track-mounted, tether controlled
- Back-up Hand UT prove up equipment
- Operating Technicians

Local Mechanical/Tank Contractor(s)

- Hoist recertification
- Hoist operators (two required)
- Lead coating removal/weld grinding
- Helium taps for testing
- Shell/concrete coring

PRICED OPTIONS

We propose to provide inspection efforts beyond the basic selective inspection on a unit priced option basis. The following scope of priced option services is proposed:

100% Scanning

1. Our tank inspection can be expanded to include 100% scanning of the tank shell and lower dome. We propose to provide scanning services on a unit price per day basis. We estimate 25 to 30 days will be required to scan 100% of the barrel and 5 to 7 days to scan 100% of the lower dome.

2. Scanning of the liner welds at anchor locations can be expanded beyond the initial 100 LF. We propose to provide additional scanning on a unit price per linear foot basis.

RED HILL TANK 19 OPTION EVALUATION/RANKING

All ranking on scale of 1 lowest, 10 highest, most attractive/desirable

Ranking Criteria	Rank Weight	Composite Tank		Bladder Tank		Repaired Tank	
		Comment	Rank	Comment	Rank	Comment	Rank
Cost comparisons							
First Cost - base level		$5,298,000		$2,339,000		$4,641,000	
First Cost, with Additive Items		$6,604,000		$3,086,000		$5,357,000	
Comment on Cost		Highest cost, but provides secondary containment and long (50 yr.?) life		Lowest cost, but must plan on replacing bladder every 10 years		Only saves $650,000 over composite repair, with much less benefit and life	
Repair cost per Barrel		$19.99		$8.83		$17.40	
Ranking of criteria against options							
Life to liner/coating replacement		20 yr. bottom dome, no shell coating (apply yr. 20)		10 year Bladder change out		20 year minimum expectancy, bottom and shell	
Quality of testing before design/constr		UT or MFE to assure structural attachment, visual to fix obvious problems		Limited UT or MFE to assure structural attachment, visual to fix obvious problems		Critical that 100% visual, MFE/UT, and Helium test find all known problems and thin spots	
Cost of testing to assure success		$50,000-$75,000		$50,000-$75,000		$500,000 +	
Need to test existing to assure success		Relatively minor		Relatively Minor		Mandatory, critical	
Leak Detection Capability							
Electronic leak detection		Possible, being evaluated/tested by others		Possible, being evaluated/tested by others		Possible, being evaluated/tested by others	
Tell tale leak detection		13 vertical zones, plus floor		Multiple vertical zones, plus floor possible		Combination horizontal and vertical zones, relies on old concrete integrity	
Zoning of leak detection		effective, vertical 24 ft. wide		Probably effective if vertical attachments included		Horizontal per shell course, allows fuel to move around tank	
visual leak detection		Easy, new shell		Possible, but only big problems. May require soaping and pressurizing		difficult, old tank surface/, poor welding	
Leak Location							

RDHLCC0027441

RED HILL TANK 19 OPTION EVALUATION/RANKING

All ranking on scale of 1 lowest, 10 highest, most attractive/desirable

Ranking Criteria	Rank Weight	Composite Tank		Bladder Tank		Repaired Tank	
		Comment	Rank	Comment	Rank	Comment	Rank
Simplicity of Leak Location		Easiest of three, limited area to search		Depends on ability to slight pressurize bladder		Most difficult as tell tale system can mislead as to leak location	
Accuracy/confidence of finding leak		Best		moderate to good		Moderate at best, recent poor tack record	
Helium detection method		Could be set up as part of tell-tale system, 24 ft wide by shell height		Need to test permeability of liner bladder with Helium		Extremely difficult and expensive due to large areas covered by tell tales and old concrete permeability	
Vacuum box method		easy, new surface		N/A		difficult, old surface	
Visual Method		easiest, new surface		May be difficult due to being a bladder		moderate, difficult at old welds	
Pressure test method		Possible, secondary containment		Possible, secondary containment, would have to have vertical attachments, only low pressure		Not practical due to porous concrete behind shell	
Quantity of shell survey to find leak		Most likely limited to 24 ft. wide, by shell height		Depends on width between bladder vertical attachments, possible to be same as Composite tank		Very difficult to predict. In worst case scenario, entire shell may need to be inspected	
Confidence in Repair							
Reliance on existing shell		Very limited, only structural attachment for standoffs. Easy to fix in construction		Very limited, only for attachment of studs and batten strip		High reliance, only steel substrate/liner	
Reliance on coatings		Limited to bottom only to prevent corrosion. Coating of barrel an additive option item, not necessary for success		Bladder is liner		extremely important to have coating that can bridge defects that are not found in surveys	
Reliance on NDE during construction		Moderate on existing, high on new welding		Moderate on existing		Extremely important to find all existing leaks and thin spots	
Reliance on contra QA/QC		normal to above average		normal to above average		Above average minimum, even more desired.	

