Red Hill Administrative Order on Consent Scope of Work Deliverable

Section: 3.2 Tank Upgrade Alternatives (TUA) Scope of Work.

In accordance with the Red Hill Administrative Order on Consent, paragraph 9, DOCUMENT CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fines and imprisonment for knowing violation.

Signature: R.D.H

CAPT R. D. Hayes III, CEC, USN
Regional Engineer, Navy Region Hawaii

Date: Sept 8 2016

Contract N62742-13-D-0001, Delivery Order 0009

3.2 TANK UPGRADE ALTERNATIVES (TUA)

Scope of Work Outline Final Submission
September 2016

RED HILL FUEL STORAGE FACILITY
NAVSUP FLC PEARL HARBOR, HI (PRL)

Joint Base Pearl Harbor-Hickam

Administrative Order on Consent
In the matter of Red Hill Bulk Fuel Storage Facility
EPA Docket No. RCRA 7003-R9-2015-01
DOH Docket No. 15-UST-EA-01

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EEI Project No. 8290

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3.0 TANK UPGRADE ALTERNATIVES (TUA)

Draft Scope of Work Outline Submission
January 2016

RED HILL FUEL STORAGE FACILITY
NAVSUP FLC PEARL HARBOR, HI (PRL)

Joint Base Pearl Harbor-Hickam

1.0 EXECUTIVE SUMMARY

The Executive Summary (Under Development)

1.1 Introduction

To include a discussion on the purpose of the study as defined by the AOC SOW paragraph 3.0

1.2 Assessment Methodology

1.3 Step 1: Available Technology Screening

1.4 Step 2: Secondary Screening of Alternatives

1.5 Step 3: Assessment of BAPT Tank Upgrade Alternatives

1.6 Related Work Completed by Others

1.6.1 AOC Section 2: Tank Inspection, Repair and Maintenance (TIRM)

1.6.2 AOC Section 4: Release Detection / Tank Tightness Testing

1.6.3 AOC Section 5: Corrosion and Metal Fatigue Practices

1.7 Construction Execution Challenges

1.7.1 Construction Power

1.7.2 Data Collection (Lower Tunnel Fiber Optic Needs)

1.7.3 Staging and Material Handling

1.7.4 Access to Tank Lining for Inspection and Repair

1.8 Execution Scheduling Issues

1.8.1 Number of Tanks at a Time

1.8.2 Acquisition Strategy Considerations

1.9 Pilot Programs

2.0 EXISTING TANK CONSTRUCTION/CONFIGURATION

The purpose of §2.0 is to set the stage for repairs and upgrades by introducing the basic concepts on how the tanks were originally built, to what standards (none), and how they have survived over the years. This will include some summary of past failure mechanisms sufficient to build on for the future

2.1 Background

The FLC Pearl Harbor Red Hill Bulk Fuel Storage Facility was constructed during August 1940 to September 1943. The facility consists of twenty underground vertical cylindrical reinforced concrete fuel storage tanks (Tanks 1 - 20) with a dome top and dome bottom, internal steel liner, fuel piping, mechanical and ventilation systems, electrical systems, Upper Tunnel, Lower Tunnel, Adits 3, 4, 5, and 6, and associated infrastructure. A 3+-mile tunnel connects the Tank Gallery area to the Underground Pumphouse at Pearl Harbor Naval facility.

The Upper Tunnel provides access to the tank manholes and gauging platforms. The Lower Tunnel provides access to the tank piping and valves. Adit 4 (located at Tanks 1 and 2) and Adit 5 (located between Tanks 13 and 15) provide access to the Upper Tunnel. Adit 3 provides access to the Lower Tunnel at Tanks 1 and 2. The only access into the tanks is via an 8 feet diameter manhole at the Upper Tunnel level.

Each tank has a steel framed tower in the center of the tank extending from the floor of the lower dome to the top of the upper dome with a walkway from the manhole at the Upper Tunnel level to the tower. The center tower was used during original construction to construct the tanks and remains in the tanks for maintenance and crane service.

Eighteen tanks are currently in service and presently used to store military fuel as follows:

- Tanks 2 to 6: JP-8
- Tanks 7 to 12: JP-5
- Tanks 13 to 16: F-76
- Tanks 17, 18, 20: JP-5

Tank 1 and Tank 19 are not in active service. Tank 19 was taken out of service circa 1986 for gauging repairs. The tank was not placed back in service.

The reason for taking Tank 1 out of service has not been disclosed.

2.2 Tank Construction/Configuration

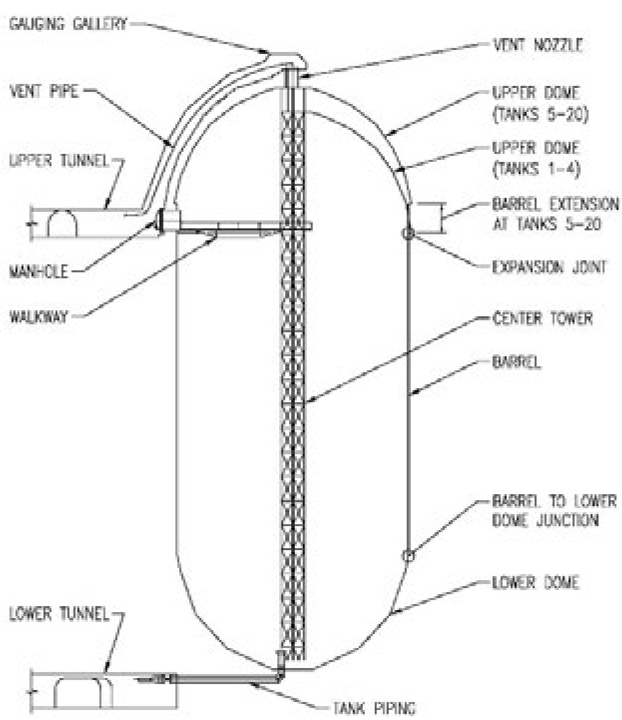
Tanks 1 to 4 are 100 feet 0 inches diameter, 238 feet 6 inches overall height and have a nominal storage capacity of 285,251 barrels (Bbl) each. Tanks 5 to 20 are 100 feet 0 inches diameter, 250 feet 6 inches overall height and have a nominal storage capacity of 302,037 Bbl each. The top of the tanks (top of the upper dome) is 110 feet to 175 feet below ground. The bottoms of the tanks range in elevation from 123 to 151 feet above sea level.

Tanks 1 to 20 were constructed by excavating the lava rock formation of Red Hill to create a chamber for each tank which was then lined with reinforced concrete and a 1/4-inch thick steel liner. The tanks are arranged in two rows of 10 tanks, spaced 200 feet on center. 100 feet of lava rock separates the tanks from each other. The primary structure of the tanks consists of an upper dome, barrel, and lower dome. The upper dome was constructed first. Rock was excavated to create a cavity for the upper dome. Steel framing and liner plates were then installed, followed by filling the cavity between the liner plates and lava rock with reinforced concrete, 4 feet thick. After the upper dome was constructed, the barrel and lower dome were excavated and the rock face was sealed with spray-applied concrete (gunite). The barrel is constructed of reinforced concrete (2 feet 6 inches thick minimum at the top, 4 feet thick minimum at the bottom). Steel angles were cast into the concrete for installation of the steel liner. The concrete tank was lined with 1/4-inch thick steel plates, which were attached by welding to the imbedded steel, and butt welded together at all plate edges. After the barrel was constructed, it was pre-stressed by injecting grout between the reinforced concrete and lava rock. The lower dome is similarly constructed of reinforced concrete and lined with 1/4-inch thick steel plates. The floor of the lower dome is flat and consists of 1/2-inch thick steel plates.

Major features of a Red Hill Tank include:

- Tank piping
- Lower Dome
- Lower Dome/Barrel junction
- Barrel
- Expansion joint at top of barrel
- Barrel extension above expansion joint (Tanks 5 to 20 only)
- Upper Dome
- Center Tower
- Gauging gallery above Upper Dome
- Tank vent
- Tell-tale Leak Detection piping

Major features of a Red Hill Tank are shown in the following graphic:



EXISTING TANK FEATURES

2.3 Historical Structural and Integrity Issues

This discussion summarizes typical structural and integrity issues. Details of tank histories are provided in other AOC Sections by others. Structural and integrity issues relevant to repairing the tank for a future use consist of:

- Internal corrosion and pitting,
- External corrosion,
- Holes in the steel liner requiring repair
- Dents and bulges in liner plates that would interfere with repairs
- Defective welds in the upper dome. Some tanks were repaired in the past by welding channels over defective welds. Other tanks were repaired by welding batten plates over defective welds. And some tanks were repaired by re-welding only the defective weld

- Defective welds in the barrel and lower dome (intermittent cracks, lack of fusion, porosity, and slag inclusions) requiring repair
- Failures (breaches) and internal corrosion in the leak detection piping (the leak detection piping in some of the tank has been removed)
- Repairs to the center tower
- Internal corrosion in the tank piping leading to the main headers in the lower tunnel

2.4 Non-Structural and Hydraulic Issues

Issues associated with tank leak detection, gauging, and release detection system upgrades are covered in AOC Section 4.

Additional material Placeholder

2.5 Impact of Tank Construction/Configuration on Upgrades

Important and related issues of actual execution of inspections, repairs and upgrades for the Red Hill tanks are unique for tank work, but have been addressed in other construction projects.

- Inspecting the barrel and upper dome involves working from suspended two-man baskets (scaffolding) supported from booms erected on the center tower, or erecting staging inside the tank. An additional alternative, to provide moveable suspended platforms on a trolley also should be investigated.
- Repairs to the existing steel liner on the barrel involves working from suspended two-man baskets (scaffolding) supported from booms erected on the center tower, or erecting staging inside the tank. An additional alternative, to provide moveable suspended platforms on a trolley also should be investigated.
- Repairs to the upper dome involves working from suspended two man-baskets (scaffolding).
- Materials for tank upgrades can only be brought into the tanks via the upper tunnel, and must fit through the tunnel doors and tank manhole.
- Recent tank cleaning, inspection, and repair projects at Red Hill tanks have identified critical deficiencies in obtaining power for construction.
- The piping from the lower dome is encased in the concrete base below each tank. Providing new piping requires boring though approximately 45 feet of concrete to the lower tunnel. Alternatives for repair of exiting piping also need to be explored.

3.0 STEP 1: AVAILABLE TECHNOLOGY SCREENING

3.1 Introduction

Step 1 in the overall development of BAPT technology alternatives was completed to identify ideas on how the present tanks may be upgraded to improve integrity, reliability, and offer credible means of leak detection and/or containment.

3.2 Key Background Documents

The following key documents have addressed in the past, upgrade alternatives for the Red Hill Tanks:

- 1997 – Upgrade of Red Hill, Tank 19: EEI completed this study under contract to NAVFAC, to develop ideas for upgrades to out of service Tank 19.
- 2008 – Update to the 1997 Tank 19 report, and expansion to Upgrade of Red Hill Tanks (with fundamentally similar findings)
- 2008 – Market Survey of Leak Detection Systems for the Red Hill Fuel Storage Facility, Michael Baker Jr. Inc.

