Final Assessment Report

Assessment of Red Hill Underground Fuel Storage Facility
Pearl Harbor, Hawaii

29 April 2022

SGH Project 220064

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PREPARED FOR:

Naval Supply Systems Command
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29 April 2022

Secretary of the Navy
Office of the Secretary of the Navy
1000 Navy Pentagon, Room 4D652
Washington, DC 20350

Project 220064 – Assessment of Red Hill Underground Fuel Storage Facility, Pearl Harbor, Hawaii
Final Assessment Report

Dear Sir:

Please find enclosed our Final Assessment Report for the subject project. Please do not hesitate to contact us should you have any questions or comments.

We appreciate being of service to Naval Supply Systems Command.

Best regards,

[redacted]

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Encls.
cc: CAPT [redacted] (NAVSUP)

EXECUTIVE SUMMARY

Background

The Red Hill Underground Bulk Fuel Storage Tank Facility (the Facility) is located on the Island of Oahu, Hawaii. The Facility is part of the broader Joint Base Pearl Harbor Hickam (JBPHH) Defense Fuel Support Point (DFSP), which supports military operations in the Pacific. The Facility consists of twenty steel-lined concrete tanks encased in concrete and built into cavities mined inside Red Hill. Each of the twenty tanks at Red Hill generally measures 100 ft in diameter and is approximately 250 ft in height. The cavity in which the tanks are built lies under a minimum 100 ft of rock. Each tank can store up to 12.5 million gallons of fuel. Presently, eighteen tanks are operational, and two are not in service (since 2007). The tanks are connected to three pipelines that run (b)(3)(A) through a tunnel to an underground pump house that distributes fuel via pipelines to above-ground storage tanks, fueling piers at Pearl Harbor, the flight line on Hickam Airfield, and receives fuel from a transfer point to PAR Hawaii Refinery.

Fuel releases from the Facility, following a series of related events starting 6 May 2021 through 28 November 2021, led to contamination of the water supply to JBPHH. Afterward, the Hawaii Department of Health (DOH) issued an Executive Order (EO). To comply with Orders 3 and 5, the Navy engaged Simpson Gumpertz & Heger Inc. (SGH) to perform an independent review of the Facility and JBPHH fueling systems which include Hotel Pier, Kilo Pier, Sierra Pier, Mike Pier, and Bravo Pier. Our objectives in this regard were to assess the design and integrity of the fuel system and the operations at JBPHH, including the Red Hill underground storage tanks, in order to safely defuel the Red Hill underground storage tanks and to safely operate the balance of JBPHH.

Our independent assessment included the following tasks: 1) Facility Walk Down; 2) Document Review; 3) Process Hazard Analysis (PHA) and Operational Readiness Assessment (performed by our subcontractor and teaming partner, Risktec); 4) Structural Integrity Assessment; 5)

Mechanical Integrity Assessment; and 6) Development of Conceptual Repair Schemes and Cost Estimates.

Recommendations – Process Safety Management and Operational Readiness

A Hazard and Operability (HAZOP) Study was performed to assess the operational risks associated with both defueling Red Hill and ongoing operations at Red Hill and JBPHH. The reviews resulted in evaluations of systems integrity and potential impacts on the environment, health and safety, the public, and mission readiness. The HAZOP report documents a PHA for the facility. The PHA team identified 120 recommendations for reducing the likelihood and/or severity of potential consequences associated with the Pearl Harbor and Red Hill Fuel Facility. The HAZOP report was created by our subcontractor and teaming partner, Risktec. Table 8-1 contains thirteen recommendations and their associated risk rankings made during the PHA (HAZOP) to be specifically considered by Navy leadership prior to commencing defueling the Red Hill Tanks. Table 8-2 contains those recommendations and associated risk rankings to be considered for ongoing operations specific to the Pearl Harbor DFSP, and Table 8-3 contains those recommendations and associated risk rankings to be considered if operations at Red Hill are resumed in the future.

It is not expected that all recommendations made as a result of the PHA or Operational Readiness Assessment will be implemented. Priority should be established by Navy leadership, taking into consideration, among other things, the assigned risk ranking associated with the recommendation, the anticipated schedule for defueling Red Hill, the expected future use of the Facility, the technical feasibility of the recommendation, the financial impact of the recommendation and other efforts underway or planned to address the risk. A preliminary implementation plan (Table 8-4) is provided for those recommendations considered critical.

Recommendations – Structural and Mechanical Integrity

Our recommendations are provided in detail in Appendix A and its five sub-appendices as follows:

- Appendix A.1 – Site Visit Observations and Recommendations (Sorted by Location)

- Appendix A.2 – Site Visit Observations and Recommendations (Sorted by Priority)
- Appendix A.3 – Conceptual Retrofit Drawings in Lower Access Tunnel
- Appendix A.4 – Repair Sketches and Photographs in Lower Access Tunnel
- Appendix A.5 – Valve Equalization By-Pass Line Concept

Our most significant recommendations (and which are all required prior to defueling) are in the lower access tunnel (LAT) adjacent to the Red Hill tanks. Our structural and mechanical integrity and design improvement recommendations are summarized as follows:

1. Performance of a surge analysis for the three fuel pipelines to determine whether a larger load than we evaluated could occur during defueling, considering the existing piping configurations and the expected sequence of valve openings associated with defueling. Based on the computed surge loads, any Dresser couplings subject to tension should be evaluated to determine whether they have sufficient capacity, with consideration to replace or strengthen the Dresser couplings.

2. Protection of Dresser couplings by ensuring cross-tunnel lateral piping is connected at tanks or provision of axial restraints at tank piping laterals. If cross-tunnel piping cannot be connected or supported with axial restraints, we recommend that any in-line Dresser couplings that could be subject to tension (e.g., if the adjacent lateral is disconnected), be evaluated to determine whether the coupling has sufficient strength to resist the tensile loads from a detailed surge analysis.

3. Provision of lateral restraint to all three main pipelines at a select number of pipe supports in the LAT and re-establishment of effective, integral cross-tunnel lateral piping at odd-numbered tanks. This includes reconnection of piping laterals to Tanks 1 and 19. This recommendation will help restrain the pipes from significant lateral movement (and the resulting damage to the piping laterals and Dresser couplings) in the event of a high-pressure surge event, similar to that which happened in May 2021. We understand that reconnection of Tank 19 was in process during this study, but our pipe stress analysis indicates that the work that is being currently performed may still not be adequate and that additional system strengthening (axial and lateral restraints) may also be required in order to resist transient surge loads.

4. Permanent connections of the lateral piping between the odd-numbered tanks and main pipelines. If this condition changes and odd-numbered tanks are disconnected, then additional axial and/or lateral restraints and line stops are required to restrain the pipeline movement due to the disconnected piping. The proposed lateral restraints and stops shown in Appendix A.3 are based on the assumption that piping laterals at Tanks 1 and 19 are being reinstated and that no odd-numbered tanks will be disconnected from the system while there is fuel in any of the tanks.

5. Provision of lateral restraints (guides) at approximately 20 locations in the LAT that can ensure the stability of the F-24 pipeline. The F-24 pipeline is presently inadequately supported and could fall from its pipe supports in the event of a high-pressure surge event or an earthquake.

6. Consideration for providing pressure equalization across both the inboard (skin) valve and the outboard valve at tanks. This recommendation can reduce the risk of future high-pressure surge events in the event that vacuum conditions in the three main fuel pipelines occur. In terms of

defueling, not all of the tanks will require pressure equalization across the valves if the Navy can plan the order in which the tanks are defueled.

We have many other recommendations, including a host of maintenance issues and repair of corroded piping, damaged coating, damaged/reconfigured pipe supports, missing bracing, corroded pipe supports, overconstrained piping and stairways at several aboveground storage tanks, degraded pier structures, follow-up on items previously identified as being in need of repair from past inspection reports, and others. See Appendices A.1 and A.2 for a complete description. Our recommendations (over 200) are sorted by location and priority in Table 8-5. A number of these will require repair prior to defueling (designated as priority D1) whereas some will only be performed as part of ongoing JBPHH operations [with designated priorities as P1 (high), P2 (lower), and P3 (maintenance)].

The tables in Appendix A.1 provide our recommendations ordered by location, while those in Appendix A.2 provide the same information ordered by recommendation priority. Both appendices provide our cost estimates for performing repairs, broken down by priorities for the same items. Costs are further broken down into our recommendations that we believe are not part of existing planned/funded projects (the first column of numbers in Table 8-7) and those that are part of such projects (the second column of numbers in Table 8-7). The additional projects that we are identifying are in the first column of numbers in the table and add to approximately (b)(3) [redacted].

Several comments regarding the cost estimates should be noted:

(b)(3) [redacted]

[redacted]

[redacted]

[redacted] (b)(3) [redacted]

[redacted]

In terms of completion schedule, the tables in Appendices A.1 and A.2 nominally assign the following implementation schedules:

- D1 – as soon as practicable.
- P1 – twelve to twenty-four months.
- P2 – twenty-four to forty-eight months.
- P3 – ongoing as part of maintenance activities.

Finally, our recommendations related to maintenance of coatings and corrosion control are also provided in Section 8.2.

General

Our general recommendations for safe defueling also include the following:

- Any modifications that affect the loading or structural response of tanks, structures or piping systems should be engineered in a coordinated manner.

- Independent third-party verification of design changes, repairs and modifications currently being planned and implemented should be employed.

- A more robust facility specific integrity management program and anomaly tracking system should be implemented.

- A risk-based process safety management system should be adopted.

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APPENDIX

ABBREVIATIONS

ADIT	An Entrance to the Red Hill Tunnel System
AFFF	Aqueous Film Forming Foam
API	American Petroleum Institute
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ATC	Applied Technology Council
CIR	Clean, Inspect, Repair
CP	Cathodic Protection
DCR	Demand to Capacity Ratio
DFSP	Defense Fuel Support Point
DLA	Defense Logistics Agency
DOD	Department of Defense
DOH	Department of Health
EEI	Enterprise Engineering, Inc.
EMS	Engineering Management System
EO	Emergency Order
EPA	Environmental Protection Agency
EXWC	Engineering and Expeditionary Warfare Center
FLCPH	Fleet Logistics Center Pearl Harbor
FOR	Fuel Oil Reclamation
HAZID	Hazard Identification
HAZOP	Hazard and Operability Study
HT	Harbor Tunnel
ICAP	Infrastructure Condition Assessment Program
ILI	In-Line Inspection
IMP	Integrity Management Plan
JBPHH	Joint Base Pearl Harbor Hickam
LAT	Lower Access Tunnel
LFET	Low Frequency Electromagnetic Technique
LRUT	Long-Range Ultrasonic Testing
MAOP	Maximum Allowable Operating Pressure
MOC	Management of Change
MOP	Maximum Operating Pressure
NAVFAC	Naval Facilities Engineering Systems Command
NAVSUP	Naval Supply Systems Command
NDT	Non-Destructive Testing
OSHA	Occupational Health and Safety Administration

PHA	Process Hazard Analysis
POAM	Plan of Actions and Milestones
POL	Petroleum, Oil, Lubricants
PRL	Pearl Harbor
psig	Pounds Per Square Inch Gauge
PSM	Process Safety Management
PVC	Polyvinyl chloride
QRVA	Quantitative Risk and Vulnerability Assessment
RHL	Red Hill
RMMR	Recurring Maintenance and Minor Repair
RBPS	Risk-Based Process Safety
SCC	Stress Corrosion Cracking
SGH	Simpson Gumpertz & Heger Inc.
SPCC	Spill Prevention Countermeasures and Controls
SZC	Splash Zone Coating
The Facility	Red Hill Underground Bulk Fuel Storage Facility
TIRM	Tank Inspection, Repair, Maintenance
UAT	Upper Access Tunnel
UBFS	Underground Bulk Fuel Storage
UPH	Underground Pumphouse
UT	Ultrasonic Testing
UTF	Upper Tank Farm
VC	Valve Chamber
VS	Valve Station

1. INTRODUCTION

The Red Hill Underground Bulk Fuel Storage Tank Facility (the Facility) is located on the Island of Oahu, Hawaii. The Facility is part of the broader Joint Base Pearl Harbor Hickam (JBPHH) Defense Fuel Support Point (DFSP), which supports military operations in the Pacific. The Facility consists of twenty steel-lined concrete tanks encased in concrete and built into cavities mined inside Red Hill. Each of the twenty tanks at Red Hill generally measures 100 ft in diameter and is approximately 250 ft in height. The cavity in which the tanks are built lies under a minimum 100 ft of rock. Each tank can store up to 12.5 million gallons of fuel. Presently, eighteen tanks are operational, and two are not in service (since 2007). The tanks are connected to three pipelines that run 2.5 mi through a tunnel to an underground pump house that distributes fuel via pipelines to above-ground storage tanks, fueling piers at Pearl Harbor, the flight line on Hickam Airfield, and receives fuel from a transfer point to PAR Hawaii Refinery. See Figure 1-1 to Figure 1-3 for the Pearl Harbor fuel facility layout and product storage locations. The Facility tanks are represented in the lower right with a black color denoting tanks that are out of service (Figure 1-3).

(b)(3)(A)

[redacted]

Figure 1-1 – Aerial Schematic of JBPHH Fuel Facilities (NAVSUP, 2022)

[redacted] (b)(3)(A)

Figure 1-2 – Schematic of Red Hill Tanks and Tunnels to Pumphouse (Pond, 2018)

[redacted] (b)(3)(A)

Figure 1-3 – Pearl Harbor Fuel Facility (Hickam Air Force Base not shown), Tank Status 19 January 2022 (picture from operator's screen)

Fuel releases from the Facility following a series of events starting 6 May 2021 through 28 November 2021 led to contamination of the water supply to JBPHH. Afterward, the Hawaii Department of Health (DOH) issued an emergency order (EO):

1. Immediately suspend operations including, but not limited to, fuel transfers at the Bulk Fuel Storage Tanks at the Facility. Respondent shall, however, maintain environmental controls, release detection and release response protocols, and compliance with applicable regulations.

2. Take immediate steps to install a drinking water treatment system or systems at Red Hill Shaft to ensure the distribution of drinking water conforms to the standards prescribed by the Safe Drinking Water Act and applicable regulations and to minimize the movement of the contaminant plume(s). The treatment system(s) shall be reviewed and approved by the Department (of Health) prior to installation and shall be installed as expeditiously as practicable.

3. Within thirty days of receipt of this EO, submit a work plan and implementation schedule, prepared by a qualified independent third party approved by the Department (of Health), to assess the Facility operations and system integrity to safely defuel the Bulk Fuel Storage Tanks. Upon the Department's (of Health) approval of the assessment, work plan, and implementation schedule, conduct necessary repairs and make necessary changes in operations to address any deficiencies identified in the assessment and work plan. Corrective actions shall be performed as expeditiously as possible.

4. Within thirty days of completion of required corrective actions under Item 3, defuel the Bulk Fuel Storage Tanks at the Facility. Any refueling shall be subject to a determination by the Department (of Health) that it is protective of human health and the environment.

5. Within thirty days of receipt of this EO, submit a work plan and implementation schedule prepared by a qualified independent third party approved by the Department (of Health) to assess operations and system integrity of the Facility to determine design and operational deficiencies that may impact the environment and develop recommendations for corrective action. Submit the assessment, proposed work, and recommendations for corrective action to the Department (of Health) with an implementation schedule. Upon the Department's (of Health) approval, perform work and implement corrective actions. Corrective actions shall be performed as expeditiously as possible.

To comply with Orders 3 and 5, the Navy engaged Simpson Gumpertz & Heger Inc. (SGH) to perform an independent review of the Facility and JBPHH fueling systems which include Hotel Pier, Kilo Pier, Sierra Pier, Mike Pier, and Bravo Pier.

Stated concisely, our objectives were to assess the design, integrity, and operations of the fuel system at JBPHH, including the Red Hill Underground Bulk Fuel Storage (UBFS) tanks, in order to safely defuel the Red Hill UBFS tanks and to safely operate the balance of JBPHH.

Our independent assessment includes the following tasks 1) Facility Walk Down, 2) Document Review, 3) Process Hazard Analysis (PHA) and Operational Readiness Assessment (performed by our subcontractor and teaming partner, Risktec), 4) Structural Integrity Assessment, 5) Mechanical Integrity Assessment, and 6) Development of Conceptual Repair Schemes and Cost Estimates. Our Plan of Actions and Milestones (POAM) lists these principal tasks.

During our walk downs and interviews with the Facility personnel, we identified operational, mechanical, and structural vulnerabilities. We reviewed past inspections, remedial work plans, and work orders that historically impacted the Facility. We also analyzed pipelines, pipe supports and components, above-ground storage tanks, and the Red Hill UBFS tanks to ascertain margins, residual capacities, and sensitivities to potential damage mechanisms and deterioration.

Though not currently used for fueling and defueling operations, Kilo and Sierra Piers and Mike and Bravo Piers were recently used for such operations; therefore, SGH also performed topside and below deck inspections of the associated and accessible fueling and defueling systems to inform our structural and mechanical integrity assessments.

1.1 Background

Defense Logistics Agency (DLA), as the Department of Defense Executive Agent for Bulk Petroleum, is responsible for funding centrally managed programs, sustainment, restoration, modernization, maintenance, and operations of the JBPHH DFSP. Naval Supply Systems Command (NAVSUP) Fleet Logistics Center Pearl Harbor (FLCPH) is responsible for the day-to-day operations of the fuel facilities. The U.S. Army Corps of Engineers provides for the execution of preventative maintenance and minor repairs. The Naval Facilities Engineering Systems Command (NAVFAC) Hawaii is responsible for Red Hill's execution of sustainment, repairs, and modernization, the water well, and environmental compliance on behalf of Commander, Navy Installation Command Region Hawaii.

Additional background information can be found in the 2017 U.S. Environmental Protection Agency, Underground Storage Tank System Evaluation Report for the Red Hill Bulk Fuel Storage Facility Joint Base Pearl Harbor Hickam.

On 21 December 2021, the Commanding Officer of NAVSUP Fleet Logistics Center, Pearl Harbor, Hawaii, Captain Albert Hornyak, issued Standing Orders for no fuel to be moved to, from, or between Red Hill Tanks 1 – 20 (Hornyak, 21 December 2021).

The Department of the Navy contracted SGH as a qualified independent third party to assess operations and system integrity of the Facility to determine design and operational deficiencies. Our assessment aims to deliver a framework to inform the Navy about necessary repairs and recommended changes in the operations of the Facility.

1.2 Facility Description

The Facility was built by contractor Pacific Naval Air Bases in the early 1940s to relocate and make safe fuel stored in above-ground storage tanks at Pearl Harbor. It is formally owned and operated by the Department of The Navy, locally operated by the Navy Supply Systems Command Fleet Logistics Center, Pearl Harbor, Hawaii. The Facility is comprised of eighteen operational and two out-of-service, 12.5-million-gallon underground fuel storage tanks, every 100 ft in diameter and 250 ft tall. The JBPHH fuel facility additionally comprises 1) six above-ground storage tanks that pre-date the Facility, 2) four above-ground storage tanks at Hickam Air Force Base, 3) truck fill stands at Pearl Harbor and Hickam Air Force Base, 4) pumphouses at Pearl Harbor and Hickam Air Force Base, 5) four underground surge tanks, 6) five piers, and 7) a network of piping systems, valve stations, and valve chambers. The Facility and JBPHH also have a fuel oil reclamation (FOR) system within the Facility and on Hotel Pier to process waste fuel and contaminated water.

The Facility is the primary bulk fuel storage facility for JBPHH. The lower dome of each underground fuel storage tank is approximately 100 – 130 ft above the basal aquifer [approximately 20 ft MSL (AECOM, 2019)] that supplies water to JBPHH and the surrounding community. An upper and lower tunnel connects each tank at two elevations. Fueling and defueling piping enter the tanks only at the lower dome. Three fuel types are stored in the Facility: Tanks 15 and 16 nominally hold Marine Diesel F-76 (transferred through [redacted] pipeline), Tanks 7 – 14, 17, 18, and 20 nominally hold Jet Fuel Propellent JP-5 (transferred through [redacted] pipeline), and Tanks 2 – 6 nominally hold NATO Grade Jet Fuel F-24 (transferred through [redacted] pipeline). Tanks 1 and 19 have been out of service for several years and hold no fuel. The head at the Facility feeds fuel [redacted] and facilitates pushing fuel throughout JBPHH and to PAR Hawaii, although fuel might be rarely transferred to PAR.

Access to the tanks is provided by an upper access tunnel (UAT) [redacted] above the tank bottoms and a lower access tunnel (LAT) [redacted] below the tank bottoms. Both upper and lower access tunnels are located between the two rows of ten tanks. The lower tunnel extends [redacted] and contains three distinct fuel lines (JP-5, F-24, and F-76). The main fuel piping in the LAT tank gallery runs approximately [redacted] from Tank 20 to Tank 1 (Y&D Drawing No. 294196). Piping from Tank 1 [redacted].

Within the LAT at the tank gallery, fuel piping is elevated and is typically supported on wide-flange beam and column pipe supports that vary in height, span, and lateral connectivity. This pipe also supports conduit, cable trays, HVAC ducting, other piping and electrical equipment, and fire suppression system piping. Downstream of the tank gallery, [redacted], the fuel pipelines transition to a stacked configuration, with the [redacted] F-76 line supported on concrete cradle type supports on the tunnel floor, while the [redacted] JP-5 line is offset above the F-76 line and supported on double angle pipe supports and the [redacted] F-24 line is offset above the JP-5 line and supported on dual angle pipe supports.

[redacted], piping extends to 1) Hotel Pier, Kilo Pier, Sierra Pier, Mike Pier, and Bravo Pier, 2) Hickam Air Force Base via above and below-ground piping, 3) PAR Hawaii, 4) four underground surge tanks [redacted], 5) six above-ground storage tanks at the Upper Tank Farm (UTF), or 6) other Red Hill tanks.

Hotel Pier is currently used to receive and send [redacted] via vessels. [redacted]. Other than Hotel Pier, the only other pier in use is Sierra Pier for the FOR transfer to and from vessels. However, until recently:

- Kilo Pier was used as a backup for Hotel Pier for the [redacted].
- Mike Pier was used to transfer [redacted].
- Bravo Pier was used to transfer [redacted].

NATO Grade Jet Fuel F-24 is pushed to Hickam Air Force Base from the underground pumphouse through valve stations [redacted]. Alternately, the pumphouse pushes NATO Grade Jet Fuel F-24 to the UTF Tanks 46 and 53 for storage, and then Hickam Air Force Base can receive fuel from these tanks through [redacted].

PAR Hawaii can issue and receive all fuel types via [redacted] multi-purpose pipe which is directed through valve stations [redacted] before the fuel is pushed throughout JBPHH.

Four underground surge tanks [redacted] are used as "atmospheric buffer tanks during receipt pumping operations" (Enterprise Engineering, Inc., 2019) and temporary storage.

The UTF is the legacy bulk fuel storage facility that predates the Red Hill Underground Bulk Fuel Storage Tanks. The tanks are nearing 100 years old, having been constructed in the 1920s. Each of the six tanks holds 6.3 million gallons of fuel. Tanks 46 and 53 store NATO Grade Jet Fuel F-24. Tanks 47, 48, and 54 store Marine Grade Diesel Fuel F-76. Tank 55 stores Jet Fuel Propellent JP-5. All tanks, except Tank 55, were once riveted, single bottom tanks. These were retrofitted by welding around each individual rivet, as well as around the rivets along the tank shell plate seams and by adding a double bottom to the tank to prevent leakage. Tank 55 is a relatively newer, fully-welded tank, as are the four tanks at Hickam. These UTF tanks can be filled by the Facility tanks, PAR Hawaii, or issuing vessels at Hotel Pier.

1.3 Scope of Work

The Department of the Navy requested SGH to perform an assessment of the operations and system integrity of the Facility to allow hydrocarbons within the Facility to be contained in tanks and pipelines to eliminate a potential future release of hydrocarbons into the environment. This assessment recommended safeguards for hardware and human actions to prevent or mitigate incidents and provided the the Navy with an assessment of Red Hill operations and system integrity identifying design and operational deficiencies.

SGH and our subcontractors evaluated and determined design and operational deficiencies to meet the project objectives. Design deficiencies were determined through a structural integrity assessment of the critical components at the Facility. Our study aims to provide the Navy with an understanding of the system integrity of the Facility. The operations and safety evaluation identified the deficiencies in process safety management, risk management, and integrity of the operations. We also developed recommendations to mitigate deficiencies in operations of the Facility and integrity of equipment and structures. The overall objective of this project was to improve the safety of the Facility and reduce process safety risks.

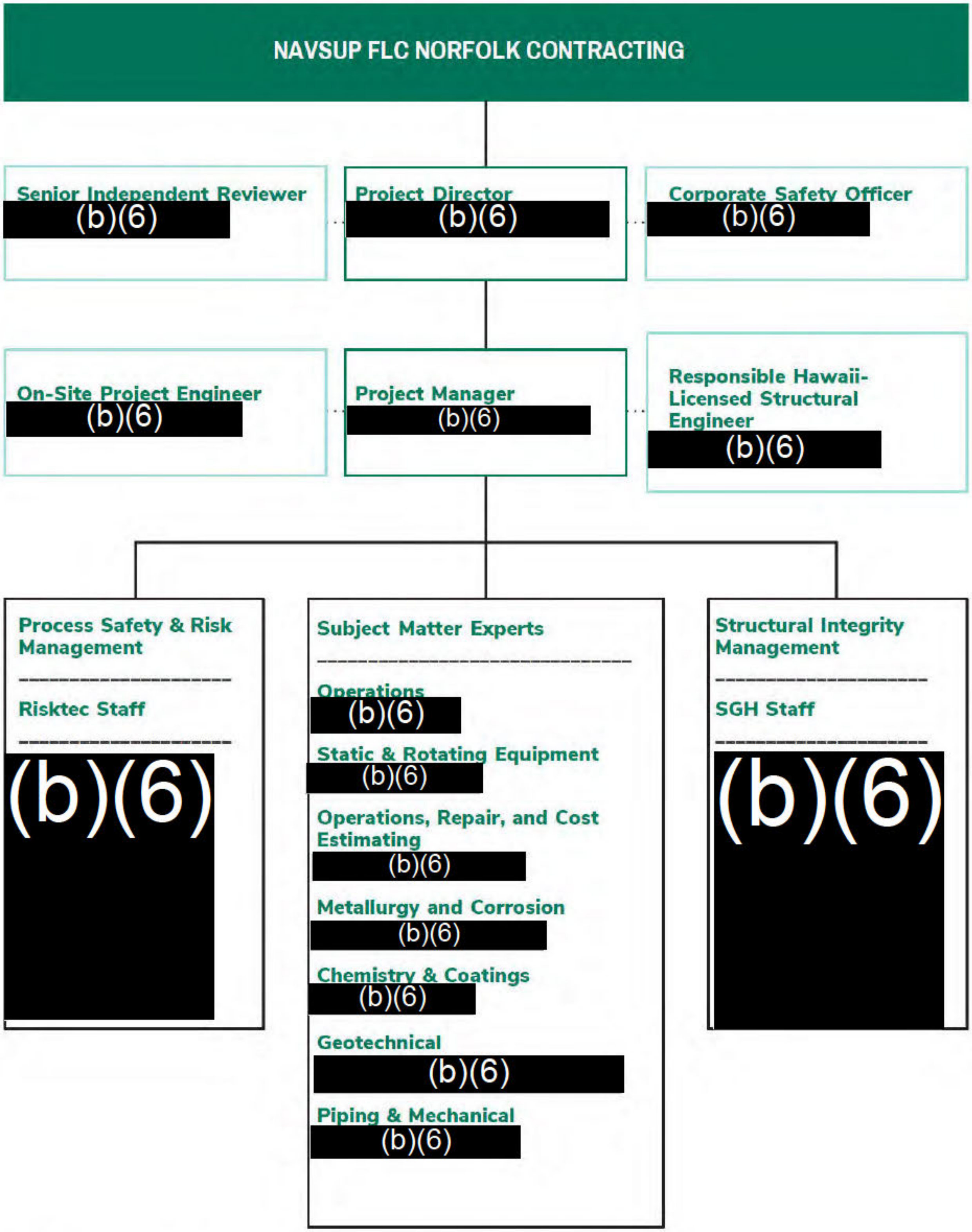
We performed structural and mechanical integrity evaluations to ensure that the degradation of critical components or design deficiencies will likely not cause failures. This effort involved the assessment of the hydrocarbon-containing systems during normal operations to ensure that hydrocarbons are contained and future hydrocarbon releases are likely prevented.

The assessment of operations and system integrity of the Facility is to determine design and operational deficiencies that may impact the environment focused on the major components of the DFSP. These components include the underground storage tanks and piping in the tunnels, the pumphouse and surge tanks, the aboveground storage tanks, the fuel piers, and the piping that connects these components up to the custody transfer point for the pipeline to the PAR Hawaii Refinery.

After completing the assessment, we developed recommendations for critical components to mitigate the identified structural integrity deficiencies. Conceptual structural mitigation recommendations were prepared to develop Class 4 cost estimates [as per the Association for the Advancement of Cost Engineering (AACE) Recommended Practice No. 18R-97 cost estimate classification system]. Cost estimates for recommendations were provided, as necessary, to the extent that those repairs do not fall under the recurring maintenance and minor repair (RMMR) program currently utilized at the Facility. Correction of identified deficiencies is expected to increase the safety of the Facility, i.e., reduce the risk at the facility.

1.4 Project Team

Our project team, organization chart (Figure 1-4), and roles and responsibilities of our team members are presented in this section.



Note: All team members are SGH employees except as denoted by *(Risktec) and **(Independent Consultant).

Figure 1-4 – Project Organization Chart

1.4.1 Roles and Responsibilities

- Project Director – The project director has ultimate responsibility for the quality, conduct, contractual obligations, staffing, scheduling, and client relationships. The project director identifies the staff assigned to the project as appropriate, coordinates staff scheduling within the firm, and establishes the overall project quality program with the project manager. The project director is responsible for overall performance, delivery excellence, and quality of the work.

- Project Manager – Working with the project director, the project manager is responsible for the day-to-day conduct of the project, establishing and controlling budgets, controlling schedules, and meeting deadlines. The project manager directs staff and maintains the project files. The project manager may assign certain tasks to additional staff members as needed. No technical staff may be assigned to the project without the approval of the project manager. The project manager maintains principal client contact and answers directly to the project director.

- Independent Reviewer – Provides technical assurance to the project team through quality reviews of reports, other work products, coaching and consultation, and a general overview of the work progress.

- Safety Officer – The project safety officer provides guidance on overall company safety policy and execution for safe day-to-day project execution. This includes briefing staff on safety protocols for site visits and confirming staff has obtained the necessary project-specific safety training.

- Security Officer – Ensures that the work is executed in compliance with applicable project security and export control requirements.

- Project Engineer – Project Engineer has the on-site liaison responsibilities and represents the project manager at the Facility. The project engineer is responsible for on-site coordination with the client, coordination with the home office, data review and transmittals, preparing requests for information (RFI), responding to client questions and comments, attending on-site project meetings with the client team, and communicating project progress and concerns.

- Operations SME – Responsible for identifying operational deficiencies and developing improvement plans.

- Process Safety and Risk SME – Responsible for identifying hazards, gaps, and deficiencies that may affect the safety of the Facility and developing improvement plans to mitigate safety risks.

- Health, Safety, and Environmental (HSE) Manager – Responsible for evaluating regulatory requirements and assessment of environmental impacts.

- Geotechnical SME – Responsible for reviewing geotechnical reports and interpretation of data to provide inputs for foundation evaluations that are part of the structural assessments.

- Materials/Metallurgical Engineering SME – Identification of the material damage mechanisms, establishment of corrosion/ erosion rates, determination of material properties including strength parameters and cracklike flaw growth parameters, development of suitable remediation methods and monitoring programs, and documentation. Also, this SME will support the analysis and interpretation of inspection data.

- Mechanical and Structural Engineers – Analysis and evaluation of structures and components, development of loading criteria, computations of the minimum required thickness for a component, performance of any required thermal and stress analysis, and knowledge in the design of and the practices relating to the pressure containing equipment including pressure vessel, piping, and tankage codes and standards.

1.4.2 Biographies of Key Team Members

- [redacted], P.E., S.E., CPEng, F.ASCE, Senior Principal, SGH. [redacted] has forty years of experience in the analysis and design of industrial structures, buildings, tanks, and pipelines subjected to both static and dynamic loads, including those from extreme events such as blasts, explosions, earthquakes, high wind, fire, and flood. He is a registered professional and structural engineer. He has served on several committees charged with developing design and evaluation criteria for both new and existing industrial facilities, including being the present Chairman of the American Society of Civil Engineers (ASCE) committees responsible for developing the guidelines, "Wind Loads for Petrochemical and Other Industrial Facilities" and "Seismic Evaluation and Design of Petrochemical and Other Industrial Facilities," co-authoring the section on tanks in the latter document. [redacted] is an ASCE Fellow and is SGH's Structural Engineering Division Head and Office Manager in Houston. He has been the structural engineer of record for the design of more than 150 buildings at petrochemical and industrial facilities throughout the U.S. and overseas. [redacted] led the seismic hazard assessment and mitigation project at Chevron USA's major petrochemical facilities in seismically active areas, including the Richmond and El Segundo, California oil refineries, during which over 1,500 tanks and all major pipe racks and process equipment in the refineries were assessed. [redacted] has provided expert witness services in disputes and litigation related to construction, leakage, collapse, settlement, wind, blast, fire, hail, and earthquake loadings.

- [redacted], Ph.D., P.E., Staff Consultant, SGH. [redacted] specializes in the design and assessment of structures, piping, and equipment at oil and gas facilities against internal and external loads. He previously worked as the owner's engineer for several onshore LNG and offshore projects. He has experience in structural integrity management of production and storage facilities. He performed inspections and led fitness for service

(FFS) studies for plant structures, foundations, tanks, piping, and equipment at oil and gas facilities. He is an expert in advanced analytics applications and has a qualification in safety-critical elements against extreme loads due to hydrocarbon accidents and natural hazards. [redacted] recent work includes the management of a PHMSA research project where the SGH team is developing performance criteria for external loading factors on external steel shell tanks. He is currently chairing the ASCE Energy Division – Task Force on Performance-Based Structural Fire Design for Petrochemical Facilities. He has published research and presented papers on a range of topics, including fire integrity analysis and passive fire protection (PFP) optimization, design of rotating equipment foundations, seismic design of offshore platforms, soil-pipeline interaction, impact load analysis of nuclear power plant structures and load distribution characteristics of highway bridges.

- [redacted], P.E., Senior Principal, SGH. [redacted] has more than forty years of experience as a project engineer, project manager, and engineering manager with strong expertise in seismic engineering, especially in the oil and gas and marine industries. In addition to project experience, he is active in code writing activities and criteria development and was the Committee Chairman and primary editor for the first edition of ASCE's "Guidelines for Seismic Evaluation and Design of Petrochemical Facilities," and is current Chairman of ASCE 61, the Standards Committee on Seismic Design of Piers and Wharves. [redacted] is also the U.S. delegate to PIANC Working Group 153 on the Design of Marine Oil Terminals. He has investigated the performance of industrial facilities in more than twenty earthquakes and other events throughout the world.

- [redacted], Ph.D., P.E., Senior Consulting Engineer, SGH. [redacted] is a licensed professional engineer with experience in structural engineering analysis, investigation, and design. She has industrial, commercial, and marine expertise, governed by domestic and international codes. She was recently the SGH on-site liaison for the assessment of the New Zealand International Convention Center, a $400M structure in Auckland, New Zealand, that was heavily damaged during a significant fire. [redacted] has collaborated on new design, investigation, and rehabilitation projects of structures subjected to natural hazards, high winds, blast loads, fire events, and operating loading conditions. She also has experience in fragility modeling, cost-benefit analysis, and component testing and modeling for material characterization. [redacted] is the incoming 2022 President of the Structural Engineers Association of Texas (SEAoT), having served as its local Houston chapter president for 2019-2020. She was born in Hawaii and has lived in Oahu.

- [redacted], Ph.D., P.E., S.E., P.Eng., Senior Project Engineer, SGH. [redacted] is a licensed professional and structural engineer with more than twenty years of experience in structural engineering analysis, design, investigation, and rehabilitation, as well as project management. He is a licensed Structural Engineer in Hawaii. [redacted] experience highlights include serving as the responsible structural engineer for steel and concrete design in petrochemical and refinery facilities. Having worked for Bechtel in the past, he has extensive expertise associated with the design, analysis, and evaluation of both new and existing industrial structures, tanks, pipe racks, and piping systems in petrochemical facilities. He is familiar with current building codes and the specifications of API, AISC, ACI, ASCE, IBC, AASHTO, and State requirements.

- (b)(6), Americas Regional Director, Risktec. (b)(6) is the Americas Regional Director for Risktec. He is a chemical engineer registered in the UK, Europe, Australia, and Canada, with thirty years of varied safety engineering, risk, reliability, and availability analysis experience in a range of industries, including oil and gas, process, and transport sectors. The work has entailed hazard analysis, identification of safety-critical elements and development of performance standards, reliability analysis, quantitative risk analysis, safety case production, safety reviews/Hazard and Operability (HAZOP) studies, and hazard identification (HAZID), fire protection, and safety engineering.

- (b)(6), P.E., Technical Director, Risktec. (b)(6) is a licensed professional engineer (chemical) with more than forty years of practical experience in chemical plants and refineries' process safety, process optimization, and technical support. She joined Risktec Solutions after working for nine years in process safety consulting and nineteen years directly in the petrochemical industry, including process engineering, operations, maintenance, and marine terminal site management. She has extensive experience in many aspects of process safety and risk management, but of particular note, (b)(6) has conducted more than 200 qualitative hazard assessments, such as Hazard and Operability (HAZOP) studies, hazard identification (HAZID)s, What-ifs, and LOPAs, has led or participated in numerous process safety compliance audits, and trained new, and current facilitators and scribes for PHA/LOPA.

- (b)(6), Consultant, Risktec. (b)(6) is a chemical and environmental engineer with more than thirty years of broad EHS experience for global chemical companies. She has managed environmental, personal safety, process safety compliance, training, and management system development and implementation. This has included the integration of a new EHS Management System, programs, standards, and systems within a large chemical corporation. (b)(6) is skilled in environmental and process safety management (PSM) compliance auditing.

- (b)(6), P.E., Consultant, Risktec. (b)(6) is a chemical and environmental engineer with over thirty years of experience in process safety, environmental safety, risk assessment, and risk management within refining and chemical manufacturing companies. (b)(6) is a skilled Lead Auditor for PSM and environmental audits.

- (b)(6), Principal Consultant, Risktec. (b)(6) is a chemical engineer with more than thirty years of experience in the oil and gas industry. (b)(6) experience includes various managerial positions within multiple refinery facilities across the U.S. and Europe, with the majority of her career being with an oil and gas company as

Health, Environment, Safety, and Operations Manager. With certifications in Process Safety and Management System Audits, Source Incident Investigation Qualified Leader, and Hazard and Operability Studies Leader, she has led training on Hazard Identification (HAZID) and Hazard and Operability (HAZOP) studies; developed life-critical standards and training, implemented learning management systems for chemical companies; and led efforts to write life-critical standards, process safety standards, and training for a major oil company.

- [redacted], CEng, Independent Consultant (Subcontractor). [redacted] is a Chartered Engineer with more than thirty-eight years of experience in the oil and gas industry and currently is an independent consultant providing services on an international basis to the industry, specializing in operations, audits, assurance, and reviews. [redacted] worked for BG Group, latterly Shell, for thirty-four years. His experience included maintenance, operations, projects, and commissioning for gas and liquids production, processing, and storage, both on and offshore. His most recent position was LNG Operations Manager, and as Operations Group Technical Authority (GTA) and Subject Matter Expert (SME) for BG's global LNG assets, he had the responsibility for the operational assurance of all BG operated and joint venture LNG assets and projects. During this time, [redacted] performed a range of functional and peer reviews as wel+l as operational audits and shared best practices across the group. [redacted] is a proficient incident investigator and has led significant investigations to the conclusion.

- [redacted], Ph.D., Independent Consultant (Subcontractor). [redacted] is the Principal at Walter Consulting Services with more than twenty years of experience specializing in static and rotating equipment risk assessment, equipment selection, testing evaluation, installation, commissioning, and operations. Prior to starting his consulting company in 2011, [redacted] was a Senior Associate at ExxonMobil and was part of a team that developed the mechanical technology for the world's largest LNG plants located in Qatar and specific technologies to optimize onshore, offshore, and subsea facilities. [redacted] has provided mechanical expertise to multiple onshore and offshore facilities where safety and integrity are foremost in equipment selection and implementation to meet operational requirements. He is currently providing commissioning expertise for gas turbines, steam turbines, generators, steam systems, and fuel gas systems for a 300 MW Combined Cycle Power Plant that provides electricity for the Ichthys LNG plant in Australia. [redacted] experience has proven effective in mature facility equipment assessments to develop maintenance and operational recommendations. [redacted] is a Hawaii resident and lives on Oahu, not far from the Red Hill facility. Walter Consulting Services is registered as an LLC in Hawaii.

- [redacted], Independent Consultant (Subcontractor). [redacted] is a mechanical engineer with over forty years of experience as an engineering specialist in industrial facilities in the U.S. and internationally. His experience has included working for Chevron Phillips Chemical Company, Caltex Petroleum Company, and Sun Refining & Marketing Company (Sunoco). He has had overall responsibility for solving technical and operational problems in an operating petroleum refinery, including addressing environmental issues to be corrected to meet new governmental regulations at petroleum storage tank and transfer facilities such as storage tank farms, marine custody transfer, and tank truck loading. During his first twenty years, he worked as Manager of Engineering at the Sunoco Philadelphia Refinery, a 100-year-old facility with many historical design and quality issues.

- [redacted], Ph.D., P.E., CWI, Staff Consultant, SGH. [redacted] is a metallurgist, corrosion specialist, and certified weld inspector with over twenty years of experience in materials engineering. He specializes in the failure analysis and structural assessment of materials systems that have been degraded by mechanisms such as corrosion, fracture/fatigue, or wear. [redacted] has an extensive technical background in laboratory testing and analysis of ASTM/NACE/API standards, including the design of fitness for purpose experimentation. He has investigated petroleum storage tank leakage due to coating failure and subsequent corrosion.

- [redacted], Ph.D., Staff Consultant, SGH. [redacted] is a chemist with over twenty-five years of experience in polymers, chemical formulations, product development, laboratory management, and problem-solving in the chemical and construction industries. His diverse background includes the design of chemical admixtures for concrete, management of a quality-control laboratory, and oversight of commercial testing laboratories in construction, metallurgy, and microbiology. His laboratory skills include chemical analysis, optical and electron microscopy, thermal analysis, and physical testing. He has investigated paint and coating failures at petroleum storage tanks, floor finish failures, trace contaminant analysis, thermal modeling, mechanical failures, concrete mix designs, metal corrosion, and moisture ingress.

- [redacted], P.E., Associate Principal, SGH. [redacted] has been with SGH since 2003. She is experienced in geotechnical engineering, providing planning, design, and construction support services in shallow and deep foundation systems, earth retention systems, seepage and stability issues, and groundwater monitoring for buildings, dams, industrial facilities, power stations, and substations. She has also participated in several investigations into causes of structural settlement, seepage, and stability issues, retaining wall failures, earth embankment and slope failures, and adjacent construction claims and has provided litigation support for various projects.

- [redacted], P.E., Senior Consulting Engineer, SGH. [redacted] has more than twenty years of experience as a mechanical engineer, with the last sixteen years being primarily for marine oil terminals while employed with SGH, Halcrow, and the Port of Oakland. His engineering experience includes design, pipe stress analysis and inspection of process piping and fire protection systems, fire water protection system analysis and design, fire plan and fire hazard risk assessments for marine oil terminals, and hydraulic analysis of piping systems.

- [redacted] Ph.D., P.E., S.E., Staff Consultant, SGH. [redacted] is a registered civil and structural engineer with over twenty-five years of experience in structural analysis and design. He has been involved in the analysis, design, and evaluation of both new and existing blast-resistant structures in petrochemical facilities and the design and evaluation of onshore and offshore structures subjected to wind, wave, current, earthquake, and blast loads. [redacted] has recently served on the American Society of Civil Engineers (ASCE) Task Committees for Wind Load Design at Petrochemical Facilities and Blast-Resistant Design at Petrochemical Facilities. [redacted] has expert knowledge about structural design code and design specifications such as API [redacted] AISC 360, AISC 341, ACI 318, IBC, ASCE 7, NFPA 59A, Eurocode, etc.

- [redacted], Ph.D., P.E., S.E., Senior Consulting Engineer, SGH. [redacted] is a registered professional and structural engineer with experience in structural engineering analysis and design. [redacted] has collaborated on new design, investigation, and rehabilitation projects of structures subjected to natural hazards, high winds, seismic, fire, blast loads, and typical loading conditions. [redacted] serves on the American Society of Civil Engineers (ASCE) Task Committees of the Energy Division on Wind-Induced Forces, Blast-Resistant Design, Structural Fire Engineering, and Onshore Heavy Industrial Modularization Guidelines.

- [redacted], P.E., Consulting Engineer, SGH. [redacted] is a licensed professional civil engineer with eight years of structural engineering experience. He has worked on several domestic as well as international oil and gas EPC projects. [redacted] has designed various steel and concrete structures, including pipe racks, cableracks, process structures, heater structures, reformer structures, and steel-clad buildings for plant modifications and new facilities, including high wind and high seismic regions. In recent years, he has worked on wind and seismic evaluation of existing structures, rehabilitation and repair design of the structures, and investigation and failure analysis of elements and connections.

- [redacted], Project Consultant, SGH. [redacted] is a Project Consultant in our Structural Engineering division. He has over nine years of experience providing structural analysis, planning, design, detailing, inspection, and construction support of buildings, steel structures, concrete structures, and waterfront structures.

- [redacted], P.E., Project Consultant, SGH. [redacted] joined SGH in 2016. He is a registered Professional Engineer with six years of experience aiding in the design, assessments, and retrofits of marine, refinery, and building structures. [redacted] also has several years of experience performing operational and seismic pipe stress analysis in accordance with ASME B31.4 and ASME B31E for pipelines at marine oil terminals in California as required by California Building Code Chapter 31F and abroad in Panama.

- [redacted], Associate Project Consultant, SGH. [redacted] joined SGH in 2022 after graduating from The University of Texas Austin with her Master's in Civil Engineering. She has experience managing the construction administration process of civil and structural engineering projects while working with contractors, architects, and other engineers overseeing the construction and engineering processes. [redacted] performs pipe stress analysis using Triflex for fuel terminals, considering operating and hydrostatic test pressures, thermal effects, seismic demands, dead loads, and variable geometries and valve configurations. She has experience using structural analysis platforms and other programs, including [redacted] SPColumn, RAM Structural Systems, and Revit.

- [redacted], P.E., S.E., Senior Project Manager, SGH. [redacted] joined SGH in 2008. Since then, [redacted] has focused on using structural mechanics and computational modeling to serve the energy, defense, water resources, rail transportation, and aerospace industries. [redacted] specializes in nonlinear dynamic finite element analysis and has extensive experience with impact loading; seismic design; fatigue and fracture mechanics; and design/analysis of concrete, steel, aluminum, and advanced composite structures.

1.5 Report Organization

The report is organized as follows:

- Sections 2, 3, and 4 contain summaries of information we rely upon, provided to us from a variety of sources. Section 2 contains the results of our review of documents on the JBPHH fuel system. Over 3,600 documents were provided to us by the Navy within 120 transmittals in response to our requests for information (RFIs). These documents include drawings, specifications, reports, calculations, letters and photographs, and other material. The information we have relied upon is summarized in Section 2. Section 3 contains summaries of information we received in conversation or directly from others, and Section 4 contains the results of our literature review of industry standards and other publicly available material.
- Section 5 contains the findings from our more than seventy walk downs of the JBPHH facility fuel systems. Photographs and field observations are provided for critical items, and Appendix A contains details in tables.
- In Section 6, we introduce the Process Safety Management (PSM) activities performed by our subcontractor, Risktec. Key documents that contain the results of the Process Hazards Analysis (PHA) Report and Operational Readiness Assessment Report are provided in Appendices B and C, respectively.

- Our structural and mechanical integrity assessment is presented in Section 7 for the various components of the JBPHH fuel system. This section contains the details of the various analytical assessments that we undertook.
- Finally, recommendations are provided in Section 8, along with cost estimates and an implementation schedule. Additional details are given in Appendices A, B, and C.

2. DOCUMENT REVIEW

For our independent assessment, it is critical to understand the design premise for integrity management studies and process hazard studies. To that end, we requested the design documents of the Facility, including design bases, specifications, drawings, data sheets, process and instrumentation diagrams (P&IDs), process flow diagrams, piping isometrics, and material certification reports from the Navy. Our requests for information (RFIs) additionally included inspection, repair, and operation documentation authored by NAVSUP, the Environmental Protection Agency (EPA), the Defense Logistics Agency (DLA), NAVFAC, the Engineering and Expeditionary Warfare Center (EXWC), the Department of Health (DOH), State of Hawaii, other stakeholders, or engineering and inspection companies employed throughout the life of the Facility. All these documents improve our understanding and independent assessment of the Facility.

Documents pertaining to previous repairs, inspection reports, and desktop studies evaluating the as-is condition of the Facility contain information used as inputs for our studies. In the absence of critical data or inconsistencies, we issued additional requests for information (RFIs). If the requested data was unavailable, we made assumptions based on our experience and engineering judgment. These assumptions are documented in this report.

The Navy engaged a third-party contractor, Pond Company, to facilitate data gathering and respond to our requests for information (RFIs). We issued over 120 requests for documents and received over 3,660 files for review. If the information existed, SGH was provided with documentation that allowed us to understand and evaluate the Facility.

Pertinent documents that provide relied-upon information for our structural and mechanical integrity assessments are grouped and listed in this section, and the key inputs obtained from these documents are presented.

2.1 Red Hill Underground Bulk Fuel Storage Tanks

The Red Hill Underground Bulk Fuel Storage Tanks were constructed by Contractor, Pacific Naval Air Bases, between 1940 and 1943. When in operation, they are subject to clean, inspect, and repair (CIR) periodically to maintain defense readiness and structural and mechanical integrity and to prevent leakage to the environment. Since the original construction, multiple instances of fuel leakage at the steel liner and stakeholders' concerns have motivated evolutions in the CIR process.

Physical stamps on the upper access tunnel tank entrances show the following CIR dates for each Red Hill tank, along with a contractor name (Tanks 3, 4, and 11 do not have completion stamps on the tanks):

Table 2-1 – Year of Last CIR Completion at Red Hill Underground Bulk Fuel Storage Tanks

Tank #	Contractor for Clean, Inspect, Repair	Date of Last CIR
1	N/A	2007 permanently closed
2	Dunken and Bush, Inc.	2009
3	N/A	N/A
4	N/A	N/A
5	APTIM	2019
6	Dunken and Bush, Inc.	2007
7	Dames & Moore	1998
8	Dames & Moore	1998
9	Aman Environmental Construction Inc.	1996
10	Dames & Moore	1998
11	N/A	N/A
12	Aman Environmental Construction Inc.	1995
13	APTIM	2021
14	APTIM	Ongoing
15	Dunken and Bush, Inc.	2006
16	Dunken and Bush, Inc.	2006
17	APTIM	2021
18	APTIM	Ongoing
19	ABHE & SVOBODA, Inc.	1999 (2007 permanently closed)
20	Dunken and Bush, Inc.	2009

According to Navy records, since 1997 (The Navy, 2022), there have been three releases from the Red Hill tanks:

6. 13 January 2014, Tank 5, Jet Fuel 27,000 gal.
7. 7 May 2021 LAT Tank 20, Jet Fuel 1,000 gal (commonly known as the 6 May 2021 event).
8. 20 November 2021, ADIT 3 AFFF low point drain, fuel oil reclamation (FOR) 14,000 gal (this release was tied to the 6 May Event).

In addition, we were informed about a release at the FOR line to Tank 14 on 1 April 2022. At that time Tank 14 was under CIR, and the incident happened during the dewatering of Tank 15. This incident was under review during this study, and the details were not known.

Historical records for the Red Hill tanks show that concerns about tank leakage of varying quantities go back to the late 1940s. The following is a broad, though not exhaustive, history of tank repair and cleaning from our literature review.

Mid Atlantic Environmental, Inc. records that in 1948 Tank 16 was suspected of a leak which resulted in the contractor and the Navy progressing through multiple iterations of emptying and refilling the tank for inspection and repair. Tank 16 was recommissioned in January 1951 (Mid Atlantic Environmental, Inc., 1998a).

In 1949, [redacted] (b)(6) (NAVSUP, 1972 - 1986), who was an observer throughout the original construction, sent a memorandum to the District Public Works Officer noting construction deficiencies in some tank upper domes leading to a concern that leaks could ensue without appropriate mitigation. He provided suggestions on accurately determining leakage from the Red Hill tanks.

Mid Atlantic Environmental, Inc. records that Tanks 6, 7, and 8 were first cleaned and repaired in 1952 (Mid Atlantic Environmental, Inc., 1998b), while Tank 10 was first cleaned and repaired in 1963 (Mid Atlantic Environmental, Inc., 1998c) and then again in 1972.

Between 1960 and 1964, four of the Red Hill storage tanks (Tanks 17 to 20) were modified to accommodate volatile fuels. Modifications included tank repairs, lining alterations, and fire protection variations. The Navy required a proprietary urethane coating for these tanks, which was discovered to blister when immersed in water (a condition that is possible at the bottom of each tank when water settles). To mitigate coating blistering, aluminizing the bottom of the tanks was recommended.

In 1966, the Navy initiated rehabilitation planning (to varying degrees) of the remaining sixteen tanks. Tanks 5, 6, and 12 were ultimately selected for repair and rehabilitation in 1970.

A follow-up design project was established to address potential deficiencies in the remaining thirteen tanks. This project included weld repairs and the application of a coating to the steel lining, which aimed to mitigate the potential for leaks. Tanks 5, 6, and 12 (previously CIR in 1970) would have a new coating applied within this new work scope as their welds were repaired during the 1970s.

Repairs on the first three tanks of the 1976 contract, which included the application of a tank liner coating, were successful to varying degrees.

In September 1980 NAVSUP emptied Tank 11 to facilitate repair work, with the direction that following completion of Tank 11 repairs, Tank 7, and then 9 and 10 would undergo follow up work. At the same time as repair work was ongoing on Tank 11, Tanks 12, 13, 14, and 15 were also undergoing CIR work; while Tanks 16, 8, 6, 5, 4, 3, 2, and 1 were scheduled for CIR through October 1983.

In 1984, Naval Supply Center Pearl Harbor tracked variations in product elevations in Tanks 2, 5, 6, and 8, all of which were accepted as serviceable after repairs in the early 1980s (NAVSUP, 1979 - 1985). Volumetric changes of less than 5 gal a day were considered acceptable and were attributed to potential thermal changes, which both Tanks 2 and 8 demonstrated in their steady-state. Tanks 5 and 6 exhibited volumetric changes greater than 5 gal per day, necessitating further investigation to ascertain if the changes indicated leakage. The product fluctuations stabilized to acceptable levels, except for Tanks 5 and 6.

From March 1982 to December 1984, multiple repair efforts were perormed on Tank 6. After the fourth entry and repair effort, Tank 6 was considered fuel tight. Tank 5 was not re-entered; rather, it was monitored through June 1984; volume changes stabilized to 5.5 gal per day, which was acceptable.

Throughout this first major repair regime for the Red Hill fuel storage tanks, multiple instances of repeat repair work were demonstrated, necessitating iterations of defueling and refueling tanks over several years (NAVSUP, 1979 - 1985) before acceptable tank tightness was achieved.

For repairs in the 1970s and 1980s, Red Hill Tank Repair specifications (Section 15007) required conformance to API 650 for Welded Steel Tanks for Oil Storage (NAVFAC, 1978). Tank piping required 1-hr 250 psig testing according to ANSI B31.3 (1975) Para. 337 and modified by Testing of Tank Piping specification Section 15009 (NAVFAC, 1978).

In January 1977 (NFC, 1977) Naval Facilities Engineering Command noted that since construction, no inspections of the external surface of the tank liners were undertaken, i.e., the face against the cast concrete. Following this, Tank 10 underwent CIR with destructive testing at the lower tank dome and around the tank barrel to evaluate the extent of corrosion on the concrete-facing steel liner. In April 1977, the documentation states that the three coupon samples revealed no backside steel corrosion.

In 1996 Mid Atlantic Environmental, Inc. performed emergency repairs on Tanks 6, 7, 8, 10, and 16. They refer to 1) API 653 for Tank Inspection, Repair, Alteration, and Reconstruction (API, 2014), 2) API 650 for Welded Steel Tanks for Oil Storage, and 3) National Association of Corrosion Engineers (NACE) Recommended Practice, PR0288-94, Inspection of Linings on Steel and Concrete, as controlling documents for their Red Hill tank inspection and repair work.

After the December 2013/January 2014 Tank 5 JP-8 fuel release, The Navy investigated the cause of the release. They directed Willbros Government Services, LLC, the contractor who performed the clean, inspect, and repair work for Tank 5 from 2010 to 2013, to re-enter the tank and assess leakage points. The investigation revealed that the contractors' quality control procedures did not discover defective welds in the tank liner, leading to JP-8 fuel release. Further, the investigation determined the clean, inspect, and repair procedures (modified API 653) were not at fault, nor was corrosion a contributor to the fuel leakage. Human error was attributed to being the sole source of leakage for this event. This report summarizes 1) the events leading to the Tank 5 release, 2) the work performed to mitigate the Tank 5 release and recommission the tank, 3) the lessons learned, and 4) planned improvements to the TIRM process (NAVFAC, 2016).

2.1.1 Leak Detection

In 2009, the Defense Logistics Agency implemented a leak detection process in all operational underground storage tanks at Red Hill. This was subsequently updated in 2014 following the Tank 5 JP-8 fuel release. Current tank tightness testing is performed bi-annually on all tanks with the product. The results of these tests, from 2016 through 2021, show that during the tests, product elevation fluctuated less than 0.5 gal per hour (Michael Baker International, 2017; Michael Baker International, 2018; Michael Baker International, 2019; Michael Baker International, 2020a; Michael Baker International, 2020b; Michael Baker International, 2021).

In summary, we understand that since the 2014 Tank 5 JP-8 fuel release, the Navy has recorded only two leaks in the vicinity of the Red Hill tanks, both of which were related to the same surge event and were from the piping and not from the tanks themselves.

2.1.2 CIR Reports

We reviewed numerous CIR reports and related documents. These include the details for out-of-service inspections and repairs conducted according to API 653.

API 653 inspections are typically conducted on a tank every twenty years. Since approximately 2000, Non-Destructive Testing (NDT) of each tank has been conducted by TesTex, covering 100% of the floor, lower dome, barrel, and upper dome steel surfaces, using a Low-Frequency Electromagnetic Technique (LFET). This scan was then backed up by ultrasonic testing (UT) inspections to verify the location and depth of locally thinned areas.

The inspection reports calculate corrosion rates based on the minimum detected wall thickness extrapolated through the service life of the tank. This corrosion rate is then used to determine the minimum acceptable current wall thickness to prevent any thinning of the tank wall to less than 0.1 in. thickness (minimum wall thickness permitting by API 653) over the time to the next API inspection (twenty years).

The key reports for each tank are summarized below:

- Tanks 1 and 19: These tanks have been decommissioned, so we have not reviewed the CIR reports for these tanks.

[redacted]

- Tank 2: Clean, Inspect, and Repair Red Hill Storage, Shaw Environmental Inc. November 2009. The API 653 evaluation in the Appendix of this report stated that the tank is suitable for service after repairs to weld defects discovered in the lower dome and barrel, localized corrosion pitting on the topside of the lower dome, and a bulge in the lower dome. The report confirmed that these repairs had been conducted, and the lower dome was recoated.

- Tanks 3, 4, and 11: We have not been provided with API 653 Inspection Reports for these tanks. We note that CIR completion stamps were not present at the upper access tunnel entrance of Tanks 3, 4, and 11.

- Tank 5: API 653 Out of Service Inspection Report, Enterprise Engineering Inc. January 2018. This API 653 evaluation lists mandatory repairs, including weld and patch plate repair to weld defects and backside corrosion in the barrel and upper dome and local repair to the lower dome coatings. We have not been provided with the repair completion report for this tank.

- Tank 6: Final API 653 Inspection Report, Weston Solutions, January 2007. This API 653 Evaluation lists requirements for weld and patch plate repairs in the lower dome, upper dome, and barrel. The report states that these repairs were completed.

- Tank 7: Emergency Repairs for Red Hills Tanks, Mid Atlantic Environmental Inc. 1998, This report documented the inspection and repairs of Tank 7 in 1998. Although the report is signed by an API 653-certified inspection, the report does not mention that the tank was inspected according to this standard. Recommended repairs were for weld defects and locally thinned areas throughout the tank. Repair reports are included in the CIR final report.

- Tank 8: Emergency Repairs for Red Hills Tanks, Mid Atlantic Environmental Inc. 1998, This report, which is similar to that of Tank 7, documents the inspection and repairs of Tank 8 in 1998. Although the report is signed by an API 653-certified inspection, the report does not mention that the tank was inspected according to this standard. Recommended repairs included weld defects and locally thinned areas throughout the tank. Repair reports are included in the CIR final report.

- Tank 9: Inspection reports have not been provided for this tank. Details of patch plate and weld repairs dated 1995 are provided, as well as documentation of a fluoropolymer coating. There is a detailed discussion regarding contamination and sludge accumulation at the bottom of several tanks.

- Tank 10: Emergency Repairs for Red Hills Tanks, Mid Atlantic Environmental Inc. 1998, This report, which is similar to that of Tank 7, documents the inspection and repairs of Tank 10 in 1998. Although the report is signed by an API 653-certified inspection, the report does not mention that the tank was inspected according to this standard.

Recommended repairs included weld defects and locally thinned areas throughout the tank. Repair reports are included in the CIR final report.

- Tank 12: No CIR documents for this tank have been provided.

- Tank 13: API 653 Out of Service Inspection and Suitability for Service Evaluation Pre-Repair Report, Enterprise Engineering Inc. May 2020. This API 653 Inspection discovered weld defects in the lower dome, barrel, and shell and localized external pitting corrosion in the top shell. We have not been provided with the repair confirmation report for this tank.

- Tanks 14 and 18: CIR process is ongoing in these tanks, so we did not review CIR reports.

- Tank 15: Final API 653 Inspection Report, Weston January 2007. Weld defects and localized corrosion were discovered throughout the tank. Weld and patch plate repairs were conducted.

- Tank 16: Final API 653 Inspection Report, Weston January 2007. Weld defects and localized corrosion were discovered throughout the tank. Weld and patch plate repairs were conducted.

- Tank 17: Clean, Inspect, and Repair Red Hill Tank 17, Enterprise Engineering Inc. April 2018. This report stated that the majority of weld defects were in the upper dome and extension ring plates. Localized backside corrosion was discovered in the upper dome, extension ring, and barrel, and patch plate repairs were conducted based on API 653 thickness requirements.

- Tank 20: Engineering Review and Suitability for Service Evaluation, Shaw Environmental Inc. January 2009. Weld defects and localized backside corrosion were discovered throughout the tank and repaired appropriately. Several voids were detected in the grout behind the lower dome, and these were repaired by grout injection. The lower dome was re-coated.

2.1.3 Structural Drawings

We reviewed a series of original structural and mechanical drawings titled Underground Fuel Storage with various dates (from 1941 to 1943) and multiple revisions. For the evaluation of the underground storage tanks, we obtained the pertinent data (such as tank dimensions, steel liner plate, and reinforced concrete details) from the drawings listed below:

- Drawing No. 293965 – General Plan & Profile of Pipe Line Tunnel.
- Drawing No. 294296 – Special Horizontal Steel for Upper Dome #1 to #4.
- Drawing No. 294297 – Dome Steel – Liner Plate Details.
- Drawing No. 294298 – Special Horizontal Steel for Upper Dome #5 to #20.

- Drawing No. 294302 – Reinforcement Steel in Tanks – Lower Dome and Barrel.
- Drawing No. 294303 – Prestressing Grout Detail.
- Drawing No. 294305 – General Design and Construction Details.
- Drawing No. 294307 – Bottom Domes - Typical Section and Plan.
- Drawing No. 294309 – Typical Liner Plates in Lower Dome.
- Drawing No. 294318 – Gen Plan & Gauging Platform.
- Drawing No. 294321 – Upper and Lower Dome Details.

The interior diameter for each tank is 100 ft based on the drawings. Each tank consists of a bottom dome, a barrel section in the middle, and an upper dome. The overall interior height is approximately 250 ft for Tanks 5 to 20. The barrel section for Tanks 5 to 20 is approximately 150 ft tall, while the upper and lower domes are approximately 50 ft tall. The barrel section for Tanks 1 to 4, which were built before the other tanks, is 12 ft shorter than that for Tanks 5 to 20, resulting in an overall interior height of about 238 ft for Tanks 1 to 4. The elevations of the tanks (extracted from Drawing No. 294318) are shown in Figure 2-1. The top of the tanks (top of the upper dome) is a minimum 100 ft below ground, as shown in Figure 2-2 (extracted from Drawing No. 293965).

ELEVATIONS FOR TANKS

	Tanks 1,2,3,4	Tanks 5 & 6	Tanks 7 & 8	Tanks 9 & 10	Tanks 11 & 12	Tanks 13 & 14	Tanks 15 & 16	Tanks 17 & 18	Tanks 19 & 20
Elev. Fin. Floor of Tunnel.	[redacted] (b)(3)(A)								
Fin. Floor to Top of Arch of Tunnel									
Elev. Bottom of Sub-Grade									
Thickness of Bottom									
Elev. Inside of Bottom									
Vertical Height of Bottom									
Elev. Bottom of Barrel Section									
Height of Barrel Section									
Elev. at Springline									
Elev. Inside Top of Dome									
Thickness of Dome									
Elev. Outside Top of Dome									
Note: Grade Level at Station 30+20 +2% Grade Beyond Sta 30+30									

Figure 2-1 – Elevations for the Red Hill Tanks (Extracted from Drawing No. 294318)

(b)(3)(A)

[redacted]

Figure 2-2 – The Top of the Tanks is a Minimum 100 ft below Ground (Extracted from Drawing No. 293965)

The construction of each tank consists of minimum 2.5 ft thick reinforced concrete (2.5 ft minimum at the top of a barrel section and 4 ft minimum at the bottom of a barrel section) with 1/4 in. thick interior steel liner plate (1/2 in. thick steel plate at the floor of the bottom dome). Each tank was constructed by excavating the lava rock formation of Red Hill. Therefore, the reinforced concrete shell of each tank was surrounded and laterally supported either by basalt (sound rock) or clinker (a softer, less stiff layer), as shown in Figure 2-3. The clinker layer was pretreated with gunite (dry-gun concrete) before reinforced concrete was placed. Figure 2-4 shows the gunite plug detail.

(b)(3)(A)

[redacted]

Figure 2-3 – Partial Section of UST (Extracted from Drawing No. 294305)

(b)(3)(A)

[redacted]

Figure 2-4 – Typical Detail Through Soft Strata for Barrel Section of UST (Extracted from Drawing No. 294305)

The reinforcement details for the barrel section concrete (extracted from Drawing No. 294302) are shown in Figure 2-5. The steel liner plates on the barrel section are arranged as 5 ft tall horizontal courses. The liner plates are connected by 3 in. x 2-1/2 in. x 5/16 in. horizontal steel angles welded to the backside of the steel liner plates at the top and bottom of the plates, and the angles are embedded or anchored into the reinforced concrete using 3/4 in. diameter steel rods. Figure 2-6 shows a typical section of barrel liner plate anchorage details (extracted from Drawing No. 294321).

(b)(3)(A)

[redacted]

Figure 2-5 – Typical UST Barrel Section Reinforcement Details
(Extracted from Drawing No. 294302)

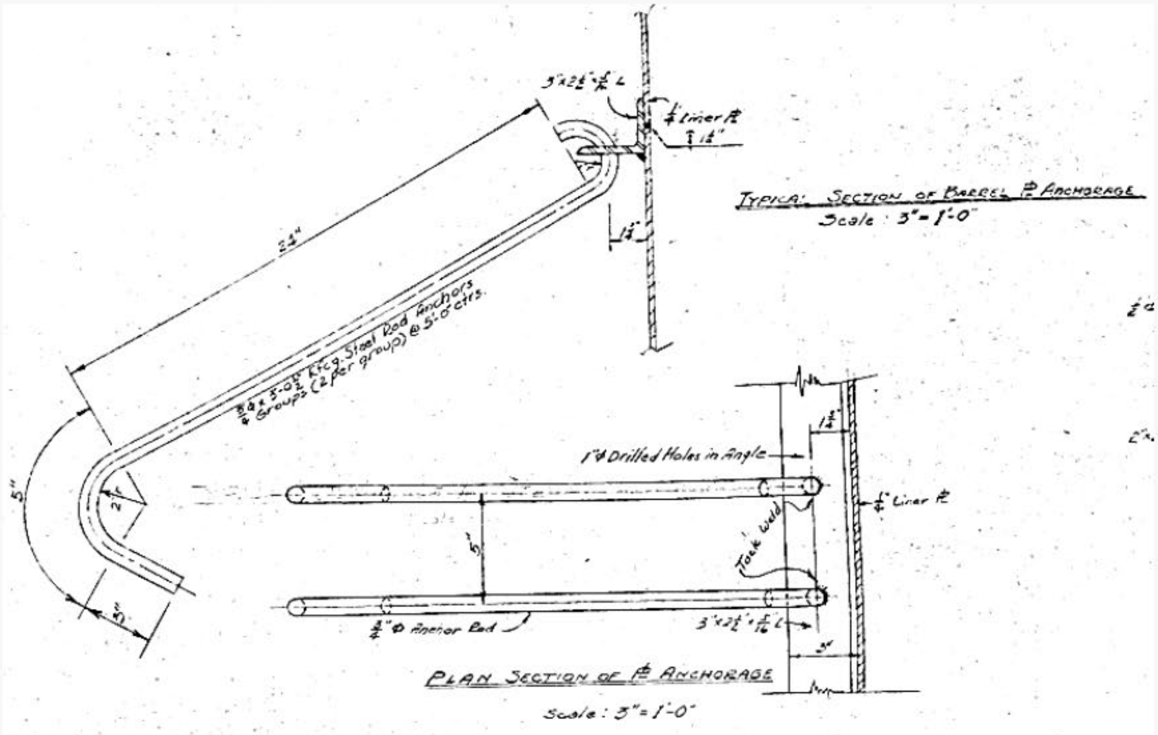


Figure 2-6 – Typical Liner Plate Anchorage Details of UST Barrel Section (Extracted from Drawing No. 294321)

After the construction of the tank wall, prestressing grout was injected through the grout pipes between the tank wall and the surrounding strata (basalt or gunite plug at softer soil layers). This prestressing grout puts concrete in the tank wall under compression. The minimum thickness of this grout or gunite lining specified in the drawings is 6 in for the upper portion of the barrel. Figure 2-7 shows the vertical section through the tank with locations of the grout grooves along tank height. A typical horizontal section through the tank barrel at a grout groove is shown in Figure 2-8. Eight grout pipes and four strain gauges are used along the perimeter of each grout groove. Figure 2-9 shows a typical grout groove detail in the cross section.

[redacted]

(b)(3)(A)

Figure 2-7 – Typical Vertical Section Through UST with Grout Grooves (Extracted from Drawing No. 294303)

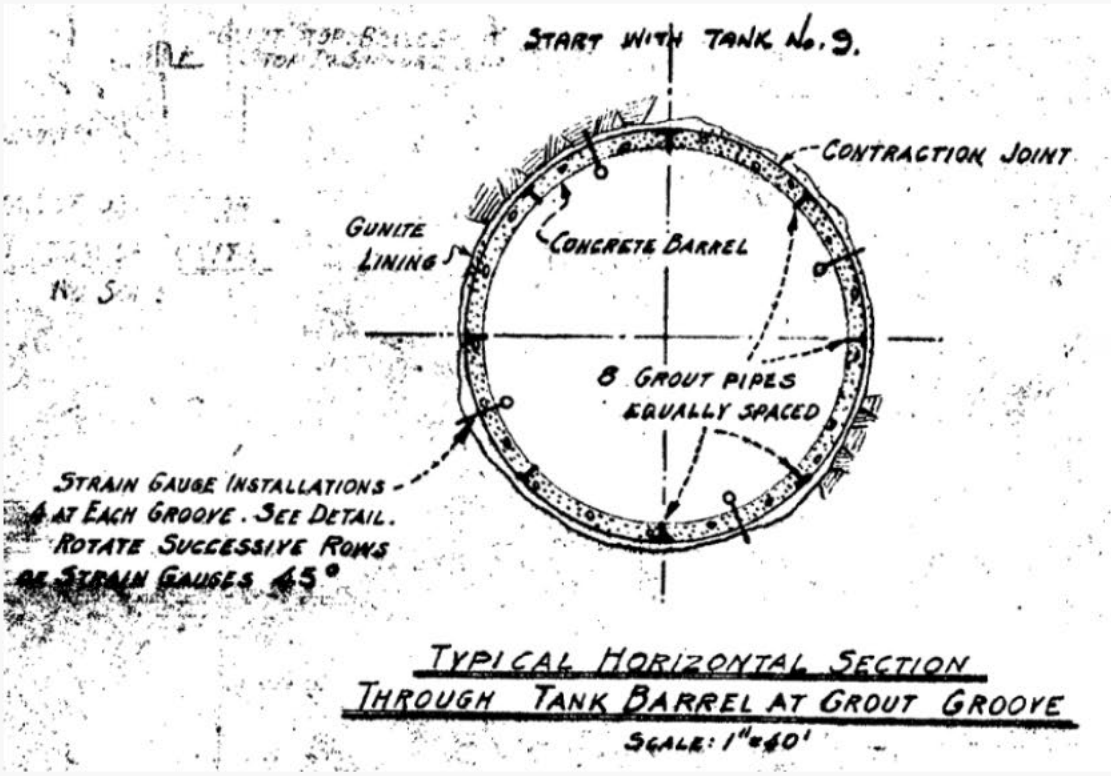


Figure 2-8 – Typical Horizontal Section Through UST Barrel at Grout Groove (Extracted from Drawing No. 294303)

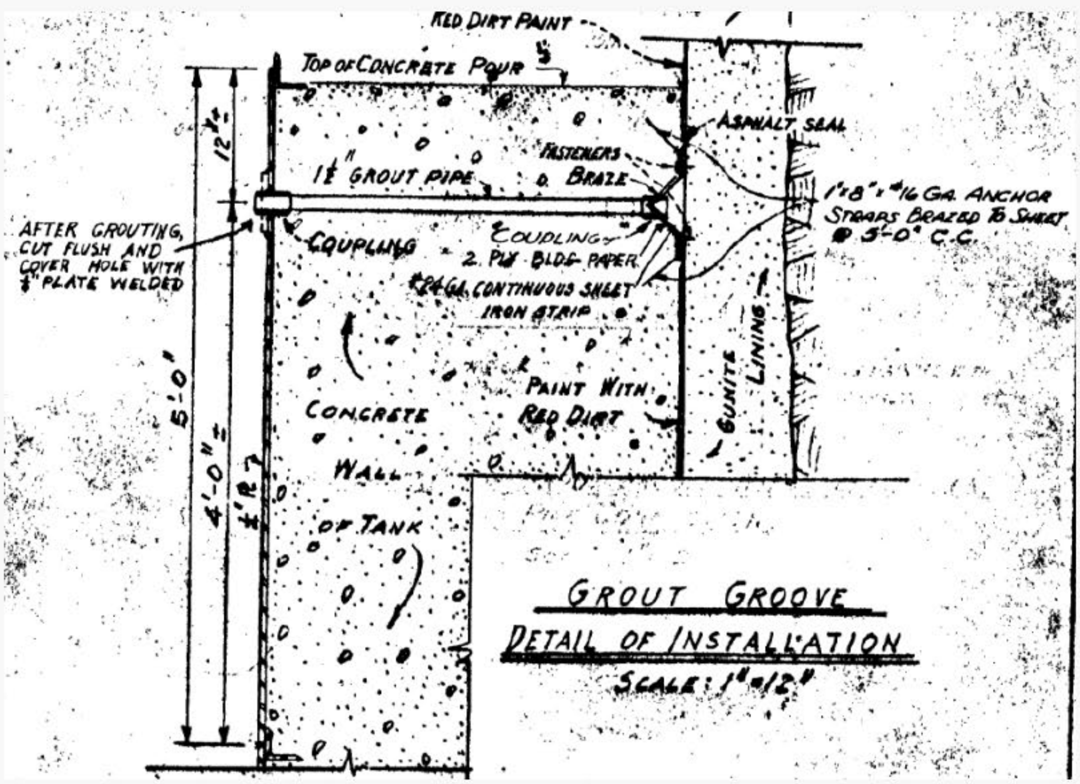


Figure 2-9 – UST Grout Groove Detail of Installation (Extracted from Drawing No. 294303)

2.1.4 Borehole Information and Log of Formation in Tank Excavation Areas

We reviewed the following drawings containing the borehole information and log of formation observed during tank excavation:

- Drawing No. 293906 – Pearl Harbor Fuel Storage Log of Diamond Drill Holes 1940.
- Drawing No. 293962 to Drawing No. 293979 – Log of Formations in Tank Excavation from Tank 1 to Tank 18.
- Drawing No. 293981 – Log of Formations in Tank Excavation for Tank 20.

Borehole No. 2B contained in Drawing No. 293906 is located adjacent to Tanks 9 and 10, and this borehole shown in Drawing No. 293906 is relevant for the evaluation of underground storage tanks. However, Bole Hole No. 2B only contains the information from El. 244.5 ft, while the base elevation of the bottom domes of Tanks 9 and 10 is 131.45 ft.

As an example, Figure 2-10 shows the log of formation recorded during Tank 6 excavation (extracted from Drawing No. 293967).

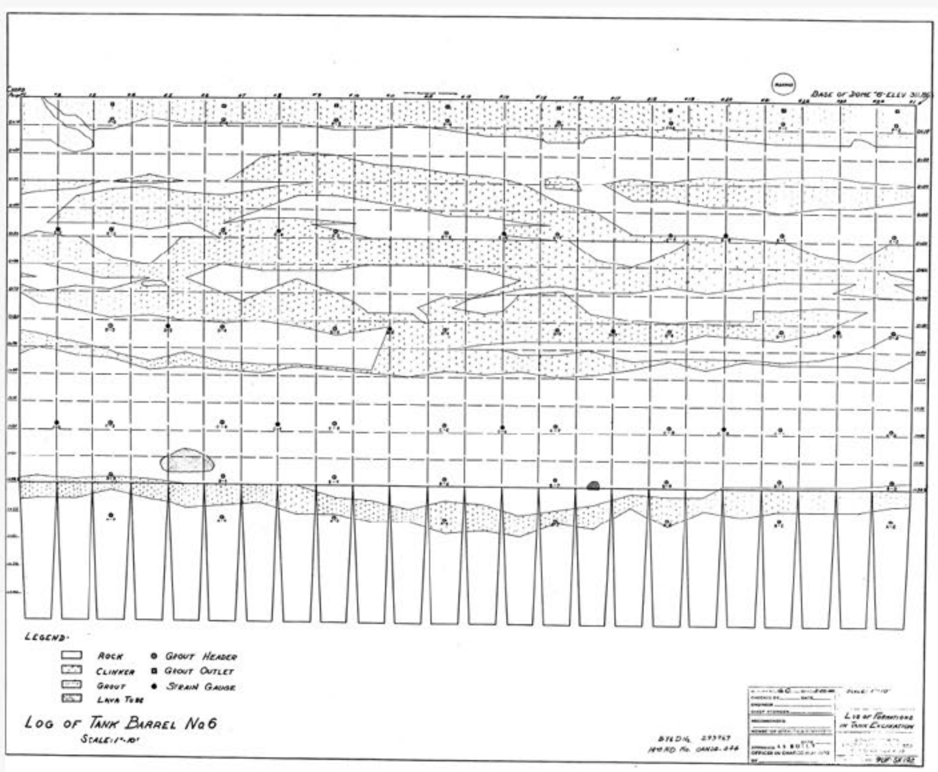


Figure 2-10 – Tank 6 Log of Formation During Excavation for Construction of USTs

2.1.5 Other Documents Reviewed

We reviewed the following document to determine the steel liner plate material properties and current conditions:

- Red Hill Bulk Fuel Storage Facility Destructive Testing Report, AOC/SOW 5.3.3, SSR-NAVFAC EXWC-CI-1941, July 7, 2019.

This report presents data on ten steel liner coupon samples from Tank 14. Eight of these samples were taken from the tank barrel, one was taken from the lower part of the upper dome, and the other was taken from the upper part of the lower dome of Tank 14. This report indicated that the steel tank liner was made from steel that generally conformed to ASTM A36 specifications based on testing the ten coupons (with dimensions of 12 in. x 12 in. for each coupon) in 2018. This report also indicated that the remaining liner plate thickness at the thinnest location for Coupon 3 (top course of steel liner in the barrel) was about 53% of the original liner plate thickness of 1/4 in. Figure 2-11 shows a cross section of Coupon 3 at the location of maximum wall loss.