RED HILL TANK 19 OPTION EVALUATION/RANKING

All ranking on scale of 1 lowest, 10 highest, most attractive/desirable

Ranking Criteria	Rank Weight	Composite Tank		Bladder Tank		Repaired Tank	
		Comment	Rank	Comment	Rank	Comment	Rank
Environmental aspects							
Secondary Containment		Yes, 6" interstitial space to original shell		Yes, bladder on top of original shell		None	
Physical Leak detection		Tell tale system, 13 zones plus bottom dome		Yes, 13 zones plus bottom dome (geotech material between liner and shell allows liquid flow)		Tell tales, but backside is concrete, horizontal connection at each shell course	
Electronic leak detection		Inventory based/mass balance type system under trial by others		Inventory based/mass balance type system under trial by others		Inventory based/mass balance type system under trial by others	
Total Unweighted Ranking Points			**0**		**0**		**0**
Total Weighted Ranking 1-10		**0**	**#DIV/0!**	**0**	**#DIV/0!**	**0**	**######**

Results from S Brooks and S DiGregorio

Total Weighted Ranking 1-10 (Steve Brooks)		**1308**	**43%**	**1146**	**38%**	**573**	**19%**
Total Weighted Ranking 1 10(Steve DiGregorio)		**1178**	**49%**	**842**	**35%**	**367**	**15%**
Ranking options by 1 -3							
Total Weighted Ranking Points (Steve Brooks)		**458**	**45%**	**365**	**36%**	**194**	**19%**
Total Weighted Ranking Points (Steve DiGregorio)		**429**	**50%**	**273**	**32%**	**159**	**18%**
Average of S Brooks and S DiGregorio		**843.25**	**46%**	**656.5**	**36%**	**323.25**	**18%**

RDHLCC0027443

RED HILL TANK 19 OPTION EVALUATION/RANKING

RANKING SCALE: **3 HIGH** **(Desirable, Best Alternative, Highest confidence, best meets criteria)**
2 MEDIUM **(Second Choice, but meets criteria)**
1 LOW **(Least Desirable, Low Confidence, Least likely to meet criteria)**

Weighting Scale: **Weighting on scale of 1 lowest, 10 highest, most important**

Ranking Criteria	Rank Weight	Composite Tank		Bladder Tank		Repaired Tank	
		Comment	Rank	Comment	Rank	Comment	Rank
Cost comparisons							
First Cost - base level		$5,298,000		$2,339,000		$4,641,000	
First Cost, with Additive Items		$6,604,000		$3,086,000		$5,357,000	
Comment on Cost		Highest cost, but provides secondary containment and long (50 yr.?) life		Lowest cost, but must plan on replacing bladder every 10 years		Only saves $650,000 over composite repair, with much less benefit and life	
Repair cost per Barrel		$19.99		$8.83		$17.40	
Ranking of criteria against options							
Life to liner/coating replacement		20 yr. bottom dome, no shell coating (apply yr. 20)		10 year Bladder change out		20 year minimum expectancy, bottom and shell	
Quality of testing before design/constr		UT or MFE to assure structural attachment, visual to fix obvious problems		Limited UT or MFE to assure structural attachment, visual to fix obvious problems		Critical that 100% visual, MFE/UT, and Helium test find all known problems and thin spots	
Cost of testing to assure success		$50,000-$75,000		$50,000-$75,000		$500,000 +	
Need to test existing to assure success		Relatively minor		Relatively Minor		Mandatory, critical	
Leak Detection Capability							
Electronic leak detection		Possible, being evaluated/tested by others		Possible, being evaluated/tested by others		Possible, being evaluated/tested by others	
Tell tale leak detection		13 vertical zones, plus floor		Multiple vertical zones, plus floor possible		Combination horizontal and vertical zones, relies on old concrete integrity	
Zoning of leak detection		effective, vertical 24 ft. wide		Probably effective if vertical attachments included		Horizontal per shell course, allows fuel to move around tank	
visual leak detection		Easy, new shell		Possible, but only big problems. May require soaping and pressurizing		difficult, old tank surface/, poor welding	
Leak Location							