3.3 Resources Consulted

EEI, being involved in numerous tank repair projects throughout the world, has been exposed to and executed a wide variety of minor and major tank repairs, and new tank engineering projects. Many of the ideas developed as candidate technologies for Red Hill are based on our individual and corporate experiences.

Additional resources consulted for ideas include industry and military fuel tank managers, internet searches, construction contractors and colleagues in the business.

3.4 Process Methodology

Technologies are not singular in practice, and are a result of a combination of repair techniques that need to address the many unique characteristics of the Red Hill tanks. We refer to them as technologies based on the concept of similarity as to materials, or application. Most all in fact use common engineered materials such as steel and coatings formulated to provide corrosion prevention, or to bridge defects in the substrate.

The method of developing the candidates was similar to the brainstorming concept, wherein ideas were tossed out and recorded for additional discussion.

EEI used the following process to identify and evaluate available tank upgrade technologies under the Step 1 Methodology:

1. Identify candidate tank upgrade technologies. The technologies or upgrade concepts are grouped into the following categories:
    a. Tank Interior Upgrades (Repair existing, coatings, liners, primarily single wall).

b. Upgrades to Provide Secondary Containment with Release Detection (Double wall, or diked)
c. Tank Exterior Upgrades (Technologies applied outside of the primary tank lining an concrete barrel)

2. Evaluate and screen candidate technologies for further investigation (summarized in Table 3-1) under Step 2 process.
3. Steps 2 take the results of Step 1, and reduce the candidates to a final group of six (6) concepts for detailed evaluation as a BAPT technology during Step 3. Table 4-1 summarizes candidate technologies being screened in Step 2.

3.5 Candidate Technologies and Initial Screening

Paragraph 3.6 discusses the candidate technologies. Table 3-1 lists candidate technologies that EEI identified for tank upgrades. Screening of the technologies considering the following criteria:

- Feasible and Testable (after construction)
- Inspectable and Repairable (future integrity assessment)

See paragraph ???? for definitions of screening criteria. Technologies passing these criteria were selected for further investigation as a part of Step 2. Technologies not passing these criteria were not selected for further investigation and comments are provided as to justification. In the event a technology passes the four criteria but is not selected for further investigation, comments as to reason for rejection are provided.

See paragraph 3.6 for detailed descriptions of candidate technologies that EEI has identified for tank upgrades and initial screening.

3.6 Available Tank Upgrade Technologies

Table 3-1 summarizes available technologies that EEI has identified for tank upgrades. The table identifies technologies that EEI selected for further investigation and technologies not selected for further investigations and reasons for rejection.

A variety of single wall and double wall technologies were considered. Characteristics of the technologies are further described, including discussion on whether or not they were considered for further evaluation.

3.6.1 Single Wall Tank Interior Upgrades

The following candidate interior upgrades represent initial brainstorming to upgrade the present tanks. Double wall/secondary containment approaches discussion follows.

> 3.6.1.1 is an example of how the initial list of candidate technologies will be presented and either accepted for moving forward, or rejected at this level

3.6.1.1 Repair of Existing Tank Shell – Patch Plates and Welding

General Description:

Alternative 1A is similar to the current approach to inspect and repair the tanks but with enhanced TIRM procedures established to assure the full integrity of the existing steel liner is investigated for long-term life extension repairs. Tank repairs include repairing pitting, holes, and defective welds (intermittent cracks, lack of fusion, porosity, and slag inclusions) in the existing steel liner. Alternative 1A also includes extensive repairs to present existing single wall concrete encased piping from the tank to the first valve outside tank or replacing the entire piping with double wall construction.

Practicable:

This general concept of tank upgrades is considered practicable based on being similar to what has already been done at Red Hill, as well as common application throughout the petroleum tank industry

Feasible and Testable (after construction): Yes

Inspectable and Repairable (future integrity assessment): Yes

Conclusion:

Overall, the inspection and repair is considered conventional construction, with the emphasis placed on thoroughness, with appropriate contractor Quality Control (QC) and government oversight and Quality Assurance program. This concept is advanced to Step 2 for additional consideration and assessment.

3.6.1.2 Replace/provide Tell Tale System

[Text – later] [Note: This is sub option that may apply to several alternatives]

3.6.1.3 Coating Systems on Existing Shell

[Generic coating discussion to be provided]

Epoxy Coating (Thin Film): xxx

[Text – later]

Polysulfide Modified Epoxy Novolac: xxx

[Text – later]

Urethane (Thin Film): xxx

[Text – later]

Polyurea (Thick Film): xxx

[Text – later]

Thermal Spray Aluminum (Metalizing): xxx

[Text – later]

Thermal Spray Ceramic: xxx

[Text – later]

Glass: xxx

[Text – later]

3.6.1.4 Lining Systems

[Generic discussions on lining systems]

3.6.1.5 Single Wall Fiberglass: xxx

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.1.6 Rubber Lining: xxx

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.1.7 Flexible Membrane: xxx

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.1.8 Carbon Fiber Sheet: xxx

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.1.9 Weld Overlay

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.1.10 Concrete

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.1.11 Spray Applied Concrete (Gunite)

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.1.12 Ceramic Tile

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.2 Upgrades to Provide Secondary Containment with Release Detection

[Add generic text on double wall concepts]

3.6.2.1 Composite Tank (Carbon Steel)

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.2.2 Composite Tank (Duplex Stainless Steel)

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.2.3 Tank within a Tank (Carbon Steel)

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.2.4 Tank within a Tank (Duplex Stainless Steel)

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.2.5 Double Wall Fiberglass (TankBau)

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.2.6 Steel Liner Plates Welded to Existing Steel Liner

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.2.7 Steel Liner Plates with Expanded Metal Welded to Existing Steel Liner

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.2.8 Stainless Steel Membrane over Existing Steel Liner (LNG Tank Concept)

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.2.9 Flexible Membrane

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.2.10 Dimple Jacket Stainless Steel

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.3 Tank Exterior Upgrades

Add general explanatory text

3.6.3.1 Cementitious Grout

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.3.2 Chemical Grout

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.3.3 Cut-off Pan

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.3.4 Sheet Pile Wall

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.6.3.5 Cryogenic Encapsulation

General Description:

Practicable:

Feasible and Testable (after construction): xxx

Inspectable and Repairable (future integrity assessment): xxx

Conclusion:

3.7 Screening Criteria Definitions

Critical definitions for screening criteria were refined at the December Scoping meetings as follows:

Feasible: Alternative can be constructed in the field at Red Hill using practicable construction means and methods.

- Any solution must be an adaptation of common or previously used methods, and avoid being a science project, but still take advantage of innovative technology when appropriate.
- Practicable must recognize the difficulty in bringing construction materials into the tanks through the limited access upper tunnel system.

Testable: Alternative can be tested and shown acceptable during construction and startup/commissioning.

- Can the contractor provide adequate Quality Control (QC), and the government adequate Quality Assurance checks (QA)?
- Are there industry acceptable practices followed during startup?
- Will the technology hold product for the foreseeable future, preferably for several inspection cycles?

Inspectable: Able to determine integrity on a periodic basis either in service, and or out of service.

- Once placed into initial service, can you determine its integrity in the future?

Repairable: Able to be repaired in field at Red Hill using practicable construction/repair means and methods.

- If a deficiency or integrity defect is discovered as a part of a future integrity inspection, can the problem be fixed?

TABLE 3-1
SUMMARY - CANDIDATE TANK UPGRADE TECHNOLOGIES

Technology	Screening Criteria				Comment
	Feasible	Testable	Inspectable	Repairable	
Tank Interior Upgrades – Single Wall					
Repair Existing Steel Liner	The alternative requires sufficiently thorough inspection of the tank envelope (floor, lower dome, and barrel, expansion joint and upper dome) to identify all defects that once repaired; provide a life extension well beyond the next inspection cycle. Specifics are outlined in AOC Section 2, the TIRM report.				
Patch Plates and Welding	Yes	Yes	Yes	Yes	• Once the locations and type of defects are identified, the actual repair is considered conventional, recognizing the difficulty of working in a Red Hill tank. Selected for further investigation. The degree of repair may vary depending on characteristics of final BAPT selected • Selected for additional Step 2 investigation under Alternatives 1A, 1B, and 1D, and as a preliminary step for Alternatives and 1E • Preliminary Step for Alternatives 2A, 2B, 2C

TABLE 3-1
SUMMARY - CANDIDATE TANK UPGRADE TECHNOLOGIES

Technology	Screening Criteria				Comment
	Feasible	Testable	Inspectable	Repairable	
Replace/provide release detection pipes (similar to original tell-tale system)	Yes	Yes Limited	Yes	Yes	• The original tell-tale system failed early on in some tanks, from a combination of corrosion and internal plugging. • Investigations into a revised tell-tale system is warranted to see if a different approach to materials and construction has merit. • This would be a sub alternative on any single wall tank alternative
Coatings	Coatings are considered an additional technology that can be applied over existing steel tank lining. The degree of inspection and repair of the existing steel as a substrate for the coating is dependent on the concept of the coating, i.e. a corrosion inhibiting feature, or a new, independent hydraulic envelope.				
Epoxy (thin film)	Yes	Yes	Yes	Yes	Very traditional, but not selected for further investigation as the Navy has selected polysulfide modified epoxy novolac for tank interior coating.
Polysulfide Modified Epoxy Novolac (thin film)	Yes	Yes	Yes	Yes	• Navy standard system • Able to bridge gaps in substrate • Selected for standardized application, if the primary steel alternative calls for a coating

TABLE 3-1
SUMMARY - CANDIDATE TANK UPGRADE TECHNOLOGIES

Technology	Screening Criteria				Comment
	Feasible	Testable	Inspectable	Repairable	
Urethane (thin film)	Yes	Yes	Yes	Yes	• Was used on the Red Hill Tanks circa late 1960s and 1970s • Urethane coating is another coating that could be considered but would not necessarily present a different solution, only a permutation thus not considered separately at this time.
Polyurea (thick film)	Yes	Yes	Yes	Yes	Not selected for further investigation: • Cures within seconds, limiting adhesion properties
Thermal Spray Aluminum (Metalizing)	Yes	Yes	Yes	Yes	• Provides corrosion protection • In 70s-80s was a standard option for Navy tank rehab, but was discontinued due to high cost, and limited benefit • Selected for further investigation (Alternative 1C)
Thermal Spray Ceramic	Yes	Yes	Yes	Yes	Ceramic coating is another type of thermal spray coating that could be considered but would not necessarily present a different solution, only a permutation of Alternative 1C, thus not considered separately at this time.
Glass	No	Yes	Yes	No	Not selected for further investigation: • Performed in factory, not applicable to field application • Once coated, steel plate cannot be welded

TABLE 3-1
SUMMARY - CANDIDATE TANK UPGRADE TECHNOLOGIES

Technology	Screening Criteria				Comment
	Feasible	Testable	Inspectable	Repairable	
Liners	**Liners generally are considered a form of new tank hydraulic envelope, inside of the original steel liner**				
Single Wall Fiberglass	Yes	Yes	Yes	Yes	Not selected for further investigation: • Very poor track record in tanks, compared to other linings/coatings
Rubber Lining	Yes	Yes	Yes	Yes	Selected for further investigation (Alternative 1E)
Flexible Membrane	Questionable	Limited	Yes	Yes	Selected for further investigation (Alternative 8)
Carbon Fiber Sheet	Yes	Yes	Yes	Yes	Not selected for further investigation: • Not intended as a hydraulic barrier
Carbon Fiber Sandwich Panel	No	Unknown	Yes	Unknown	Not selected for further investigation: • Sandwich panels are rigid and cannot be formed to curvature of tank • Difficult to seal joint between panels • Not intended as a hydraulic barrier
Dimple Jacket					•
Weld Overlay					•
Concrete					•
Gunite					•
Ceramic Tile					•