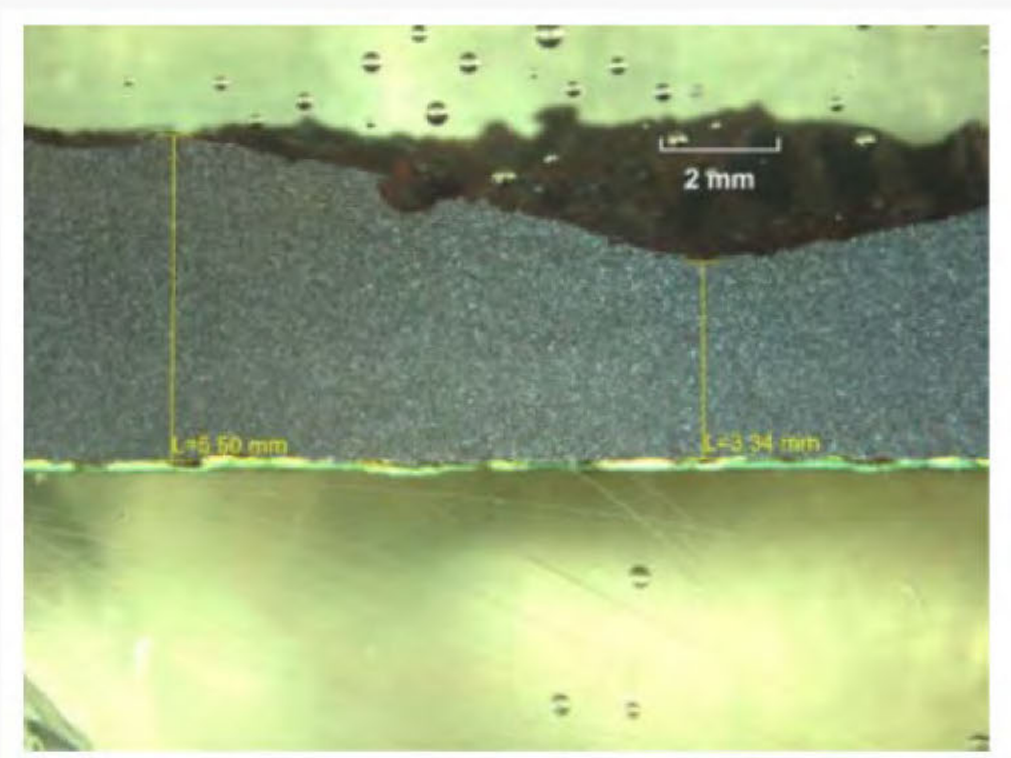


Figure 2-11 – Cross Section of Coupon 3 at Area of Maximum Wall Loss (Tank 14)

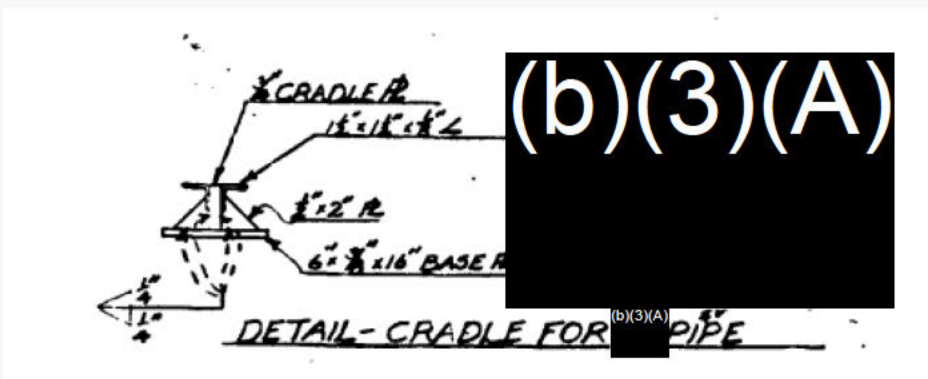
2.2 Piping Systems

We reviewed the following documents as part of our piping assessment.

2.2.1 Underground Fuel Storage – 1941 As-Built Structural and Mechanical Drawings

These are the original as-built drawings of the Red Hill facility. These drawings detail the physical layout of the primary fuel pipelines in the Facility. The drawings also detail typical support conditions throughout the lower tank gallery and underground harbor tunnel. Pipeline properties such as wall thickness and diameter are specified. The nominal strength of the pipe material was not found in the reviewed documents.

The drawings indicate that typically the supports for the [redacted] JP-5 header includes a cradle that is welded to the support after installing the pipeline. As shown in Figure 2-12, the detail does not indicate a weld size, length, or grade.



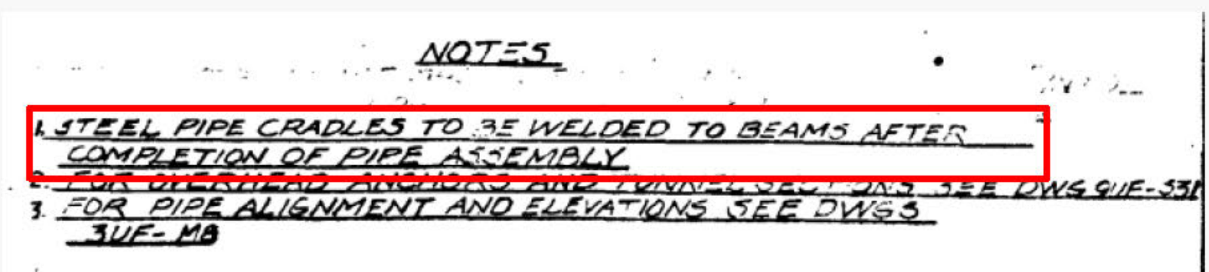


Figure 2-12 – Cradle Support Details for [redacted] Pipeline

2.2.2 Dresser Manufacturing Division – Test Report No. C2613 – 23 August 1966

This test report details the test of a Style 38 Dresser coupling on a 48-3/4-in. outside diameter pipe. The report also explains the procedure under which the Dresser coupling was tested for vacuum and provides the results from the test. The coupling was tested to a temperature of 130°F and a vacuum of 20 in. of mercury. The dresser was moved axially inward and outward 3/16-in. and the vacuum of 20-in. of mercury was maintained. The test report is shown in Figure 2-13.

Proprietary Information

[redacted]

Figure 2-13 – Dresser Manufacturing – Proprietary Information

2.2.3 Seismic Pipe Stress Analysis CR NO 00537 – 21 April 1994

This analysis detailed a seismic assessment performed in 1994 for the cross-tunnel lateral piping from the main header to the tanks. The report determined that the cross-tunnel piping is adequate for the required operational loads in combination with seismic loading. This report corroborated established parameters such as pipeline wall thicknesses and diameters. The report also established the following criteria and parameters for checking the pipe stresses:

- ASME B31.4 is the applicable code for evaluating pipeline stresses.
- A fuel-specific gravity of approximately 0.76.
- Material Strength S_y = 35,000 psi for the cross-tunnel pipelines.

2.2.4 DFSP Pearl Harbor Hydraulic Surge Analysis Study [redacted] DFM (SPAWAR, 2000)

We reviewed the 2000 Hydraulic Surge Analysis Study, which determined that the safe Maximum Allowable Working Pressure for the different pipe sizes should be reduced due to pipeline deterioration and mismatched ratings between the pipe and fitting elements. Additionally, this report noted that the flow within the pipe is controlled not by the capacity of the pipe within the LAT and HT but rather at the transfer points, i.e., the [redacted] hoses to and from the ships at Hotel Pier.

2.2.5 Surge Engineering Study (SPAWAR, 2002)

We reviewed the 2002 Surge Engineering Study, which evaluated the effect of installing automatic control valves, as recommended by the DFSP Pearl Harbor Hydraulic Surge Analysis Study, [redacted] DFM, Report (SPAWAR, 2000), to eliminate or reduce overpressure hammer events and thus minimize the risk of physical damage and protect the safety of personnel. The surge event is described as the result of a pump trip and subsequent check valve slamming shut. The report notes that the greater the valve closure velocity and the greater the product velocity, the greater the surge pressure. They note that "there are no other active elements in the piping system that would produce the observed results."

This report additionally documents that in 1998 the nearly sixty-year-old pumps, with 600 hp motors, were replaced with 500 hp motors based on information by Winzler & Kelly, who noted 500 hp motors were sufficient to meet the pump performance curves. The 2002 Surge Engineering Study highlights, however, that due to the downgrade, special procedures are followed by operators to prevent the pumps from tripping their circuits.

They state that the valves are highly sensitive to valve opening and closing rates, mismanagement of which could lead to piping failures.

They also conclude that the surge can be avoided by replacing the simple swing check valves with no-slam check valves that close at a controlled speed.

2.2.6 Final Project Summary Report – Emergent Ball Valve and Dresser Coupling Repair – February 2005

This report summarized repairs performed at the Red Hill facility, which included verification of Dresser coupling gaps and repairs to the Dresser couplings, which exceeded the specified gap of 0.5 in. page 10 of the report states that "The Dresser coupling is a friction-fit sleeve and gasket..." and goes on to state, "MIL-HDBK-1022 (Para. 9.2.3) prohibits the use of friction-fits and other non-fire resistant expansion devices." The report also states that "NFPA 30 prohibits the indoor use of friction joints or joints that rely on a resilient or combustible material to seal." The excerpt from the report is shown in Figure 2-14.

This document reports that Dresser couplings installed between 2000 and 2003 for even-numbered Tanks 1 to Tank 16 were not built and installed to the original design specifications (Figure 2-15) and were in need of rehabilitation. A total of sixteen Dresser couplings (eight (b)(3)(A) [redacted] and eight (b)(3)(A) [redacted] components) were repaired.

Appendix A of the document includes a drawing with the Dresser coupling details for Tanks 1 to Tank 16. The drawing is marked as "As-Built Conditions 18DEC04." The drawing calls out three 3/4 in. diameter round bars for each 12 in. Style 38 Dresser coupling, and eight 3/4 in. diameter bars for each (b)(3)(A) [redacted] Style 38 Dresser coupling (Note: we refer to these round bars as "retention rods" throughout this report). The retention rods are held in place by harness lugs.

The harness lug plate thickness is 3/4 in. with 1/2 in. thick stiffeners. Figure 2-15 shows excerpts from that drawing.

Fire Safety, Codes and Criteria

- The Dresser coupling is a friction-fit sleeve and gasket with compression rings used to join sections of straight pipe. Primary applications are underground iron pipe in water or sewer service. Since the resilient material (gasket) is subject to degradation from elevated temperatures, the couplings are inherently at risk if used in a fuel application, where the potential of an exposure fire event exists.
- MIL-HDBK-1022 (Par. 9.2.3) prohibits the use of friction-fits and other non-fire resistant expansion devices.
- NFPA 30 (Par. 3.4.3) prohibits the indoor use of friction joints or joints that rely on a resilient or combustible material to seal.

Figure 2-14 – Excerpt from Final Project Summary Report (February 2005) – Emergent Ball Valve and Dresser Coupling Repair Addressing Fire Safety, Codes, and Criteria

(b)(3)(A)

[redacted]

Figure 2-15 – Excerpt from As-Built Drawing Showing Dresser Coupling Details (Even-Numbered Tanks 1 to 16) (February 2005)

Section 4 of this report also indicates that the terminal can receive cargo from colder climates and at lower temperatures than the pipeline ambient temperatures inside the tunnel. The cargo was reported to be as much as 20° colder than the ambient pipeline installation temperature, Figure 2-16.

> Thermal expansion and contraction is the primary cause of pipe movement and stresses at the Red Hill Facility. The ambient temperature within the mountain stays relatively constant, however product receipt from mainland facilities located in colder climates can introduce product into the piping system that is as much as 20 degrees colder than the pipe system's ambient temperature. To determine if the pipe has sufficient flexibility to withstand such events, a flexibility and stress analysis was conducted. The analysis uses the Caesar II software program and data gathered during the site investigation.

Figure 2-16 – Excerpt from Final Project Summary Report (February 2005) – Addressing Thermal Loads on Piping and Flexibility Analysis

2.2.7 Hydraulic Analysis and Dynamic Transient Surge Evaluation (NAVFAC, 2009)

Enterprise Engineering, Inc. performed a hydraulic study of the Facility piping to determine the risk of physical damage and harm to personnel due to steady-state and dynamic transient surge events. They aimed to establish a safe operating pressure to limit these risks. They concluded that operating at the full flow potential posed a substantial risk of surges which could damage the system. They note that operators limit the flow rate, generally based on the receipt/transfer point capacity, which reduces the risk of damaging surge events.

The report highlights that potential surge pressures exceed code-allowable pressures in nearly all cases analyzed, which they state is due to a lack of records demonstrating the piping was qualified for pressures above the static/operational pressures. In their assessment, they qualify the pipe using the static head of full Red Hill tanks as the basis for the pressure rating.

To mitigate future surge events, they recommend continuing to control maximum operational flow rates and upgrading operational procedures and control system safety features. They additionally recommend using "the butterfly valves in the underground pumphouse as the primary means of throttling and stopping flow during issue and transfer operations in order to greatly reduce the risk of surges during normal operations." Enterprise Engineering stated that the use of the butterfly valve in the underground pumphouse eliminated surge pressures in all their analyses. Previous to this report, Enterprise Engineering notes that the operators used to control the flow rate at the pier riser valves.

They additionally state that the maximum allowable operating pressure (MAOP) should be no greater than 285 psig for all piping in FISC Pearl Harbor. MAOP represents the maximum code based allowable pressure that the pipeline may be subjected to. MAOP is established by hydrostatic testing of the pipeline in question.

Within their report, Enterprise Engineering notes that the F-76 product pumps at the underground pumphouse are rated at 500hp, while the JP-8 (no longer in use) and JP-5 pumps are rated at 300 hp.

This report also lists limited mechanical test data conducted by EDG Inc. and Dmitrijev & Associates in August 2001 to determine the yield strength of the fuel pipes. The locations of these pipes are not stated. This test data is presented in Figure 2-17.

Pipeline	Yield Strength
(b)(3)(A) [redacted] F-76	30,420 psi
JP-5	40,090 psi
JP-8	38,940 psi

Figure 2-17 – Tensile Test Results for Red Hill Fuel Pipes (NAVFAC, 2009)

2.2.8 Final 2015 Annual Pressure Testing Report of Seven Sections (36,626 ft) of Petroleum Pier Pipelines – 5 May 2015

This report discusses the procedures utilized during the testing of seven sections of pier pipelines at JBPHH in 2015 and the results of the testing. It also establishes a Maximum Allowable Working Pressure (MAWP) of 200 psi and hydrotest pressure of 300 psi (1.5 x MAWP) for the petroleum pier pipelines. MAWP is the maximum pressure, as established by calculations and codes that the pipeline may be subjected to during normal operations. The Maximum Allowable Operating Pressure (MAOP) cannot exceed MAWP.

2.2.9 Quantitative Risk and Vulnerability Assessment (Phase 1) Report – 12 November 2018

This report documents a risk assessment of the Red Hill facility performed by ABS Consulting (ABS). ABS evaluated the level of risk the Facility might pose to the surrounding groundwater due to internal events, excluding internal fire and flooding. This includes but is not limited to equipment or structural failures in both frontline and support systems, human errors, etc.

It was noted that “potential fuel releases from the tank nozzles (the main fuel flow piping leading into and out of the main storage tanks up to the upstream flange connections for the tank skin valves) are important to risk.”

2.2.10 Root Cause Analysis of the JP-5 Pipeline Damage – 7 September 2021

This report discusses the root cause of the piping failure on the JP-5 pipeline during the 6 May 2021 incident. The report used field data and discussions with personnel at the Red Hill facility to determine that a transient surge had occurred due to a vacuum in the JP-5 pipeline. The report detailed a hydraulic and surge analysis that calculated a surge pressure of 357 psi at the end of the JP-5 main header. The report corroborated this surge pressure by performing a pipe stress analysis. A force was applied at the end of the JP-5 lateral towards Tank 19 until the lateral displacement at the end of the JP-5 header matched the 16 in. displacement observed in the field by the contractor. This force was determined to be 78,000 lbf which back-calculated to a surge pressure of 320 psi based on the area of an (b)(3)(A) [redacted] pipe blind flange. Figure 2-18 shows an excerpt from the root cause report, which depicts the supports assumed and boundary conditions used for the model to determine the force necessary to move the pipe.

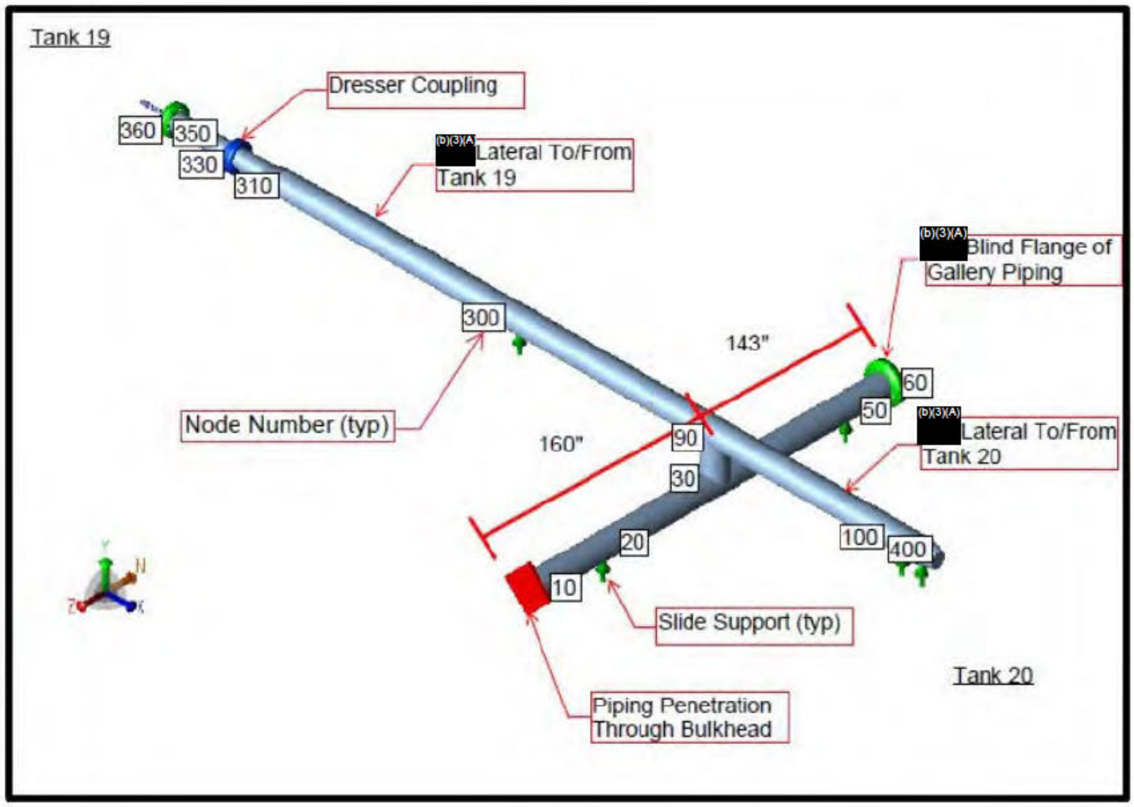


Figure 2-18 – Root Cause Analysis Report Showing Model and Support Conditions

The model from the root cause report specified a full fixity restraint at the pipe penetration through the firewall (Node 10) and sliding supports at Pipe Supports 1 and 2 (Nodes 20 and 50, respectively).

2.2.11 Pipeline In-line Inspections

Pipeline inspections are based on API 570 and were performed by certified inspectors employed by third-party contractors. We reviewed the in-line inspection (ILI) reports to gather information about the current condition of the pipelines and observed defects.

During the 2004 multi-product construction project (NAVFAC, 2004), valve station (b)(3)(A) was built to provide an above-ground pigging station for parts of the JBPHH fuel pipe. Piping (b)(3)(A) [redacted], which is the distribution valve station between PAR and JBPHH.

2.2.12 Inspection and Repair of Red Hill Pipelines (Enterprise Engineering, Inc., 2016)

Between October 2014 and January 2016, Enterprise Engineering, Inc. (EEI) performed API 570 inspections on each of the three pipelines in the Red Hill bulk fuel storage facility [redacted] [redacted] and [redacted] EEI lists 350 repair locations, seventeen of which are considered "urgent." They note that alterations to assessment methodologies, such as using a lower maximum operating pressure (MOP) and Level III API 579 assessments of marginal defects, could reduce the overall number of repairs and the economic and operational impact of the repairs. They recommend that "urgent" repairs be conducted within three months and that the Navy monitor the repair locations until the repairs are completed. They also suggest follow-up reinspection once the repairs are completed and an assessment of the MOPs.

Urgent repairs are those defined as failing an ASME API 579 Level II Fitness-for-service evaluation. EEI considers these critical to the hydraulic and structural integrity of the piping.

Further to the three-month "urgent" repairs, EEI lists 203 short-term repairs to be completed within six months.

Given the observed conditions, EEI performed calculations evaluating the pipe capacity under internal operating pressures to determine safe MOPs for each of the three pipelines: 202 psig for [redacted] pipe, 111 psig for [redacted] pipe, and 168 psig for [redacted] pipe. Each of these calculated MOPs is less than the required MOP (275 psig). The report states that the required MOP can be reestablished through the implementation of the mandatory repairs (urgent and short term). MOP is defined as the highest pressure that a pipeline system may be normally operated and cannot exceed the Maximum Allowable Operating Pressure (MAOP).

EEI employed a variety of inspection techniques to assess the piping, including in-line inspection (ILI), long-range ultrasonic testing (LRUT), external visual examinations, and hands-on API 570 inspections.

This report contains an appendix presenting data from the tests conducted by Finlay in May 2001. They took ten coupons from each pipe size to determine the tensile properties and ten weld coupons from each pipe size for flattening tests:

- [redacted] Pipe – Average Yield Strength 48.7ksi, Average Tensile Strength 69.4ksi.
- [redacted] Pipe – Average Yield Strength 50.1ksi, Average Tensile Strength 74.3ksi.
- [redacted] Pipe – Average Yield Strength 38.0ksi, Average Tensile Strength 58.9ksi.

The locations from which these test samples were retrieved are not known, but all weld coupons passed the flattening test.

2.2.13 Inspection and Repair of Red Hill Pipelines (APTIM, 2019)

APTIM carried out forty-nine repairs, seven of which represent the “urgent” repairs listed in the EEI 2016 engineering report. The scope of work (SOW) for the NAVFAC contract included twenty-three repairs, which were expanded to forty-nine repairs based on the findings of the engineering assessment.

They report that the 2014-2016 Red Hill pipeline inspections were as follows:

- All three fuel pipelines from the Tank Gallery to the underground pumphouse were externally visually inspected.
- Within the Tank Gallery, only the [redacted] pipe received a hands-on API 570 inspection.
- From ADIT 3 to the Tank Gallery, both the [redacted] and [redacted] pipelines were in-line inspected via smart pigging. In this same length, all three pipelines received hands-on API 570 inspection, while the [redacted] pipeline additionally received long-range ultrasonic testing.
- From ADIT 2 to ADIT 3, the [redacted] and [redacted] pipelines were in-line inspected via smart pigging and received follow-up hands-on API 570 inspections.
- From the underground pumphouse to ADIT 2, the [redacted] and [redacted] pipelines received long-range ultrasonic testing and follow-up hands-on API 570 inspection.

The report states that alternate assessment methods were used to reduce the number of required repairs, such as through the reduction of the MOP. Thus, the 350 total repair count was reduced; the report does not expand on other alternate methods nor what the final repair count was after the reduction of the MOP.

APTIM notes that all welds are 100% visually and radiography inspected in accordance with ASME B31.3. Successful radiography inspection meant the repaired pipeline sections did not require hydrostatic testing, in accordance with ASME B31.3 Clause 345.2.3.

2.2.14 FY21 Emergent Design-Build Repair Red Hill Piping (NAVSUP FLC Pearl Harbor, 2021)

This project program describes the design for the JP-5 repairs in the Red Hill fuel storage facility. NAVSUP states the design-build project should "project services to design restraint sufficient to withstand the effects of dead load, seismic forces, and hydraulic operations of the piping system. At Tank 1 for F-24 and F-76 piping, design restraint which will limit movement due to cross-tunnel spools which have been removed. Design in accordance with UFC 3-460-01, UFC 3-301-01, and ASCE 7-16. Intent is to restore structural stability which was present in the original design."

This design-build project additionally stipulates those predictive repairs shall be validated during the design phase.

Grouped with this scope of work is resetting pipe supports where the pipe is not supported at the cradles or adding low friction sliding pads where the pipe is inappropriately supported directly on the pipe supports.

2.2.15 FY21 Emergent Pipeline Repair Red Hill (January 2022)

This document serves as the basis of design for repairs to the fuel pipelines at the Red Hill facility. The report contains drawings that detail anticipated repairs and support conditions for the JP-5 pipelines near Tanks 19 and 20. We used information from these drawings to model boundary conditions for our piping evaluation as part of defueling operations. Pipeline material and schedule are specified for the repairs in the technical specifications, and the layout is shown in the drawing isometrics. However, we were unable to find dimensions for the piping repairs at Tanks 19 and 20, nor were surge loads discussed in the document. See Figure 2-19 and Figure 2-20 for isometric drawings showing bends in the lateral JP-5 pipe to Tanks 19 and 20, respectively.

(b)(3)(A) [redacted]

Figure 2-19 – Enterprise Engineering Isometric Drawings Reconnecting Tank 19 Lateral Pipe

(b)(3)(A) [redacted]

Figure 2-20 – Enterprise Engineering Isometric Drawings Reconnecting Tank 20 Lateral Pipe

2.3 Pipe Supports and Pipe Racks

2.3.1 Existing Structural Drawings

We reviewed the available structural drawings to gather technical information for the modeling and analysis of the pipe supports in the harbor and lower access tunnels. The drawings detail typical support conditions and configurations. Table 2-2 lists the drawings that contained critical information for our analyses. We supplemented this information with observations made during our site visits (Section 5.3).

The available drawings provided to us mainly in response to our RFIs cover the original design of the pipe supports in the harbor and the lower access tunnels.

Table 2-2 – List of Lower Access Tunnel and the Harbor Tunnel Pipe Support Drawings

Drawing Number	Drawing Title	Information
294160	Lower Access Tunnel Tanks 1, 2, 3, and 4 Overhead Pipe Supports	Longitudinal bracing details and typical pipe support configurations
294161	Harbor and Lower Access Tunnels Typical Sections, Pipe Supports, and Anchors	Geometry, configuration, and member sizes for pipe supports
294162	Lower Access Tunnel Tanks 5-20 Overhead Pipe Supports	Geometry, spacing, configuration, and member sizes for pipe supports
294263	Piping – Lower Access Tunnel Sta. 24+90 to Sta. 26+40	Geometry, configuration, and member sizes for pipe supports

- From Drawing 294160, we extracted typical structural design details for Pipe Supports 15 to 17 and 55 to 96 (Figure 2-21), Pipe Supports 97 and 98 (Figure 2-22), and details for longitudinal braces (Figure 2-23).

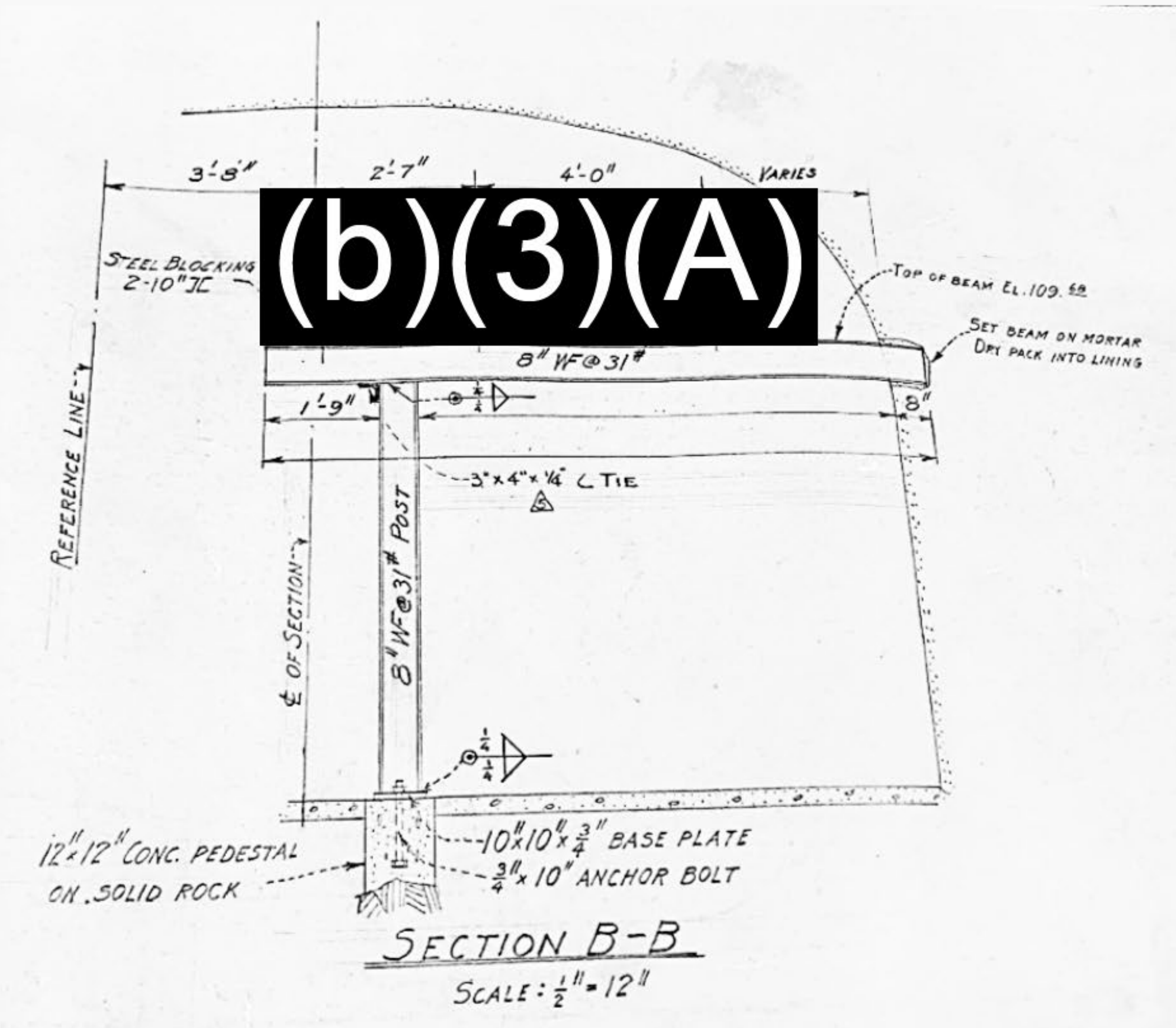


Figure 2-21 – Typical Configuration for Pipe Supports 70 to 96

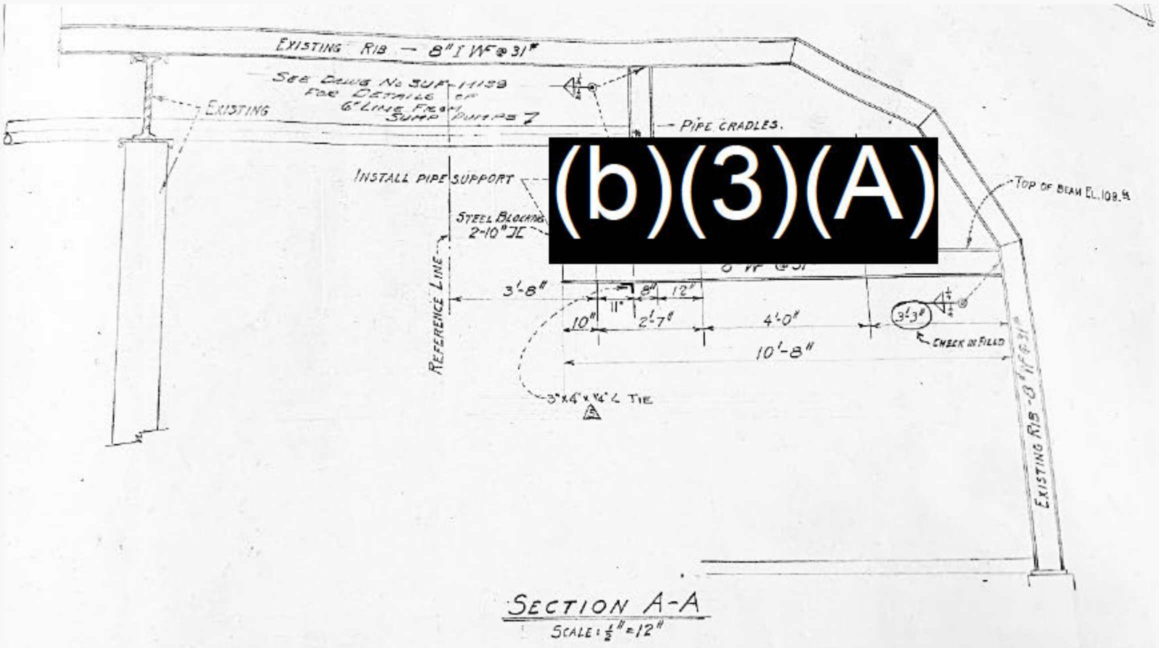


Figure 2-22 – Typical Configuration for Pipe Supports 97 and 98

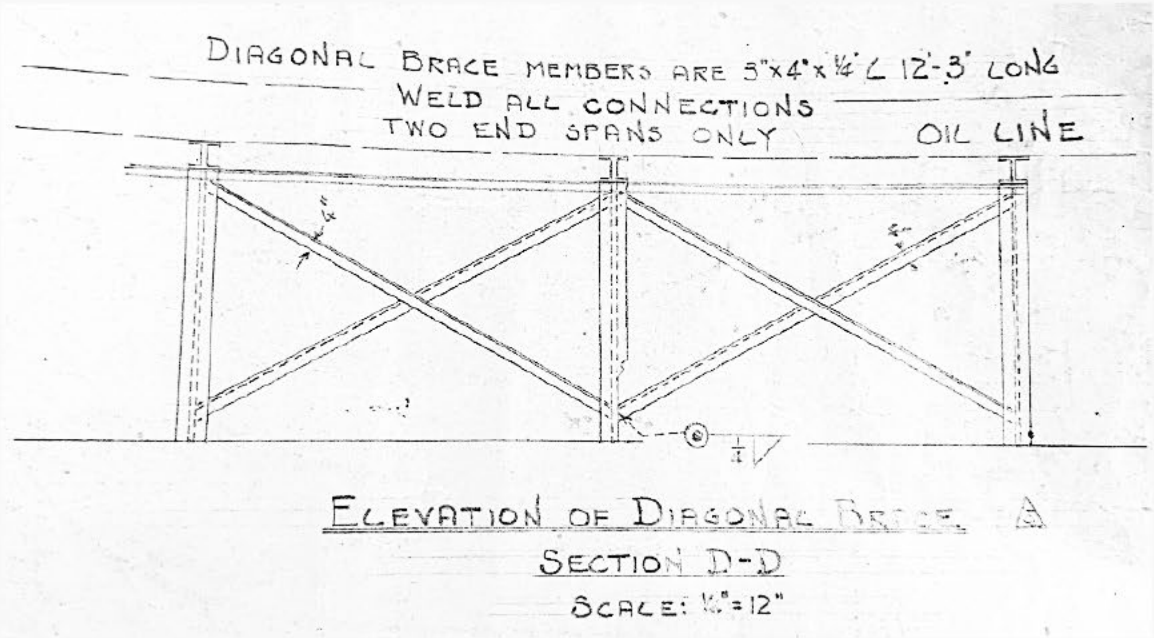


Figure 2-23 – Details for Longitudinal Braces

- From Drawing 294161, we extracted the typical configuration for the pipe supports in the harbor tunnel (Figure 2-24).

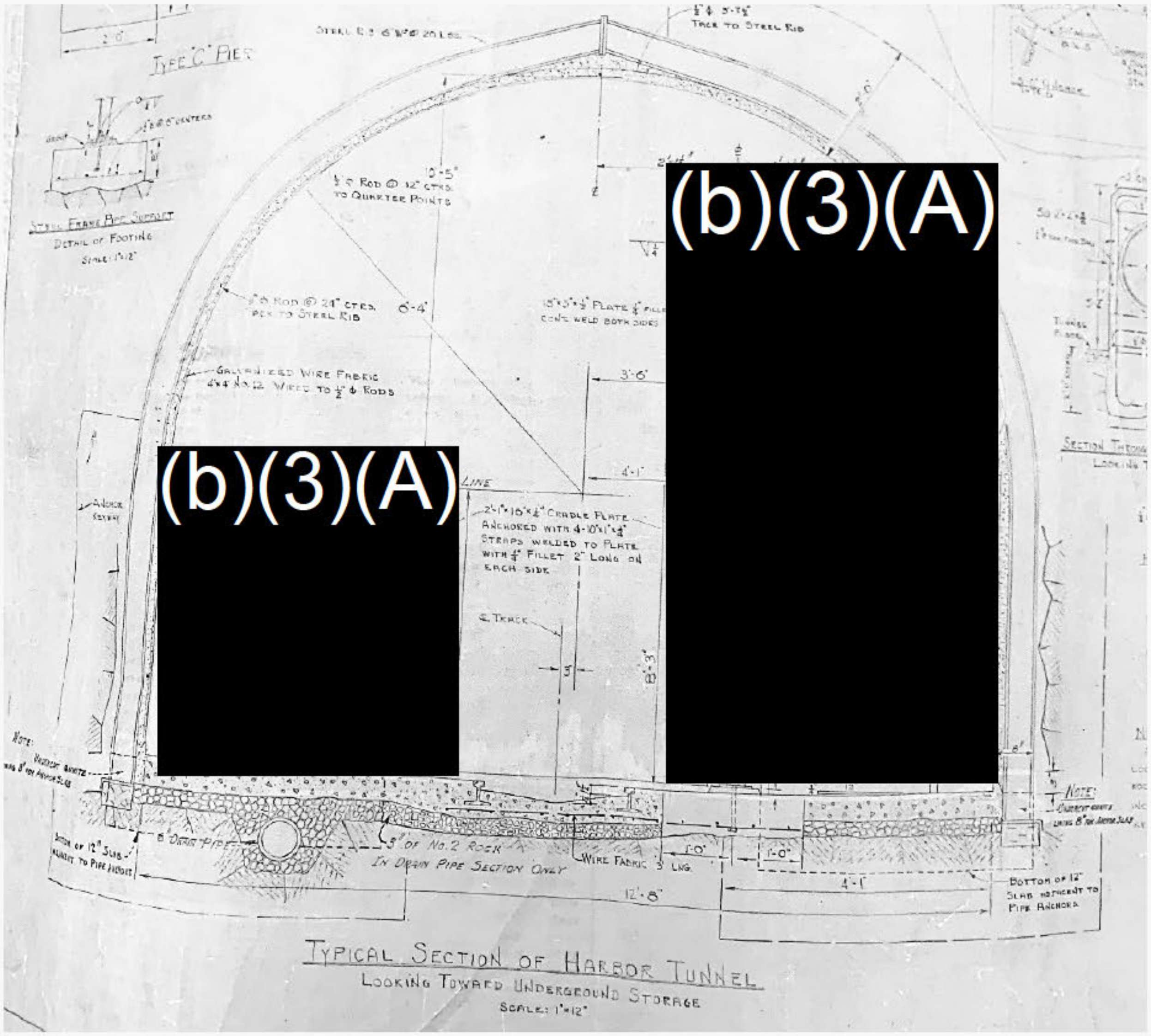


Figure 2-24 – Typical Pipe Supports in the Harbor Tunnel

- From Drawing 294162, we extracted a table (Figure 2-25) with geometry, spacing, and member size information for Pipe Supports 3 to 73. We also extracted the typical configuration for Pipe Supports 1 to 54 (Figure 2-26) and details for the longitudinal bracing.

(b)(3)(A)

[redacted]

Figure 2-25 – Lower Access Tunnel Pipe Support Data

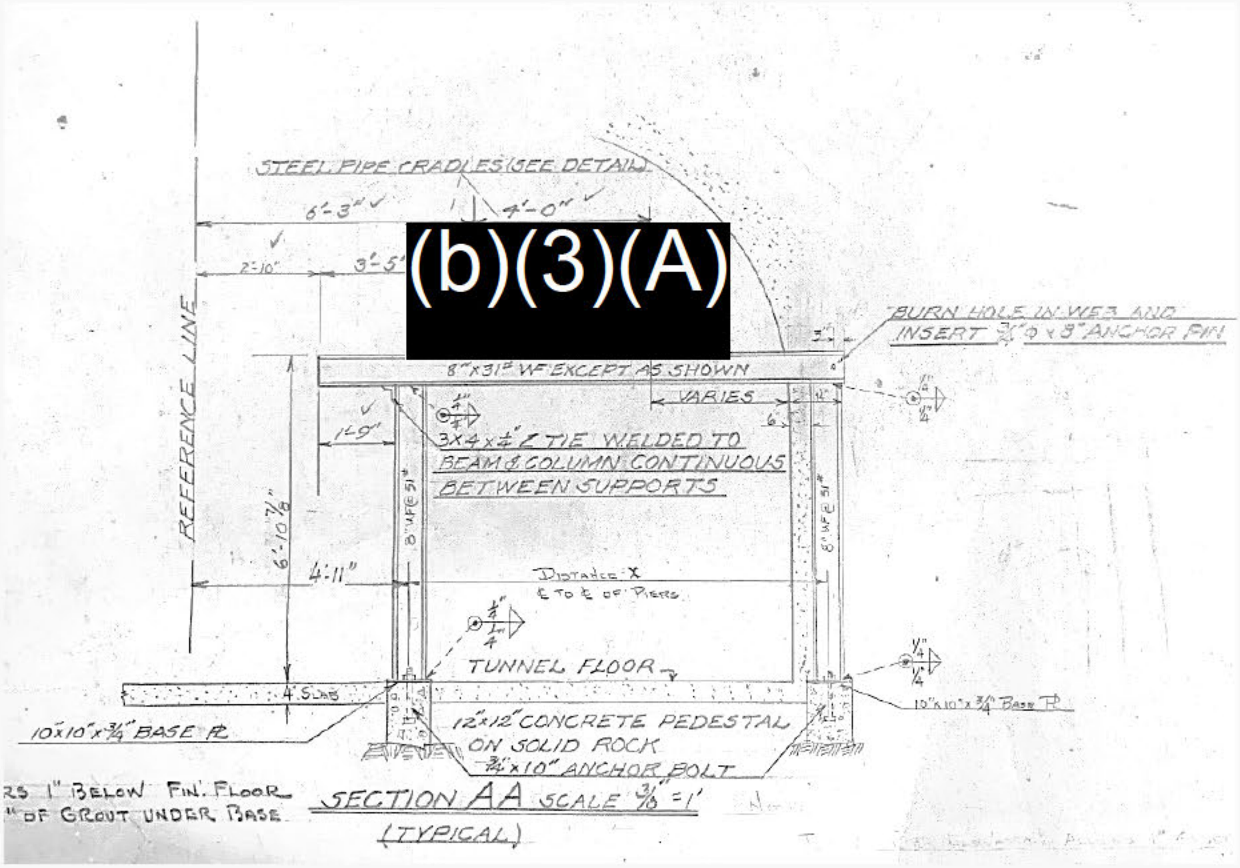


Figure 2-26 – Typical Configuration for Pipe Supports 1 to 54

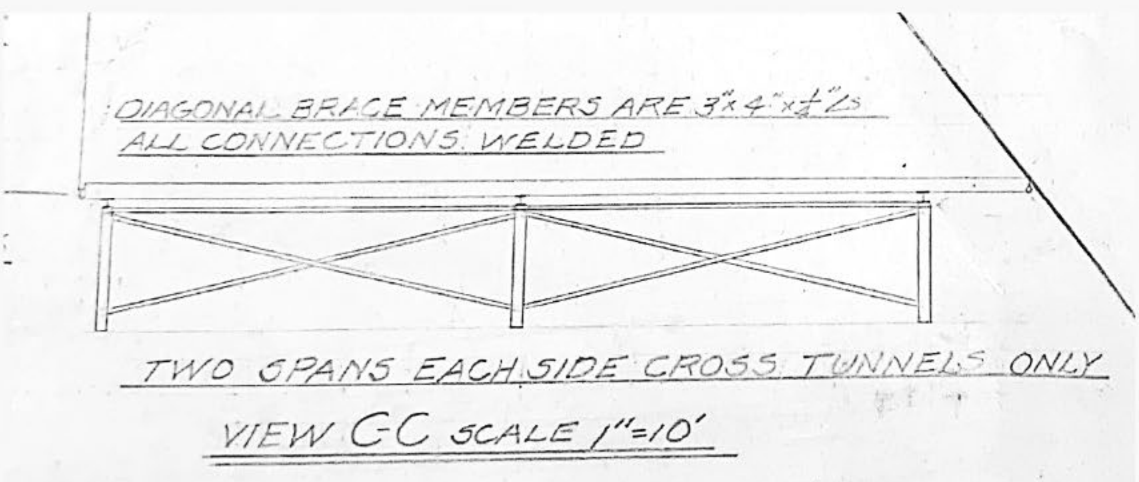


Figure 2-27 – Details for Longitudinal Braces

- In the drawings, we observed some pipe supports that consist of two columns having one column embedded in the tunnel wall. Additionally, the same section shows an angle tie (strut) running longitudinally connecting the pipe supports.

- From Drawing 294263, we extracted the typical configuration for the Pipe Supports 99 to 103 in the lower access tunnel (Figure 2-28).
- We could not find any information in the drawings regarding the steel material properties.

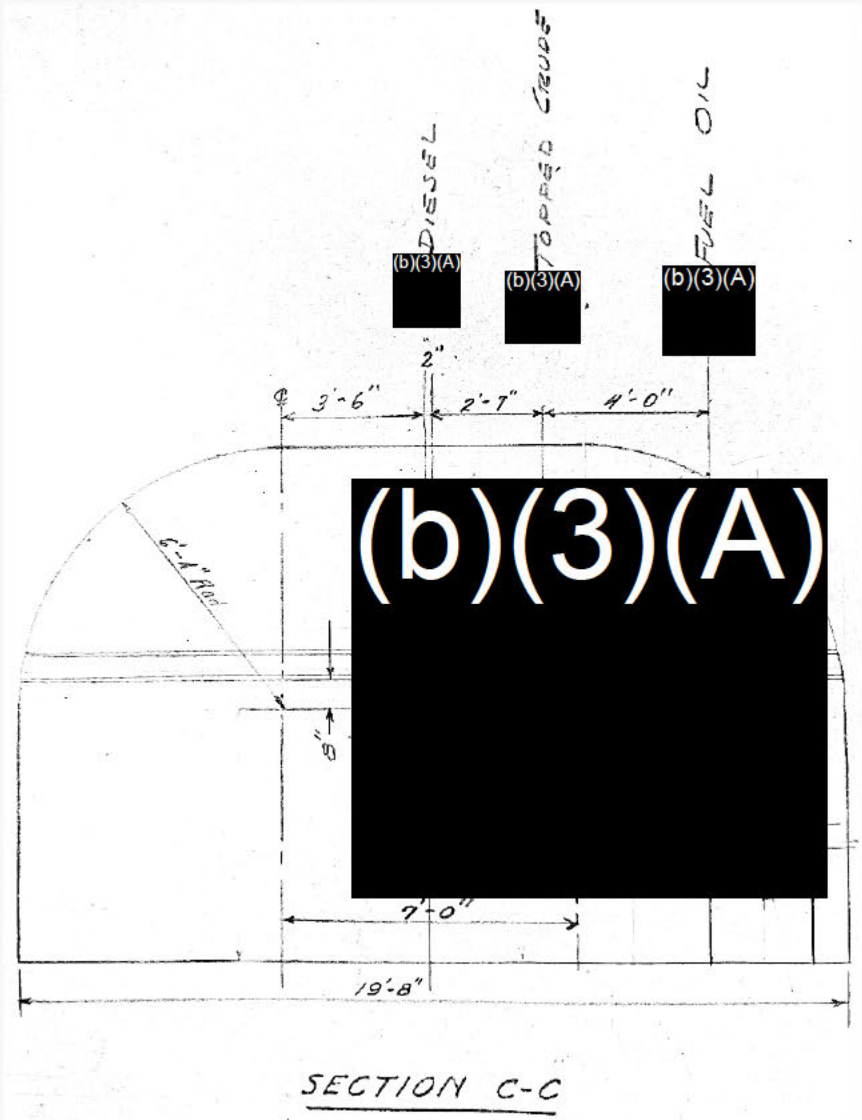


Figure 2-28 – Typical Configuration for Pipe Supports 99 to 103

2.3.2 Inspection and Repair of Red Hill Pipelines (2016)

During the October 2014 to January 2016 pipeline inspection, in which EEI documented 350 repair locations, they additionally made observations about deficient pipe support conditions. They specifically noted four locations of pipe support failure, although they note there are numerous deficient pipe supports. These instances include corroded pipe support column bases (Pipe Supports 47/48), missing cradles between the pipe and the pipe support resulting in the unsupported pipe (Pipe Support 74), corroded cradles with adjacent pipe coating damage (Pipe Support 75/76), as well as a one-sided pipe support cradle (Pipe Support 6).

Corrosion and through holes at the steel support base for the [redacted] line in the Tank Gallery [redacted]

[redacted]

[redacted]ine lifted off the pipe support in the Tank Gallery. [redacted]

[redacted]

Corrosion on the pipe support shoe on th[redacted] line in the Tank Gallery. [redacted]

[redacted]

Missing guide on the pipe support on the [redacted] line in the Tank Gallery. [redacted]

Figure 2-29 – Deficient Pipe Supports in Tank Gallery from EEI 2016 Report (Enterprise Engineering, Inc., 2016)

2.3.3 Other Documents

We reviewed the report "Conceptual Site Model, Investigation and Remediation of Releases and Groundwater Protection and Evaluation, Red Hill Bulk Fuel Storage Facility Joint Base Pearl

Harbor Hickam, Oahu, Hawaii," dated 30 June 2019, to extract a table with fuel densities, specifically those values shown in Attachment B.7.1. to the document.

2.4 Pumphouse

Hardcopies of pumphouse drawings were reviewed during a visit to the document library at the Facility.

2.5 Surge Tanks

We reviewed the original structural drawings dated 1941 for the four surge tanks located adjacent to the pumphouse, as listed below:

- Drawing No. 294125 – General Layout.
- Drawing No. 294127 – Steel Bottoms.
- Drawing No. 294128 – Steel Details.
- Drawing Nos. 294130 and 294131– Concrete Shell & Access Shaft.
- Drawing No. 294132 – Top Slab Concrete & Reinforcing Steel.
- Drawing No. 294133 – Top Slab Reinforcing Steel Bottom Layers.
- Drawing No. 294134 – Top Slab Reinforcing Steel Top Layers.

The interior dimensions for each surge tank are 60 ft in diameter by 21 ft in height, as shown in Figure 2-30 (extracted from Drawing No. 294125). The construction of each surge tank consists of a minimum 12 in. thick reinforced concrete shell with a 1/4 in. thick interior steel liner plate. Similar to the underground storage tanks, each surge tank was constructed by excavating the volcanic rock formation. The four surge tanks share one integral reinforced concrete roof slab with a minimum slab thickness of 6 ft.

[redacted]

(b)(3)(A)

Figure 2-30 – Surge Tank Layout and Dimensions

In addition, we reviewed the following CIR and API 653 inspection reports for the four surge tanks:

- Weston Solutions, Inc, Clean, Inspect, and Repair Surge Tank 1, Final Project Summary Report, November 2006.
- Weston Solutions, Inc, Clean, Inspect, and Repair Surge Tank 2, Final Project Summary Report, December 2006.
- Weston Solutions, Inc, Clean, Inspect, and Repair Surge Tank 3, Final Project Summary Report, December 2006.
- NAVSUP FLC Pearl Harbor, Surge Tank 4 – Return to Service Closeout Documents (including Suitability for Service Evaluation and Inspection Reports by EEI), July 2019.

2.6 Aboveground Storage Tanks

2.6.1 CIR and API 653 Inspection Reports

We reviewed the CIR and API 653 inspection reports and tank drawings for the following above-ground storage tanks:

- Tanks 46, 47, 58, 53, 54, and 55.
- Tanks B1 and B2.
- Tanks 301 and 311.
- Tanks 11-1, 11-2, 11-3, and 11-4 (at Hickam Field).

Specifically, we reviewed the following CIR and API 653 inspection reports or other evaluation reports to gather information about the tanks:

- Weston Solutions, Inc, Clean, Inspect, and Repair Storage Tank Facility S754 (Tank 46), Draft Repair Certification Report, October 2016.
- Enterprise Engineering, Inc, Tank 47 API 653 Out-of-Service Inspection and Suitability for Service Evaluation, Final Report, March 2015.
- Pond and Company, Tank 48 (Facility S-756) INSPECTION REPORT/API 653 In-Service (External) Inspection, August 2015.
- Technical Scanning System, API 653 Out-of-Service Inspection of Aboveground Storage Tank 48 (1403), 8 August 2007.
- Austin Brockenbrough & Associates, LLP, Tank Facility UTF 53 API 653 In-Service Inspection Report, October 2018.
- Weston Solutions, Inc, Clean, Inspect, and Repair Storage Tank Facility S761 (Tank 53), Draft Repair Certification Report, September 2013.
- Powers Engineering and Inspection, Inc. (PEI), API 653 Out-of-Service Inspection Report (Tank 54), Inspection date of 28 June 2018.
- Enterprise Engineering, Inc, Tank 54 (Facility No. S762) API 653 In-Service Inspection and Suitability for Service Evaluation, May 2015.
- Enterprise Engineering, Inc, Tank 55 (Facility No. 1751) API 653 In-Service Inspection and Suitability for Service Evaluation, January 2015.
- Cape – Burns & McDonnell JV, Tank 55 API Standard 653 Inspection Report/ Out-of-Service Inspection, 15 February 2019.
- Engineering & Inspections Hawaii, Inc, Tank No. B-1 Inspection, 25 September 2008.
- Enterprise Engineering, Inc, Tank B-1 Engineering Review and Suitability for Service Evaluation, July 2008.
- Engineering & Inspections Hawaii, Inc, API 653 Out-of-Service Inspection (Tank B2), 22 January 2009.
- Enterprise Engineering, Inc, Tank B-2 Engineering Review and Suitability for Service Evaluation, March 2009.
- Pond and Company, TANK 301 API 653 Out-of-Service Inspection Report, 29 August 2018.

[redacted]

- Enterprise Engineering, Inc, Tank 301 (Facility No. S9251) API 653 In-Service Inspection and Suitability for Service Evaluation, Draft Report, February 2015.
- Enterprise Engineering, Inc, Tank 311 (Facility No. 311) API 653 In-Service Inspection and Suitability for Service Evaluation, Draft Report, January 2015.
- Enterprise Engineering, Inc, Tank 11-1 (Facility No. 41053) API 653 In-Service Inspection and Suitability for Service Evaluation, Pre-Final Report, December 2016.
- Powers Engineering & Inspection, Inc, Tank 11-1 API Inspection Report/ Out-of-Service with External Checklist, 19 April 2011.
- Enterprise Engineering, Inc, Tank 11-2 (Facility No. 41054) API 653 In-Service Inspection and Suitability for Service Evaluation, Pre-Final Report, December 2016.
- Powers Engineering & Inspection, Inc, Tank 11-2 API Inspection Report/ Out-of-Service with External Checklist, 19 April 2011.
- Pond and Company, TANK 11-3 (25K BBL) Inspection Report/API 653 Out-of-Service Inspection, September 2014.
- Enterprise Engineering, Inc, Tank 11-4 (Facility No. 41056H) API 653 In-Service Inspection and Suitability for Service Evaluation, Draft Report, February 2015.
- Engineering & Inspections Hawaii, Inc, Tank 11-4 API 653 Out-of-Service Inspection, August 2016.

2.6.2 ASCE Seismic Evaluation and Design of Petrochemical and Other Industrial Facilities

We reviewed the ASCE Task Committee on Seismic Evaluation and Design of Petrochemical Facilities, "Seismic Evaluation and Design of Petrochemical and Other Industrial Facilities," Third Edition, 2020. The ASCE guidelines are intended to provide practical recommendations in several areas that affect the safety of a petrochemical facility during and following an earthquake. The guidelines provide evaluation methodologies that rely heavily on experience from past earthquakes, coupled with focused analyses of existing facilities. The guidelines emphasize methods to address seismic vulnerabilities that building codes do not cover but that experienced engineers can identify.

The following discussion regarding the evaluation of aboveground storage tanks is extracted from Chapter 7 of the ASCE (2020) guidelines.

Flat-bottomed vertical liquid storage tanks have sometimes failed with the loss of contents during strong earthquake shaking. In some instances, the failure of storage tanks had disastrous consequences. The response of unanchored tanks, in particular, during earthquakes is highly nonlinear and much more complex than implied in available design standards. The effect of seismic ground shaking is to generate an overturning force on the tank. This, in turn, causes a portion of the tank baseplate to lift from the foundation. The weight of the fluid resting on the uplifted portion of the baseplate, together with the weight of the tank shell and roof, provides the restraining moment against further uplift. While uplift, in and of itself, may not cause serious damage, it can be accompanied by large deformations and major changes in the tank wall stresses. This is especially apparent when the seismic loading reverses and the (formerly) uplifted segment moves down, impacting the ground and introducing high compression stresses into the tank shell.

In general, tanks, especially unanchored tanks, are particularly susceptible to damage during earthquakes. This is because all of the mass contributes to the overturning moment, but only a small portion of the mass contributes to the overturning resistance (the reason for this is that the contained fluid and the relatively flexible tank shell and bottom plate cannot transfer the lateral shear induced by the earthquake to the foundation). Some examples of unanchored tank damage that has occurred in past earthquakes include:

- Buckling of the tank wall, known as “elephant foot” buckling. Essentially, this occurs because the vertical compressive stresses in the portion of the tank wall remaining in contact with the ground (i.e., diametrically opposite the uplifted portion) greatly increase when uplift occurs. More precisely, that portion of the tank shell is subjected to a biaxial state of stress, consisting of hoop tension and axial compression. In addition, the baseplate prevents the radial deformation that would normally occur under internal pressure. As a result, bending stresses are introduced into the shell wall, further increasing the tendency to buckle. See Figure 2-31 as an example (reproduced from Figure 7-1 of the ASCE guidelines).

Figure 2-31 – Elephant Foot Buckling and Failure of Rigid Piping

- Seismic shaking causes the surface of the tank fluid to slosh. If insufficient freeboard is provided to accommodate this sloshing, damage to the tank's floating roof or fixed roof, followed by spillage of fluid over the tank walls, may result. This type of damage is usually considered only minor but may be important for some stored products.

- Breakage of piping connected to the tank as a result of relative movement between the tank and the nearest pipe support. This is one of the most prevalent causes of loss of contents from storage tanks during earthquakes. Failures of this type are typically due to inadequate flexibility in the piping system (termed "overconstrained piping") between the nozzle location at the tank shell and the adjacent pipe support. See Figure 2-31 as an example.

- Tearing of tank wall or tank bottom due to overconstrained stairways anchored at the foundation and tank shell.

- Tearing of tank wall at overconstrained walkways connecting the two tanks – Figure 2-32 [adapted from Figure 7.7 of ASCE guidelines (ASCE, 2020)].

Proprietary Information

[redacted]

Figure 2-32 – Examples of Overconstrained Piping Stairway and Walkway Connections at Aboveground Storage Tanks Proprietary Information

When performing walkthrough inspections, experienced engineers familiar with the seismic design and the effects of earthquakes should be consulted to answer questions regarding “how much flexibility is sufficient.” The assumed value of tank uplift is critical to answering this question. Values of 6 to 8 in. have been common in the past. The first version of these guidelines recommended using values on the order of 6 to 12 in. of vertical displacement and 4 to 8 in. of horizontal displacement in the zones of highest seismicity.

2.7 Valves and Pumps

The documents reviewed related to the valves and pumps are:

- Operation, Maintenance, Environmental, And Safety Plan (OMES) (Trinity Bhate and Pond, 2018):

This document provides the overarching guidance for the operation and maintenance of the facility. The operability and maintainability intent within this document is guidance to develop specific operating and maintenance procedures for the pumps and valves.

- Commissioning Summary Report - P1551 Upgrade Fire Suppression and Ventilation Systems (Coffman Engineers, 25 January 2018).

  This document provides an overview of the commissioning plan and results of the commissioning verification for the Aqueous Film Forming Foam (AFFF) system. The commissioning plan outlines the steps to ensure the AFFF components and the complete system function as designed. The document also contains the results of the component commissioning tests and any issues that require correction before the system is put into service.

- RH Root Cause Analysis Memo and Report dated 7 September 2021 (Austin Brockenbrough, September 7, 2021).

  This document provided the analysis by Austin Brockenbrough regarding the 6 May 2021 event.

- Equipment Information.

The following data are provided in spreadsheet form and are focused on providing the location of the equipment, service type, manufacturer, model number, and capacity/rating.

- PRL Pump data.
- PRL Motor data.
- RHL Pump data.
- RHL Motor data.
- PRL Static Equipment data.
- RHL Static Equipment data.
- Pump Curves (b)(3)(A)

An example of the type of pump data is illustrated in Figure 2-33. The main fuel pump curves that were used are the original pump curves from the manufacturer, Byron Jackson, and are dated 1941. The pump curves depict the performance of the pump for various flow rates. One of the pump curves is illustrated in Figure 2-34 and predicts the pump head, power, and efficiency for various flow rates of fuel.

(b)(3)(A) [redacted]

Figure 2-33 – Typical Pump Data

(b)(3)(A) [redacted]

Figure 2-34 – Typical Main Fuel Pump Curve

- Maintenance

    1. The following maintenance-related documents are specific equipment maintenance procedures and records of some recent recurring maintenance activities.
    2. Unified Facilities Criteria (UFC) – Petroleum Fuel Systems Maintenance (Department of Defense, 2021).
    3. RHL – Facility Maintenance Plan (Department of Defense, 2021).
    4. 2020_03_16 N6_RHL_OY2_Q4 (Pond Recurring Maintenance and Minor Repair).
    5. 2020_06_10 N6_RHL_OY3_Q1_SA1 (Pond Recurring Maintenance and Minor Repair).
    6. 2020_09_04 N6_RHL_OY3_Q2 (Pond Recurring Maintenance and Minor Repair).
    7. 2020_12_10 N6_RHL_OY3_Q3_SA2_A (Pond Recurring Maintenance and Minor Repair).
    8. 2021_03_16 N6_RHL_OY3_Q4 (Pond Recurring Maintenance and Minor Repair).

- Aqueous Film Forming Foam (AFFF) System

    1. The following are operational and maintenance documents for the AFFF system. These documents describe how the AFFF was designed to operate, and the maintenance documents provide data on the recent status of the sump pumps.
    2. Fire Protection O&M (In Synergy Engineering, October 2014).
    3. ADIT 1 21152 Semi-Annual Sump Pump.
    4. ADIT 2 21152 Semi-Annual Sump Pump.
    5. ADIT 3 21152 Semi-Annual Sump Pump.
    6. Fire Alarm O&M (In Synergy Engineering, October 2014).
    7. Fire Pumps O&M (In Synergy Engineering, October 2014).
    8. Nitrogen O&M (In Synergy Engineering, October 2014).
    9. Plumbing O&M (In Synergy Engineering, October 2014).
    10. PRV O&M (In Synergy Engineering, October 2014).
    11. Lower Tunnel OPD 21152 Semi-Annual Sump Pump.
    12. Lower Tunnel Zone 1 21152 Semi-Annual Sump Pump.
    13. Lower Tunnel Zone 2 21152 Semi-Annual Sump Pump.
    14. Lower Tunnel Zone 3 21152 Semi-Annual Sump Pump.
    15. Lower Tunnel Zone 4 21152 Semi-Annual Sump Pump.
    16. Lower Tunnel Zone 5 21152 Semi-Annual Sump Pump.
    17. P1551 Red Hill BOD – excerpt (In Synergy Engineering, October 2014).
    18. P-1551 Retention Line Point Paper – final draft.
    19. Red Hill Fire Suppression System Isometric Diagram_000D2160
    20. Submersible Pump Testing.

21. Sump Pump findings.

- Process hazard analysis documents relating to pumps and valves are:

  1. Pump Deadhead Findings (spreadsheet of the maximum pressure that a pump can discharge and be used to verify pipe/hose rating).
  2. Red Hill storage tank Venting (1964 to present) (drawing from 1964 of the RH tank vents).
  3. DFSP Pearl Harbor Specific Operations Order – F-76 Fuel Issue to Hotel Pier (an example of the fuel movement operations order that provided the level of detail in the typical operations orders).
  4. Piping Diagrams/Drawings – HNCJV14.0019 M-001 to M-124 (diagrams did not include instrumentation used during the PHA to identify pipe dimensions, pipe connections, valve locations, pump locations, tank locations, and how fuel is routed to the various locations within the fuel system).

The following documents relating to valves and pumps were requested, but were not available:

- Pump data sheets.

- Motor data sheets.

- Valve data sheets.

- Maintenance history of valves and pumps.

  Data sheets are a listing of the design and operational data from the manufacturer. The manufacturers' data include pump/valve material selection, pump/valve casing pressure limits, pump seal selection, valve internal design details, pump shaft/impeller design, valve internal and stem design, pump fluid flow capacity, valve flow capacity, valve pressure drop, and specific data for the pumped fluid.

  The maintenance history of the pumps and valves from the time of installation to the present could provide insight into the historical timing of major maintenance interventions and what repairs were made. This data may also identify recurring issues that may require further engineering review of the equipment and how it is operated.

2.8 Marine Facilities

2.8.1 Pier Inspection Report

Marine Solutions, Inc. performed an inspection of fueling and defueling piers in 2018 (Kilo (b)(3)(A), Mike (b)(3)(A), and Brave (b)(3)(A)), assessing their structural condition above and below water (Marine Solutions, Inc., 2018). In their inspection report, they cite that the inspection and assessment were conducted in accordance with NAVFAC EXWC contract requirements.

The report cites that through the Navy's Infrastructure Condition Assessment Program (ICAP), Engineering Management System (EMS) software was used to assess the general condition of the piers and individual structural components. For the piers and components, the software generates a Condition Index (CI) based on analysis and inspection data. Marine Solutions, Inc. notes that the EMS software is not officially deployed; therefore, they correlate their assessment rating with the CI and provide definitions of each rating level. The assessment ratings range from "good" to "critical," with the CI rating of 84-100 associated with "good" and the CI rating of 0-25 associated with "critical."

Bravo Pier [redacted] (Figure 2-35) is rated as "satisfactory," having moderate to minor defects and deterioration observed but no significant reduction in structural capacity. The associated CI ratings range between 74 and 78, and repair costs are estimated at approximately [redacted]. According to the report, Bravo Pier was last modified in 2013.

[redacted]

Figure 2-35 – Bravo Pier Berthing Locations

Mike Pier is comprised of [redacted] (Figure 2-36). [redacted], all of which correspond to "fair" condition defined as "all primary structural elements are sound, but minor to moderate defects and deterioration observed. Localized areas of moderate to advanced deterioration may be present but do not significantly reduce the structural capacity." Repair costs are estimated at approximately [redacted]. According to the report, Mike Pier was last modified in 2013.

[redacted]

Figure 2-36 – Mike Pier Berthing Locations

Kilo Pier [redacted] (Figure 2-37) are rated "satisfactory" (CI rating 67-78), [redacted] are rated "fair" (CI rating 63), and [redacted] is rated "serious" (CI rating 34) as defined by "advanced deterioration, overstressing or breakage may have significantly affected the load-bearing capacity of primary structural components. Local failures are possible." Repair costs are estimated at approximately [redacted]. According to the report, Kilo Pier was last modified in 2013.

[redacted]

Figure 2-37 – Kilo Pier Berthing Locations

2.8.2 Petroleum, Oil, Lubricant Integrity Management Plan

The 2019 Petroleum, Oil, Lubricant (POL) Integrity Management Plan (IMP) (Enterprise Engineering, Inc., 2019) highlighted below Hotel Pier the use of a polyvinyl chloride (PVC) FOR line, which is designed to hold up to 100% fuel. The report states that "the existing PVC drain-pipe was installed with nitrile seals which the manufacturer stated are not rated for fuel service". Fuel concentration in waste stream can be 100% which may cause gaskets to break down over time. Should the gasket fail, the waste stream will drain into the harbor and lead to possible fines and impact to mission critical operations."

2.9 Coatings and Corrosion Control

Coating and corrosion documents are summarized in this section.

2.9.1 UFGS-09 97 13.27 Unified Facilities Guide Specification – High-Performance Coating for Steel Structures – December 2021

This guide specification (Department of Defense, 2021) outlines the requirements for zinc-rich epoxy, epoxy, and polyurethane coating systems for non-immersion environments where high performance is required, such as those for piping and aboveground fuel tanks. The specification is intended for both new construction and repairs. The document outlines the required quality assurance procedure, such as test reports and qualification of contractors, the standards of the coating products, and the execution of the coating process, including surface preparation, environment, and product application. The required components of the coating system include the following:

- Zinc-Rich Epoxy Primer Coat (Epoxy polyamide satisfying MIL-DTL-24441/19).
- Epoxy Intermediate Coat (Epoxy polyamide satisfying MIL-DTL-24441/31).
- Polyurethane Topcoat (Polyurethane satisfying MIL-PRF-85285).

2.9.2 UFGS-09 97 13.15 Epoxy/Fluoropolyurethane Interior Coating of Welded Steel Petroleum Fuel Tanks– February 2010

This guide specification (Department of Defense, 2010) covers the requirements for epoxy/fluoropolyurethane coating systems for interiors of newly constructed bulk fuel storage tanks. Guidelines for maintenance (repair) coatings are included to avoid degrading the original coating. The quality assurance and coating execution sections are similar to those on the Steel Structures Guide Specification (Department of Defense, 2021). The required components of the coating systems include the following:

- Epoxy Primer Coat (epoxy polyamide satisfying DTL-24441/29).
- Epoxy Intermediate Coat (epoxy polyamide satisfying MIL-DTL-24441/31).

- Fluoropolyurethane Topcoat (composition requirements for this component are provided).

2.9.3 UFGS-09 97 13.26 Coating of Steel Waterfront Structures, Zero VOC, Splash Zone Coatings – February 2016

This guide specification (Department of Defense, 2016) covers the requirements for coating new or existing steel-sheet piling and other steel waterfront structures. This coating system may also be used for repairing and coating aged surfaces. The quality assurance and coating execution sections are similar to those on the Steel Structures Guide Specification (Department of Defense, 2021). The required components of the coating system include the following:

- Self-Priming Splash Zone Coating (SZC) Material (two coating layers).
- Chevron Phillips Chemical Co. TZ 904, PolySpec LPE 5100, or Premier Coating Systems, Inc. PCS 1200 TA.

2.9.4 Coatings Guidance for Naval Facilities, Naval Facilities Engineering Service Center, July 2000

This document (NAVFAC, 2000) contains guidance for coatings used by the Navy for facilities, including surface preparation, coating guidance specifications, maintenance painting, present coating work, and Navy coating needs. We note that although the Guide Specifications from the date of this document have changed, their substance appears to be similar.

The Steel Structures Guide Specification (Department of Defense, 2021) states that “With routine spot repair(s) of corroded surfaces and reapplication of topcoat every five to eight years, approximate service life is 20+ years.”

The Tank Interior Guide Specification (Department of Defense, 2010) states that “by utilizing the Fluoropolyurethane topcoat, performance generally exceeds that of three-coat epoxy system. With routine spot repair(s) of corroded surfaces, approximate service life is 25+ years.”

2.9.5 Coating Inspection and Completion Report, Abhe and Svoboda, November 2015

This report outlined the surface preparation, coating application, and quality control for recoating fuel pipes at Red Hill, using two coats of Sherwin Williams Macropoxy 646 Fast Cure Urethane. It references a project specification, but we were not provided with this document.

2.9.6 Cathodic Protection of POL Systems Annual Surveys 2012 – 2021

These reports summarize the annual surveys of Cathodic Protection (CP) at the Joint Base Pearl Harbor-Hickam conducted by Corrpro. The infrastructure protected by impressed current CP includes the ASTs, buried fuel pipe including fuel pier supply pipes and the transfer piping to Hickam, hydrant systems, and loading stands. The report references standard NACE and API standards for CP protection and testing. Annual testing includes inspection of rectifiers for physical and electrical damage, measurements of structure to electrolyte potentials in both energized and depolarized conditions, grounded performance such as electrical resistance, and electrical isolation from unprotected infrastructure. These reports provide annual recommendations for maintenance and system upgrades, including a list of outstanding items from previous reports.

2.9.7 Engineering Assessment of Fuel Pipelines at Hydrant Systems 1 – 4 Anderson Air Force Base, Guam, Enterprise Engineering May 2020 (Enterprise Engineering, 2020)

This report discusses stress corrosion cracking (SCC) discovered in hydrant fueling pumphouses in Guam, which had caused numerous weeps of fuel through the stainless steel pipe cracks. These cracks, which were due to chloride contamination on the pipes, occurred only within the pumphouse, probably due to rain washing preventing significant build-up of contamination on external pipes. Stress corrosion cracking occurs when certain contaminants (chlorides) are present on susceptible metal surfaces (stainless steel) in the presence of tensile stresses. The observed cracks were located adjacent to circumferential pipe welds in areas of elevated residual stress.

The report notes that regular visual examination of the pipes is recommended to detect cracking, and surfaces should be regularly washed to prevent the build-up of chlorides. It states that several other Air Force installations have similar environmental conditions with the Andersen Airforce Base in Guam. Therefore, SCC is possible at these other facilities as well.

2.9.8 Coating Products

Pond provided us with two coatings systems that are used for repairs on fuel pipes by different contractors:

- Sherwin Williams Three Part Coating System

    1. Zinc-Clad III HS 100 Organic Zinc Rich Epoxy Primer.
    2. Macropoxy 646 Fast Cure Urethane.
    3. Hi-Solids Polyurethane.

- PPG Two Part Coating System

    1. Amerlock 2 Fast drying surface tolerant VOC compliant epoxy.
    2. PSX 700 Two-component, engineered siloxane coating.

2.10 Facility-Wide Integrity Management

We understand that there are integrity management plans for specific elements of the Facility, but no overarching facility-wide integrity management plan was provided, and facility personnel referred to UFC 3-460-03 (Department of Defense, 2021) for general maintenance requirements. We were provided with API 570 and API 653 integrity management studies for piping and tanks, respectively.

2.11 Operations and Process Safety Management

Operations and Process Safety Management (PSM) related documents are contained in Appendices B and C. The review of documentation consisted of:

- Organizing all procedures, plans, and evidence provided by the client.
- Requesting additional procedures, plans, and documents.
- Reviewing each procedure and document and recording concerns.
- Generating recommendations.

The assessment team reviewed information on each specific element against a standard protocol. Additionally, Risktec personnel reviewed ergonomics, industrial hygiene, safety culture, personal protective equipment, and other areas during the visit.

3. INFORMATION BY OTHERS

Information provided by [redacted] (Supervisory General Engineer NAVSUP Fleet Logistics Center Pearl Harbor, C701) includes:

- On 21 March 2022, [redacted] stated that Hotel Pier and Sierra Pier currently have fuel in the piping and that Hotel Pier transfers F-76, JP-5, F-24, FOR, and multi-purpose products.

- On 23 March 2022, [redacted] stated that during normal operations, the lower access tunnel and harbor tunnel pipelines are fully packed and that operations do not regularly drain lines or run partially full.

Information provided by [redacted] (General Engineer NAVSUP Fleet Logistics Center Pearl Harbor, C701) includes:

- On 29 March 2022, [redacted] shared his understanding of the last CIR on Tanks 3, 4, and 11, i.e., tanks without a visual stamp on their upper access tunnel entrance, similar to other tanks listed in Table 2-1. Tanks 3 and 4 were last inspected in 1982, Tank 11 was last inspected in 1983.

Information provided by [redacted] (Deputy Director, Fuel and Facilities Management NAVSUP Fleet Logistics Center Pearl Harbor) includes:

- On 14 April 2022, [redacted] stated that Hotel Pier and Sierra Pier currently have fuel in the piping and that Hotel Pier transfers [redacted].

- On 14 April 2022, [redacted] stated that there are [redacted] facility locations that house fuel pumps:

    1. [redacted]
    2. [redacted].
    3. [redacted].
    4. [redacted]
    5. [redacted] Sierra Pier for FOR line.
    6. [redacted]
    7. ADIT 3 pumps for water only, not fuel or firefighting related.

- On 14 April 2022, [redacted] stated that a few years ago, an API 570 certified inspector noted that the SS304 pipe in the Ewa and Diamond Head pumphouses at Hickam looked similar to conditions he observed during an inspection in Guam, where chloride stress cracking occurred. After a follow-up inspection of the Hickam pipe, no chloride stress cracking was observed.

- (b)(3)(A) [redacted]

During our site inspection of the Underground Bulk Fuel Storage Tanks in February 2022, we met with TesTex personnel to discuss their NDT scanning techniques and quality control process to detect weld defects and locally thinned areas in the tank liner. They confirmed that any thinned areas detected during the eddy current scan are then re-examined using UT inspections to confirm the extent of section loss. They showed us the steel calibration plates being used for these inspections (they were scanning Tank 18 whilst we were on site), and we noted that these were representative of the defects that could be expected in the tank steel liner.

With respect to coatings, we had discussions with Pond (routine maintenance and minor repair contractor) over the course of our assessment and were provided with the following information related to the coatings:

- Contractor walks the facility quarterly to review pipe conditions, which includes documenting coating and corrosion issues. If coating damage is discovered during these quarterly inspections, then local repairs are conducted. However, these repairs are intended for the short term, and typically no project specification for this repair coating process is used.

- Long-term coating projects are conducted every five years according to areas identified as a high priority. A coating inspector will review whole sections of the system and map our lengths of pipe requiring repair and recoating. Project specifications are written based on the guide specifications.

- The quality control process is the responsibility of the coating contractor.

- Wrap coatings on the fuel pipes along the piers were intended to be a temporary repair, not a permanent solution.
- In the past twenty years, there has been an effort to remove the bituminous wrap coatings on the fuel pipes along the tunnel and replace with a modern coating. However, the wrap has been found to contain asbestos, and the original coating contains lead, which complicates the removal process.
- Pipe supports in the lower access tunnel require lead abatement for retrofit/remedial works.

4. INDUSTRY LITERATURE

Codes, standards, and industry guidelines applicable to structural and mechanical integrity assessments and from which information was gathered are summarized in this section.

4.1 United Facilities Criteria

United Facilities Criteria (UFC) documents are the main standards governing the design, construction, maintenance, inspection, and repairs of the Navy facilities. The UFC refers to industry standards like those from API and provides additional provisions as required for the military facilities. In the hierarchy of codes and standards, UFC is regarded as a high-level overarching document. Some of the applicable UFC and their provisions pertaining to our studies are noted in this section.

4.1.1 UFC 3-460-01 – Design: Petroleum Fuel Facilities

"The guidance contained in this UFC is intended for use by facility planners, engineers, and architects for individual project planning and for preparing engineering and construction documentation for all real property facilities used for storing, distributing, and dispensing fuels for reciprocating and jet engine aircraft, automotive fuels, lubricating oils, and alternate fuels. In addition, it is intended for use by operations and maintenance personnel as a guidance document for facility design, modifications, and improvements.

This Unified Facilities Criteria, UFC 3-460-01 (Department of Defense, 2022), contains general criteria and standard procedures for the design and construction of military land-based facilities which receive, store, distribute, or dispense liquid fuels. We reviewed Change 2 version dated 12 January 2022 during this study. We note that UFC 3-460-01 replaced MIL-HDBK-1022.

UFC 3-460-01 lists the physical properties of fuels (such as densities) in Section 2-3. These properties are used in self-weight and seismic inertial load calculations.

Section 2-13.7.1 of this UFC indicates that underground storage tanks are to be double wall type, and single wall underground storage tanks are not allowed for environmental protection purposes. This is consistent with modern standards applicable to new build projects.

For the marine structures, such as berthing piers, it is recognized that permanent fuel piping and system components may be installed on berthing piers, which were not primarily designed for handling fuel (Section 5-3). This practice involves the addition of fuel pipes to existing piers, which is considered to be the reason for vulnerable piping configurations for some of the piers at JBPHH based on discussions with the Facility staff.

Section 9-3.2 provides pipe support requirements and typical configurations and notes that rollers, hangers, and supports allowing the movement of pipe on a metal surface are not acceptable for new designs. These types of pipe support configurations were observed at the Facility (Section 5).

UFC 3-460-01 recommends that design avoid a lack of restraint in high seismic regions that can lead to excessive pipe motion and failure. The Facility is not located in a high seismic region but is in the area of moderate seismic risk, and it is considered a good practice to limit the movement of piping due to transient loads in addition to seismic inertial loads. An arrangement that provides in-line-restrained sliding (guided slide) pipe supports or another method of maintaining alignment on each side of the expansion joint is recommended. It stated that mitered bends for changes in direction should not be used. UFC 3-460-01 also states that for complex systems, computerized code-compliant pipe stress analysis programs must be used to assure proper pipe support selection for load conditions according to ASME B31.3 and/or ASME B31.4.

Chapter 12 outlines the procedures for major rehabilitation projects. “It is recommended that a Physical Condition Survey be conducted to survey the condition of the Facility with the goal of identifying major deficiencies and prioritizing the work required.” Furthermore, for the pipe support upgrades, “any changes to support type must be accompanied by a seismic and thermal flexibility analysis.” For pipeline repairs, complete seismic and thermal flexibility analysis must be performed to verify support type and location. Plates 015 and 017 of UFC 3-460-01 presents examples of the guided sliding pipe support and U-bolt pipe supports, respectively. These pipe support examples, which can be used for retrofitting purposes as well, are shown in Figure 4-1 and Figure 4-2. It is worthwhile noting that the pipe shoes should be welded to pipes, when provided, according to these standard details. The pipeline and pipe support configurations observed at the Facility (Section 5) are compared with the best practices and recommendations noted in UFC 3-460-01 to identify the deficiencies and required physical changes to improve the design.