RED HILL TANK 19 OPTION EVALUATION/RANKING

RANKING SCALE: **3 HIGH** **(Desirable, Best Alternative, Highest confidence, best meets criteria)**
2 MEDIUM **(Second Choice, but meets criteria)**
1 LOW **(Least Desirable, Low Confidence, Least likely to meet criteria)**

Weighting Scale: **Weighting on scale of 1 lowest, 10 highest, most important**

Ranking Criteria	Rank Weight	Composite Tank		Bladder Tank		Repaired Tank	
		Comment	Rank	Comment	Rank	Comment	Rank
Simplicity of Leak Location		Easiest of three, limited area to search		Depends on ability to slight pressurize bladder		Most difficult as tell tale system can mislead as to leak location	
Accuracy/confidence of finding leak		Best		moderate to good		Moderate at best, recent poor tack record	
Helium detection method		Could be set up as part of tell tale system, 24 ft wide by shell height		Need to test permeability of liner bladder with Helium		Extremely difficult and expensive due to large areas covered by tell tales and old concrete permeability	
Vacuum box method		easy, new surface		N/A		difficult, old surface	
Visual Method		easiest, new surface		May be difficult due to being a bladder		moderate, difficult at old welds	
Pressure test method		Possible, secondary containment		Possible, secondary containment, would have to have vertical attachments, only low pressure		Not practical due to porous concrete behind shell	
Quantity of shell survey to find leak		Most likely limited to 24 ft. wide, by shell height		Depends on width between bladder vertical attachments, possible to be same as Composite tank		Very difficult to predict. In worst case scenario, entire shell may need to be inspected	
Confidence in Repair							
Reliance on existing shell		Very limited, only structural attachment for standoffs. Easy to fix in construction		Very limited, only for attachment of studs and batten strip		High reliance, only steel substrate/liner	
Reliance on coatings		Limited to bottom only to prevent corrosion. Coating of barrel an additive option item, not necessary for success		Bladder is liner		extremely important to have coating that can bridge defects that are not found in surveys	

RDHLCC0027445

RED HILL TANK 19 OPTION EVALUATION/RANKING

RANKING SCALE: **3 HIGH** **(Desirable, Best Alternative, Highest confidence, best meets criteria)**
2 MEDIUM **(Second Choice, but meets criteria)**
1 LOW **(Least Desirable, Low Confidence, Least likely to meet criteria)**

Weighting Scale: **Weighting on scale of 1 lowest, 10 highest, most important**

Ranking Criteria	Rank Weight	Composite Tank		Bladder Tank		Repaired Tank	
		Comment	Rank	Comment	Rank	Comment	Rank
Reliance on NDE during construction		Moderate on existing, high on new welding		Moderate on existing		Extremely important to find all existing leaks and thin spots	
Reliance on contra QA/QC		normal to above average		normal to above average		Above average minimum, even more desired.	
Environmental aspects							
Secondary Containment		Yes, 6" interstitial space to original shell		Yes, bladder on top of original shell		None	
Physical Leak detection		Tell tale system, 13 zones plus bottom dome		Yes, 13 zones plus bottom dome (geotech material between liner and shell allows liquid flow)		Tell tales, but backside is concrete, horizontal connection at each shell course	
Electronic leak detection		Inventory based/mass balance type system under trial by others		Inventory based/mass balance type system under trial by others		Inventory based/mass balance type system under trial by others	
Total Unweighted Ranking Points			**0**		**0**		**0**
Total Weighted Ranking Points		**0**	**######**	**0**	**######**	**0**	**######**

Total Weighted Ranking Points (Steve Brooks)		**458**	**45%**	**365**	**36%**	**194**	**19%**
Total Weighted Ranking Points (Steve DiGregorio)		**429**	**50%**	**273**	**32%**	**159**	**18%**