TABLE 3-1
SUMMARY - CANDIDATE TANK UPGRADE TECHNOLOGIES

Technology	Screening Criteria				Comment
	Feasible	Testable	Inspectable	Repairable	
Upgrades to Provide Secondary Containment with Release Detection					
Composite Tank (Carbon Steel)	Yes	Yes	Yes	Yes	Selected for further investigation (Alternative 2A)
Composite Tank (Duplex Stainless Steel)	Yes	Yes	Yes	Yes	Selected for further investigation (Alternative 2B)
Tank within a Tank (Carbon Steel)	Yes	Yes	Yes	Yes	Selected for further investigation (Alternative 3A)
Tank within a Tank (Duplex Stainless Steel)	Yes	Yes	Yes	Yes	Selected for further investigation (Alternative 3B)
Double Wall Fiberglass with Release Detection (TankBau system)	Unknown	Limited	Yes	Limited	Selected for further investigation (Alternative 4)
Steel Liner Plates Welded to Existing Steel Liner	Yes	Yes	Yes	Yes	Selected for further investigation (Alternative 5A)
Steel Liner Plates with Expanded Metal Plate between Existing Steel Liner and Steel Liner	Yes	Yes	Yes	Yes	Selected for further investigation (Alternative 5B)
Stainless Steel Membrane over existing steel liner (similar to LNG membrane tank concept)	Yes	Yes	Yes	Yes	Selected for further investigation (Alternative 6)

TABLE 3-1
SUMMARY - CANDIDATE TANK UPGRADE TECHNOLOGIES

Technology	Screening Criteria				Comment
	Feasible	Testable	Inspectable	Repairable	
Flexible Membrane	Doubtful	Limited	Yes	Yes	Selected for further investigation (Alternative 7)
Tank Exterior Upgrades					
Encapsulation					
Cementitious Grout	Doubtful	No	No	Questionable	•
Chemical Grout (Types of chemical grout include urethane, polyurethane, sodium silicate, and acrylic. Each has different properties and uses.)	Doubtful	No	No	Questionable	•
Cut-off Pan	Doubtful	No	No	No	
Sheet Pile Wall	No	No	No	No	
Cryogenic (Ice layer outside Tank)	No	No	No	Questionable	•

4.0 STEP 2: SECONDARY SCREENING OF ALTERNATIVES

4.1 Tank Upgrade Alternatives – Summary of BAPTs Considered

Table 4-1 summarizes the tank upgrade alternatives considered for further investigation after Step 1, Available Technology Screening.

4.2 Secondary Screening Methodology

This section takes a new look at the xx candidate Alternatives developed in Step 1, and further assesses the Alternative on its merits, for further consideration as a candidate BAPT technology for detailed assessment under Step 3.

The primary items considered in the Step 2 review are:

Practicability: Can the candidate alternative truly be completed inside of a Red Hill Tank.

Suitability: Is it a technology that is established for the storage of petroleum products, and more importantly, military fuels that contain special additives.

Constructible: Can it truly be constructed with expectations of a successful contractor quality control program, and government quality assurance program?

Desirability: When compared against the competing candidate alternatives, does it provide a better feature, or nothing of additional benefit

4.3 Review of Candidate Alternatives

4.3.1 Alt 1A: Restoration of Tank

4.3.2 Alt 1B: Restoration of Tank plus Interior Coating

4.3.3 Alt 1C: Restoration of Tank plus Metalizing

4.3.4 Alt 1D: Remove Existing Steel Liner, Install New Liner

4.3.5 Alt 1E: Rubber Liner Bonded to Existing Steel

4.3.6 Alt 2A: Composite Tank – Carbon Steel

4.3.7 Alt 2B: Composite Tank – Stainless Steel

4.3.8 Alt 3A: Tank in Tank – Carbon Steel

4.3.9 Alt 3B: Tank in Tank – Stainless Steel

4.3.10 Alt 4: Double Wall Fiberglass with Release Detection

4.3.11 Alt 5A: Steel Plates Welded to Existing Liner

4.3.12 Alt 5B: Steel Plates Welded to Existing Liner with Mesh in Interstice

4.3.13 Alt 6: Stainless Steel Membrane welded to Existing Steel Liner

4.3.14 Alt 7: Flexible Membrane Liner

4.4 Table 4-1 Tank Upgrade Alternatives Evaluated

Table 4-1 summarizes the individual Alternatives, overall characteristics, and conclusion of Step 2 assessment as to moving forward to Step 3, BAPT Assessment.

TABLE 4-1
TANK UPGRADE ALTERNATIVES EVALUATED (SUMMARY)

Alternative	Concept	Discussion
Single Wall – Existing Tank Upgrade Concepts		
1A	Restoration of Existing Tank (similar to current integrity inspection and repair approach, with improvements)	• Use of current concept to inspect and repair the existing tank • Will utilize enhanced procedures developed in TIRM (AOC Section 2) • The tank would not have secondary containment, thus would have to rely on BAPT release detection system and periodic tightness testing for environmental compliance. • Existing steel barrel and upper dome liner not coated or repaired. Lower dome coating repaired or renewed. • This Alternative includes extensive repairs to, or replacing existing concrete encased piping from the tank to the first valve outside tank with double wall construction. This is considered a Sub Alternative separately assessed. • Installation of a Tell-Tale system considered as a Sub-Alternative • The physical volume of the container to contain liquid includes the lower dome, barrel, and upper dome and does not consider safe fill height, level alarm set point, or overfill protection shutoff. • Alternative 1A deemed worthy of further consideration under Step 3, BAPT Assessment

TABLE 4-1 TANK UPGRADE ALTERNATIVES EVALUATED (SUMMARY)		
Alternative	**Concept**	**Discussion**
1B	Restoration of Existing Tank plus Interior Coating	• Same as Alternative 1A plus an enhanced coating/lining system such as polysulfide modified epoxy novolac (the NAVFAC approved tank coating system). • The tank would not have secondary containment, thus would have to rely on BAPT release detection system and periodic tightness testing for environmental compliance.. • This Alternative includes extensive repairs to, or replacing existing concrete encased piping from the tank to the first valve outside tank with double wall construction. This is considered a Sub Alternative separately assessed. • Installation of a Tell-Tale system considered as a Sub-Alternative • Note that numerous alternative industrial grade coatings could be considered, but all must pass the criteria of surviving military additives in fuel. Any alternative would not necessarily present a different solution, only a permutation of Alternative 1B, thus not considered separately at this time. • Storage volume consideration same as Alternative 1A. • Alternative 1B deemed worthy of further consideration under Step 3, BAPT Assessment

TABLE 4-1 TANK UPGRADE ALTERNATIVES EVALUATED (SUMMARY)		
Alternative	**Concept**	**Discussion**
1C	Restoration of Existing Tank plus Metalizing and Interior Coating on Existing Steel Liner	• Same as Alternative 1A plus a spray applied metalizing coating (aluminum) on the existing steel liner and an enhanced coating/lining system such as polysulfide modified epoxy Novolac (the NAVFAC approved tank coating system) over the metalizing. • The tank would not have secondary containment, thus would have to rely on BAPT release detection system and periodic tightness testing for environmental compliance. • Storage volume consideration same as Alternative 1A. A further evaluation of the metallizing concept resulted in it being rejected from further consideration due to the following reasons: • Metalizing is no longer considered suitable technology for anything other than enhanced corrosion protection, or physical material build up in the most critical applications, with no other appropriate means of meeting the requirements, such as use of liquid applied coatings/linings • Application requirements are stringent in terms of material surface preparation (white metal blast), exceeding that of liquid applied coatings. • Metalizing is inherently porous, resulting in the need to apply a liquid lining/coating over the metalizing. • Alternative 1C not considered worthy for further assessment
1D	Remove existing steel liner on all tank surfaces, and provide a new steel liner, welded to original imbedded steel in concrete	•

TABLE 4-1 TANK UPGRADE ALTERNATIVES EVALUATED (SUMMARY)		
Alternative	**Concept**	**Discussion**
1E	Rubber Lining Bonded to Existing Steel Liner.	• The tank would not have secondary containment, thus would have to rely on BAPT release detection system and periodic tightness testing for environmental compliance. • This alternative includes replacing existing concrete encased piping from the tank to the first valve outside tank with double wall construction. • Storage volume consideration same as Alternative 1A. A further evaluation of the metallizing concept resulted in it being rejected from further consideration due to the following reasons: • Need to prepare existing steel liner to remove protrusions and coating systems that prevent bonding. The likelihood for successfully completing was not ranked highly given the highly varied surface with considerable protrusions throughout the tank. • No added benefit of a thick rubber liner over more conventional liquid applied coating systems. Alternative 1D not considered worthy for further assessment

TABLE 4-1
TANK UPGRADE ALTERNATIVES EVALUATED (SUMMARY)

Alternative	Concept	Discussion
Secondary Containment Concepts Note: Secondary containment concepts include inherent release detection barrier and release detection capability outside of the primary barrier (tank shell). Release detection sensors provide direct measurement/indication of a release.		
2A	Composite Tank (Double Wall) Carbon Steel	• Steel liner with concrete or grout filled (3-inch) interstitial space for release detection. • Existing steel shell becomes secondary containment envelope after inspection/repair. No coating repairs or renewal on existing steel liner. Steel liner requires inspection and integrity repairs per TIRM requirements, which may be same, or of different degree than that used for alternatives relying on existing liner as primary tank envelope. • Steel liner (primary tank envelope) will be pre-coated with final primer before installation and the final coating (polysulfide modified epoxy novolac) applied after erection. • Release detection provided by secondary containment interstice zoned by shell area, and piped by gravity to sensor racks in lower tunnel. Provides dynamic full time release detection with sensors to alarm at central location. • This alternative includes replacing existing concrete encased piping from the tank to the first valve outside tank with double wall construction. • Upper dome would not receive composite liner and thus not be used for fuel storage; this results in a reduction in storage capacity.
2B	Composite Tank (Double Wall) Duplex Stainless Steel	•
3A	Tank within a Tank (Carbon Steel)	•
3B	Tank within a Tank (Duplex Stainless Steel)	•
4	Double Wall Fiberglass System with Release Detection	•
5A	Steel Liner Plates Welded to Existing Steel Liner	•

TABLE 4-1 TANK UPGRADE ALTERNATIVES EVALUATED (SUMMARY)		
Alternative	Concept	Discussion
5B	Steel Liner Plates Expanded Metal Plate between Existing Steel Liner and Steel Liner	•
6	Stainless Steel Membrane over Existing Steel Liner (similar to LNG membrane tank concept)	•
7	Flexible Membrane Liner (no steel plates), not bonded to steel liner	•

4.5 Sub-Alternatives

Several partial repair concepts have implications across multiple alternatives, and thus are discussed separately below. Section 5.0 further outlines when a sub-alternative is applicable to any given final BAPT Alternative being assessed.