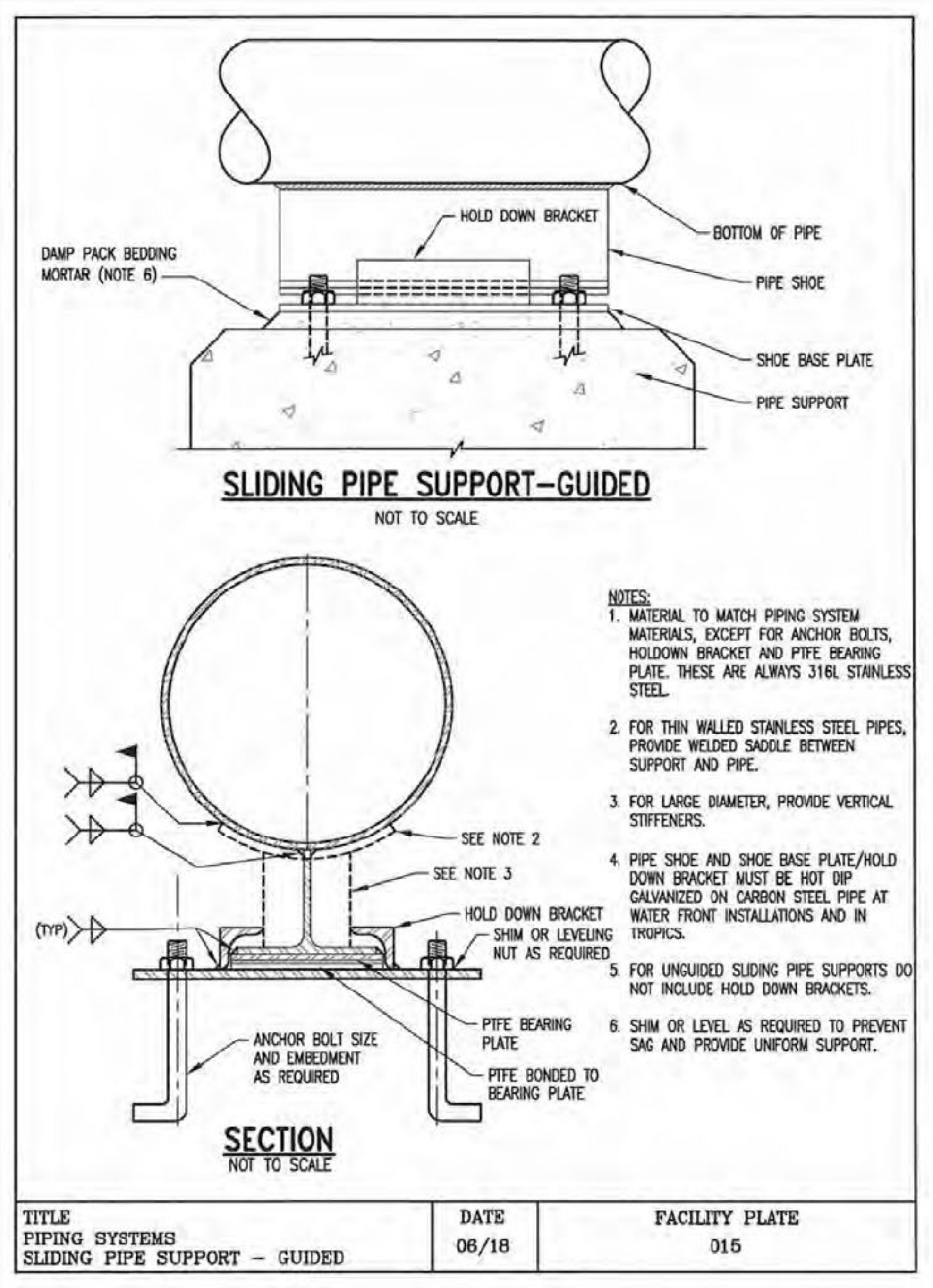


Figure 4-1 – UFC 3-460-01 Piping Systems Sliding Pipe Support – Guided (Department of Defense, 2022)

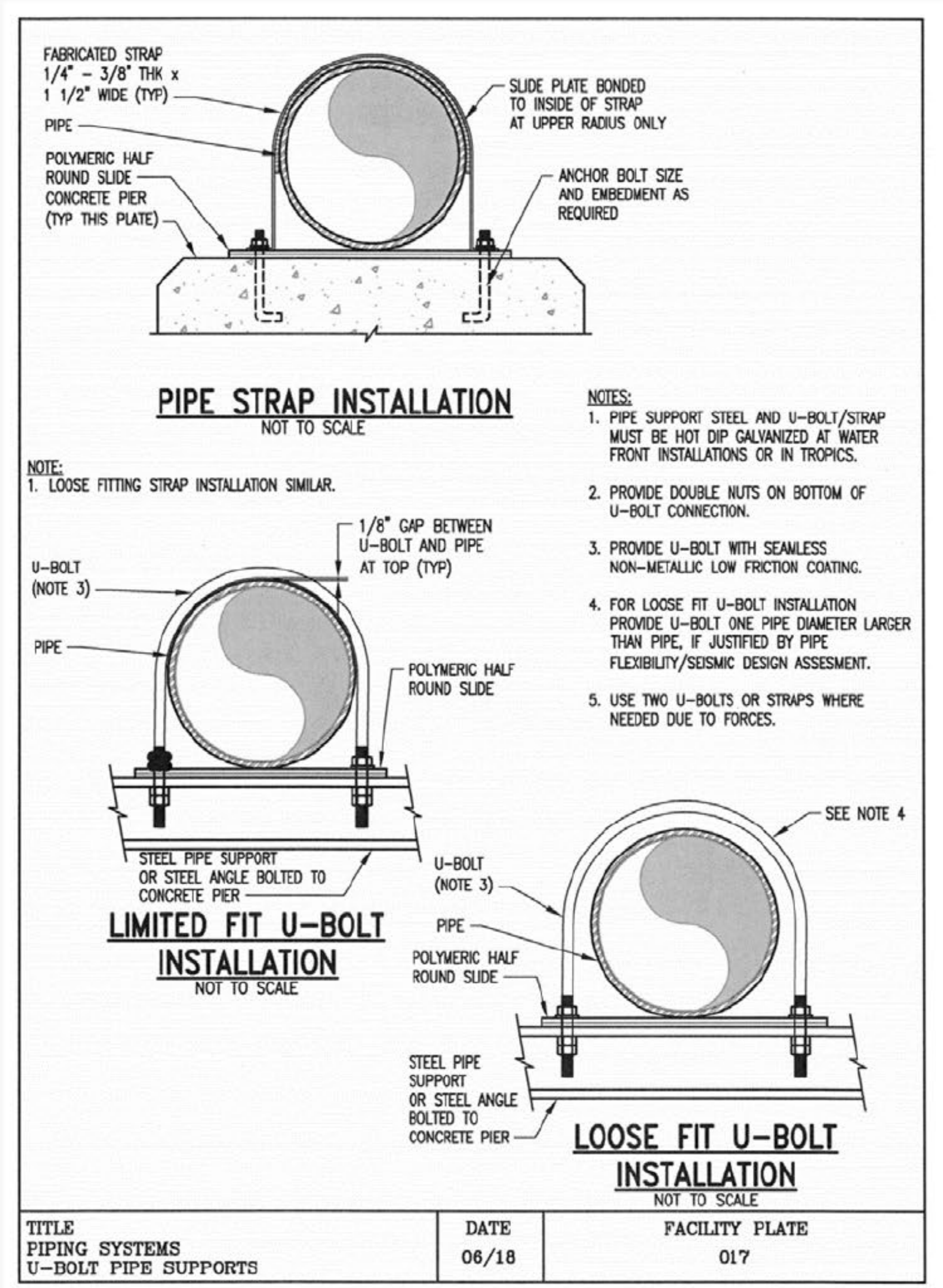


Figure 4-2 – UFC 3-460-01 Piping Systems U-Bolt Pipe Supports (Department of Defense, 2022)

4.1.2 Other UFC Standards

There are several UFC and MIL standards applicable to fuel facilities. The following criteria documents are other applicable documents that helped inform our assessment.

- Unified Facilities Criteria (UFC 3-301-01), "Structural Engineering."
- UFC 1-200-01 – DOD Building Code. This document represents the foundational document of the UFC program in providing general building requirements and overarching criteria, establishing the use of consensus building codes and standards, establishing criteria implementation rules and protocols (including core UFC), and identifying unique military criteria. It refers to 2018 IBC and 2018 IEBC as consensus standards and provides additional provisions (Department of Defense, 2022).
- UFC 4-152-01 – Design. Piers and Wharves: This UFC contains descriptions and design criteria for pier and wharf construction, including subsidiary, contiguous, and auxiliary structures. Loading details, regulations, furnishings, appurtenances, and other information are discussed when applicable (Department of Defense, 2017).
- UFC 3-460-03 – Petroleum Facilities Maintenance. This manual emphasizes inspection and preventive maintenance to avoid system shutdowns, prevent fuel contamination, and decrease fire, safety, and health hazards. It is not a design manual but provides the Facility maintenance requirements (Department of Defense, 2021).

    1. Section 2-10.3 states that available as-built information for petroleum fuel systems must be preserved and protected, and as-built information must be updated when there is a configuration change.
    2. It covers pipe-visual inspections and API 570 inspections, stating that "each petroleum fuel pipeline facility should have a Pipeline Integrity Management Plan (PIMP) to assist with and guide pipeline integrity maintenance. PIMPs improve the integrity management of piping systems and help prevent leaks or pipeline failures."
    3. There are provisions for different valve types. UFC 3-460-01 does not allow butterfly valves to be used as isolation valves in the construction of new petroleum fuel systems, as they are not considered positive shut-off valves.
    4. Pressure and vacuum instrumentation requirements are covered in Section 6 and the coating repair provisions.
    5. Appendix G provides general requirements pertaining to pipe testing, pipe properties, maximum operating and test pressures, dynamic surge, and system components. It is also stated that "special consideration must be given to systems having non-standard fittings such as mitered elbows, orange peel reducers, stab-in connections, and similar. Note that under ASME B31.3, some of these fittings are acceptable when operation pressure results in stress less than 20% of SMYS."

The provisions in these UFC documents were reviewed and used to identify the design deficiencies for the assessed structures, equipment, and piping systems.

4.2 Department of Defense Handbook – MIL-HDBK-1022 – 30 June 1997

This document provides basic guidance for designing petroleum fuel facilities and systems. Section 9 refers to the guidance and design of the piping systems in these facilities. Section 9.2.3 specifically refers to the arrangement of pipes for expansion and contraction. It is noted that “expansion devices which employ packings, slip joints, friction fits, or other non-fire-resistant arrangements” are prohibited per this section. Dresser couplings fall under the categories mentioned above. The excerpt from the handbook is shown in Figure 4-3.

> **9.2.3 Arrangement.** Arrange pipes to provide for expansion and contraction caused by changes in ambient temperature. Where possible, accommodate expansion and contraction by changes in direction in piping runs, offsets, loops, or bends. Where this method is not practical, use flexible ball joint offsets. Provide sliding pipe supports or other method of maintaining alignment on each side of the expansion joint. Do not use expansion devices which employ packings, slip joints, friction fits, or other non-fire resistant arrangements. Use ball-type offset joints to accommodate possible settlement of heavy structures such as storage tanks, if piping design cannot provide enough flexibility. Design expansion bends, loops, and offsets within stress limitations in accordance with ANSI/ASME B31.3 and ANSI/ASME B31.4.

Figure 4-3 – MIL-HDBK-1022 Section 9.2.3

4.3 Hawaii Administrative Rules, Title 11, Chapter 280.1 (HAR 11.280.1)

Hawaii regulation for underground storage tanks and auxiliary systems.

- Section 280.1-40 lists general requirements for all USTs. They state noncompliance with this section requires facility updates to demonstrate compliance or closure. In general, these requirements state that a leak detection method is in place to reliably detect leaks in a timely manner and that the leak detection method is calibrated and maintained by competent persons. They reference subsequent sections of the rules for specific allowable thresholds and state that each method must have a 95% confidence of positively capturing a leak. This section also stipulates reporting the occurrence of a leak to the DOH.

- Section 280.1-41 is related to petroleum USTs and requires leak detection testing at least every thirty-one days for tanks installed before 2013.

- Section 280.1-43 is related to methods of leak detection for tanks and states leak detection must be capable of detecting leaks of 1% of flow-through plus 130 gal per month. For field-constructed tanks, one or a combination of the following leak detection methods may be used:

1. Annual tank tightness tests must be performed to capture 0.5 gal per hour leakage,
2. Automatic tank gauging with 1 gal per hour fidelity every thirty-one days must be combined with tank tightness testing every three years that can capture 0.2 gal per hour leakage,
3. Automatic tank gauging with 2 gal per hour fidelity every thirty-one days must be combined with tank tightness testing every two years that can capture 0.2 gal per hour leakage,
4. Vapor monitoring to detect 1 gal per hour fidelity every two years,
5. Inventory control to capture 0.5% flow-through loss must be combined with tank tightness tests to capture 0.5 gal per hour leakage performed every two years and vapor monitoring or groundwater testing, or
6. Another approved method.

- Section 280.1-44 is related to methods of leak detection for piping and states:

1. Automatic line leak detection,
2. Semi-annual or annual line tightness testing per Table 4-1 combined with Table 4-2 if the semiannual test cannot meet a maximum 3 gal per hour leak rate, perform vapor monitoring, perform inventory control, and
3. Tightness methods per 280.1-43.

- Section 280.1-45 states that records of maintenance, testing, leakage occurrences, and product specifications shall be kept for a minimum of three years.

Table 4-1 – HAR Title 11 Chapter 280 Maximum Leak Detection Rate per Test

Test section volume (gallons)	Semiannual test—leak detection rate not to exceed (gallons per hour)	Annual test—leak detection rate not to exceed (gallons per hour)
<50,000	1.0	0.5
≥50,000 to <75,000	1.5	0.75
≥75,000 to <100,000	2.0	1.0
≥100,000	3.0	1.5

Table 4-2 – HAR Title 11 Chapter 280 Phase in for Piping Segments

First test	Not later than July 15, 2021 (may use up to 6.0 gph leak rate).
Second test	Between July 15, 2021 and July 15, 2024 (may use up to 6.0 gph leak rate).
Third test	Between July 15, 2024 and July 15, 2025 (must use 3.0 gph for leak rate).
Subsequent tests ..	Not later than July 15, 2025 begin using semiannual or annual line testing according to the Maximum Leak Detection Rate Per Test Section Volume table above.

4.4 Civil and Structural

Applicable industry codes and standards are listed below:

- American Concrete Institute (ACI, 2019) – Building Code Requirements for Reinforced Concrete."

- American Institute of Steel Construction:

  AISC ANSI/AISC-360-10 Specification for Structural Steel Buildings
  AISC Steel Construction Manual
  AISC 341 – Seismic Provisions for Structural Steel Buildings.

- American Petroleum Institute (API 650) – Welded Tanks for Oil Storage.

- American Society of Civil Engineers:

  ASCE 7-16 – Minimum Design Loads for Buildings and Other Structures.
  ASCE Task Committee on Seismic Evaluation and Design of Petrochemical Facilities – Seismic Evaluation and Design of Petrochemical and Other Industrial Facilities.

- American Welding Society (AWS D1.1) – Structural Welding Code Steel.
- International Code Council (IBC) – International Building Code (IBC).
- Process Industry Practices (PIP STC01015) – Structural Design Criteria.

4.5 Piping

The following industry codes are applicable for the evaluation of the Red Hill facility pipelines.

- American Society of Mechanical Engineers:

  ASME B31.4 – Pipeline Transportation Systems for Liquids and Slurries.
  ASME B31E – Standard for the Seismic Design and Retrofit of Above-Ground Piping Systems.
  ASME B16.5 – Pipe Flanges and Flanged Fittings.
  ASME B16.9 – Factory-Made Wrought Buttwelding Fittings.

- DNV-OS-F101 (DNV) – Offshore Standard – Submarine Pipeline Systems.
- National Fire Protection Association:

  NFPA 30 – Flammable and Combustible Liquids Code.

4.6 Marine Facilities

ASCE Manuals and Reports on Engineering Practice No. 130 on Waterfront Facilities

Inspection and Assessment:

- The American Society of Civil Engineers (ASCE) Manuals and Reports on Engineering Practice No. 130 on Waterfront Facilities Inspection and Assessment (ASCE, 2015) provide guidance on the structural assessment of the reinforced concrete marine structure. This industry-standard verbally and pictorially categorizes reinforced concrete damage from minor to severe to standardize the assessment of these structures. Severe damage is described by structural cracks wider than 0.25 in. or complete concrete breakage or loss of coverage of reinforcing steel resulting in higher than 30% cross section loss of main reinforcing bars. An overall assessment of a pier is then determined considering the aggregate of element ratings and their importance in the system.

4.7 Integrity Management

- American Petroleum Institute:

  1. API 570 – Piping Inspection Code: In-service Inspection, Rating, Repair, and Alteration of Piping Systems.
  2. API 579-1/ASME FFS-1 – Fitness for Service.
  3. API 653 – Tank Inspection, Repair, Alteration, and Reconstruction.

5. SITE VISITS

From 19 January 2022 through 18 April 2022, SGH performed multiple site visits to the Facility and JBPHH fuel system. Our subcontractor Risktec also performed several site visits. These site visits focus on understanding 1) the current as-is conditions, 2) historic release events, and 3) opportunities for retrofit to safely operate and defuel the Facility. All our requests for access to the Facility and the JBPHH fuel system were granted in a timely manner, and when required, knowledgeable escorts familiar with the focus of our site walks provided real-time information about the fuel systems. To date and cumulatively, SGH and Risktec personnel have performed over seventy site walks of the Facility and JBPHH.

Our site visit observations are tabulated in Appendix A. Tables in Appendix A include photographs of the observation, location, component type, description, observation type, severity, priority, recommendation, status, and some discussion. Descriptions of the terms and symbols used to document the site visit observations are presented in Table 5-1.

Table 5-1 – Site Visit Observation Terms and Categorization of Deficiencies

Component	Pipe support beam, pipe cradle, pipe, valve, etc.
Description	Brief description of the observed issue (corrosion loss, missing member, etc.)
Observation Type	CD – coating damage; CR – corrosion; DV – design variation; LI – lack of integrity; MB – missing member; PD – physical damage; WD – weld defect; LP – load-path; IR – improper restraint (missing pipe supports, etc.); IC – the interaction of components (contact risk, over restrained pipes by the tanks, stress concentration, etc.); OT – other
Severity	H – high, M – medium, L – low (depending on the observed condition)
Priority	D1 – defuel, P1 – high, P2 – lower, P3 – maintenance (based on the importance of the component, severity of the condition, and its relevance to safe defueling and operation of the Facility)
Recommendation	Actionable recommendations such as evaluate, repair, replace corroded member, add brace, etc.

5.1 Red Hill Underground Bulk Fuel Storage Tanks

5.1.1 Tank 14 Interior

On 21 January 2022, a Certified Weld Inspector from SGH conducted an inspection of a portion of the interior of Tank 14 (undergoing CIR) using a crane-suspended basket. We visually inspected the welds and the surface condition of the coating and used an Ultrasonic Thickness (UT) Gauge to verify the local plate thicknesses.

We inspected a vertical section of the tank at locations R2P13, R10P3, and R20P13 below the central rim and A59, B58 above the rim (these location identifiers are written on each plate by the contractor).

The plates are all butt welded rather than lap welded. All welds appear smooth with no visible undercut, surface porosity, or other defects (Figure 5-1). This is in agreement with the previous tank inspection reports, which indicated that the main weld defects identified by the eddy current inspection were sub-surface lack of fusion.

Figure 5-1 – Tank 14 Liner Plate Welds

The surface coating is largely intact, with no cracks or delamination in the areas that we inspected. There is some local blistering of the coating, indicating that it is starting to deteriorate (Figure 5-2), but we were informed that the tank surface will be cleaned and recoated during the ongoing CIR process.

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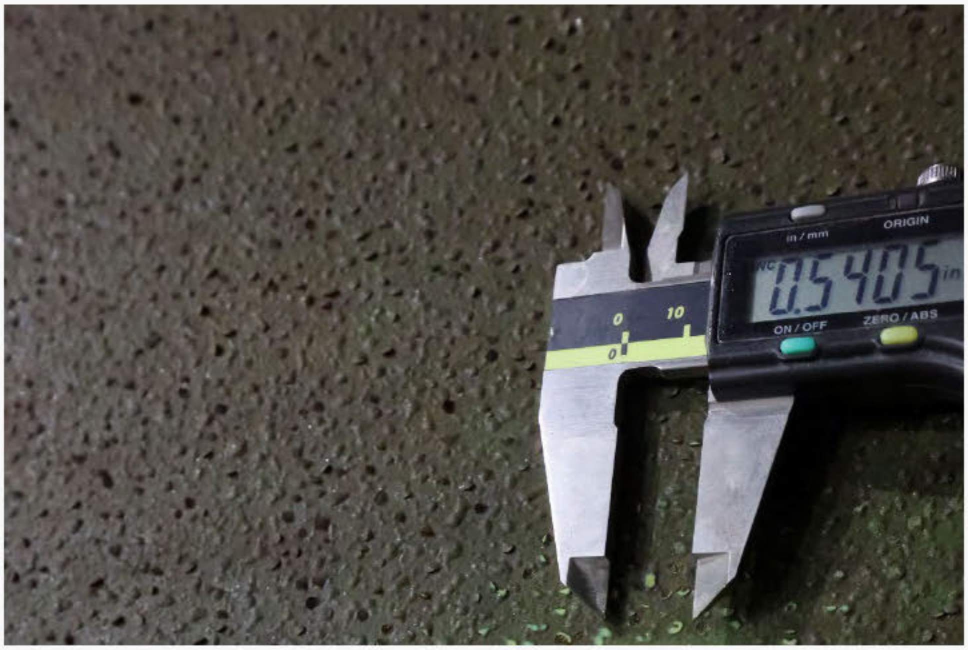

Figure 5-2 – Tank 14 Steel Liner Surface Coating

We ground local areas of the steel surface smooth using 120 grit silicon carbide paper and measured the plate thickness using an Olympus 45MG Ultrasonic Thickness Gauge. The surface preparation did not remove the coating, so our measurements included coating thickness. Our measurements are listed in Table 5-2. Locations align with plate numbers written on the plates by the CIR contractor (APTIM, 2018).

Table 5-2 – Ultrasonic Thickness Measurements from Tank 14

Steel Liner Location Identifiers	Thickness (in.)
R2P13	0.297
R10P13	0.303
R20P13	0.285
R27P13	0.276
A59	0.264
B58	0.294

5.1.2 Access Above the Upper Tank Dome

We conducted a site visit to observe the conditions in accessible areas above the underground storage tanks' upper dome. From the upper access tunnel, at each tank entry hatch, a ladder allows access to a portion of the top of the dome. We observed gauging ports and ventilation shafts that sometimes penetrate through the upper tank dome; we also observed the concrete and gunite surfaces around the tunnel walls, ceiling, and floors. We looked for concrete cracking, leakage, spalls, and delamination conditions. We visited the tops of all the tanks except for Tanks 1, 14, and 18, which were blocked off by contractors working in those areas.

The ventilation shafts for the tanks extend along the ladder access to the top of the tanks. For Tanks 13 to 20, these shafts are diverted down into the tanks, while for Tanks 2 to 12, the ventilation shafts are diverted up (Figure 5-3). This configuration is consistent with the structural drawings Drawing No. 294322 (Contractors, Pacific Naval Air Bases, 1942). In some instances, we observed gouges in the encasement around the ventilation pipe, which revealed the underlying steel pipe (Figure 5-4). Occasionally we observed dents in this pipe. The tanks with recent CIR dates (13 and 17, for example) had new ventilation piping without gunite encasement (Figure 5-5).

We observed spider cracking and old indications of leakage through the cracks in the wall around the access to the top of the upper tank dome at Tank 16. When hammer sounded, there did not appear to be delaminated concrete or gunite around these cracks. There were no visible signs of corrosion through the wall, nor were there signs of spalls or exposed reinforcing (Figure 5-6). This wall is not the tank wall.

The top of the upper tank domes, notably for tanks not recently in CIR, have a gunite layer over the concrete dome that occasionally is delaminated (when hammer sounded). Sound concrete is inaccessible in these locations due to the presence of the gunite. The gunite layer over the top of the upper tank domes has been removed for the tanks recently in CIR. No delaminated areas were discovered when hammer sounding the revealed concrete tank dome (Figure 5-7). We did not observe delaminations, spalls, cracking, or exposed reinforcing in any of the concrete we observed on the top of the upper dome (i.e., all tanks except for 1, 14, and 18 which were inaccessible).

(b)(3)(A) [redacted]

(b)(3)(A) [redacted]

Figure 5-3 – Top of Upper Tank Dome 12 (left) and 13 (right)

(b)(3)(A) [redacted]

Figure 5-4 – Ventilation Shaft with Missing Gunite Encasement – Tank 20

(b)(3)(A)

[redacted]

Figure 5-5 – Ventilation Shaft after Clean, Inspect, Repair – Tank 13

(b)(3)(A)

[redacted]

Figure 5-6 – Spider Cracking in Wall above Tank Dome Access – Tank 16

[redacted]

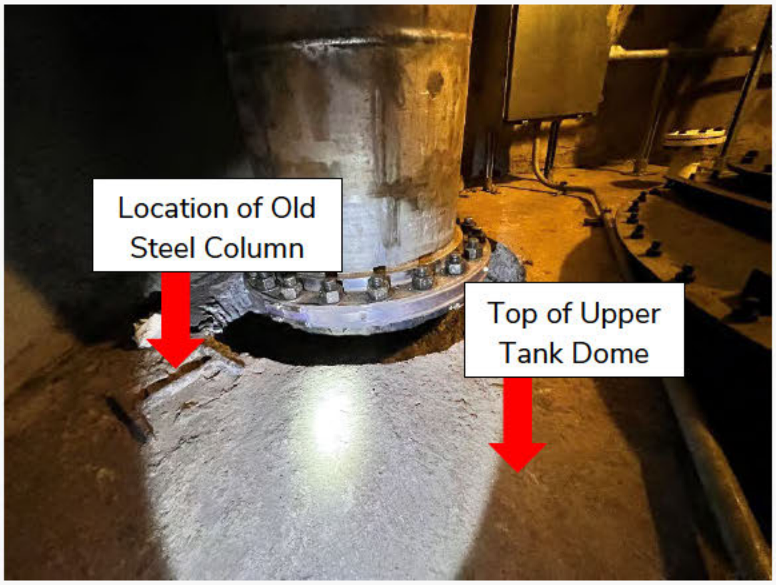

Figure 5-7 – Top of Tank Dome after Clean, Inspect, Repair – Tank 13

5.2 Piping

Appendix A presents significant site observations and deficiencies observed during our site visit.

5.2.1 Ongoing Repairs to the JP-5 Pipeline in Red Hill

On 22 and 30 March 2022, we performed site visits to the tank gallery, specifically at Tanks 19 and 20, to observe the existing conditions and perform measurements for our pipe stress analysis and retrofit recommendations. While at Tank 19, we observed APTIM performing repairs on the JP-5 lateral pipeline, reconnecting the pipe to the tank via a bent configuration due to the nonalignment between the lateral "T" and the tank penetration (see isometric drawing in Figure 2-19 and confirming site observations in Figure 5-8 and Figure 5-9).

(b)(3)(A)

[redacted]

Figure 5-8 – 22 March 2022 Observation of JP-5 Lateral Pipe Reconnection at Tank 19

(b)(3)(A)

[redacted]

Figure 5-9 – 30 March 2022 Observation of JP-5 Completed Reconnection to Tank 19

5.2.2 Internal Pipeline Condition

Starting in January 2022, APTIM was contracted to perform JP-5 emergent pipeline repairs in the Red Hill fuel storage facility, according to the NAVSUP FY21 Design-Build Repair Red Hill Piping project (NAVSUP FLC Pearl Harbor, 2021). These included reconnecting lateral lines to Tanks 19, 20, and 1, in addition to repairing trunk line segments. While these segments were being repaired, SGH observed the interior steel surface of the JP-5 pipeline. We observed small pits uniformly distributed throughout the pipeline lateral to Tank 19 (Figure 5-10) and the trunk line between Tanks 15 and 16.

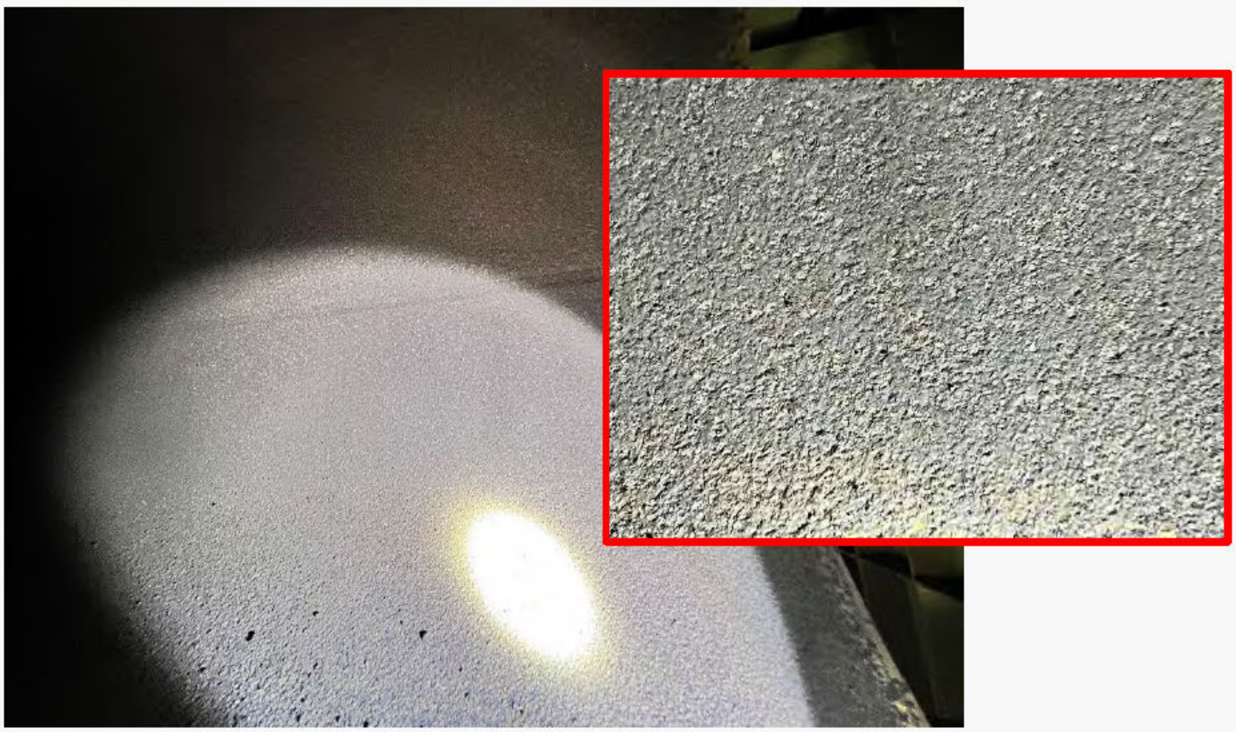

Figure 5-10 – JP-5 Lateral Pipeline to Tank 19 at Repair Location

5.2.3 Failed Dresser Couplings

Failed Dresser coupling components were in place and on the ground during our initial January 2022 walk down. During the surge event on 6 May 2021, some of the Dresser coupling retention lugs failed at Tank 18 and Tank 20. The appearance of the components indicated lug plate tearing and weld failures. Figure 5-11 shows the retention lug failure at Tank 20 and our on-site measurements.

[redacted] (b)(3)(A)

[redacted] (b)(3)(A)

Figure 5-11 – Retention Lug Failure at Tank 20

Tank 19 was permanently out of service during our walk down, and the fuel pipe at Tank 19 was blind-flanged (Figure 5-12). This configuration does not provide lateral restraint to the main JP-5 fuel line between Tanks 19 and 20, as was the case during the surge event, and no other lateral restraints were observed. The maximum lateral displacement of the main JP-5 fuel line towards Tank 19 was measured to be about 15 in. during the surge event, and the permanent displacement was about 6 in. (Figure 5-13) based on the visible damage to nearby ducting and the current position of the JP-5 pipeline.

During the surge event on 6 May 2021, lateral displacement of the main JP-5 fuel line caused significant tension in the Dresser coupling retention rods at Tank 20, potentially resulting in the retention lug failure. A similar retention lug failure was observed in the Dresser coupling at Tank 18. Tank 17 was under CIR on 6 May 2021, and the pipe to Tank 17 was blind-flanged during the surge event.

(b)(3)(A)

[redacted]

Figure 5-12 – Blind Flange at JP-5 Pipe toward Tank 19

[redacted]

Figure 5-13 – Lateral Displacement of JP-5 Fuel Line (between Tanks 19 and 20)

5.2.4 Intact Dresser Couplings

For comparison, Figure 5-14 shows the [redacted] and [redacted] Dresser couplings at Tank 16 were replaced in the early 2000s. The [redacted] Dresser coupling consists of three 3/4 in. diameter retention rods and each [redacted] Dresser coupling consists of eight 3/4 in. diameter retention rods. The retention lug plate thickness is 3/4 in. with 1/2 in. thick stiffeners (see Figure 2-15 for details). Fire protection jackets that are wrapped over calcium silicate insulation blocks are also visible in Figure 5-14. These passive fire protection elements are critical to maintaining the integrity of Dresser couplings in case of a fire. They have some components that are not heat resistant and can result in a fuel leak when subjected to high heat. During our visit, we observed that a Dresser coupling at Tank 10 did not have the fire protection jacket installed (Figure 5-15).

[redacted]

Figure 5-14 – [redacted] Dresser Couplings by Tank 16 (Replaced in the Early 2000s)

[redacted]

Figure 5-15 – Tank 10 Dresser Coupling without Fire Protection

Additionally, we noted the incorrect installation of Dresser coupling harness lugs and deflection rings (Figure 2-15, Figure 5-16, and Figure 5-17).

(b)(3)(A) [redacted]

Figure 5-16 – Harness Lugs at Dresser Coupling Installed Backward – F-76 Pipe

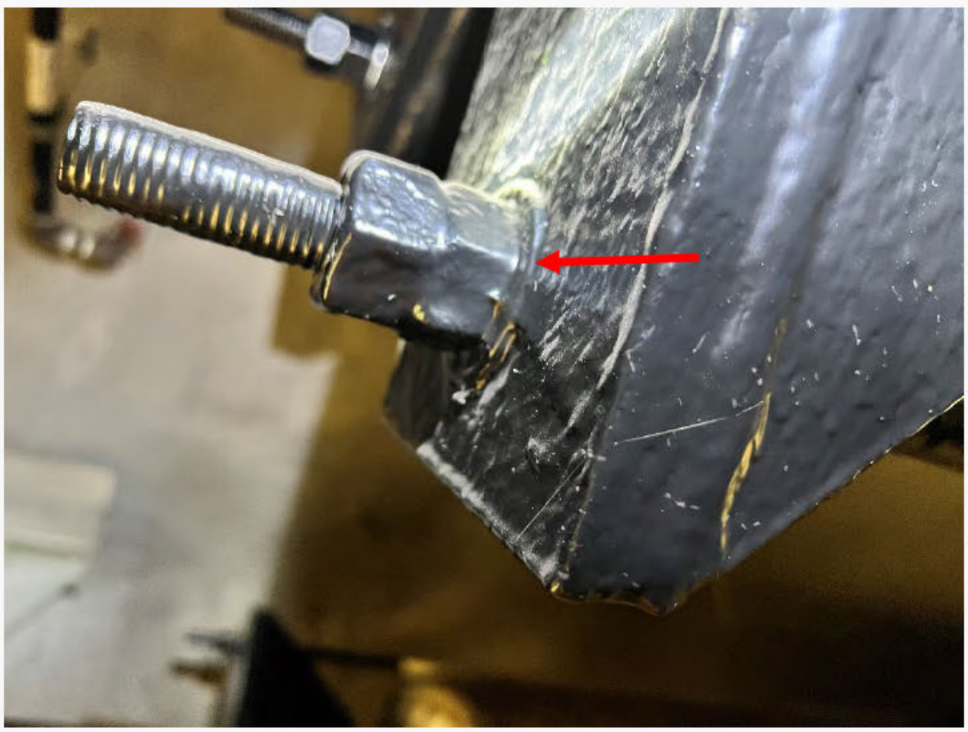

Figure 5-17 – Apparent Washer at Location of Dresser Coupling Deflection Ring – Tank 2

5.2.5 F-24 Pipeline at Concrete Anchors in Lower Access Tunnel

We performed a site walk in the lower access tunnel to ascertain if high point vents exist in the F-24 line at the downstream end of the two concrete anchor walls adjacent to Pipe Supports 24 (Figure 5-18) and 62 (Figure 5-19). We did not observe any high point vents in the F-24 line except at the end of the trunk line header adjacent to Tanks 15 and 16.

(b)(3)(A) [redacted] (b)(3)(A) [redacted]

Figure 5-18 – F-24 Bend at Concrete Anchor Wall (left), No Visible High Point Vent in F-24 Line Downstream of Concrete Anchor Wall (right) – Pipe Support 24

(b)(3)(A) [redacted] (b)(3)(A) [redacted]

Figure 5-19 – F-24 Bend at Concrete Anchor Wall (left), No Visible High Point Vent in F-24 Line Downstream of Concrete Anchor Wall (right) – Pipe Support 62

5.2.6 Mislabeled Piping and Tank 2 Product Contents

At Tanks 1 and 2, the JP-5 and F-24 lines are not tied together at the trunk line via a T-connection, as is the condition at laterals upstream; instead, they have individual laterals that extend to the Tank wall. Additionally, at Tanks 1 and 2, the F-76 line does not have a lateral branch to the tanks. We observed that the painted naming convention indicates that the two laterals to Tanks 1 and 2 are F-24 and F-76. We noted that the line named F-24 is tied to the JP-5 trunk line, while the line called F-76 is actually tied to the F-24 trunk line. In the OMES manual (Trinity Bhate and Pond, 2018), Tank 2 is documented as being full of F-24 (Figure 5-20), which would come via the pipe that is labeled F-76. From a site walk of the upper access tunnel, we observed that the digital display on Tank 2 notes the product as JP-8 (Figure 5-21).

(b)(3)(A) [redacted] (b)(3)(A) [redacted]

Figure 5-20 – Tank 2 Pipe Laterals Labeled F-76 and F-24 (left); Looking towards Tank 1 JP-5 and F-24 T-Connection (right)

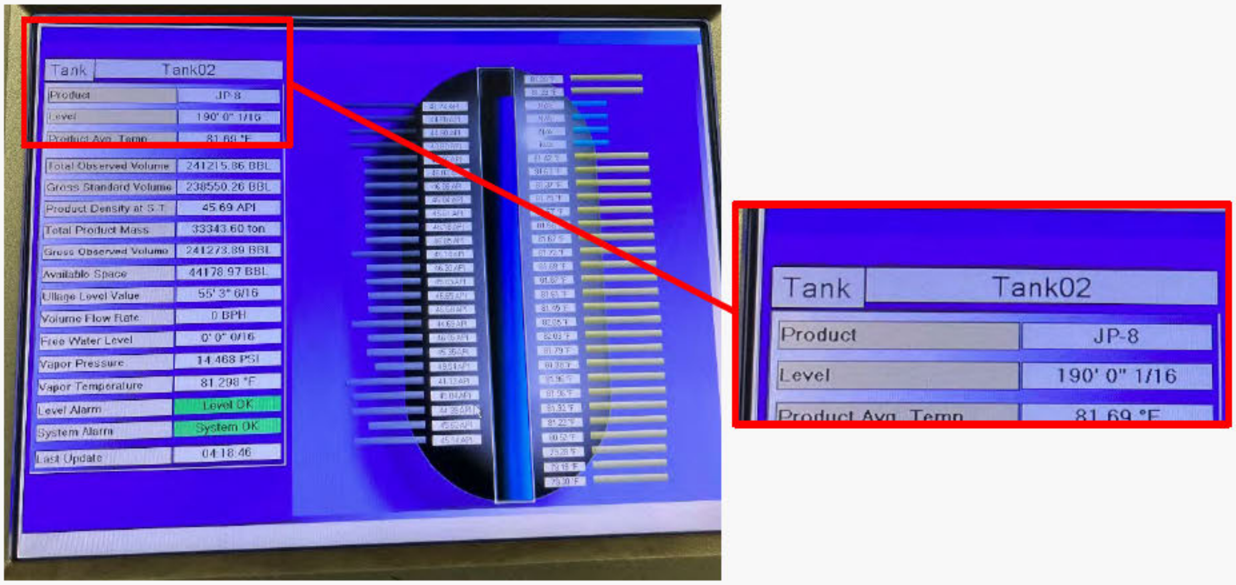

Figure 5-21 – Digital Display of Tank 2 Contents Note JP-8 Product

5.3 Pipe Supports and Pipe Racks

We performed numerous walkthroughs to visually inspect the components of the pipe supports located at the harbor (HT) and the lower access tunnels (LAT). We looked at different components, including pipe supports, pipes, cradles, valves, etc. We summarized the observed deficiencies and areas of concern in more detail in the tables that can be found in Appendix A. We conducted multiple site visits to document consistency with supports and dimensions as laid out on the drawings and determine where site conditions and supports varied between those originally present on the drawings and those in the current as-is condition.

5.3.1 Pipe Supports at Harbor Tunnel

We found a variety of different issues, such as the following:

- Improper vertical supports bearing on the pipe: Figure 5-22 shows an example at Pipe Support 138 where we noticed vertical support under the JP-5 pipeline bearing on the F-76 pipeline. This condition is repeated through Pipe Support 141. These vertical supports appear to replace the primary pipe supports as the horizontal leg of the primary pipe supports does not align with the JP-5 pipeline elevation.

(b)(3)(A) (b)(3)(A)

Figure 5-22 – Vertical Support Bearing on Pipe

- Corrosion of columns and base plates at numerous locations. Examples at two different locations are shown in Figure 5-23.

(b)(3)(A)

Figure 5-23 – Corrosion of Column Base Plate at Pipe Supports 510 (left) and 600 (right)

- Ponding of water along several pipes supports potentially leads to corrosion problems. We observed that water starts ponding near Pipe Support 550, and it stops near Pipe Support 567, as shown in Figure 5-24.

(b)(3)(A) [redacted] (b)(3)(A) [redacted]

Figure 5-24 – Water Ponding at Base of Pipe Support 550 (left) and Transition to Dry Region at Pipe Support 567 (right)

- Missing cradles and/or friction pads. Figure 5-25 shows an example in Pipe Support 651 where we noticed that the three pipes are bearing on the steel support without any layer of protection underneath, such as a cradle or a friction pad.

(b)(3)(A) [redacted]

Figure 5-25 – No Pipe Cradles at Pipe Support 651

Figure 5-26 – Corrosion of Pipe support: Base Plate and Column at No. 16 (a), Beam at No. 23 (b), Bottom of Column at No. 48 (c), and Bracing Member at No. 52 (d)

5.3.2 Pipe Supports at Lower Access Tunnel

We found a variety of different integrity and design issues, such as the following:

- Corrosion of base plates, beams, columns, and bracing members at numerous locations. Examples for each component with defects are shown in Figure 5-26.

- Missing braces at numerous locations: We noticed this condition at several locations, especially at the start of the lower access tunnel, near the galleries of Tanks 17 to 20. Figure 5-27 shows an example between Pipe Supports 3 and 8.

Figure 5-27 – Missing Braces Between Pipe Supports 3 and 8

- At Pipe Support 4, the pipe cradle for the JP-5 pipeline is present on one side only. This condition appears similar to that documented in the 2016 EEI report (Enterprise Engineering, Inc., 2016).
- Damaged bracing members at different locations: We observed damage to bracing members (excessive out-of-plane deformation) in some cases due to possible impacts. Examples at two different locations are shown in Figure 5-28.

Figure 5-28 – Damaged Bracing Members: Between Pipe Supports 39 and 40 (left) and between Pipe Supports 41 and 42 (right)

- Missing pipe cradles and supports: Examples of this condition are shown in Figure 5-29 and Figure 5-30. The unsupported pipe at Pipe Support 74, i.e. gap between the F-24 line and the pipe support beam in Figure 5-29, and the missing cradle condition at Pipe Support 6 (shown in Figure 5-30) appear unchanged from the conditions documented in the EEI 2016 inspection report (Enterprise Engineering, Inc., 2016) referenced in Section 2.3.2.

(b)(3)(A) [redacted] (b)(3)(A) [redacted]

Figure 5-29 – Lack of Pipe and Support Contact Under JP-5 Pipeline at Pipe Support 11 (left) and Under F-24 Pipeline at Pipe Support 74 (right)

(b)(3)(A) [redacted]

Figure 5-30 – Missing Cradle at JP-5 Pipeline at Pipe Support 6

- Damage to existing ventilation ducts caused by the lateral movement of unrestrained pipe dead-end is shown in Figure 5-31.

- Changes to the original design such as modifications to typical support types, Figure 5-32 (a) and (b), removal or reconfiguration of braces, Figure 5-32 (c), and relocation of columns, Figure 5-32 (d). Figure 5-32 (d) shows a clear example where we observed that this reconfiguration left a heavy elevated valve for the (b)(3)(A) [redacted] pipe insufficiently supported.

(b)(3)(A)
[redacted]

Figure 5-31 – Damage to Existing Ventilation Ducts at Pipe Support 1

(b)(3)(A)
[redacted]

(b)(3)(A)
[redacted]

(b)(3)(A)
[redacted]

(b)(3)(A)
[redacted]

Figure 5-32 – Reconfiguration of Pipe Supports 18 (a) and 19 (b), Removal of Braces Between Pipe Supports 26 and 27 (c), and Relocation of Columns Between Pipe Supports 47 and 48 (d)

- Out-of-plumb columns are shown in Figure 5-33.

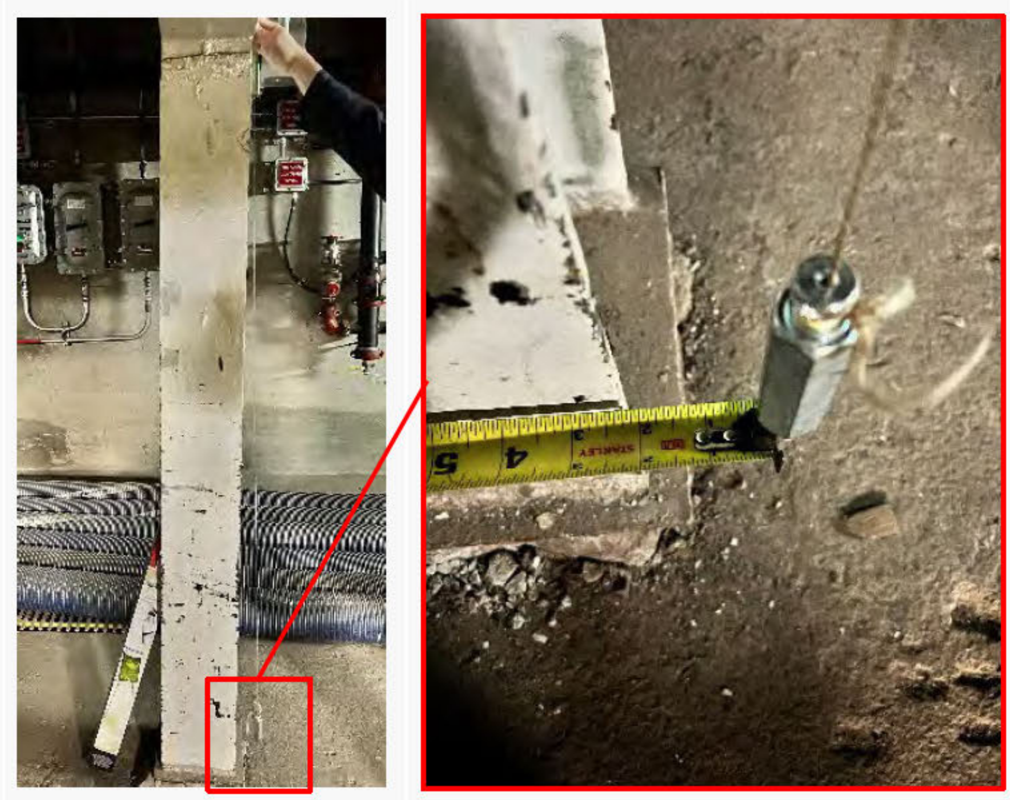

Figure 5-33 – Out-of-plumb Column at Pipe Support 6

- Cracking of protective encasement that appears to be gunite around columns shown in Figure 5-34Figure 5-34 .

Figure 5-34 – Encasement around Columns, Cracking by Tank 17

- Improper supports for special conditions where the pipelines change the configuration. Figure 5-35 shows an example where the JP-5 pipeline is rerouted under the concrete anchor.

(b)(3)(A) [redacted]

Figure 5-35 – Improper Support of JP-5 Pipeline Between Pipe Supports 26 and No. 27

- The impact risk for existing overhead drain valves in AFFF retention piping is shown in Figure 5-36.

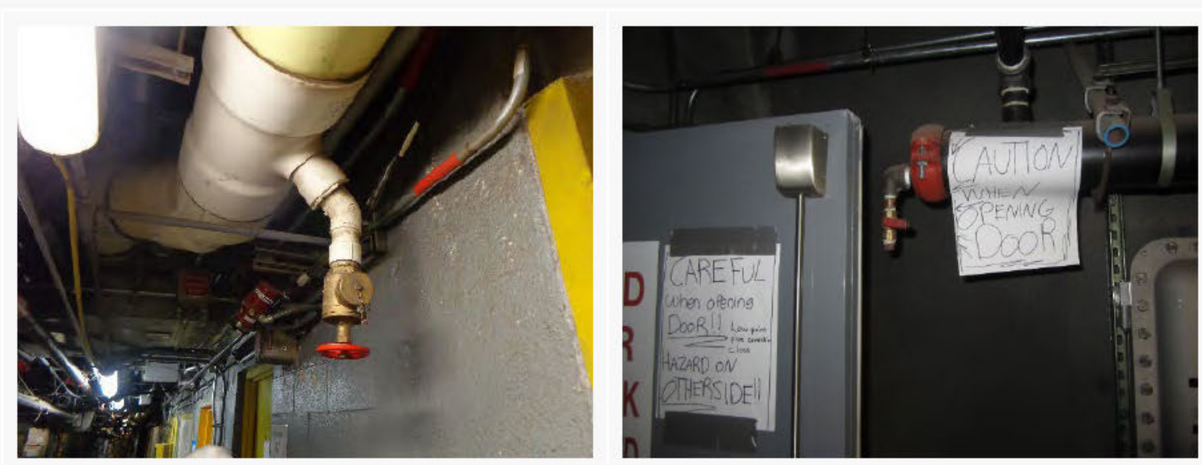

Figure 5-36 – Overhead Drain Valves in AFFF Retention Piping Between Pipe Supports 14 and 15 (left) and Between Pipe Supports 31 and 32

- Interference and clashing risk between components of different systems are shown in Figure 5-37.

(b)(3)(A)

[redacted]

Figure 5-37 – Interference Between Fuel Pipe Flange and Fire Suppression Valve Between Pipe Supports 47 and 48

- Leakage through the tunnel wall is shown in Figure 5-38.

Figure 5-38 – Leakage Through Tunnel Wall Between Pipe Supports 78 and 79

- We conducted a site walk of the lower access tunnel pipe supports where the pipe support beam penetrates the tunnel wall to ascertain the presence of an embedded steel column, as shown in Structural Drawing 294162 (Figure 2-26). We used ground penetrating radar (GPR) and the NDT method to locate steel in the tunnel wall. GPR sends a radar pulse through a substrate, in this case, a gunite layer overcoating a reinforced concrete wall. We used the GPR to validate the structural drawings where we understood an embedded steel column might exist. The GPR scans in Figure 5-39 confirm the presence of an embedded steel column at Pipe Support 57. In the left image, the white horizontal portion of the scan represents the straight flange portion of the exposed steel column; this scan was performed to establish a baseline reading for a steel column flange. A similar resulting scan is seen in the right image, which was scanned at the tunnel wall, i,e, no visible column.

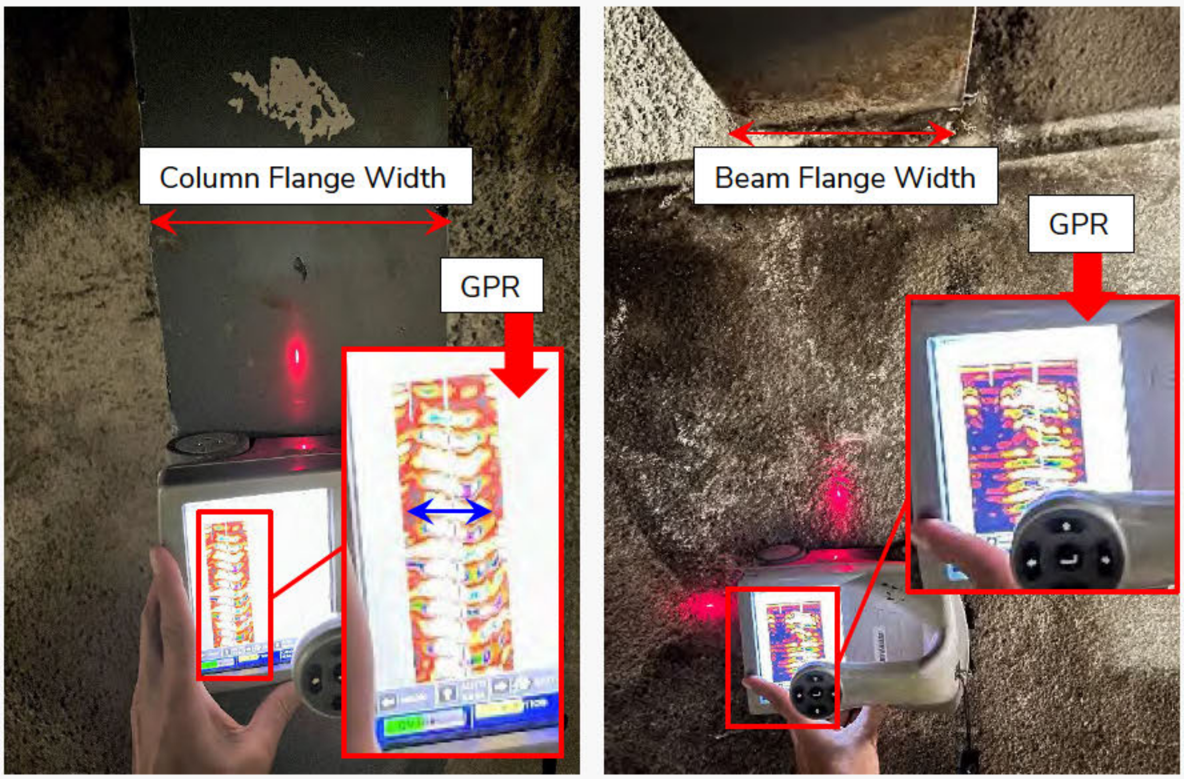

Figure 5-39 – GPR Scan of Exposed (left) and Embedded (right) Steel Column Flange (Blue Arrow Indicates Width of Steel)

5.3.3 Observations on Design Changes

We compared the existing drawings (Contractors, Pacific Naval Air Bases, 1942) to the current as-is conditions we observed during our walk downs. We recorded the differences between these conditions to incorporate them into our analysis. A summary of the inconsistencies is listed below.

- Drawings 294160 and 294163 do not show the pipe support configuration observed at Pipe Supports 1, 2, 3, 4, 8, and 10 to 13, where we observed that the span between columns is considerably larger than those of the other supports.

- Drawings 294160 and 294163 do not show the pipe support configuration observed between Pipe Supports 46 to 48, where we observed a heavy elevated valve that is potentially inadequately supported and anchored.

- Drawings 294160 and 294162 specify the member size of the bracing members as L3 in. x4 in. x 1/4 in. for only two bays adjacent to each tank gallery. The as-is bracing members are L2-1/2 in. x 2-1/2 in. x 5/16 in., and they extend to more than just two bays.

- Drawing 294162 shows the spacing between Pipe Supports 46 and 47 as 22 ft. Measurement of the as-is condition indicates that this spacing is only 16 ft.

- Drawing 294162 shows the spacing between Pipe Supports 47 and 48 as 21 ft. Survey of the as-is condition indicates that this spacing is only 5 ft.

- Drawing 294162 shows the member size for the column and beam components of the pipe support as W8 or W10 for all locations. However, we observed that most of the pipe supports were built with W8 sections, with the exception of the last pipe support right before each tank gallery, which was built using W10 sections.

- We observed that the cross-bracing members are connected at the midpoint by means of welds.

- We performed ultrasonic thickness measurements at several locations to spot-check the pipe thicknesses. The [redacted] pipe (F-76) is nominally 0.375 in thick, the [redacted] pipe (JP-5) is nominally 0.25 in. thick, and the [redacted] (F-24) is nominally 0.25 in. thick.

- Angle struts, as indicated in the design drawings connecting Pipe Supports 1 to 54 to each other, were not present; rather, pipe supports were typically connected by pairs of braces.

5.4 Ventilation System in the Red Hill Tunnels

An electrical classification study was carried out by Austin Brockenbrough in 2014. Based on several code requirements, electrical equipment does not need to be designed for hazardous areas if a certain quantity of ventilation/air volume changes per minute occurs. The ventilation fans at the Facility are backed up, per facility personnel, with emergency generators at various locations on Red Hill.

It was observed that a transformer and other "main" switchgear are located inside of the LAT. This equipment is inside a "drywall" enclosed room with ventilation into the room. During our walk down, it was noticed that the ventilation does not provide positive pressure, and therefore, there can be fire and explosion hazards within the rooms. A recommendation to move this equipment out of the tunnel was discussed during the HAZOP (Appendix B), during which it was noted that a study may already be underway to accomplish this (Table 8-3 Item 30).

5.5 Pumphouse

We visited the pumphouse to visually inspect the control room, pumps, valves, pipelines, pipe supports, and other components. We summarized the important observations in the tabulated format in Appendix A.

We observed a variety of different issues, such as the following:

- The existing interior window of the control room, which is facing the pump gallery, is not blast-resistant (Figure 5-40). Operators should be protected against a blast event. Also, control room staff would be at risk in the case of a hydrocarbon release from the pumps, valves, or flanges in this area. There can also be fire risks in this area. Blast and fire resistance of the wall and door facing the pump gallery can also be critical to protecting the control room occupants and the functionality of the equipment.

Figure 5-40 – Interior Window, Wall, and Door at Control Room (Facing Pump Gallery)

- We found a cabinet with flammable materials that are unanchored (Figure 5-41). This cabinet could overturn during an earthquake or if impacted. Cabinets throughout the Facility storing flammable or toxic materials should be anchored or laterally restrained to prevent overturning.

Figure 5-41 – Unanchored and Unrestrained Cabinet in Pumphouse

- We observed some flanges with bolts that were not fully engaged (Figure 5-42).

(b)(3)(A)

Figure 5-42 – Flange with Short Bolts

- The diesel tank that is part of the backup generator for the pumphouse (b)(3)(A) [redacted] is likely unanchored. If it is unanchored, the backup generator may not function following an earthquake due to a rupture of the attached diesel piping (Figure 5-43).

Figure 5-43 – Unanchored Diesel Tank for Emergency Generator

5.6 Surge Tanks

We conducted a site visit to the surge tank area adjacent to the pumphouse on 20 January 2022. The surge tanks were filled with fuel during our visit. Therefore, we were not able to see the inside of the surge tanks. Figure 5-44 shows several photos taken from the surge tank tunnel showing the outside of the tanks.

(b)(3)(A) [redacted]

Figure 5-44 – Photos of the Surge Tank Tunnel

5.7 Aboveground Storage Tanks

5.7.1 Site Visits

We conducted visited the following aboveground storage tanks (ASTs) on January 21 and 14 February 2022:

- Tanks 46, 47, 58, 53, 54, and 55 located at the Upper Tank Farm.
- Tanks B1 and B2 located at Fuel Oil Reclamation Facility (FORFAC).
- Horizontal Tanks 1811 and 1812 located at Lube Oil Facility.
- Tank 301 located near the Lube Oil Facility.
- Tanks 311 and AFFF Storage Tank located near the entrance to Red Hill tunnels at ADIT 3.
- Tanks 11-1, 11-2, 11-3, and 11-4 located at Hickam Field.
- Horizontal Tanks 5-1, 5-2, 9-3, and 9-4 located at Hickam Field.

The locations of these aboveground storage tanks are shown in Figure 5-45, Figure 5-46, and Figure 5-47.

(b)(3)(A)
[redacted]

Figure 5-45 – ASTs at Upper Tank Farm, FORFAC, Lube Oil Facility, and Tank 301

(b)(3)(A)

[redacted]

Figure 5-46 – Tank 311 and AFFF Tank near the Tunnel Entrance at ADIT 3

(b)(3)(A)

[redacted]

Figure 5-47 – ASTs Located at Hickam Field

Table 5-3 and Table 5-4 present a tank data summary for the vertical above-ground storage tanks (based on name plate data, inspection reports and drawings).

Table 5-3 – Above-Ground Storage Tanks – Design Data Summary

Location	Upper Tank Farm						FORFAC	
Tank ID	**46**	**47**	**48**	**53**	**54**	**55**	**B1**	**B2**
Diameter	164'-0"	164'-0"	164'-0"	164'-0"	164'-0"	160'-0"	60'-0"	60'-0"
Height	38'-5"	40'-0"	40'-0"	39'-11"	40'-0"	42'-0"	21'-9"	21'-9"*
Anchored (A) / Unanchored (U)	U	U	U	U	U	U	U	U
New Double Bottom	Yes	Yes	Yes	Yes	Yes	No***	Yes	Yes**

* Tank drawings indicate a significantly larger height than 21'-9", but on-site observation indicates the height for Tank B2 is similar to that for Tank B1 (21'-9").

** Tank B2 is currently under CIR, and the new double bottom is to be installed.

*** Original Tank 55 was replaced in 1978 with welded steel construction.

Table 5-4 – Aboveground Storage Tanks – Design Data Summary (cont'd)

Location	Near Lube Oil Facility	Entrance of Adit 3		Hickam Field			
Tank ID	**301**	**311**	**AFFF**	**11-1**	**11-2**	**11-3**	**11-4**
Diameter	42'-0"	21'-0"	33'-0"	93'-0"	93'-0"	63'-0"	63'-0"
Height	24'-0"	16'-0"	25'-0"	48'-0"	48'-0"	54'-0"	54'-0"
Anchored (A)/ Unanchored(U)	A	A	U	U	U	A	A
New Double Bottom	No	No	No	No	No	No	No

5.7.2 Observations

In the UTF, we noted that the original riveted Tank 55 was replaced with a welded steel tank (Figure 5-48) in 1978. The remaining five tanks (Tanks 46, 47, 48, 53, and 54) in the UTF consist of riveted steel construction from the original 1920s, but the rivets and shell plates are now welded in place. We also observed a new double bottom was installed for these five tanks. As an example, Figure 5-49 shows the riveted steel construction and new double bottom plate for Tank 46. The new double bottom plate is about 14 in. from the grade level (see a close-up view in Figure 5-49).

Figure 5-48 – Original Riveted Tank 55 was Replaced with New Welded Steel Tank in 1978

Figure 5-49 – Riveted Steel Construction and New Double Bottom (Tank 46)

We performed UT and DFT measurements of Tanks 47 and 55 (Table 5-5). At Tank 47, we evaluated the steel tank wall and coating thicknesses in the vicinity of observed corrosion at the double bottom rim plate. We additionally measured pit depths at the corroded tank wall. At Tank 55, we evaluated the steel tank wall and coating thicknesses at an elevation approximately equal to that of the Tank 47 measurement. There was no observed corrosion at the Tank 55 steel tank wall.

Table 5-5 – UT and DFT Measurements from Tanks 47 and 55 at the UTF

Tank No.	Measurement Instance	UT Measurement Steel (in)	DFT Measurement (mil)	Pit Depth (in)
47	1	0.956	4.8	-
	2	0.98	0	0.04
55	1	0.834	2.07	-
	2	0.811	0.212	-
	3	0.802	0.529	-
	4	0.806	1.659	-

In the Fuel Oil Reclamation Facility, Tank B1 has a new double bottom plate, while Tank B2 is currently under CIR, and a new double bottom plate is under construction (Figure 5-50).

Figure 5-50 – New Double Bottom Plate under Construction (Tank B2, FORFAC)

During the site visits, we made some observations regarding the performance of the above-ground storage tanks during a potential earthquake event. Several examples are described below. See Appendix A for our detailed observations of all the above-ground storage tanks.

- Tank 55, Upper Tank Farm – Potential concern due to overconstrained piping. The first pipe support adjacent to the tank shell constrains the uplift of the attached piping and is bolted to the concrete (Figure 5-51). The overconstrained piping could cause potential tank damage and loss of contents in the event of tank uplift during an earthquake event.

(b)(3)(A) [redacted]

Figure 5-51 – Overconstrained Piping (Tank 55, Upper Tank Farm)

- Tank 47, Upper Tank Farm – Corrosion above the new tank double bottom (Figure 5-52). Corrosion damage could lead to failure and loss of product if not addressed.

Figure 5-52 – Corrosion of Shell at New Double Bottom (Tank 47, Upper Tank Farm)

- Tanks 11-1 and 11-2, Hickam Field – Potential concern due to overconstrained piping. The first pipe support adjacent to the tank constrains the uplift of the attached piping. The guide observed during our visit would allow for longitudinal (but not vertical) movement (Figure 5-53). The overconstrained piping could cause potential tank damage and loss of product in the event of tank uplift during an earthquake event.

(b)(3)(A) [redacted] (b)(3)(A) [redacted]

Figure 5-53 – Overconstrained Piping (Tanks 11-1 and 11-2, Hickam Field)

- All the horizontal tanks (Tanks 1811 and 1812 at the Lube Oil Facility, and Tanks 5-1, 5-2, 9-3, and 9-4 at Hickam Field) appeared to be adequately anchored, and there was no evidence of significant corrosion in the attached piping. Figure 5-54 shows adequate anchorage for Horizontal Tanks 1811 and 1812.

Figure 5-54 – Anchorage for Horizontal Tanks 1811 and 1812

5.8 Pumps and Valves

5.8.1 Lower Access Tunnel Main Tank Valves

The critical valves on Red Hill are in the LAT adjacent to the tanks and are the main tank valves; an inboard valve, sometimes referred to as the “skin” valve and an outboard valve. These valves are in a double-block and bleed arrangement (Figure 5-55). The term “double block and bleed” refers to an arrangement when the two valves are closed, the space between the valves is drained, and any “leak-by” of the valves, which is routed to a closed drain system, is an indication that the in-board valve or “skin” valve is not sealing. Leak-by would trigger an investigation to determine the best course of action to repair the valve.

As shown in Figure 5-55, the valves are mounted in the overhead piping that is painted black, and the valve stems extend downward for access to the local valve actuator controls. These valves are also operated remotely from the control room adjacent to the underground pumphouse.

(b)(3)(A) [redacted] (b)(3)(A) [redacted]

Figure 5-55 – Valves Mounted in Overhead Piping, MTV-1 (left) and MTV-2 (right)

During the visit to the LAT, it was observed that the main tank valves were not equipped with pressure equalization lines. In general, high-energy valves are recommended to be pressure equalized prior to the opening, which is a common practice in the oil and gas and chemicals industries.

Discussions during the site visit and the HAZOP regarding the 6 May 2021 incident seem to indicate that a vacuum formed in the product line when line "sag" occurs may have been a contributor to the 6 May 2021 event. Since the 6 May 2021 event, the Red Hill fuel team has adopted a procedure to clear this vacuum by attaching a flexible hose to the high point vent of the product line and the FOR-sump system (Figure 5-56). The high point vent valve is opened to relieve the vacuum with ambient air. Once the vacuum is relieved, the outboard main tank valve is slowly "cracked" open or "throttled" to allow fuel to enter the product line and displace the air from the high point vent and into the FOR-sump system. Once fuel is observed through a sight-glass in the vent line, the high point vent valve and the main fuel valve are closed.

(b)(3)(A) [redacted]

Figure 5-56 – High Point Vent Connection (left) and Vent Connection to FOR Sump System (right)

The main fuel valves (inboard and outboard) are not recommended to be used as throttling valves as they are on-off isolation valves.

5.8.2 Lower Access Tunnel Sectional Valves

There are several "sectional" valves in the main product piping in the LAT and at the end of the HT (Figure 5-57). Figure 5-57 shows a typical sectional valve, and all the sectional valves appear to be in good condition as no visible leaks were observed during our visit. (Note: The internal condition of these valves is not known.)

There are sectional valves for each product line, and there are three sectional valves in the F-76 product line, three sectional valves in the JP-5 product line, and two sectional valves in the F-24 product line.

(b)(3)(A)

[redacted]

Figure 5-57 – Sectional Valve in Harbor Tunnel

5.8.3 Lower Access Tunnel Main Sump

The main sump in the lower access tunnel is equipped with two parallel operated positive displacement pumps that discharge to the FOR storage tank (Figure 5-58). These main sump pumps have been operating satisfactorily, according to the fuel team personnel's comments during the site visit.

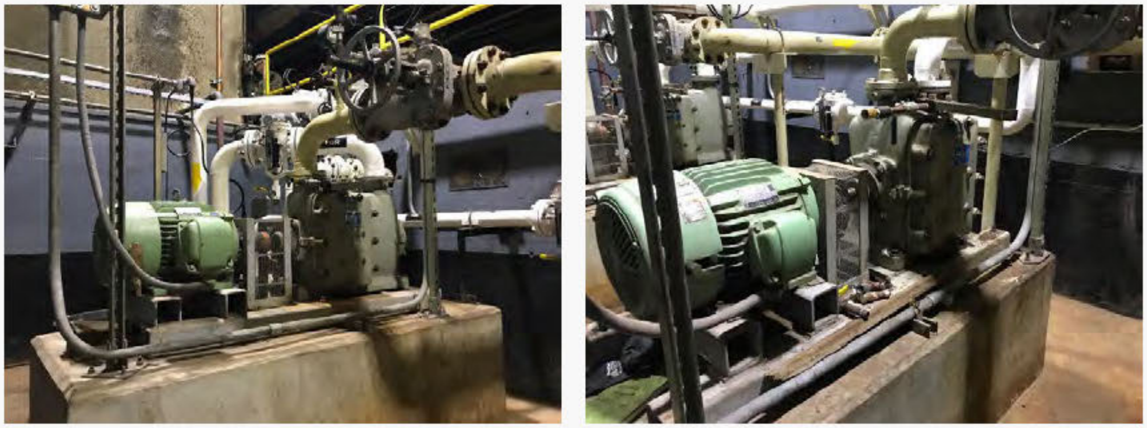

Figure 5-58 – Main Sump Pumps, MSP-1 (left) and MSP-2 (right)

5.8.4 Fire Suppression Systems

The LAT was retrofitted with an AFFF fire suppression system in 2019. There are five AFFF riser stations in the LAT that supply the fire suppression foam in the event of a fire. At each riser station, there is an AFFF sump for a total of five AFFF sumps (Figure 5-59). Each AFFF sump is equipped with five AFFF sump pumps and one groundwater pump.

At the time of the site visit, the fuel team personnel indicated that the AFFF fire suppression system was active, but the AFFF sump pumps were “locked out” because of technical problems with the sump pump operation.

The UAT is supplied with a network of water sprinklers (no AFFF foam). The water supply for the sprinkler system is from the main fire suppression pumphouse located outside of the Red Hill tunnel system, where the main water pumps and AFFF pumps are located (Figure 5-60).

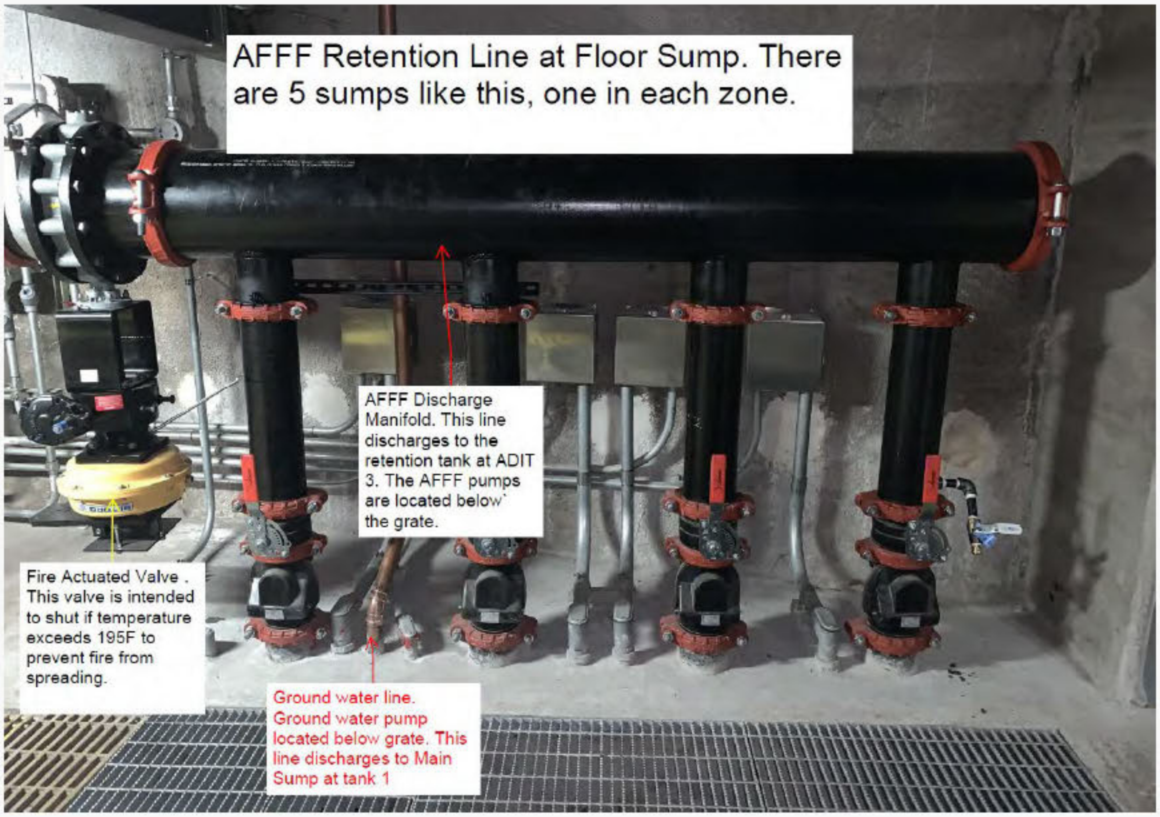

Figure 5-59 – AFFF-1 Retention System (from AFFF O&M Manual with Annotation)

Figure 5-60 – AFFF Pumps in Main Fire Suppression Pumphouse

5.8.5 Underground Pumphouse Main Pumps

The underground pumphouse is the location for the main fuel pumps that are used to pump fuel into the Red Hill storage tanks. There are [redacted] pumps in total: [redacted] (b)(3)(A) Figure 5-61. The first pump in Figure 5-61 (left) is one of the F-76 main pumps, and the first pump in Figure 5-61 (right) is one of the JP-5 main fuel pumps. The JP-5 main fuel pumps are between the F-76 and F-24 main fuel pumps.

The three products are delivered at different flow rates, and thus, the pumps are different for each fuel product. The pump data for each fuel type is provided in Table 5-6.

Table 5-6 – Main Fuel Pump Data

(b)(3)(A)

The main fuel pumps appear to be in good condition. The pumps are the original pumps but were refurbished in the 1980s, and new electric motors were installed at that time.

These pumps are planned to be replaced with new centrifugal pumps and motors in the near future based on the feedback from facility personnel.

(b)(3)(A) (b)(3)(A)

Figure 5-61 – Underground Pumphouse Pumps

5.8.6 Underground Pumphouse Valves

The underground pumphouse is equipped with numerous valves to facilitate the movement of fuel into and out of the Red Hill storage tanks (Figure 5-62). These valves appear to be in good condition from an external visual inspection. Again, the internal condition of the valves is unknown.

(b)(3)(A) [redacted]

Figure 5-62 – Underground Pumphouse Valves

Of interest are the “T-Valves” that are located near (b)(3)(A) [redacted], and Figure 5-63 shows one of the T-valves on the F-76 product line.

During the HAZOP, the fuel team personnel commented that the “T-valves” are used to “hold” the fuel in the product lines, and these valves are suspected of “leaking-by” and may therefore be a contributor to the line sag that leads to the vacuum forming at the upper end of the product lines.

The fuel team personnel added that the level in the surge tanks is monitored, and at times, a noticeable increase in surge tank level occurs because of the T-valve leak-by.

The T-valves are butterfly valves, which are recommended for flow control or throttling but not for holding pressure in the main product lines.

(b)(3)(A)

[redacted]

Figure 5-63 – Underground Pumphouse Butterfly Valve (T-Valve)

5.9 Marine Facilities

While performing observations of the fueling and the defueling systems at JBPHH piers, we observed structural conditions adjacent to the piping, pipe supports, and valves. These observations do not constitute a 100% above-water inspection. Markings "By Others" on structural elements, i.e., measurement notations and spray paint around discrete structural areas, indicate previous inspections noted these conditions as well.

5.9.1 Hotel Pier

Some examples at Hotel Pier include delaminated bent caps Figure 5-64. We also observed a yellow PVC line at multiple penetrations above the deck. This pipe is part of the collection system for spills and fluid within the trough that contains the fuel pipe.

(b)(3)(A)

Figure 5-64 – Apparent Delaminated Concrete at Pile Bent Cap – Hotel Pier

Figure 5-65 – PVC FOR Pipe Under Hotel Pier

5.9.2 Kilo Pier

While performing our below deck inspection of Kilo Pier, we observed an active leak at a potable water pipe. The pipe leak was at an apparent repair clamp. Adjacent to the leak is corroded sections of the water pipe. The plastic-wrapped fuel pipe is outboard of the potable water pipe and is in the spray zone.

We additionally observed instances of concrete spalls and exposed reinforcing at square concrete piles (Figure 5-67).

We were informed that a section of the Kilo Pier pipe was repaired after a leak. The clamp at the repair location was re-wrapped and, therefore, not accessible for observation.

[redacted] (b)(3)(A)

Figure 5-66 – Leaking Water Pipe – Kilo Pier

[redacted]

Figure 5-67 – Spalled Concrete and Exposed Reinforcing at Pile – Kilo Pier

5.9.3 Sierra Pier

Sierra Pier is used as a FOR transfer pier. The pier is supported on square piles and reinforced concrete bent caps. The FOR pipe is below deck and wrapped in a black and white striped wrap and supported via suspension hangers tied back to the reinforced concrete bents. We observed a few locations of cracking and delamination at the corners of piles Figure 5-68. Previous pile repairs encased and enlarged the original piles, with the formwork remaining post-repair (Figure 5-69).

Figure 5-68 – Crack in Square Pile – Sierra Pier

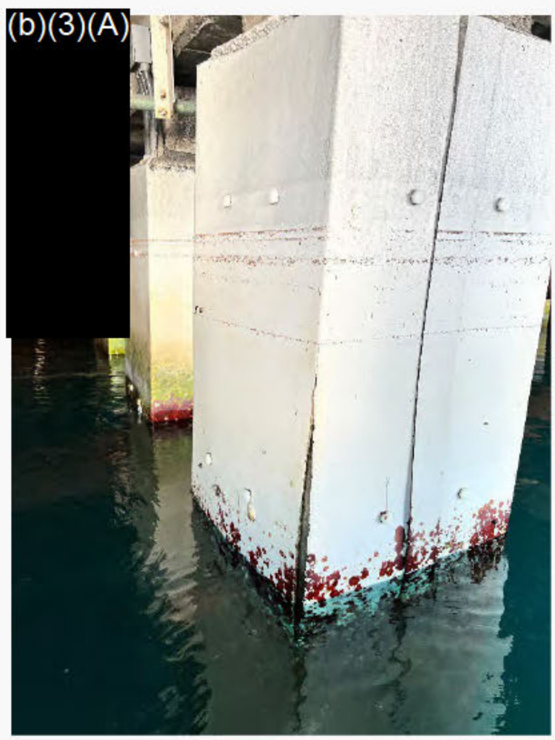

Figure 5-69 – Enlarged and Encased Square Pile – Sierra Pier

5.9.4 Mike Pier

There are repeated instances of exposed rebar on beams (Figure 5-70 and Figure 5-72) and the underside deck (Figure 5-71) at Mike Pier. We performed observations between piles where ladder access from the topside of the deck allowed, where our kayak could enter between the bents, and where topside penetrations facilitated below deck viewing. At multiple locations, we noted spalled concrete and exposed reinforcing at the underside of the deck (Figure 5-72). Delaminated concrete/gunite at the underside of the deck has been spray-painted around its perimeter to highlight (by others) the deficiency; delaminated areas appear to be locations of previous repairs (Figure 5-73).

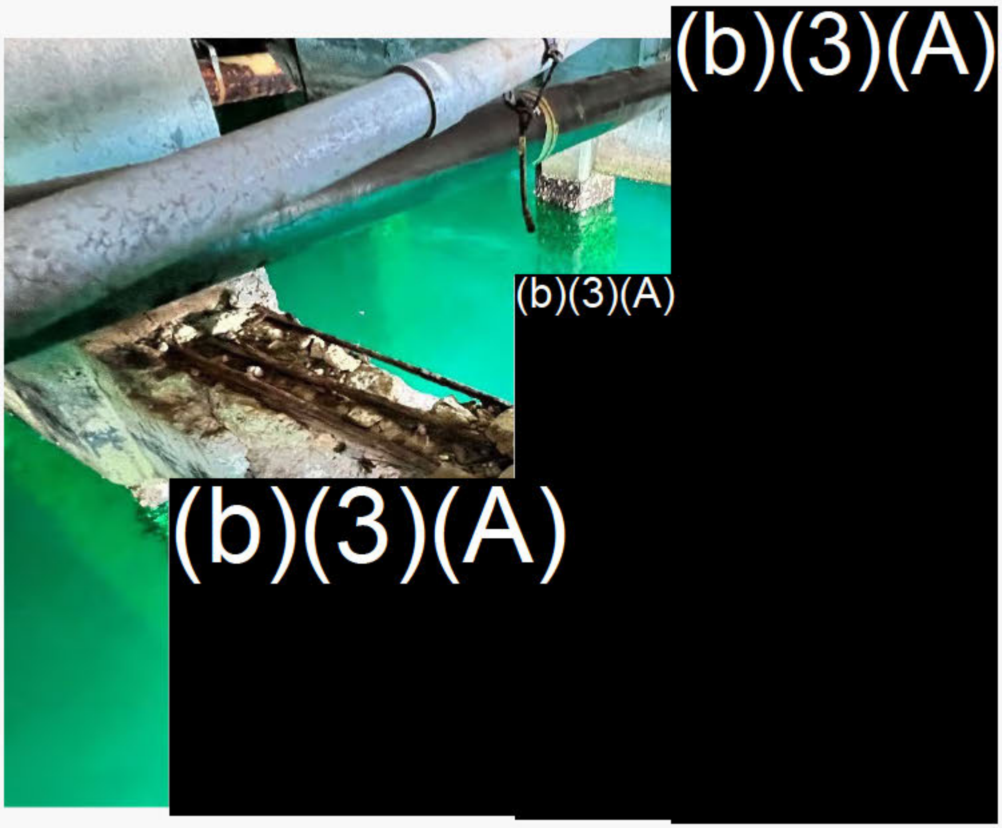

Figure 5-70 – Spalled Concrete and Exposed Reinforcing at Pipe Support Beam – Mike Pier

[redacted]

Figure 5-71 – Spalled Concrete and Exposed Reinforcing at Tie-Beam between Bents – Mike Pier

Figure 5-72 – Spalled Concrete and Exposed Reinforcing at Deck Underside – Mike Pier

Figure 5-73 – M2 Below Deck – Mike Pier

5.9.5 Bravo Pier

We performed a site walk along the underside of the deck at Bravo Pier (approximately along B22 to B24) via the catwalk access. We observed previous repairs to the underside of the deck. Blue coating over strips running parallel to shore, i.e., spanning between bents and around the perimeter of the exposed deck face (Figure 5-74). We observed the fuel pipe resting on the flange of another pipe, with the fuel pipe wrap disturbed (Figure 5-75). We also observed corrosion and deterioration on the sheet pile wall behind the interior row of piles (Figure 5-76).