RDHLCC0027446

RED HILL TANK 19 OPTION EVALUATION/RANKING

All ranking on scale of 1 lowest, 10 highest, most attractive/desirable

Ranking Criteria	Rank Weight	Composite Tank Comment	Composite Tank Rank	Bladder Tank Comment	Bladder Tank Rank	Repaired Tank Comment	Repaired Tank Rank
Cost comparisons							
First Cost - base level		$5,298,000		$2,339,000		$4,641,000	
First Cost, with Additive Items		$6,604,000		$3,086,000		$5,357,000	
Comment on Cost		Highest cost, but provides secondary containment and long (50 yr.?) life		Lowest cost, but must plan on replacing bladder every 10 years		Only saves $650,000 over composite repair, with much less benefit and life	
Repair cost per Barrel		$19.99		$8.83		$17.40	
Ranking of criteria against options							
Life to liner/coating replacement	7	20 yr. bottom dome, no shell coating (apply yr. 20)	9	10 year Bladder change out	5	20 year minimum expectancy, bottom and shell	8
Quality of testing before design/constr	9	UT or MFE to assure structural attachment, visual to fix obvious problems	8	Limited UT or MFE to assure structural attachment, visual to fix obvious problems	9	Critical that 100% visual, MFE/UT, and Helium test find all known problems and thin spots	2
Cost of testing to assure success	7	$50,000-$75,000	9	$50,000-$75,000	9	$500,000 +	2
Need to test existing to assure success	7	Relatively minor	9	Relatively Minor	9	Mandatory, critical	2
Leak Detection Capability							
Electronic leak detection	6	Possible, being evaluated/tested by others	5	Possible, being evaluated/tested by others	5	Possible, being evaluated/tested by others	5
Tell tale leak detection	8	13 vertical zones, plus floor	8	Multiple vertical zones, plus floor possible	6	Combination horizontal and vertical zones, relies on old concrete integrity	4
Zoning of leak detection	8	effective, vertical 24 ft. wide	8	Probably effective if vertical attachments included	8	Horizontal per shell course, allows fuel to move around tank	4
visual leak detection	9	Easy, new shell	8	Possible, but only big problems. May require soaping and pressurizing	5	difficult, old tank surface/, poor welding	4
Leak Location							
Simplicity of Leak Location	10	Easiest of three, limited area to search	8	Depends on ability to slight pressurize bladder	5	Most difficult as tell tale system can mislead as to leak location	3

RED HILL TANK 19 OPTION EVALUATION/RANKING

All ranking on scale of 1 lowest, 10 highest, most attractive/desirable

Ranking Criteria	Rank Weight	Composite Tank		Bladder Tank		Repaired Tank	
		Comment	Rank	Comment	Rank	Comment	Rank
Accuracy/confidence of finding leak	10	Best	9	moderate to good	7	Moderate at best, recent poor tack record	5
Helium detection method	6	Could be set up as part of tell tale system, 24 ft wide by shell height	8	Need to test permeability of liner bladder with Helium	5	Extremely difficult and expensive due to large areas covered by tell tales and old concrete permeability	2
Vacuum box method	4	easy, new surface	7	N/A	10	difficult, old surface	5
Visual Method	6	easiest, new surface	8	May be difficult due to being a bladder	5	moderate, difficult at old welds	5
Pressure test method	6	Possible, secondary containment	10	Possible, secondary containment, would have to have vertical attachments, only low pressure	9	Not practical due to porous concrete behind shell	0
Quantity of shell survey to find leak	9	Most likely limited to 24 ft. wide, by shell height	8	Depends on width between bladder vertical attachments, possible to be same as Composite tank	7	Very difficult to predict. In worst case scenario, entire shell may need to be inspected	3
Confidence in Repair							
Reliance on existing shell	7	Very limited, only structural attachment for standoffs. Easy to fix in construction	8	Very limited, only for attachment of studs and batten strip	9	High reliance, only steel substrate/liner	3
Reliance on coatings	6	Limited to bottom only to prevent corrosion. Coating of barrel an additive option item, not necessary for success	9	Bladder is liner	9	extremely important to have coating that can bridge defects that are not found in surveys	5
Reliance on NDE during construction	7	Moderate on existing, high on new welding	8	Moderate on existing	8	Extremely important to find all existing leaks and thin spots	4
Reliance on contra QA/QC	6	normal to above average	7	normal to above average	7	Above average minimum, even more desired.	3
Environmental aspects							
Secondary Containment	9	Yes, 6" interstitial space to original shell	9	Yes, bladder on top of original shell	8	None	0

RED HILL TANK 19 OPTION EVALUATION/RANKING

All ranking on scale of 1 lowest, 10 highest, most attractive/desirable

Ranking Criteria	Rank Weight	Composite Tank		Bladder Tank		Repaired Tank	
		Comment	Rank	Comment	Rank	Comment	Rank
Physical Leak detection	9	Tell tale system, 13 zones plus bottom dome	8	Yes, 13 zones plus bottom dome (geotech material between liner and shell allows liquid flow)	7	Tell tales, but backside is concrete, horizontal connection at each shell course	5
Electronic leak detection	6	Inventory based/mass balance type system under trial by others	5	Inventory based/mass balance type system under trial by others	5	Inventory based/mass balance type system under trial by others	5
Total Unweighted Ranking Points			**176**		**157**		**79**
Total Weighted Ranking Points (Steve Brooks)		**1308**	**43%**	**1146**	**38%**	**573**	**19%**

