Red Hill AOC/SOW Section 3
TANK UPGRADE ALTERNATIVES - BAPT MATRIX

Item	Alternative												
	1A	1B	1C	2A	2B	3A	3B	4	5A	5B	6	7	8
Description	Restoration of Tank	Restoration of Tank plus Interior Coating	Restoration of Tank plus Metalizing and Interior Coating on Existing Steel Liner	Composite Tank (Double Wall) Carbon Steel	Composite Tank (Double Wall) Duplex Stainless Steel	Tank within a Tank (Carbon Steel)	Tank within a Tank (Duplex Stainless Steel)	Double Wall Fiberglass System with Release Detection	Steel Liner Plates Welded to Existing Steel Liner	Steel Liner Plates with Expanded Metal between Existing Steel Liner and Steel Liner	Stainless Steel Membrane over Existing Steel Liner	Rubber Lining Bonded to Existing Steel Liner	Flexible Membrane Liner
Primary Positive Attributes	Low cost Least volume lost	Low cost Least volume lost	Low cost Least volume lost	Double wall barrel and lower dome with release detection	Same as 2A. Use of stainless steel, eliminates coatings.	Exterior of tank fully visible and inspectable. Existing tank serves as secondary containment	Same as 3A. Use of stainless steel eliminates coating of tank	Double wall with release detection	Double wall with release detection	Same as Alt 5A	Double wall, stainless steel liner, no coatings	None identified	None identified
Primary Negative Attributes	Single wall, must rely on BAPT release detection system	Single wall, must rely on BAPT release detection system	Single wall, must rely on BAPT release detection system Difficult surface prep for metalizing	Modest loss of fuel storage in lower dome and barrel, no fuel stored in upper dome	Modest loss of fuel storage in lower dome and barrel, no fuel stored in upper dome	Considerable reduction in fuel storage capacity	Same as Alt 3A	Release detection piping must be inside of primary tank. Fiberglass historically does not last as long as steel, easily damaged.	Release detection piping must be inside of primary tank	Same as 5A	Not yet determined ability to provide release detection channeling. Stainless steel membrane may suffer damage during future inspection and cleaning.	Single wall, must rely on BAPT release detection system	Inability to obtain certified strapping tables as liner not attached to steel liner at all points. May not be suitable for pressure at bottom of tank
Constructible and Testable	Conventional construction and testing	Conventional construction and testing	More difficult construction, but testable	Conventional construction and testing	Conventional construction and testing	Conventional construction and testing	Conventional construction and testing	Unknown, never applied to height and pressures inside tanks like Red Hill	Yes, but complex to provide plate to plate connectivity for release detection, while still providing structural and hydraulic integrity	Same as 5A	Difficulties with existing shapes inside tank may make system difficult to install	Possibly, but would require considerable prep of steel liner to eliminate protrusions	Questionable
Inspectable and Repairable	Yes - conventional	Yes - conventional	Yes, however metalizing may impact Inspectability	Yes, primary tank direct, secondary containment indirect	Yes, same as Alt 2A	Yes - Conventional	Yes - Conventional	Future inspections, but repair is very difficult	Yes	Yes	Unknown	No	Limited ability to inspect. Repairs very difficult to accomplish
Release Detection System Testable	Not directly, only over time as to discrepancies of BAPT “System”	Not directly, only over time as to discrepancies of BAPT “System”	Not directly, only over time as to discrepancies of BAPT “System”	Yes, vacuum test interstice at any desirable interval	Yes, vacuum test interstice at any desirable interval	Yes, secondary containment and shell is visible, floor telltale testable with vacuum test	Yes, AST shell is visible, floor telltale testable with vacuum test	Yes, vacuum test at any desirable interval	Yes, vacuum test at any desirable interval	Yes, vacuum test at any desirable interval	Not directly, only over time as to discrepancies of BAPT “System”	Not directly, only over time as to discrepancies of BAPT “System”	Very questionable