Figure 5-74 – Previous Underside Deck Repair – Bravo Pier

(b)(3)(A)

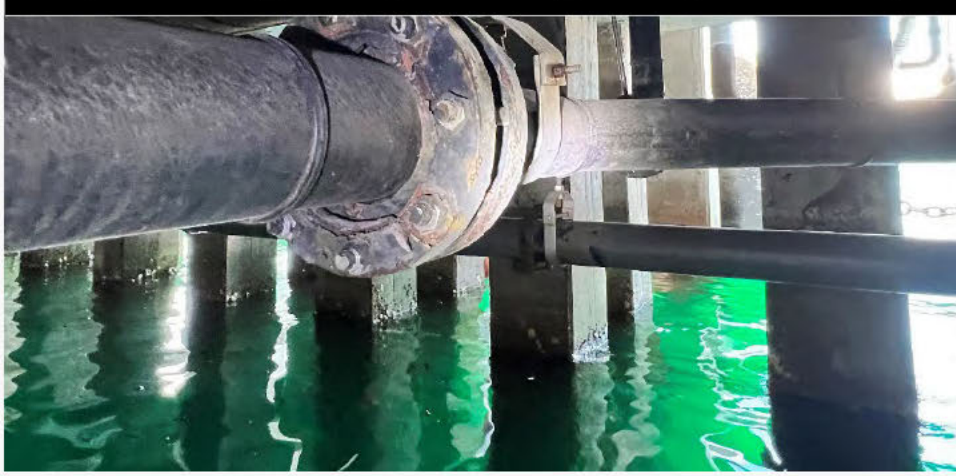

Figure 5-75 – Fuel Pipe Resting on the Flange of a Lower Pipe – Bravo Pier

Figure 5-76 – Deteriorated Sheet Pile Wall Behind Interior Piles – Bravo Pier

5.10 Corrosion and Coatings Maintenance

Between 19 January and 18 February 2022, a NACE-certified Corrosion Specialist from SGH conducted a visual corrosion assessment of the exterior of the fuel pipes and associated equipment between the lower tank gallery and the fuel piers, including the UTF. At areas of significant coating degradation and localized pitting corrosion, we measured the section loss using a pit depth gauge and/or a UT (ultrasonic thickness) gauge.

5.10.1 Above-Ground Storage Tanks

The coating of the above-ground storage tanks is generally in good condition with no significant deterioration or corrosion loss. However, at Tank 47, the rim around the newly installed tank double bottom is sloped towards the tank, resulting in standing water against the tank wall. This is causing deterioration of the coating and pitting corrosion of the tank wall at discrete locations around the tank circumference (Figure 5-77).

Figure 5-77 – Pitting Corrosion above Tank Double Bottom Plate Rim at Tank 47

5.10.2 Pipes and Supports

5.10.2.1 Lower Tank Gallery

The pipes in the lower tank gallery appear to be in good condition, with limited visible pitting on the external surfaces or coating degradation. However, we noticed that several of the pipe supports in this area were corroded, particularly Pipe Supports 47 and 48 (Figure 5-78), together with attached diagonal braces. We suspect this was due to a leaking hose in the past (there is an adjacent drain line hose outlet) as no other supports in this area were corroded, and there is no visible water infiltration at the ceiling of the tunnel. The corroded sections are coated, suggesting that the corrosion has been mitigated in the past without renewing the structural metal. This condition is similar to that documented in the EEI 2016 inspection report (Enterprise Engineering, Inc., 2016) referenced in Section 2.3.2. This indicates that recent corrosion has been suspended, although the pipe support remains unrepaired.

Figure 5-78 – Corroded Section of Pipe Support and Diagonal Brace (Pipe Support 47)

5.10.2.2 Harbor Tunnel

We conducted several inspections of the [redacted] (b)(3)(A) [redacted] (b)(3)(A) and [redacted] (b)(3)(A) fuel lines that run from [redacted] (b)(3)(A) [redacted] (b)(3)(A) The majority of the length of these pipes is wrapped in a bituminous cloth, but there are several sections of what appears to be an older black epoxy coating and a more recent white repair coating.

In the lower half of the Harbor Tunnel, we observed numerous locations of water infiltration from the tunnel ceiling that drip water directly onto the pipes. Attempts have been made to prevent the water from dripping onto the pipe using stainless steel sheets as water shields, but it often appears that the water can bypass these shields. This water infiltration has resulted in the complete loss of a section of several pipe wall brackets (e.g., Pipe Supports 304, 304, and 310) and at the base of Pipe Supports 310, 313-317, 324, 326, 492, 493, 510, 560, 565, and 600.

We observed deterioration of the wrap coating, particularly at locations of water infiltration to the tunnel (Figure 5-79). We cleaned the corrosion products from the surface at these locations using a wire brush and observed the surface pitting of the steel (Figure 5-80). In general, the depth of these pits is shallow, with a maximum pit depth of less than 0.0625 in.

[redacted]

Figure 5-79 – Failure of Pipe Wrap at Pipe Support 107

Figure 5-80 – Pitting at Pipe Surface at Pipe Support 308

We observed that a white coating had been applied to the pipes at areas of water infiltration. There does not appear to be a primer applied beneath this coating. At multiple locations, this repair coating is starting to crack and spall from the surface (Figure 5-81).

(b)(3)(A) [redacted]

Figure 5-81 – Failure of Repair Coating at Pipe Support 277

Along the harbor tunnel, we observed approximately twenty dents in the fuel pipes. (e.g., adjacent to Pipe Supports 166, 211, 229, 258, 370, 401, 414, and 533). These appear to have been reported in the API inspection reports discussed in the literature review but not repaired.

We noted several instances of coating failure at pipelines and pipe flanges; see an example in Figure 5-82.

(b)(3)(A) [redacted]

Figure 5-82 – Coating Failure at Pipe Flange Between Pipe Supports 92 and 93

Detailed information, including specific locations, can be found in Appendix A.

We observed repetitive occurrences of leakage through the tunnel wall onto the fuel, oil, reclamation (FOR) pipeline that runs close to the ground between Pipe Supports 102 to 200. Wall brackets supporting conduit pipe are heavily corroded and direct leakage onto the FOR pipe. The FOR pipe coating is damaged, and surface corrosion is evident on the surface of many sections of pipe. In one instance, there appeared to be lamellar corrosion from their crown (Figure 5-83).

Figure 5-83 – Coating Issues and Apparent Lamellar Corrosion at FOR Pipe (Pipe Support 124)

We observed a similar instance at Pipe Support 146 (Figure 5-84).

Figure 5-84 – Cracking in Exterior Surface of FOR Pipe – Pipe Support 146

We observed coating failure at different components, including pipes and pipe flanges. Examples at two different locations are shown in Figure 5-85. We also observed dents on pipelines at numerous locations. Examples at two different locations are shown in Figure 5-86.

(b)(3)(A) [redacted] (b)(3)(A) [redacted]

Figure 5-85 – Coating Degradation on Pipeline at Pipe Supports 217 (left) and 543 (right)

(b)(3)(A) [redacted] (b)(3)(A) [redacted]

Figure 5-86 – Dents on Pipeline at Pipe Supports 221 (left) and 414 (right)

5.10.2.3 Pumphouse

We did not observe any deterioration of pipe coatings or pipe corrosion within the pumphouse.

5.10.2.4 Hickam Aboveground Pipes and Pumphouses (Ewa and Diamond Head)

The fuel pipes at the Hickam location are stainless steel, compared to the coated carbon steel pipes at the rest of JBPHH. Manufacturers' stamps on the pipe flanges indicated that the material is Type 304L stainless steel. We did not observe a material stamp on the pipe sections.

We observed minor streaks of surface discoloration on the pipe surfaces both outdoors (Figure 5-87) and indoors (Figure 5-88) in the pumphouses. We note that this corrosion is more advanced in the indoor environment. This discoloration is typical of Type 304 and 304L steel in a marine environment, where local depassivation of the surface occurs due to the high chloride environment from rainwater and dispersed aerosols from breaking waves. We observed that this discoloration is particularly concentrated at weld locations (Figure 5-89). However, we did not observe any of the deep pits or microcracks, which have been reported in stainless steel fuel pipes in the Guam Anderson facility (reference), which is a similar marine environment.

[redacted] (b)(3)(A)

Figure 5-87 – Surface Corrosion on Outdoor Stainless Steel Pipe – Hickam

[redacted] (b)(3)(A)

Figure 5-88 – Surface Corrosion on Indoor (Pumphouse) Stainless Steel Pipe – Hickam

[redacted]

Figure 5-89 – Corrosion Concentrated at Weld Seams on Outdoor Stainless Steel Pipe – Hickam

5.10.2.5 Above-Ground Pipes

We inspected the piping sections from the pumphouse to the fuel piers. We note that much of the piping in this downstream of the pumphouse is buried, which is discussed in the literature review of the cathodic protection reports.

In general, the coating of the above-ground pipes is well maintained. There are occasional areas difficult to reach where the coating is deteriorating, such as the slope [redacted] (Figure 5-90). There are several locations along the pipes adjacent to [redacted] where corrosion pits are present on the surface, but these have been covered by a coating (Figure 5-91).

We observed numerous locations where crevice corrosion is occurring between the pipe and pipe supports (Figure 5-92 and Figure 5-93).

The design of pipe supports is inconsistent across the Facility. At some locations, the pipe support is raised from its base and a curved plate seal welded around the pipe to eliminate crevices, thus providing protection from crevice corrosion. At other locations, however, the pipe is sitting on curved support, which traps water between the support and pipe, causing aggressive corrosion in this marine environment.

[redacted] (b)(3)(A)

Figure 5-90 – Coating Failure on Fuel Pipe at Upper Tank Farm [redacted] (b)(3)(A)

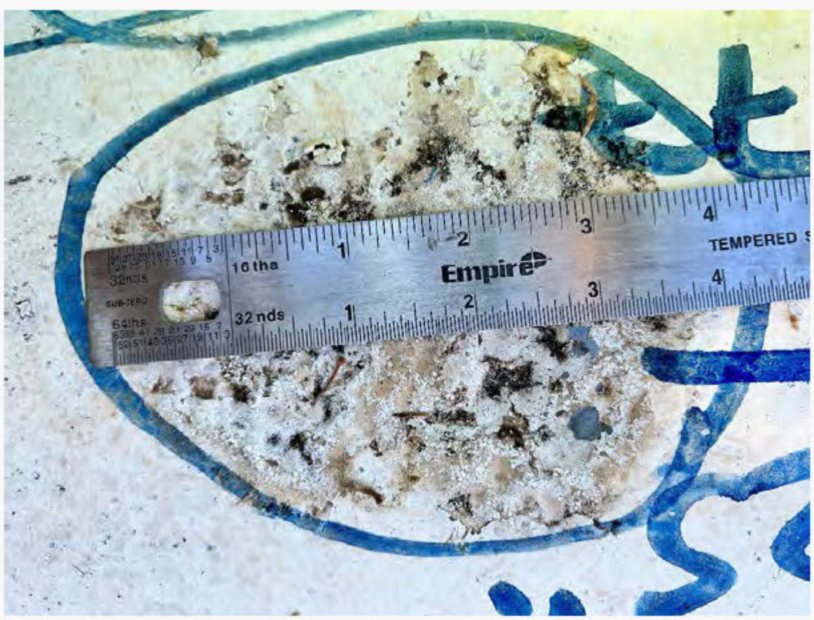

Figure 5-91 – Pitting Corrosion Covered by Repair Coating [redacted] (b)(3)(A)**,**
Adjacent to Pipe Support 74

[redacted]

Figure 5-92 – Crevice Corrosion and Pitting Between Pipe and Deteriorated Cradle (Left Cradle Removed), [redacted]

At ADIT 3, the FOR line rises aboveground, runs uphill, and then downhill before reaching Tank 311. The pipe supports and surrounding vegetation facilitate the accumulation of debris around the pipe which leads to significant crevice corrosion at multiple pipe supports. Previous evidence of pitting is overcoated with a white coating. This coating failed at the bottom of FOR pipes adjacent to many pipe supports (Figure 5-93).

In general, the pipe has a protective wrap applied at soil penetrations, providing physical protection for the coating and additional corrosion protection. However, at many locations, this wrap is either deteriorating or missing (Figure 5-94).

Figure 5-93 – Pitting and Crevice Corrosion at FOR Line from ADIT 3 to Tank 311

(b)(3)(A)

[redacted]

Figure 5-94 – Deteriorating Wrap and Pipe Ground Penetration, JP-5 Line

5.10.2.6 Valve Stations and Chambers

We conducted a site walk at [redacted] We observed significant coating failure and pipe corrosion at the FORFAC yard adjacent to the B1/B2 tanks (Figure 5-95). The pipe coatings at other above-ground valve stations are in good condition.

[redacted]

Figure 5-95 – Coating Failure and Pitting Corrosion of FOR Pipe

However, significant corrosion is occurring in the crevices of flange connections at valves and other fittings (Figure 5-96). This is particularly common on flanges for vertical sections, where the horizontal surface of the flange does not allow rainwater to drain. At some valve stations, stainless steel bands with grease ports are installed at these flanges to protect against crevice corrosion. We note that these protective bands are not uniformly installed at flanges across the Facility.

(b)(3)(A)

Figure 5-96 – Crevice Corrosion at Vertically Oriented Flanges, (b)(3)(A)

The below-ground valve chambers have pipes and valves with deteriorating coatings and pipe pitting corrosion, with the worst conditions occurring in the low point drain lines in (b)(3)(A) [redacted] (Figure 5-97).

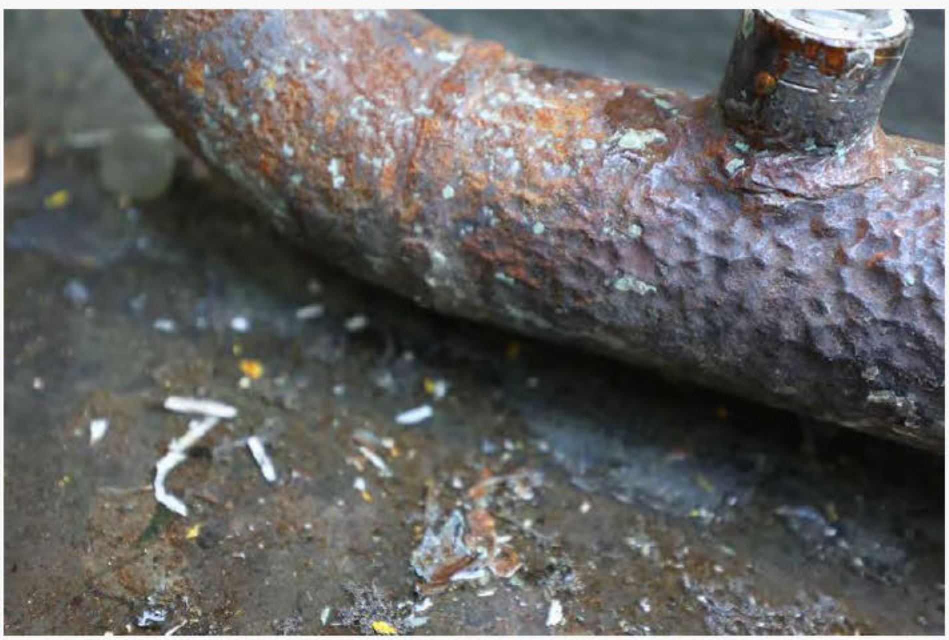

Figure 5-97 – Pitting of Low Point Drain, (b)(3)(A)

Although the valve chamber at [redacted] has recently been renovated, the fuel pipe appears to be corroding behind the wall penetration (Figure 5-98).

[redacted]

Figure 5-98 – Apparent Pipe Corrosion behind Wall Penetration, [redacted]

5.10.2.7 Fuel Piers

Hotel Pier

Diesel and aviation fuel pipes run along either side of Hotel Pier in a concrete trough, supported on concrete plinths with an embedded steel friction plate. Due to limited access, we were only able to inspect one section of piping at the end of the pier.

We observed that the coating at the top of the pipes and valves appears to be in good condition. However, the coating on the underside of the pipes and flanges is deteriorating at several locations, and crevice corrosion is occurring at several pipe supports (Figure 5-99).

[redacted] (b)(3)(A)

Figure 5-99 – Coating Failure and Corrosion at Pipe Support, F-76 – Hotel Pier

Kilo Pier

The diesel fuel pipe along Kilo Pier is supported by stainless steel hangers below the pier and is located in the tidal zone. The pipe is wrapped along its length with a bituminous cloth in the first section and a PVC wrap towards the end (Figure 5-100). Multiple sections of this wrap are deteriorating. We could not visually inspect the pipe due to the wrap.

We observed several locations where the hanger-type pipe support bolts had corroded and fractured, resulting in unsupported local sections of pipe.

[redacted] (b)(3)(A)

Figure 5-100 – Wrapped Fuel Pipe within Tidal Zone, F-76 – Kilo Pier

Sierra Pier

The diesel fuel pipe along Sierra Pier is supported by stainless steel hangers below the pier and is in the tidal zone. These hangers are larger than those under Kilo Pier and are generally intact. The pipe is wrapped along its length with a PVC wrap. Multiple sections of this wrap are deteriorating (Figure 5-101). We could not visually inspect the pipe due to the wrap.

(b)(3)(A)

[redacted]

Figure 5-101 – Coating Failure, Multi-Purpose Fuel Pipe – Sierra Pier

Mike Pier

The diesel fuel pipe along Mike Pier is supported on rollers on top of pier beams and appears to be above the high tide line. The pipe is coated along its length, but the coating is degrading at multiple locations (Figure 5-102). There is also crevice corrosion at the pipe supports. There are two low point drains along the pier, and the valves at these drains are severely corroded (Figure 5-103).

(b)(3)(A)

[redacted]

Figure 5-102 – Coating Failure, F-76 – Mike Pier

Figure 5-103 – Corrosion at Low Point Drain Valve, F-76 – Mike Pier

Bravo Pier

The diesel fuel pipe along Bravo Pier is supported on rollers hanging below the pier and appears to be above the high tide line. The pipe is wrapped along its length with a bituminous cloth. Multiple sections of this wrap are deteriorating (Figure 5-104). We could not visually inspect the pipe due to the wrap. Some of the fuel risers and low point drain lines are coated, and these coatings are deteriorating (Figure 5-105). Deep corrosion pits are present in the distressed areas (Figure 5-106).

(b)(3)(A) [redacted]

Figure 5-104 – Bituminous Wrap Failure, F-76 – Bravo Pier

(b)(3)(A)

[redacted]

Figure 5-105 – Coating Failure at Fuel Pipe Riser, F-76 – Bravo Pier

Figure 5-106 – Corrosion and Pitting at Low Point Drain, F-76 – Bravo Pier

6. PROCESS SAFETY MANAGEMENT

The Risktec team conducted an operational readiness assessment and Hazard and Operability Study (HAZOP) to identify facility systems integrity risks that may impact the environment and identify corrective actions to address any deficiencies. Recognizing the proximity of the underlying aquifer to the Red Hill Underground Bulk Fuel Storage (UBFS) tanks and the conveyance piping in the tunnels, the approach we took to mitigate environmental and cultural impacts was to develop recommendations that would minimize the risk of significant releases; impacts to the environment and the public were assessed using the Navy's risk matrix. Our approach included the following:

- Assess the Facility operations and system integrity to safely defuel the UBFS tanks.
- Assess operations and system integrity of the Facility to determine design and operational deficiencies that may impact the environment and develop recommendations for corrective action.

The assessment was conducted on site. The methodology included completing the Occupational Health and Safety Administration (OSHA) Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119) Audit Checklist (OSHA, 1992) and the Environmental Protection Agency (EPA) Spill Prevention Countermeasures and Controls (SPCC,40 CFR 112) Field Inspection and Plan Review Checklist. These checklists are used by OSHA, EPA, and facilities to audit their PSM and SPCC programs against regulations and best practices. The Operational Readiness Assessment is discussed further in Section 6.2 below.

PSM and SPCC are two U.S. regulatory programs commonly in place at large marine petrochemical terminals. Regardless of regulatory applicability, these programs represent good industry practices and are also applied outside the United States through Risk-Based Process Safety (RBPS) programs and strong spill management and containment programs.

A HAZOP was also performed to assess the operational risks associated with both defueling Red Hill and ongoing operations at Red Hill and Pearl Harbor. The HAZOP is a baseline operational risk assessment for the Facility and can be used to manage operational risks within a management system for continual improvement.

The reviews resulted in evaluations of systems integrity and potential impacts on the environment, health and safety, the public, and mission readiness.

The recommendations from the HAZOP and the Operational Readiness Assessment are in Section 8.1. The Process Hazard Analysis is discussed further in Section 6.1 below, and Operational Readiness is discussed in Section 6.2.

6.1 Process Hazards Analysis (PHA)

The HAZOP report documents a Process Hazard Analysis (PHA) for Pearl Harbor and Red Hill Fuel Terminal for NAVSUP FLCPH. The review was conducted using the Hazard and Operability (HAZOP) and What-If methodologies. The methodologies employed in this study meet the requirements of the Occupational Safety and Health Administration (OSHA) rule, Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119) (OSHA, 1992), and the Environmental Protection Agency's rule 40 CFR Part 68, Accidental Release Prevention Requirements, Risk Management Program Under the Clean Air Act, Section 112(r)(7) (EPA, 1994).

The PHA was conducted in person on dates 7 February 2022 through 11 and 21 February 2022 through 25 February 2022. The PHA Team met for a total of ten days. The PHA was facilitated and documented by Risktec with key participation from Navy Supply Fleet Logistics Center Pearl Harbor personnel and support personnel. The multidisciplinary team identified process hazards associated with the Pearl Harbor and Red Hill Fuel Terminal. The team focused on those process hazards that could lead to a significant impact on mission readiness, safety or health, public, and/or the environment during routine and non-routine operations.

The PHA team identified 120 recommendations for reducing the likelihood and/or severity of potential consequences associated with the Pearl Harbor and Red Hill Fuel Terminal. The HAZOP report was created by our subcontractor and teaming partner, Risktec, with input from Navy personnel who participated in the HAZOP. Please see Appendix B for process safety risks and operational deficiencies.

Table 8-1 contains those thirteen recommendations and their associated risk rankings made during the PHA (HAZOP) to be specifically considered by Navy leadership prior to commencing defueling the Red Hill Tanks.

Table 8-2 contains those recommendations and associated risk rankings made during the PHA (HAZOP) to be considered for ongoing operations specific to the Pearl Harbor DFSP.

Table 8-3 contains those recommendations and associated risk rankings made during the PHA (HAZOP) to be considered if operations at Red Hill are resumed in the future.

All PHA recommendations are also shown in the Process Hazard Analysis Report in Appendix B.

6.2 Operational Readiness Summary

Risktec reviewed operational practices to assess the state of ongoing operations at Red Hill and Pearl Harbor. Facility systems integrity was evaluated to determine potential impacts on the environment, personnel health and safety, the public, and mission readiness. Assessments were conducted for defueling Red Hill and ongoing operations at Pearl Harbor and Red Hill.

The assessment was conducted onsite. The methodology included completing the Occupational Health and Safety Administration (OSHA) Process Safety Management of Highly Hazardous Chemicals 29 CFR 1910.119 Audit Checklist (OSHA, 1992) and the Environmental Protection Agency (EPA) Spill Prevention Countermeasures and Controls (SPCC, 40 CFR 112) Field Inspection and Plan Review Checklist (EPA, 2002). These checklists are used by OSHA, EPA, and facilities to audit their Process Safety Management (PSM) and SPCC programs against regulations and best practices.

PSM and SPCC are two U.S. regulatory programs commonly in place at large marine bulk terminals. Regardless of regulatory applicability, these programs represent good industry practices and are also applied outside the United States through Risk-Based Process Safety (RBPS) programs and through strong spill management and containment programs.

In addition to general recommendations, Risktec made recommendations for:

- Safely Defueling Red Hill (HAZOP).
- Ongoing Operations at Red Hill (HAZOP).
- Ongoing Operations (Not Including Red Hill) at Pearl Harbor DFSP (HAZOP).

Recommendations for Operational Readiness are shown in Table 8-1 (Defueling), and Table 8-2 (Ongoing Operations) and are also shown in the JBPHH Operational Readiness Assessment report contained in Appendix C.

A proposed high-level implementation plan is shown in Table 8-4 and also in Section 5 of the Operational Readiness Assessment Report (Appendix C).

7. STRUCTURAL AND MECHANICAL INTEGRITY ASSESSMENT

Structural integrity is defined as the ability of a structure or equipment to perform its required function effectively over a defined period while protecting health, safety, and the environment. It is an ongoing process throughout the lifecycle of the Facility. Structural integrity management (SIM) ensures that the systems and operational procedures that deliver integrity are in place and will perform when required. This is especially critical for components that have exceeded the normal design life or have deficiencies. Our team performed the following activities, as needed, to put some of the HAZOP decisions into practice and develop effective actions to mitigate future incidents:

- Information Management. Collect and review relevant maintenance and operational history. This review will also include design documents, inspection reports, and previous assessments to understand the current state of the Facility and its vulnerabilities.
- SIM Program Evaluation. Review Facility SIM system to potentially identify gaps in the inspection program and structural evaluations.
- Structural Evaluation. Review the current condition of the structures and equipment compared to when it was last assessed and changes in parameters that may affect integrity and risk levels. Identify analysis, repair, and maintenance requirements for structures and components to meet the acceptance criteria for structural integrity.
- Repair. Develop repair schemes to proactively improve the condition of safety-critical elements, including equipment and structures, based on the structural evaluation.

Inspection and fitness-for-service studies are the main pillars of a successful integrity management program. Based on our inspections and document reviews, we evaluated the risks based on data and prioritized the repairs to mitigate future failures. This integrity management study is expected to enable the Navy to make better-informed decisions. Additionally, it helps the stakeholders to better understand the Facility-wide conditions.

Piping, tanks, and structures were grouped based on similarities in design and defects. Selected representative and critical cases are assessed in detail, as discussed in this section. We developed analytical models of the structures and performed structural assessments as required to advise on planned modifications.

The load cases for civil and structural elements, including dead, live, and operating loads, are based on ASCE 7 and other structural design codes, as noted in Section 0. For pipelines, we followed ASME B31.3 and B31.4, as discussed in Section 4.5. API 650 and 653 are used for an assessment of storage tanks.

We performed hand calculations and finite element (FE) analyses, as necessary, to check the response of structural elements for normal and abnormal loads. Static and dynamic (response spectrum) analyses were performed. We used SAP2000 and TRIFLEX software packages for structural and piping analyses, respectively. The ABAQUS software package was used for nonlinear capacity analysis of the failed Dresser couplings. Also, the underground storage tank was modeled using ABAQUS software to check the response against internal and external pressures. ABAQUS is a general-purpose, nonlinear finite element analysis method software developed by Dassault Systems. ABAQUS is widely used to perform complex civil, structural, and mechanical systems analyses in critical applications, including the aerospace and nuclear industries.

Analysis inputs were determined from reviewed documents and our measurements at the site. Capacities of reinforced concrete and structural steel elements were determined using ACI 318 and AISC 360, respectively. Demand-to-capacity ratios (DCRs) were checked for the elements to determine strengthening requirements.

The integrity of degrading pipe sections was evaluated using API 579. API 579 is widely used to determine a component's fitness-for-service (FFS). FFS assessments are quantitative engineering evaluations that are performed to demonstrate the structural integrity of an in-service component that may contain a flaw or damage, or that may be operating under a specific condition that might cause a failure. This standard provides guidance for conducting FFS assessments using methodologies specifically prepared for pressurized equipment.

These assessments allowed us to make run-repair-replace decisions to help determine if components containing flaws identified by inspection can continue to operate safely for some time and when it needs to be repaired to mitigate failures. This type of FFS assessment is recognized and referenced by the API codes and standards, including API Recommended Practices (RPs) 510, 570, and 653, as suitable means for evaluating the structural integrity of pressure vessels, piping systems, and storage tanks where inspection has revealed degradation and flaws in the equipment. The FFS assessment procedures in API 579 cover the present integrity of the component given a current state of damage.

The flaw types and damage conditions that were observed include general and localized corrosion, widespread and localized pitting, laminations, dents, and gouges, and coating failures. The FFS assessment involves the following steps:

- Flaw and Damage Mechanism Identification. Identify the flaw type and cause of damage based on the original design and fabrication practices, the material of construction, and the service history and environmental conditions.

- Data Requirements. Determine FFS analysis inputs from the original component design data, maintenance and operational history, expected future service, flaw size, state of stress in the component at the location of the flaw, and material properties.

- Select Assessment Techniques and Acceptance Criteria: Based on the damage mechanism, select the most suitable options.

7.1 Material Specifications

Detailed material properties were not shown in the available drawings. Based on the time of construction (above storage tanks in the upper tank farm in the 1920s; the underground storage tanks in the 1940s), we have assumed the following material specifications in our assessment:

- Concrete Compressive Strength and Steel Grades:

    1. Concrete - Compressive strength at 28 days, fc’= 3,000 psi.
    2. Reinforcing steel – ASTM A15 Gr. 40 (minimum yield stress = 40 ksi).
    3. Steel liner (underground storage tanks) – ASTM A36 (minimum yield stress = 36 ksi).
    4. Steel pipes – ASTM A53 Gr. B (minimum yield stress = 35 ksi).
    5. Aboveground storage tank steel – ASTM A283 Gr. C (minimum yield stress = 30 ksi).
    6. Structural steel for pipe racks (beams, columns, angles) - ASTM A36 (minimum yield stress = 36 ksi).

[redacted]

- Modulus of Elasticity:

    1. Reinforcing bars and steel, modulus elasticity elastic E_s = 29,000 ksi.
    2. For concrete with f_c'= 3,000 psi, per ACI 318, the modulus of elasticity:

$$E_c = 57{,}000\sqrt{f_c^{'}}$$

- Material Density:

    1. Reinforcing bars and steel: 490 lbs/ft^3.
    2. Reinforced concrete: 150 lbs/ft^3.

In addition, we used the following specific gravity for fuels, extracted Tables 2-1 and 2-2 of UFC 3-460-01 (Department of Defense, 2021):

- JP-5 Fuel – Specific gravity = 0.788 to 0.845.
- F-24 Fuel - Specific gravity = 0.775 to 0.840.
- F-76 Fuel - Specific gravity = 0.830 to 0.860.

7.2 Red Hill Underground Bulk Fuel Storage Tanks

We developed three FE models for a typical underground tank: a local FE model of the barrel, a local FE model of a liner plate, and a global FE model of the tank using ABAQUS. The purpose of our analyses is to check adequacy against the following postulated scenarios:

- Liner plate and concrete wall spanning between two basalt (rock) layers above and below the intermediate softer soil layer (Section 7.2.1).
- Liner plate spanning over potential (assumed) concrete voids (Section 7.2.2).
- Tank and its components against seismic loads (Sections 7.2.3 and 7.2.3).

7.2.1 UST Barrel Section Local FE Model

The purpose of this analysis is to evaluate the adequacy of the concrete wall spanning between two basalt (rock) layers above and below the intermediate softer soil layer under internal fuel pressure. Note the typical detail through soft strata in Figure 2-4 shows a gunite plug for the depth of the soft strata. We evaluated the concrete tank wall for a postulated scenario with this gunite plug being deteriorated for certain assumed lengths resulting in no resistance or softer resistance provided by the softer soil strata behind the deteriorated gunite plug.

We developed two FE models, one to evaluate the tank wall with assumed deteriorated gunite plug (for an assumed length) near the base of the barrel section with no resistance provided by softer soil and the other model to evaluate the tank wall with assumed deteriorated gunite plug (for the entire tank perimeter) near mid-height of the barrel section with lower resistance provided by clinker layers. We selected representative areas with deteriorated gunite plugs based on the areas of clinker layers around the tank from the log of formations drawings.

7.2.1.1 Local FE Model near Base of the Barrel

This section discusses our local FE model near the base of the barrel section in a typical underground tank.

FE Model

In this local FE model, we represented a 30 ft tall portion of a typical underground tank located near the base of the barrel section. Figure 7-1 shows our local FE model. We modeled the 4 ft thick concrete wall using solid elements and a 1/8 in. thick liner plate using shell elements. The liner plate thickness specified is ¼ in. in the drawings. The Red Hill Bulk Fuel Storage Facility Destructive Testing Results Report, AOC/SOW 5.3.3 (SSR-NAVFAC EXWC-CI01941) lists the thinnest measured thickness of the coupon samples taken for the destructive testing from Tank 14 in 2018. The thinnest thickness for coupons taken from the barrel section varies from 0.122 in. to 0.248 in., indicating the corrosion is nonuniform and scattered across the barrel section. Conservatively, we assumed that half of the liner plate thickness is uniformly lost due to corrosion in our analysis. We modeled the vertical reinforcement (1 in. diameter bars at 6 in. center to center) and inside hoop reinforcement (1 in. diameter bars at 12 in. center-to-center spacing) per Drawing 294305 (Contractors, Pacific Naval Air Bases, 1942). Figure 7-2 shows a representation of reinforcement in our local FE model. We modeled the steel reinforcement using beam elements and embedded them in concrete.

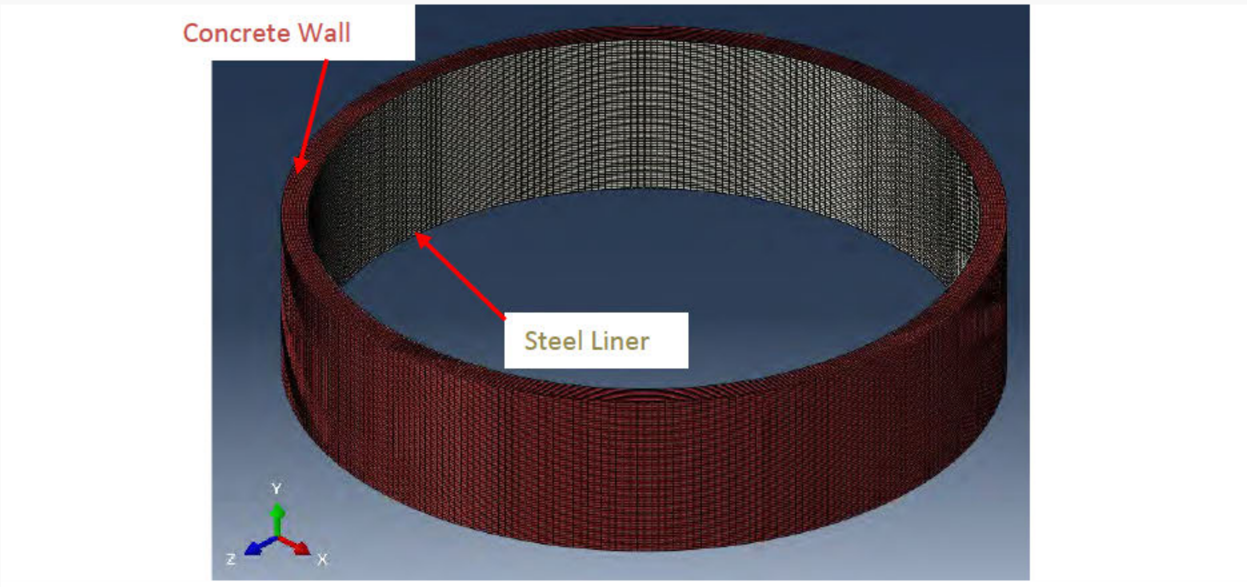

Figure 7-1 – UST Barrel Section Local FE Model near Base of the Barrel

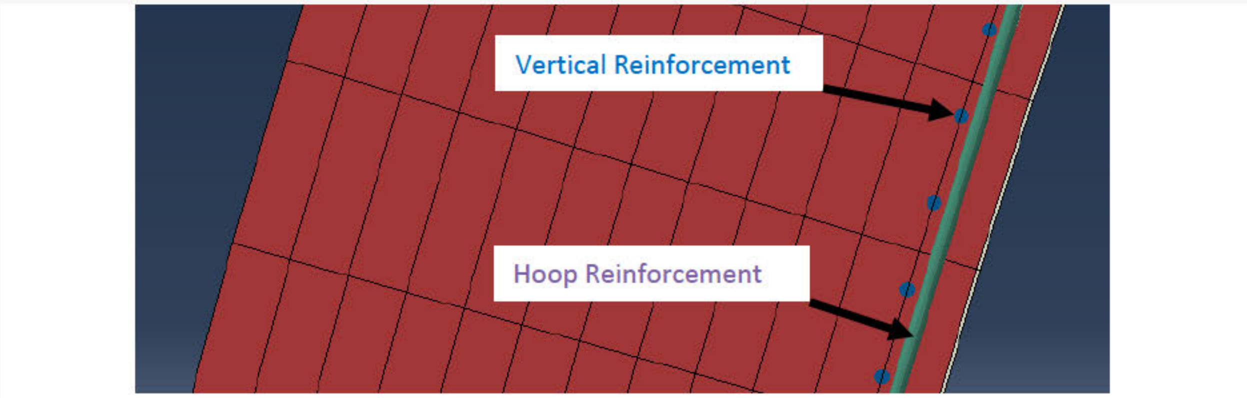

Figure 7-2 – Reinforcement in UST Barrel Section Local FE Model (Partial Plan)

Material Modeling

We assumed a characteristic compressive strength of 3,000 psi for concrete, yield strength of 36 ksi for liner plate, and 40 ksi for reinforcement. Our assumptions of the material properties fall within the suggested ranges of the material properties to use based on the time of construction of the Facility per ASCE 41-17. We used nonlinear material properties for both steel (elastic-perfectly plastic, see Figure 7-3 and Figure 7-4) and concrete (damaged plasticity models) in our FE model. The damaged plasticity model was initially developed by Lubliner et al. (Lubliner, 1989) with modifications proposed by Lee and Fenves (Lee, 1998) to account for the different behavior in tension and compression. This model is a continuum, plasticity-based damage model. We used mean material properties for concrete. Concrete stress-strain curves used in our material model are shown in Figure 7-5 and Figure 7-6.

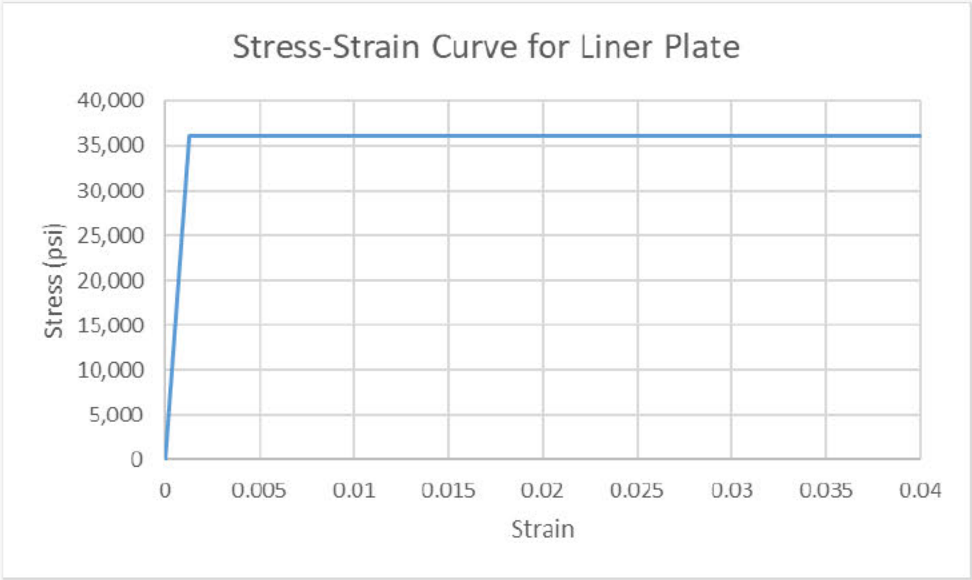

Figure 7-3 – Liner Plate Stress-Strain Curve

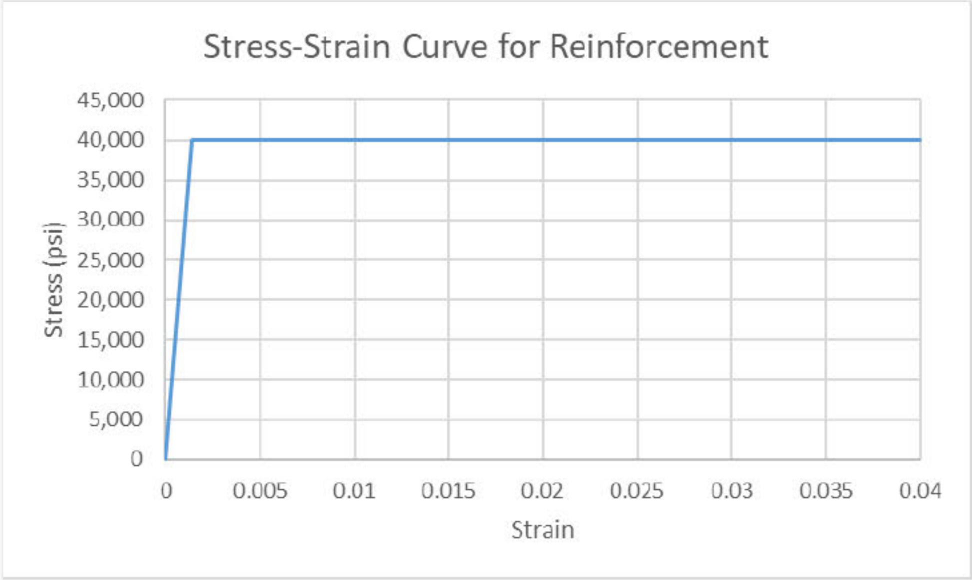

Figure 7-4 – Reinforcement Stress-Strain Curve

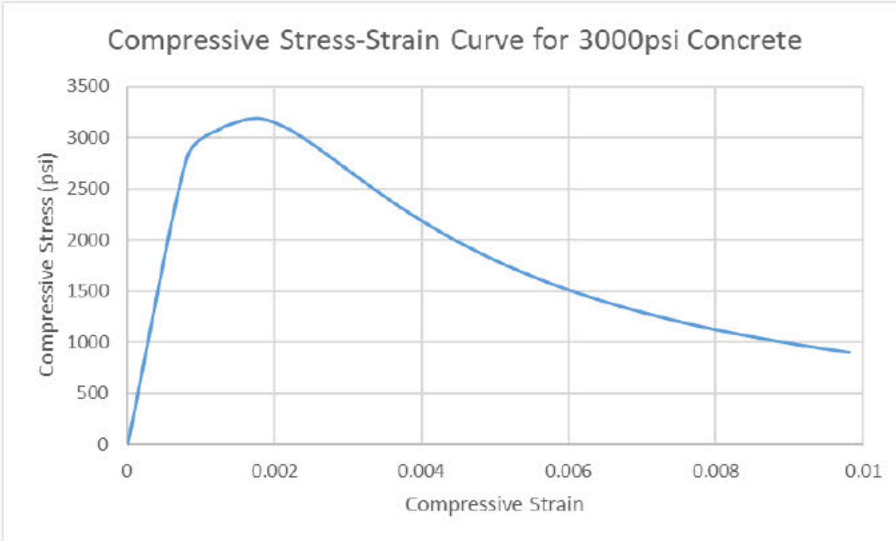

Figure 7-5 – Concrete Stress-Strain Curve in Compression

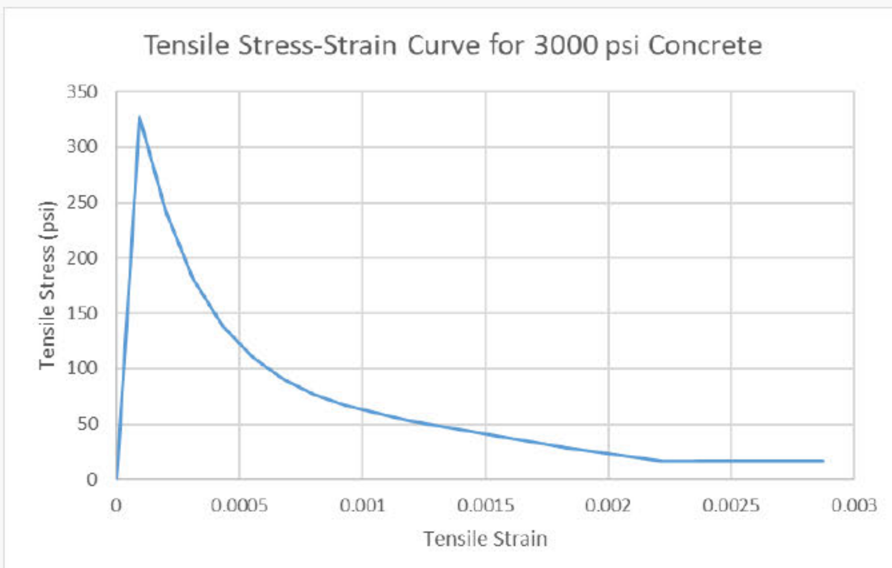

Figure 7-6 – Concrete Stress-Strain Curve in Tension

Boundary Conditions and Loading

We used pinned boundary conditions in the radial direction on the exterior of the tank wall to represent the resistance provided by the rock/soil sections and fixed boundary conditions at the top and bottom of the ring to represent the continuity of the tank. We assumed no lateral support to the tank wall for the (assumed) length of deteriorated gunite plug.

We reviewed the log of formations drawings for USTs and considered the strata around Tank 10 shown in Figure 7-7 below. The areas with dots are clinker sections. As can be seen, the height of clinker sections varies along the tank perimeter. A gunite plug is constructed across clinker sections spanning between sound rock layers.

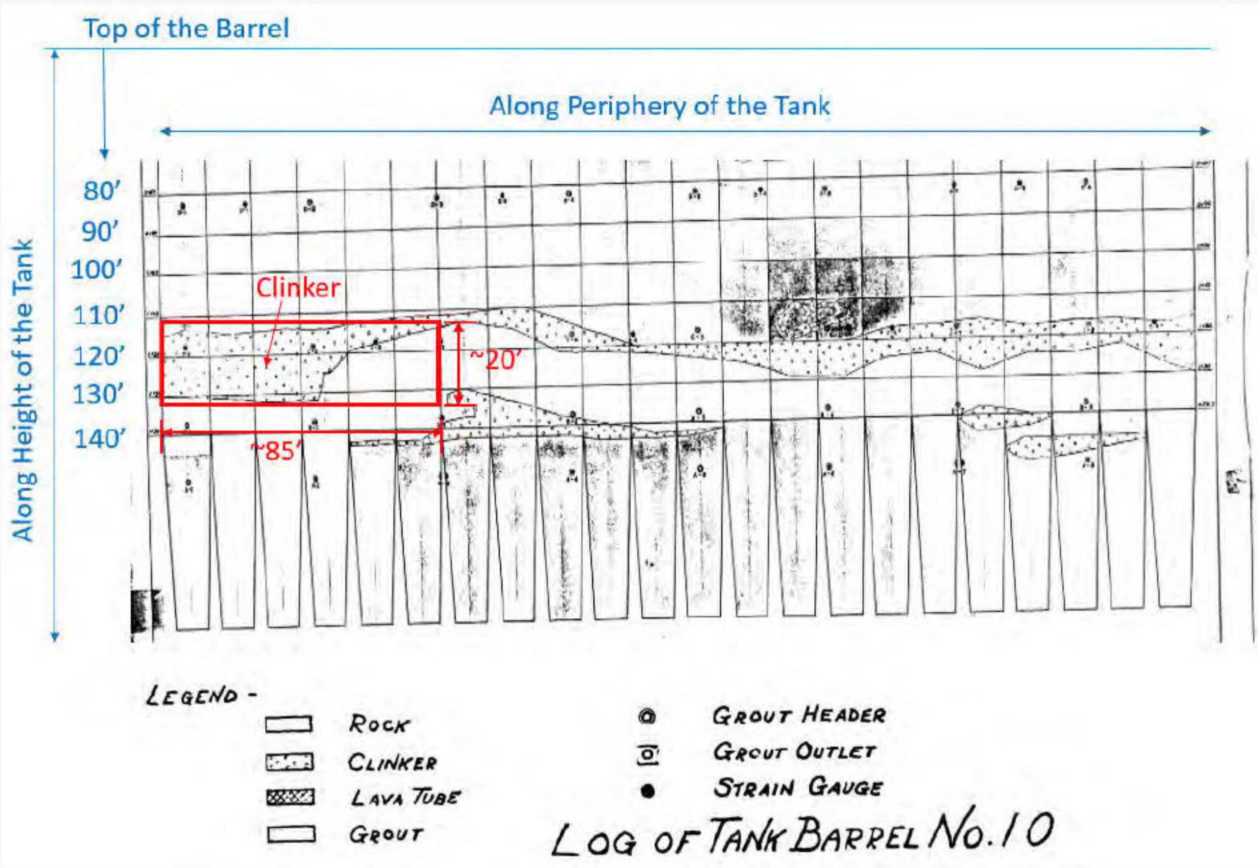

Figure 7-7 – Partial Log of Formations, Tank #10 (Drawing 293971)

We assumed a case where the gunite plug is deteriorated or damaged for a 20 ft deep section with a length approximately equal to 85 ft (a quarter of the perimeter of the tank) in the red-colored box marked in Figure 7-8. We made a conservative assumption that the tank wall is unsupported in the lateral direction over this entire assumed deteriorated gunite plug area, as shown in Figure 7-8.

We applied internal fuel pressure on the tank. We calculated the pressure at the base of the barrel section (51.3 psi) using a fuel density of 0.845 kg/L and applied that calculated pressure as a uniform pressure to the 30 ft tall tank walls, as shown in Figure 7-9.

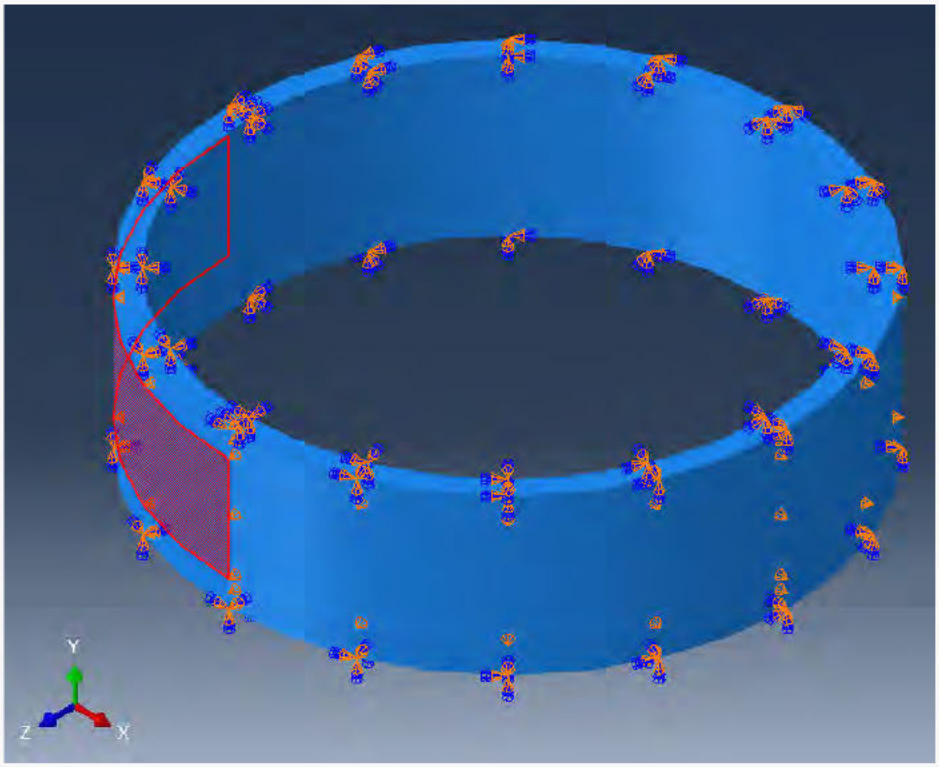

Figure 7-8 – Boundary Conditions in the Local FE Model, Highlighted (Red) Areas with Loss of Lateral Support

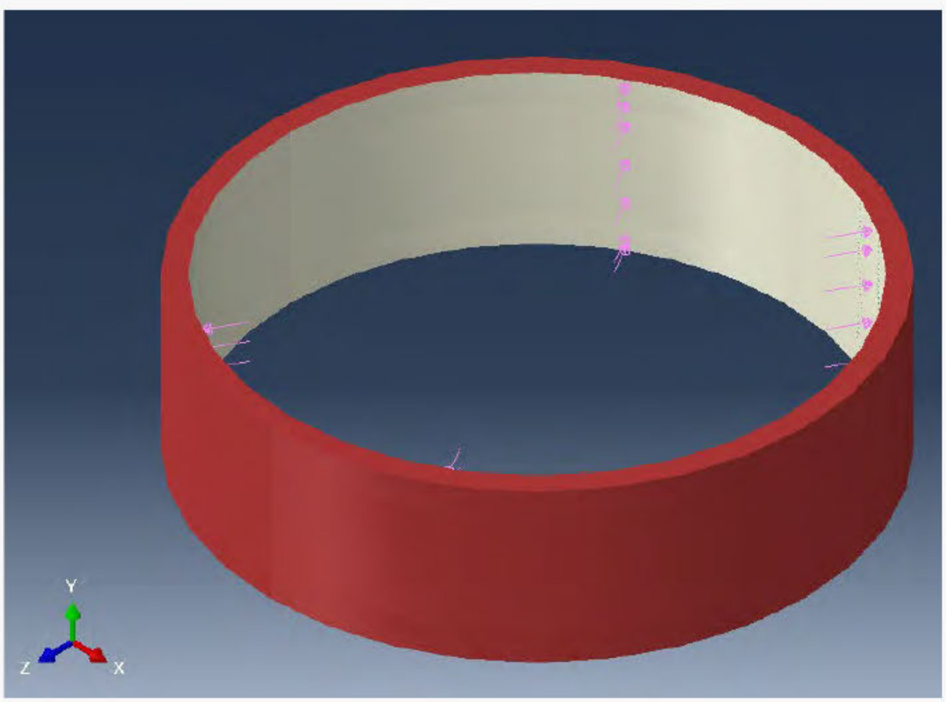

Figure 7-9 – Internal Fuel Pressure on Tank (Pink Arrows)

Analysis Results

Figure 7-10 shows a magnified deflected shape of the tank wall bulging out in the areas with no lateral support (due to the assumed loss of and damage to the gunite plug). The maximum displacement in the radial direction is on the order of 0.03 in.

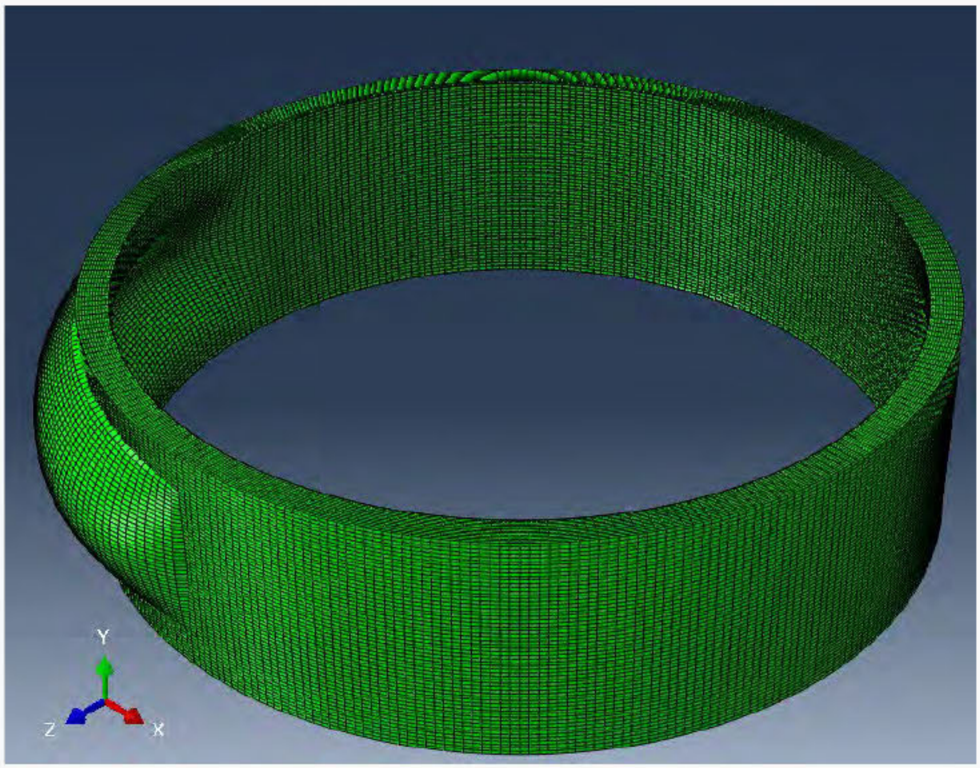

Figure 7-10 – Deflected Shape of the Barrel Ring with Postulated Gunite Damage due to Internal Pressure (Magnified by a Factor of 3,000)

The analysis predicted stresses in the reinforcement and the liner plate are well below the yield stress. Figure 7-11 shows von Mises stresses in the liner plate; the maximum von Mises stress is approximately 3 ksi. Analysis indicates the steel reinforcement and the liner plate remain elastic.

The minimum principal stress in the concrete predicted by the analysis is well below the peak compressive stress of the concrete material, so concrete elements in compression remain elastic. Figure 7-12 the maximum principal stress in the concrete (positive values indicating tension). The maximum tensile stress is calculated as 334 psi. Some concrete elements on the exterior of the wall in tension begin to experience permanent deformation. Figure 7-13 shows the equivalent plastic tensile strains (PEEQT) in concrete. Blue areas in the figure indicate areas with zero PEEQT. Areas with any other color indicate the concrete elements experiencing some minor cracking in tension. Note that the maximum PEEQT is 1.22×10^{-5}, which is much smaller than the value of the strain that corresponds to the onset of visible cracking (about 0.001 for 3,000 psi concrete), indicating only minor cracks. Note that the analysis predicts these minor cracks just on the exterior surface of the tank wall and do not extend through the thickness of the wall as shown in Figure 7-13. Also, note that we made a conservative assumption that the tank wall areas with deteriorated gunite plugs are laterally unsupported, neglecting the resistance provided by the clinker layers. The clinker layers provide significant lateral support, as shown in Section 7.2.1.2.

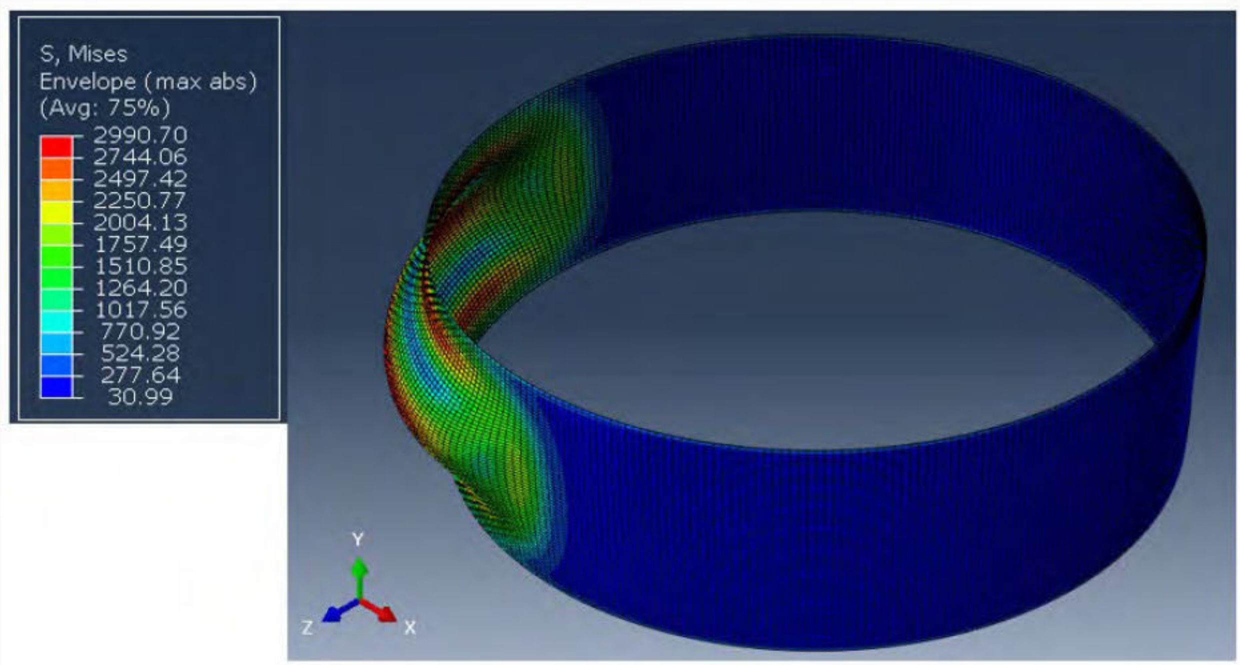

Figure 7-11 –Von Mises Stress in Liner Plate (psi)

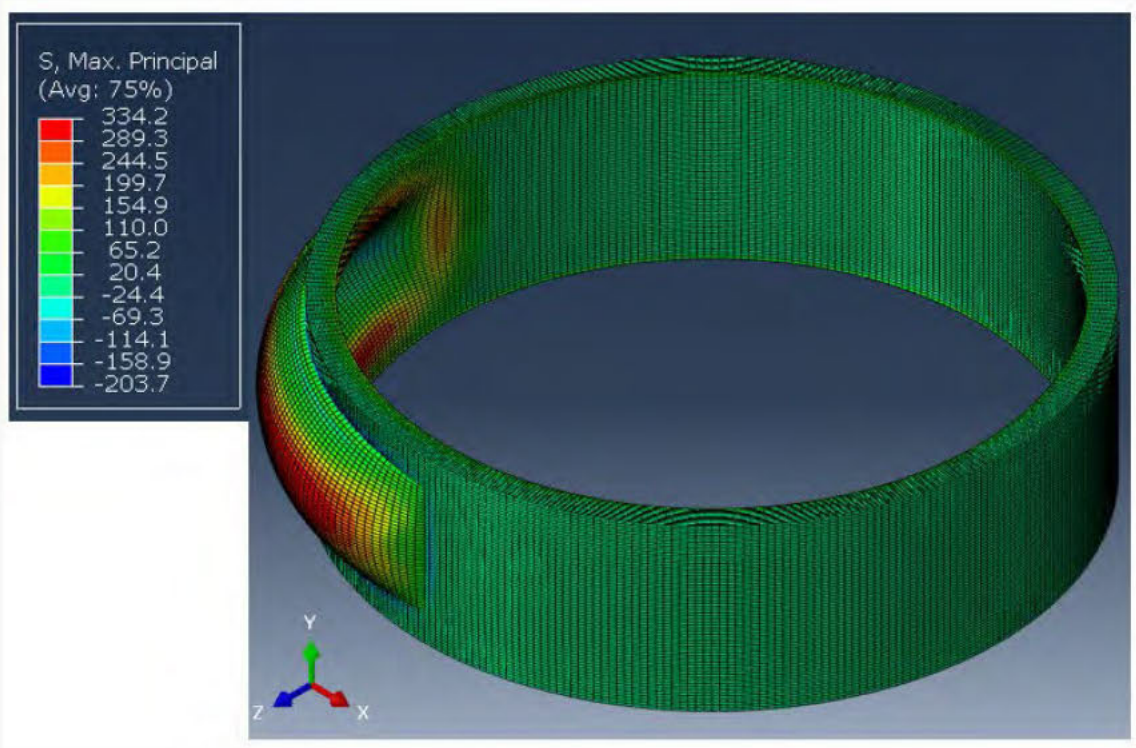

Figure 7-12 – Maximum Principal Stress in Concrete (psi)

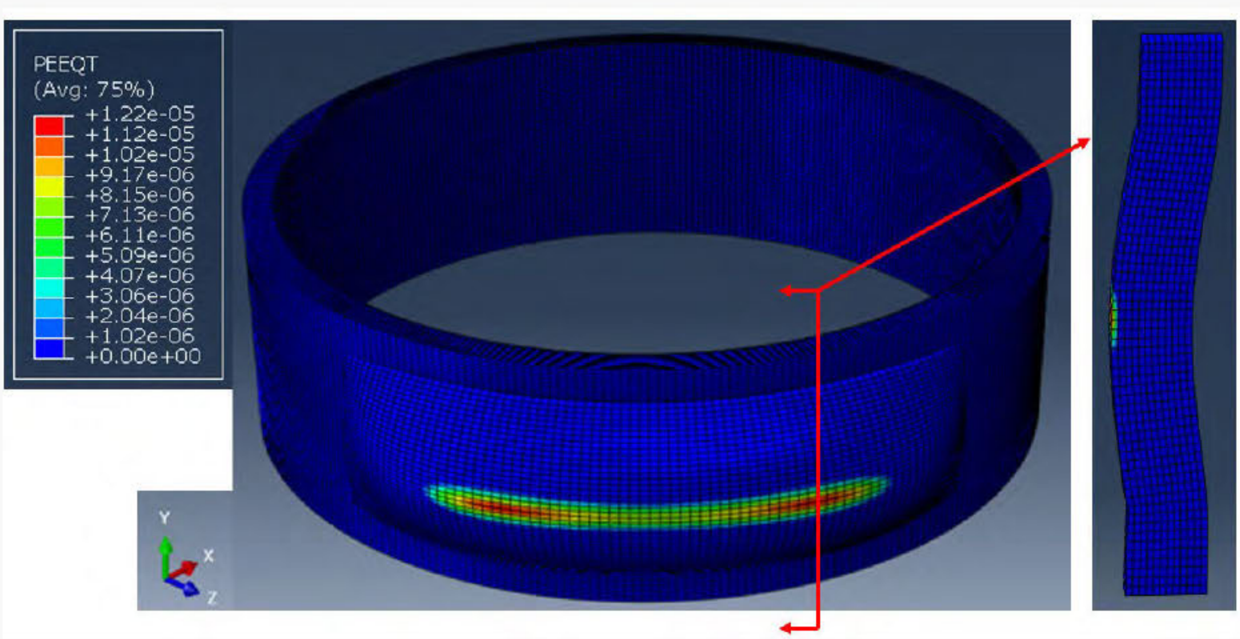

Figure 7-13 – Equivalent Plastic Tensile Strains in Concrete

This FE analysis predicts that if the gunite plug has deteriorated in a local area such as 20 ft x 85 ft near the base of the barrel, which is very unlikely, would not cause any overstresses in the liner plate and any associated fuel leakage from the tank under internal fuel pressure. Since the fuel pressure is the maximum at the bottom of the barrel section, the presence of the local deteriorated plug areas of similar size, if any, along the height of the barrel section would not result in overstressing of the liner plate and any associated fuel leakage due to internal fuel pressure.

7.2.1.2 Local FE Model near Mid-Height of the Barrel

This section presents our local FE model near the mid-height of the barrel section in a typical underground tank.

FE Model

In this local FE model, we represented a 75 ft tall portion of a typical underground tank located near the mid-height of the barrel section. Figure 7-14 shows our local FE model. We also modeled the gunite plug. We considered the strata around Tank 2, shown in Figure 7-15. The areas with dots are clinker sections. As can be seen, the height of the clinker sections varies along the tank perimeter. A gunite plug is constructed across clinker sections spanning between rocks layers.

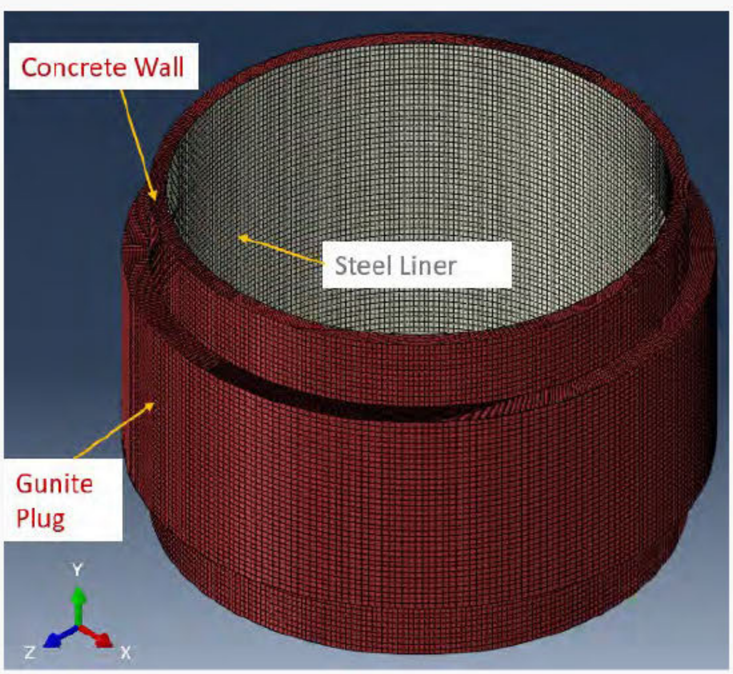

Figure 7-14 – UST Barrel Section Local FE Model near Mid Height of the Barrel

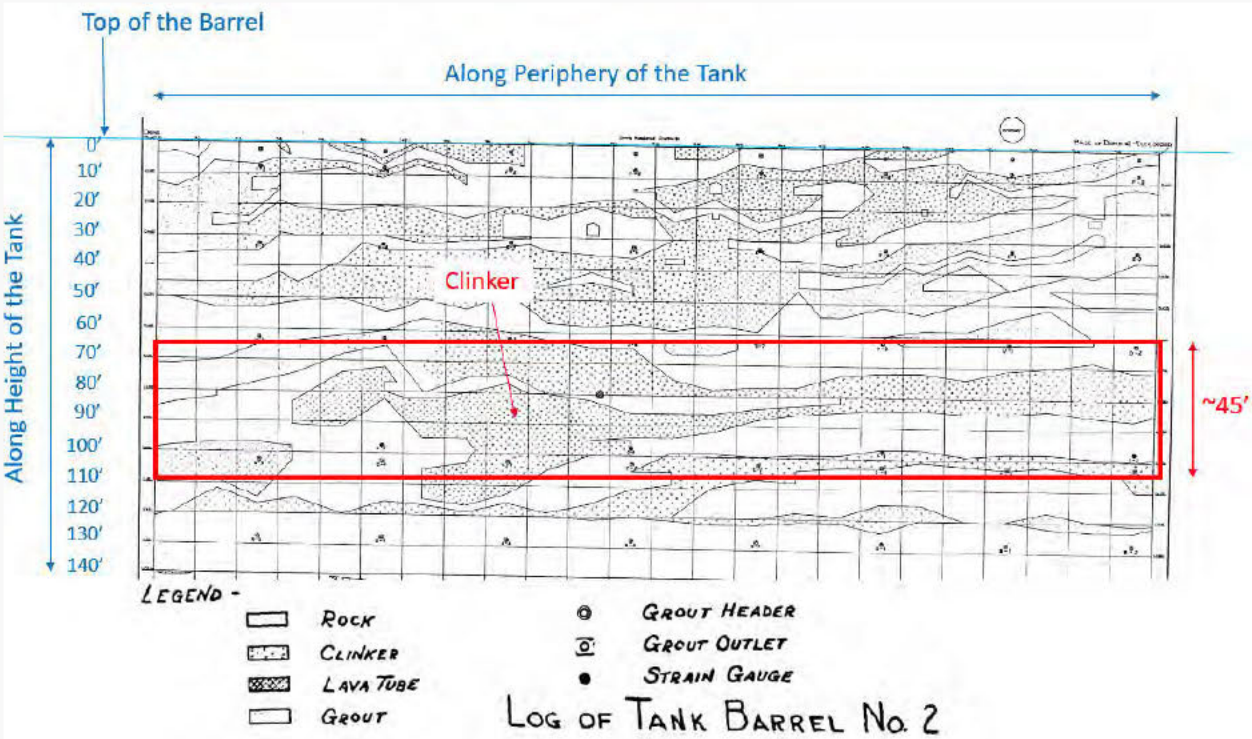

Figure 7-15 – Partial Log of Formations, Tank #2 (Drawing 293963)

We modeled the 3.41 ft thick concrete wall using solid elements to represent the average thickness of the concrete wall in the barrel section under consideration (section in the red-colored box in Figure 7-15). Note that our model extends 15 ft above and below the height of the red box in Figure 7-15. We modeled the gunite plug for the uniform height of the clinker section (45 ft) using solid elements. We modeled a 1/8 in. thick liner plate using shell elements, assuming 1/8 in. of section loss (50%) due to corrosion. We also assumed that the reinforcement lost 1/8 in. of the section resulting in 7/8 in. diameter for 1 in. diameter bars specified in the drawings. We modeled the vertical reinforcement (7/8 in. diameter bars at 12 in. center to center) and inside hoop reinforcement (7/8 in. diameter bars at 12 in. center-to-center spacing) specified near the mid-height of the barrel in Drawing 294305 (Contractors, Pacific Naval Air Bases, 1942). We modeled the steel reinforcement using beam elements and embedded them in concrete. We used a characteristic compressive strength of 3,000 psi for concrete and gunite, yield strength of 36 ksi for liner plate, and 40 ksi for reinforcement.

We assumed a case where the gunite plug is deteriorated or damaged in the red-colored box marked in Figure 7-15. It is 45 ft deep and extends for the whole perimeter of the tank. Note that the clinker layer is not uniform in that 45 ft height, and we made a conservative simplification to consider the clinker and gunite plug in the 45 ft height for the entire perimeter of the tank wall. To represent the deterioration in the gunite plug, we used a modulus of elasticity of cracked concrete (30% of nominal value) per ASCE 41-17 in the material model for the plug. Instead of assuming no lateral support to this deteriorated gunite plug area, we used soil springs to represent the resistance provided by the clinker sections.

Lateral Modulus of Subgrade Reaction for Clinker Layers

Based on our review of published literature (H.G. Brandes, 2011), and the soil test boring logs included in the 30 June 2019 AECOM report, the clinker layers encountered around the underground tanks likely consist of rubble-like material which tends to be similar to a silty to clayey gravel in the upper portions of the strata, becoming more indurated with depth.

For evaluation purposes, we assumed the clinker consists of a medium dense to dense gravel with the following engineering parameters:

- Unit Weight (g)– 125 pcf.
- Soil Friction Angle (Ø) – 33°.
- Cohesion (c) – 0 psf.

The above parameters are likely conservative. For modeling purposes to determine the contribution of the clinker layers to laterally support the underground tanks, we performed calculations to estimate the lateral modulus of subgrade reaction (k_h) for the clinker. Our calculation of k_h generally follows the procedure outlined by Terzaghi (Terzaghi, 1955) for vertical walls, as shown in Figure 7-16 of Terzaghi's paper below, where the curve C (solid line) is the actual relationship between the horizontal displacement y of the vertical wall with height D buried in the sand. The coefficient of earth pressure K and straight lines 0-a-b are the assumed relationship used in the analysis.

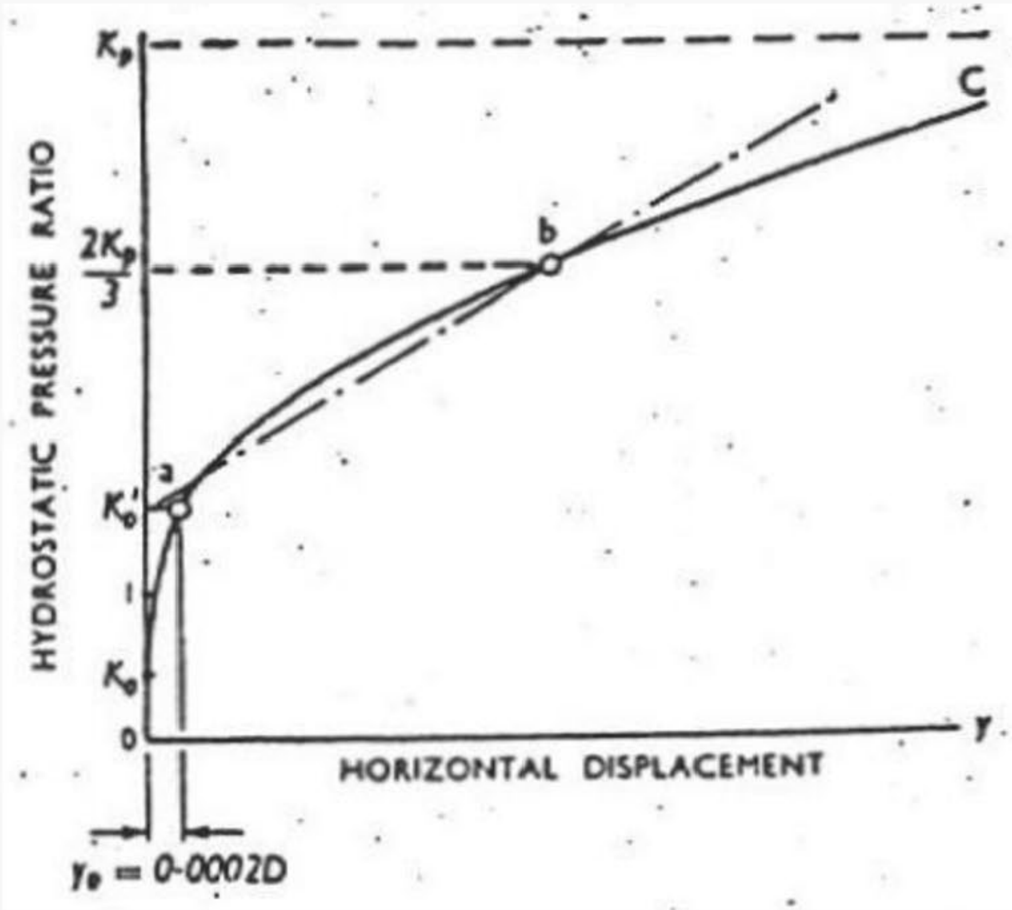

Figure 7-16 – Hydrostatic Pressure Ratio vs. Horizontal Displacement Graph for Vertical Walls, Recreated from Terzaghi (1955)

Where:

D = Vertical wall embedment into the soil. For purposes of our calculation, D is the thickness of the clinker stratum.

Ko = Coefficient of earth pressure at rest, calculated as 1-sinf= 0.5.

K'o = Coefficient of earth pressure corresponding to lateral displacement of a wall with embedment D over a distance equal to 0.0002D. We used a value of K'o of 1 as representative of a medium to dense sand soil. (Terzaghi recommends a K'o value of 0.8 for medium dense sand and a value of 1.2 for dense sand).

Kp = Coefficient of passive earth pressure, calculated as $\tan^2$ (45°+f/2) = 3.4.

For modeling purposes, we conservatively truncated the curve shown in Figure 7-16 at point a since the lateral tank displacement is smaller than 0.0002D, as shown in the analysis results section.

Boundary Conditions and Loading

We used soil springs to represent the resistance provided by the clinker sections in this FE model. We calculated the soil spring stiffness of 1.88 kip/in^2/in stiffness (stiffness, k1=1.0*gz/0.0002D, where g=soil density=125pcf, z=depth of clinker layer from ground level with Elevation of about 235 ft, D=thickness of clinker layer=45 ft), in the lateral direction. Figure 7-17 shows the soil springs in the deteriorated gunite plug area in FE model.