Total Weighted Ranking Points (Steve DiGregorio)		**1178**	**49%**	**842**	**35%**	**367**	**15%**

Ranking options by 1 -3

Total Weighted Ranking Points (Steve Brooks)		**458**	**45%**	**365**	**36%**	**194**	**19%**

Total Weighted Ranking Points (Steve DiGregorio)		**429**	**50%**	**273**	**32%**	**159**	**18%**

RED HILL TANK 19 OPTION EVALUATION/RANKING

RANKING SCALE: **3 HIGH** **(Desirable, Best Alternative, Highest confidence, best meets criteria)**
2 MEDIUM **(Second Choice, but meets criteria)**
1 LOW **(Least Desirable, Low Confidence, Least likely to meet criteria)**

Weighting Scale: **Weighting on scale of 1 lowest, 10 highest, most important**

Ranking Criteria	Rank Weight	Composite Tank		Bladder Tank		Repaired Tank	
		Comment	Rank	Comment	Rank	Comment	Rank
Cost comparisons							
First Cost - base level		$5,298,000		$2,339,000		$4,641,000	
First Cost, with Additive Items		$6,604,000		$3,086,000		$5,357,000	
Comment on Cost		Highest cost, but provides secondary containment and long (50 yr.?) life		Lowest cost, but must plan on replacing bladder every 10 years		Only saves $650,000 over composite repair, with much less benefit and life	
Repair cost per Barrel		$19.99		$8.83		$17.40	
Ranking of criteria against options							
Life to liner/coating replacement	7	20 yr. bottom dome, no shell coating (apply yr. 20)	3	10 year Bladder change out	2	20 year minimum expectancy, bottom and shell	3
Quality of testing before design/constr	9	UT or MFE to assure structural attachment, visual to fix obvious problems	2	Limited UT or MFE to assure structural attachment, visual to fix obvious problems	3	Critical that 100% visual, MFE/UT, and Helium test find all known problems and thin spots	1
Cost of testing to assure success	7	$50,000-$75,000	3	$50,000-$75,000	3	$500,000 +	1
Need to test existing to assure success	7	Relatively minor	3	Relatively Minor	3	Mandatory, critical	1
Leak Detection Capability							
Electronic leak detection	6	Possible, being evaluated/tested by others	2	Possible, being evaluated/tested by others	2	Possible, being evaluated/tested by others	2
Tell tale leak detection	8	13 vertical zones, plus floor	3	Multiple vertical zones, plus floor possible	2	Combination horizontal and vertical zones, relies on old concrete integrity	1
Zoning of leak detection	8	effective, vertical 24 ft. wide	3	Probably effective if vertical attachments included	2	Horizontal per shell course, allows fuel to move around tank	1
visual leak detection	9	Easy, new shell	3	Possible, but only big problems. May require soaping and pressurizing	1	difficult, old tank surface/, poor welding	1
Leak Location							

RDHLCC0027450

RED HILL TANK 19 OPTION EVALUATION/RANKING

RANKING SCALE: **3 HIGH** **(Desirable, Best Alternative, Highest confidence, best meets criteria)**
2 MEDIUM **(Second Choice, but meets criteria)**
1 LOW **(Least Desirable, Low Confidence, Least likely to meet criteria)**

Weighting Scale: **Weighting on scale of 1 lowest, 10 highest, most important**

Ranking Criteria	Rank Weight	Composite Tank		Bladder Tank		Repaired Tank	
		Comment	Rank	Comment	Rank	Comment	Rank
Simplicity of Leak Location	10	Easiest of three, limited area to search	3	Depends on ability to slight pressurize bladder	2	Most difficult as tell tale system can mislead as to leak location	1
Accuracy/confidence of finding leak	10	Best	3	moderate to good	2	Moderate at best, recent poor tack record	1
Helium detection method	6	Could be set up as part of tell-tale system, 24 ft wide by shell height	3	Need to test permeability of liner bladder with Helium	1	Extremely difficult and expensive due to large areas covered by tell tales and old concrete permeability	1
Vacuum box method	4	easy, new surface	3	N/A	3	difficult, old surface	1
Visual Method	6	easiest, new surface	3	May be difficult due to being a bladder	1	moderate, difficult at old welds	2
Pressure test method	6	Possible, secondary containment	3	Possible, secondary containment, would have to have vertical attachments, only low pressure	2	Not practical due to porous concrete behind shell	1
Quantity of shell survey to find leak	9	Most likely limited to 24 ft. wide, by shell height	3	Depends on width between bladder vertical attachments, possible to be same as Composite tank	2	Very difficult to predict. In worst case scenario, entire shell may need to be inspected	1