4.5.1 Tell-Tale System

4.5.2 Tank Nozzles

5.0 STEP 3: ASSESSMENT OF BAPT TANK UPGRADE ALTERNATIVES

5.1 Alternatives Considered

Step 2, secondary screening of Tank Upgrade Alternates with input from stakeholders at the December 3rd and 4th 2015 AOC Scoping Meetings resulted in six final candidates (three single wall tank alternatives and three double wall tank/secondary containment alternatives) for the Step 3, detailed BAPT assessment. The six selected alternatives are:

Single Wall Tank Alternatives:

- Alternative 1A – Restoration of Existing Tank
- Alternative 1B – Restoration of Existing Tank plus Interior Coating
- Alternative 1D – Remove Existing Steel Liner, Install New Steel Liner

Double Wall Tank/Secondary Containment Alternatives:

- Alternative 2B – Composite Tank (Double Wall) Carbon Steel
- Alternative 2B – Composite Tank (Double Wall) Stainless Steel
- Alternative 3A – Tank within a Tank (Carbon Steel)

5.2 BAPT Attribute Definitions and Ranking System

Each BAPT is assessed for several attributes, with a ranking system applied to each attribute to aid in evaluating each alternative relative to each other. Attributes and suggested ranking system are defined in the following table.

TABLE 5-1
BAPT ATTRIBUTE DEFINITIONS AND RANKING SYSTEM

Attribute	Definition	Ranking System
1. **Primary Positive Attributes**	Summarizes the pros of the alternative	N/A – subjective information
2. **Primary Negative Attributes**	Summarizes the cons of the alternative	N/A – subjective information

TABLE 5-1
BAPT ATTRIBUTE DEFINITIONS AND RANKING SYSTEM

Attribute	Definition	Ranking System
3. Risks	Summarizes the risks of the Alternative Risk is a measure of the uncertainty of achieving goals and considers the likelihood (i.e. probability) of an event's occurrence and consequence (i.e. impact) on achieving goals.	Low (most likely to succeed) Medium (expected to succeed) High (success is not assured)
4. Benefits	Summarizes the benefits of the alternative	None
5. Constructible	Can be constructed in field at Red Hill using practicable construction means and methods	Numerical Ranking: 0 N/A or Not successful (0%) 1 Minimal (~10%) 2 Low (~30%) 3 Moderate (~50%) 4 Moderately High (~70%) 5 High (~90%)
6. Testable	Can be tested and shown acceptable during construction (QC/QA) and startup/commissioning	Numerical ranking, see above
7. Inspectable	Able to determine integrity on a periodic basis while tank is in service, or out of service	Numerical ranking, see above
8. Repairable	Able to be repaired in field at Red Hill using practicable construction/repair means and methods	Numerical ranking, see above
9. Restorability	Can alternative be undone in future?	Numerical ranking, see above
10. Is Concept Practicable? (Likelihood of Successful Construction)	Able to be done or put into practice successfully	Numerical ranking, see above
11. Successful Implementation at Other Large Fuel Depots in Preventing Leaks	Alternative has/has not been put into place at other large fuel depots and is/is not successful in preventing leaks	Numerical ranking, see above

TABLE 5-1
BAPT ATTRIBUTE DEFINITIONS AND RANKING SYSTEM

Attribute	Definition	Ranking System
12. Applicability to the Red Hill Bulk Fuel Storage Facility	Alternative is relevant and can be applied to the Red Hill tanks.	Numerical ranking, see above
13. Reliability (level of confidence)	Ability of a system or component to perform its required functions under stated conditions for a specified period of time	Numerical ranking, see above
14. Manufacturer's Technical Information Available	Is published information on major components available from vendors	
15. Ability to Obtain Vendor or Manufacturer Guarantee	Is there a vendor or manufacturer of the tank upgrade, and are they willing to provide a guarantee that exceeds the normal one year construction warrantee	Yes, Partially, No
16. Dependency on Existing Tank Integrity	Identifies if and how the alternative is dependent in the integrity of the existing tank to be successful	0 High Dependency (~90%) 1 Moderately High (~70%) 2 Moderate (~50%) 3 Low (~30%) 4 Minimal (~10%) 5 No Dependency (~90%)
17. Lower Dome Treatment Considerations and Alternatives		
18. Upper Dome Treatment Considerations and Alternatives		
19. Testing and Commissioning Procedures		
20. Rationale for Testing and Commissioning Procedures		

TABLE 5-1
BAPT ATTRIBUTE DEFINITIONS AND RANKING SYSTEM

Attribute	Definition	Ranking System
21. Ability to Repair Failures		0 No Ability (0%) 1 Minimal (~10%) 2 Low (~30%) 3 Moderate (~50%) 4 Moderately High (~70%) 5 High (~90%)
22. Service Life Limitations	Identifies limitations of a technology to either survive to the future, with appropriate expected normal and usual repairs, or is limited by some characteristic of the technology	1 year 5 to 10 years 10 to 20 years 20 to 30 years 40 years or greater
23. Provides Secondary Containment	Alternative provides/does not provide secondary containment of a release from the primary tank. A primary tank is the wall of the tank that provides primary containment, e.g. the wall of a single wall tank or the inner wall of a double wall tank.	No - Does not provide secondary containment Yes - Provides secondary containment
24. Impact on Storage Volume	Alternative results in a reduction in tank storage volume. Storage volume is based on the physical volume of the container to contain liquid compared to existing and does not consider safe fill height, level alarm set point, or overfill protection shutoff	
25. Impact on ATG	Identifies if the technology has no impact on Automatic Tank Gauging systems, or if the technology complicates, or prevents application of a DoD grade tank inventory system via an automatic tank gauging system	

TABLE 5-1
BAPT ATTRIBUTE DEFINITIONS AND RANKING SYSTEM

Attribute	Definition	Ranking System
26. Impact on Tank Venting	Identifies if the present tank venting system needs to be modified, or is it acceptable in fundamentally same configuration	
27. Impact on Tank Nozzles	Identifies degree of modification to the tank nozzles needed to support the new tank configuration	
28. Impact on Operating Requirements and Procedures	Identifies if the current means of filling, emptying, or management of a static tank condition is impacted by the tank configuration	
29. Impact on Maintenance Requirements and Practices	Identifies broad form tank maintenance requirements, and if different then general current requirements and practices	
30. TIRM Requirements for Original Alternative Execution	Identifies level of TIRM needed for inspection of existing tank steel lining, prior to application of upgrade technology	
31. TIRM Requirements for Future Integrity Inspections	Identifies level of maintenance and inspection required to maintain the system *A discussion of post construction operational and maintenance requirements that will ascertain tank integrity, and provide for the normal and usual repair and long term maintenance of the tank. Information on schedules of major events (frequency and duration), and parametric (planning level) cost estimates to execute recommendations will be provided.*	

TABLE 5-1
BAPT ATTRIBUTE DEFINITIONS AND RANKING SYSTEM

Attribute	Definition	Ranking System
32. Ability to Identify Release Location	Alternative provides/does not provide the capability to identify the location of a release from the tank, or to identify the general area of a leak within the envelope	0 No Ability (0%) 1 Minimal (~10%) 2 Low (~30%) 3 Moderate (~50%) 4 Moderately High (~70%) 5 High (~90%)
33. Ability to Identify Release Quantity	Alternative provides/does not provide the capability to identify the quantity of a release to an acceptable degree of accuracy	0 No Ability (0%) 1 Minimal (~10%) 2 Low (~30%) 3 Moderate (~50%) 4 Moderately High (~70%) 5 High (~90%)
34. Can release detection system be used to stop a primary envelope breach from reaching the environment	Does the nature and configuration of the secondary containment, or other release detection system inherently prevent a leak to the environment	0 No Ability (0%) 1 Minimal (~10%) 2 Low (~30%) 3 Moderate (~50%) 4 Moderately High (~70%) 5 High (~90%)
35. Ability to Reduce (Minimize) the Magnitude of a Release	Ability to restrict the flow rate of a leak to minimize quantity released so that appropriate response measures may be taken before quantity of release is considered catastrophic (such as permitting a tank draindown)	0 No Ability (0%) 1 Minimal (~10%) 2 Low (~30%) 3 Moderate (~50%) 4 Moderately High (~70%) 5 High (~90%)
36. Associated Release Detection System	Type of leak detection generic concept, and reliance on accuracy	
37. Capabilities (Release detection)		
38. In tank Release Detection System Required	Is it mandatory to have sensors within the tank envelope in order to determine if a leak occurs	

TABLE 5-1
BAPT ATTRIBUTE DEFINITIONS AND RANKING SYSTEM

Attribute	Definition	Ranking System
39. Release Detection Provided Outside Primary Envelope	Are primary leak detection sensors outside of the tank.	Yes - No
40. Release Detection System Testable	Physical ability to simulate a leak, or remove sensor for testing of accuracy	
41. Compatibility with Current Release Detection System		
42. Compatibility with Current Tank Tightness Tests	Identifies if the periodic (currently annually) tank tightness testing can be continued the same, or modified procedure, but attain similarly accurate results, or if alternative is such that Tightness Testing is no longer needed	
43. Compatibility with existing ancillary equipment and if required, upgrades to implement the technology	Identifies issues associated with tank piping, Valving, sampling, manholes, and other physical/operational characteristics that may be impacted by upgrade configuration	None-low-med-high
44. Commercially Available Products – Existing Tank Preparation and Repairs/Construction		
45. Commercially Available Products – Release Detection Concept		

TABLE 5-1 BAPT ATTRIBUTE DEFINITIONS AND RANKING SYSTEM		
Attribute	**Definition**	**Ranking System**
46. Tank Upgrade Construction Cost Estimate (Planning Level) **(not including release detection system or fiber optic communication system)**	An execution cost estimate of one tank constructed as a part of a multiple tank repair contract (2-4 tanks per contract) inclusive of an engineer's estimate of construction costs and associated government execution costs will be developed. This execution cost estimate will be based on normal and usual planning level guidelines for major military projects, using parametric estimating techniques.	None
47. Construction Schedule	*An estimate of execution time for one tank upgrade, and combinations of tank upgrades inclusive of typical government contracting time requirements.*	None
48. Consistency with Local Policies and Resolution	*A general statement attesting to the alternative being consistent with Applicable and Apropriate regulations as identified*	Yes, No

5.3 Alternatives

The following are examples of detailed discussion on the alternatives that will be developed later. See Alt 2A for somewhat better developed example

5.3.1 Alternative 1A – Restoration of Tank

5.3.1.1 General Description

Alternative 1A is similar to the current approach to inspect and repair the tanks but with enhanced TIRM procedures established to assure the full integrity of the existing steel liner is investigated for long term life extension repairs. Tank repairs include repairing pitting, holes, and defective welds (intermittent cracks, lack of fusion, porosity, and slag inclusions) in the existing steel liner. Alternative 1A also includes extensive repairs to present existing single wall concrete encased piping from the tank to the first valve outside tank or replacing the entire piping with double wall construction.

Overall the inspection and repair is considered conventional construction, with the emphasis placed on thoroughness, with appropriate contractor Quality Control (QC) and government oversight and Quality Assurance program.