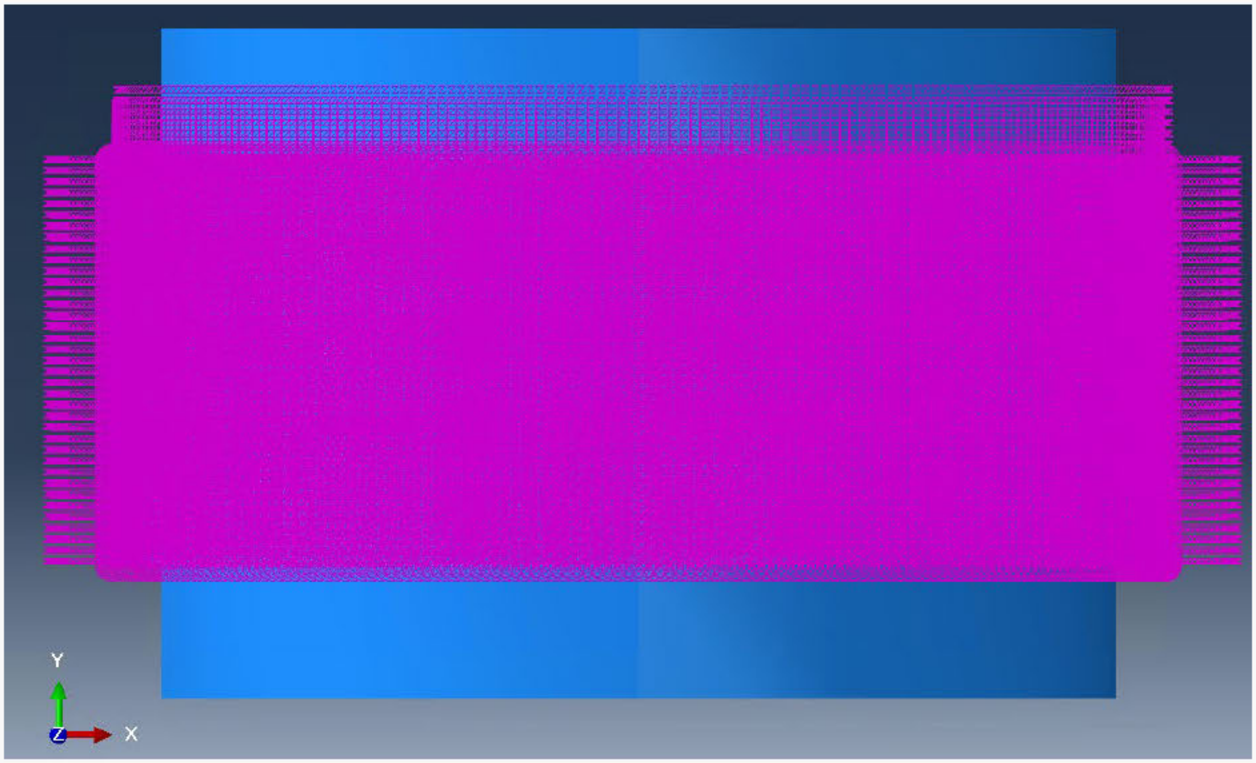

Figure 7-17 – Soil Springs (Pink Elements) in the Deteriorated Gunite Plug Area, Tank Elevation View

We used pinned boundary conditions in the radial direction on the exterior of the tank wall (except for the areas supported by soil springs) to represent the resistance provided by the rock and fixed boundary conditions at the top and bottom of the ring to represent the continuity of the tank similar to our previous local FE model discussed in Section 7.2.1.1.

We applied internal fuel pressure on the tank. We calculated the pressure (34.1 psi) at the two-third of the height of the barrel considered (i.e., pressure at the two-third of the height in the red box in Figure 7-15 (pressure at approximately 92.5 ft from the top of the barrel)) and applied that calculated pressure as a uniform pressure to the tank walls in the model.

Analysis Results

Figure 7-18 shows a magnified deflected shape of the tank wall uniformly bulging out in the areas with deteriorated gunite plugs supported by clinker layers. The maximum displacement in the radial direction is on the order of 0.017 in.

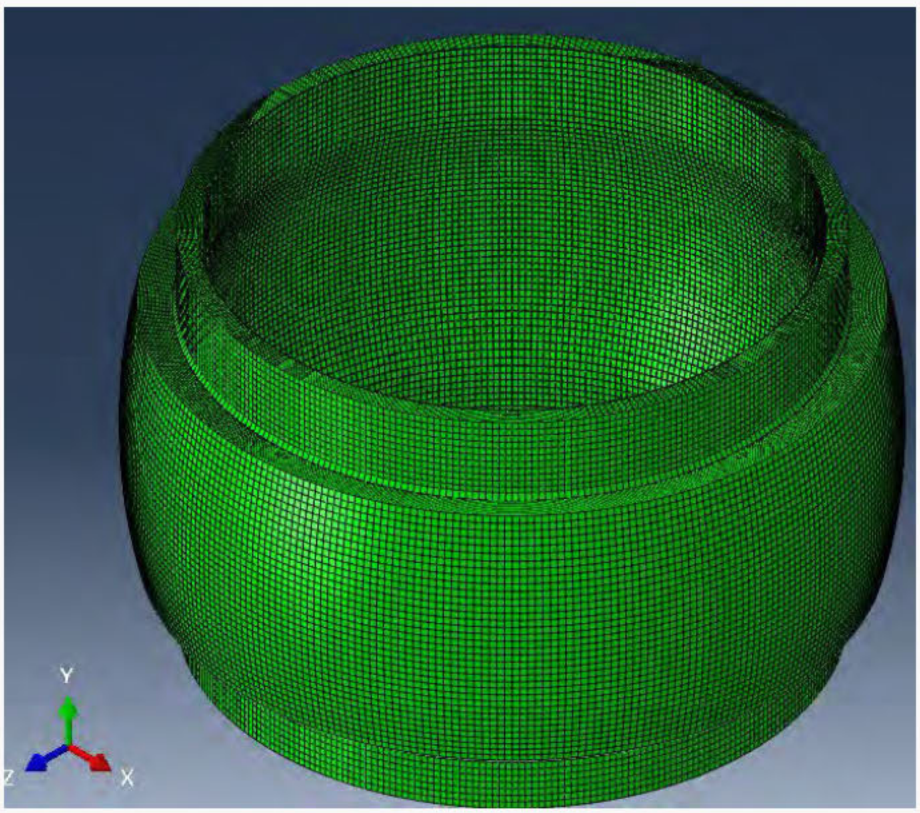

Figure 7-18 – Deflected Shape of the Barrel Ring+Gunite Plug with Postulated Gunite Damage near Barrel Mid-Height due to Internal Pressure (Magnified by a Factor of 3,000)

The analysis predicted stresses in the concrete are well below the compressive and tensile strengths of the concrete material. Similarly, the stresses in the reinforcement and the liner plate are well below the yield stress. Figure 7-19 shows von Mises stresses in the liner plate. Analysis indicates that the concrete, steel reinforcement, and liner plate remain elastic.

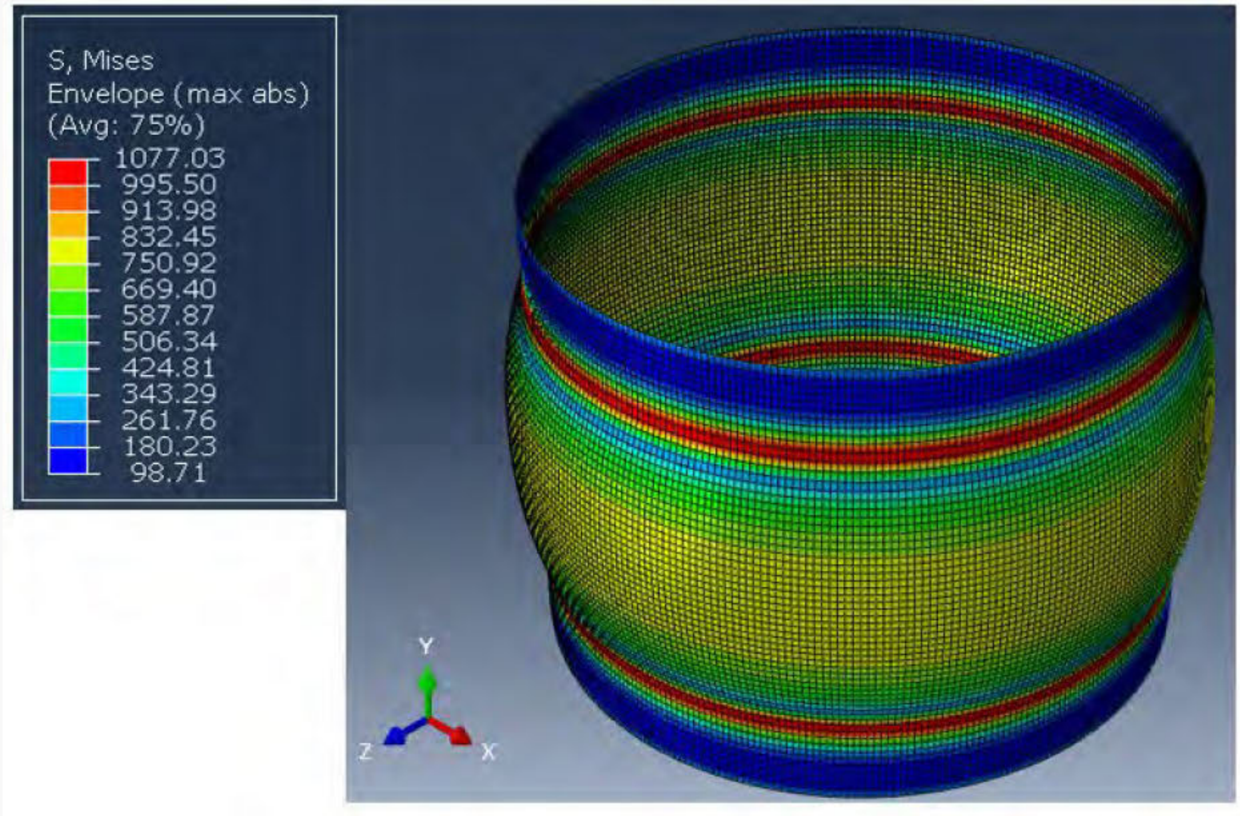

Figure 7-19 – Von Mises Stress in Liner Plate (psi)

This FE analysis predicts that the clinker sections offer sufficient stiffness to limit the displacements and the stresses in the tank for the internal fuel pressure condition. The liner plate would remain elastic even if the gunite plug has deteriorated for a longer length and any associated fuel leakage from the tank under internal fuel pressure is highly unlikely.

7.2.2 Liner Plate Local FE Model for Internal Fuel Pressure

The purpose of this analysis is to evaluate the adequacy of the liner plate spanning over an assumed void (if any) in the concrete wall under internal fuel pressure. Note the Red Hill Bulk Fuel Storage Facility Destructive Testing Results Report, AOC/SOW 5.3.3 (SSR-NAVFAC EXWC-CI01941) summarizes, "*On-site testing and laboratory testing of concrete powder samples indicated that the concrete behind the steel tank liner is in sound condition. No spalling or cracks were detected in the concrete behind the coupons, and the concrete was found to be in good condition.*" regarding the destructive testing conducted in Tank 14 in 2018. We understand that it is unlikely to have any large voids behind the liner plate. Conservatively, we are assuming a few concrete void sizes in our analysis to evaluate liner plate in case any voids are present (highly unlikely).

FE Model

We prepared a local FE model of a liner plate spanning over a concrete void, as shown in Figure 7-20. We modeled the liner plate using shell elements and elastic-perfectly plastic steel material with a yield strength of 36 ksi. We considered the thickness specified in the drawing 1/4 in. and assumed reduced thickness due to corrosion, 1/8 in. We used fixed boundary conditions at the edge of the plate to simulate continuity of the liner plate and concrete wall in vertical/longitudinal and tangential directions. We applied fuel pressure (51.3 psi) to the liner plate, assuming the void is located closer to the base of the barrel section, where the internal fuel pressure is the largest. We varied the size of the concrete void, i.e., unsupported lengths and widths of the liner plate, to evaluate its adequacy. The local liner plate model, loading, and deformed shape are presented in Figure 7-21.

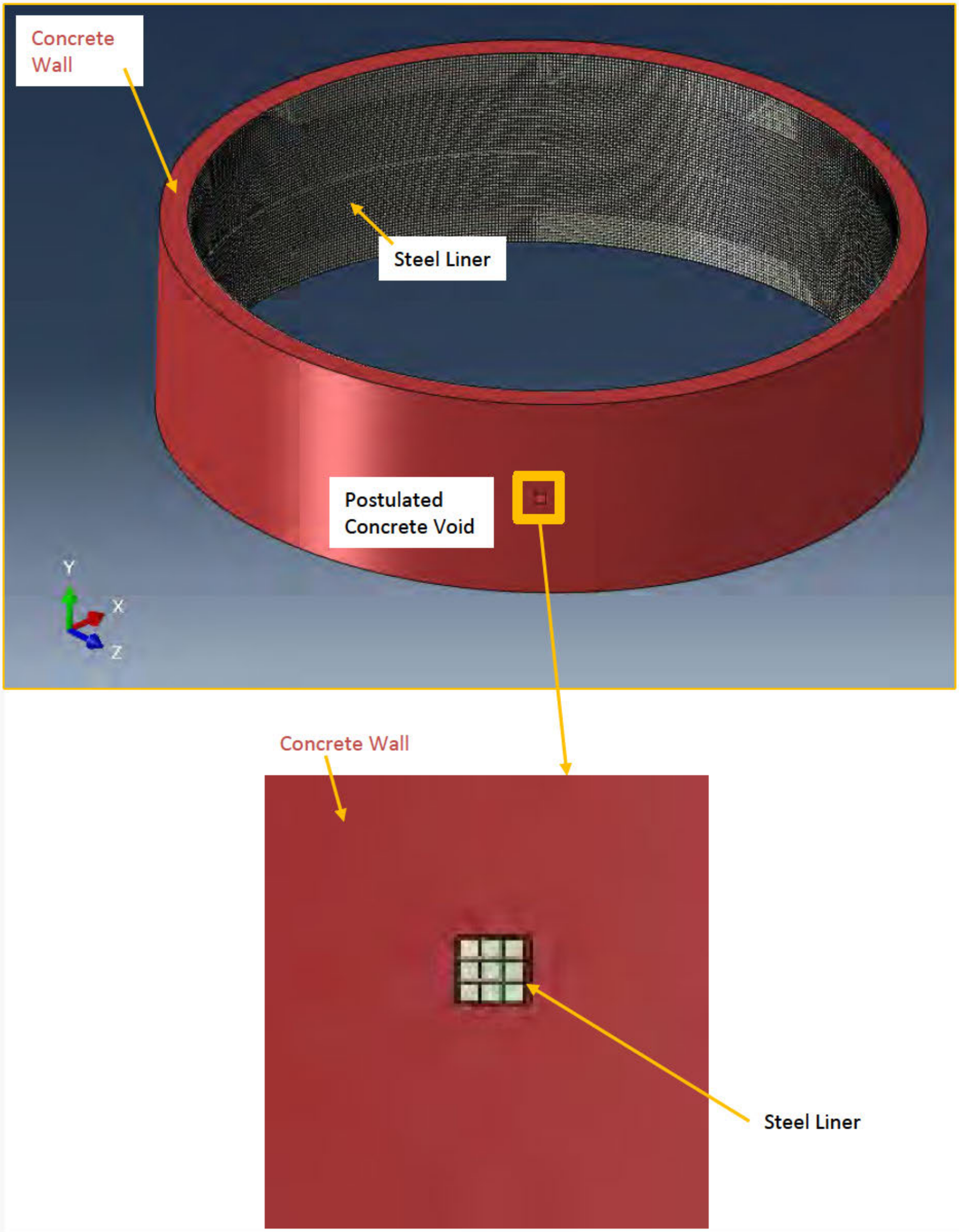

Figure 7-20 – Postulated Void in Concrete Wall

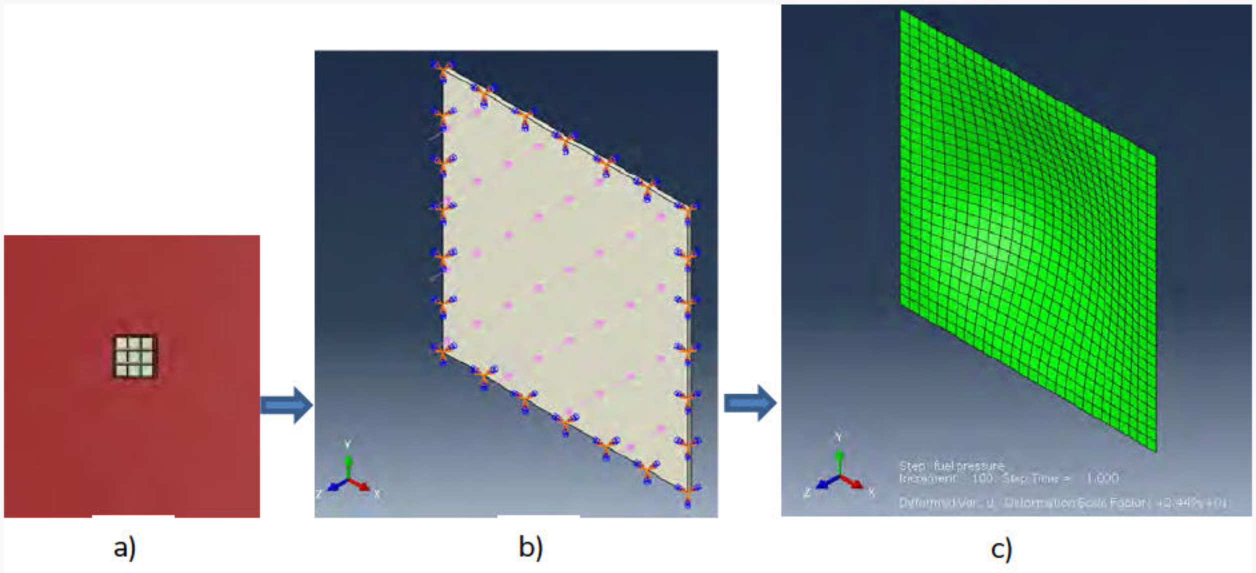

Figure 7-21 – Local Liner Plate FE Model: a) Postulated Void in Concrete Wall, b) Internal Fuel Pressure on Liner Plate, and c) Liner Plate Deformed Shape (Magnified by a Factor of 25)

Analysis Results

Analysis results indicate that ¼ in. thick plate remains elastic when the void size is 12 in. x 12 in. Figure 7-22 shows von Mises stresses in the liner plate, and the maximum stress (27.1 ksi) is below the yield stress. Maximum displacement is on the order of 0.033 in. (~1/32 in.). Results for voids larger than 12 in. x 12 in. show initiation of yielding of the liner plate.

Analysis results indicate that the 1/8 in. thick plate (assumed corroded plate) remains elastic when the void size is 6 in. x 6 in. Figure 7-23 shows von Mises stresses in the (assumed corroded) liner plate and the maximum stresses (26.2 ksi) are below the yield stress. Maximum displacement is on the order of 0.016 in. (~1/64 in.). Results for voids larger than 6 in. x 6 in. show initiation of yielding of the liner plate.

This analysis predicts that the concrete voids (if any) of size 12 in. x12 in. or smaller for uncorroded plate and 6 in. x 6 in. or smaller for heavily corroded plate located near the base of the barrel would not cause yielding of the liner plate.

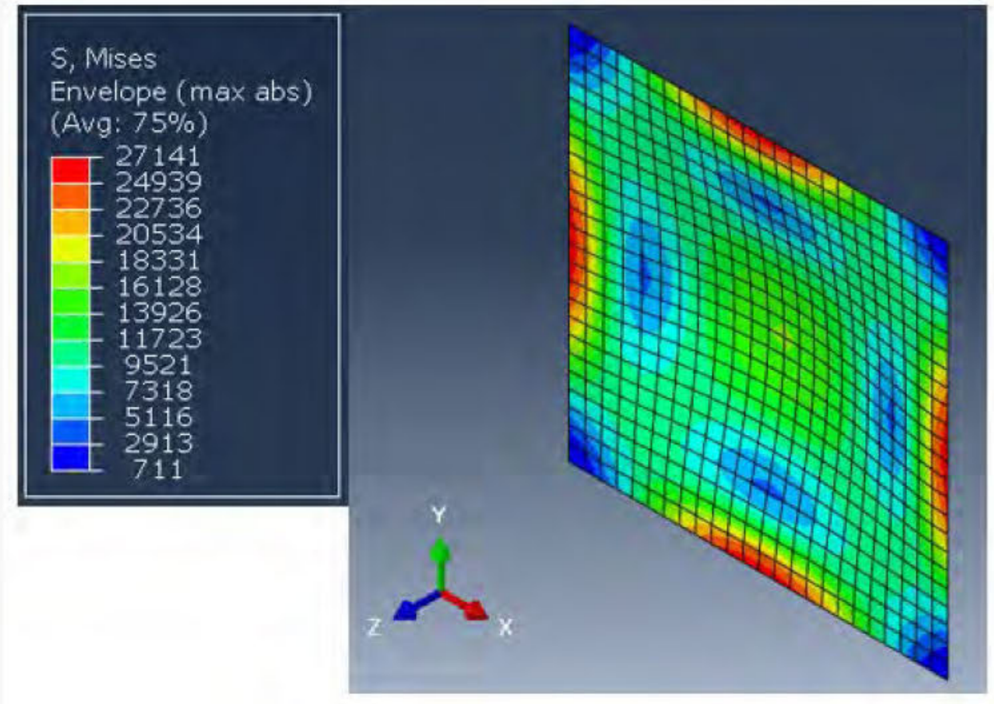

Figure 7-22 –Von Mises Stress in Uncorroded Liner Plate (12 in. x 12 in.) Local Model (psi)

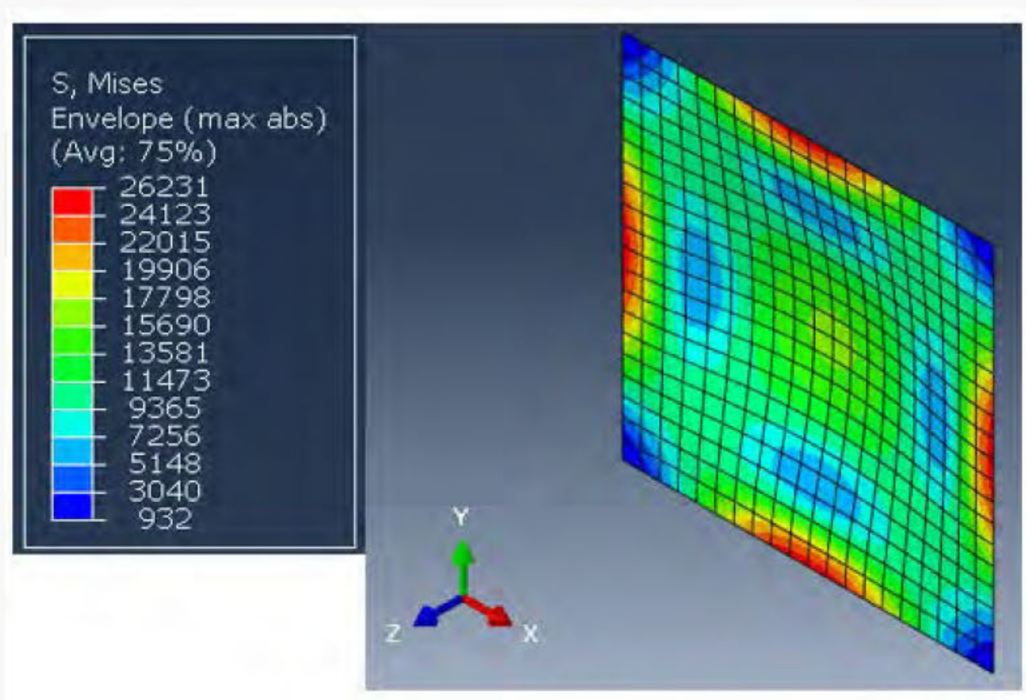

Figure 7-23 –Von Mises Stress in Corroded Liner Plate (6 in. x 6 in.) Local Model (psi)

7.2.3 UST Global FE Model for Seismic Analysis

The purpose of this global nonlinear analysis is to evaluate the structural response of the tank due to seismic loads.

FE Model

In this FE model, we simulated a typical underground tank. Figure 7-24 shows our global FE model. We modeled the concrete wall with varying thickness (4 ft at the base of the barrel section and 2.5 ft at the top of the barrel section) and the 1/4 in. thick steel liner plate. We also modeled the vertical and hoop reinforcement (both 1 in. diameter bars at 12 in. center-to-center spacing) in the barrel section.

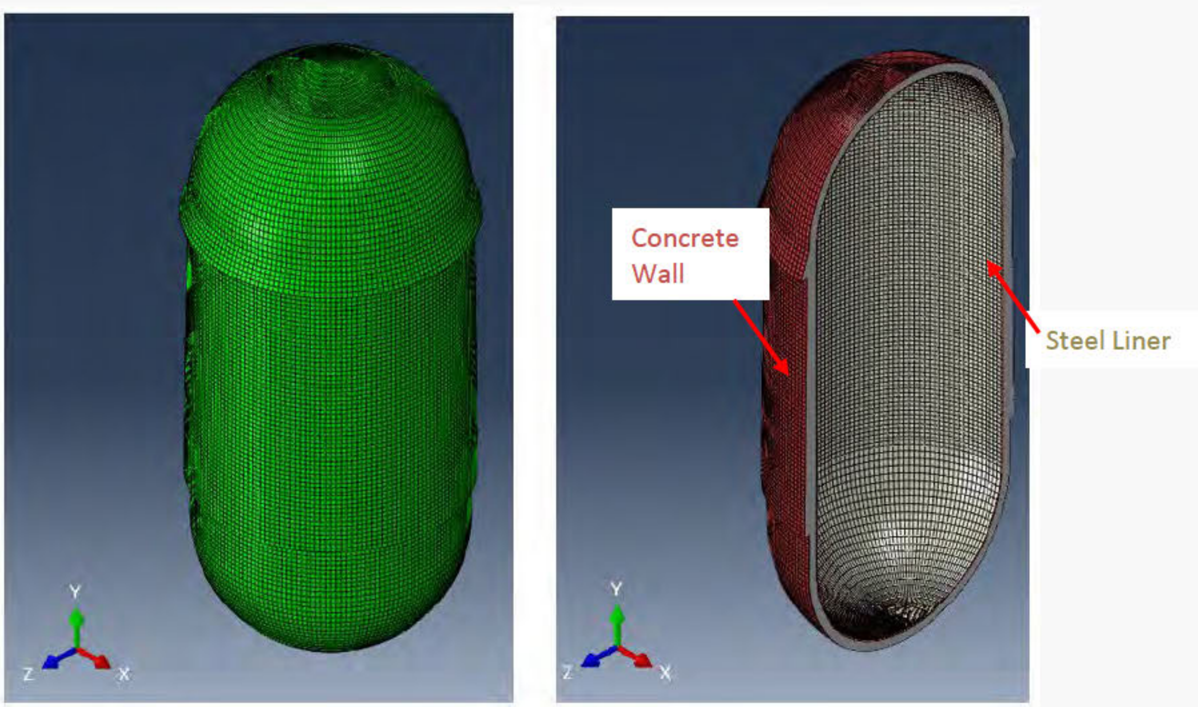

Figure 7-24 – Global FE Model of a Typical Underground Tank

We considered the strata around Tank 2, as shown in Figure 7-25. The areas with dots are clinker sections. We conservatively assumed that all the soil layers around the tank perimeter above the 20 ft. distance from the bottom of the barrel section (above the redline in Figure 7-25) are clinker layers. We modeled the gunite plug (2.5 ft. thick) at these clinker layers.

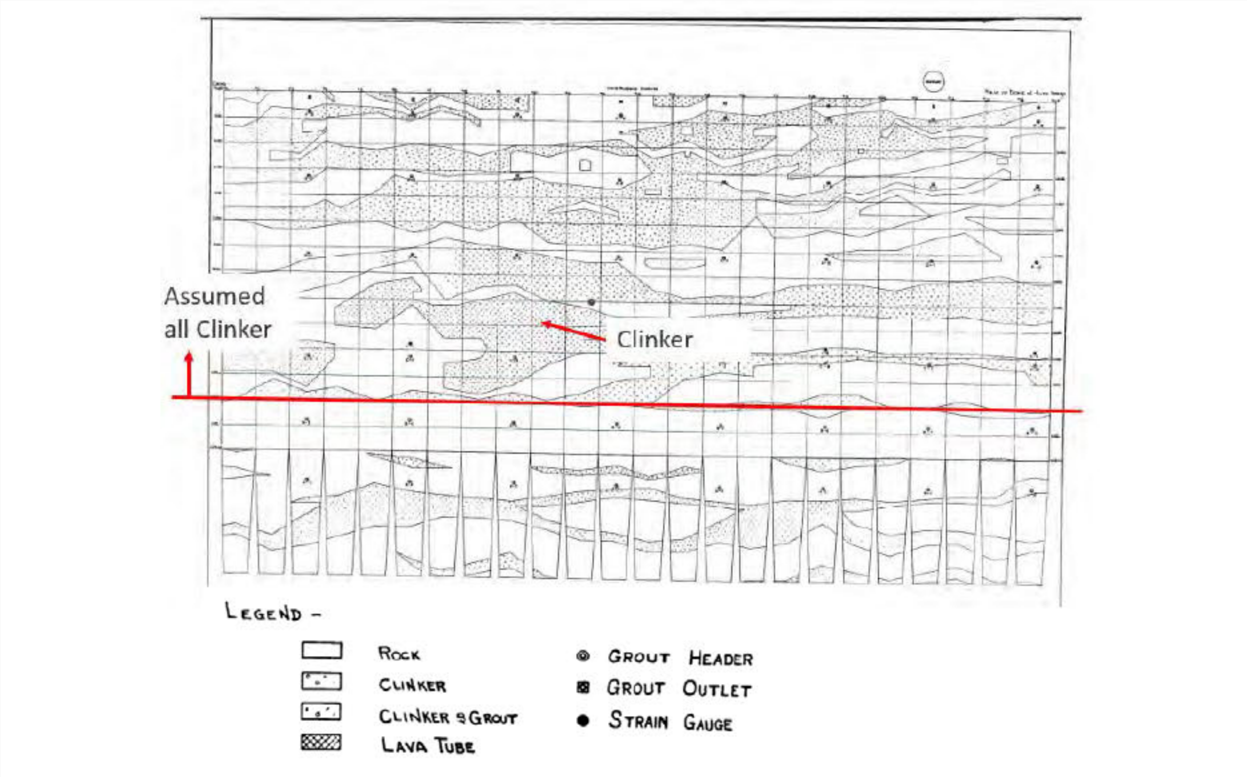

Figure 7-25 – Log of Formations, Tank 2

We modeled the concrete walls and the gunite plug using solid elements. We modeled the liner plate using shell elements. We modeled the steel reinforcement using beam elements and embedded them in concrete. We used a characteristic compressive strength of 3,000 psi for concrete and gunite, yield strength of 36 ksi for liner plate, and 40 ksi for reinforcement.

Boundary Conditions

We used compression-only soil springs to represent the resistance provided by the clinker layers in the model. We calculated the soil spring stiffness of 0.63 kip/in^2/in (stiffness, k1=1.0*gz/0.0002D, where g=soil density=125 pcf, z=depth of clinker layer from ground level with an elevation of about 210 ft, D=thickness of clinker layer=120 ft), in the lateral direction. Note that our assumption of 120 ft deep clinker layer results in a softer spring stiffness than that calculated in Section 7.2.1.2, representing conservatism in our assumption. Figure 7-26 shows the soil springs modeled in our FE model. We assume that the seismic waves do not pass through the tank, and so the soil on the opposite side of the ground motion propagation direction will resist the movement of the tank (modeled through compression-only springs), e.g., if the seismic waves propagate from north to south, we assume that the soil around the tank on the south side will resist the movement of the tank based on the lateral stiffness provided by the clinkers.

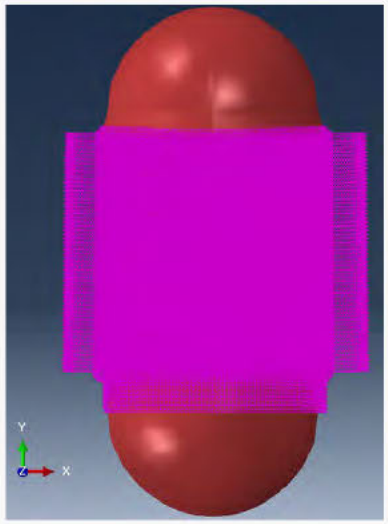

Figure 7-26 – Compression only Soil Springs (Pink Elements) at Clinker Layers, Tank Elevation View

We used pinned boundary conditions in the radial direction on the exterior of the tank wall in the bottom 20 ft of the barrel section to represent the resistance provided by the sound rock layer and fixed boundary conditions at the exterior of the bottom dome to represent the bottom dome being encased in mass concrete in Figure 7-27.

Figure 7-27 – Boundary Conditions in the Model, Tank Elevation View

Estimation of Seismic Loads and Application of Loads

We used the simplified method outlined in Section 8.2.2 of ASCE 4-16 to calculate the soil pressure on the tank due to a design-level earthquake event. This method is generally used for estimating dynamic soil pressures for rigid embedded walls retaining a homogeneous linear elastic soil and connected on a rigid base with rock or firm foundation. It is used when no significant structure-to-structure interaction is present. Note that the tanks are relatively close to each other at Red Hill (100 ft of the clear distance between the tanks), so there may be some interaction between the tanks. A more detailed approach (such as soil-structure interaction) may be required to better estimate the upper bound seismic loads and tank's response. Also, note that we made several conservative assumptions, such as 120 ft deep clinker layer, corresponding to smaller soil spring stiffnesses, and neglecting friction between the soil and the tank. In addition, we also assumed that the clinker layer is extended further from the top of the barrel section to the ground level by adopting the simplified approach. Overall, it is judged to be a reasonable and conservative approach with the conservative assumptions we made.

We calculated the soil pressure using the graph showing the variation of normal dynamic soil pressure as shown in Figure 7-28. The Y-axis shows the ratio Y/H, and the X-axis shows the dimensionless normal stress, σ^0_x/gH, where Y=distance of the section under consideration from the base of the barrel section (varies along the height of the barrel, we used 20 ft intervals), H=embedment height= depth at the base of the tank from ground level with an elevation of 340 ft., σ^0_x=lateral dynamic soil pressure against the tank for 1.0 g peak ground acceleration, g=soil density=125 pcf, and v=Poisson's ratio (assumed 0.3 for dense gravel/sand). The peak ground acceleration for a design level earthquake was estimated based on a Risk Category III, Soil Class C, and the location of Red Hill [redacted] (b)(3)(A). We scaled the soil pressure calculated from Figure 7-28 to 0.194g peak ground acceleration presented in Table 7-1.

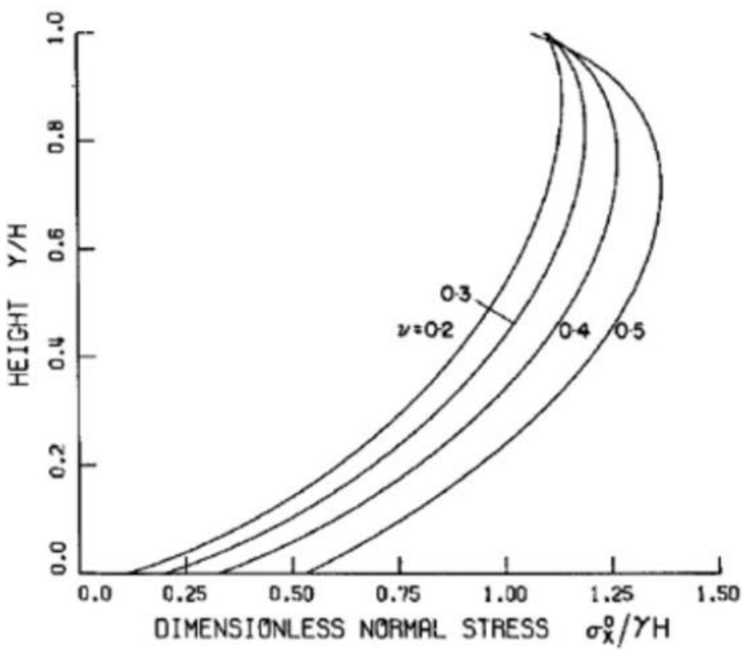

FIGURE 8-1. Variation of Normal Dynamic Soil Pressures for the Simplified Elastic Solution

Note: *H* = embedment height; *Y* = distance from base of retaining structure; γ = soil unit weight; ν = Poisson's ratio; and σ_2^o = lateral dynamic soil pressure against the retaining structure for 1.0*g* peak ground acceleration.

Figure 7-28 – Soil Pressure Distribution for the Simplified Method, Recreated from ASCE 4-16

Table 7-1 – Calculated Soil Pressure across the Height of the Clinker Layer

Distance from the Top of the Barrel Section/Clinker Layer	Calculated Soil Pressure, psi
10 ft	53.2
30 ft	49.8
50 ft	44.7
70 ft	40.7
90 ft	34.4
110 ft	26.9

We applied the calculated soil pressures presented in Table 7-1 in the horizontal direction (across the height of the clinker layer) on one side of the tank (right half), as shown in Figure 7-29. We also applied the hydrostatic pressure of the fuel on the internal side, as discussed in previous sections. We used a factor of 0.8 (i.e., 80%) on the hydrostatic pressure to consider 20% of the fuel acting out-of-phase with the tank during a seismic event (assumed).

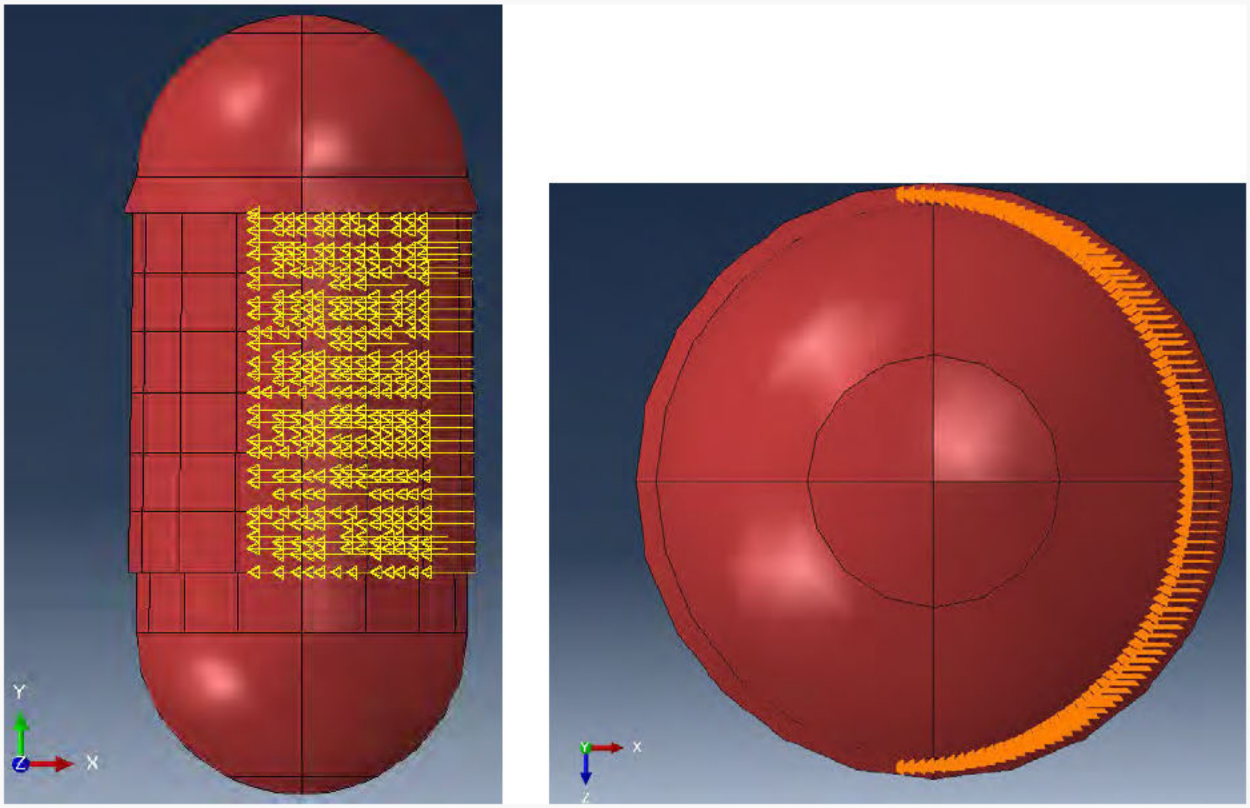

Figure 7-29 – Seismic Load Application, Elevation (Left), and Plan (Right)

Analysis Results

Figure 7-30 shows the deflection contours of the tank. The tank deflects towards the left due to soil pressure applied at clinker layers on the right half of the tank. The displacement at the top of the barrel on the left side is on the order of 0.15 in. The upper dome goes along for the ride (no springs/boundary conditions modeled at the upper dome) with slightly larger displacements. The vertical section cut shows the local bending of the tank on the right side of the tank (blue areas) with a maximum displacement on the order of 0.6 in.

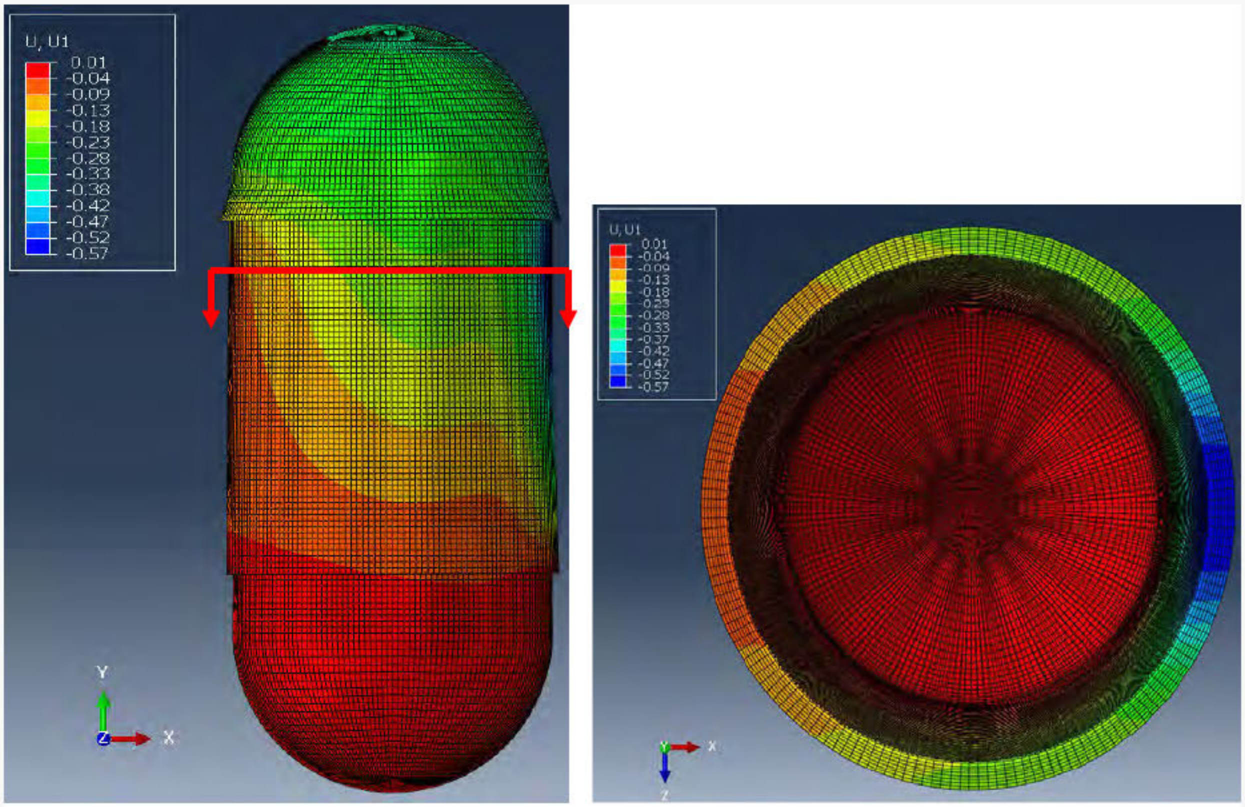

Figure 7-30 – Deflection Contours of the Tank for Applied Soil Pressure

The analysis predicted that the reinforcement and the liner plate remain elastic. Figure 7-31 shows the von Mises stresses in the liner plate. The maximum stress is approximately 23 ksi at the interface of the rock and clinker layer on the loading side, indicating stress concentration at the interface. The analysis also predicted the concrete at the interface of the rock and clinker layer on the loading side cracks, but this cracking is limited in a local area near the interface and not widespread. This local cracking will not likely affect the tank performance after an earthquake event.

The results of the analysis indicate that since the liner plate is not overstressed, the fuel inside will be contained in a design-level seismic event, and any leakage is highly unlikely.

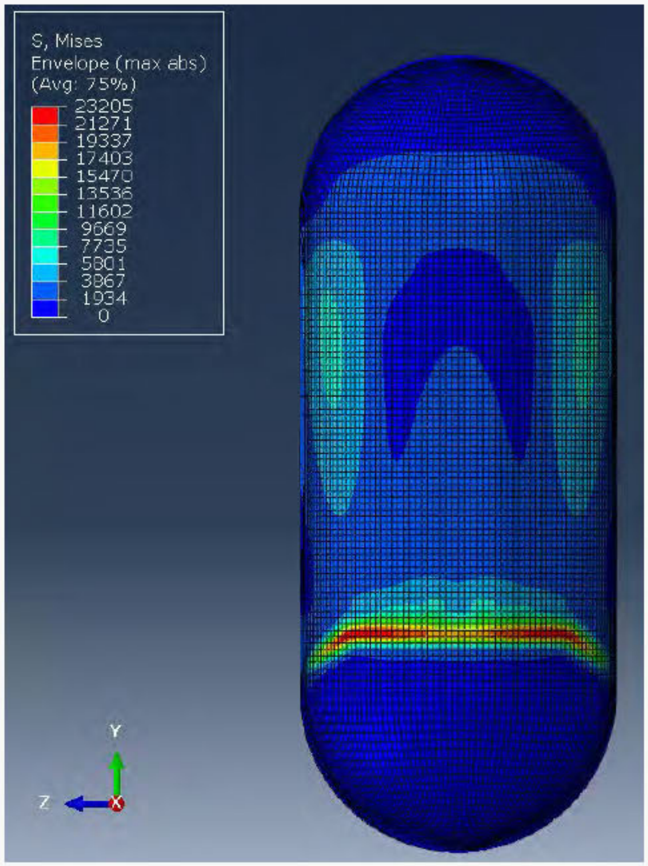

Figure 7-31 – Von Mises Stress in Liner Plate (psi)

7.2.4 Discussion

7.2.4.1 Clean, Inspect, Repair Program

We reviewed the CIR documents provided to us, including numerous API 653 inspection reports and recommendations. The complete CIR process implemented for these tanks is comprehensive and includes tank cleaning, scanning of 100% of the tank liner surface, calculations of tolerable corrosion according to API 653, and mandatory repairs to the metal plates, welds, and coatings, followed by a repair completion report.

The API 653 inspection program, which has a twenty-year inspection cycle, is the industry standard for ensuring that storage tanks are fit for service. As well as inspecting for defects and corrosion loss and listing mandatory repairs, the inspection standard provides a conservative corrosion allowance for the twenty-year interim based on the worst-case corrosion of the tank shell.

As of our site inspections in April 2022, 13 tanks were in the current CIR inspection program, two tanks were undergoing the CIR process, two tanks were permanently out of service, and no documentation was provided for the remaining three tanks. We understand that prior to the announcement of the defueling of the tanks, the remaining three tanks without inspection status were due to undergo API 653 inspections once the current work on Tanks 14 and 18 was completed.

We note that the conditions observed in all tanks are similar. The scanning has revealed numerous weld defects, including lack of fusion, porosity, and occasional cracking. Still, these are not unusual on historical welds and are readily repaired during the CIR process. Occasional localized internal corrosion pitting of the tanks has occurred, but the most severe corrosion appears to be external corrosion at the upper tank dome, where failure will not produce leaking from these tanks.

The current CIR is suitable for these tanks. Assuming that the tanks are going to be defueled within one to two years, then no recommendations are necessary for these tanks. However, if the tanks are to be used in the long term, the remaining three tanks should enter the CIR process as soon as practicable, and all tanks should undergo API 653 inspections every twenty years.

7.2.4.2 Finite Element Analysis

We performed nonlinear finite element analysis of the local ring sections near the base of the barrel and near mid-height of the barrel in a typical underground tank to evaluate the adequacy of the tank and its components to resist internal fuel pressure considering a postulated scenario where the gunite plug is deteriorated for a certain length and is either laterally unsupported or supported by clinker layers (softer than basalt layers). The primary objective is to check and identify if these postulated scenarios would result in any environmental concerns, mainly fuel leakage, under internal fuel pressure conditions. We made several conservative assumptions to simplify our analysis, as discussed in previous sections. The results show that the liner plate remains elastic (well below its yield stress) in both the cases (with unsupported tank wall case and supported by clinker layers case in the (postulated) deteriorated gunite plug areas), indicating the possibility of any leakage is highly unlikely under the internal fuel pressure condition.

We also performed a nonlinear finite element analysis of the local liner plate spanning over assumed concrete voids located near the base of the barrel. Note that the presence of large voids in concrete is highly unlikely. We considered the uncorroded and highly corroded (assumed only half of the design thickness is effective) conditions. The results show that the presence of concrete voids (if any) of size 12 in. x12 in. or smaller for uncorroded plates and 6 in. x 6 in. or smaller for heavily corroded plate located near the base of the barrel does not cause yielding of the liner plate. Any associated fuel leakage from the tank for the internal fuel pressure condition is highly unlikely.

We performed a nonlinear finite element analysis of the entire tank to evaluate its adequacy for a design-level seismic event. We conservatively assumed a 120 ft deep clinker layer. We calculated the soil pressure due to earthquake using the simplified method for dynamic soil pressure on embedded walls from ASCE 4-16 and used compression-only springs to represent the restraints offered by the clinker layers. The analysis results demonstrate that when the soil pressure from the clinker layers is applied to the tank, the displacements are small, and the stresses in the liner plate remain well below the yield stress indicating the possibility of any fuel leakage due to a design level earthquake event is highly unlikely.

7.3 Piping

We developed several pipeline stress analysis models to analyze conditions in The Facility. We conducted all analyses in accordance with ASME B31.4, which is for pipeline transportation systems. We used the commercially available pipe stress analysis software TRIFLEX by PipingSolutions, Inc. to perform the analysis. We created the following models to evaluate the impact of surge forces in the pipelines due to defueling:

- Red Hill – 6 May 2021 Event Models.
- Red Hill – JP-5 Defueling Model – Near Tanks 19 and 20.
- Red Hill – F-76 Defueling Model – Near Tanks 15 and 16.

- Red Hill – JP-5/F-24 Defueling Model – Near Tanks 15 and 16.
- Red Hill – Defueling Model – Near Tanks 13 and 14.

Additionally, we created the following models to evaluate observations that were considered potential deficiencies and typical conditions:

- Red Hill – Nozzle Tank Wall – Local Analysis.
- Harbor Tunnel – Straight Segment.
- Harbor Tunnel – Unsupported Valve Segment.

We considered the following material and section properties for the pipelines:

- Piping Material – ASTM A53 Gr. B (Fy = 35 ksi, all pipelines).
- JP-5, F-24 Pipelines Wall Thickness – 0.25-in.
- F-76 Pipeline Wall Thickness – 0.375-in.
- Repair Piping Wall Thickness – 0.375-in.

We considered the following operational loads for all the pipeline models:

- Operating Pressure of 200 psig (2015 Pressure Testing Report).
- Thermal Differential of +/-20°F (Emergent Ball Valve and Dresser Coupling Repairs).
- Self-Weight of Pipelines and Product (S.G. dependent on service, See UFC 3-460-01 Tables 2-1 and 2-2 (Department of Defense, 2021)).

The surge force analysis models also considered a point load equivalent to a pressure of 320 psi acting on an area that would stop the momentum of fluid rushing in to fill the vacuum (e.g., blind flange, closed valve). We took this pressure from the 2021 Root Cause Analysis Report. This pressure was used to corroborate the pressure determined using a hydraulic and surge analysis within the same report. Detailed analysis and results for each of the models is provided in the following sections.

7.3.1 Red Hill – 6 May 2021 Event Models

We developed two separate models to recreate the effects of the transient surge that occurred during the 6 May 2021 event resulting in pipe failure. The two models differed in terms of restraints, and boundary conditions observed and are detailed in the following sections.

7.3.1.1 6 May 2021 Event Model – Root Cause Report Boundary Conditions

This is the first model SGH developed to recreate the piping analysis performed in the 2021 Root Cause Report using their suggested boundary conditions and forces. Those assumptions are detailed below and shown graphically in Figure 7-32:

- Full fixity restraint at the firewall between the Tank 19 – 20 area and the remainder of the lower tank gallery.
- Sliding support at Pipe Supports 1 and 2 in the Tank 19 – 20 area.
- 78,000 lbf surge force acting at the unrestrained blind flange towards Tank 19.
- Pipeline disconnected from Tank 20, representing the post-failure of the Dresser coupling condition.

In this analysis, we were able to validate the calculated surge load and estimated displacements for the assumptions described above. Using the boundary conditions from the root cause report, we were able to calculate a lateral displacement of approximately 14.6 in., which is within 10% of the calculated displacement from the Root Cause Report of 16 in.

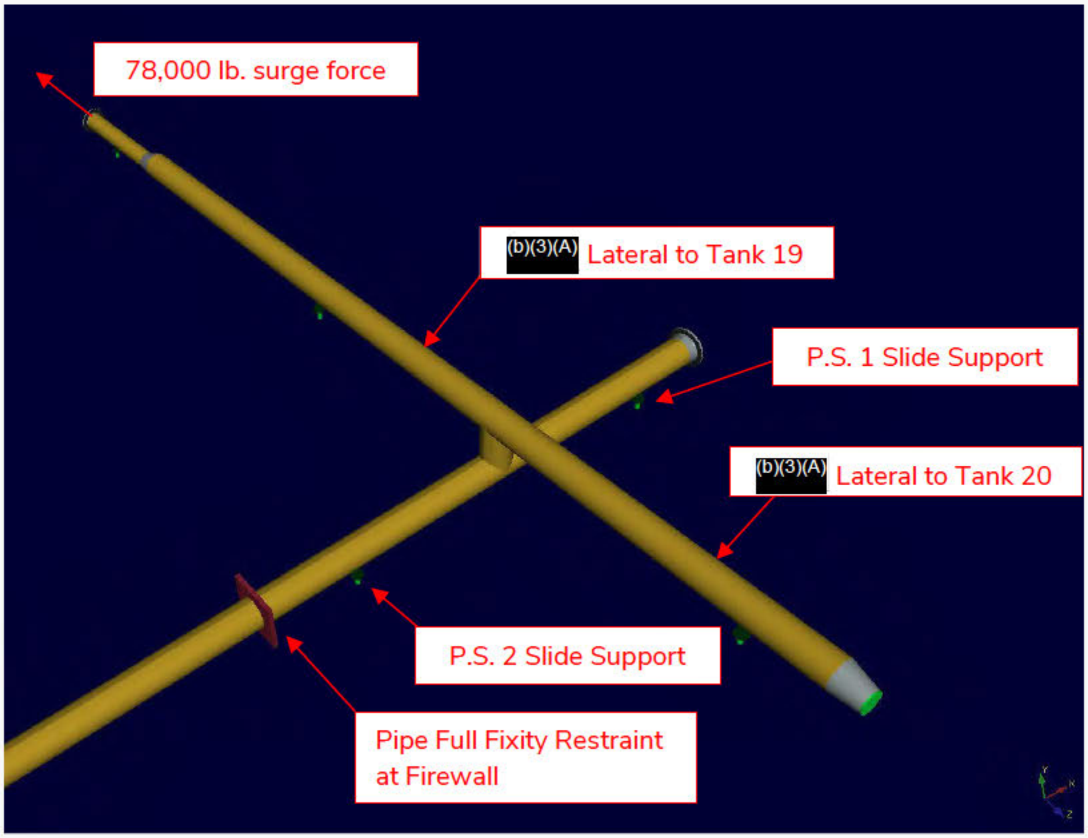

Figure 7-32 – 6 May 2021 Event – Root Cause Report Boundary Condition Model

7.3.1.2 6 May 2021 Event Model – SGH Observed Boundary Conditions

Based on our observations in the field during site visits and from our review of as-built drawings, we modified the model described above to reflect support conditions that we believe are consistent with the conditions present during the 6 May 2021 incident.

In particular, we altered the sliding pipe supports used in the Root Cause Report model based on our observations of the presence of pipeline cradles at most pipe supports, as previously depicted in Figure 2-12. A photograph of the support cradle at Pipe Support 2 is shown in Figure 7-33.

(b)(3)(A)

[redacted]

Figure 7-33 – Cradle Support Photo at Pipe Support 2

The cradle support is neither sliding support nor a full lateral pipe restraint. SGH used TRIFLEX to adjust the restraints to a 45° angle on both sides to model the restraint conditions more accurately at the cradle (Figure 7-34).

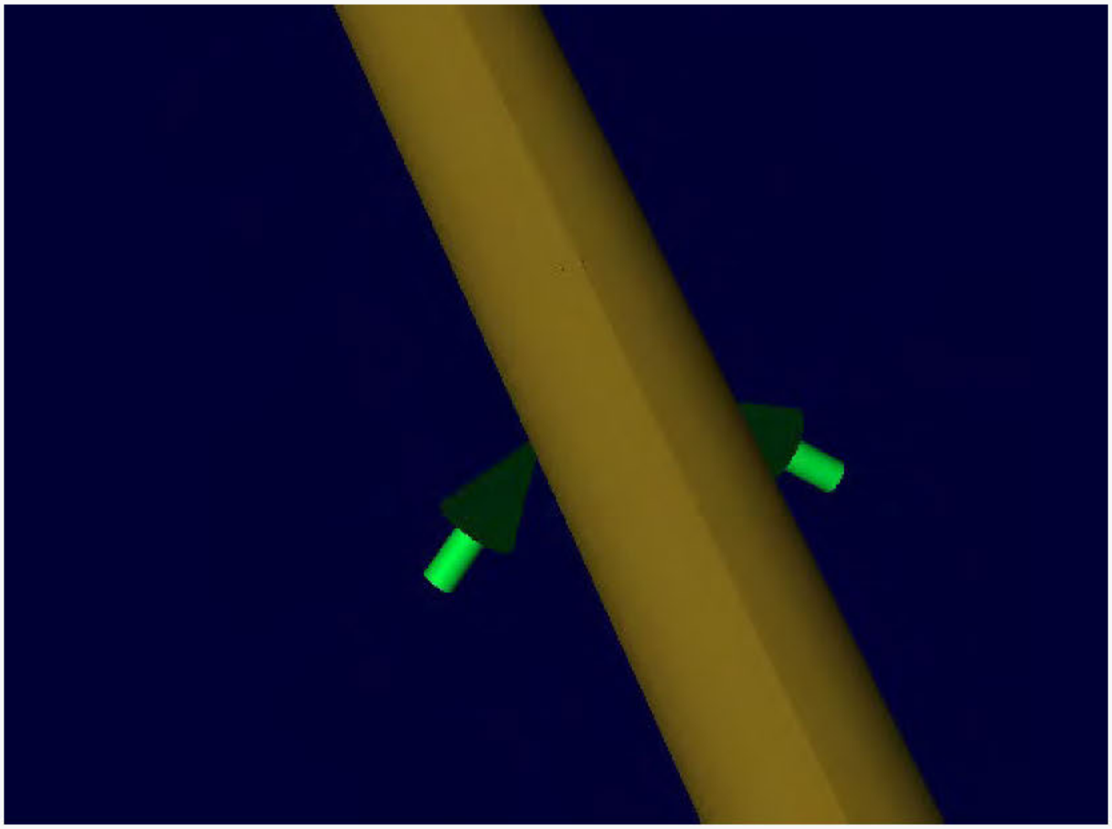

Figure 7-34 – Cradle Support Modeled in TRIFLEX Software

We then made additional modifications to the model to further reflect observations in the field, including the following:

- Modifying the full fixity restraint at the firewall to lateral and vertical gap restraints. This is because the wall does not appear to restrain rotation based on-site observations and measurements (Figure 7-35). The gap was measured to be 0.75 in. above the pipe. The horizontal gap was then assumed to be 0.375 in. on either side of the pipe. These gap restraints were placed 6 in. apart to reflect the thickness of the firewall itself.

- Modeling the pipelines past Tanks 17-18 to account for the additional pipeline flexibility past the firewall.

- Including pipeline saddle restraints at Pipe Supports 4, 6, 7, and 8, as observed in the field (Figure 7-36).

- Include sliding supports at Pipe Supports 3 and 5 (Figure 7-37).

(b)(3)(A)

[redacted]

Figure 7-35 – Pipe Penetration at Firewall After Tanks 19-20, 0.75 in Gap Allowing Rotation and Displacement

(b)(3)(A)

[redacted]

Figure 7-36 – Cradle Support at Pipe Support 4 (Pipe Supports 6, 7, and 8 Similar)

[redacted] (b)(3)(A)

Figure 7-37 – No Cradle Support at Pipe Support 3 (Pipe Support 5 Similar)

A model image showing the additional modifications to boundary conditions and restraints in our final model is shown in Figure 7-38 and Figure 7-39. Like above, the model served to capture the sensitivity of the surge force required to move the main header 16 in. when accounting for the more refined boundary conditions.

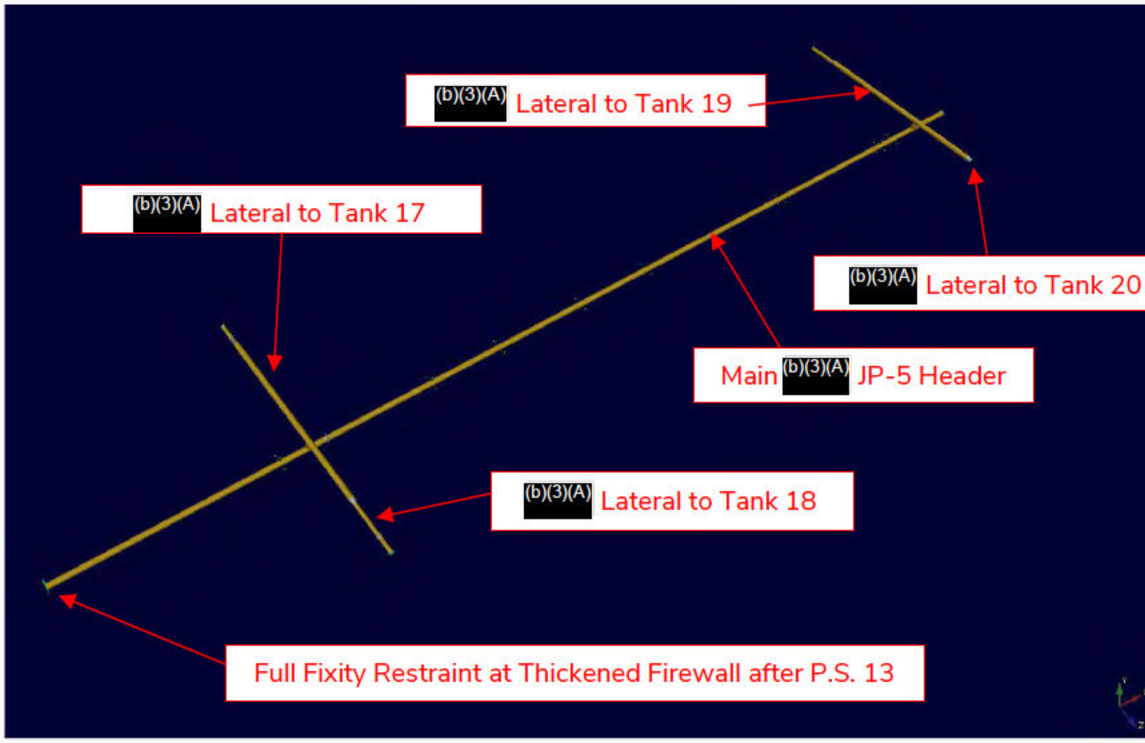

Figure 7-38 – 6 May 2021 Event – SGH Boundary Condition Model – Global View

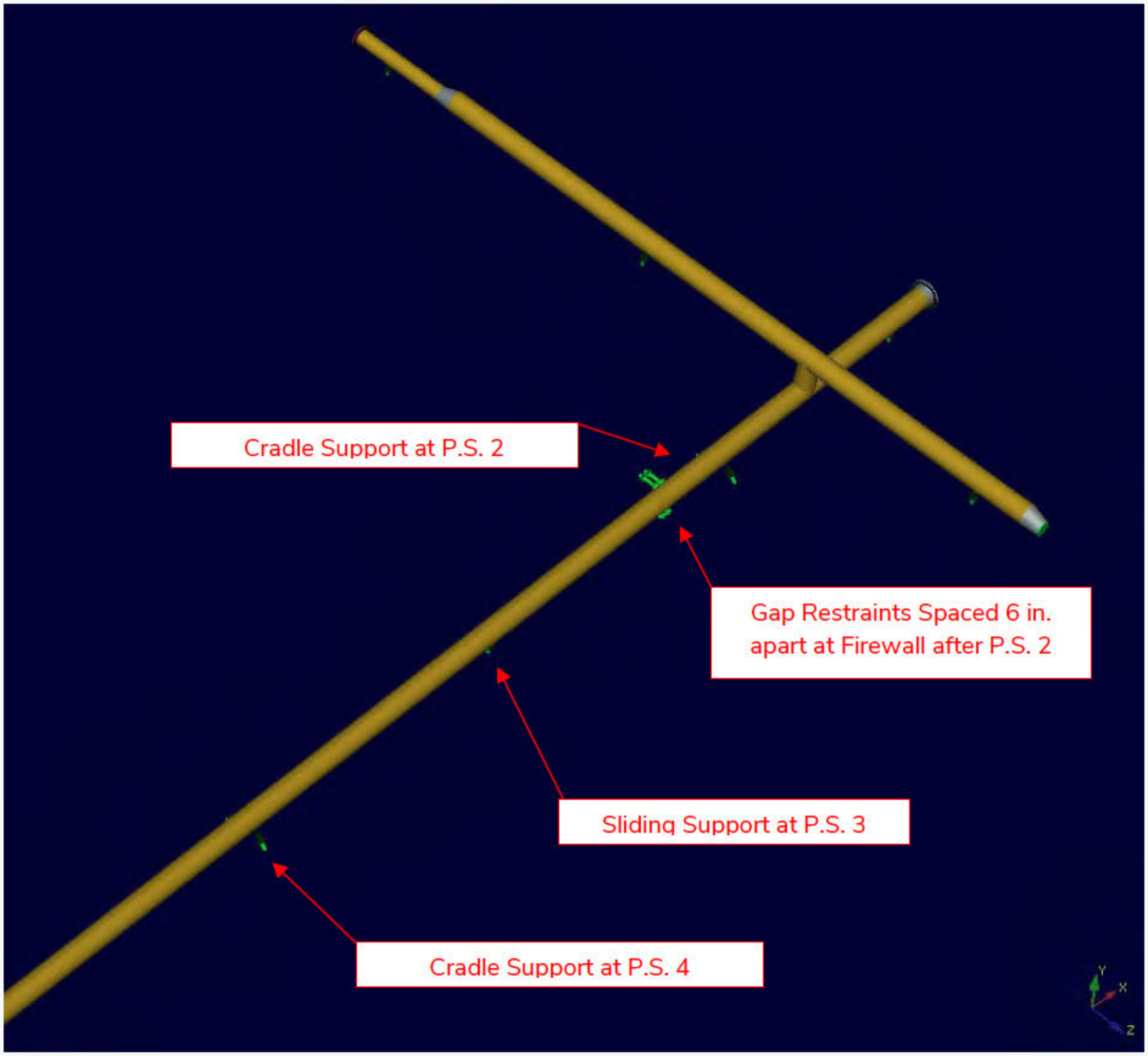

Figure 7-39 – 6 May 2021 Event – SGH Boundary Condition Model – Tanks 19 and 20 View

Using these updated boundary conditions, we calculated the force required to move the main [redacted] JP-5 header to be approximately 60,000 lbf. This reduced force required to move the header is likely due to the more flexible boundary conditions that we used as opposed to the rigid anchor restraint from the Root Cause Report model. We maintained these boundary conditions moving forward, as we believe them to be more accurate when considering what was observed in the field. However, we conservatively used the 78,000 lbf surge force and associated pressure when considering surge conditions for the pipeline defueling models, given the degree of uncertainty associated with potential future surge events.

7.3.2 Red Hill – JP-5 Defueling Models – Tanks 19-20

We created several models to determine the impact of surge loads at the end of the JP-5 header near Tanks 19-20 during defueling operations. These models considered the anticipated repairs near the Tank 19 and 20 connections. We analyzed the following surge conditions for each of the models.

- Surge Load – Acting at Tank 19 Spectacle Blind.
- Surge Load – Acting at the end of JP-5 Header Blind Flange.
- Surge Load – Acting at Tank 20 Ball Valve.

We developed a separate model considering an axial restraint near the Tank 20 ball valve to determine the impact of an axial restraint has in resisting the axial surge loads in the pipeline laterals and protecting the pipe bends. Analysis details and results are described in the sections below.

7.3.2.1 JP-5 Defueling – Surge Load at Tank 19 Spectacle Blind

We modeled the piping at Tanks 19-20, considering the repairs shown in the January 2022 Enterprise Engineering drawings. These include the following modifications:

- Additional Piping to Tank 19 Wall Nozzle.
- Additional Piping from End of JP-5 Header to LAT Wall.
- Replacement Piping Between Tank 20 Ball and Double-Block and Bleed Valves.

While the general arrangement of the repairs at Tanks 19-20 was shown in the drawings, no dimensions were provided. Because of this, we had to approximate dimensions from measurements taken in the field of the completed and in-progress repairs. We applied the surge force in this model at the location of the spectacle blind on the Tank 19 lateral, as this is where fluid momentum would be halted in the event of a surge due to a vacuum in the pipe. An image of the model arrangement is shown in Figure 7-40.

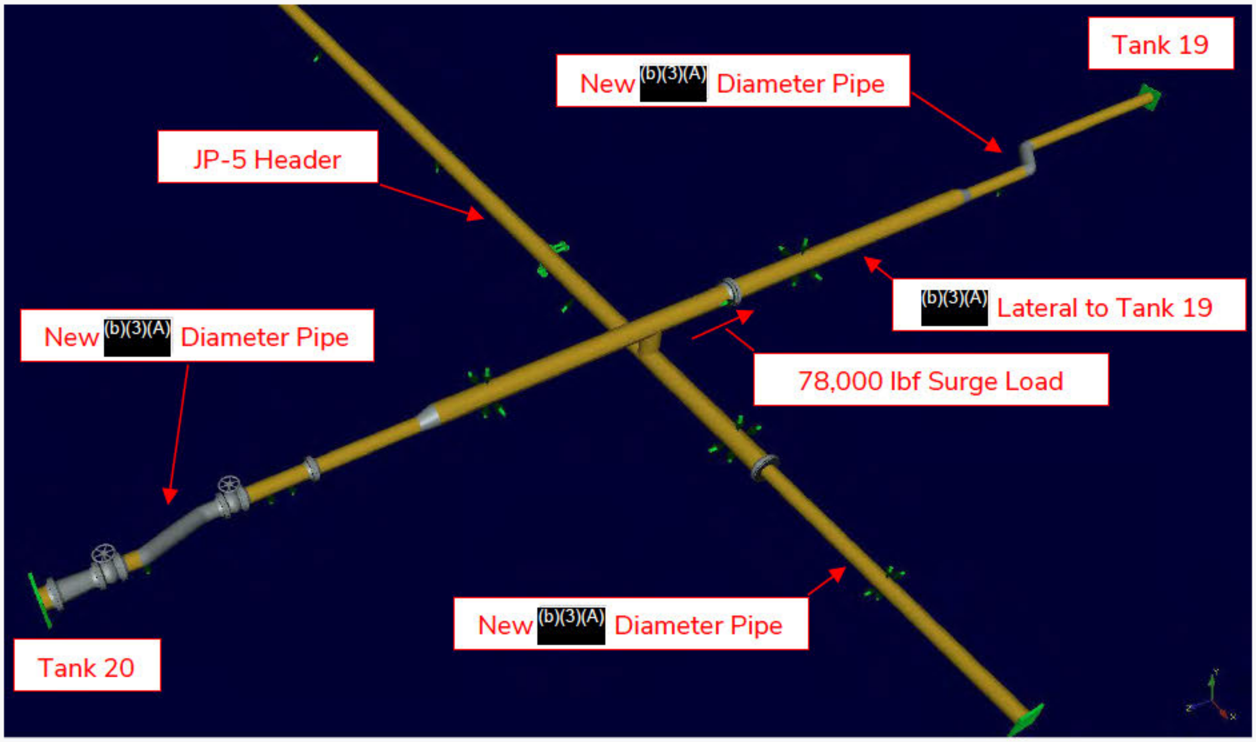

Figure 7-40 – JP-5 Defueling Model – Surge at Tank 19 Spectacle Blind

We found that the stresses in the piping at Tanks 19-20 would slightly exceed ASME B31.4 code allowable stresses in this support configuration. A diagram showing the ratio of demand longitudinal stress in the pipeline to allowable code stress is shown in Figure 7-41.

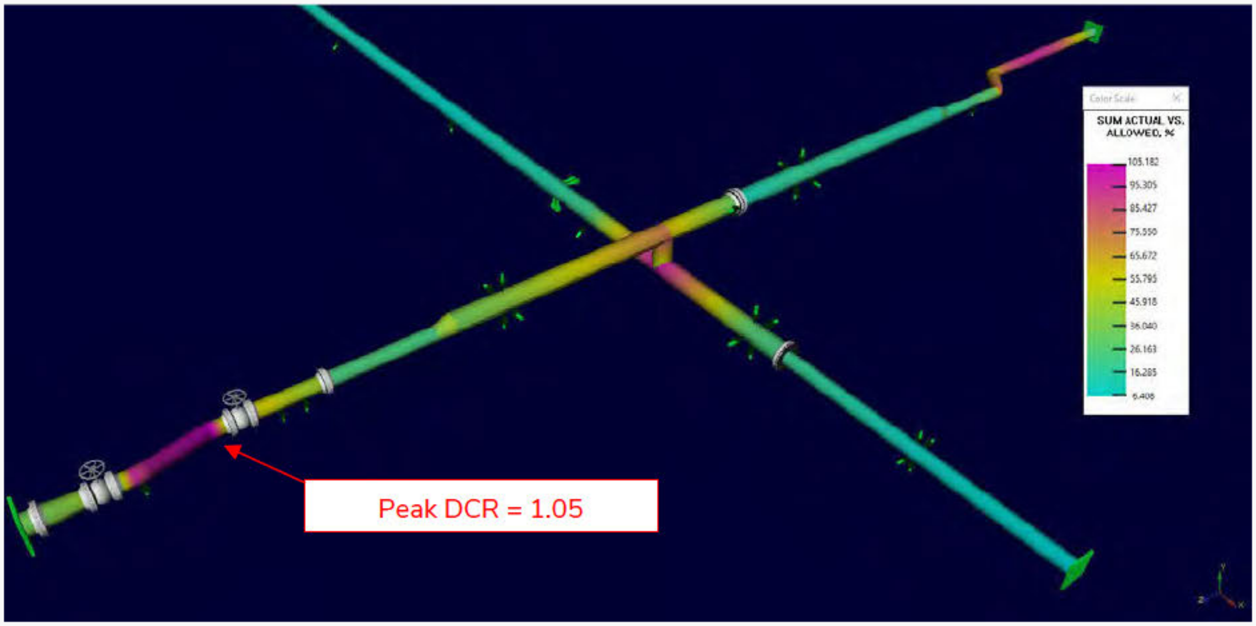

Figure 7-41 – Surge at Tank 19 - Demand vs. Code Longitudinal Stress Ratios

The peak ratio of demand to allowable longitudinal stress as calculated per ASME B31.4 was 1.05 at the bend between the ball and double-block and bled valve near Tank 20. The ratio was 1.01 at the base of the tee connecting the JP-5 header to the laterals. These ratios indicate potential small overstress at these locations due to the surge loading. We observed stress ratios to be less than 1.0 everywhere else in the model.

7.3.2.2 JP-5 Defueling – Surge Load at the End of JP-5 Header

We then checked the JP-5 piping considering the surge force to be acting at the blind flange at the end of the main JP-5 header. The blind flange at this location presents another surface that would halt the fluid momentum during a fluid surge due to a vacuum condition at the end of the header. Aside from the surge force location, we kept all other model geometry the same. A model image of the revised configuration is shown in Figure 7-42.

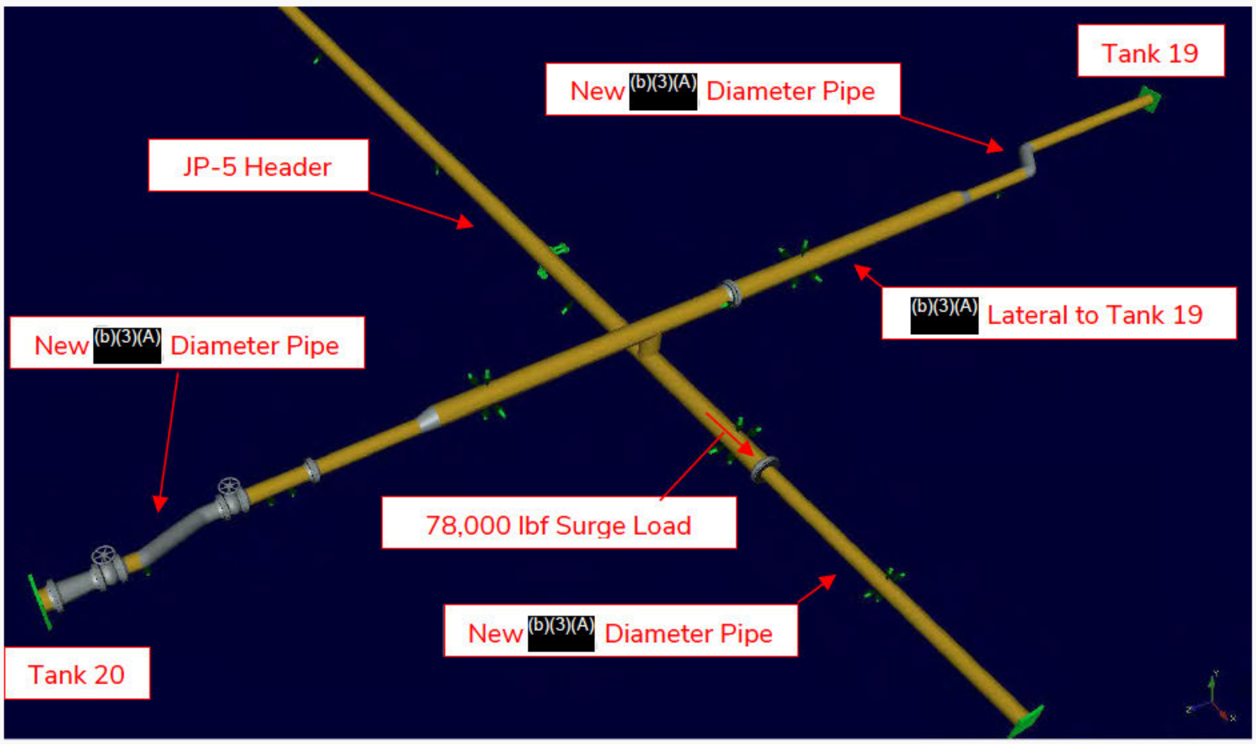

Figure 7-42 – JP-5 Defueling Model – Surge at the End of JP-5 Header

We found no overstress in the model when the surge load was applied at the end of the JP-5 header. All the ratios of demand to allowable stress were less than 1.0, with a peak ratio of 0.27 at the tee between the JP-5 header and laterals. Stress ratios are shown in Figure 7-43.

[redacted]

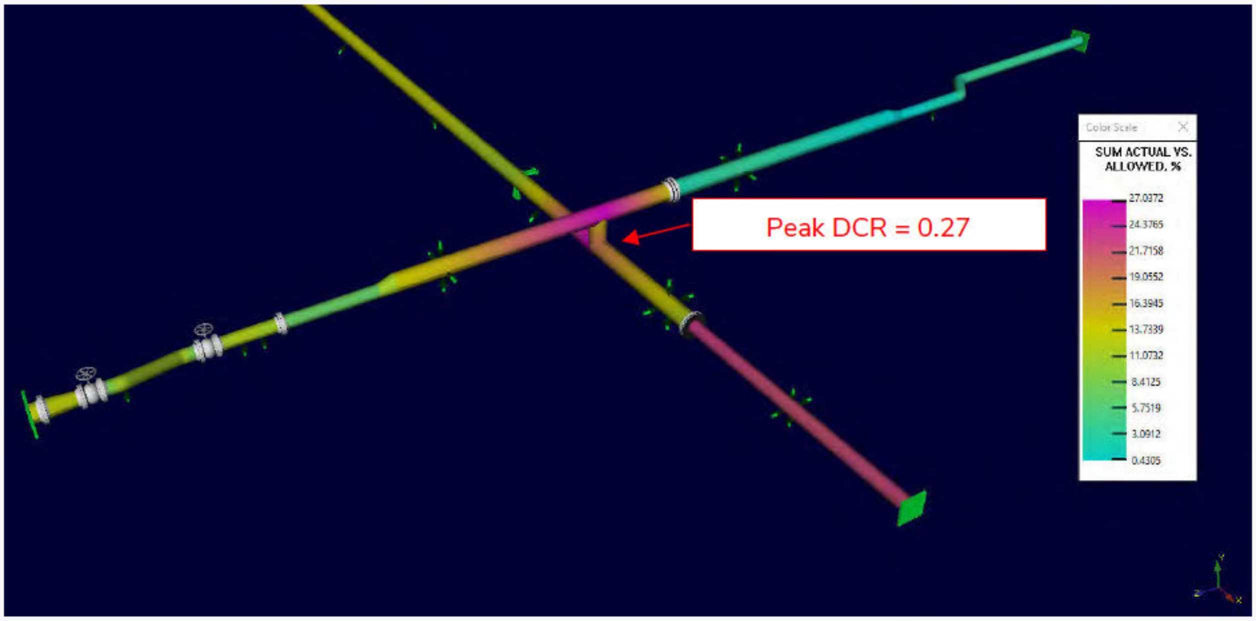

Figure 7-43 – Surge at Main Header – Demand vs. Code Longitudinal Stress Ratios

7.3.2.3 JP-5 Defueling – Surge Load at Tank 20 Ball Valve

The final location we evaluated for surge loading was if the Tank 20 ball valve was closed. The surging force due to a vacuum in the JP-5 line could act against the closed surface of the valve. As with the evaluation at the end of the JP-5 header, all piping geometry is the same other than the location of the applied force. The updated configuration is shown in Figure 7-44.