RDHLCC0027451

RED HILL TANK 19 OPTION EVALUATION/RANKING

RANKING SCALE: **3 HIGH** **(Desirable, Best Alternative, Highest confidence, best meets criteria)**
2 MEDIUM **(Second Choice, but meets criteria)**
1 LOW **(Least Desirable, Low Confidence, Least likely to meet criteria)**

Weighting Scale: **Weighting on scale of 1 lowest, 10 highest, most important**

Ranking Criteria	Rank Weight	Composite Tank		Bladder Tank		Repaired Tank	
		Comment	Rank	Comment	Rank	Comment	Rank
Confidence in Repair							
Reliance on existing shell	7	Very limited, only structural attachment for standoffs. Easy to fix in construction	3	Very limited, only for attachment of studs and batten strip	3	High reliance, only steel substrate/liner	1
Reliance on coatings	6	Limited to bottom only to prevent corrosion. Coating of barrel an additive option item, not necessary for success	3	Bladder is liner	3	extremely important to have coating that can bridge defects that are not found in surveys	1
Reliance on NDE during construction	7	Moderate on existing, high on new welding	2	Moderate on existing	3	Extremely important to find all existing leaks and thin spots	1
Reliance on contra QA/QC	6	normal to above average	3	normal to above average	3	Above average minimum, even more desired.	1
Environmental aspects							
Secondary Containment	9	Yes, 6" interstitial space to original shell	3	Yes, bladder on top of original shell	3	None	1
Physical Leak detection	9	Tell tale system, 13 zones plus bottom dome	3	Yes, 13 zones plus bottom dome (geotech material between liner and shell allows liquid flow)	2	Tell tales, but backside is concrete, horizontal connection at each shell course	1
Electronic leak detection	6	Inventory based/mass balance type system under trial by others	2	Inventory based/mass balance type system under trial by others	2	Inventory based/mass balance type system under trial by others	2
Total Unweighted Ranking Points			**62**		**50**		**27**
Total Weighted Ranking Points (Steve Brooks)		**458**	**45%**	**365**	**36%**	**194**	**19%**
Total Weighted Ranking Points (Steve DiGregorio)		**429**	**50%**	**273**	**32%**	**159**	**18%**

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RED HILL TANK 19 OPTION EVALUATION/RANKING

All ranking on scale of 1 lowest, 10 highest, most attractive/desirable

Ranking Criteria	Rank Weight	Composite Tank		Bladder Tank		Repaired Tank	
		Comment	Rank	Comment	Rank	Comment	Rank
Cost comparisons							
First Cost - base level		$5,298,000		$2,339,000		$4,641,000	
First Cost, with Additive Items		$6,604,000		$3,086,000		$5,357,000	
Comment on Cost		Highest cost, but provides secondary containment and long (50 yr.?) life		Lowest cost, but must plan on replacing bladder every 10 years		Only saves $650,000 over composite repair, with much less benefit and life	
Repair cost per Barrel		$19.99		$8.83		$17.40	
Ranking of criteria against options							
Life to liner/coating replacement	7	20 yr. bottom dome, no shell coating (apply yr. 20)	10	10 year Bladder change out	5	20 year minimum expectancy, bottom and shell	10
Quality of testing before design/constr	10	UT or MFE to assure structural attachment, visual to fix obvious problems	7	Limited UT or MFE to assure structural attachment, visual to fix obvious problems	7	Critical that 100% visual, MFE/UT, and Helium test find all known problems and thin spots	1
Cost of testing to assure success	3	$50,000-$75,000	10	$50,000-$75,000	10	$500,000 +	1
Need to test existing to assure success	5	Relatively minor	10	Relatively Minor	10	Mandatory, critical	1
Leak Detection Capability							
Electronic leak detection	1	Possible, being evaluated/tested by others	1	Possible, being evaluated/tested by others	1	Possible, being evaluated/tested by others	1
Tell tale leak detection	10	13 vertical zones, plus floor	7	Multiple vertical zones, plus floor possible	7	Combination horizontal and vertical zones, relies on old concrete integrity	7
Zoning of leak detection	10	effective, vertical 24 ft. wide		Probably effective if vertical attachments included		Horizontal per shell course, allows fuel to move around tank	
visual leak detection	10	Easy, new shell	10	Possible, but only big problems. May require soaping and pressurizing	5	difficult, old tank surface/, poor welding	1