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Applicability at the Red Hill Bulk Fuel Storage Facility	Yes, currently used	Yes, enhancement of Alt 1A	Yes, standard industrial practice	Yes, can be engineered to barrel and lower dome	Yes, can be engineered to barrel and lower dome	Yes, standard API 650 tank inside existing tank cavity	Yes, standard API 650 tank inside existing tank cavity	Quite possibly not practicable, under review by manufacturer	Yes, can be engineered to barrel and lower dome	Yes, can be engineered to barrel and lower dome	Possibly	May not be practicable due to physical constraints of existing steel liner	No - without having strapping tables, cannot operate facility
Provides secondary containment	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Successful implementation at other facilities in preventing leaks	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Only has been used overseas on cut and cover tanks up to 32 ft. tall	Occasionally used for double bottom floor construction. Unknown if ever applied to shell	Occasionally used for double bottom floor construction. Unknown if ever applied to shell	Very successful in liquefied natural gas (LNG) as liner for underground concrete barrel tanks.	Used in multiple industries, but not in petroleum fuel storage tank industry	Occasionally used for short term repairs to ASTs, but not as tall as Red Hill. "Bladders used extensively in military for tanker aircraft, and ground tactical storage, but configuration quite different then Red Hill.
Operating Requirements and Procedures	Conventional	Conventional	Conventional	Conventional	Conventional	Conventional	Conventional	All tank entry requires special care, no welding to shell possible for tank work. Erection of staging may not be possible.	Conventional	Conventional	Under investigation	Conventional	Under investigation
Maintenance Requirements and Procedures	Conventional	Conventional	Conventional	Conventional	Conventional	Conventional	Conventional	Very specialized	Conventional	Conventional	Under investigation	Periodic visual inspection for damage, 10 year interval?	Periodic visual inspection for damage, 5 year interval?

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TANK UPGRADE ALTERNATIVES - BAPT MATRIX

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Ability to Identify Release Location and Quantity	Dependent on BAPT release detection system	Dependent on BAPT release detection system	Dependent on BAPT release detection system	Yes, collected by interstitial release system, 14 zones by tell-tale system in interstice, with vessel and sensors in lower tunnel	Yes, collected by interstitial release system, 14 zones by tell-tale system in interstice, with vessel and sensors in lower tunnel	Yes, visual on shell, slotted concrete on lower dome to tell-tale collection with vessel and sensors in lower tunnel	Yes, visual on shell, slotted concrete on lower dome to tell-tale collection with vessel and sensors in lower tunnel	Yes, however system of tell-tales will need to be in tank interior, not outside of primary envelope	Yes, however system of tell-tales will need to be in tank interior, not outside of primary envelope	Yes, however system of tell-tales will need to be in tank interior, not outside of primary envelope	Under investigation	No	Yes, however system of tell-tales will need to be in tank interior, not outside of primary envelope
Future Maintenance and Integrity Requirements	Periodic Integrity Inspection and repairs (20 year cycle)	Periodic Integrity Inspection and repairs (20 year cycle) Renew coatings 30+ years	Periodic Integrity Inspection and repairs (20 year cycle) Renew coatings 30+ years	Periodic Integrity Inspection and repairs (20 year cycle) Renew coatings 30+ years	Periodic Integrity Inspection and repairs (20 year cycle) No coating renewal required	Periodic Integrity Inspection and repairs (20 year cycle) Renew coatings 30+ years	Periodic Integrity Inspection and repairs (20 year cycle) No coating renewal required	Periodic Integrity Inspection and repairs (10 year cycle?) Special precautions needed to prevent damage to fiberglass.	Periodic Integrity Inspection and repairs (20 year cycle)	Periodic Integrity Inspection and repairs (20 year cycle)	Under investigation	Periodic damage repair	Most likely repair by replacement due to shorter life
In tank release detection system required	Yes	Yes	Yes	No	No	No	No	No	No	No	Yes?	Yes	No
Outside primary envelope release detection provided	Not provided with this alternative as there is existing release detection at the Red Hill Facility consisting of ground water monitoring and soil vapor testing at each tank in addition to annual tightness testing.	Not provided with this alternative as there is existing release detection at the Red Hill Facility consisting of ground water monitoring and soil vapor testing at each tank in addition to annual tightness testing.	Not provided with this alternative as there is existing release detection at the Red Hill Facility consisting of ground water monitoring and soil vapor testing at each tank in addition to annual tightness testing.	Yes (interstice with tell-tale system)	Yes (interstice with tell-tale system)	Yes –visual shell, tell-tale on lower dome	Yes –visual shell, tell-tale on lower dome	Yes, tell-tale piping must be inside of tank and penetrate tank envelope in lower dome	Yes, tell-tale piping must be inside of tank and penetrate tank envelope in lower dome	Yes, tell-tale piping must be inside of tank and penetrate tank envelope in lower dome	Under investigation	No	Yes, existing shell and liner interstice
Environmental Compliance Requirement	Yes, with BAPT release detection system and tightness testing	Yes, with BAPT release detection system and tightness testing	Yes, with BAPT release detection system and tightness testing	Yes, double wall construction with release detection	Yes, double wall construction with release detection	Yes, tank is AST with secondary containment and under floor release detection	Yes, tank is AST with secondary containment and under floor release detection	Yes, double wall construction with release detection	Yes, double wall construction with release detection	Yes, double wall construction with release detection	Concrete barrel/steel liner serves as secondary containment, but is not inspectable	Yes, with BAPT release detection system and tightness testing	Yes, only if integrity of concept can be demonstrated, which is questionable