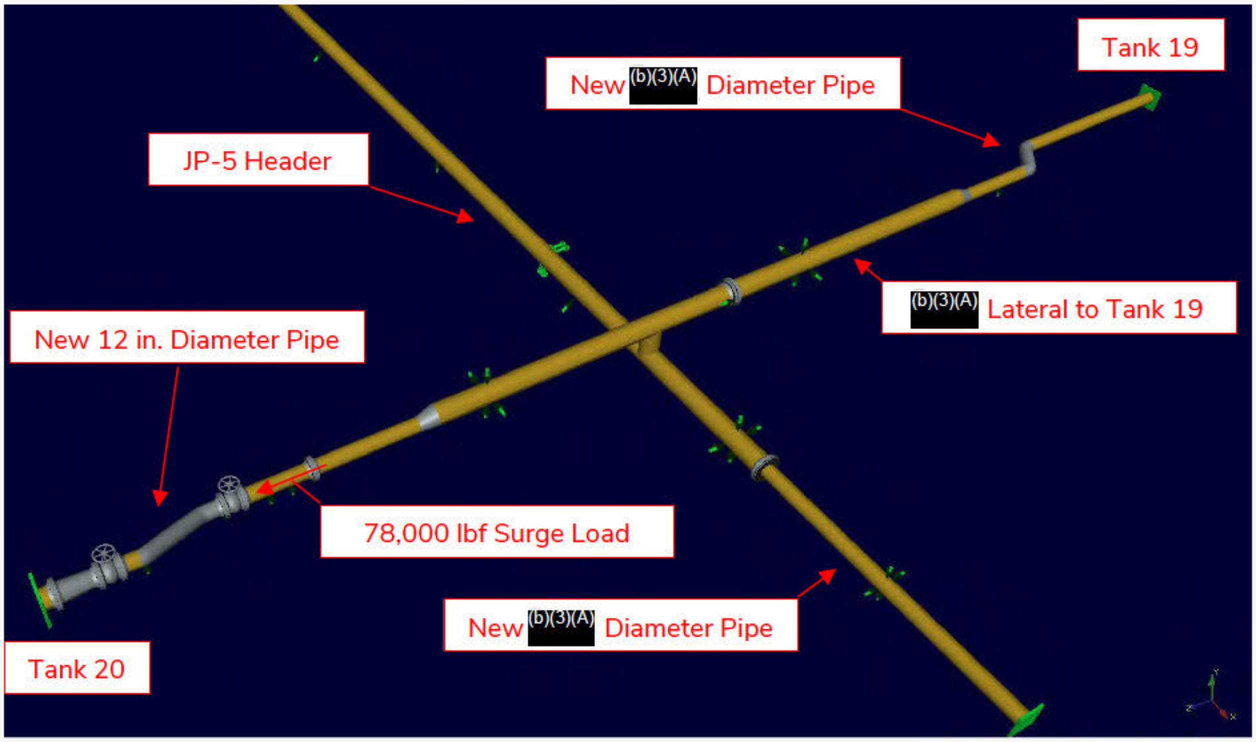

Figure 7-44 – JP-5 Defueling Model – Surge at Tank 20 Ball Valve

We found that the stresses in the piping at Tanks 19-20 would exceed ASME B31.4 code allowable stresses by a reasonable margin in this support configuration. A diagram showing the ratio of demand longitudinal stress in the pipeline to allowable code stress is shown in Figure 7-45.

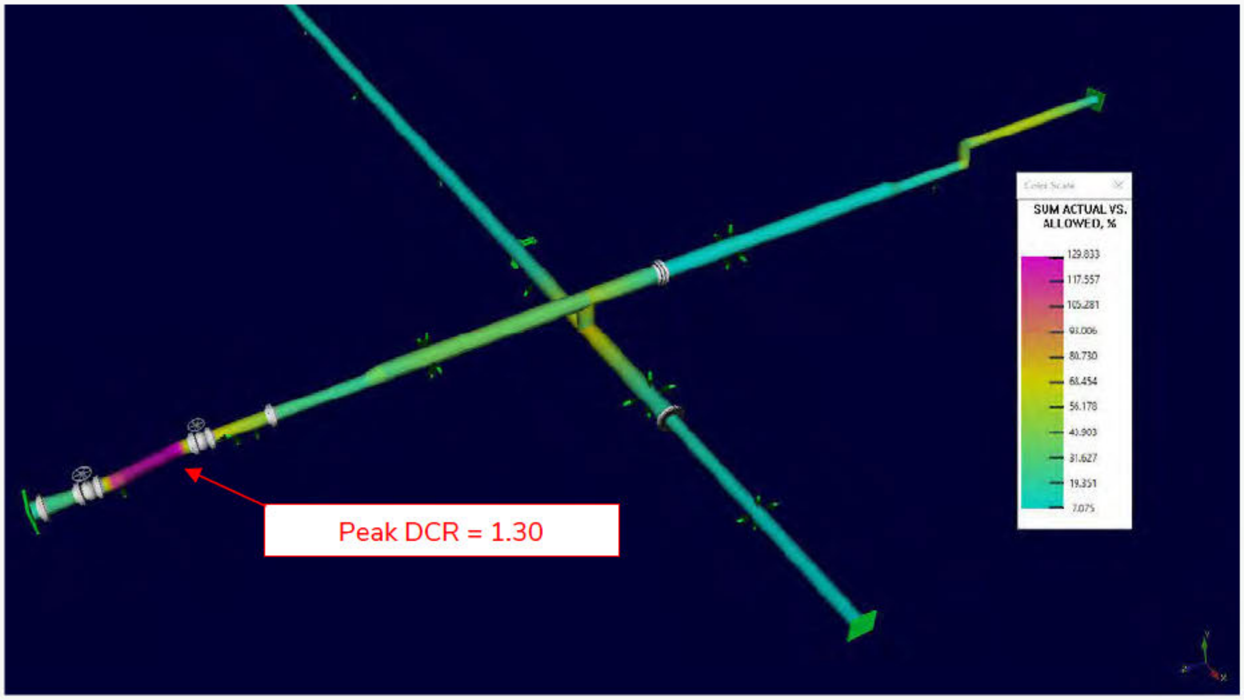

Figure 7-45 – Surge at Tank 20 – Demand vs. Code Longitudinal Stress Ratios

The peak ratio of demand to allowable longitudinal stress as calculated per ASME B31.4 was 1.30 at the bend between the ball and double-block and bled valve near Tank 20, indicating potential overstress at this location due to the surge loading. We observed stress ratios to be less than 1.0 everywhere else in the model.

7.3.2.4 JP-5 Defueling – Surge Load at Tank 20 Ball Valve – Axial Restraint

We created a modified version of the model with the surge force acting at the Tank 19 spectacle blind. In this model, we added an axial restraint at the pipe support, where we applied the surge force at the blind flange. We did this to determine the effect the restraint had on the observed overstress in the piping. A model image of the modified piping is shown in Figure 7-46.

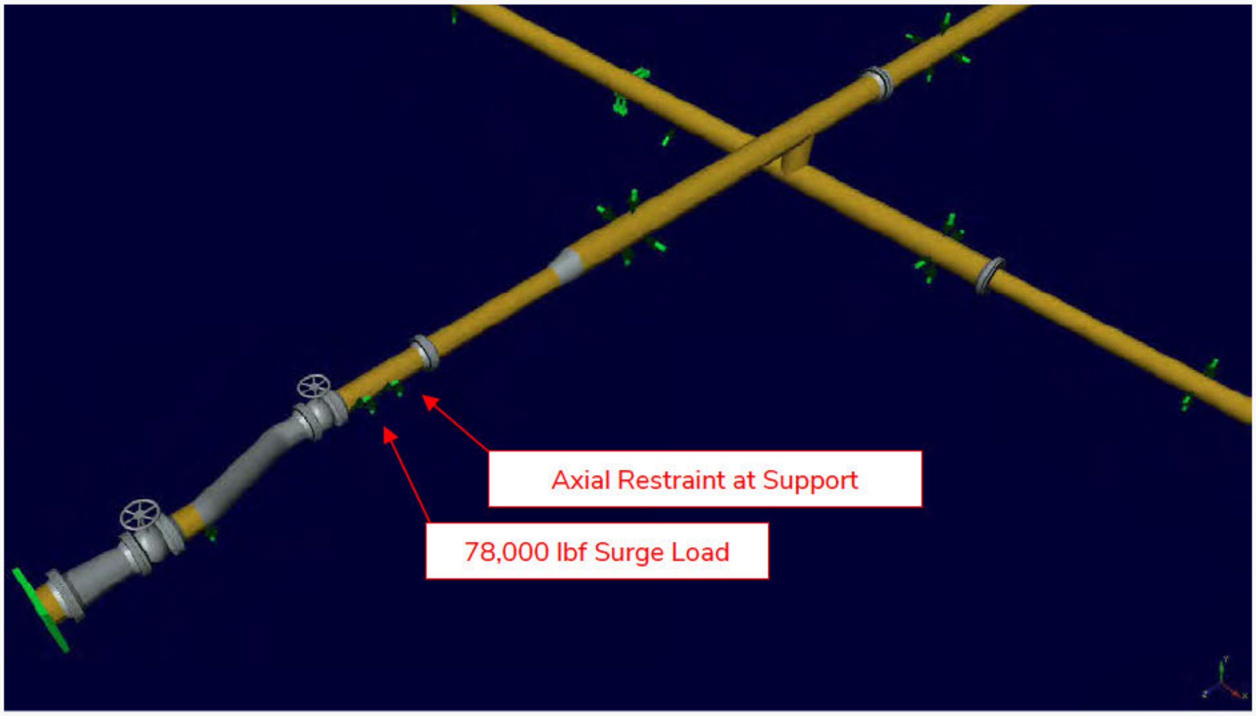

Figure 7-46 – JP-5 Defueling Model – Surge at Tank 20, Axial Restraint Modification

The surging force was maintained at the same location as the spectacle blind. We found that when we added the axial restraint near the surge load location, stress demands were significantly reduced in the piping system near Tanks 19-20. Demand to code allowable stress ratios was reduced from 1.30 at the Tank 20 bend to 0.13. The peak stress ratio was 0.42 in the pipe segment between the applied force and the axial support. This is due to the restraint taking most of the load and protecting the rest of the piping system. A diagram showing the stress ratios is shown in Figure 7-47.

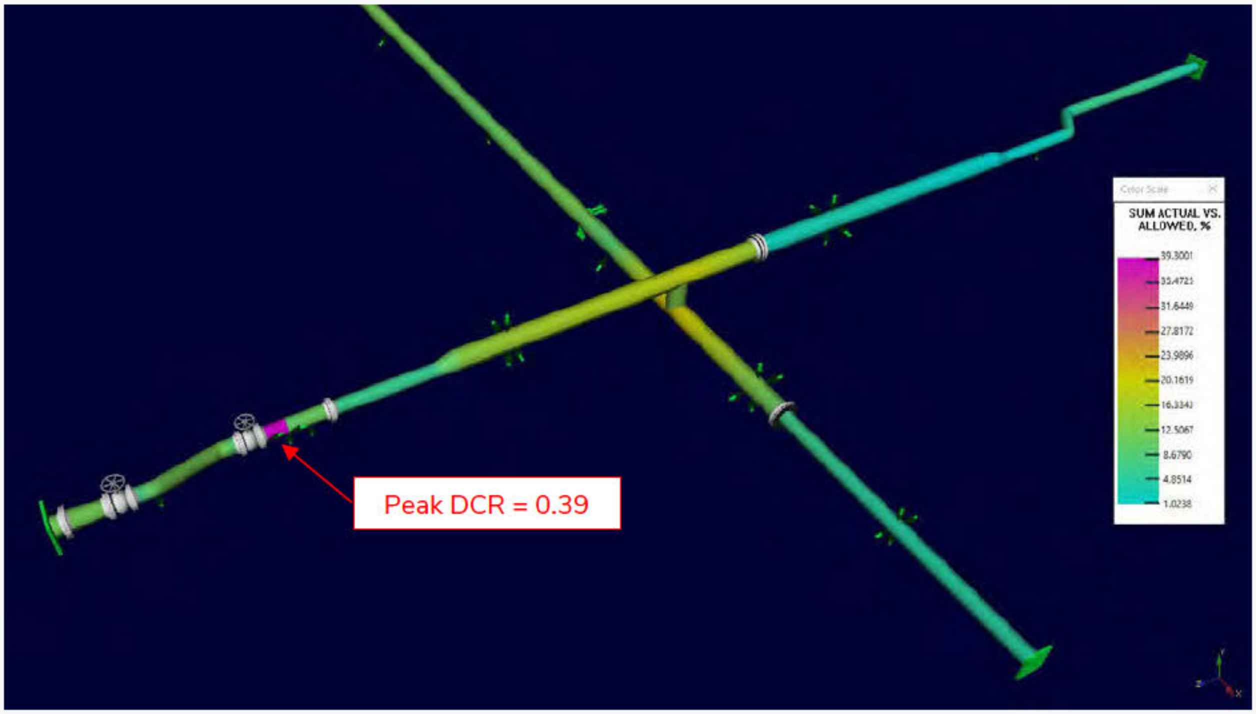

Figure 7-47 – Surge at Tank 20 Ball Valve – Axial Restraint Added – Demand vs. Code Longitudinal Stress Ratios

7.3.3 Red Hill – F-76 Defueling Models – Tanks 15-16

The F-76 line contains diesel fuel and terminates at Tanks 15-16. Like the other lines, the F-76 line is susceptible to the formation of a vacuum due to leak-by at the UGPH. Therefore, the potential for surge loading at the end of the F-76 header also exists. We evaluated the F-76 line between Tanks 15 and 16 under the impact of a surge load during defueling operations in a similar manner to the JP-5 line above. Modeling assumptions are as follows:

- F-76 header connected to Tanks 15-16 with straight pipe laterals.
- Cradle supports along main F-76 header, slide supports at laterals.
- Pipeline anchor after P.S. 25.
- Surge force scaled using 320 psi value from Root Cause Report.

The three models analyzed were as follows:

- Surge Load – Acting at Tank 15 Ball Valve.
- Surge Load – Acting at the end of F-76 Header Blind Flange.
- Surge Load – Acting at Tank 16 Ball Valve.

Figure 7-48 below shows the geometry overview for the F-76 defuel model.

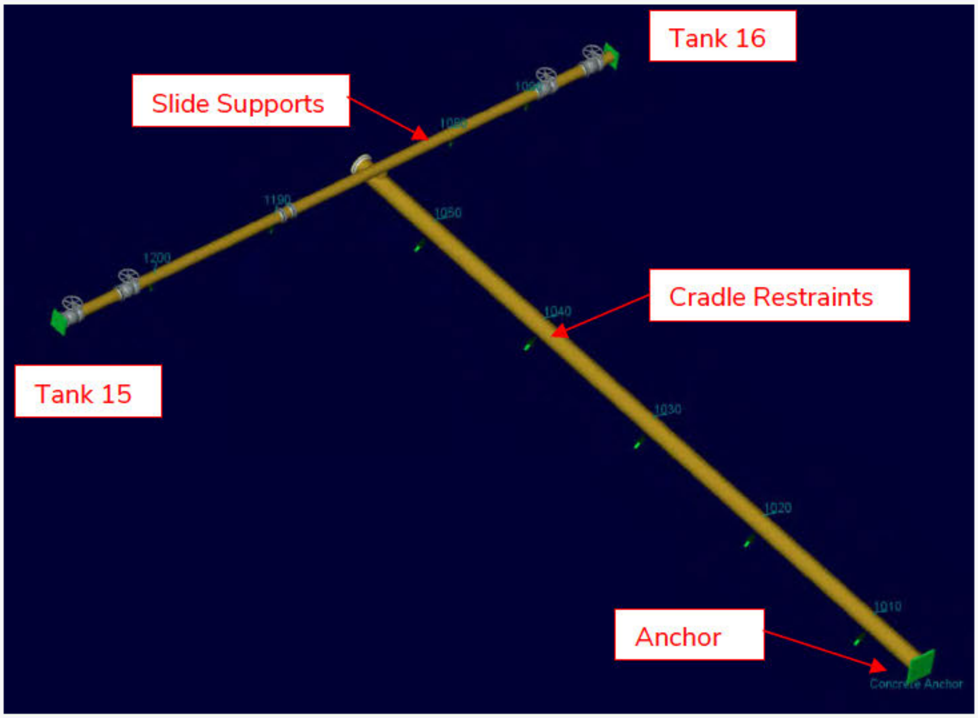

Figure 7-48 – F-76 – Tanks 15-16 Model Global View

7.3.3.1 F-76 Defueling – Surge Load at Tank 15 Ball Valve

For this analysis, we applied the surge load at the closed ball valve outboard of Tank 15. Figure 7-49 shows the results of the analysis. The highest ratio of the demand longitudinal stress to the allowable code stress is 0.37, indicating that the pipeline is not overstressed in the event of a surge load in this configuration. The peak stresses occur at the midsection of the lateral pipe segment connecting Tanks 15 and 16.

[redacted]

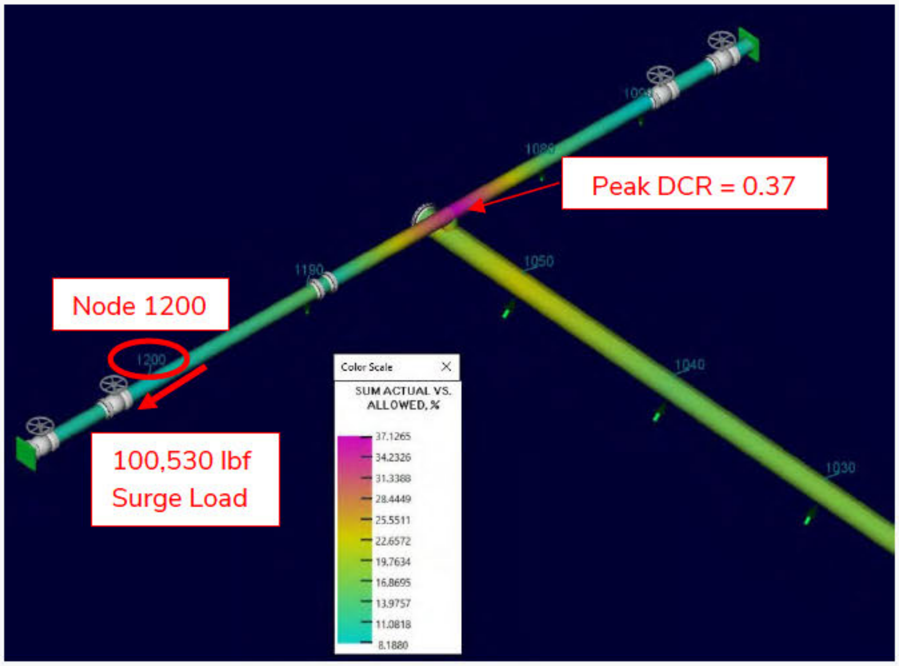

Figure 7-49 – F-76 Defueling Model – Surge at Tank 15 Ball Valve

7.3.3.2 F-76 Defueling – Surge Load Acting at the End of F-76 Header Blind Flange

For this analysis, we applied the surge load at the end of the F-76 header blind flange. Figure 7-50 shows the results of the analysis. The highest ratio of the demand longitudinal stress to the allowable code stress is 0.72, indicating that the pipeline is not overstressed in the event of a surge load. The demand to allowable stresses were all less than 1.0, with a peak ratio of 0.72 at the midsection of the laterals.

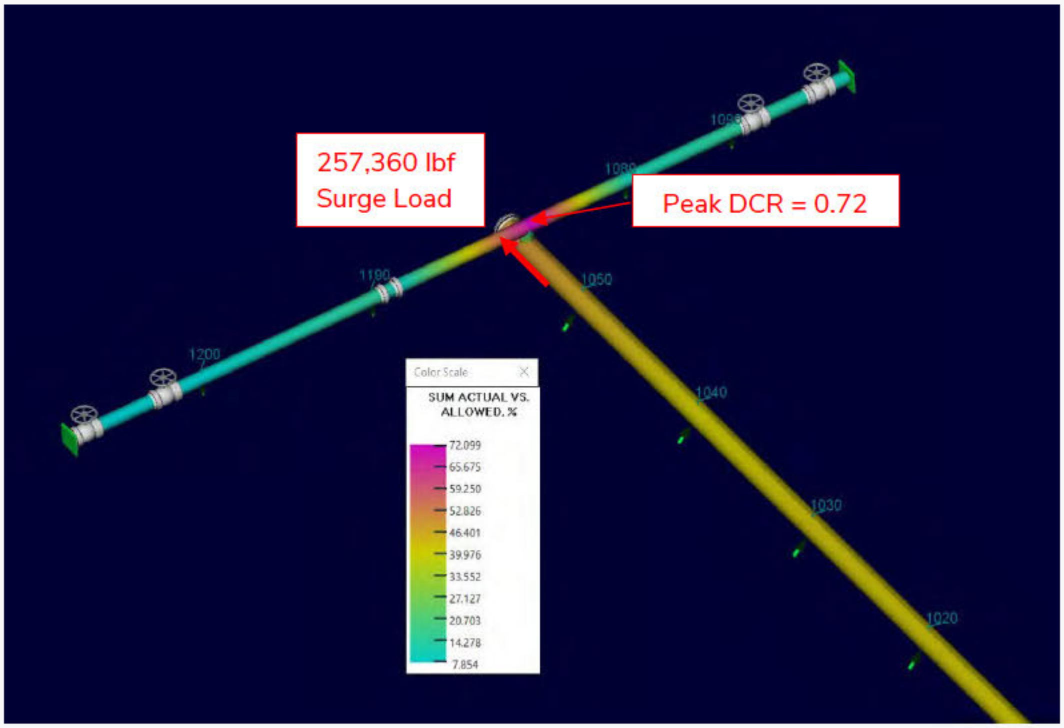

Figure 7-50 – F-76 Defueling Model – Surge at the End of the F-76 Header

7.3.3.3 F-76 Defueling – Surge Load at Tank 16 Ball Valve

The final location we evaluated for surge loading for the F-76 line near Tanks 15-16 was at the Tank 16 ball valve. The model configuration is shown in Figure 7-51. Similar to when the surge load acts at the Tank 15 ball valve, the peak stresses do not exceed allowable code stress and occur at the tee between the lateral and main F-76 header.

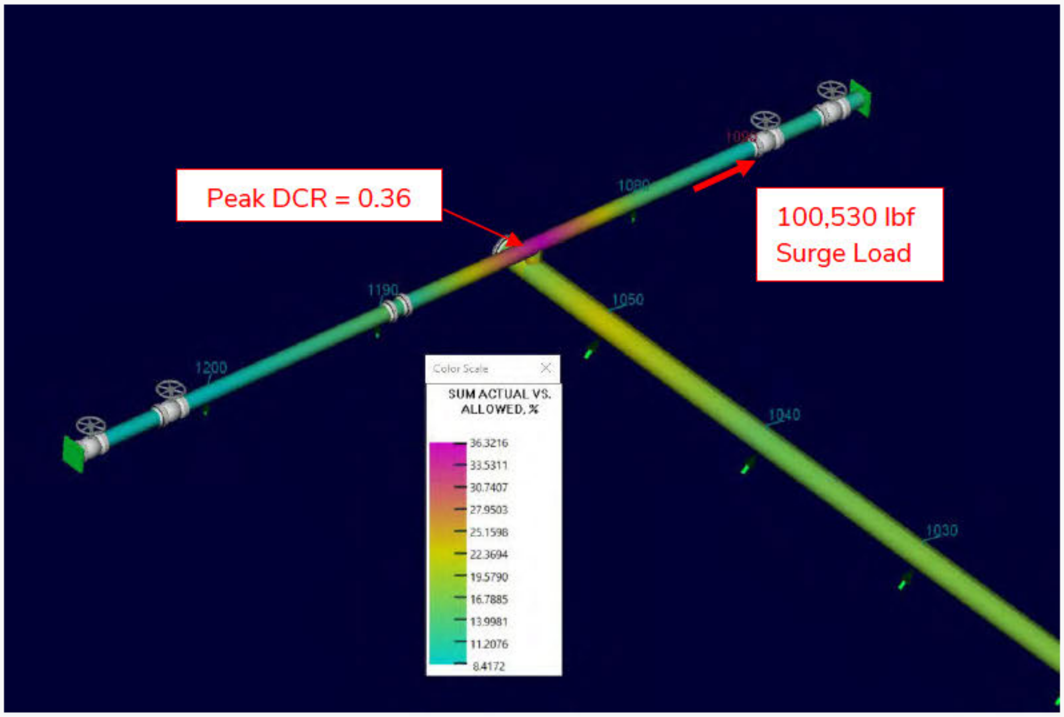

Figure 7-51 – F-76 Defueling Model – Surge at Tank 16 Ball Valve

7.3.4 Red Hill – JP-5/F-24 Defueling Models – Tanks 15-16

The F-24 line contains Jet Fuel and terminates at Tanks 15-16. The JP-5 and F-24 lines are connected at the laterals near Tanks 15-16. Like the JP-5 near Tanks 19-20 and F-76 near Tanks 15-16 lines, the potential for surge loading at the end of the F-24 header also exists, whereas the JP-5 header continues onward to Tanks 17-20. We evaluated the JP-5/F-24 line between Tanks 15 and 16 under the impact of a surge load during defueling operations in a similar manner to the JP-5 and F-76 lines above. Modeling assumptions are as follows:

- The JP-5/F-24 headers connected to Tanks 15-16 with straight pipe laterals.
- Cradle supports along main JP-5/F-24 headers, slide supports at laterals.
- JP-5 pipeline anchor after P.S. 25, F-24 pipeline anchor after P.S. 31 (bounding point for model at next set of tanks).
- Surge force scaled using 320 psi value from Root Cause Report.

The three models analyzed were as follows:

- Surge Load – Acting at Tank 15 Ball Valve.
- Surge Load – Acting at the end of F-24 Header Blind Flange.

- Surge Load – Acting at Tank 16 Ball Valve.

Figure 7-52 below shows the global view for the JP-5/F-24 defuel model near Tanks 15-16.

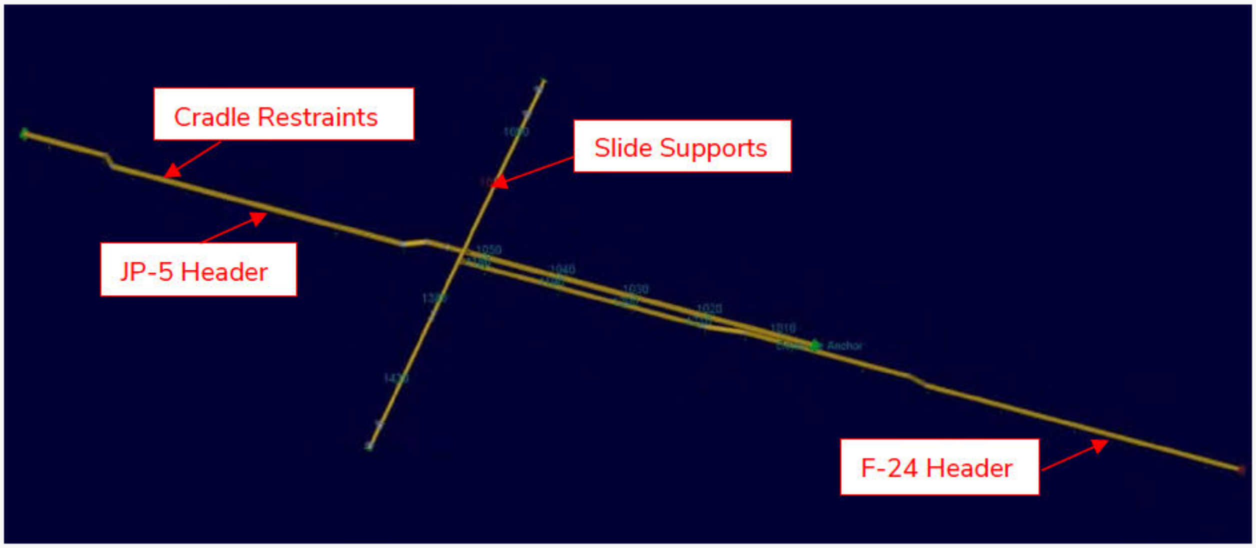

Figure 7-52 – JP-5/F-24 – Tanks 15-16 Model Global View

7.3.4.1 JP-5/F-24 Defueling – Surge Load at Tank 15 Ball Valve

For this analysis, we applied the surge load at the closed ball valve outboard of Tank 15. Figure 7-53 shows the results of the analysis. The highest ratio of the demand longitudinal stress to the allowable code stress is 0.35, indicating that the pipeline is not overstressed in the event of a surge load. The peak ratio of 0.35 occurs at the bends along both JP-5 and F-24 lines.

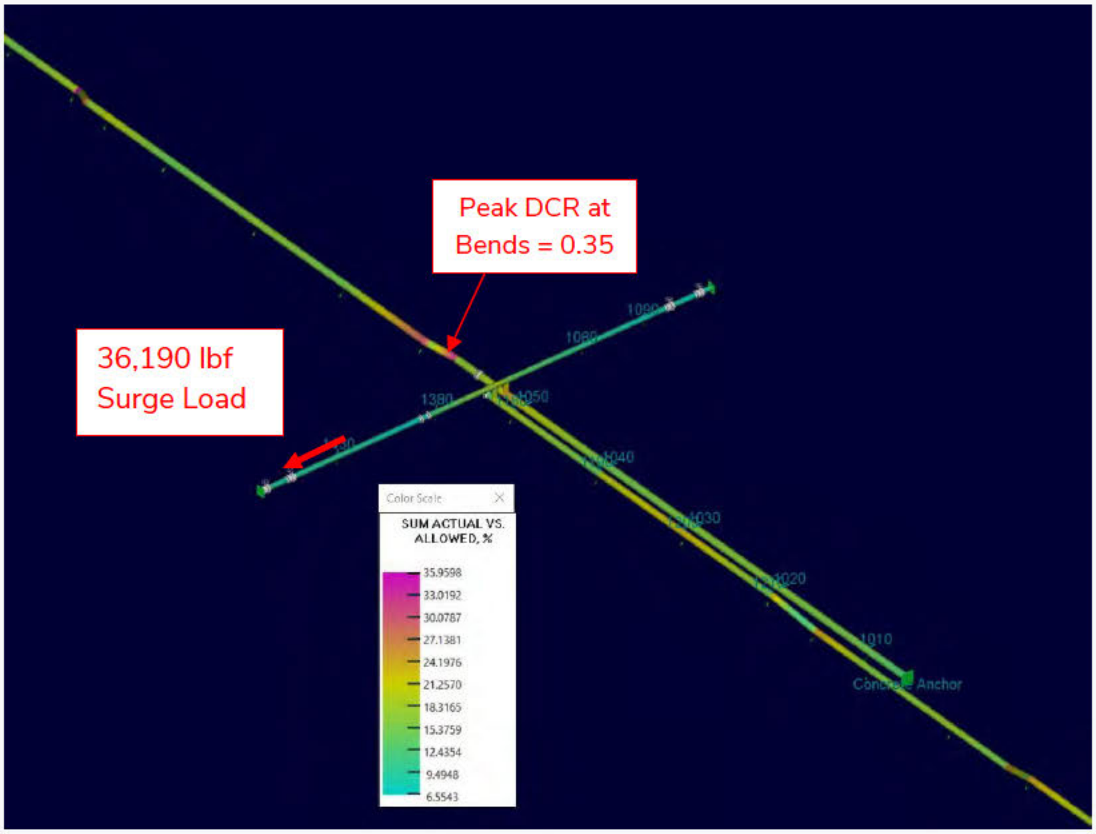

Figure 7-53 – JP-5/F-24 Defueling Model – Surge at Tank 15 Ball Valve

7.3.4.2 JP-5/F-24 Defueling – Surge Load Acting at the End of the F-24 Header Blind Flange

For this analysis, we applied the surge load at the end of the F-24 header. We found that the stresses in the piping at the base of the tees connecting the JP-5 and F-24 headers to the laterals would exceed ASME B31.4 code allowable stresses considerably. A diagram showing the ratio of demand longitudinal stress in the pipeline to allowable code stress is shown in Figure 7-54.

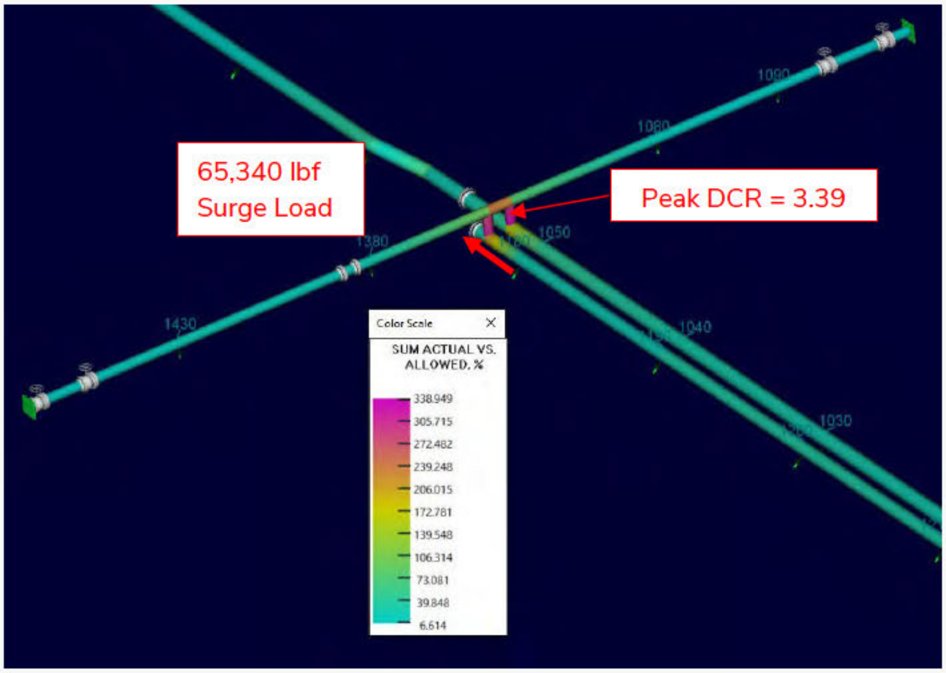

Figure 7-54 – JP-5/F-24 Defueling Model – Surge at the End of F-24 Header

7.3.4.3 JP-5/F-24 Defueling – Surge Load Acting at the End of the F-24 Header Blind Flange – Axial Restraint Added

To mitigate the overstresses at the tee joints, we added an axial restraint at the support closest to the F-24 main header blind flange. The results of this analysis found that the peak ratio of demand to allowable longitudinal stress as calculated per ASME B31.4 was 0.45. This axial restraint configuration is similar to the recommendation to address the overstresses at the JP-5 lateral near Tanks 19-20.

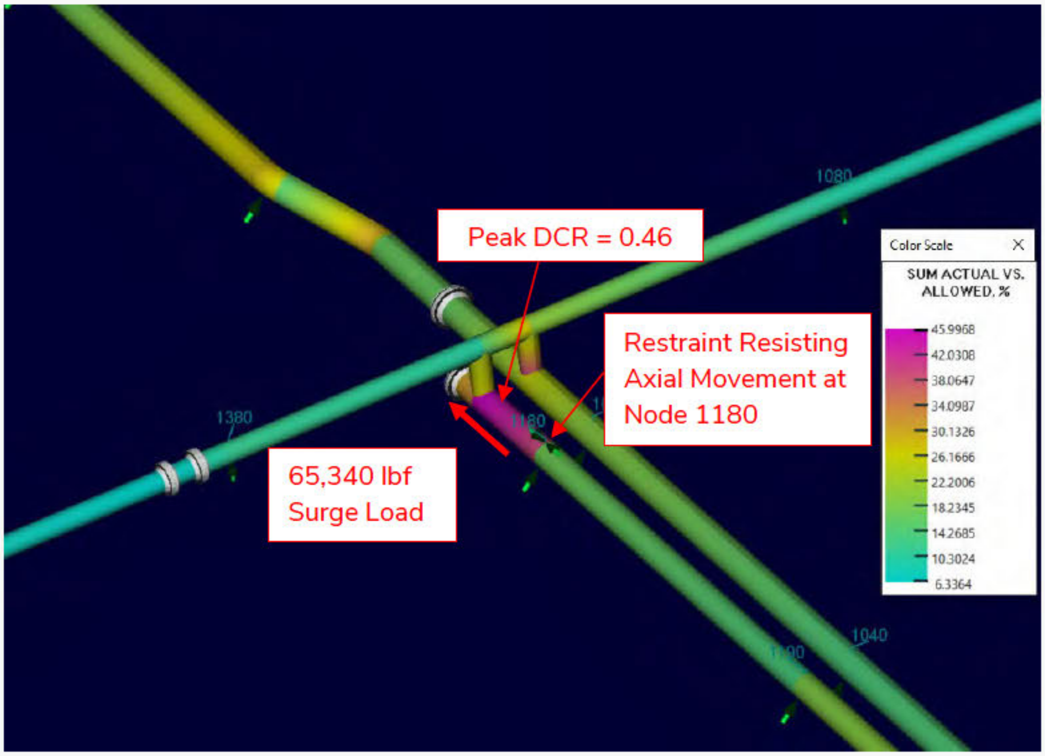

Figure 7-55 – JP-5/F-24 Defueling Model – Surge at the End of F-24 Header with Modification

7.3.4.4 JP-5/F-24 Defueling – Surge Load at Tank 16 Ball Valve

The final location we evaluated for surge loading for the JP-5/F-24 lines near Tanks 15-16 was at the Tank 16 ball valve. The model configuration is shown in Figure 7-56. Similar to the surge load configuration acting at the Tank 15 ball valve, the peak stresses do not exceed allowable code stress and occur at the bends along both the JP-5 and F-24 headers.

[redacted]

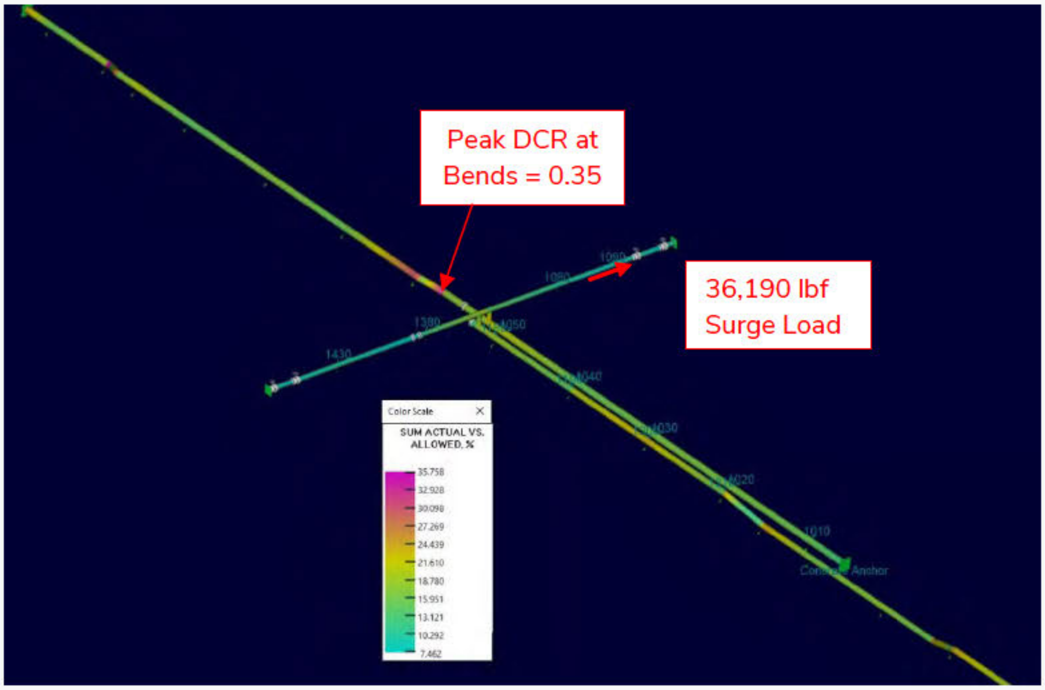

Figure 7-56 – JP-5/F-24 Defueling Model – Surge at the Tank 16 Ball Valve

7.3.5 Red Hill – Tank 13-14 Defueling Models

The final surge load models we developed were at Tanks 13-14. At this location, the piping laterals have been reconfigured at the Tank 13 side and are currently being reconfigured at the Tank 14 side. At each side, the final configuration for the JP-5/F-24 piping lateral lines will tee into the larger diameter piping lateral for the F-76 line near the tank wall. This configuration is depicted in Figure 7-57, which is Item J from the January 2022 Enterprise Engineering drawings. Once again, no dimensions were provided for the pipeline repairs. We approximated dimensions from the typical values taken in field measurements. The associated pipe stress model is shown in Figure 7-58.

(b)(3)(A)

Figure 7-57 – Piping Lateral Repair Configuration at Tank 14

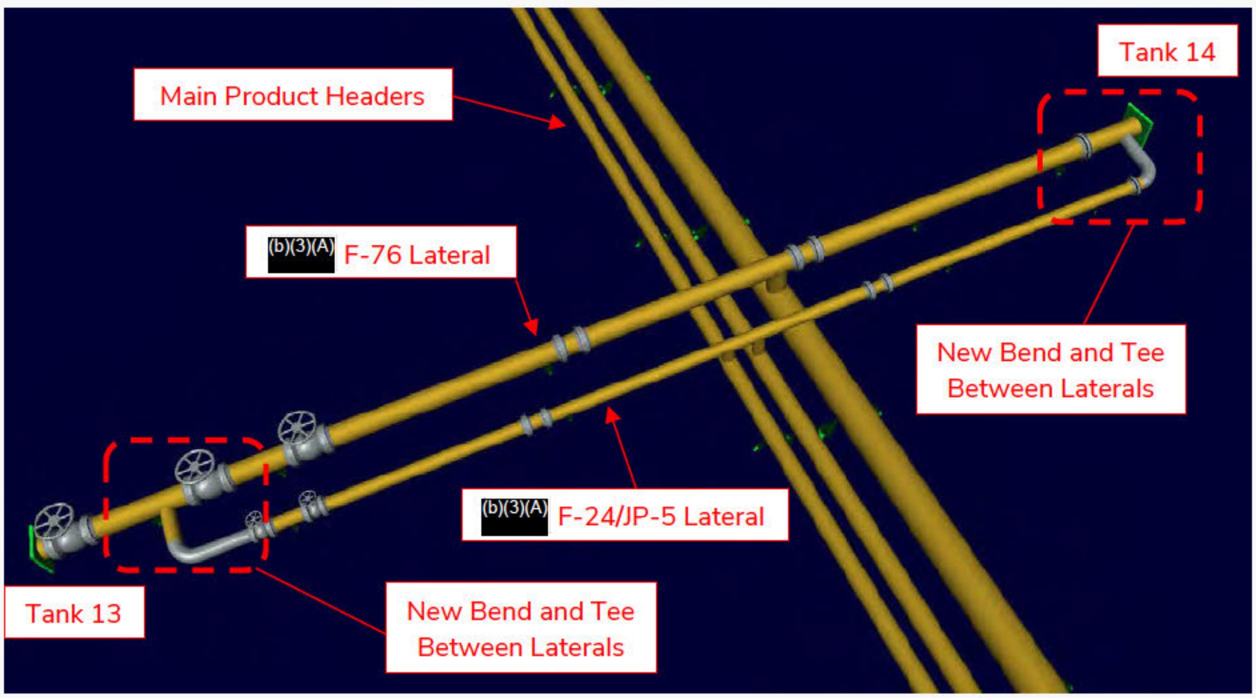

Figure 7-58 – Defueling Model Near Tanks 13-14 – Overview

We evaluated this configuration for surge loads at the following locations:

- Surge Load – Acting at F-76 Blind Flange – Tank 14 Side.

- Surge Load – Acting at F-24/JP-5 Blind Flange – Tank 14 Side.
- Surge Load – Acting at F-76 Ball Valve – Tank 13 Side.
- Surge Load – Acting at F-24/JP-5 Ball Valve – Tank 13 Side.

7.3.5.1 Tank 13-14 Defueling – Surge at F-76 Blind Flange – Tank 14 Side

The model showing the surge force acting on the F-76 blind flange is shown in Figure 7-59. The force was scaled for the [redacted] diameter pipeline lateral.

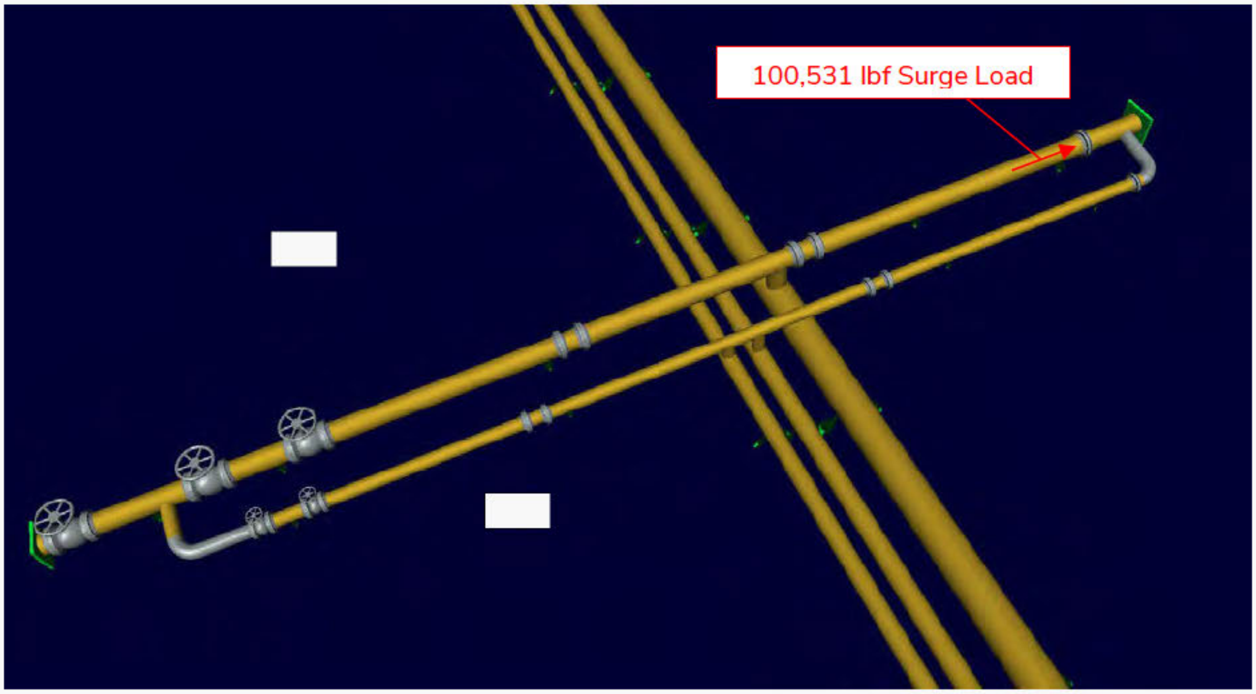

Figure 7-59 – Tank 13-14 Defueling – Surge at F-76 Blind Flange, Tank 14 Side

We found no overstress in the model when the surge load was applied at the F-76 lateral blind flange. All the ratios of demand to ASME B31.4 allowable stress were less than 1.0, with a peak ratio of 0.24 at the tee between the F-76 header and laterals. Stress ratios are shown in Figure 7-60.

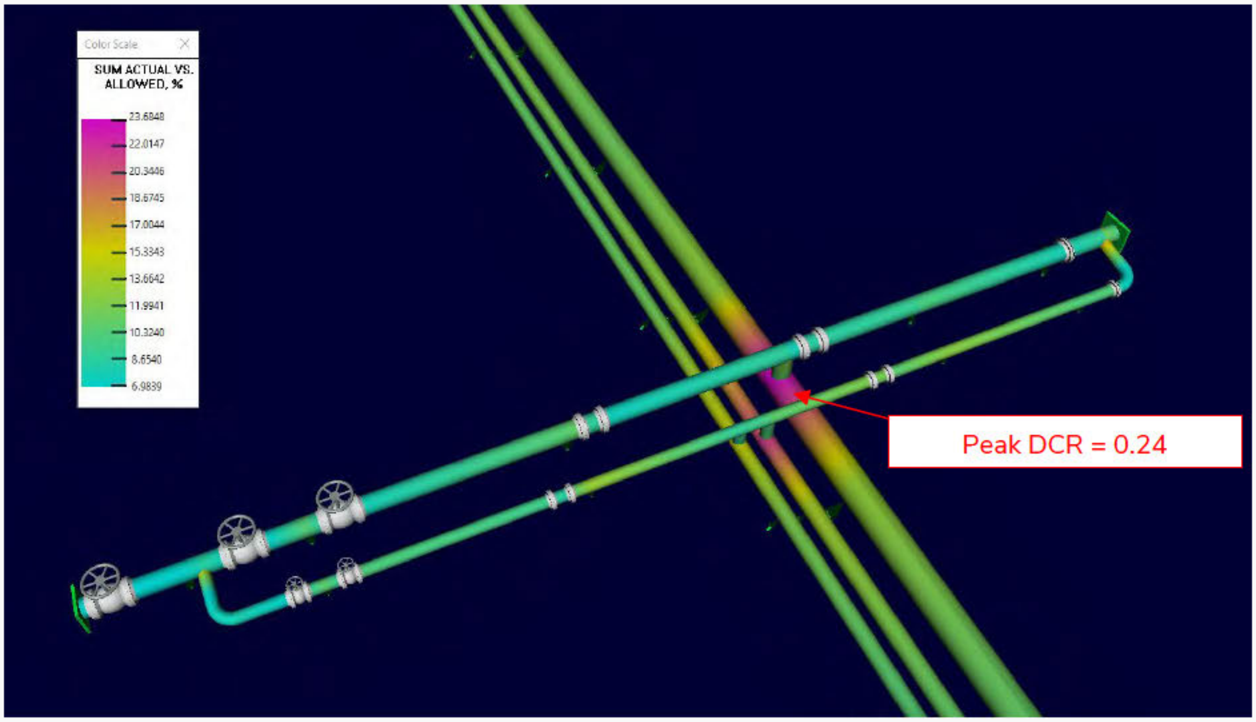

Figure 7-60 – Surge at F-76 Blind Flange, Tank 14 Side – Demand vs. Code Longitudinal Stress Ratios

7.3.5.2 Tank 13-14 Defueling – Surge at F-24/JP-5 Blind Flange – Tank 14 Side

The model showing the surge force acting on the F-24/JP-5 lateral blind flange is shown in Figure 7-61. The force was scaled for the smaller [redacted] diameter pipeline lateral.

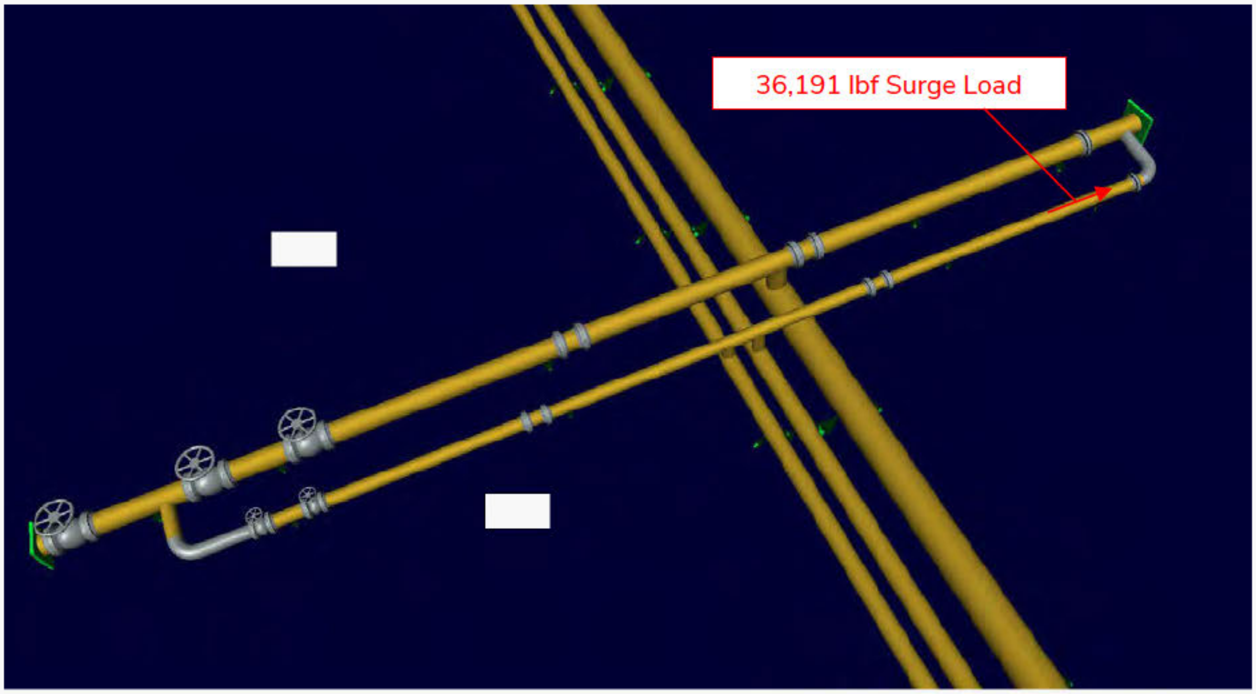

Figure 7-61 – Tank 13-14 Defueling – Surge at F-24/JP-5 Blind Flange, Tank 14 Side

For the F-24/JP-5 laterals, when the surge load was applied at the lateral blind flange near Tank 14, we observed overstress at the tee joint connection to the larger F-76 lateral. The peak ratio of demand to allowable longitudinal stress as calculated per ASME B31.4 was 1.56, indicating significant overstress at the tee joint. Elsewhere in the model, stress ratios were all below 1.0. Stress ratios are shown in Figure 7-62.

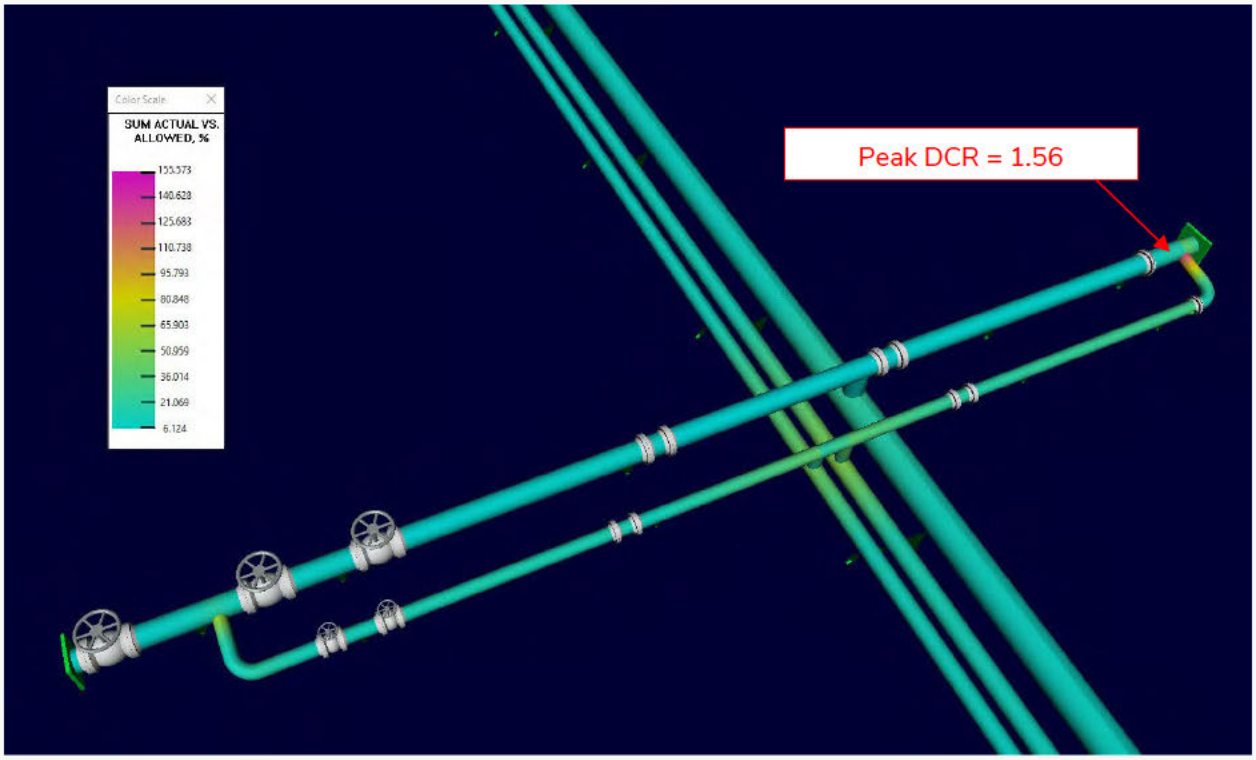

Figure 7-62 – Surge at F-24/JP-5 Blind Flange, Tank 14 Side – Demand vs. Code Longitudinal Stress Ratios

7.3.5.3 Tank 13-14 Defueling – Surge at F-76 Ball Valve – Tank 13 Side

The model showing the surge force acting at the outboard F-76 ball valve near Tank 13 is shown in Figure 7-63. The force was scaled for the (b)(3)(A) diameter pipeline and applied similarly to the model with the surge at the blind flange.

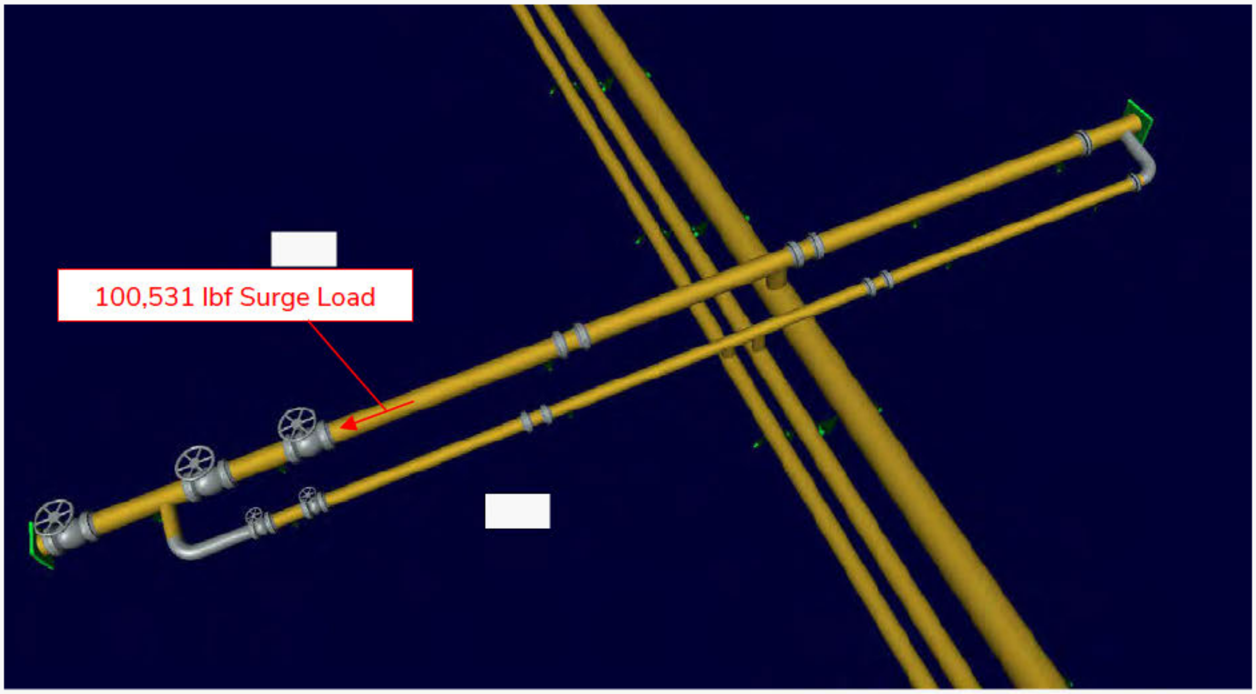

Figure 7-63 – Tank 13-14 Defueling – Surge at F-76 Ball Valve, Tank 13 Side

Similar to the model with the surge force placed at the Tank 14 blind flange, we found no overstress in the model when the surge load was applied at the F-76 lateral ball valve. All the ratios of demand to ASME B31.4 allowable stress were less than 1.0, with a peak ratio of 0.24 at the tee between the F-76 header and laterals. Stress ratios are shown in Figure 7-64.

[redacted]

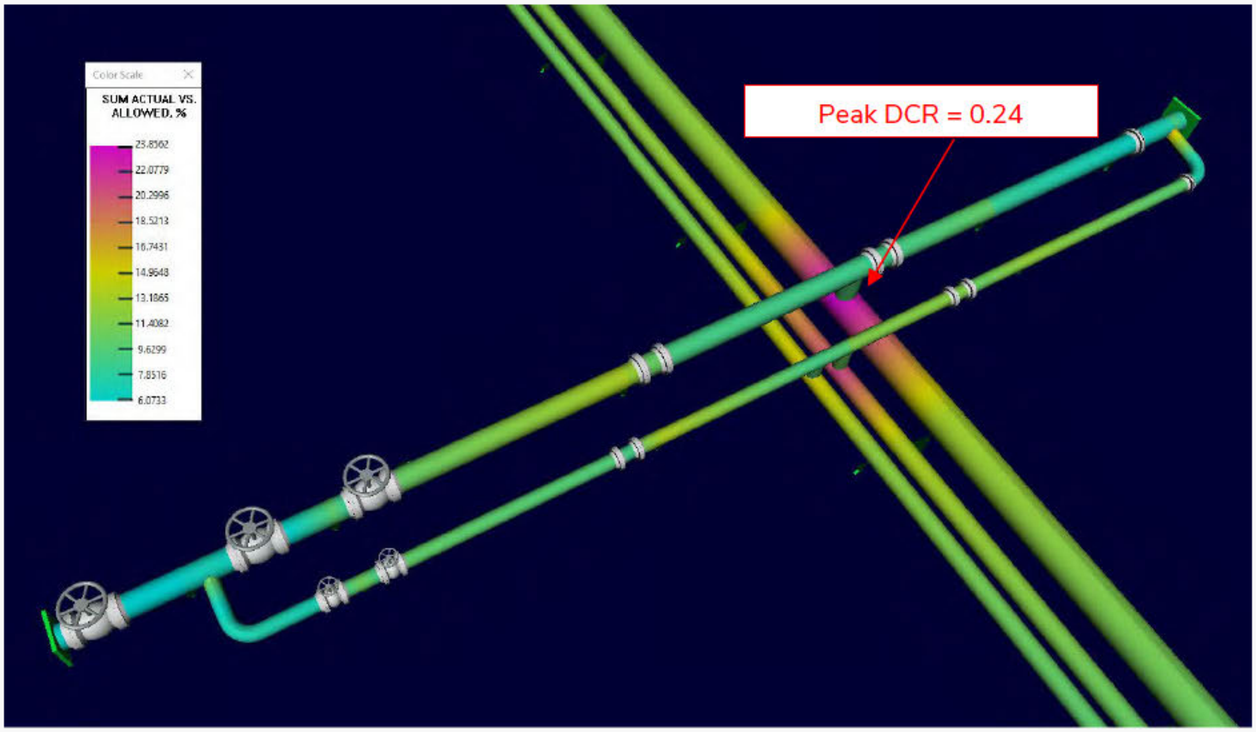

Figure 7-64 – Surge at F-76 Ball Valve, Tank 13 Side – Demand vs. Code Longitudinal Stress Ratios

7.3.5.4 Tank 13-14 Defueling – Surge at F-24/JP-5 Ball Valve – Tank 14 Side

The model showing the surge force acting at the outboard F-24/JP-5 ball valve near Tank 13 is shown in Figure 7-65. The force was scaled for the [redacted] diameter pipeline and applied similarly to the model with the surge at the blind flange.

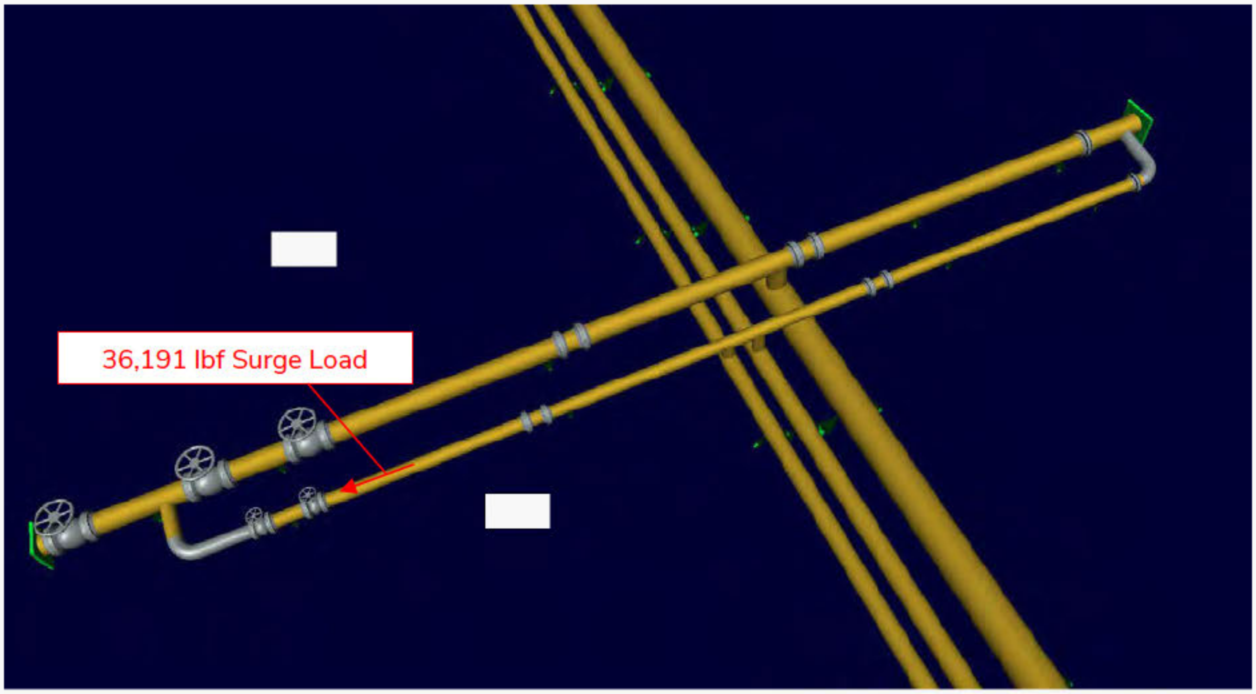

Figure 7-65 – Tank 13-14 Defueling – Surge at F-24/JP-5 Ball Valve, Tank 13 Side

Similar to the model with the surge force placed at the blind flange near Tank 14, we found significant overstress at the tee joint in the model when the surge load was applied at the F-24/JP-5 lateral ball valve near Tank 13. The peak ratio of demand to allowable longitudinal stress as calculated per ASME B31.4 was 1.45. Elsewhere in the model, stress ratios were all below 1.0. Stress ratios are shown in Figure 7-66.

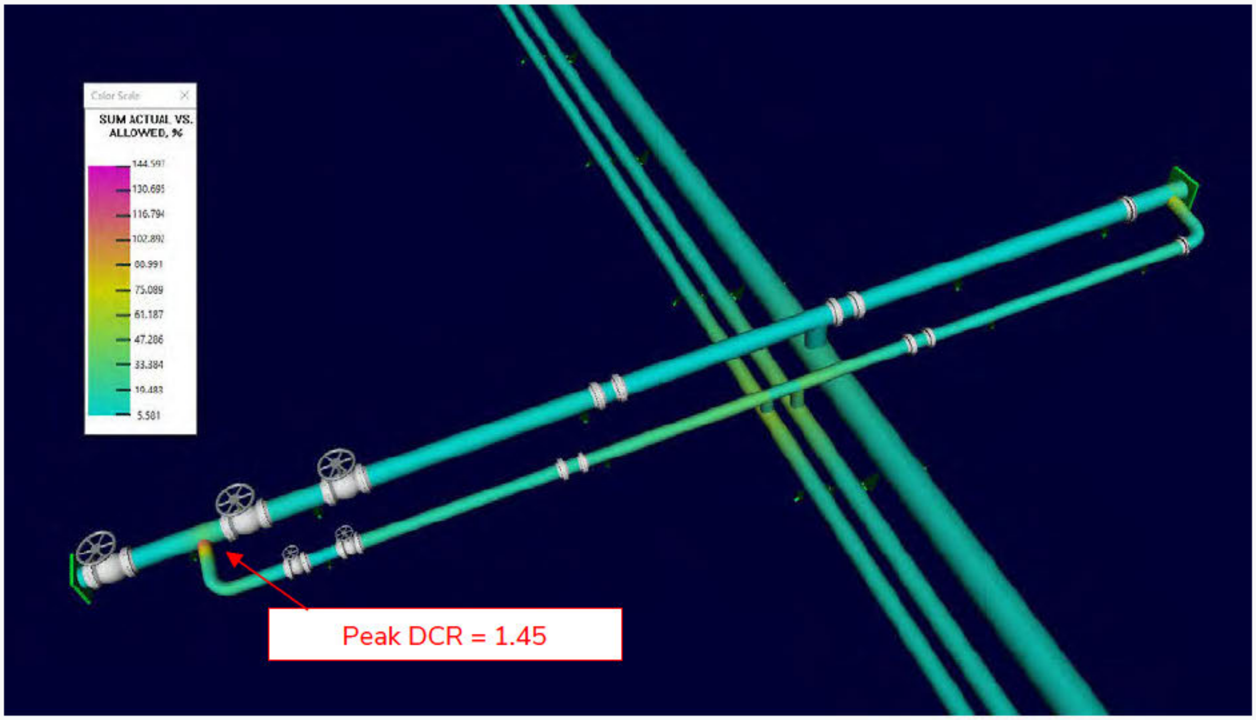

Figure 7-66 – Surge at F-24/JP-5 Ball Valve, Tank 13 Side – Demand vs. Code Longitudinal Stress Ratios

7.3.6 Red Hill – Nozzle Local Analysis Model

The 2018 Quantitative Risk and Vulnerability Assessment (QRVA) Report highlighted the failure of the tank nozzles at the Red Hill facility as a potential risk for fuel leaks. The lower part of the fuel storage tanks is encased in mass concrete with a pipe segment typically exiting the mass concrete into the lower tank gallery. Figure 7-67 shows a typical pipe exiting the mass concrete at Tank 17. This area is called the nozzle in the QRVA Report.

[redacted]

(b)(3)(A) [redacted]

Figure 7-67 – Piping Nozzle Exiting Tank 17 Concrete Wall with Adjacent Inboard Valve

The double block and bleed (DBB) and ball valves are supported close to the nozzle adding additional weight close to the nozzle penetration. We developed localized pipeline stress models at these penetrations to check for potential overstress of the nozzle reducers at the locations anchored into concrete. The model for the Tank 17 nozzle is shown in Figure 7-68.

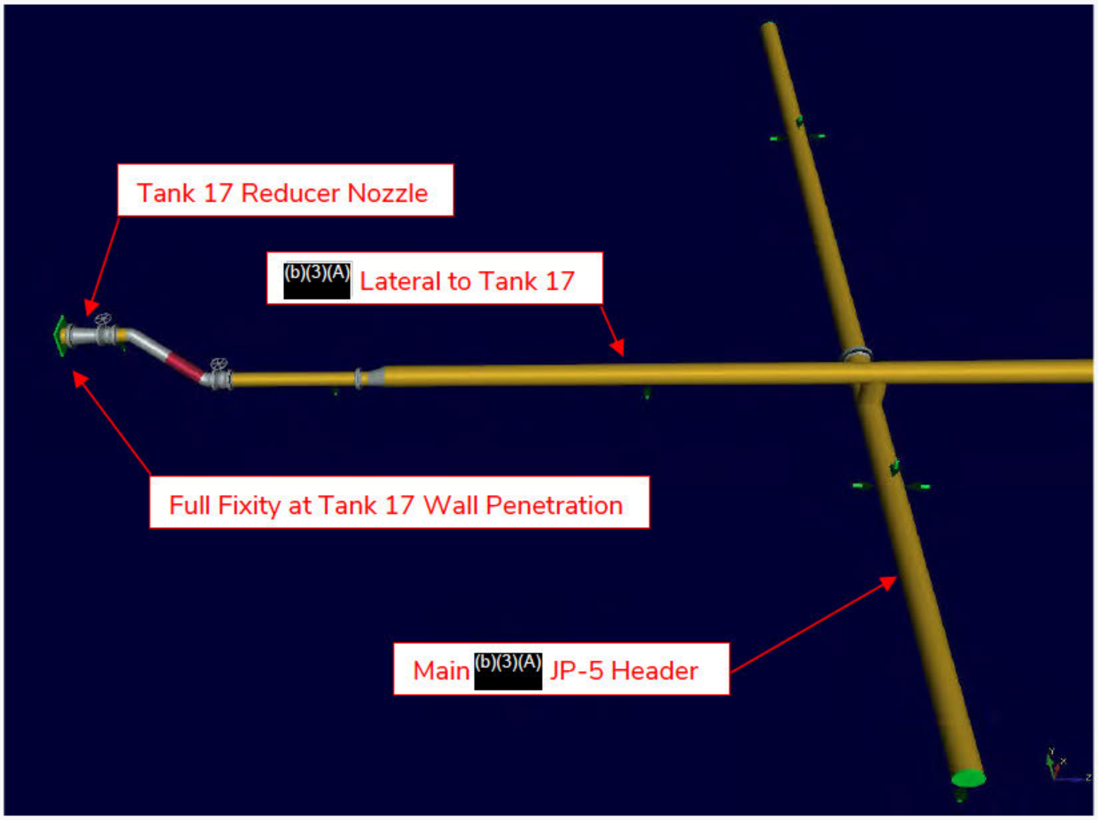

Figure 7-68 – Tank 17 Nozzle Analysis – Piping Model

We found no overstress at the reducer nozzle due to the weight of valves or operational loads. The ratio of demand longitudinal stress to ASME B31.4 allowable stress was 0.11 at the nozzle, with a peak of 0.29 occurring at the bend just before the nozzle. This indicates low-stress demands at the nozzle location. Stress ratios are shown in Figure 7-69. Additionally, for the surge models, we observed no overstress at any of the nozzle locations or locations where tank piping was modeled as anchored due to penetration into the concrete wall. Therefore, we believe the piping nozzles near the concrete wall penetrations are adequately supported.

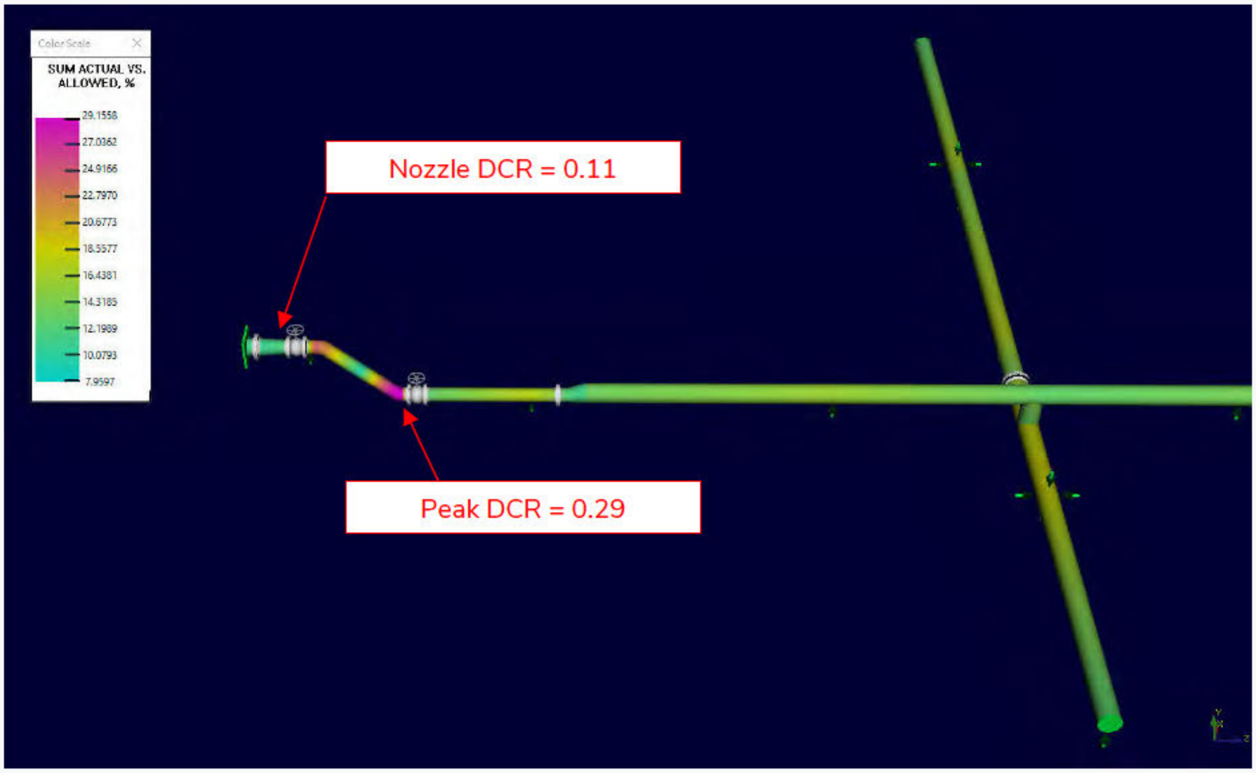

Figure 7-69 – Tank 17 Nozzle Analysis – Demand vs. Code Longitudinal Stress Ratios

7.3.7 Harbor Tunnel – Straight Segment Model

We modeled a typical straight section of the harbor tunnel (HT) pipeline between concrete anchor points to determine code compliance for operational and seismic loading. The model is used to determine whether additional lateral stops would be required for pipelines at deadweight supports for seismic loads to prevent the pipeline from falling off the pipe supports due to excessive deformation. A model of the F-76 Harbor Tunnel segment is shown in Figure 7-70. The F-24 and JP-5 models are similar.

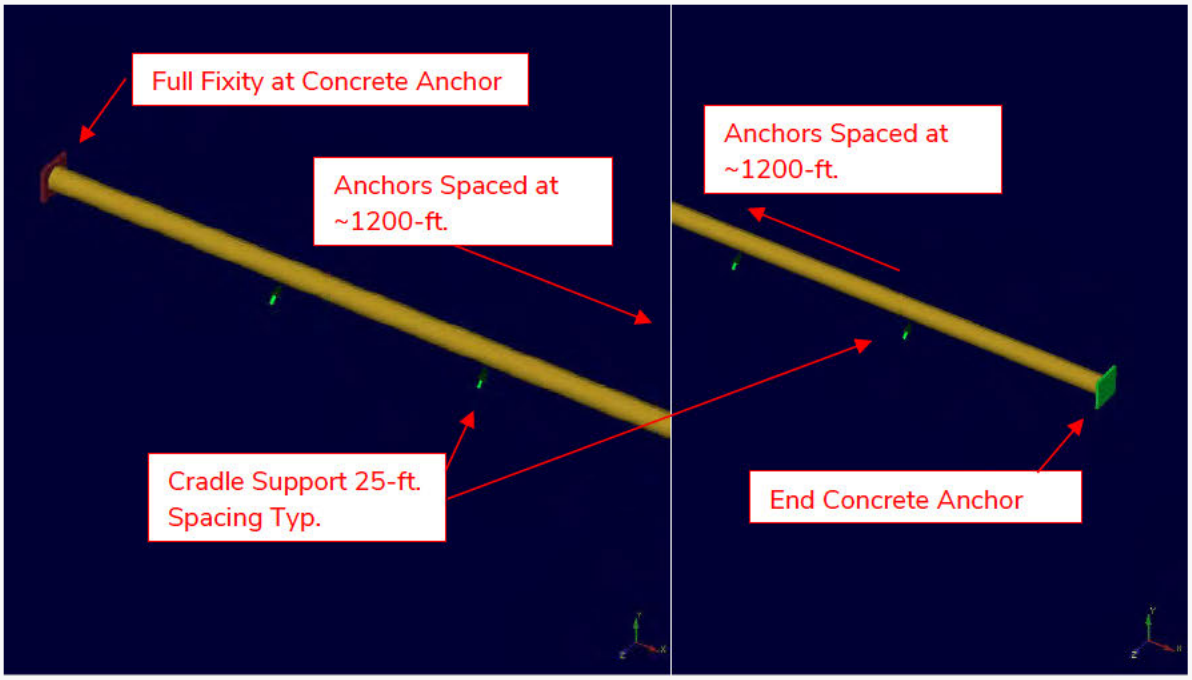

Figure 7-70 – F-76 Harbor Tunnel Model – Straight Segment (Beginning and End)

We found no overstress in the harbor tunnel piping segments due to operational or seismic loading. The ratio of peak demand longitudinal stress to ASME B31.4 allowable stress was 0.14 at the beginning concrete anchor. This indicates low-stress demands throughout the piping segment between piping anchors. Stress ratios are shown in Figure 7-71.