This alternative only includes recoating the lower dome with DoD approved polysulfide modified epoxy Novolac coating system.

The presumption in this AOC Section 3 is that the resultant single wall tank solution will result in the need for a qualified technology based in-situ "leak detection" system as outlined in AOC Section 4, Release Detection / Tank Tightness Testing.

5.3.1.2 Preparatory Inspection and Repair of Existing Tank Liner

5.3.1.3 Features of Alternative 1A Upgrades

5.3.1.4 Construction Logistics

5.3.1.5 Table 5-2.1A

The following table provides detailed responses on individual attributes.

TABLE 5-2.1A BAPT ALT-1A: RESTORATION OF TANK (similar to current approach)		
Attribute	**Discussion/Comment**	**Supplemental Comment**

TABLE 5-2.1A BAPT ALT-1A: RESTORATION OF TANK (similar to current approach)		
Attribute	**Discussion/Comment**	**Supplemental Comment**

Add full tank attribute presentation table. The table will use all the attributes and discuss their relation to the proposed alternative

5.3.2 Alternative 1B – Restoration of Tank plus Interior Coating

5.3.2.1 General Description

Alternative 1B is same as Alternative 1A, including coating the existing steel line on the lower dome, except Alternative 2 includes coating the existing steel liner on the barrel and upper dome with polysulfide modified epoxy Novolac coating.

5.3.2.2 Preparatory Inspection and Repair of Existing Tank Liner

5.3.2.3 Features of Alternative 1B Upgrades

5.3.2.4 Construction Logistics

5.3.2.5 Table 5-2.1B

The following table provides detailed responses on individual attributes.

TABLE 5-2.1B BAPT ALT-1B: RESTORATION OF TANK PLUS INTERIOR COATING		
Attribute	**Discussion/Comment**	**Supplemental Comment**
Note: Alt-1B is nearly identical to Alt-1A. Items in Alt-1B that differ from Alt-1A are indicated in bold italics.		

Add full tank attribute presentation table

5.3.3 Alternative 1D – Remove Steel Liner, Install New Liner

5.3.3.1 General Description

5.3.3.2 Preparatory Inspection and Repair of Existing Tank Liner

5.3.3.3 Features of Alternative 1D Upgrades

5.3.3.4 Construction Logistics

5.3.3.5 Table 5-2.1D

The following table provides detailed responses on individual attributes.

TABLE 5-2.1D BAPT ALT-1D: REMOVE STEEL LINER, INSTALL NEW LINER		
Attribute	**Discussion/Comment**	**Supplemental Comment**

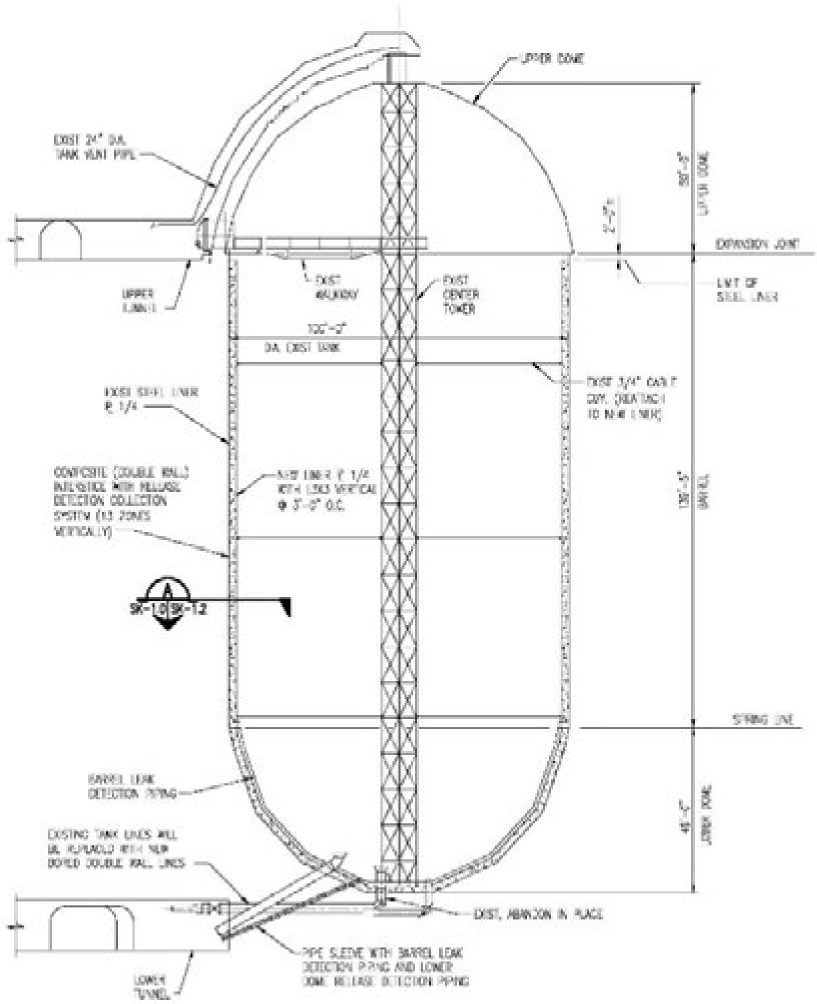
Add full tank attribute presentation table

5.3.4 Alternative 2A – Composite Tank (Double Wall) Carbon Steel

5.3.4.1 General Description

Alternative 2A – Composite Tank, consists of providing a 1/4 inch thick carbon steel liner inside the tank supported by structural steel angles welded to the existing steel liner. The new steel liner is the primary tank envelope and is separated from the existing steel liner by angles to create a 3-inch wide interstitial space for release detection. To resist fluid pressure from tank contents, the interstitial space is filled with self-leveling concrete or grout. The product side of the primary steel liner will be coated with a polysulfide modified epoxy Novolac in accordance with UFGS 09 97 13.15 "Low VOC Polysulfide Interior Coating of Welded Steel Petroleum Fuel Tanks". The existing steel liner will not be coated.

General Description to include a discussion of 1) NOT filling the interstitial space with grout, 2) installation of a Cathodic protection system and 3) application of the design at other tank systems



ELEVATION
SCALE: 1"=20'-0"

5.3.4.2 Preparatory Inspection and Repair of Existing Tank Liner

Prior to the construction of the new tank liner, the existing steel shell must undergo an inspection and repair that will identify the integrity of the existing liner to serve as a secondary containment liner, and identify deficiencies needing repair. This also will serve to minimize the risk of a future breach permitting groundwater, if present, from entering the secondary containment.

The basic requirements for inspection of the existing liner were discussed above under Alternative 1A, and are based on the findings of AOC Section 2, Tank Inspection, Repair and Maintenance (TIRM).

Modifications to the base TIRM, to reflect the needs of this alternative include:

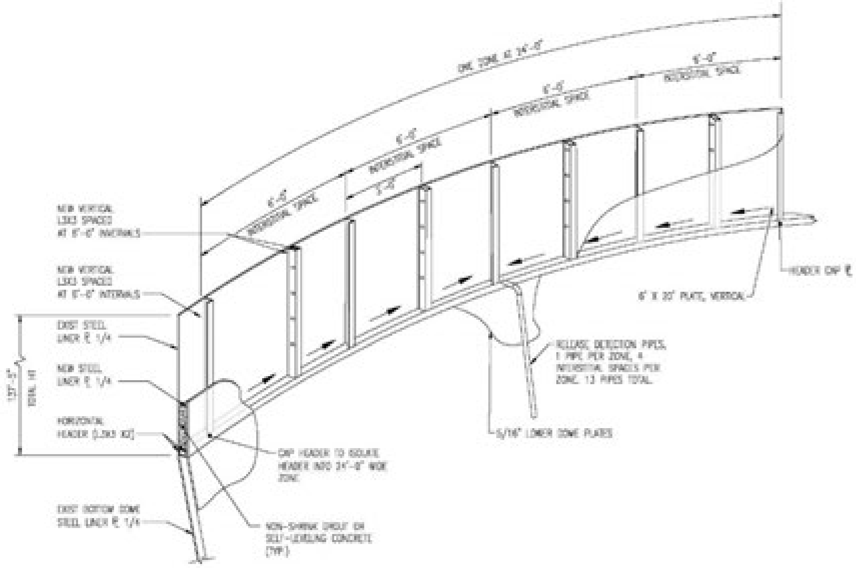
Some discussion and development of TIRM deviations/modifications

5.3.4.3 Features of Alternative 2A Upgrades

Specific features of the Alternative 2A Composite System include:

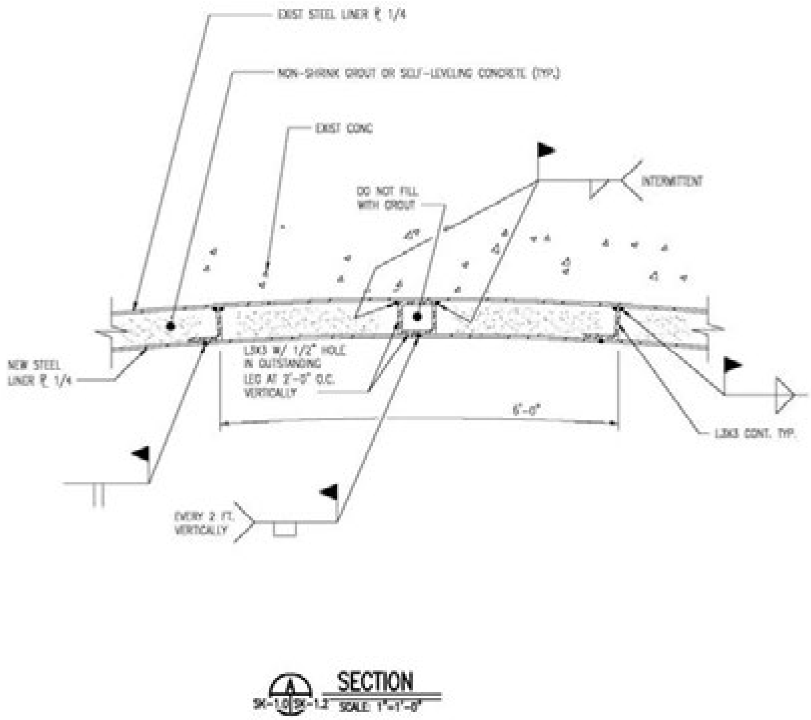
- Six foot wide, 1/4 inch thick, 20-foot long carbon steel liner plates arranged vertically on the tank barrel.
- Liner plates supported by 3 inch x 3 inch angles (L3x3x1/4) at 6'-0" on center, arranged vertically and welded to the existing steel liner, extending from the lower dome spring line to 2'-0" below the expansion joint between the barrel and upper dome. This compartmentalizes the interstitial space of the tank barrel into 52 vertical spaces for improved release detection and leak location.
- The width of the liner plates and spacing of the angles at 6'-0" on center is based on the maximum width of the liner plate that can be moved through the existing isolation doors in the Upper Tunnel to Tanks 17, 18, 19, and 20. Slightly wider sheets could be used for Tanks 1 to 16; however, the sheets would still need to fit through the 8-foot diameter manhole of the tank. EEI recommends 6'-0" wide x 20'-0" long plates for all tanks.
- Interstitial space filled with self-leveling concrete or non-shrink grout having a minimum compressive strength of 2,500 psi. To resist fluid pressure in the interstitial space from the concrete or grout without excessive bulging, the self-leveling concrete or grout must be placed in lifts not exceeding 5 feet and the liner plates need to be supported continuously with vertical