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Reliability	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Unknown for tank of Red Hill sizes. Only a few known failures in 24 ft. high tanks.	Difficulty in actual execution of barrel plates raises some concern on reliability	Difficulty in actual execution of barrel plates raises some concern on reliability	Unknown if acceptable for bulk petroleum storage as compared to acceptable for LNG storage	In industry it has been shown to be reliable. Unknown for petroleum storage.	At this point questionable based on discussions with liner manufacturers
Ability to Repair Failures	Very good	Very good	Very good	Primary Envelope - very good, secondary liner difficult, but possible	Primary Envelope - very good, secondary liner difficult, but possible	Primary Envelope and secondary containment - very good	Primary Envelope and secondary containment - very good	Repair of secondary containment foil and fiberglass is questionable, repair of primary fiberglass layer possible	Primary Envelope - very good, secondary liner difficult, but possible	Primary Envelope - very good, secondary liner difficult, but possible	Under investigation	Believed to be repairable	Small failures yes, but this has not been shown to be reliable in dike lining industry. Repairs sometimes damage surrounding membrane
Design or Anticipated Service Life	Greater than 40 years with proper maintenance	Greater than 40 years with proper maintenance	Greater than 40 years with proper maintenance	Greater than 40 years with proper maintenance	Greater than 40 years with proper maintenance	Greater than 40 years with proper maintenance	Greater than 40 years with proper maintenance	Questionable, less than 40 years expected	Greater than 40 years with proper maintenance	Greater than 40 years with proper maintenance	Under investigation	Unknown	Would not want to exceed 10 year service life.
Impact on Volume	None	None	None	Reduction, no fuel stored in upper dome	Reduction, no fuel stored in upper dome	Reduction, no fuel stored in upper dome and in annular space around tank shell	Reduction, no fuel stored in upper dome and in annular space around tank shell	Reduction, no fuel stored in upper dome	Reduction, no fuel stored in upper dome	Reduction, no fuel stored in upper dome	Under investigation	Little, if also applied to upper dome	Reduction, no fuel stored in upper dome
Impact on ATG	None	None	None	None	None	None	None	None expected	None	None	None	None	Inability to obtain accurate strapping tables makes ATG unreliable (which is unacceptable)
Impact on Venting	None	None	None	None	None	Tank vent must be connected to existing vent system	Tank vent must be connected to existing vent system	None	None	None	None	None	None
Impact on Tank piping	All options include new double wall piping from present tank cavity to lower tunnel (approximately 50 feet) as with several concepts, this piping is an extension of the tank, thus double wall construction warranted												

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Is concept practicable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Questionable	Yes but not as good as other alternatives	Yes but not as good as other alternatives	Under investigation	Yes	Very questionable
Planning Level Tank Upgrade Construction Cost Estimate [redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]												
	[redacted]												
	[redacted]												

PRIVILEGED Procurement Sensitive, Source Selection Information

See FAR 2.101 and 3.104, 5 U.S.C. 552(b)(3), 5 USC 552(b)(5)