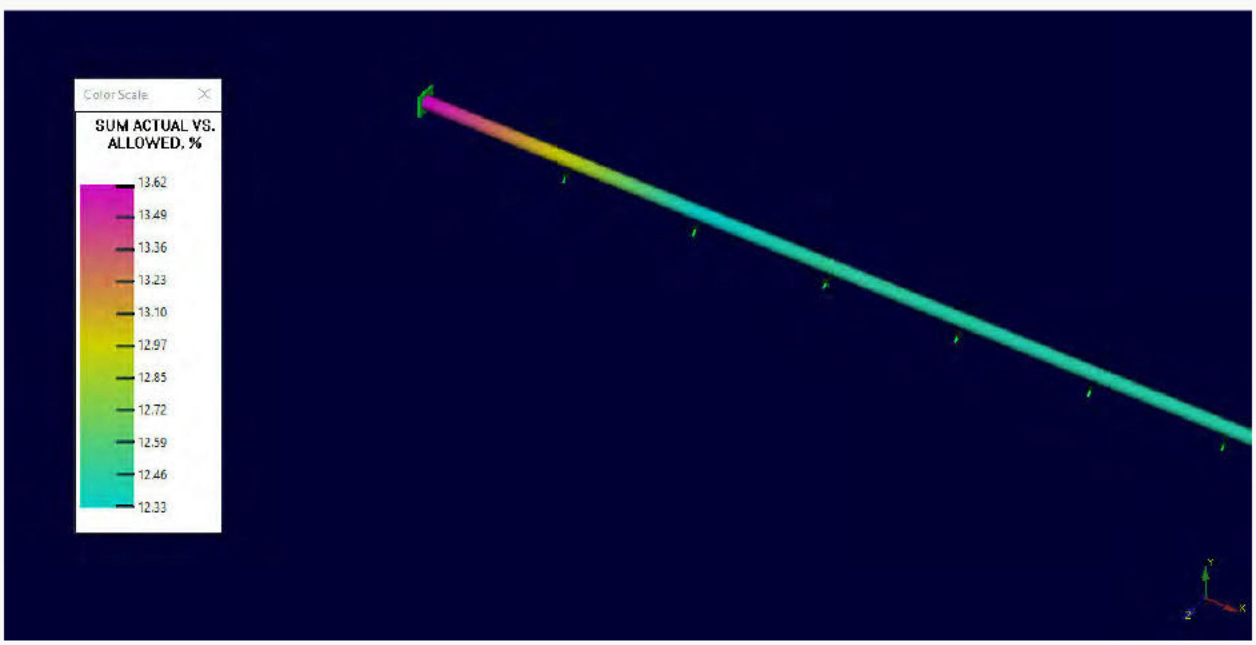

Figure 7-71 – F-76 Harbor Tunnel Model – Demand vs. Code Longitudinal Stress Ratios

Stress ratios for the F-24 and JP-5 pipelines were also low, with peaks of 0.14 and 0.15, respectively, for each pipeline.

7.3.8 Harbor Tunnel – Unsupported Valve Segment Model

We identified concerns about the sectional valves located near Pipe Supports 203 and 204 in the HT. The heavy sectional valves are not supported directly underneath and instead rely on the pipeline itself to distribute the weight to the pipe supports located several feet away. This condition is shown in Figure 7-72.

(b)(3)(A)

[redacted]

Figure 7-72 – Unsupported Valves on Main Pipelines

We developed a pipe stress model to evaluate the segment of piping at the sectional valves between the two adjacent anchor blocks to determine whether the weight of the valves caused any overstress in the piping itself. A model image of the F-76 pipeline segment is shown in Figure 7-73. Models for the JP-5 and F-24 pipelines are similar, with slide supports instead of cradle supports.

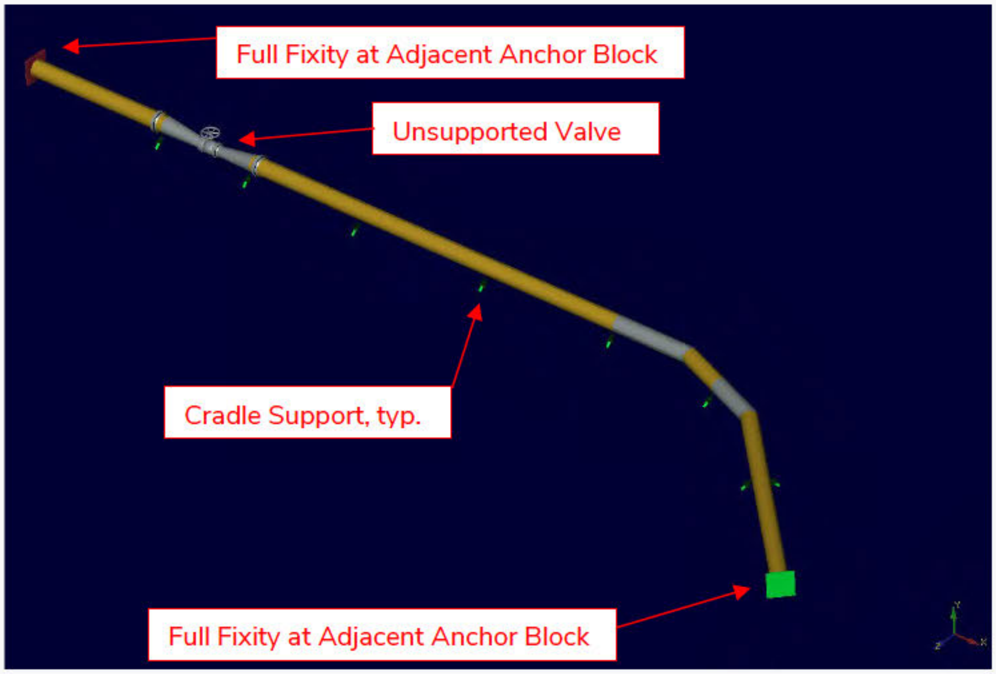

Figure 7-73 – (b)(3)(A) F-76 Pipeline – Harbor Tunnel Unsupported Valve Segment Model

We found stress ratios to be within allowable code limits at this location. The ratio of longitudinal stress to the ASME B31.4 allowable stress was 0.19 near the valves, with a peak of 0.34 near the anchor block after the bend. This indicates that stress demands near the valve location are low. Stress ratios are shown in Figure 7-74. Results were similar for the JP-5 and F-24 lines, with peak stress ratios of 0.20 and 0.19, respectively.

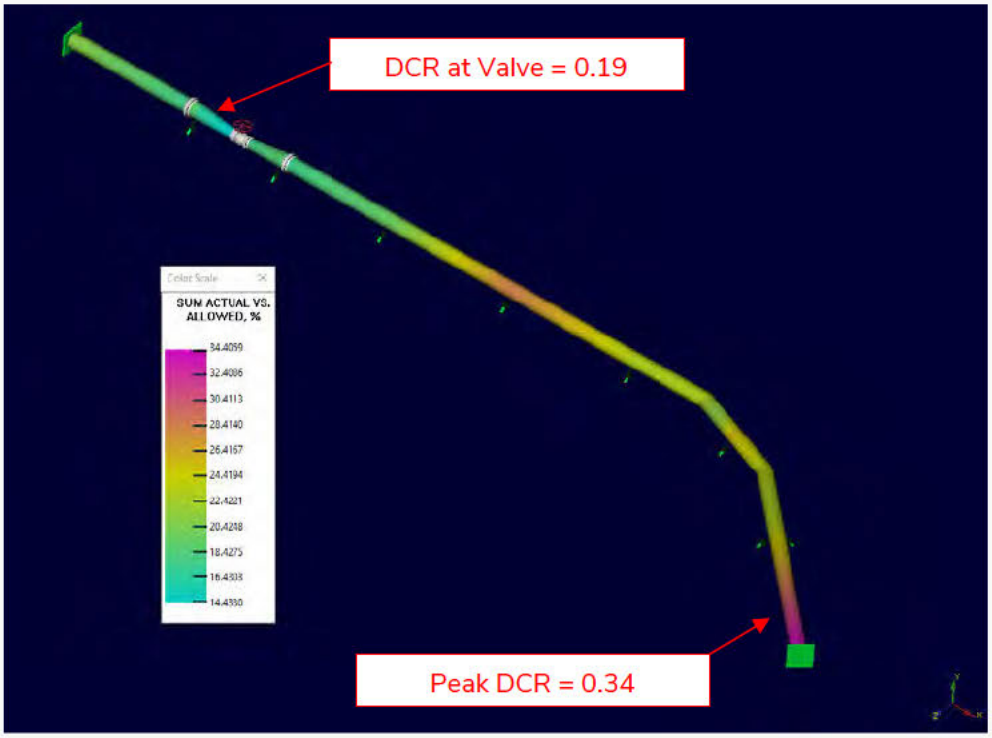

Figure 7-74 – F-76 Unsupported Valve Analysis – Demand vs. Code Longitudinal Stress Ratios

7.3.9 Dresser Coupling FE Model and Nonlinear Analysis

We developed a detailed finite element model using ABAQUS software package to simulate the Dresser coupling failure at Tank 20 during the surge event on 6 May 2021. The preliminary FE model and analysis results are described in this section.

There are four retention rods at the Tank 20 Dresser coupling location. The 5/8 in. diameter retention rod is about 26 in. long, and the lug plate thickness is 1/4 in. See Figure 5-11 for our field measurements.

The 12 in. diameter pipe (nominal size) at the Dresser coupling location is assumed to be a Schedule 10 pipe with a wall thickness of 0.406 in. The material properties are not known. We have assumed the following material properties in our preliminary analysis model:

- The 12 in. pipe – ASTM A53 Grade B (with a yield stress of 35 ksi and ultimate stress of 60 ksi).
- Retention lug and rod – ASTM A36 (with a yield stress of 36 ksi and ultimate stress of 58 ksi).

7.3.9.1 FE Model

Due to the symmetric geometry of the pipe and retention lug/rod, we only modeled a quarter of the pipe section initially and one retention rod and two corresponding lugs, as shown in Figure 7-75. We used shell elements for pipe, lug, and nut, and we used the beam element for the rod.

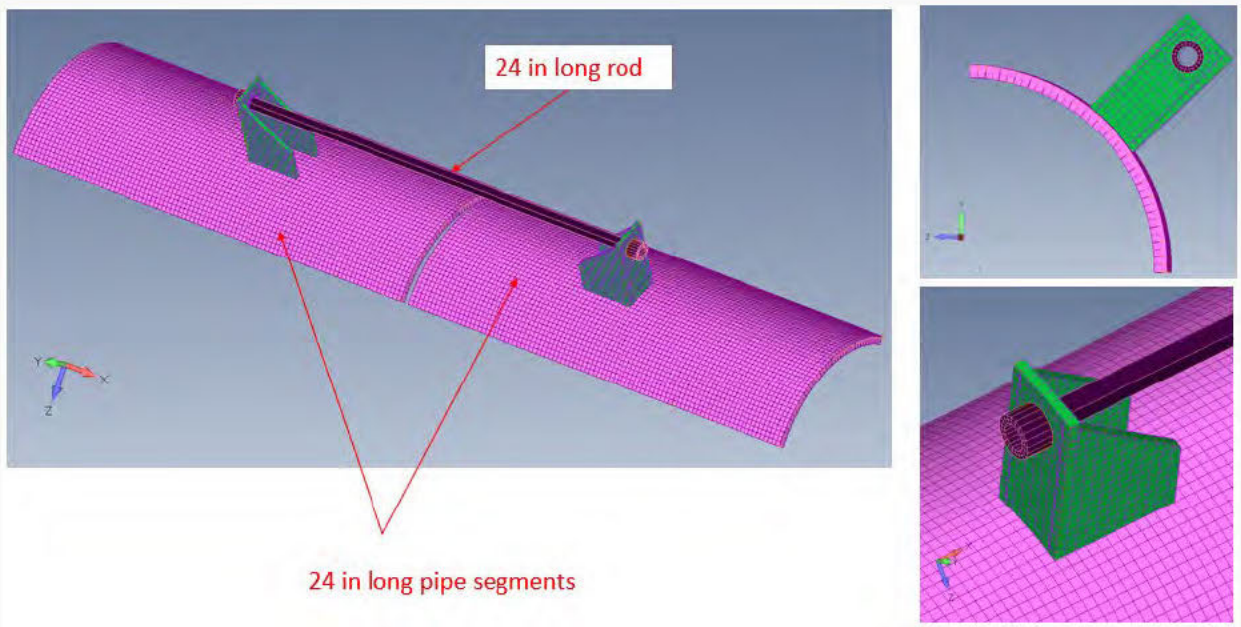

Figure 7-75 – FE Model Consisting of Quarter Pipe Section and Retention Rod Assembly

While Figure 7-75 shows our representative model taking into account symmetric geometry, i.e., a quarter Dresser coupling, Figure 7-76 shows our 3-D preliminary model of the 12 in. Dresser coupling.

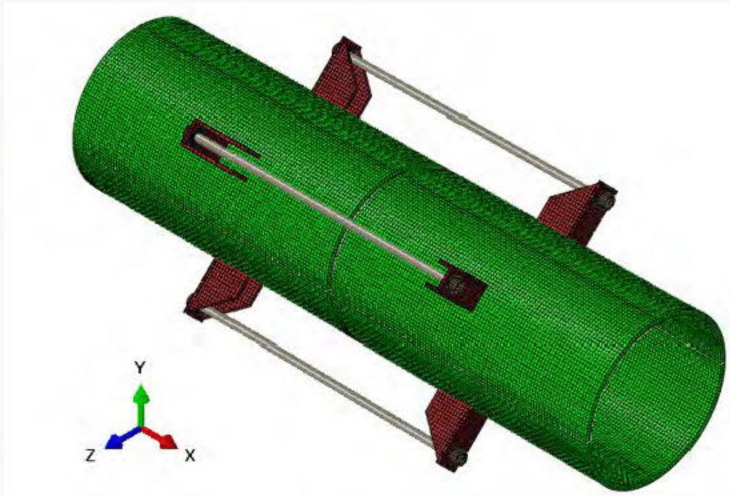

Figure 7-76 – Whole FE Model of [redacted] Dresser Coupling

For this preliminary FE model, we did not explicitly model the fillet weld between the retention lug plate and the pipe. In addition, we did not explicitly model the deflection ring at the end of the retention rod.

7.3.9.2 Steel Material Modeling

Figure 7-77 illustrates a typical engineering strain hardening material model used for ductile steel in the finite element analysis. In Figure 7-77, σy is the yield stress, σu is the ultimate stress, εy is the strain at yield, εst is the strain at initial strain hardening, Es is the elastic modulus, and Est is the strain hardening modulus. The typical value for Est is Es/50, which is a mean value from tests and has been used in the derivation of the AISC compactness requirements. A typical value of εst is approximately equal to $12\varepsilon y$.

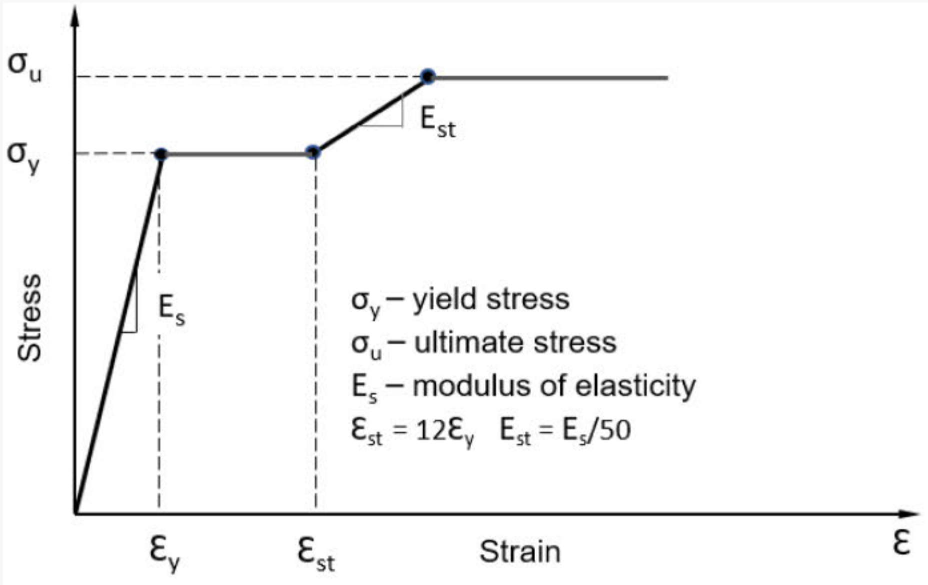

Figure 7-77 – Engineering Strain Hardening Material Model

For finite element analysis, the engineering stress-strain curve (based on the original cross-sectional area) needs to be converted to a true stress-strain curve (based on actual cross-sectional area). The true stress-strain curve was then used as one of the analysis input parameters. As an example, Figure 7-78 shows the true stress-strain curve for ASTM A36 material together with the engineering stress-strain curve.

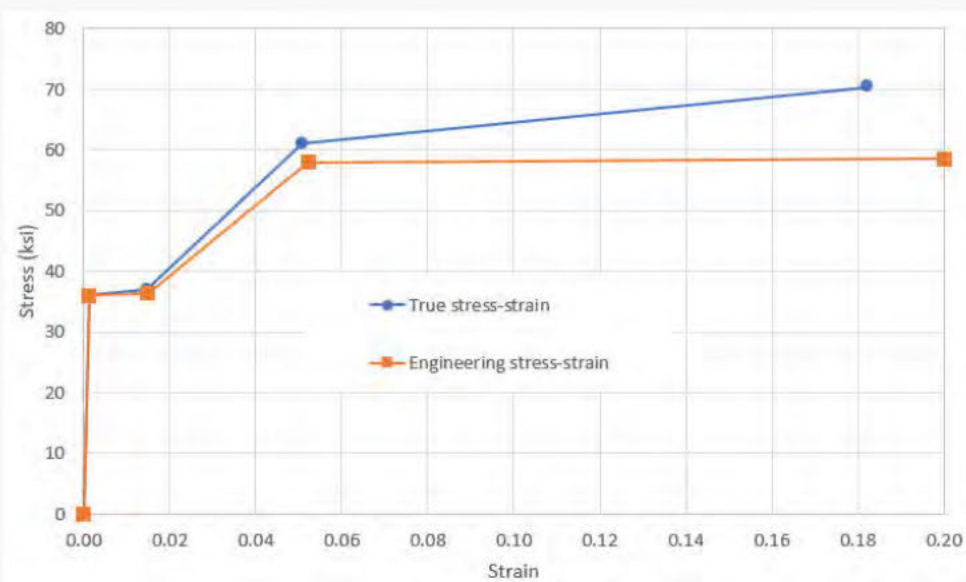

Figure 7-78 – Stress-strain Curves for ASTM A36 Material

7.3.9.3 Boundary Conditions and Loading Application

Apart from the symmetry boundary conditions shown in Figure 7-79, we restrained all nodes at one end in three translational directions (X, Y, and Z) and released rotational degrees of freedom for these nodes. On the other end of the model, we applied monotonically increasing uniform displacement-controlled loading in the axial direction (X direction in the model).

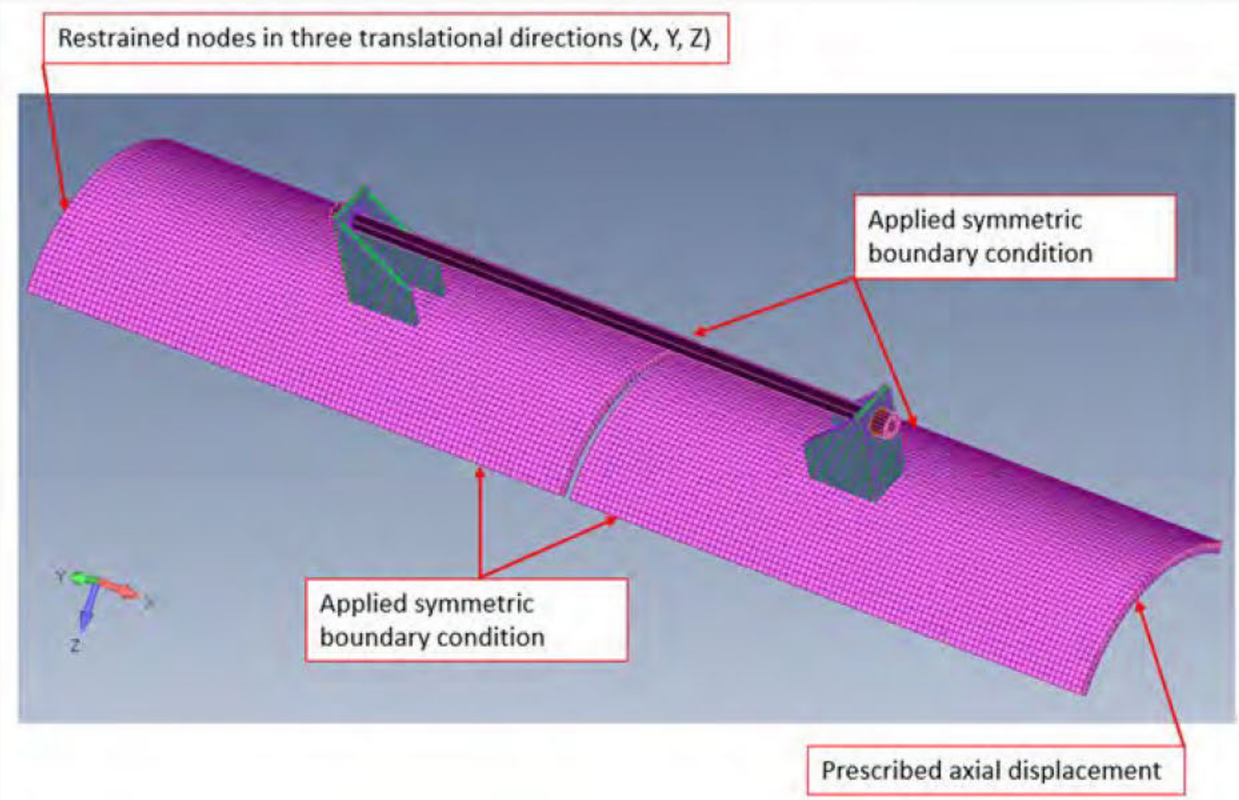

Figure 7-79 – Boundary Conditions of Preliminary Dresser Coupling FE Model

7.3.9.4 Preliminary Analysis Results

In our preliminary analysis model, we did not explicitly model the fillet weld between the retention lug plate and the pipe. Our preliminary analysis results indicate that the lug bending deformation (or lug plate tearing) is likely the weakest link assuming the weld strength is sufficient. The lug plastic strain started at an early loading stage. When the axial displacement reaches about 2 in., the lug plate is expected to fail. Figure 7-80 shows plastic strain (PEEQ) contour when the axial displacement reaches 2.1 in. in the model. For low carbon ductile steel material like ASTM A36, steel rupture would start to occur when the plastic strain reaches about 15% to 20%. At a displacement of 2.1 in. in the model, the lug steel plate plastic strain immediately adjacent to the rod has reached 15% to 20% or above, indicating the lug plate is expected to fail.

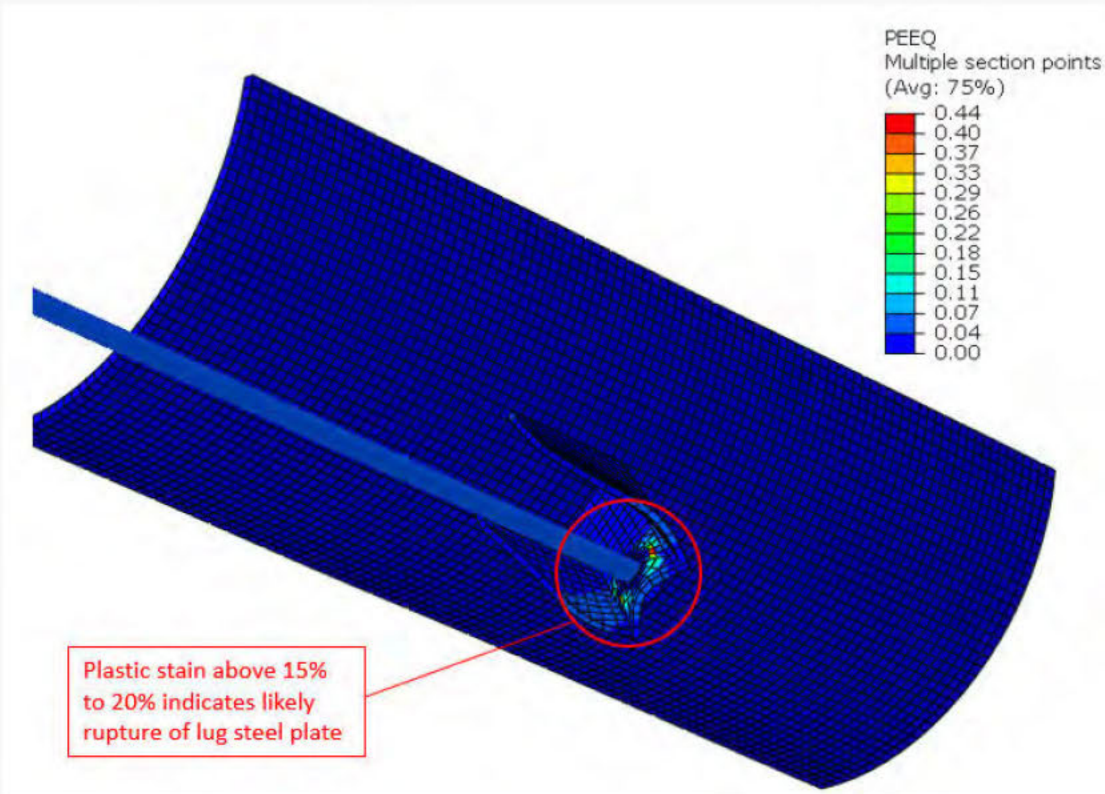

Figure 7-80 – Plastic Strain (PEEQ) at Displacement of 2.1 in. in the Model

Figure 7-81 shows the lug plate bending from our FE analysis when the axial displacement reaches 2.1 in. compared to the actual lug bending observed on site.

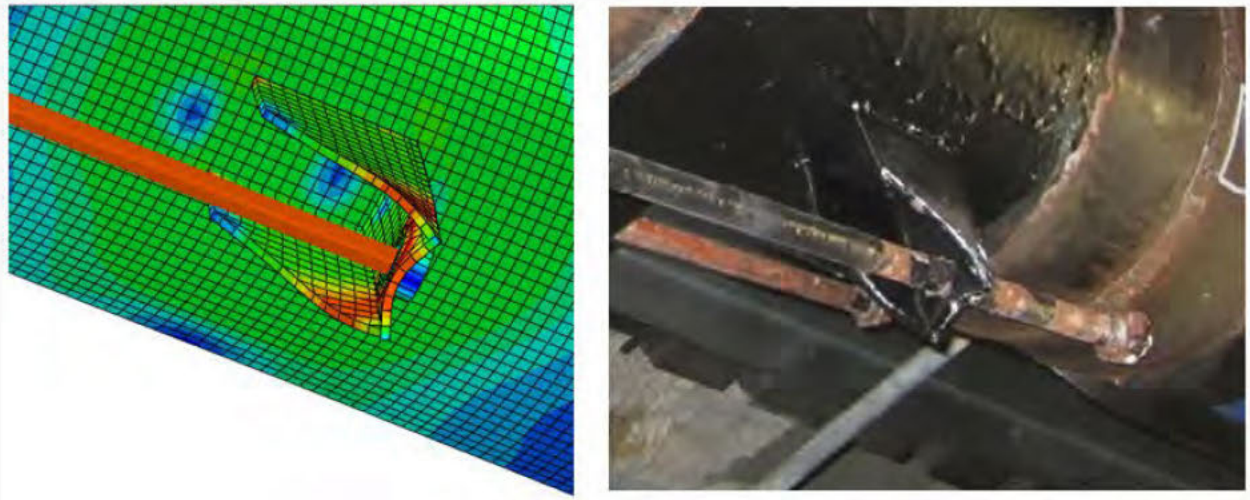

Figure 7-81 – Lug Plate Bending – FE Analysis Result (left), Actual Bending (right)

Figure 7-82 shows the load-displacement curve for the entire 12 in. dia. pipe considering the modeling symmetry and lug/rod responses at different loading stages. When the load reaches about 30 kips, the lug plate has already started to yield. When the load reaches about 45 kips, the retention rod has started to yield. When the load reaches about 76 kips with a corresponding displacement of 2.1 in., the lug plate is expected to fail.

Note that the load-displacement curve, as shown in Figure 7-82, did not take into account the initial displacement, if any, accommodated by the deflection ring, which was not explicitly modeled in the analysis.

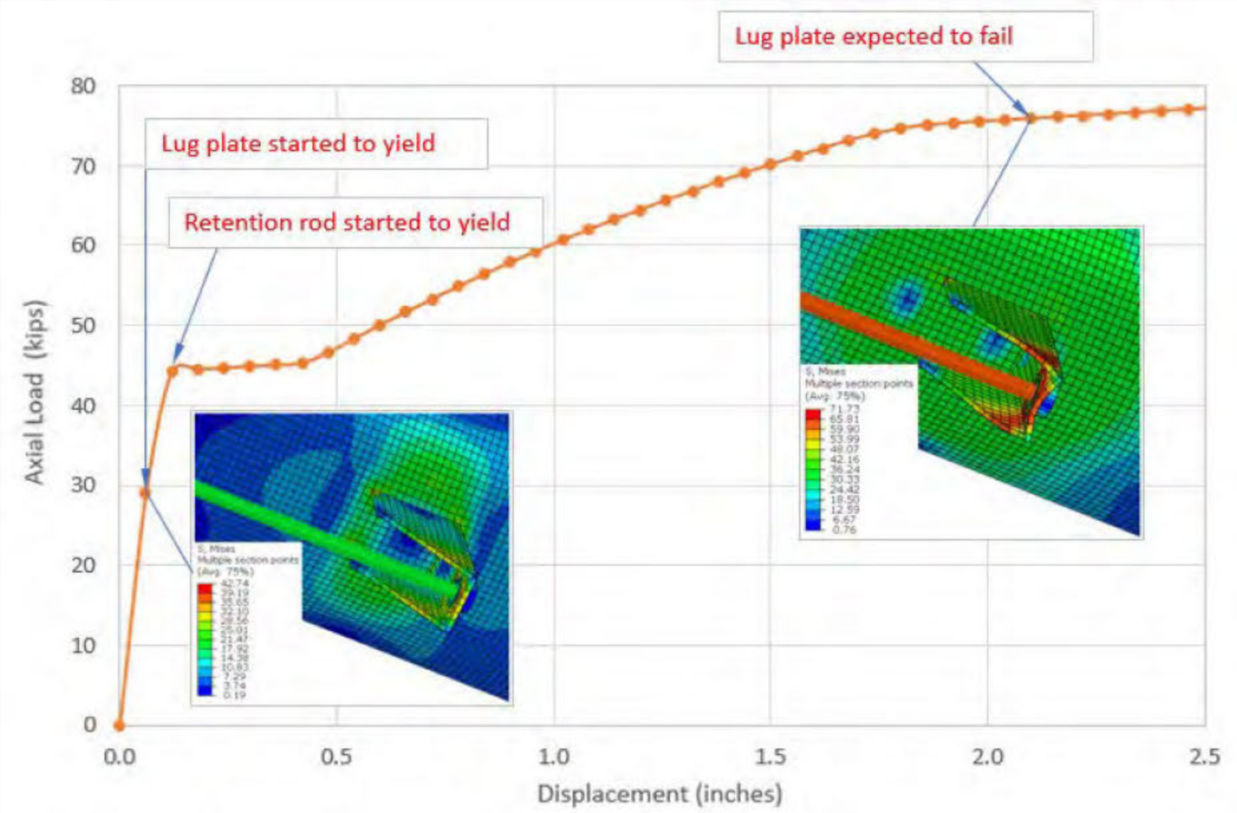

Figure 7-82 – Load-Displacement Curve for the Entire (b)(3)(A) Diameter Pipe

7.3.10 Local Buckling Evaluation Under Vacuum Condition

We assessed local pipe buckling under vacuum conditions per Offshore Standard DNV-OS-F101 (DNV). Sections 5 D400, D600, and 13 D700 of the standard were used to evaluate the local buckling under external overpressure and combined loading conditions on offshore pipelines (system collapse). Below are the calculation assumptions:

- External pressure of the system is equal to atmospheric pressure (14.7 psi), and the minimum internal pressure is zero.
- Minimum yield strength of the pipe is 30,420 psi.
- Approximate corrosion allowance of 20% of nominal pipe thickness.

The local buckling calculation resulted in a demand to capacity ratio (DCR) of 0.45, indicating the pipe can withstand a vacuum condition under the assumptions listed above. Additionally, we checked for local buckling under a combined loading condition. Section 5 D 607 in the DNV states the criteria for local buckling of a pipe under combined loading. We considered pipe members subjected to a combination of bending moment, axial force, hoop stresses, and external overpressure. The local buckling under the combined loading check resulted in a DCR of 0.48, indicating the pipe can withstand a vacuum condition under combined loading.

7.3.11 Discussion

7.3.11.1 Surge Loading

We performed a series of pipe stress analyses for the piping connecting the tanks, considering the possibility of a surge equal to the magnitude calculated for the 6 May 2021 event in the Root Cause Analysis Report. The equivalent surge load was back-calculated through a pipe stress model in both the Root Cause Report and SGH independently. The Root Cause Analysis Report independently calculated a surge pressure using hydraulic analysis.

While we used the equivalent pressure of 320 psi from the Root Cause Analysis Report for our calculations, we note that there is significant uncertainty associated with the surge loading. The pressure in the Root Cause Analysis Report was calculated using the specific circumstances related to the piping configuration and valve opening sequence at the time of the 6 May 2021 event, only in the JP-5 pipeline. Because this pressure is based on a single historical event in a single pipeline, it is unclear if smaller or larger surge pressures could be encountered during defueling operations based on vacuum conditions that may be present, differences in the configuration of the F-24 or F-76 pipelines, or different valve operating sequences causing different surge events.

We recommend that additional evaluation of the potential surge for all three pipeline systems be performed to establish a maximum surge event that could take place during defueling operations considering piping configurations in place and likely operating procedures.

7.3.11.2 Pipeline System Configuration

Regardless of the uncertainty related to the magnitude of the surge loads, we made several conclusions related to the response of the pipeline system to the surge forces that are valid despite this uncertainty.

- When piping to any of the tanks is disconnected, surge loads cause high stresses in the tee section connecting the header to the lateral piping sections. Additional lateral supports on the header and lateral piping do not effectively mitigate these high stresses.
- In addition to the high stresses in the tee sections, should the blind flange at the disconnected end of piping be on the tank side of a Dresser coupling, that Dresser

coupling may experience tension loads in excess of its capacity, similar to what happened during the 6 May 2021 event.

- When the lateral piping goes directly into the tank without bends, the overall stresses from the surge loads in the piping system are low. However, bends in that piping may introduce overstress conditions. This is due to code-specified Stress Intensification Factors associated with bends, as well as additional bending in the pipeline caused by eccentric axial loads.
- Surge loads at the end of the main header for the F-24 line cause overstress at the tee due to lack of axial restraint (as with the JP-5 pipeline) or insufficient section (as with the F-76 pipeline).
- Axial restraint of the piping at pipe supports adjacent to bends and at the end of the F-24 header appears to mitigate these overstress conditions.
- Pipelines are adequate for loads resulting from typical operational pressures, temperature differentials, and self-weight when not considering effects from surge loads.

We note that Enterprise Engineering used 30,420 psi for the F-76 line based on limited destructive testing performed on the pipeline. We used a standard yield stress of 35,000 psi associated with ASTM A53 Grade B material in our pipe stress analyses. The use of the less conservative yield stress used by Enterprise increases the peak DCR of 0.72 calculated in our analysis to 0.83, which is still within ASME B31.4 limits. For the other pipelines, the assumed yield stress of 35,000 psi is conservative compared to values used by Enterprise based on limited testing for both the JP-5 and F-24 lines.

7.3.11.3 Dresser Couplings

Previous evaluations (Section 2.2.6) have stated that Dresser couplings are prohibited by military specifications because they are classified as expansion devices. Our review of those specifications indicates that the intent is to prohibit non-fire-resistant installations. However, the details of these Dresser couplings (Section 2.2.6) show modifications from a standard design to include insulated piping joints and insulating blankets on the installation. The previous conclusions by others that the non-standard Dresser couplings used here are prohibited may not be appropriate for this installation.

We evaluated the Dresser couplings that failed at Tank 20 during the surge event on 6 May 2021 by performing a nonlinear finite element analysis of the couplings. Our analysis results indicate that the lug bending deformation (or lug plate tearing) is likely the weakest link. This conclusion is supported by observations of the actual failed couplings. To increase capacity in the event of a future surge event of similar magnitude, the strengths of both the lug plate and retention rod need to be increased. The lug plate strength can be increased by increasing the lug plate thickness. The retention rod strength can be increased by increasing retention rod diameter and material strength. Alternatively, additional lugs and restraining bolts can be provided.

Additionally, we reviewed Test Report No. C2613 provided, which was provided by Dresser Utility. This test report provides empirical evidence of the Dresser coupling being able to maintain a seal under vacuum pressures. The vacuum pressure in the test report was 20-in. of mercury which corresponds to 9.82 psi. This is approximately 67% of atmospheric pressure, which was highlighted in the PHA as a concern. Dresser Utility also indicated in correspondence that the seal of the Dresser coupling should be maintained so long as the metallic coupling components and pipe do not deform. This is because the coupling seal is "based on gasket pressure developed through tightening of the follower bolts." We independently performed a calculation demonstrating the adequacy of the piping for vacuum conditions in Section 7.3.10. Based on the test report from Dresser Utility and the check we performed for the piping for vacuum pressure, we believe the couplings do not pose a significant risk of leaking due to vacuum pressures.

7.4 Pipe Supports and Pipe Racks

We performed our evaluation of pipe supports and pipe racks for dead loads, surge loads, and earthquake loads using methods defined in ASCE 7-16. We obtained specific earthquake ground shaking acceleration values that are based on USGS mapped values for the Red Hill area of Oahu using the ATC Hazards Map found online at https://hazards.atcouncil.org/#/ (ATC, 2017), for [redacted] (b)(3)(A). We used values calculated for the same level of seismic hazard used for a new design of structures throughout the United States.

These mapped values probabilistically consider nearby faults, the type of fault and historical fault activity, their location and distance to the site, distribution of possible earthquake magnitudes caused by each fault, and numerous other properties.

We used the following seismic design parameters:

- Risk Category – III (Table 2-2 of UFC 3-301-01 (Department of Defense, 2022)).
- Importance Factor, I_E = 1.25 (Table 2-2 of UFC 3-301-01 (Department of Defense, 2022)).
- Site Class – C (very dense soil and soft rock, Table 20.3-1 of ASCE 7-16 (ASCE, 2017).
- Response modification factor (impulse), R = 3.0 (Table C15.5-1 of ASCE 7-16, and Table 4.C.2 of ASCE Guidelines for Seismic Evaluation and Design of Petrochemical Facilities (ASCE, 2020)).S_S = 0.575g (5% damping, risk-targeted maximum considered earthquake, MCE_R, at 0.2s).
- S_1 = 0.166g (5% damping, risk-targeted maximum considered earthquake, MCE_R, at 1.0s).
- F_a = 1.27 (site amplification factor at 0.2s).
- F_v = 1.50 (site amplification factor at 1.0s).
- S_{MS} = 0.73g = F_aS_S.
- S_{M1} = 0.249g = F_vS_1.
- S_{DS} = 0.486g = (2/3)S_{MS} (design earthquake spectral response acceleration at 0.2s).
- S_{D1} =0.166g = (2/3)S_{M1} (design earthquake spectral response acceleration at 1.0s).
- T_L = 4.0s (long-period transition period).
- SDC (Seismic Design Category) = C.

The 5% damping design horizontal response spectrum (also obtained from ATC Hazards website (ATC, 2017)), as shown in Figure 7-83, was used in our modal response spectra analysis.

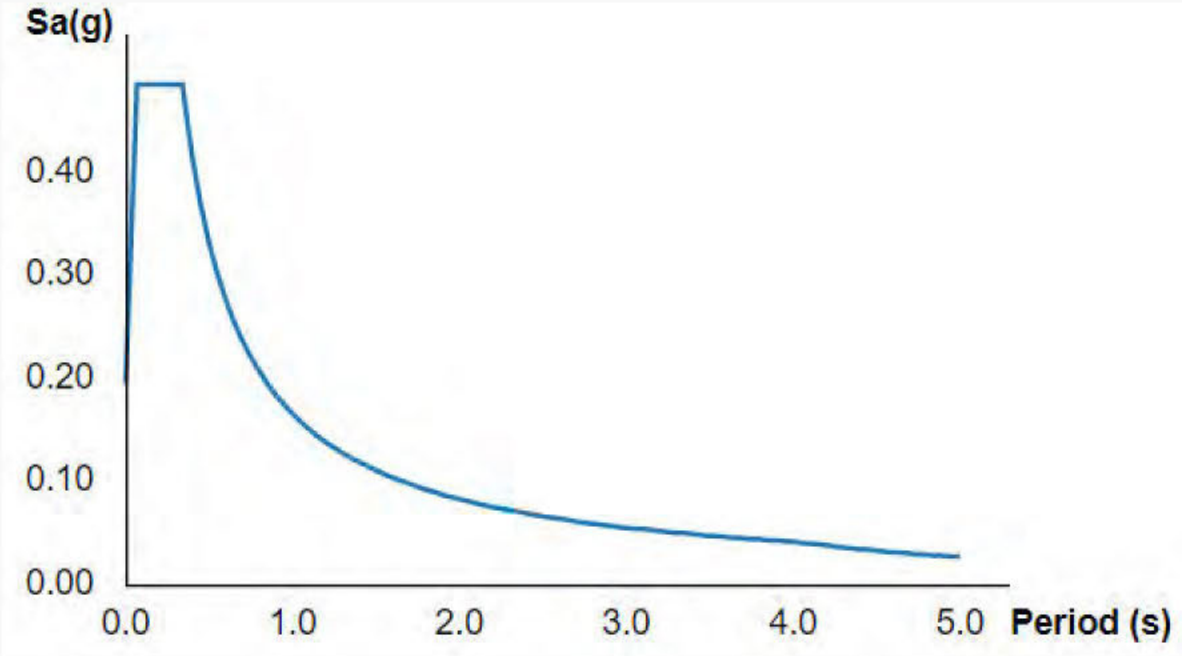

Figure 7-83 – 5% Damping Design Horizontal Response Spectrum

We selected representative pipe support segments in different areas of the Harbor Tunnel (HT) and Lower Access Tunnel (LAT) to evaluate them using a series of finite element models developed using SAP2000. Our objective was to evaluate the pipe supports under operational loads and other conditions. We modeled the pipe supports assuming they were as-designed, ignoring any defects that were observed during our site visits, and reported in Appendix A on the presumption that such significant defects would need to be repaired.

We do not know the actual material properties, but we assumed and modeled all steel elements using ASTM A36 material as it is typical for structural steel members at the time of construction. The geometry of the pipe supports was based on available drawings supplemented by our field observations and measurements. We accounted for the base plates and connections to the tunnel wall using pin supports.

The weight of the fuel in the pipes was taken conservatively as the largest fuel density listed in Attachment B.7.1 of the report “Conceptual Site Model, Investigation and Remediation of Releases and Groundwater Protection and Evaluation, Red Hill Bulk Fuel Storage Facility Joint Base Pearl Harbor Hickam, Oahu, Hawaii.” Fuel density is taken as 0.893 kg/L.

We developed the following finite element models:

- The HT steel pipe supports between concrete anchors.

- Segments of pipe supports in the LAT.

    1. Model of Pipe Supports 30 to 38 to evaluate typical pipe supports composed of two columns and one beam.
    2. Model of Pipe Supports 46 to 48 to evaluate the stability and conditions of this area where we observed a heavy 20 in. valve with potentially inadequate support.
    3. Model of Pipe Supports 49 to 57 to evaluate the transition between two different types of supports, those with one column and those with two columns.
    4. Model of Pipe Supports 78 to 92 to evaluate typical pipe supports composed of one column with the other end embedded in the tunnel wall.
    5. Model of Pipe Support 97 to evaluate typical pipe support composed of one vertical bracket with the other end embedded in the tunnel wall.
    6. Model of Pipe Support 100 to evaluate typical pipe support with both ends embedded in the tunnel wall.

- Pipe supports in the lateral tank galleries

    1. Model of pipe support in Tank Gallery 10.
    2. Model of pipe support in Tank Gallery 15.
    3. Model of pipe support in Tank Gallery 20.

Pipe supports were modeled using frame elements to capture the interaction between different structures and piping systems. The weight of the pipes were calculated with a wall thickness of 0.375 in. for the [redacted] pipe (F-76), 0.25 in for the [redacted] pipe (JP-5), 0.25 in. for the [redacted] pipe (F-24) per measurements taken in the field. Typical longitudinal bracing is made of L2-1/2 in. x 2-1/2 in. x 5/[redacted] angles, and they are considered connected at the center (intersection of the two cross braces), which was the condition seen in our field observations.

The weight of the fuel inside the pipe was calculated and applied as point load on the frames at the pipe support locations.

We evaluated the pipe support using the above-mentioned finite element models for operational (gravity) loads and seismic loads. For operational loads, we included the self-weight of the structure and the pipes, plus the weight of the fuel if the pipes were full of fuel. We considered a load combination of 1.2xDead + 1.2xFuel (operating load) according to PIP STC01015 (PIP, 2017). We also considered the extra dead load of the small-bore pipes, conduit and cable trays, and miscellaneous components by adding a uniform distributed load of 30 psf between the fuel pipes per PIP STC01015 (PIP, 2017) and field observations. For seismic loads, we performed a response spectrum analysis per ASCE 7-16. We considered the self-weight of the components and the weight of the fuel as the seismic mass for the analysis to account for a scenario where an earthquake occurs while all three pipes are full of fuel.

We analyzed the seismic and operational demands on the structural elements obtaining the loads imposed on each element. Afterward, we calculated the structural capacity of each structural element per the American Institute of Steel Construction (AISC). By comparing the structural demand to the structural capacity of each element, we obtained a demand-to-capacity ratio (DCR) of each element.

For the seismic analysis of the pipe supports, we used Site Class C, Seismic Design Category C, and the seismic parameters for the Red Hill area. We also used R=3.

We produced details for the repairs and retrofits of the pipe supports where necessary. Details can be found in Appendix D.

7.4.1 Pipe Supports at Harbor Tunnel

We modeled a section of pipeline and pipe supports between two concrete anchors. The typical pipe support is made of angle sections, as shown in Figure 7-84. Vertical members were modeled using two back-to-back angles L3 in. x 3 i.n x 1/4 in. The upper horizontal members were modeled using a single angle L4 in. x 3 in. x 1/4 in., while the lower horizontal members were modeled using a single angle L4 in. x 3 in. x 5/[redacted]

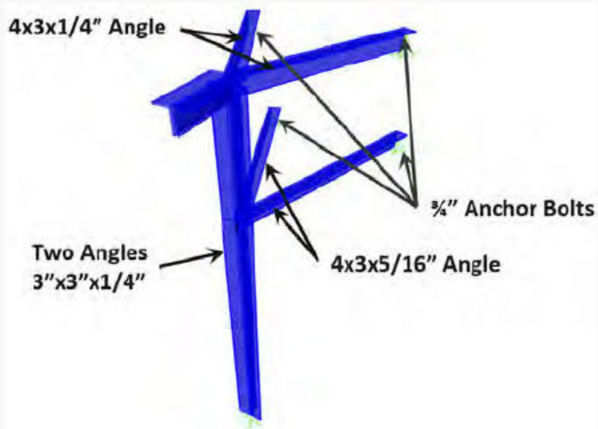

Figure 7-84 – Representation of a Typical Support in the Harbor Tunnel

Figure 7-85 shows the modeled segment of the pipeline between concrete anchors with the corresponding pipe supports.

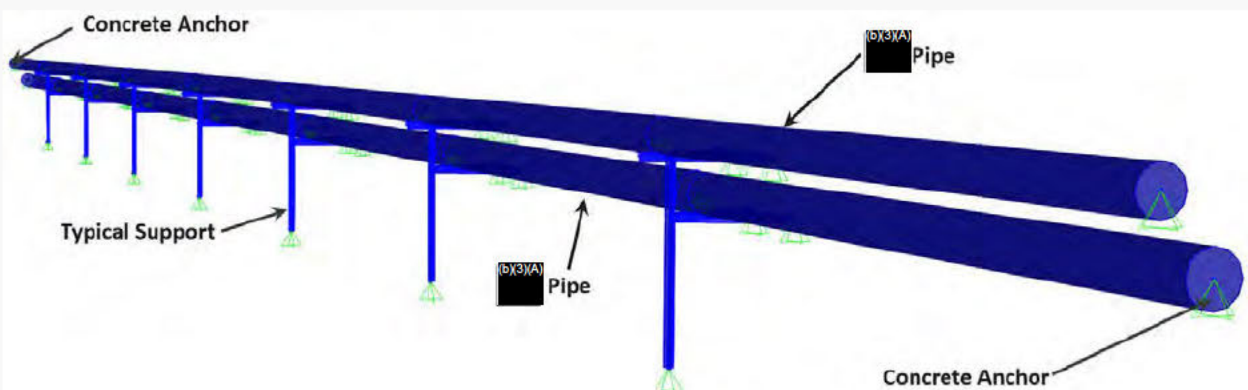

Figure 7-85 – Representation of Typical Pipe Supports Between Anchors

Figure 7-86 below shows the DCRs for the different elements of the controlling pipe support. The maximum DCR is 0.60. The DCRs for the elements analyzed show that the structural capacity of the pipe supports is adequate for operational and seismic loads.

Figure 7-86 – Demand-to-Capacity Ratios (DCRs) for Pipe Supports at Harbor Tunnel

7.4.2 Model of Pipe Supports 30 to 38

This model represents the pipe supports that consist of two columns and one beam. We selected this section between Tank Galleries 11-12 and 13-14 as representative of a group of pipe supports.

Pipe supports, beams, and columns were modeled using W8x31 and W10x49 elements according to available drawings and field measurements. Figure 7-87 shows the model of Pipe Supports 30 to 38.

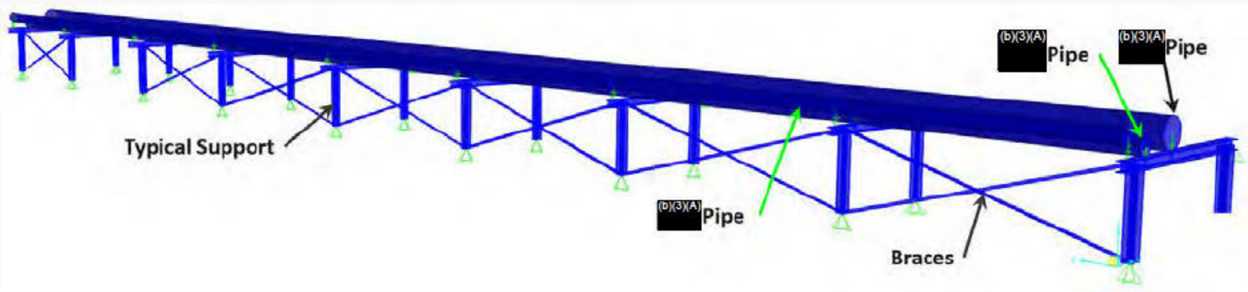

Figure 7-87 – Finite Element Model of Pipe Supports 30 to 38

Some of the two-column pipe supports have the beam connected or embedded into the wall.

Figure 7-88 shows the DCRs for the different elements. The maximum DCR is 0.55. The DCRs for the elements analyzed show that the structural capacity of the pipe supports is adequate for operational and seismic loads.

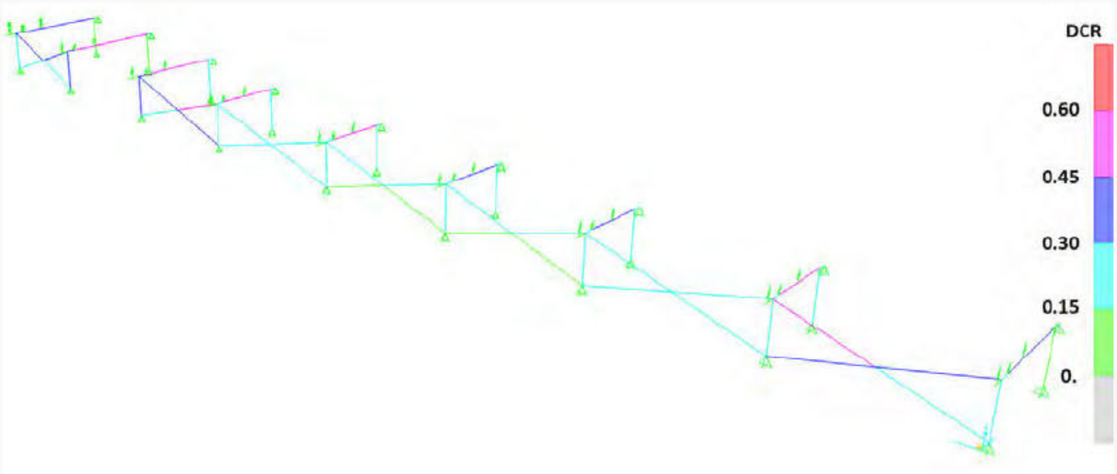

Figure 7-88 – Demand-to-Capacity Ratios (DCRs) for Pipe Supports 30 to 38 Beams Connected to the Wall

7.4.3 Model of Pipe Supports 46 to 48

We developed this model to evaluate the area between Pipe Supports 46 and 48, where during our site visits, we observed a large (b)(3)(A) valve with potentially incomplete/inadequate supports and other deficient structural conditions (corroded and damaged members). Pipe supports, beams, and columns were modeled using W8x31 and W10x49 elements according to available drawings and field measurements.

The weight of the valve was taken as (b)(3)(A) based on similar size valve data sheets available in the public domain. The post that supports the valve was modeled as a 6 in. Sch. 40 pipe. Figure 7-89 shows the model of Pipe Supports 46 to 48.

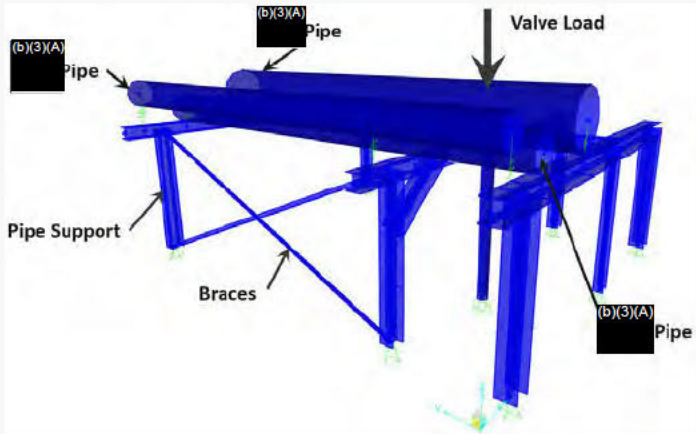

Figure 7-89 – Finite Element Model of Pipe Supports 46 to 48

Figure 7-90 below shows the DCRs for the different elements for seismic and operational conditions. The maximum DCR is 4.37. The DCRs for the elements analyzed show that the structural capacity of the braces is inadequate during a seismic event.

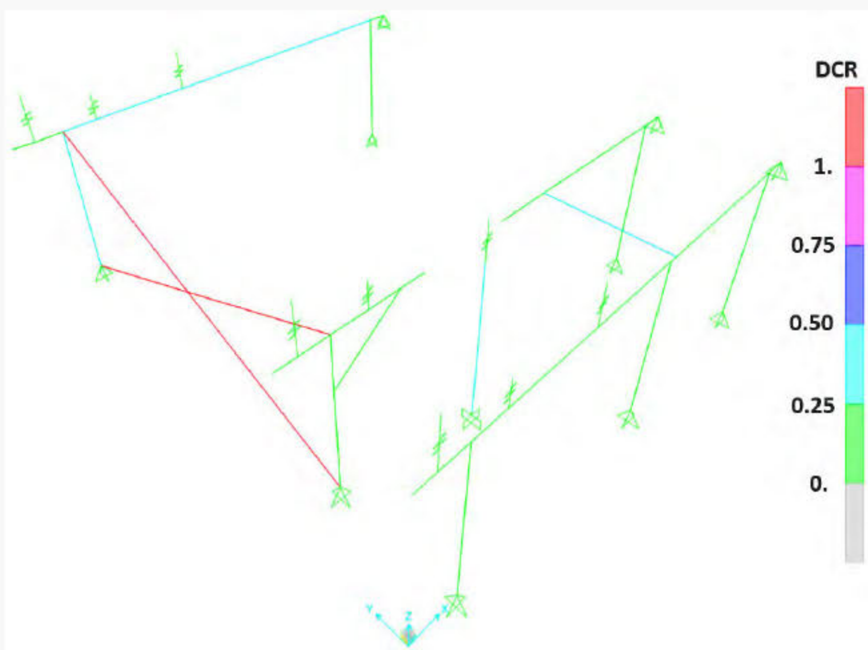

Figure 7-90 – Demand-to-Capacity Ratios (DCRs) for Pipe Supports 46 to 48

We designed a retrofit concept to improve the structural stability of the structure around the large 20 in. valves and to better distribute the seismic loads that reduce the stress on the braces. Figure 7-91 below shows the DCRs for the different elements after the retrofit. The maximum DCR is 0.53. The DCRs for the elements analyzed show that the structural capacity of the pipe supports after retrofit is adequate for operational and seismic loads and the stress in the braces is reduced to acceptable levels.

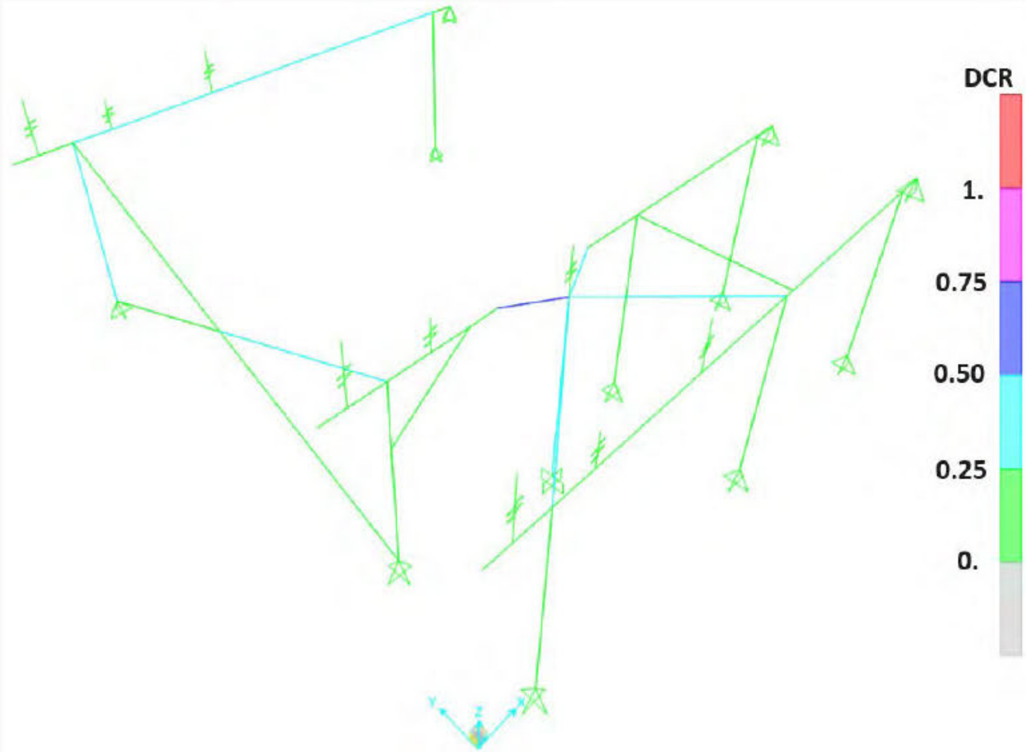

Figure 7-91 – Demand-to-Capacity Ratios (DCRs) for Pipe Supports 46 to 48 After Retrofit of Pipe Supports 49 to 57

This model was created to capture the transition between two types of pipe supports. We observed that the pipe supports changed from two columns (one at each end) to supports with one column with the other end supported on the tunnel wall. This section is located between Tank Galleries 7-8 and 9-10. Pipe supports, beams, and columns were modeled using W8x31 and W10x49 elements according to available drawings and field measurements. Figure 7-92 shows the model of Pipe Supports 49 to 57.

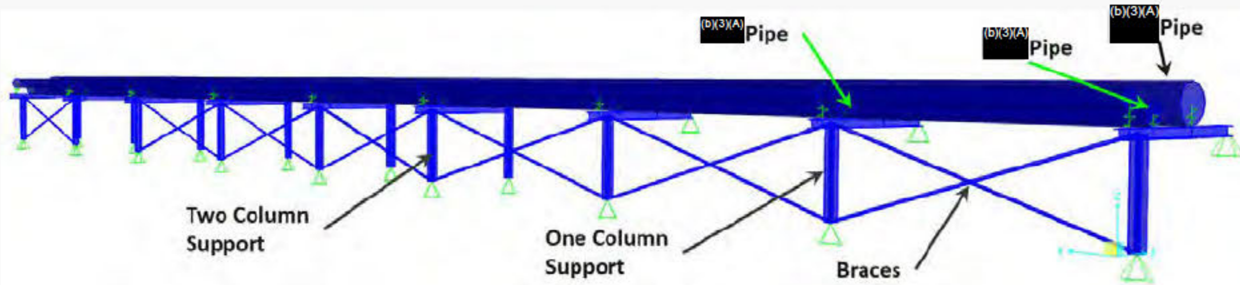

Figure 7-92 – Finite Element Model of Pipe Supports 49 to 57

Figure 7-93 below shows the DCRs for the different elements. The maximum DCR is 0.65. The DCRs for the elements analyzed show that the structural capacity of the pipe supports is adequate for operational and seismic loads.

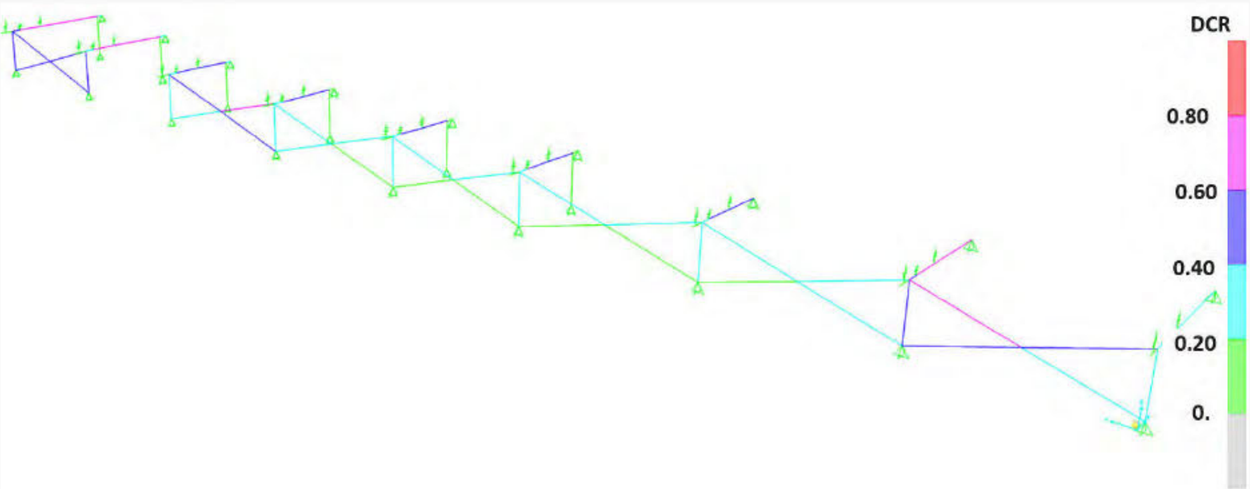

Figure 7-93 – Demand-to-Capacity Ratios (DCRs) for Pipe Supports 49 to 57

7.4.4 Model of Pipe Supports 78 to 92

This model represents the pipe supports that consist of a beam supported on the tunnel wall and one column. We selected for the analysis the portion between Tank Galleries 1-2 and 3-4. Pipe supports, beams, and columns were modeled using W8x31 and W10x49 elements according to available drawings and field measurements. Figure 7-94 shows the FE model of Pipe Supports 78 to 92.

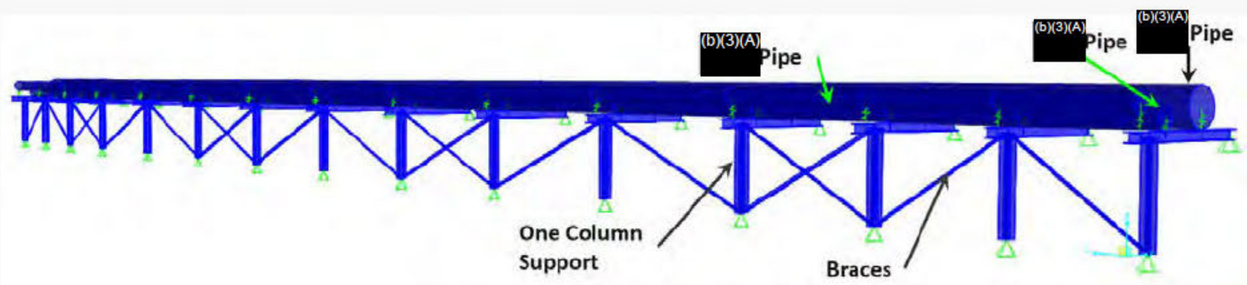

Figure 7-94 – Finite Element Model of Pipe Supports 78 and 92

Figure 7-95 below shows the DCRs for the different elements for seismic and operational conditions. The maximum DCR is 4.47. The DCRs for the elements analyzed show that the structural capacity of the braces at the end of the pipe supports are inadequate during a seismic event.

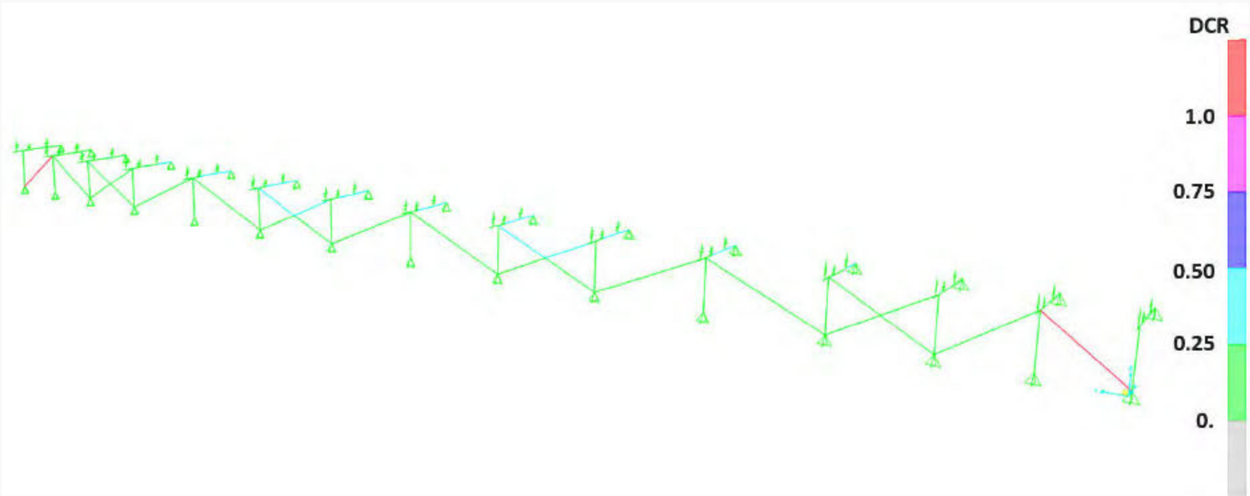

Figure 7-95 – Demand-to-Capacity Ratios (DCRs) for Pipe Supports 78 to 92

We added one brace at each end to complete an X brace on the end bays of the pipe support segment. Figure 7-96 below shows the DCRs for the different elements after the retrofit. The maximum DCR is 0.28. The DCRs for the elements analyzed show that the structural capacity of the pipe supports is adequate for operational and seismic loads, and the stress in the braces is reduced to acceptable levels.

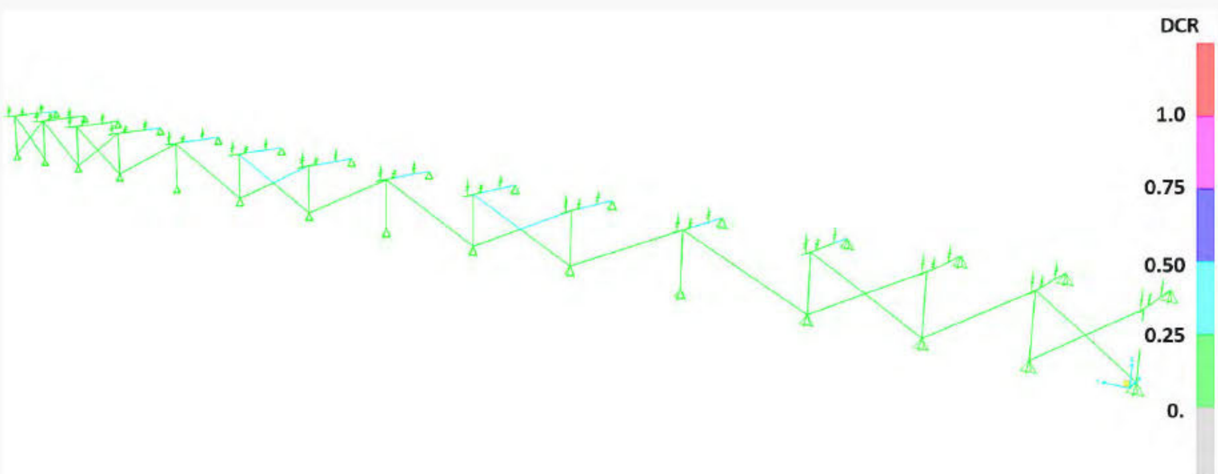

Figure 7-96 – Demand-to-Capacity Ratios (DCRs) for Pipe Supports 78 to 92 After Retrofit

Model of Pipe Support 97

This model was created to simulate the response of Pipe Supports 97 and 98, where the beam that supports the pipes is connected to the tunnel wall on one end and supported by a vertical member (bracket) from the ceiling of the tunnel on the other end. Pipe supports, beams, and the vertical bracket were modeled using W8x31 elements according to the available information. Figure 7-97 shows the model of Pipe Support 97.

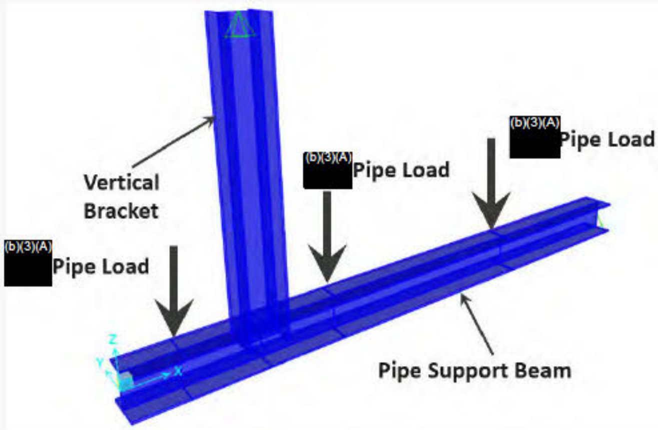

Figure 7-97 – Finite Element Model of Pipe Support 97

Figure 7-98 below shows the DCR s for the different elements. The maximum DCR is 0.24. The DCRs for the elements analyzed show that the structural capacity of the pipe supports is adequate for operational and seismic loads.

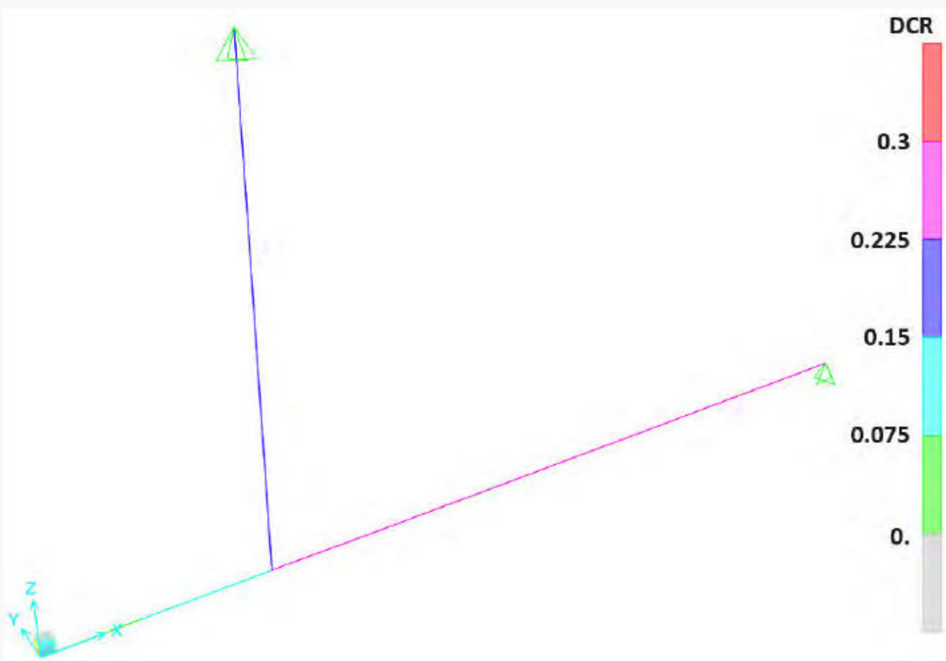

Figure 7-98 – Demand-to-Capacity Ratios (DCRs) for Pipe Support 97

7.4.5 Model of Pipe Support 100

This model was created to capture the configuration of Pipe Supports 99 to 103, where the beam that supports the pipes is connected to the tunnel wall on both ends. The beam was modeled using frame elements. The tributary weight of the pipes and the weight of the fuel were applied as point loads considering the spacing between Pipe Support 100 and adjacent supports. The beam was modeled using W8x31 elements according to available drawings. Figure 7-99 shows the FE model of Pipe Support 100.

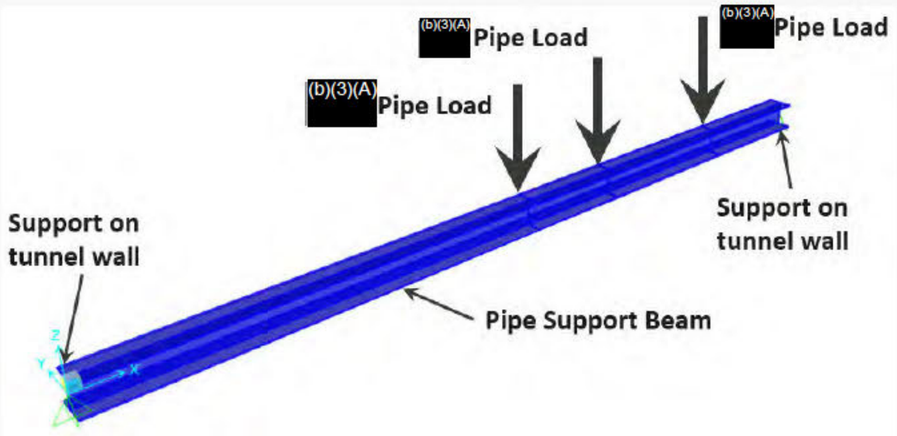

Figure 7-99 – Finite Element Model of Pipe Support 100

Figure 7-100 below shows the DCR s for the different elements. The maximum DCR is 0.73. The DCRs for the elements analyzed show that the structural capacity of the pipe supports is adequate for operational and seismic loads.

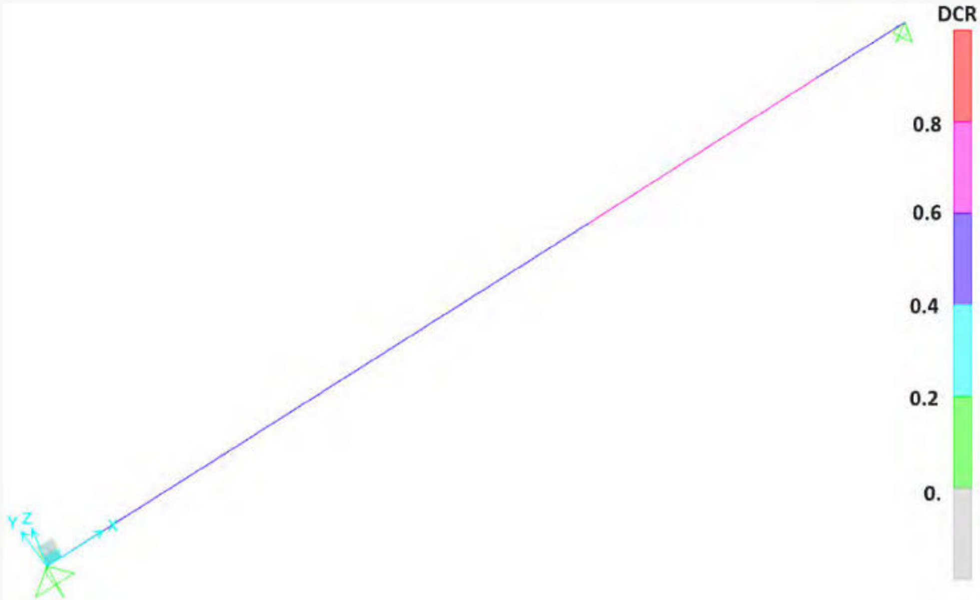

Figure 7-100 – Demand-to-Capacity Ratios (DCRs) for Pipe Support 100

7.4.6 Model of Pipe Supports in Tank Galleries 10, 15, and 20

We selected a representative sample of pipe supports in three tank galleries. The tributary weight of the pipes and the weight of the fuel were applied as point loads considering the distance to adjacent supports. The beam and columns were modeled using W8x31 elements according to available drawings and field measurements. Figure 7-101 and Figure 7-102 show the models of pipe supports at Tanks 10, 15, and 20, respectively.

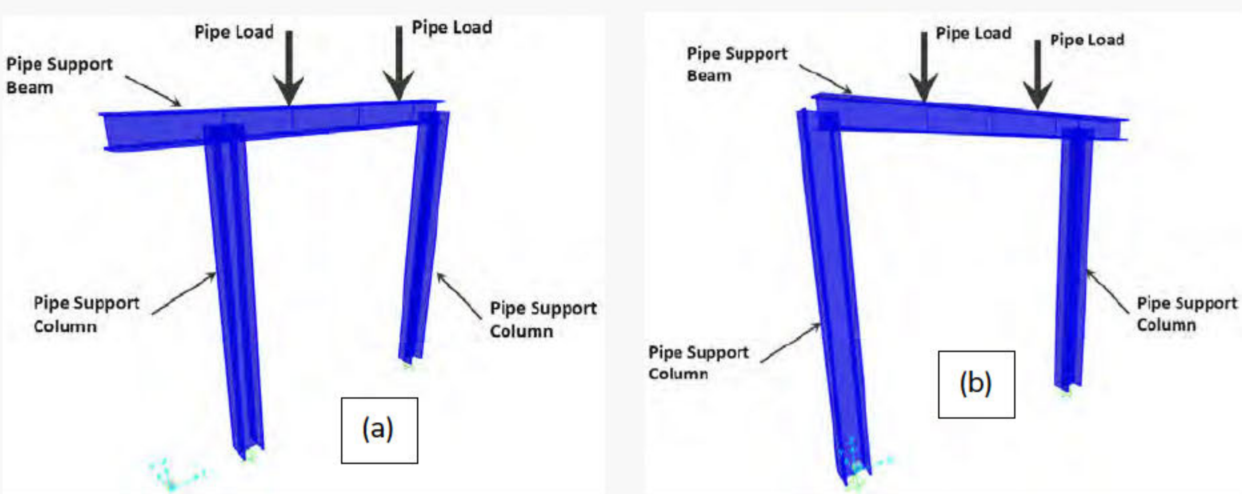

Figure 7-101 – Finite Element Model of Pipe Support at Tank 10 (a) and Tank 15 (b)

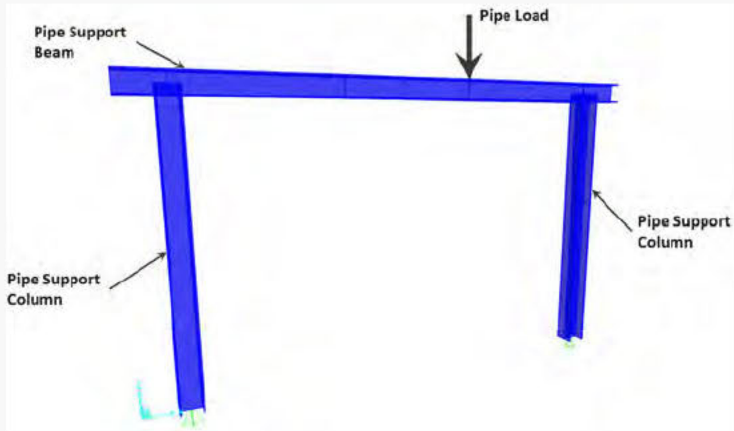

Figure 7-102 – Finite Element Model of Pipe Support at Tank 20

Figure 7-103 shows the DCRs for the different elements of the pipe support at Tank 10 and the pipe support at Tank 15. The maximum DCR for Tank 10 is 0.40. The maximum DCR for Tank 15 is 0.35. The DCRs for the elements analyzed show that the structural capacity of the pipe supports is adequate for operational and seismic loads.

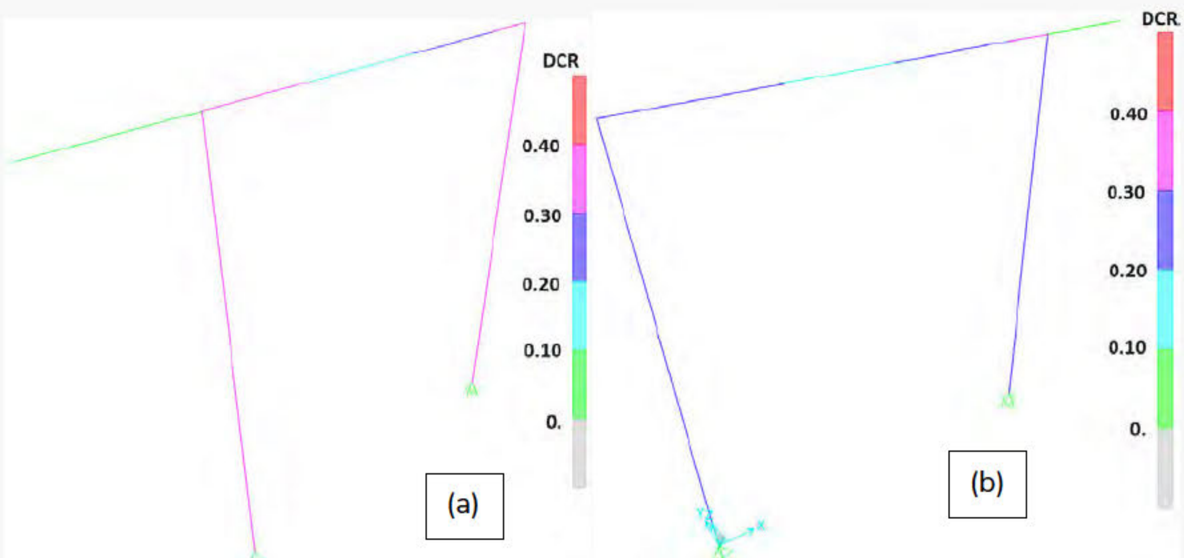

Figure 7-103 – Demand-to-Capacity Ratios (DCRs) for Pipe Support at Tank 10 (a) and at Tank 15 (b)

Figure 7-104 below shows the DCRs for the different elements of pipe support at Tank 20. The maximum DCRs is 0.62. The DCRs for the elements analyzed show that the structural capacity of the pipe supports is adequate for operational and seismic loads.