angles welded to the existing steel line at 3'-0" on center



PARTIAL ISOMETRIC
SCALE: NTS

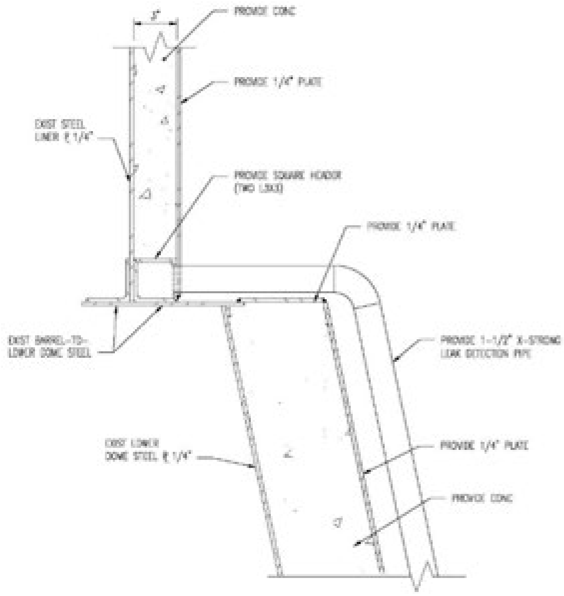
- Two vertical angles arranged in the shape of a tube will be provided in the interstitial space at the center of the liner plate to support the liner plate and form a drainage path for release detection. To prevent compartmentalizing the interstitial spaces into 3'-0" wide spaces the two support angles at the center of the liner plate which form a drainage tube will be welded to the existing liner with intermittent fillet welds and will have drainage holes so that liquid (fuel or water) in the interstitial space can drain into the drainage space to the release detection pipes.



- The primary steel liner plates in the lower dome will be supported similar to the liner plates on the barrel except the support angles will be will extend radially from the center of the bottom of the dome up to the spring line.
- Alternative 2A does not include lining the upper dome, due to the very high incremental cost compared to the increase in storage capacity of approximately 45,900 Bbl. (based on a 3inch wide interstitial space). The composite liner will terminate and be sealed approximately 2 feet below the expansion joint of the upper dome. The upper dome will be inspected and repaired only to prevent infiltration of ground water.

The Composite tank concept includes an integral release detection system as follows:

- A horizontal drainage "tube" space will be provided in the interstitial space at mid-height and the bottom of the barrel. These horizontal "tube" spaces will be continuous around the tank and be compartmentalized into 13 zones each.
- The vertical drainage tube in each of 52 interstitial spaces in the barrel will tie into the horizontal tube space at mid-height and the bottom of the barrel. As the horizontal tubes are compartmentalized to into 13 zones, four 6'-0" wide interstitial spaces are headered together per zone. This provides 13 zones on the lower half of the barrel and 13 zones in the upper half of the barrel (26 zones total).



BARREL-TO-LINEAR DOME CONNECTION
SCALE: NTS

- Release detection piping will be provided and connect to the 13 compartments in each horizontal tube space. Thus, there will be 26 leak release detection pipes, each pipe serving 4 interstitial spaces of the barrel.
- Piping will be 1-1/2" diameter, extra strong pipe to reduce possibility of pipe blockage and to increase service life. All release detection piping will be fully welded. No threaded fittings will be permitted. The 13 release detection pipes servicing the upper half of the barrel will be routed through an 18-inch diameter penetration in the lower dome to the Lower Tunnel. The 13 release detection pipes servicing the lower half of the barrel will be through second 18-inch diameter penetration in the lower dome to the Lower Tunnel. Drilling or coring of the concrete between the existing lower dome and the Lower Tunnel will be required in order to provide a path for the release detection piping.
- In addition to the 26 zones for the tank barrel, one zone will be provided for the entire lower dome. The release detection piping for the lower dome will be routed from a sump below the center of the lower dome floor to the Lower Tunnel.
- The release detection pipes from the 26 zones of the barrel and the one zone of the lower dome will be grouped into a manifold in the Lower Tunnel.

If a leak is detected in the barrel, the search for the leak can be narrowed to a 24'-0" wide area of the barrel consisting of 4 interstitial spaces. The release detection system also can be used for injection of a detectable gas in the interstitial space to locate the leak. As the entire lower dome is one zone for release detection, a leak detected in the lower dome would involve inspecting the entire lower dome to locate and repair the leak.

5.3.4.4 Construction Logistics

5.3.4.5 Table 5-2.2A

The following table provides detailed responses on individual attributes.

TABLE 5-2.2A
BAPT ALT-2A: COMPOSITE TANK (Double wall)
CARBON STEEL

Attribute	Discussion/Comment	Supplemental Comment
Summary Description	• Creates double wall, secondarily contained tank. • 1/4 inch thick carbon steel liner inside the tank supported by structural steel angles welded to the existing steel liner. Steel liner is separated from the existing steel liner by angles to create a 3 inch wide interstitial space for release detection. Steel liner becomes primary tank envelope. • Interstitial space filled with concrete or grout to resist fluid pressure on steel liner from tank contents. • Product side of the steel liner coated with polysulfide modified epoxy Novolac in accordance with UFGS 09 97 13.15 "Low VOC Polysulfide Interior Coating of Welded Steel Petroleum Fuel Tanks". • Zoned interstitial space release detection concept provides dynamic full time release detection with alarming to central location. • Existing steel liner is inspected and repaired and becomes secondary containment. • Only lower dome and barrel receive composite liner. • This alternative includes replacing the existing single wall concrete encased piping from the tank to the first valve outside tank with double wall construction.	Note that numerous alternative industrial grade coatings could be considered, but all must pass the criteria of surviving military additives in fuel. Any alternative would not necessarily present a different solution, only a permutation of this Alternative, thus not considered separately at this time.

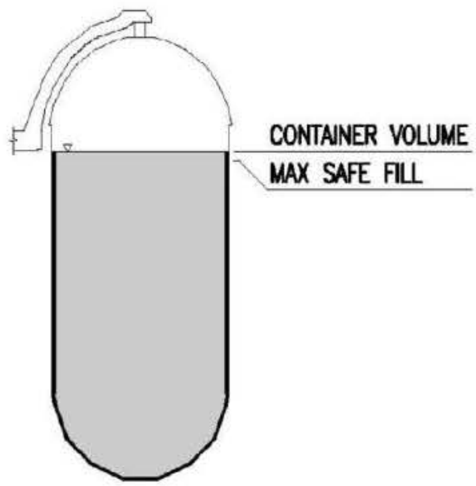
TABLE 5-2.2A BAPT ALT-2A: COMPOSITE TANK (Double wall) CARBON STEEL		
Attribute	**Discussion/Comment**	**Supplemental Comment**
Graphic		
1. Primary Positive Attributes	• Provides secondary containment. • Provides release detection. No special technology required for release detection other than sensors in release detection piping/chamber in lower tunnel.	
2. Primary Negative Attributes	• Higher cost than restoration of existing tank (Alternatives 1A, 1B, and 1C). • Reduced storage volume (upper dome not used).	
3. Risks	• Risk of a release to the environment is very low as the tank would have secondary containment. • Risk of failure of construction resulting in an unacceptable end product must be addressed by appropriate design, contractor quality control, and government quality assurance systems and controls in place.	

TABLE 5-2.2A BAPT ALT-2A: COMPOSITE TANK (Double wall) CARBON STEEL		
Attribute	**Discussion/Comment**	**Supplemental Comment**
4. Benefits	• Provides secondary containment that is testable for integrity. • Able to detect, locate (within 14 or more zones), and contain leaks in existing steel liner and primary steel liner (primary tank envelope). • Detectable volume of liquid released is very small, as liquid conveyed to collection point below tank by release detection system within interstitial space.	
5. Feasible	• Construction will follow fairly standard industry tank and structural steel erection techniques, followed by coating application. Greatest challenge for construction is based on logistics and restrictions due to working at Red Hill and inside the fuel storage facility and inside the tank.	
6. Testable	• All aspects of construction are fully inspectable during the construction process and testable for integrity as a part of final testing and commissioning.	
7. Inspectable	• Future inspection for integrity no different than current integrity inspections of existing tanks (liner plate scanning, weld scanning) following industry practices adapted to Red Hill conditions. Updated TIRM to be utilized. • Integrity testing of interstitial space and release detection system provided by design.	

TABLE 5-2.2A
BAPT ALT-2A: COMPOSITE TANK (Double wall)
CARBON STEEL

Attribute	Discussion/Comment	Supplemental Comment
8. Repairable	• Repair of coatings and primary tank envelope follows industry practice. • Corrosion in the steel liner plates and plate welds can be repaired using conventional repair methods (i.e. patch plates and welding). • Repair of the existing steel liner used for secondary containment after composite liner is installed is possible but would require removing the primary steel liner and concrete/grout fill in the interstitial space, locating and repairing the the existing steel liner, replacing the primary steel liner, and filling the interstitial space with concrete or grout. • All repairs to primary steel liner and secondary containment require tank draindown and cleaning and removal of interior coating at area of repair to perform repairs followed by repair of the coating after repairs are complete. • Repair of coatings and primary tank envelope follows industry practice. • Repair of secondary barrier (existing steel liner) possible, but requires removal of primary barrier to access.	
9. Restorability	• Unlikely that the concept would be reversed to a single wall tank and existing primary lining.	
10. Is the Concept Practicable? (Likelihood of Successful Construction)	• Yes	
11. Successful Implementation at Other Large Fuel Depots in Preventing Leaks	• The concept has been used on several large cut and cover tanks at NAVSUP FLC Yokosuka Japan (Tanks 112 and 113)	
12. Applicability to Tanks at Red Hill	• This alternative can be applied to tanks at Red Hill.	

TABLE 5-2.2A
BAPT ALT-2A: COMPOSITE TANK (Double wall)
CARBON STEEL

Attribute	Discussion/Comment	Supplemental Comment
13. Reliability (confidence)	• Performance is dependent on inspection (i.e. ability to find and locate defects), welder qualifications, and nondestructive examination of completed repairs. Technology of repairs not questioned. • Does not rely upon inferential release detection systems requiring longer testing cycles, very special sensor technology, and rigorous computer based statistical analysis of measurement to determine if a release has occurred.	
14. Manufacturer's Technical Information	• Not applicable. All repairs would be based on acceptable engineering standards and applicable industrial guidelines.	
15. Ability to Obtain Vendor or Manufacturer Guarantee	• No, This is an engineered solution constructed by a selected contractor. There is no vendor or manufacturer per se.	
16. Dependency on Existing Tank Integrity	• Existing steel liner on tank barrel and lower dome becomes secondary containment, thus integrity must be fully investigated and deficiencies repaired.	Similar to current integrity management approach (with enhancements as noted in TIRM)
17. Lower Dome Treatment Considerations and Alternatives	• Existing steel liner of lower dome would be inspected and repaired same as the steel liner on the tank barrel using conventional repair methods (i.e. patch plates and welding). • Lower dome would receive steel liner and concrete or grout filled interstitial space same as the tank barrel and release detection.	
18. Upper Dome Treatment Considerations and Alternatives	• Upper dome will be inspected and repaired to prevent infiltration of ground water. • Upper dome surface will be coated same as tank primary envelope. • Upper dome does not receive composite liner.	