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Leak Location							
Simplicity of Leak Location	10	Easiest of three, limited area to search	10	Depends on ability to slight pressurize bladder	5	Most difficult as tell tale system can mislead as to leak location	1
Accuracy/confidence of finding leak	10	Best	10	moderate to good	5	Moderate at best, recent poor tack record	3
Helium detection method	5	Could be set up as part of tell-tale system, 24 ft wide by shell height	10	Need to test permeability of liner bladder with Helium	5	Extremely difficult and expensive due to large areas covered by tell tales and old concrete permeability	3
Vacuum box method	5	easy, new surface	10	N/A		difficult, old surface	1
Visual Method	10	easiest, new surface	10	May be difficult due to being a bladder	3	moderate, difficult at old welds	3
Pressure test method	3	Possible, secondary containment	10	Possible, secondary containment, would have to have vertical attachments, only low pressure	5	Not practical due to porous concrete behind shell	3
Quantity of shell survey to find leak	3	Most likely limited to 24 ft. wide, by shell height	7	Depends on width between bladder vertical attachments, possible to be same as Composite tank	5	Very difficult to predict. In worse case scenario, entire shell may need to be inspected	1
Confidence in Repair							
Reliance on existing shell	5	Very limited, only structural attachment for standoffs. Easy to fix in construction	10	Very limited, only for attachment of studs and batten strip	10	High reliance, only steel substrate/liner	1
Reliance on coatings	5	Limited to bottom only to prevent corrosion. Coating of barrel an additive option item, not necessary for success	7	Bladder is liner	10	extremely important to have coating that can bridge defects that are not found in surveys	1
Reliance on NDE during construction	5	Moderate on existing, high on new welding	5	Moderate on existing	5	Extremely important to find all existing leaks and thin spots	1
Reliance on contra QA/QC	5	normal to above average	5	normal to above average	5	Above average minimum, even more desired.	4
Environmental aspects							

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Secondary Containment	10	Yes, 6" interstitial space to original shell	10	Yes, bladder on top of original shell	10	None	1
Physical Leak detection	10	Tell tale system, 13 zones plus bottom dome	10	Yes, 13 zones plus bottom dome (geotech material between liner and shell allows liquid flow)	10	Tell tales, but backside is concrete, horizontal connection at each shell course	5
Electronic leak detection	1	Inventory based/mass balance type system under trial by others	1	Inventory based/mass balance type system under trial by others	1	Inventory based/mass balance type system under trial by others	1
Total Unweighted Ranking Points			**170**		**124**		**51**
Total Weighted Ranking Points		**1178**		**842**		**367**	

RED HILL TANK 19 OPTION EVALUATION/RANKING

RANKING SCALE: **3 HIGH** **(Desirable, Best Alternative, Highest confidence, best meets criteria)**
2 MEDIUM **(Second Choice, but meets criteria)**
1 LOW **(Least Desirable, Low Confidence, Least likely to meet criteria)**

Weighting Scale: **Weighting on scale of 1 lowest, 10 highest, most important**

Ranking Criteria	Rank Weight	Composite Tank Comment	Composite Tank Rank	Bladder Tank Comment	Bladder Tank Rank	Repaired Tank Comment	Repaired Tank Rank
Cost comparisons							
First Cost - base level		$5,298,000		$2,339,000		$4,641,000	
First Cost, with Additive Items		$6,604,000		$3,086,000		$5,357,000	
Comment on Cost		Highest cost, but provides secondary containment and long (50 yr.?) life		Lowest cost, but must plan on replacing bladder every 10 years		Only saves $650,000 over composite repair, with much less benefit and life	
Repair cost per Barrel		$19.99		$8.83		$17.40	
Ranking of criteria against options							
Life to liner/coating replacement	7	20 yr. bottom dome, no shell coating (apply yr. 20)	3	10 year Bladder change out	1	20 year minimum expectancy, bottom and shell	3
Quality of testing before design/constr	10	UT or MFE to assure structural attachment, visual to fix obvious problems	3	Limited UT or MFE to assure structural attachment, visual to fix obvious problems	3	Critical that 100% visual, MFE/UT, and Helium test find all detectable problems and thin spots	1
Cost of testing to assure success	3	$50,000-$75,000	3	$50,000-$75,000	3	$500,000 +	1
Need to test existing to assure success	5	Relatively minor	3	Relatively Minor	3	Mandatory, critical	1
Leak Detection Capability							
Electronic leak detection	1	Possible, being evaluated/tested by others	3	Multiple vertical zones, plus floor possible	2	Combination horizontal and vertical zones, relies on old concrete integrity	1
Tell tale leak detection	10	13 vertical zones, plus floor	3	Multiple vertical zones, plus floor possible	2	Combination horizontal and vertical zones, relies on old concrete integrity	1
Zoning of leak detection	10	effective, vertical 24 ft. wide	3	Probably effective if vertical attachments included	1	Horizontal per shell course, allows fuel to move around tank	1
visual leak detection	10	Easy, new shell	3	Possible, but only big problems. May require soaping and pressurizing	1	Difficult, old tank surface/, poor welding	1