TABLE 5-2.2A BAPT ALT-2A: COMPOSITE TANK (Double wall) CARBON STEEL		
Attribute	**Discussion/Comment**	**Supplemental Comment**
19. Testing and Commissioning Procedures	• Perform 100% scanning of the existing steel liner and welds of barrel and lower dome of the existing tank. • Perform nondestructive examination of repairs to existing steel liner. • Perform nondestructive examination of welds of primary steel liner. • Perform in process quality control of primary tank envelope following industry standards, modified for Red Hill construction (based on API tank construction and industry practice). • Perform integrity testing of interstitial space and release detection collection piping prior to introducing fuel into the tank. • Perform tank integrity leak testing with fuel as a part of return to service commissioning.	Leak testing would be equivalent to, or same as current annual tank tightness testing. Note that a hydrostatic test with water is not required as it is a structural test, more than a leak test. Based on the tank upgrades as described, a structural test is not warranted.
20. Rationale for Testing and Commissioning Procedures	• Industry standard quality control during construction, and government quality assurance programs can be applied to assure a liquid tight container is constructed. • Integrity testing of interstitial space and release detection system is crucial to initially placing the tank in service. • Integrity testing with fuel provides final check of hydraulic integrity of primary steel liner. Presence of fuel in release detection pipes would indicate a breach in the primary steel liner.	

TABLE 5-2.2A BAPT ALT-2A: COMPOSITE TANK (Double wall) CARBON STEEL		
Attribute	**Discussion/Comment**	**Supplemental Comment**
21. Ability to Repair Failures	• Corrosion in the steel liner plates and plate welds can be repaired using conventional repair methods (i.e. patch plates and welding). • Repair of leaks in existing steel liner used for secondary containment after composite liner is installed is possible but would require removing the primary steel liner and concrete/grout fill in the interstitial space, locating and repairing the leak in the existing steel liner, replacing the primary steel liner, and filling the interstitial space with concrete or grout. • All repairs to primary steel liner and secondary containment require tank drain down and cleaning and removal of interior coating at area of repair to perform repairs followed by repair of the coating after repairs are complete.	
22. Service Life Limitations	• Service life of existing steel liner and primary steel liner is dependent on inspection and repairs performed at time of base-line repairs. • The government to determine design service life. For example if a 40 year life is selected, corrosion rates, minimum remaining thickness below which would require repair, and subsequent repairs to existing steel liner would be based on this. This 40 year life of the existing steel liner could be extended by repairing more deficiencies, with the result of extending the life perhaps another 70 years.	
23. Provides Secondary Containment	• Existing steel liner on tank barrel and lower dome becomes secondary containment.	

TABLE 5-2.2A BAPT ALT-2A: COMPOSITE TANK (Double wall) CARBON STEEL		
Attribute	**Discussion/Comment**	**Supplemental Comment**
24. Impact on Storage Volume	• Alternative provides for fuel storage in lower dome and tank barrel up to 2 feet below the expansion joint at the top of the barrel, and no fuel storage in upper dome. • The interstitial space (3-inches all around) also results in reduction in storage volume. • Tank container volume: 234,846 Bbl • With a 3 inch interstitial space and not using the upper dome space, there is a reduction in storage volume compared to Alts 1A, 1B, and 1C: - Tanks 1 to 4: 50,289 Bbl reduction per tank - Tanks 5 to 20: 67,075 Bbl reduction per tank • Storage volume at level alarm set points: - HLA (90%): 211,361 Bbl - HHLA (95%): 223,104 Bbl • Storage volume at max safe fill (90%): 211,361 Bbl	• Storage volume is based on the physical volume of the container to contain liquid compared to existing and does not consider safe fill height, level alarm set point, or overfill protection shutoff. • Level alarm set points are per UFC 3-460-01. • HLA: High Level Alarm • HHLA: High-High Level Alarm
25. Impact on ATG	• None, the same, or similar system can be used. • New tank calibration (strapping) required	
26. Impact on Tank Venting	• None	
27. Impact on Tank Nozzles	• Modifications required to accommodate new tank composite liner, and to respond to existing integrity concerns	
28. Impact on Operating Requirements and Procedures	• Reduced volumes would need to be addressed in Standard Operating Procedures	

TABLE 5-2.2A
BAPT ALT-2A: COMPOSITE TANK (Double wall)
CARBON STEEL

Attribute	Discussion/Comment	Supplemental Comment
29. Impact on Maintenance Requirements and Procedures	• Perform periodic cleaning and inspection. The goal is a minimum 20 year inspection cycle. • Repair of defects in steel liner (primary tank envelope) will require removal of interior coating followed by repair of the coating after steel liner repairs are complete. • Recoating of the steel liner (primary tank envelope) can be expected on a 30-40 year basis, plus periodic maintenance at out of service inspections.	
30. TIRM Requirements for Original Alternative Execution	• To be developed	
31. TIRM Requirements for Future Integrity Inspections	• To be developed	
32. Ability to Identify Release Location	• A leak can be isolated to area of the shell covered by the leak detection zone	
33. Ability to Identify Release Quantity	• The nature of the secondary containment interstitial system is such that the leak is captured and stopped before entering the environment. Also, the leak detection interstitial zone can be drained into suitable container in the lower tunnel area, and measured	
34. Ability to Stop a Release from the Tank	• Inherent within system design	
35. Ability to Reduce (Minimize) the Magnitude of a Release	• Very good	

TABLE 5-2.2A BAPT ALT-2A: COMPOSITE TANK (Double wall) CARBON STEEL		
Attribute	**Discussion/Comment**	**Supplemental Comment**
36. Associated Release Detection System	• Release detection zones in the barrel (14 to 26 zones) and lower dome (1 zone), and piped by gravity to sensor racks in lower tunnel. Provides dynamic full time release detection. • Very small leaks can be detected with conventional pressure rated sensors. • Easy to test release detection sensors.	Integrity testing of release detection system (entire secondary containment zone) possible if designed for this need.
37. Capabilities (Release Detection)	• Leaks identified outside of primary tank envelope, via interstitial space. • Able to detect, locate, and contain leaks in existing steel liner and primary steel liner (primary tank envelope). Leaks detected before they enter the environment. • Release detection zoned by shell area (26 zones) and lower dome (1 zone), and piped by gravity to sensor chamber in lower tunnel. Provides dynamic full time release detection with alarming to central location.	• Tubes cast in interstitial space in barrel to improve connectivity of breach location to zone collection headers. • Tell-tales from barrel zones conveyed through exposed pipe inside tank in lower dome.
38. In tank Release Detection System Required	• no	
39. Release Detection Provided Outside Primary Envelope	• yes	
40. Release Detection System Testable	• Within limitations, yes, depending on design solutions and construction considerations	
41. Compatibility with Current Release Detection System	• Compatible.	
42. Compatibility with Current Tank Tightness Tests	• Compatible. No impact to current tank tightness testing. • Frequency of testing is policy issue, not engineering issue.	Note that with contemplated interstitial secondary containment, tank tightness testing no longer required as currently conducted.

TABLE 5-2.2A BAPT ALT-2A: COMPOSITE TANK (Double wall) CARBON STEEL		
Attribute	**Discussion/Comment**	**Supplemental Comment**
43. Compatibility with existing ancillary equipment and if required, upgrades to implement the technology	• Compatible. No impact to existing ancillary equipment. • However, it is anticipated that a new ATG system would be implemented at time of repairs.	
44. Commercially Available Products – Existing Tank Preparation and Repairs/Construction	• Integrity testing for repairs is specialized, but commercially available. Tank repair materials are common to any fuel storage tank repair. • Construction of steel liner is specialized in Red Hill, but well within the capabilities of commercial/industrial application. • Coating systems are readily available, and DoD had conducted extensive experiments to prove out suitability for DoD fuels with additives (as compared to un-additized commercial fuels).	
45. Commercially Available Products – Release Detection Concept	• Interstitial space for release detection is common. • Permits use of off the shelf industrial release detection sensor outside the tank (will be in lower tunnel), numerous technologies available.	
46. Tank Upgrade Construction Cost Estimate (Planning Level) (not including release detection system or fiber optic communication system)	• To be determined	
47. Construction Schedule	If aggressive means taken, and multiple shifts permitted, a two year schedule is possible. Under normal military construction approach, more likely a four year schedule expected.	Bid package must anticipate full range of potential repairs to minimize change order delays.

TABLE 5-2.2A BAPT ALT-2A: COMPOSITE TANK (Double wall) CARBON STEEL		
Attribute	**Discussion/Comment**	**Supplemental Comment**
48. **Consistency with Local Policies and Resolution**	*A general statement attesting to the alternative being consistent with Applicable and Apropriate regulations as identified*	Yes, No

5.3.5 *Alternative 2B – Composite Tank (Double Wall) Duplex Stainless Steel*

5.3.5.1 General Description

Alternative 2B is same as Alternative 2A except uses duplex stainless steel instead of carbon steel liner.

General Description to include a discussion of 1) NOT filling the interstitial space with grout adand 2) installation of a Cathodic protection system and 3) application of the design at other tank systems

5.3.5.2 Preparatory Inspection and Repair of Existing Tank Liner

5.3.5.3 Features of Alternative 2B Upgrades

5.3.5.4 Construction Logistics

5.3.5.5 Table 5-2.2B

The following table provides detailed responses on individual attributes.

TABLE 5-2.2B BAPT ALT-2B: COMPOSITE TANK (Double wall) DUPLEX STAINLESS STEEL		
Attribute	**Discussion/Comment**	**Supplemental Comment**
Note: Alt-2B is nearly identical to Alt-2A. Items in Alt-2B that differ from Alt-2A are indicated in bold italics.		

Add full tank attribute presentation table

5.3.6 Alternative 3A – Tank within a Tank (Carbon Steel)

5.3.6.1 General Description

Alternative 3A involves constructing a carbon steel tank within the existing tank. The tank will be 90'-0" diameter, 150'-0" shell height. The smaller diameter of the new tank provides a 5'-0" wide annular space around the tank that allows inspection of the exterior of the tank shell and the steel liner on the barrel and upper dome of the existing tank. The new tank will be designed in accordance with the applicable sections of API 650. The tank will be braced laterally with struts to the existing tank to resist rocking from seismic ground motions.

The existing steel liner on tank barrel and lower dome is inspected and repaired and becomes secondary containment.

5.3.6.2 Preparatory Inspection and Repair of Existing Tank Liner

5.3.6.3 Features of Alternative 1D Upgrades

5.3.6.4 Construction Logistics

5.3.6.5 Table 5-2.3A

The following table provides detailed responses on individual attributes.

TABLE 5-2.3A BAPT ALT-3A: TANK WITHIN A TANK (CARBON STEEL)		
Attribute	**Discussion/Comment**	**Supplemental Comment**
	•	

Add full tank attribute presentation table

5.4 BAPT Tank Upgrade Decision Matrix

TABLE 5-3
TANK UPGRADE ALTERNATIVES - BAPT DECISION MATRIX

Attribute	Alternative					
	1A	1B	1D	2A	2B	3A
Description	Restoration of Tank	Restoration of Tank plus Interior Coating	Remove Existing Steel Liner, Install New Steel Liner	Composite Tank (Double Wall) Carbon Steel	Composite Tank (Double Wall) Duplex Stainless Steel	Tank within a Tank (Carbon Steel)
1. Primary Positive Attributes						
2. Primary Negative Attributes						
3. Risks						
4. Benefits						
5. Constructible						
6. Testable						
7. Inspectable						
8. Repairable						
9. Restorability						
10. Is Concept Practicable? (Likelihood of Successful Construction)						

TABLE 5-3
TANK UPGRADE ALTERNATIVES - BAPT DECISION MATRIX

Attribute	Alternative					
	1A	1B	1D	2A	2B	3A
Description	Restoration of Tank	Restoration of Tank plus Interior Coating	Remove Existing Steel Liner, Install New Steel Liner	Composite Tank (Double Wall) Carbon Steel	Composite Tank (Double Wall) Duplex Stainless Steel	Tank within a Tank (Carbon Steel)
11. Successful Implementation at Other Large Fuel Depots in Preventing Leaks						
12. Applicability to the Red Hill Bulk Fuel Storage Facility						
13. Reliability						
14. Manufacturer's Technical Information						
15. Ability to Obtain Vendor or Manufacturer Guarantee						
16. Dependency on Existing Tank Integrity						

TABLE 5-3
TANK UPGRADE ALTERNATIVES - BAPT DECISION MATRIX

Attribute	Alternative					
	1A	1B	1D	2A	2B	3A
Description	Restoration of Tank	Restoration of Tank plus Interior Coating	Remove Existing Steel Liner, Install New Steel Liner	Composite Tank (Double Wall) Carbon Steel	Composite Tank (Double Wall) Duplex Stainless Steel	Tank within a Tank (Carbon Steel)
17. Lower Dome Treatment Considerations and Alternatives						
18. Upper Dome Treatment Considerations and Alternatives						
19. Testing and Commissioning Procedures						
20. Rationale for Testing and Commissioning Procedures						
21. Ability to Repair Failures						
22. Service Life Limitations						
23. Provides secondary containment						

TABLE 5-3
TANK UPGRADE ALTERNATIVES - BAPT DECISION MATRIX

Attribute	Alternative					
	1A	1B	1D	2A	2B	3A
Description	Restoration of Tank	Restoration of Tank plus Interior Coating	Remove Existing Steel Liner, Install New Steel Liner	Composite Tank (Double Wall) Carbon Steel	Composite Tank (Double Wall) Duplex Stainless Steel	Tank within a Tank (Carbon Steel)
24. Impact on Storage Volume						
25. Impact on ATG						
26. Impact on Tank Venting						
27. Impact on Tank Nozzles						
28. Impact on Operating Requirements and Procedures						
29. Impact on Maintenance Requirements and Procedures						
30. TIRM Requirements for Original Alternative Execution						
31. TIRM Requirements for Future Integrity Inspections						

TABLE 5-3
TANK UPGRADE ALTERNATIVES - BAPT DECISION MATRIX

Attribute	Alternative					
	1A	1B	1D	2A	2B	3A
Description	Restoration of Tank	Restoration of Tank plus Interior Coating	Remove Existing Steel Liner, Install New Steel Liner	Composite Tank (Double Wall) Carbon Steel	Composite Tank (Double Wall) Duplex Stainless Steel	Tank within a Tank (Carbon Steel)
32. Ability to Identify Release Location						
33. Ability to Identify Release Quantity						
34. Ability to Stop a Release from the Tank						
35. Ability to Reduce (Minimize) the Magnitude of a Release						
36. Associated Release Detection System						
37. Capabilities (Release detection)						
38. In tank Release Detection System Required						

TABLE 5-3
TANK UPGRADE ALTERNATIVES - BAPT DECISION MATRIX

Attribute	Alternative					
	1A	1B	1D	2A	2B	3A
Description	Restoration of Tank	Restoration of Tank plus Interior Coating	Remove Existing Steel Liner, Install New Steel Liner	Composite Tank (Double Wall) Carbon Steel	Composite Tank (Double Wall) Duplex Stainless Steel	Tank within a Tank (Carbon Steel)
39. Release Detection Provided Outside Primary Envelope						
40. Release Detection System Testable						
41. Compatibility with Current Release Detection System						
42. Compatibility with Current Tank Tightness Tests						
43. Compatibility with existing ancillary equipment and if required, upgrades to implement the technology						
44. Commercially Available Products – Existing Tank Preparation and Repairs/Construction						

TABLE 5-3
TANK UPGRADE ALTERNATIVES - BAPT DECISION MATRIX

Attribute	Alternative					
	1A	1B	1D	2A	2B	3A
Description	Restoration of Tank	Restoration of Tank plus Interior Coating	Remove Existing Steel Liner, Install New Steel Liner	Composite Tank (Double Wall) Carbon Steel	Composite Tank (Double Wall) Duplex Stainless Steel	Tank within a Tank (Carbon Steel)
45. Commercially Available Products – Release Detection Concept						
46. Tank Upgrade Construction Cost Estimate (Planning Level) (not including release detection system or fiber optic communication system)						
	The following cost occurs during the first group of tank upgrades but the infrastructure is used for all tanks: Pole Line Electrical Power Fiber Optics (Data Transmission) for Release Detection on single wall tanks (Alts 1A, 1B, and 1C)					
47. Construction Schedule						
48. Consistency with Local Policies and Resolution						

6.0 CONSTRUCTION EXECUTION ISSUES

6.1 Staging and Material Handling

6.1.1 Contractor Yard and Laydown

6.1.2 Tunnel Access to Tanks

6.2 Temporary Electrical Power

6.2.1 Existing Electrical Power at Red Hill

6.2.2 Temporary Power Supply

6.2.2.1 Temporary Overhead Line Alternative

6.2.2.2 Diesel Engines for Temporary Power

6.2.3 Temporary Tank Repair Electrical System

6.3 Data Communication – Fiber Optics

6.3.1 Existing Conditions

6.3.2 Need for New Fiber Optic Communications

6.4 Tank Access Shaft

6.4.1 Access for Power and Ventilation to Tank

6.5 Tank Staging Concepts for Work

6.5.1 Existing-Center Column Booms

6.5.2 Erect conventional Staging

6.5.3 Erect Trolley and Multiple Platforms around Perimeter

6.6 Tank Ventilation and Dehumidification

6.6.1 Welding Ventilation Requirements

6.6.2 Coating Ventilation and Dehumidification Requirements

6.7 Construction Schedule

The Construction Schedule will be provided

7.0 RELATED AOC INITIATIVES

7.1 Tank Inspection Repair and Maintenance (TIRM)

AOC Section 2.0 discusses TIRM

7.2 Release Detection / Tank Tightness Testing

AOC Section 4.0 addresses this

7.3 Corrosion and Metal Fatigue Practices Report

AOC Section 5.0 addresses this

8.0 COST ESTIMATES

8.1 Cost Estimate Summaries

9.0 DEFINITIONS

The following terms are used in this report. The definitions are from 40 CFR 280 Final Rule.

- *Existing Tank System:* A tank system used to contain an accumulation of regulated substances or for which installation has commenced on or before December 22, 1988.
- *New Tank System:* A tank system that will be used to contain an accumulation of regulated substances and for which installation has commenced after December 22, 1988.
- *Release:* Any spilling, leaking, emitting, discharging, escaping, leaching or disposing from an UST into groundwater, surface water or subsurface soils.
- *Release Detection:* Determining whether a release of a regulated substance has occurred from the UST system into the environment or a leak has occurred into the interstitial space between the UST system and its secondary barrier or secondary containment around it.
- *Secondary Containment or Secondarily Contained:* A release prevention and release detection system for a tank or piping. This system has an inner and outer barrier with an interstitial space that is monitored for leaks. This term includes containment sumps when used for interstitial monitoring of piping.
- *Underground Storage Tank or UST:* Any one or combination of tanks (including underground pipes connected thereto) that is used to contain an accumulation of regulated substances, and the volume of which (including the volume of underground pipes connected thereto) is 10 percent or more beneath the surface of the ground. This term does not include: Storage tanks situated in an underground area (such as a basement, cellar, mine working, drift, shaft, or tunnel) if the storage tank is situated upon or above the surface of the floor.

Additional Definitions

- *Primary Tank:* The wall of the tank that provides primary containment, e.g. the wall of a single wall tank or the inner wall of a double wall tank.

List of Critical Definitions

10.0 ABBREVIATIONS AND ACRONYMS

AFHE	Automated Fuel Handling Equipment
API	American Petroleum Institute
ATG	Automatic Tank Gauging
BAPT	Best Available Practicable Technologies
Bbl	Barrels
CFR	Code of Federal Regulations
DOH	Department of Health
EPA	Environmental Protection Agency
FG	Fiberglass
GPH	Gallons per Hour
HAR	Hawaii Administrative Rule
HECO	Hawaiian Electric Company
HLA	High Level Alarm
HHLA	High-High Level Alarm
HTG	Hydrostatic Tank Gauge
IFB	Invitation for Bid
IWA	In Accordance With
LNG	Liquefied Natural Gas
LRDP	Low-Range Differential Pressure
MDLR	Minimum Detectable Leak Rate
NMCI	Navy Marine Corps Intranet
NWGLDE	National Working Group on Leak Detection Equipment
RDS	Release Detection System
ROM	Rough Order of Magnitude Cost
RTU	Remote Terminal Unit
SAES	Scope of Architect-Engineer Services
SPA	State Program Approval
UFGS	Unified Facilities Guide Specification
UFM	Unscheduled Fuel Movement
UGPH	Underground Pumphouse
UST	Underground Storage Tank

11.0 REFERENCES

Once citation links are added, the citation information will be published here

12.0 PROJECT TEAM

Contracting Agency: NAVFAC Pacific

Prime Consultant: HDR.

Francis T. Hino, P.E.	Project Manager, responsible for overall management of A/E efforts on the Red Hill study and participant in discussions.

Sub-Consultant: Enterprise Engineering, Inc. (EEI). Tank Engineer/Subject Matter Specialist.

Kevin S. Murphy, P.E.	Principal in Charge
Stephen J. DiGregorio, P.E.	Project Manager/Lead Structural Engineer/API 653 Certified Aboveground Tank Inspector. Responsible for investigating BAPT tank upgrade alternatives
Stephen S. Brooks P.E.	Technical Specialist/Lead Mechanical Engineer/API 653 Certified Aboveground Tank Inspector. Responsible for overall technical review and Quality Assurance
Douglas J. Kieley, P.E.	Mechanical Engineer/API 653 Certified Aboveground Tank Inspector/API 570 Certified Piping Inspector. Responsible for investigating Release Detection Systems and Tank Tightness Testing for the Red Hill tanks
Mel Yokota, Power Engineers	Electrical Engineer (EEI sub-consultant)

13.0 QUALITY CONTROL PROGRAM

Report to include a discussion of quality assurance and quality control (“QA/QC”) procedures as stipulated in the AOC Statement of Work, Paragraph 1.6. The QA/QC procedures shall be used to ensure that environmental or other data generated meets standards established by the Parties.