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RED HILL TANK 19 OPTION EVALUATION/RANKING

RANKING SCALE: **3 HIGH** (Desirable, Best Alternative, Highest confidence, best meets criteria)
2 MEDIUM (Second Choice, but meets criteria)
1 LOW (Least Desirable, Low Confidence, Least likely to meet criteria)

Weighting Scale: **Weighting on scale of 1 lowest, 10 highest, most important**

Ranking Criteria	Rank Weight	Composite Tank		Bladder Tank		Repaired Tank	
		Comment	Rank	Comment	Rank	Comment	Rank
Leak Location							
Simplicity of Leak Location	10	Easiest of three, limited area to search	3	Depends on ability to slightly pressurize bladder	1	Most difficult as tell tale system can mislead as to leak location	1
Accuracy/confidence of finding leak	10	Best	3	moderate to good	2	Moderate at best, recent poor tack record	1
Helium detection method	5	Could be set up as part of tell-tale system, 24 ft wide by shell height	3	Need to test permeability of liner bladder with Helium	1	Extremely difficult and expensive due to large areas covered by tell tales and old concrete permeability	1
Vacuum box method	5	easy, new surface	3	N/A		Difficult, old surface	1
Visual Method	10	easiest, new surface	3	May be difficult due to being a bladder	1	Moderate, difficult at old welds	1
Pressure test method	3	Possible, secondary containment	3	Possible, secondary containment, would have to have vertical attachments, only low pressure	2	Not practical due to porous concrete behind shell	1
Quantity of shell survey to find leak	3	Most likely limited to 24 ft. wide, by shell height	3	Depends on width between bladder vertical attachments, possible to be same as Composite tank	2	Very difficult to predict. In worse case scenario, entire shell may need to be inspected	1
Confidence in Repair							
Reliance on existing shell	5	Very limited, only structural attachment for standoffs. Easy to fix in construction	3	Very limited, only for attachment of studs and batten strip	3	High reliance, only steel substrate/liner	1
Reliance on coatings	5	Limited to bottom only to prevent corrosion. Coating of barrel an additive option item, not necessary for success	3	Bladder is liner	3	Extremely important to have coating that can bridge defects that are not found in surveys	1

RED HILL TANK 19 OPTION EVALUATION/RANKING

RANKING SCALE: **3 HIGH** **(Desirable, Best Alternative, Highest confidence, best meets criteria)**
2 MEDIUM **(Second Choice, but meets criteria)**
1 LOW **(Least Desirable, Low Confidence, Least likely to meet criteria)**

Weighting Scale: **Weighting on scale of 1 lowest, 10 highest, most important**

Ranking Criteria	Rank Weight	Composite Tank		Bladder Tank		Repaired Tank	
		Comment	Rank	Comment	Rank	Comment	Rank
Reliance on NDE during construction	5	Moderate on existing, high on new welding	3	Moderate on existing	3	Extremely important to find all existing leaks and thin spots	1
Reliance on contra QA/QC	5	normal to above average	3	Normal to above average	3	Above average minimum, even more desired.	1
Environmental aspects							
Secondary Containment	10	Yes, 6" interstitial space to original shell	3	Yes, bladder on top of original shell	3	None	1
Physical Leak detection	10	Tell tale system, 13 zones plus bottom dome	3	Yes, 13 zones plus bottom dome (geocushion material between liner and shell allows liquid flow)	2	Tell tales, but backside is concrete, horizontal connection at each shell course	1
Electronic leak detection	1	Inventory based/mass balance type system under trial by others	3	Inventory based/mass balance type system under trial by others	3	Inventory based/mass balance type system under trial by others	3
Total Unweighted Ranking Points			**66**		**45**		**26**
Total Weighted Ranking Points (Steve DiGregorio)		**429**	**50%**	**273**	**32%**	**159**	**18%**

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