[redacted]

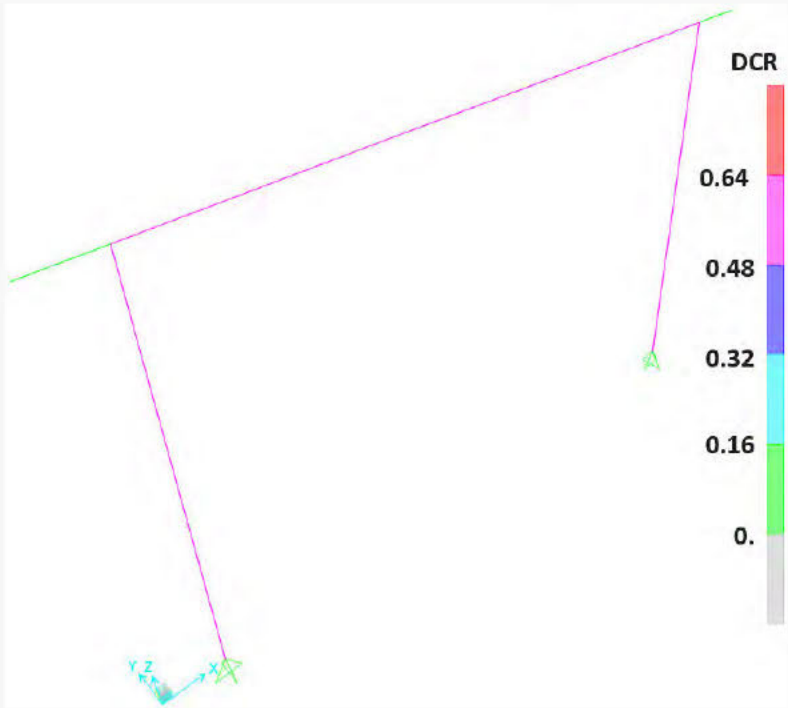

Figure 7-104 – Demand-to-Capacity Ratios (DCRs) for Pipe Support at Tank 20

In Tank Gallery 20, the pipe has been closed with a blind flange and connected to the tunnel wall. We developed a retrofit solution to transfer a possible surge load from the pipe to the pipe supports, with adequate resistance for the pipe supports to resist the surge load. The surge load was assumed as 78,000 lbf per the suggestions in the 2021 Root Cause Report of the 6 May 2021 event. Figure 7-105 below shows the proposed retrofit.

(b)(3)(A) [redacted]

Figure 7-105 – Retrofits to Tank Gallery 20 Pipe Supports

We developed a finite element model to analyze the effects of the surge load on the retrofitted structure. Figure 7-106 below shows the DCRs for the different elements of pipe support at tank gallery 20 after the retrofit and considering the surge load. The maximum DCR is 0.95. The DCRs for the elements analyzed show that the structural capacity of the pipe supports is adequate to resist the surge load after implementing the retrofit.

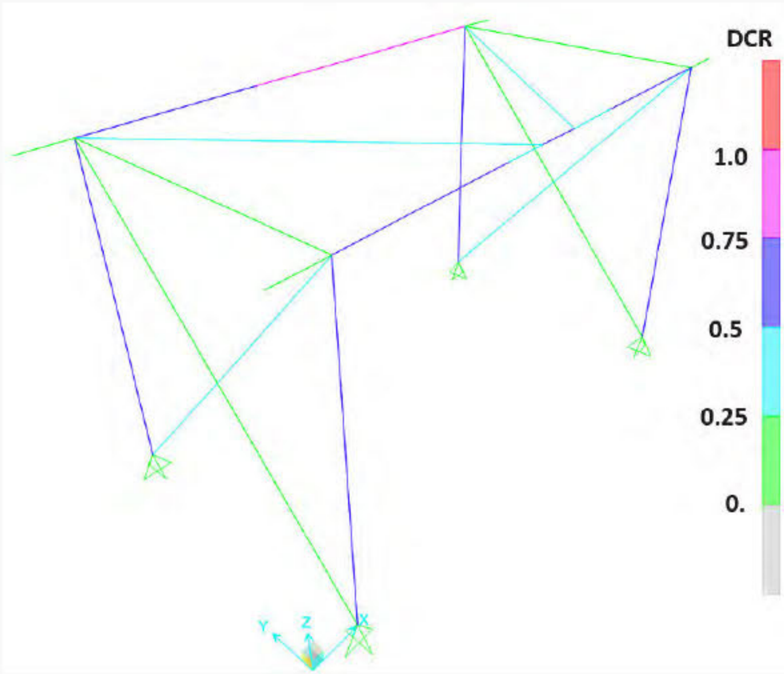

Figure 7-106 – Demand-to-Capacity Ratios (DCRs) for Surge Load at Pipe Support at Tank 20 After Retrofit

7.4.7 Discussion

Based on the analysis of the portions of the pipe racks we evaluated in the LAT and HT, the DCRs show that the structural capacity of the pipe supports, as-built and following repair, are adequate for operational and seismic loads (see Table 7-2). We computed maximum DCRs of 0.60 in the HT and 0.73 in the LAT and tank galleries. Based on our analysis, we recommend the following:

- Braces should be added to the end bays of Pipe Supports 78 to 92 to resist seismic loads.
- Pipe Supports 46 to 48 should be retrofitted as discussed in Section 7.4.3 to improve the stability of the valve support and to resist seismic loads.
- Pipe supports in Tank Gallery 20 should be retrofitted as discussed in Section 7.4.6 to resist the surge load on the pipe.
- All observed pipe support defects such as missing braces, damaged braces, corroded base plates, and other conditions that we report in Appendix A were not considered in the analysis, and they should be repaired.

Table 7-2 – Summary of Pipe Support DCRs

Model	Maximum DCR (After Retrofit)	Comment
Harbor Tunnel Pipe Supports	0.60	Adequate for operational and seismic loads
Supports 30 to 38	0.55	Adequate for operational and seismic loads
Supports 46 to 48	4.37 (0.53)	Needs retrofit for seismic loads and around the existing valve. Additional column and bracing added
Supports 49 to 57	0.65	Adequate for operational and seismic loads
Supports 78 to 92	4.47 (0.28)	Adequate for operational loads, two additional braces required for seismic loads.
Pipe Support 97	0.24	
Pipe Support 100	0.73	
Pipe Supports in Tank Gallery 10	0.39	

7.5 Surge Tanks

The dimensions for each surge tank are 60 ft in diameter by 21 ft in height. The construction of each surge tank consists of a minimum 12 in. thick reinforced concrete shell with 1/4 in. thick interior steel liner plate. The four surge tanks share one integral reinforced concrete roof slab with a minimum slab thickness of 6 ft.

Given the unique construction, the surge tanks appear to be adequate to withstand both operational loads and seismic design loads.

The major potential issue for the surge tanks is the corrosion of the steel liner plates and steel bottom plates and the corrosion of the weld between the steel plates. Significant corrosion, if not addressed in a timely manner, could cause potential fuel leaking given the past leaking history of these surge tanks (for example, Surge Tank 3 experienced some fuel seeping through the wall of the surge tank tunnel in 2001). We suggest that the steel liner plates and bottom plates be inspected in accordance with the intervals recommended in API 653.

The latest API 653 internal out-of-service inspection for Surge Tank 4 was completed in 2018. The inspector recommended the next API 653 internal out-of-service inspection for Surge Tank 4 be performed no later than November 2028 based on an inspection interval of ten years.

Surge Tanks 1 – 4 were contracted for CIR in 2019 (Kalp, 2019), however we were only provided the Surge Tank 4 2019 completion report (APTIM Federal Services, Inc., 2019). Our document review shows Surge Tanks 1-3 underwent CIR in 2006 (Westin Solutions, Inc., 2006a) (Westin Solutions, Inc., 2006b) (Westin Solutions, Inc., 2006c) (Westin Solutions, Inc., 2006d). We recommend CIR on those tanks that have not undergone CIR since 2006. We also recommend the interval for internal out-of-service inspection of these surge tanks not be more than ten years.

7.6 Above-Ground Storage Tanks

We evaluated all the aboveground storage tanks as listed in Table 5-3 and Table 5-4 in accordance with the procedures described in Annex E, "Seismic Design of Storage Tanks" of API 650 (12th Edition). The location of the upper tank farm is: Latitude = 21.359229, Longitude = -157.938645. The evaluation was performed using the following seismic design parameters:

- Risk Category – III (Section 2-21, Structural Design, UFC 3-461-01).
- Seismic Use Group – II (API 650, E.3.1.2).
- Importance Factor, I_E = 1.25(Table 2-2 of UFC 3-301-01 and Table E.5 of API 650).
- Site Class – D (Stiff Soil, default soil class per Section 11.4.3 of ASCE 7-16).
- Response modification factor (impulse), R_{wi}, (Table E.4 of API 650).

  R_{wi} = 3.5 (self-anchored).
  R_{wi} = 4.0 (mechanically anchored).

- Response modification factor (convective), R_{wc}, (Table E.4 of API 650).

  R_{wc} = 2.0 (self-anchored).
  R_{wc} = 2.0 (mechanically anchored).

- S_S = 0.569g (5% damping, risk-targeted maximum considered earthquake, MCE_R, at 0.2s).
- S_1 = 0.163g (5% damping, risk-targeted maximum considered earthquake, MCE_R, at 1.0s).
- F_a = 1.345 (site amplification factor at 0.2s).
- F_v = 2.148 (site amplification factor at 1.0s. note API 350 12th Edition referenced ASCE 7-10).
- S_{MS} = 0.765g = $F_a S_S$.
- S_{M1} = 0.350g = $F_v S_1$.
- S_{DS} = 0.51g = (2/3)S_{MS} (design earthquake spectral response acceleration at 0.2s).
- S_{D1} =0.233g = (2/3)S_{M1} (design earthquake spectral response acceleration at 1.0s).
- T_L = 4.0s (long-period transition period).

Detailed evaluation results for the aboveground storage tanks will be included in the upcoming 100% report, but all tanks are stable.

7.6.1 Tank Evaluation Per Annex E of API 650

We evaluated all the aboveground storage tanks in accordance with the procedures as described in Annex E of API 650. Section 7.6.2 presents a summary of our evaluation results. As an example, we present a detailed evaluation of Tank 11-1 at Hickam Field in this section, as shown below.

General Notes

1. Tank nomenclature, equation and section references are from API STD 650 12th Edition unless otherwise noted.
2. Input Value indicates a cell with a manually inputed value.

Tank & Foundation Properties

NAME	HCK 11-1	Specific name of this tank
D	93.000	Nominal tank diameter, measured to the inside of the wall (ft)
Ht	48.000	Total shell height excluding knuckle (ft)
H	42.500	Fill Height (ft) (note: Maximum fill height is aka MOL and TCL)
tb	0.375	Thickness of bottom plate (in)
tr	0.188	Thickness of roof plate (in)
G	0.840	Specific gravity of tank contents
L	2.000	Width of Bottom Annulus (ft)
Roof	Cone	Roof type
Hr	3.000	Roof Height Above Shell Height (ft)
Anchorage	Self-Anchored	Self-anchored or Anchored
Fnd Type	Ringwall	
CA =	0.0000	Corrosion Allowance (in)

Material Properties Of Tank

Fty	30,000	Minimum yield strength of bottom course (psi)
Fby	30,000	Minimum yield strength of bottom plate (psi)
E_{mod}	29,000,000	Elastic modulus (psi)

Seismic Parameters Per ASCE 7-10 Spectra (API 650 12th Edition References ASCE 7-10)

Site Class	D	Site Class
SUG	II	Seismic Use Group, API 650 Section E.3.1
S_s	0.569	MCE spectral response acceleration at short periods
F_a	1.345	Site coefficient
S_{MS}	0.765	Adjusted spectral response acceleration for short periods
S_1	0.163	MCE spectral response acceleration at 1.0 sec period
F_v	2.148	Site coefficient
S_{M1}	0.350	Adjusted spectral response acceleration at 1.0 sec period
S_{DS}	0.510	Design spectral response acceleration at short periods
S_{D1}	0.233	Design spectral response acceleration at 1.0 sec period
Ts	0.46	=Sd1/Sds (s)
T_L	4	Long-period transition period (s)
I_E	1.25	Seismic Importance Factor, API 650 Table E.5

Shell Data

D	93.000	Nominal tank diameter (ft)
Ht	48.000	Total tank height (ft)
H	42.500	Fill Height (ft) (note: Maximum fill height is aka MOL and TCL)
Hr	3.000	Roof Height Above Shell Height (ft)
t	0.630	Thickness of bottom course (in)

Shell Geometry and Weight

Course	Material	Table 5.2b Product Design Stress Sd (psi)	Yield Strength (psi)	Weld Efficiency	(1) Elevation of Top of Course (ft.)	(2) Course Height (ft.)	(3) Plate Thickness (in)	(4) CG Elevation (ft.)	(5) Cross Section Area (ft^2)	(6) Total Course Weight (lbs)	(6)*(4) Wt*CG (lbs*ft)	Total weight of courses (lbs)
1	ASTM A283C	20,000	30,000	0.85	8.000	8.000	0.630	4.000	15.35	60,162	2.41E+05	227,337
2	ASTM A283C	20,000	30,000	0.85	16.000	8.000	0.518	12.000	12.62	49,462	5.94E+05	167,175
3	ASTM A283C	20,000	30,000	0.85	24.000	8.000	0.415	20.000	10.11	39,623	7.92E+05	117,714
4	ASTM A283C	20,000	30,000	0.85	32.000	8.000	0.318	28.000	7.74	30,359	8.50E+05	78,091
5	ASTM A283C	20,000	30,000	0.85	40.000	8.000	0.250	36.000	6.09	23,866	8.59E+05	47,731
6	ASTM A283C	20,000	30,000	0.85	48.000	8.000	0.250	44.000	6.09	23,866	1.05E+06	23,866
7												
									Σ =	227,337	4.39E+06	

Overall Weights

Ws	227,337	Total weight of tank shell and all appurturences (lbs)
Wr	104,125	Total weight of the tank roof (lbs)
	25.0%	% of roof weight supported by shell wall (= 0 for a floating roof)
Wrs	26,031	Total weight of the tank roof supported by shell
Xs	19.3	Centroid distance from bottom of tank (ft)

Evaluation using API 650 Annex E:

Tank Data

Tank Name	**HCK 11-1**	
D	93.000	Nominal tank diameter (ft)
Ht	48.000	Total height of the tank shell (ft)
H	42.500	Top capacity limit (ft)
G	0.840	Specific gravity of tank content
Ge	0.759	Effective specific gravity including seismic effects
t	0.630	Thickness of bottom course (in)
tb	0.375	Thickness of bottom annulus (in)
L	2.000	Width of Bottom Annulus (ft)
Fty	30,000	Min. yield strength of all shell courses (psi)
Fby	30,000	Min. yield strength of bottom annulus (psi)

Tank Weights

Ws	227,337	Total weight of tank shell and all appertunces (lbs)
Xs	19.3	Height from bottom of tank shell to shell c.g. (ft)
Wr	104,125	Total weight of the tank roof (lbs)
Wrs	26,031	Total weight of the tank roof supported by tank shell in the vertical direction (lbs)
Wf	104,016	Total weight of tank bottom

API 650 Appendix E - Seismic Design of Storage Tanks

Response Modification Factors (ref. Table E-4)

R_{wi} =	3.50
R_{wc} =	2.00

Design Response Spectrum

Sai =	0.51	(g)	ASCE 7-10 Eqn 15.7-7 - 15.7-9
Sac =	0.04	(g)	ASCE 7-10 Eqn 15.7-10 - 15.7-11

Horizontal Design Accelerations for Ground-Supported Tanks (Section E.4.6.1)

Ai =	0.182	(g)	1.25	E.4.6.1-1
Ac =	0.026	(g)		E.4.6.1-4

Ground-Support Flat Bottom Tanks

Natural Periods (Section E.4.5.1)

Tc =	5.77	First mode sloshing wave period (s)

Design Overturning Moment at the Bottom of the Shell (Section E.6.1.1)

Wp =	15,132,427	Total weight of the Tank Contents (lbs)	
Wi =	7,632,512	Effective impulsive weight (lbs)	E.6.1.1-1
Wc =	7,101,907	Effective convective weight (lbs)	E.6.1.1-3
Xi =	15.94	Height from bottom of shell to centroid of the lateral seismic force applied to Wi (ft)	E.6.1.2.1-1
Xc =	25.14	Height from bottom of shell to centroid of the lateral seismic force applied to Wc (ft)	E.6.1.2.1-3
Mrw =	24,328,631	Design overturning moment at the bottom of the shell (ft-lbs)	E.6.1.5-1

[redacted]

Design Shear and Overturning Moment at the Top of the Foundation (Section E.6.1.2)

Dbp =	94.49	Diameter of bottom plate (ft)	
tbp =	0.38	Thickness of bottom plate (in)	
Wf =	107,374	Total weight of tank bottom (lbs)	
Vf =	1,482,309	Design shear at the top of the foundation due to horizontal design acceleration (lbs)	E.6.1-3

Design Overturning Moment at the Slab (Section E.6.1.2)

Xis =	36.81	Height from shell bot. to centroid of Wi adjusted to incl. the effects of varying bottom pressures (ft)	E.6.1.2.2-1
Xcs =	34.34	Height from shell bot. to centroid of Wc adjusted to incl. the effects of varying bottom pressures (ft)	E.6.1.2.2-2
Ms =	53,287,291	Design overturning moment acting across the entire tank base cross-section (ft-lbs)	E.6.1.5-2

Resistance to Overturning (Section E.6.2.1.1)

tb=	0.375	Thickness of bottom annulus used to calculated seismic stability (in)	
wa =	2,915	The resisting force of the bottom annulus (plf)	E.6.2.1.1-1b
J =	**0.760**	Anchorage ratio	E.6.2.1.1.1-1
	No shell uplift, tank is self-anchored since J<=0.785		

See the table below for the anchorage ratio criteria (extracted from Table E.6 of API 650)

Anchorage Ratio J	Criteria
$J \leq 0.785$	No calculated uplift under the design seismic overturning moment. The tank is self-anchored.
$0.785 < J \leq 1.54$	Tank is uplifting, but the tank is stable for the design load providing the shell compression requirements are satisfied. Tank is self-anchored.
$J > 1.54$	Tank is not stable and cannot be self-anchored for the design load. Modify the annular ring if $L < 0.035D$ is not controlling or add mechanical anchorage.

Bottom Annulus Width (Section E.6.2.1.1.2)

Note: Annulus width is measured inward of tank. If tank is mechanically anchored, the minimum required width, L, does not apply

Lreq =	2.47	Minimum required width of the bottom annulus, measured from the inside of the bottom shell (ft)	E.6.2.1.1.2-1b
L =	2.00	Actual width of bottom annulus (ft)	
Ls	3.26	ft Reduced required width of bottom annulus	

Shell Stresses (Section E.6.1.4 & E.6.2.2)

wrs =	89.1	Roof load acting on shell (plf)
wt =	867	Weight of tank shell, apperturances, and portion of roof (plf)
CA =	0	Corrosion allowance (in)
ts =	0.63	Actual thickness of bottom shell course less the specified corrosion allowance, if any (in)
σc =	599	Longitudinal shell compression (psi). (Eq. E.6.2.2.2-1a)
D =	93.00	Nominal tank diameter (ft)
R =	558.00	Nominal radius of the tank (in)
H =	42.50	MOL, or TCL, or Design Liquid Level (ft)
G =	0.84	Product specific gravity

Course	Thickness (in)	CA (in)	Thickness minus CA (in)	Course Height (in)	Elevation to bottom of tank (in)	Sd (psi)	Y (ft)
1	0.63	0	0.63	96	0	20,000	42.500
2	0.518	0	0.518	96	96	20,000	34.500
3	0.415	0	0.415	96	192	20,000	26.500
4	0.318	0	0.318	96	288	20,000	18.500
5	0.25	0	0.25	96	384	20,000	10.500
6	0.25	0	0.25	96	480	20,000	2.500
11							

Note: "Y" is measured from top of design water level to bottom of course, because that is where course hoop stress is greatest.

	Hoop Tensile Forces & Stresses							
Course	Dynamic impulsive force, Ni (lbs/in)	Dynamic, convective force, Nc (lbs/in)	Static force, Nh (lbs/in)	Static Stress (psi)	Dynamic stress, σ_s (psi)	Total stress (psi)	Allowable stress (psi)	D/C
1	1,301	67	8,632	13,702	2,068	16,152	22,950	0.70
2	1,255	71	7,007	13,528	2,426	16,279	22,950	0.71
3	1,116	81	5,382	12,970	2,697	15,940	22,950	0.69
4	886	100	3,758	11,816	2,804	14,841	22,950	0.65
5	563	129	2,133	8,531	2,312	10,983	22,950	0.48
6	149	171	508	2,031	905	2,957	22,950	0.13
7								

OK! Sufficient tensile hoop strength

Note: "dynamic" implies "seismic"

Note: Per E.6.2.4, a 1/3 increase is allowed when calculating the Allowable Tensile Hoop Stress

	Longitudinal Compression Stress							
Course	Seismic allow. long. shell comp. stress, σ_e (psi)	h_i (ft)	X_{si} - h_i (ft)	1- h_i / H_t (ft)	Overturning Moment (lbs-ft)	w_{ti} (plf)	Longitudinal shell comp. stress, σ_c (psi)	D/C
1	6,295	0.00	19.29	1.00	24,328,631	867	599	0.10
2	5,570	8.00	16.80	0.83	20,273,859	661	597	0.11
3	4,462	16.00	14.17	0.67	16,219,087	492	588	0.13
4	3,419	24.00	11.33	0.50	12,164,316	356	572	0.17
5	2,688	32.00	8.00	0.33	8,109,544	252	490	0.18
6	2,688	40.00	4.00	0.17	4,054,772	171	261	0.10
7								

OK! Sufficient compression strength E.6.2.2.1-1b

Note: Fc calculated per E.6.2.2.3

Note: Overturning Moment varies linearly from bottom of shell to top, per E.6.1.5.

Vertical Design Acceleration (Section E.6.1.3)

Av =	0.24	(g)

Freeboard & Sloshing Wave Height (E.7.2)

Hroof =	48.00	Height to bottom of roof for purpose of calculating freeboard and sloshing loads (ft)
SDS	0.51	Spectral acceleration of convective wave (g)
SUG	II	Seismic Use Group
TC	5.77	First mode sloshing wave period (s)
Af	0.053	Acceleration coefficient for sloshing wave height calculation
δs =	2.05	Sloshing wave height above Fill Height (ft) (E.7.2-1)
df req'd =	1.44	Minimum required Freeboard (ft) Table E.7
df =	5.50	Freeboard available (ft)

A freeboard equal to δs is required unless one of the following alternatives are provided: Seondary containment is provided to control the product spill; The roof and tank shell are designed to contain the sloshing liquid.

Yes	Sufficient freeboard available?

Summary of evaluation results for Tank 11-1 at Hickam Field (SUG II):

Tank Name	**HCK 11-1** **(SUG II)**
Tank Diameter, D (ft)	93.00
Tank Height, Ht (ft)	48.00
Fill Height, H (ft)	42.50
Importance Factor	1.25
Anchorage	Self-Anchored

Course	Course Height (ft)	Thickness (in)	Material	Seismic Hoop Tensile Forces	Seismic Longitudinal Shell-Membrane Compression Stress
1	8.000	0.630	ASTM A283C	0.70	0.10
2	8.000	0.518	ASTM A283C	0.71	0.11
3	8.000	0.415	ASTM A283C	0.69	0.13
4	8.000	0.318	ASTM A283C	0.65	0.17
5	8.000	0.250	ASTM A283C	0.48	0.18
6	8.000	0.250	ASTM A283C	0.13	0.10
7					
Freeboard Required (ft)		1.44			
Available Freeboard (ft)		5.50	*OK! Adequate Freeboard*		

Anchorage Ratio

J= 0.76

No shell uplift, tank is self-anchored since J<=0.785

As a comparison, a summary of evaluation results for Tank 11-1 at Hickam Field is presented below, assuming SUG III:

Tank Name	**HCK 11-1**	**(SUG III)**
Tank Diameter, D (ft)	93.00	
Tank Height, Ht (ft)	48.00	
Fill Height, H (ft)	42.50	
Importance Factor	1.50	
Anchorage	Self-Anchored	

Course	Course Height (ft)	Thickness (in)	Material	Seismic Hoop Tensile Forces	Seismic Longitudinal Shell-Membrane Compression Stress
1	8.000	0.630	ASTM A283C	0.72	0.12
2	8.000	0.518	ASTM A283C	0.73	0.15
3	8.000	0.415	ASTM A283C	0.72	0.21
4	8.000	0.318	ASTM A283C	0.67	0.33
5	8.000	0.250	ASTM A283C	0.50	0.51
6	8.000	0.250	ASTM A283C	0.14	0.48
7					

Freeboard Required (ft)	2.46	
Available Freeboard (ft)	5.50	*OK! Adequate Freeboard*

Anchorage Ratio

J= 0.91

Potential uplift, but tank is stable

7.6.2 Summary of Evaluation Results

Following the procedures demonstrated in Section 7.6.1 for Tank 11-1 at Hickam Field, we evaluated all the aboveground storage tanks. Table 7-3 and Table 7-4 present a summary of the evaluation results.

Table 7-3 – Summary of Evaluation Results per Annex E of API 650

Location	Upper Tank Farm						FORFAC	
Tank ID	46	47	48	53	54	55	B1	B2
Diameter	164'-0"	164'-0"	164'-0"	164'-0"	164'-0"	160'-0"	60'-0"	60'-0"
Height	38'-5"	40'-0"	40'-0"	39'-11"	40'-0"	42'-0"	21'-9"	21'-9"
Max Fill Height	37'-0"	39'-5"	39'-0"	37'-0"	37'-0"	39'-0"	19'-7"	19'-7"
Anchored(A)/ Unanchored (U)	U	U	U	U	U	U	U	U
New Double Bottom	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Shell Hoop Stress and Compression Stress Are Adequate	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sufficient Freeboard/ Allowable Fill Height if Insufficient	Yes	No/ 38'-9"	No/ 38'-9"	Yes	Yes	Yes	Yes	Yes
Tank Uplift	No	No	No	No	No	No	No	No

Table 7-4 – Summary of Evaluation Results per Annex E of API 650 (cont'd)

Location	Near Lube Oil Facility	Entrance of Adit 3		Hickam Field			
Tank ID	301	311	AFFF	11-1	11-2	11-3	11-4
Diameter	42'-0"	21'-0"	33'-0"	93'-0"	93'-0"	63'-0"	63'-0"
Height	24'-0"	16'-0"	25'-0"	48'-0"	48'-0"	54'-0"	54'-0"
Max Fill Height	20'-0"	16'-0"	23'-0"	42'-6"	42'-6"	45'-0"	45'-0"
Anchored(A)/ Unanchored (U)	A	A	U	U	U	A	A
New Double Bottom	No	No	No	No	No	No	No
Shell Hoop Stress and Compression Stress Are Adequate	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sufficient Freeboard/ Allowable Fill Height if Insufficient	Yes	No/ 14'-9"	Yes	Yes	Yes	Yes	Yes
Tank Uplift	NA	NA	Yes	Yes*	Yes*	NA	NA

* For Tanks 11-1 and 11-2 at Hickam Field, evaluation results indicate that although the tanks are stable, there is potential tank uplift during a design seismic event assuming Seismic Use Group III.

Based on the evaluation results, we have the following conclusions:

- The freeboard is insufficient for Tanks 47 and 48 at Upper Tank Farm and Tank 311 at Entrance of Adit 3, and there could be resulting roof damage. See Table 7-3 and Table 7-4 for the allowable maximum fill height for these three tanks.

- For AFFF Storage Tank, evaluation results indicate that the tank uplift is possible, but the tank is stable during a seismic design event. However, the likelihood of the AFFF Storage Tank being full of liquid during an earthquake event is extremely low. Therefore, AFFF Storage Tank is judged to be adequate.

- For Tanks 11-1 and 11-2 at Hickam Field, evaluation results indicate that the tank uplifting is unlikely during a seismic design event assuming Seismic Use Group II. However, there is potential tank uplift during a seismic design event assuming Seismic Use Group III, although the tanks are stable.

7.6.3 Discussion

During our site visits, we observed overconstrained piping for the following three tanks:

- Tanks 11-1 and 11-2 at Hickam Field.

- Tank 55 at Upper Tank Farm.

For Tanks 11-1 and 11-2 at Hickam Field, our evaluation results, as shown in Section 7.6.2, indicate that there is potential tank uplift during a design seismic event assuming Seismic Use Group III although the tanks are stable. We recommend that overconstrained piping be mitigated for Tanks 11-1 and 11-2 to avoid potential tank damage and loss of product in the event of tank uplift during an earthquake event.

For Tank 55 at Upper Tank Farm, our evaluation results indicate that the tank is adequate during a seismic design event and will likely not uplift. However, we still recommend that overconstrained piping be mitigated for Tank 55 to avoid potential tank damage and loss of product in the event of tank uplift during an earthquake event.

In high seismicity zones, the recommended values for piping flexibility (ASCE, 2020) are 6 to 12 in. of vertical displacement and 4 to 8 in. of horizontal displacement. In Pearl Harbor, with moderate seismicity, we recommend 4 to 6 in. for vertical displacement and 2 to 4 in. for horizontal displacement to be considered for the piping flexibility.

In addition, our evaluation results indicate that the freeboard is insufficient for Tanks 47 and 48 at Upper Tank Farm and Tank 311 at Entrance of Adit 3. Although analysis would recommend that the fill levels for these three tanks be limited to the allowable maximum fill heights as shown Table 7-3 and Table 7-4, consideration of Insufficient freeboard and the resulting potential roof damage caused by the liquid sloshing during an earthquake event is a secondary consideration that need not be mitigated here.

We also recommend that overconstrained stairways be mitigated at all tanks, as applicable.

7.7 Pumps and Valves

Pump and valve integrity is primarily maintained by proper use and proper maintenance. Wear and tear on a valve may increase when the valve is repeatedly opened and closed with a high differential pressure as it tends to wear the sealing surfaces. Also, the main tank valves seem to be used for throttling fuel to clear the vacuum in the main product lines, but these valves are designed for isolation or on-off purposes. Using these valves for throttling can deteriorate the internal sealing surfaces of the valve by hydraulic erosion. Hydraulic erosion occurs when a valve is “cracked” open so that the downstream piping segment can be pressurized. Hydraulic erosion occurs where high-velocity fluid flows over the sealing surfaces of the valve. Over time, this situation can lead to the sealing surface wear in the localized area of the high-velocity fluid and cause a “leak-by” of the valve when it is closed.

The T-valves in the underground pump house have been used to hold pressure, but these valves are originally designed for flow control or throttling. The T-valves are butterfly valves and are generally not recommended for use where a “tight-shutoff” is needed to hold pressure.

The sump pumps and main fuel pumps seem to be used for their intended purpose and do not exhibit abnormal wear and tear.

Most of the valves used in the Red Hill and Pearl Harbor fuel facilities seem to be used for their intended purpose and do not exhibit abnormal wear and tear. There may be occasional leaks from the valve flanges and stem seals that need repair over time, but the overall function of the valves seems to be good. However, an exhaustive review of the maintenance records of all the pumps and valves is not possible because the records were not available.

The Red Hill fuel facility does have a maintenance plan in place. The guidance for maintenance and Inspections of equipment are provided in the “Unified Facilities Criteria UFC – Petroleum Fuel Systems Maintenance” (Department of Defense, 2021).

7.7.1 Pump Maintenance

Section 3-8 of the UFC Petroleum Fuel Systems Maintenance document describes the guidelines for the various types of pumps that are used in the fuel storage facility. The Inspection and Maintenance activity frequency are generally divided into quarterly, semi-annual and annual tasks.

Different types of pumps require different maintenance activities. Most of the pumps at Red Hill (with a few exceptions) are centrifugal pumps. The general maintenance activities for centrifugal pumps include:

- Check for proper operations while the pump is in use. Check suction and discharge pressure gauges for abnormal readings. (Frequency: Quarterly.)
- Check for unusual noise, vibration, and overheating of bearings or cases. (Frequency: Quarterly.)
- If equipped with a lubricating oil charge, check the oil level and adjust as necessary. (Frequency: Quarterly.)
- Tighten or replace loose, missing, or damaged nuts, bolts, or screws. (Frequency: Quarterly.)
- Inspect suction and discharge isolation dampeners for misalignment and wear. (Frequency: Quarterly.)
- Inspect mechanical seals, if possible, for proper operating temperature, drips, leaks, and dirt. (Frequency: Quarterly.)
- Check for alignment, clearances, and rotation of shaft and coupler (requires the removal of coupler shroud or cover). (Frequency: Annually.)
- Lubricate pump bearings. (Frequency: Annually.)

- If equipped with lubricating oil charge, drain the old oil, and fill with new oil to full mark on sight indicator (also fill bulb). (Frequency: Annually.)
- Refer to Section 9-1.7, "Electric Motors," for inspection and maintenance requirements of electric motors.

7.7.2 Valve Maintenance

Section 6-6 of the UFC Petroleum Fuel Systems Maintenance document describes the guidelines for the various types of valves that are used in the fuel storage facility. The Inspection and Maintenance activity frequency are generally divided into quarterly and semi-annual tasks.

Different types of valves may have some differences in the maintenance activity included in the maintenance document. In general, most valve maintenance activities include:

- Open and close the valve to check for ease of operation. (Frequency: Quarterly.)
- Lubricate valve operator stems and grease fittings. (Frequency: Semi-annually.)
- Inspect valve exterior for corrosion and tightness of bolts. Repaint and retighten as required. (Frequency: Semi-annually.)

Ball valves require an extra inspection step:

- Open and close the valve to check for ease of operation. (Frequency: Quarterly.)
- Lubricate overhead-valve chain operator gears. (Frequency: Quarterly.)
- Adjust packing per manufacturer's specifications as needed. (Frequency: Quarterly.)
- Inspect valve exterior for corrosion and tightness of bolts. Repaint and retighten as required. (Frequency: Quarterly.)
- Refer to Section 6-6.2.10 Manual Valve Gear Operators for inspection and maintenance of gear operators if equipped.

Valves that are equipped with an internal Double Block and Bleed include many more inspection steps than general valves:

- Open and close the valve to check for ease of operation. (Frequency: Quarterly.)
- Lubricate overhead-valve chain operator gears if equipped. (Frequency: Quarterly.)

- Adjust packing per manufacturer's specifications as needed. (Frequency: Quarterly.)
- Inspect valve exterior for corrosion and tightness of bolts. Repaint and retighten as required. (Frequency: Quarterly.)
- Operate the body cavity drain when the valve is in the closed position to ensure that the valve is closing properly. (Frequency: Quarterly.)
- Keep the valve operator housing full of lubricant to displace and prevent moisture from accumulating and freezing, in accordance with the manufacturer's recommendations. (Frequency: Semi-annually.)
- Remove the bottom drain plug and drain valve. (Frequency: Annually.)
- Refer to Section 6-6.2.10 Manual Valve Gear Operators for inspection and maintenance of gear operators if equipped.
- Some double block and bleed valves are equipped with integrated pressure/thermal relief valves. Refer to Section 6-6.3 Thermal and Pressure Relief Valves for inspection and maintenance requirements of pressure/thermal relief valves.
- Check valves also have a planned maintenance program that includes:
    1. Use the external test lever to ensure the valve is not sticking if equipped. If a check valve is suspected of not checking and cannot be serviced in place, it must be removed from the piping system and serviced in a shop. (Frequency: Quarterly.)
    2. Inspect valve exterior for corrosion and tightness of bolts. Repaint and retighten as required. (Frequency: Quarterly.)

7.7.3 Discussion

The main fuel pumps (b)(3)(A) are in operable condition and appear to be in satisfactory condition. These pumps were in normal operation until all fuel movements were suspended sometime after May 6, 2021. These pumps are included in a maintenance program. These pumps are scheduled to be replaced soon, and it is our understanding that material has been ordered (Section 3).

The FOR main sump pumps in the Red Hill lower tank gallery areas are in operable condition and appear to be in satisfactory condition. These pumps are currently in operation and are included in a maintenance program.

The AFFF sump pumps are currently locked out from operation due to some technical issues. These issues are currently being addressed by the AFFF vendor. These sump pumps are operable, but the logic controls for the pumps seem to be the source of the technical issue. The time frame to resolve this issue is not known at the time of this report. These pumps are included in a maintenance program.

The main tank valves and sectional valves that are in the Red Hill lower tank gallery and the Harbor tunnel are in operable condition, and up to the time that fuel movements were suspended, these valves were in operation. These valves are included in a maintenance program.

The throttling valves or “T-valves” that are located at [redacted] (b)(3)(A) are operable but are suspected to “leak-by.” These valves are “butterfly” valves and are not normally used to hold pressure or used in “tight-shutoff” service. These valves are included in a maintenance program.

The various valves that are located [redacted] (b)(3)(A) are all in operable condition. Some of these valves are in current use because they are required to direct fuel to portions of the Upper Tank Farm. These valves are included in a maintenance program.

The remainder of the valves and pumps (not included in Red Hill) that are in the following areas are all operable, included in a maintenance program, and are currently in use:

(b) [redacted]

7.8 Marine Facilities

7.8.1 Evaluation

SGH performed below deck inspections of the fuel system at five fuel piers (Hotel Pier, Kilo Pier, Sierra Pier, Mike Pier, Bravo Pier). We reviewed the fuel pipeline, including the condition of the pipe, coating, pipe supports, and adjacent structural elements where access allowed (in some cases, our boat could not pass between piles, or there were ships berthed obstructing access). For those structural elements adjacent to the fuel piping, we documented conditions of cracks, spalls, apparent delamination, exposed reinforcing, and corroded reinforcing in the piles, bents, fender piles, and underside of the deck.

7.8.2 Discussion

Although our observations do not constitute a 100% review of the fuel piers, they highlight conditions that we recommend be further evaluated for safe fueling/defueling and continued general use of the piers.

Many observations in Section 5.9.4 indicate “severe” concrete damage (ASCE, 2015) (see our site observations for Mike Pier in Appendix A). The majority of the “severe” conditions we observed were outside the tie beams between bents (it is unclear the structural function of these tie beams and the effect of their deterioration on the capacity of the pier) and at the underside of the deck in discrete locations. Tension forces at the midspan of the deck, between bent lines, are taken primarily by the reinforcing steel. When the reinforcement spanning between bent lines is exposed, tensile capacity is compromised, and this reduces the vertical load-carrying capacity of the deck.

We reviewed the 2018 inspection report by Marine Solutions, Inc. (Marine Solutions, Inc., 2018) related to Bravo Pier, Kilo Pier, and Mike Pier (Section 2.8.1). Considering the structural deficiencies we observed at the piers (four years of progressive deterioration), we recommend the Navy: 1) consider reducing access across the deck areas of Mike Pier, which potentially have reduced tensile capacity, 2) evaluate the piers for safe continued use at full capacity considering the deficient tie beams, piles, bent caps, and deck, 3) perform timely repairs of high priority items to prevent continued degradation and compromise of the pier system, and 4) for future maintenance of all JBPHH fuel piers, establish robust structural maintenance and repair schedule following industry standards.

We additionally recommend future inspection and maintenance include 100% visual inspection of the above and below water elements of the piers, removal of marine growth or coatings to expose the underlying structural member for inspection, and a combination of non-destructive testing and destructive testing to reveal hidden or interior damage (i.e., Levels I, II, and III assessments per (ASCE, 2015)). Following such an inspection regime, we recommend high priority repairs be executed within a timely manner.

Additionally, at Hotel Pier, the below deck piping includes a 4 in. PVC drainage/FOR line, 12 in. wrapped water line, (b)(3)(A) [redacted] multi-product line, and other abandoned lines (Pond, 2018). According to the Pipeline Integrity Management Plan (IMP), the PVC lines may be packed with 100% fuel in the waste stream (Enterprise Engineering, Inc., 2019). Figure 5-65 shows PVC pipe used as a FOR line under Hotel Pier. We recommend this pipe be replaced using appropriate fuel-grade material.

7.9 Fuel Pipe Fitness-for-Service Assessment

We conducted a quantitative FFS assessment of local external corrosion pitted sections of piping according to API 579-1 2016. We note that similar assessments have been conducted in the past by Enterprise Engineering Inc. (EEI) following their In-Line Inspection (ILI) or pigging surveys. We independently conducted a quantitative FFS assessment of local external corrosion pitted sections of piping according to API 579-1 2016.

7.9.1 Mechanical Properties of Pipe Steel

The Enterprise Engineering Inc 2016 report listed mechanical properties of tests conducted on pipe samples from an unknown location by Finlay in 2000. According to the requirements of ASME B31.4, EEI used the value of 80% of the average yield strength of these tests as the basis of the yield strength for their FFS calculations. The values they used are as follows:

- (b)(3)(A) [redacted] pipe – Yield Strength 38.9 ksi.

- [redacted] pipe – Yield Strength 40.0 ksi.
- [redacted] pipe – Yield Strength 30.4 ksi.

No information is reported on the mechanical properties of the aboveground pipes. It is possible that these pipes conform to ASTM A53 Grade B steel pipe, which has minimum values of 35 ksi yield strength and 60 ksi tensile strength.

Given the limited test data and the unknown locations from which these mechanical tests were removed, we have used a yield strength of 30ksi for all pipes in our FFS calculations, which is a conservative assumption.

7.9.2 Measurements

Following our walk down visual inspection of the Harbor Tunnel pipes, the above-ground pipes, and the pipes along fuel piers, we measured select external corrosion pit depths at corroded areas. We selected locations that appeared to have the worst pitting corrosion in the visible and accessible areas. There were certain locations where there was not sufficient access to measure pit depths, such as in the crevices of the pipe supports along [redacted], but we understand that Pond is already repairing pipes and supports at these locations.

We used a wire brush and/or a knife to remove corrosion products and then a pit depth gauge to measure the loss of the external section.

7.9.3 Assumptions

We made the following assumptions:

- The yield strength of all steel pipe is 30ksi.
- The maximum working pressure of the pipe is 300 psi, which we understand is the test pressure used for testing valves and fittings around the facility. Previous calculations used a working pressure of 275 psi.
- We measured the pipe thickness away from corrosion pits using an ultrasonic thickness gauge and determined that the wall thickness of the [redacted] [redacted] and [redacted] tunnel pipes are 0.25 in., 0.25 in., and 0.375 in., respectively. The pipe thickness of the above- ground fuel piping downstream of the pump house is consistent with ASTM A53 Schedule 40.

- The previous reports indicated widespread minor pitting corrosion inside the pipes with an approximate pit depth of 0.03 in. Hence an internal corrosion loss of 0.03 in. has been applied to all pipes for the assessment.

- There is no future corrosion allowance for the pipes. This assumes that no further internal corrosion will occur, which is reasonable as low points are regularly drained of water, and external coatings will be properly maintained.

- Minimum safety factors of 1.5 for yield strength and 3 for tensile strength have been applied to the assessment as required by ASME B31.3, Para. 302.3.2.

- The original construction code of the pipeline is unknown, so we have used a quality factor of 0.7, as required by API 579 Para. 2C.7.

- We used Section 6 of the standard (Assessment of Pitting Corrosion Pitting Corrosion) for our calculation, including a factor for widespread pitting corrosion damage. Note that this assumption is equivalent to the Section 5 (Local Thinned Area) calculation.

- Dents and corrosion pits are remote from welds and structural discontinuities, which matches our general observations.

- The internal pressure on the pipe is constant rather than cyclical, which is defined by the standard as fewer than 150 cycles over the service life. We discussed this assumption with (b)(6) (Supervisory General Engineer NAVSUP Fleet Logistics Center Pearl Harbor, C701) on 23 March 2022 (Section 3). He confirmed that these pipes have only ever been emptied for inspection and repair.

7.9.4 API 579 Section 6 Level 1 Assessment of Pitting Corrosion Calculation

We conducted a Level 1 assessment of the corrosion pits that we measured. Note that Level 1 is a conservative application of this assessment compared to Level 2 and 3 assessments, which utilize a higher level of stress analysis.

We used our measurements and assumptions to calculate the maximum allowable working pressure (MAWP) for the pipe's longitudinal and circumferential stress according to API 579 Part 2C.5 “Piping and Boiler Component.” We then used our measurements to calculate the reduced MAWP at the pit location. If the margin of this reduced MAWP compared to the maximum working pressure is greater than 0, then the pipe has passed the assessment. A negative value indicates that the section fails the FFS assessment. The results are listed in Table 7-5.

Table 7-5 – Level 1 FFS Assessment for External Corrosion Pits on Select Pipes

Location	Fuel	Nominal Pipe Size (in.)	Nominal Pipe Thickness (in.)	External Pit Depth (in.)	Pit Depth (% of Nominal)	Reduced MAWP Margin (%)	FFS Level 1 Assessment
[redacted]	F-76	[redacted]	0.375	0.140	37.3%	70%	Pass
	F-76		0.375	0.150	40.0%	62%	Pass
Outside [redacted] (Reclamation Yard)	FOR	6	0.280	0.100	35.7%	142%	Pass
[redacted] Low Point Drain	F-76	2.5	0.203	0.085	41.9%	233%	Pass
[redacted] Low Point Drain	F-76	2.5	0.203	0.085	41.9%	233%	Pass
[redacted] Low Point Drain	F-76	2.5	0.203	0.065	32.0%	309%	Pass
Hotel Pier (End)	F-76	[redacted]	0.375	0.080	21.3%	120%	Pass
Bravo Pier #44 Riser	F-76		0.237	0.220	92.8%	-131%	Fail
Bravo Pier Low Point Drain	F-76	4	0.237	0.044	18.6%	290%	Pass
[redacted]	F-76	[redacted]	0.375	0.130	34.7%	-30%	Fail
	F-24		0.250	0.038	15.2%	19%	Pass
	F-76		0.375	0.119	31.7%	-26%	Fail

We note that all corrosion pits we observed in aboveground piping passed this Level 1 assessment, apart from the pit in the riser of Bravo Pier, which had penetrated through 93% of the wall thickness. Pond informed us that this pipe is to be replaced. The two pits in the HT [redacted] diameter F-76 also failed this Level 1 assessment by a small margin, so we subsequently conducted a Level 2 assessment for these locations.

We calculated the critical Level 1 assessment pit depth (in terms of % of nominal thickness) at which the reduced MAWP is equal to the maximum working pressure, i.e., RSF is 0, the maximum allowable pit depth, for the various sizes of pipes that we encountered. Our results are listed in Table 7-6.

Table 7-6 – Critical Pit Depth to Pass Level 1 FFS Assessment

Pipe Size (in.)	Pipe Outer Diameter (in.)	Nominal Pipe Thickness (in.)	External Pit Depth (in.)	Pit Depth (% of Nominal)
[redacted]		0.375	0.040	10.7%
		0.25	0.048	19.2%
		0.25	0.067	26.8%
		0.375	0.225	60.0%
		0.280	0.188	67.1%
		0.237	0.165	69.6%
		0.203	0.147	72.2%

These results show that for the above-ground pipes outside [redacted], a pit depth of up to 60% of wall thickness can be tolerated as fit for service.

We also conducted a Level 1 assessment of the gravity-loaded AST #47, where we observed local pitting in the tank wall due to ponding water around the tank rim. This result is shown in Table 7-7, and this pit is judged to be acceptable.

Table 7-7 – FFS Assessment for Corrosion Pit on AST #47

Location	Fuel	Specific Gravity	Nominal Wall Thickness (in.)	External Pit Depth (in.)	Pit Depth (% of Nominal)	Reduced MAWP Margin (%)	FFS Level 1 Assessment
AST #47 Tank Exterior Wall	F-76	0.85	1	0.04	4	39%	Pass

7.9.5 API 579 Section 5 Level 2 Assessment of Pitting Corrosion Calculation

For the two corrosion pits in HT [redacted] diameter F-76 pipe that failed the Level 1 FFS assessment, we conducted a Level 2 assessment using Part 5 (Local Thinned Areas). We assumed that these pits have maximum dimensions of 1 by 1 in. and have a conical profile and that there is a uniform internal section loss of 0.03 in.

In addition, we conducted this Level 2 assessment on speculated corrosion loss to the [redacted] pipe. We note that in the 2016 EEI Pipeline Report, it is stated that "there is evidence suggesting there is internal pitting of up to 0.150 inches at the bottom of the pipe at scattered locations", but the report then stated that these measurements had not been confirmed and no locations were given. We assumed that this thinned area has a conical profile.

For our calculations, we used the same mechanical properties and assumptions as our Level 1 assessment. The results are listed in Table 7-8.

Table 7-8 – Level 2 FFS Assessment for Corrosion Pits on HT [redacted] Pipe

Location	Thinned Area Dimensions (in.)	Nominal Pipe Thickness (in.)	Maximum Pit Depth (in.)	Pit Depth (% of Nominal)	Reduced MAWP Margin (%)	FFS Level 2 Assessment
[redacted]	1x1	0.375	0.130	34.7%	2%	Pass
[redacted]	1x1	0.375	0.119	31.7%	2%	Pass
Unknown	9x9	0.375	0.150	40%	1%	Pass

Both of the external pits that failed the Level 1 Assessment passed this Level 2 Assessment. For the local internal pitting with section loss up to 0.15 in. reported in the 2016 EEI Pipeline Report, we calculated that locally thinned areas up to 9 by 9 in. can be tolerated.

7.9.6 API 579 Section 12 Assessment of Dents and Gouges Calculation

We conducted a Level 1 assessment of the dents we measured at select locations along the HT fuel pipes. Note that Level 1 is a conservative application of this assessment compared to Levels 2 and 3 assessments, which utilize a higher level of stress analysis.

We assumed that the depth of the pipe dent was the same in the pressurized and unpressurized conditions. As the pipes are not in cyclic service, and there is no significant wall thinning at the dent location, according to Step 4 of the calculation, the dent is acceptable if the depth is less than 7% of the depth of the outer diameter of the pipe.

Our measurements and FFS calculation results are listed in Table 7-9. Note that the maximum dent depth we measured is 2% of the pipe diameter.

Table 7-9 – Level 1 FFS Assessment for External Dents on Select Pipes

Location	Fuel	Pipe Outer Diameter (in.)	Nominal Thickness (in.)	Dent Depth (in.)	Dent Depth (%)	FFS Assessment
[redacted]	F-24	[redacted]	0.25	0.29	1.8%	Pass
[redacted]	F-24	[redacted]	0.25	0.19	1.2%	Pass
[redacted]	F-76	[redacted]	0.375	0.26	0.8%	Pass
[redacted]	JP-5	[redacted]	0.25	0.24	1.3%	Pass
[redacted]	F-76	[redacted]	0.375	0.26	0.8%	Pass
[redacted]	F-76	[redacted]	0.375	0.2925	0.9%	Pass
[redacted]	F-24	[redacted]	0.25	0.151	0.9%	Pass

7.9.7 Discussion

Our FFS calculations for the fuel pipes around the facility are in agreement with the previous FFS assessments conducted by others. We have shown that for pipe sizes of [redacted] or less, which cover [redacted], corrosion pits with depths of up to 60% wall thickness can be tolerated. This concurs with the corrosion control protocol currently implemented by Pond, where pipes with corrosion pits greater than 50% section loss are repaired.

Apart from the corrosion pit at the Bravo Pier fuel riser, which has a local section loss of 93%, all the corrosion pits that we measured around the facility passed the FFS assessment. We note that regular inspections and measurements of pit depths are necessary for the continual assessment of above-ground fuel pipes. Once a coating protection system is breached, pitting and/or crevice corrosion can proceed rapidly in this tropical marine environment.

We conducted a Level 2 FFS analysis of local thinning in the HT [redacted] diesel pipe as a previous investigation suggested that localized internal pitting up to 0.15 in. deep is present. We determined that locally thinned areas in these pipes are acceptable as long as their width/length is less than 10 in. These pits are unlikely to have grown significantly in the past six years as the pipe is regularly dewatered. For long-term use of this pipe, the location and extent of this local internal pitting should be verified.

We observed and measured several dents in the HT pipes. The maximum dent depth that we measured is 2% of outer pipe diameter; therefore, all observed dents pass the FFS assessment. Note that the previous FFS assessment assumed that the pipes are undergoing daily load cycles; thus, their tolerance of dents might be overly conservative compared to that in our analyses.

7.10 Coatings and Corrosion Control

7.10.1 Internal Pipe Corrosion Discussion

We did not inspect the inside surface of any fuel pipes, but according to previous inspection reports, minimal internal corrosion has occurred during the service life of these pipes, with a maximum section loss of 0.03 in. Although fuel pipes are normally protected from corrosion from the fuel product, corrosion can occur along the pipe invert if water is present in the product, but these pipes are regularly dewatered, so internal corrosion should not be an issue. We assumed a uniform internal section loss of 0.03 in. for our FFS calculations. We inspected the internal surfaces of several valves that had been removed from service, and these were clean with no visible pitting corrosion.

The 2016 EEI HT Pipe Inspection Report states that their measurements suggested localized pitting corrosion has occurred along the invert of the HT [redacted] pipeline, with section loss of up to 0.15 in. However, no follow-up measurements or inspections have been conducted, so this section loss has not been verified. Internal corrosion can occur along the invert of fuel pipes if water is allowed to accumulate, but these pipelines are now regularly dewatered, so it is unlikely that active corrosion is now occurring at this location.

7.10.2 Cathodic Protection Discussion

Our review of the annual Corrpro CP inspections indicates that the AST and buried pipe infrastructure is satisfactorily protected against corrosion across the facility. The CP system appears to follow NACE and API guidelines and is typical of petrochemical facilities. We observed occasional damage to protective wraps at pipe ground penetrations and some material degradation of flange isolation joints. We note that recommendations for system maintenance and upgrades are sometimes not completed by the time of the subsequent annual report, and we recommend that maintenance is completed in a timely manner to avoid possible corrosion of the system.

7.10.3 Coatings Discussion

The guide specification UFGS-09 97 13.27 (Steel Structures) is satisfactory for high-performance coatings for the exterior of tanks and fuel pipes and conforms to typical industry standards. The zinc-rich primer provides additional corrosion protection if the coating fails, the epoxy mid coat is high build and protects coats rough surfaces such as welds if properly applied, and the polyurethane topcoat has good resistance to chemicals and ultraviolet degradation. The NAVFAC coatings guidance document states that this coating will last for at least twenty years if properly maintained. This coating is not designed for immersion, so surfaces should be sloped to avoid ponding water. It is not suitable for structures that are located in the tidal zone, such as the pier fuel pipelines. For the products that we were informed are used to coat fuel pipes, the Sherwin Williams system conforms with this standard, but the PPG system does not.

The guide specification UFGS-09 97 13.15 (Fuel Tank Interiors) is satisfactory and conforms to typical industry standards. The epoxy intermediate coat is high build and protects welds if properly applied, and the fluoropolyurethane is chemically stable. The NAVFAC coatings guidance document states that this coating will last for at least twenty-five years if properly maintained. We were not provided with a list of products used for this application.

The guide specification UFGS-09 97 13.26 (Splash Zone Coating) appears to be inferior to that of the Steel Structures Specification as there is no zinc-rich primer specified for additional corrosion protection. This may be due to the difficulty in the field applying and curing a coating in a splash zone environment. This specification appears to be intended for waterfront structures rather than high-performance applications, therefore is probably not intended for fuel pipes.

Although the guide specifications for steel structures are satisfactory for twenty years of service life if properly maintained, we observed many areas where the coating is degraded during our site inspection of fuel pipes. The tropical marine environment in Hawaii can lead to rapid coating spallation and corrosion of the substrate once the coating starts to fail.

There seems to be a disconnect between the coating specification and the maintenance program. It is important that once coating degradation has been observed, a properly specified coating repair should be conducted at this location rather than using a temporary repair coating. Improvements should be made to avoid standing water and immersion by pitching surfaces to drain and sealing crevices such as at pipe supports and flanges. The stainless steel flange bands which are present at some valve stations to protect against crevice corrosion should be installed at all flanges across the facility. In addition, the guide specifications do not offer guidance on how to prepare for and apply spot repairs at locations of small surface damage/corrosion. There should be a guide specification for conducting repairs that are considered permanent.

The wrap coatings used for the fuel pipes in the tidal zone of the fuel piers are not suitable for this environment. These coatings should be removed and replaced with a high-performance coating suitable for marine immersion. Alternatively, these pipes should be raised above the tidal zone and coated according to UFGS-09 97 13.27 (Steel Structures).

The bituminous wrap coating on the fuel pipes in the Harbor Tunnel does not provide adequate corrosion resistance at locations where water is dripping on them due to water infiltration through the tunnel roof. In addition, wrap coatings do not allow the steel pipe to be directly inspected for coating failure and localized corrosion. Despite the complications associated with the lead and asbestos content of this coating, if these pipes are to be maintained in the long term, this coating should be removed and replaced with a modern coating satisfying UFGS-09 97 13.27 (Steel Structures).

7.10.4 Stainless Steel Stress Corrosion Cracking

The 2020 EEI report concerning stainless steel stress corrosion cracking (SCC) on stainless steel fuel pipes at AFB Guam suggests that similar environmental (tropical marine) conditions are present in other Air Force locations. The only stainless steel piping at the Pearl Harbor base is at Hickam. Our visual inspections of stainless steel piping at this location, both inside the Pumphouses and external, did not reveal the presence of any cracks. The localized brown staining/shallow pitting on the pipes is typical of Type 304 stainless steel in a marine environment and not indicative of the onset of SCC.

However, we suggest that a higher resolution inspection using NDT, such as Dye Penetrant (DP), be conducted on these pipes to determine if small cracks are present. We note that stress corrosion cracking on stainless steel piping at ambient temperature is unusual, so there might be other variables such as contamination during manufacturing/installation that has caused this issue in Guam.

8. RECOMMENDATIONS

The recommendations from all sources are included in this section. These include Process Hazard Analysis (PHA) and Operational Readiness Assessment recommendations, as well as the Structural and Mechanical Integrity recommendations.

Recommendations are classified in terms of those required prior to defueling and those required for continuing operations across the entire Joint Base Pearl Harbor Hickam (JBPHH) fuel system. However, recognizing that after defueling occurs, a portion of the JBPHH fuel system may never be brought back into service, some of the recommendations associated with continuing operations may not be required. Specifically, these recommendations apply to the Red Hill Underground Bulk Fuel Storage (UBFS) tanks and the fuel conveyance system in the tunnels. These specific recommendations are identified and need not be adopted.

8.1 PHA Recommendations and Operational Readiness Assessment

8.1.1 Prior to Defueling

Table 8-1 contains recommendations to be considered prior to defueling the Red Hill UBFS tanks. These recommendations arise from the PHA and the Operational Readiness Assessment. Some recommendations did not receive a risk ranking since they were generated outside the PHA, or there was insufficient information to adequately assess the level of risk.

Table 8-1 – Defueling Recommendations – Red Hill

Recommendations to be Addressed Prior to Defueling	Risk Ranking	Source
1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions, including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of the document control system. (High Priority.) This recommendation aligns with the 2018 Phase 1 Quantitative Risk and Vulnerability	1	PHA

Recommendations to be Addressed Prior to Defueling	Risk Ranking	Source
Assessment (QRVA) of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).		
6. Install additional Pressure Indicating Transmitters (PITs) in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in the scheduled Preventive Maintenance (PM) program for improved reliability of critical instrumentation. (High Priority.)	1	PHA
25. Include verification step in Operations Order that piping is restrained before starting any evolution involving transferring liquid from any tank in Red Hill Tank Gallery. (High Priority.)	1	PHA
27. If possible, add an equalization line across the outboard main tank valve <u>prior to defueling</u> to reduce the likelihood of sudden opening of a large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing the equalization line. (High Priority.)	1	PHA
28. Ensure Oil Tight Door 1) will remain functional during the loss of power and 2) is part of a PM program to improve the reliability of closure on demand. (High Priority.)	1	PHA
31. Evaluate underlying cause(s) of line sag, creating a vacuum and modifying as warranted. (High Priority.)	1	PHA
32. Evaluate the need for Dresser Couplings in the [redacted] (b)(3)(A) and [redacted] (b)(3)(A) main distribution piping in Red Hill Tank Gallery between Tank (TK) 114 JP-5 Tank (Red Hill) and TK 116 F-76 Tank (Red Hill), shown on Drawing [redacted] (b)(3)(A) If they can be removed safely, remove the Dresser Couplings. JP-5 Emergent Pipeline Repairs were underway at the time of the Process Hazard Analysis (PHA) and will include eliminating the old Dresser Coupling on [redacted] (b)(3)(A) JP-5 piping. This recommendation should be completed prior to returning JP-5 piping to service. (High Priority.)	1	PHA

Recommendations to be Addressed Prior to Defueling	Risk Ranking	Source
8. Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around pumps installed in Underground Pump House (UGPH) and Red Hill Tank Gallery. Consider modifying the design if the manufacturer has an alternate sealing system and Dresser Couplings remain part of the design. (High Priority.)	2	PHA
9. Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling. (High Priority.)	2	PHA
38. Develop a car-seal or lock administrative control system and identify safety-critical manual valves which should be controlled to reduce the likelihood of human error. Valves to consider include but are not limited to 24" butterfly tank vent valves at Red Hill (RHL), manual block valves on the inlet or discharge of relief devices, manual block valves on bleed of the body cavity of twin-seal Double Block, and Bleed (DBB) device, key firewater supply, and distribution valves. (High Priority.)	3	PHA
14. Evaluate the current ratings of all piping and hoses between RHL and piers to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority.)		PHA
99. The Navy policy is to use the Incident Command System (ICS)/Unified Command (UC) for structuring Navy spill response management organizations. The NAVSUP FLCPH fuel personnel manages the initial response. If additional resources are needed, the Federal Fire Department Incident Commander will establish an emergency command post and assume responsibility for the response. The Emergency Spill Coordinator or the Commanding Officer can contact the Region Navy On-Scene Coordinator to activate the Region Spill Management Team (SMT). The Region SMT will then establish other ICS functions. Port Operations is the coordinator for the Facility Response Team (FRT), an on-water contractor resource based on Ford Island. The roles, staffing, and resources for each organization need to be clearly defined, drilled, and aligned prior to defueling operations. (High Priority.)		PHA
107. Consider additional operators and technical support for defueling operations. (High Priority.)		PHA

Recommendations to be Addressed Prior to Defueling	Risk Ranking	Source
Operating orders (procedures) should be established in writing for each work activity and all operational phases. A new procedure template with all industry best practice sections (like health and safety, the consequence of deviation, etc.) included should be developed. NOTE: During the Hazard and Operability Study (HAZOP), a procedure template was provided to Pond personnel.		Operational Readiness
Ensure a section of the new procedure template discusses the Personal Protective Equipment (PPE) required, the hazards of the fuels, and what to do if you come in contact with the fuels.		Operational Readiness
All operating orders/procedures should be version-controlled within a document control system where changes/revisions to the documents are managed and to allow for yearly document review.		Operational Readiness
Develop a formal written procedure implementing a Lock-out/Tag-out (LOTO) process, including training on the LOTO work permit.		Operational Readiness
Develop a formal written procedure implementing a line opening process that addresses hazards and controls that must be in place.		Operational Readiness
Implement an access control process that includes electronic badging into and out of the facility. This system should report real-time accounting for all personnel in the facility. In lieu of an electronic system, implement a sign-in/sign-out process that is controlled by the Control Room Operator (CRO).		Operational Readiness
Emergency response sections on the current operating orders address spills and leaks. They do not have any operation orders or emergency actions that address the loss of electricity, building ventilation, fire, or explosion.		Operational Readiness
Develop a formal written procedure implementing a Pre-Start-up Safety Review (PSSR) program.		Operational Readiness
Develop a formal written procedure implementing a Management of Change (MOC) process. The process should be paper-based initially, to move to an electronic system once the program is fully implemented and understood.		Operational Readiness
Part of the MOC and PSSR procedures require operator training before any process change is made.		Operational Readiness

[redacted]

Recommendations to be Addressed Prior to Defueling	Risk Ranking	Source
Develop and implement a hot work program that is owned by the Operations/Fuels group. This program should meet the criteria of OSHA Process Safety Management (PSM). It should ensure that Operators know what hot work is being performed in their area and that operators are trained to write hot work permits. In addition, develop and implement a Safe Work program that includes procedures and controls for confined space entry, energy isolation, elevated work, and other Life Critical procedures.		Operational Readiness
Develop and implement a written process for incident investigation, including reporting requirements, data tracking, training, thorough incident investigation tools, etc. The level of incident investigation may be fit for the purpose of the incident severity. Incident investigations should be completed in a timely manner and communicated across the affected organizations to share learnings.		Operational Readiness
Obtain training for specific employees on incident investigative tools (like TapRoot, Apollo, etc.).		Operational Readiness
Ensure personnel is trained and there is a system to carry out and document headcount following a local muster or evacuation.		Operational Readiness
Typically, facilities have alarms for local emergencies (leave the work area and muster at a safe distance) and evacuation alarms (evacuate the facility). It is recommended to distinguish between local emergencies with muster points and evacuation emergencies. All employees entering the facility should be trained on alarms and muster/evacuation routes via an initial orientation. It is recommended that alarms are tested weekly to ensure alarm operability and to raise awareness of employee understanding of alarm types.		Operational Readiness
Ensure an emergency response critique is carried out, and documented and that actions are followed up after each actual emergency response or drill.		Operational Readiness

[redacted]

8.1.2 Ongoing Operations (Without Red Hill)

Table 8-2 shows recommendations to be considered for Ongoing Operations at Pearl Harbor DFSP (excluding any recommendations associated with the Red Hill UBFS facility).

Table 8-2 – Ongoing Operations Recommendations – Without Red Hill

Recommendations for Ongoing Operations at Pearl Harbor DFSP	Risk Ranking	Source
1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions, including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of the document control system. (High Priority.) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	1	PHA
2. Ensure the PITs located [redacted] (b)(3)(A) are in a scheduled PM system using certified and calibrated test equipment. The calibration should meet the requirements of OPNAV Instruction 3960.16B. (High Priority.)	1	PHA
3. Consider installing local Emergency Shutdown (ESD) on refueling piers at Pearl Harbor (PRL). Ensure ESD actions are consistent with Coast Guard requirements and do not create additional hazards. (Medium Priority.)	1	PHA
4. If additional safeguards are warranted, design and install automation to safely shut down refueling piers at PRL in the event of emergency or loss of containment, including isolation of sectional valves to minimize the quantity of the loss of containment. (High Priority.)	1	PHA
5. Consider equipping [redacted] (b)(3)(A) with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority.)	1	PHA

[redacted]

Recommendations for Ongoing Operations at Pearl Harbor DFSP	Risk Ranking	Source
10. Ensure the Pressure Safety Low sensors (PSLs), Pressure Safety High sensors (PSHs), PITs, Velocity Sensor (VSs), Temperature Transmitters (TTs), Current Transmitters (CTs), and Flow Sensors (FSs) on (b)(3)(A) [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority.)	1	PHA
21. Consider equipping all French drains at PRL and RHL with a check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority.)	1	PHA
41. Add testing for sulfur compounds (or other credible toxic compounds) as part of pre-offloading analysis for fuel receipts at PRL. (Medium Priority.)	1	PHA
52. Provide means to remove contamination from the water supply. (High Priority.)	1	PHA
74. Remove electrical connections and sockets from the inside of the Fuel Oil Reclamation Facility (FORFAC) containment area to reduce the likelihood of electrocution during periods of heavy rain or spill in secondary containment. If not feasible, install protective safeguards to reduce the risk of electrocution. (High Priority.)	1	PHA
75. As an interim recommendation, 1) replace sockets with Ground Fault Circuit Interrupter (GFCI) sockets inside the FORFAC secondary containment, 2) develop a Standard Operating Procedure (SOP) to engage NAVFAC prior to predicted heavy rainfall and include emergency phone numbers for power company contact, 3) provide access to breaker box near Tank 1301 Reclaim (B1) Tank, and 4) install signage that specifies "do not enter during periods of heavy rain or standing water" and includes a phone number contact to de-energize the area. (High Priority.)	1	PHA

[redacted]

Recommendations for Ongoing Operations at Pearl Harbor DFSP	Risk Ranking	Source
13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with an allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority.)	2	PHA
20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority.)	2	PHA
78. Establish a stand-alone maintenance contract apart from other base facilities with documented maintenance standards. (High Priority.)	2	PHA
83. Consider a SOP for all individuals in tunnels to have a 15 min. escape air bottle system for emergency egress during activation of the fire suppression system, which shuts down ventilation. (Medium Priority.)	2	PHA
11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce, where appropriate, to reduce the quantity of liquid that may be released on overfill. (High Priority.)	3	PHA
64. Consider testing for fluorides and chlorides in all liquids before defueling if possible or after receipt, and consider alternatives to receiving defuels from Navy vessels if data warrants. (Medium Priority.)	3	PHA
67. Investigate anchor chair requirements for all tanks in the Upper Tank Farm (UTF) and FORFAC, and Tank 311 at RHL. (Medium Priority.) This recommendation may be similar to a recommendation from SGH.	3	PHA
69. Install PITs on the suction and discharge of [redacted] Pump to allow CRO to monitor [redacted] performance. (Medium Priority.)	3	PHA
71. Consider installing a second dissimilar check valve adjacent to 6 in. check valve on the discharge of [redacted] Pump to reduce the likelihood and quantity of reverse flow. (Low Priority.)	3	PHA

Recommendations for Ongoing Operations at Pearl Harbor DFSP	Risk Ranking	Source
72. Use the existing level switch to activate a new, local audible and visual alarm with Level Safety High LSH-1328. (Medium Priority.)	3	PHA
92. Consider treating the engine compartment as a confined space which would include controlled access, deactivation of fire suppression system while inside, and reactivation of system when entry is complete. (High Priority.)	3	PHA
58. Perform Job Safety Analysis (JSA) on high-risk tasks to address human factors and PPE requirements. (Medium Priority.)	4	PHA
59. Ensure seals and enclosures necessary to maintain electrical area classification Class 1 Div I are included in PM program. (Medium Priority.)	4	PHA
60. Ensure transformers, switchgear, automatic transfer switch (ATS), and other equipment in Switch Gear Room meets requirements of Class 1 Div I. (High Priority.)	4	PHA
68. Install a differential pressure transmitter/switch and alarm across Duplex strainer on the suction of (b)(3)(A) Pump to decrease the likelihood of cavitation of (b)(3)(A) (Medium Priority.)	4	PHA
70. Include all PRL cameras in the scheduled PM program. (Medium Priority)	4	PHA
73. Install a pressure relief device on the discharge of (b)(3)(A) Pump, sized and documented for blocked outlet and discharges to a safe location. (Medium Priority.)	4	PHA
56. Implement a document control system to generate unique, trackable operations orders and log revisions.	5	PHA
90. Ensure scupper plugs in secondary containment coamings are verified in place prior to transfer as part of the work order for both vessels to vessel and barge/YON to shore transfers. (High Priority.)	5	PHA
91. Develop a procedure for verifying the presence of water in all cargo tanks, and if water is present, a procedure for removing water-contaminated fuel with a vacuum truck. (High Priority.)	5	PHA
12. Due to the variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure the marine		PHA

Recommendations for Ongoing Operations at Pearl Harbor DFSP	Risk Ranking	Source
transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority.)		
55. Determine the maximum pressure that can be provided by PAR Refinery if the pressure control valve malfunctions open and ensure piping at PRL and RHL is adequate for resultant pressure, and if not implement safeguards to reduce the likelihood of overpressuring PRL and RHL piping. (High Priority.)		PHA
62. Ensure Area Classification boundaries are clearly denoted in written PSI and understood by impacted personnel. (High Priority.)		PHA
94. Develop a procedure that outlines the specific manpower requirements for multiple, simultaneous operations as the number of operations increases and that requires written approval for Simultaneous Operations (SIMOPS) by the appropriate level of management. (High Priority.)		PHA
95. Consider adding additional Automatic Fuel Handling Equipment (AFHE) workstations and larger monitors to accomplish the need for visibility of more quadrants simultaneously. (Medium Priority.)		PHA
96. Evaluate the size and location of the current backup control room to better accommodate additional CROs and reduce access and distractions. (High Priority.)		PHA
97. Provide government smart phones to all Rovers for improved communications due to current radio reliability and that some communications are lengthy and better suited for a cell phone instead of radio. (High Priority.)		PHA
98. Create a fatigue policy for all Fuels Distributions System workers, operators, and maintainers that limits hours worked in a day and days worked consecutively. (High Priority.)		PHA
100. Review the current sampling schedule and identify opportunities for optimization and eliminating non-required sampling and analysis. (Medium Priority.)		PHA
101. Improve communications between fuel laboratory and CROs after analysis is complete for increased efficiency during multiple simultaneous operations. (Medium Priority.)		PHA

Recommendations for Ongoing Operations at Pearl Harbor DFSP	Risk Ranking	Source
102. Ensure safeguards are adequate for (b)(3)(A) [redacted] cavitation or deadheading due to closed valve during the loading process. If not, add additional safeguards as warranted. (Medium Priority.)		PHA
103. Consider the requirement for flame retardant clothing while working in a hydrocarbon environment. (High Priority.)		PHA
104. Consider installing emergency PPE throughout the facility. (High Priority.)		PHA
106. Consider inventorying spare parts/replacements for critical instrumentation to reduce the wait time for repairs. (Medium Priority.)		PHA
108. Implement the Management of Change Program. (High Priority.)		PHA
109. Develop an Incident Investigation Program that includes Incident Investigation techniques and near-miss reporting and investigation, and sharing of lessons. (High Priority.)		PHA
110. Implement a tunnel sign-in/sign-out process to be able to account for all personnel within the tunnel at any time. (Medium Priority.)		PHA
111. Require guides and all groups to have at least one form of emergency communication – likely a radio. (Medium Priority.)		PHA
112. Post signs periodically indicating the distance to the nearest emergency phone and instructions to dial “99” then “911”. (Medium Priority.)		PHA
113. Locating and tracking people is crucial for underground working conditions. Traditional technologies such as GPS and WiFi tracking do not work underground. Consider implementation of a system designed to locate and track personnel while in the tunnel. (Low Priority.)		PHA
114. Consider requiring Self-Contained Breathing Apparatus (SCBA), emergency air packs, installing SCBA station(s), or breathing airline throughout the tunnel. (Medium Priority.)		PHA
116. Consider providing appropriate PPE, for example, bunker gear and safeguards to allow CROs ample time to escape the area during an emergency. (High Priority.)		PHA
117. Consider the relocation of the control room from the UGPH to the back control room located in the Fuels Distribution Building. (Low Priority.)		PHA

[redacted]

Recommendations for Ongoing Operations at Pearl Harbor DFSP	Risk Ranking	Source
118. Review the need for emergency stations (safety shower and eyewash) and first aid stations throughout the facility in proximity to fuel piping. (Low Priority.)		PHA
119. Due to the geographical vastness of this facility, review the need for installing alarms on safety showers and eyewash stations. (Low Priority.)		PHA
120. Implement a formal safe work system, which includes coordination and control of all "intervention" work on the process and references all Life Critical standards, such as hot work, confined space, lock-out/tag-out, etc. (High Priority.)		PHA
Develop a Process Safety Information (PSI) policy that identifies the necessary PSI, how it will be maintained and where it will be stored and who will be responsible.		Operational Readiness
Consider repeating/revalidating the Process Hazard Analysis (PHA) every five years to assess the hazards introduced by implementing changes to the process. The next PHA would be due in 2027.		Operational Readiness
Develop a policy and schedule for PHA completion that includes techniques and methods to be used, personnel to include, and information to be reviewed. Include a requirement for all major projects to include a PHA as part of the project design.		Operational Readiness
All areas should be evaluated as to whether or not they are confined spaces, and signage should be provided. Develop a formal written procedure implementing a confined space permitting system and training for all employees.		Operational Readiness
Implement a formal written program establishing operator initial and refresher training requirements. Job shadowing can be one aspect of this training program but should not constitute the primary training method. Consider operator pre-qualification requirements prior to employment. Establish a training department/coordinator to be responsible for all training activities and consider using a process simulator for CRO initial and refresher training.		Operational Readiness
Develop and implement detailed Mechanical Integrity (MI) procedures for all equipment subject to test and inspection requirements.		Operational Readiness
Develop structured written procedures for training personnel to maintain the ongoing integrity of process equipment.		Operational Readiness

8.1.3 Ongoing Operations (with Red Hill)

Table 8-3 contains those recommendations and associated risk rankings made during the PHA (HAZOP) to be considered if operations at Red Hill are resumed in the future.

Table 8-3 – Ongoing Operations Recommendations – Red Hill

Recommendations for Ongoing Operations at Red Hill	Risk Ranking
5. Consider equipping [redacted] (b)(3)(A) with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority.)	1
15. Install ESD functionality to both suction and discharge MOVs to [redacted] (b)(3) to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on the loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority.)	1
16. Evaluate alternate design to eliminate the use of Dresser Couplings throughout PRL and RHL. (High Priority.)	1
17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high-level alarm to be similar to Red Hill Main Sump. (High Priority.)	1
18. Evaluate the need for emergency electrical supply to ESD Motor Operated Valves (MOVs) and Oil Control Valves (OCVs) (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority.)	1
19. Ensure OCVs on the discharge of each [redacted] (b)(3)(A) are pressure or leak tested per schedule and records retained for auditing. (Medium Priority.)	1
24. Modify Clean Inspect and Repair (CIR) contracts to include restraining pipe between blanked sections when taking the tank out of service for maintenance or inspection. (High Priority.)	1
26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in the pipeline. (Medium Priority.)	1

Recommendations for Ongoing Operations at Red Hill	Risk Ranking
29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce the reliability of safety systems such as Oil Tight Door closure. (Medium Priority.)	1
30. Evaluate the location of the electrical room, which contains the transformer, primary disconnects, and Motor Control Center (MCC) switchgear [redacted] (b)(3)(A) and consider relocation to [redacted] (b)(3)((High Priority.)	1
45. Ensure run status indication on all pumps inside all AFFF Sumps (twenty pumps) is integrated with the AFHE SCADA to alert Control Room Operator (CRO) to the potential release of fuel and/or AFFF. (High Priority.)	1
46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and [redacted] (b)(3)(A) Sump) with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to the potential release of fuel. (Medium Priority.)	1
47. Evaluate the design of the 14" AFFF discharge line piping on the discharge of 20 AFFF Sumps pumps as part of the current project to upgrade PVC to CS. The PHA Team is concerned about 1) the volume flow and separately, 2) line slope or configuration to trap liquid in retention line, and 3) lack of damage control isolation in long-run of piping. (High Priority.)	1
48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High Priority.)	1
49. Train all affected personnel on the design, intent, and operation of the AFFF System, including refresher training. (High Priority.)	1
50. Consider equipping AFFF Retention Tank with reliable level indication and level alarm to alert Control Room Operator (CRO) to the presence of level in the AFFF Retention Tank. (Medium Priority.)	1
51. Consider designing a system to separate oil and water to reduce the likelihood of discharging flammable liquid to the environment from Adit 3 Groundwater Sump. (Medium Priority.)	1
53. Evaluate an emergency breathing air supply for Harbor Tunnel due to its long length, limited egress, and reduced ventilation. (Medium Priority)	1
66. Design and install interlock and permissive systems for all fuel movements to/from RHL and UGPH to reduce the likelihood of human error of sequencing valves during lineup. Design should consider the use of the manual clutch to bypass MOV operation. (High Priority.). Some action is already underway as the result of AB&A Root Cause Analysis into the 6 May 2021 mishap.	1

[redacted]

Recommendations for Ongoing Operations at Red Hill	Risk Ranking
7. Perform a Pipe Collapse Pressure Study to determine the pressure required to collapse the existing pipe and identify and install safeguard(s) as warranted. Consider integrating this recommendation with the upcoming API 570 Assessment. (High Priority.)	2
76. Develop a full documentation package with P&IDs for the fire suppression system for RHL. (High Priority.)	2
77. Ensure firewater and AFFF main, and jockey pumps are on a PM schedule, and automatic transfer switches to emergency diesel-driven generators are tested periodically at load to meet the requirements of NFPA. (Medium Priority.)	2
79. Evaluate the available inventory of AFFF on site and determine if additional quantities are desired. NFPA 30 Chapter 16 requires 15 min. of foam concentrate inventory based on design flow rate. (Low Priority.)	2
80. Evaluate combining the SCADA systems for AFHE and fire suppression for ease of CRO monitoring or consider a Smart Grid system solution. (Low Priority.)	2
82. Identify an alternative to AFFF that does not contain Perfluorinated Chemicals (PFAS) or Perfluorooctanoic acid (PFOA) to eliminate exposure potential to humans or the environment. (High Priority.)	2
11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce, where appropriate, to reduce the quantity of liquid that may be released on overfill. (High Priority.)	3
22. Ensure new replacement pumps for (b)(3)(A) [redacted] are equipped with 1) appropriate seal materials for the resulting temperatures of periods of lower than normal flow operation and 2) minimum flow recirculation protection to reduce the likelihood of increased temperature during periods of lower than normal flow operation. (High Priority.)	3
33. Evaluate lighting at the discharge location of the 24 in. horizontal vent pipe to increase the likelihood of detection by the camera in the area and improve lighting if warranted. (Medium Priority.)	3
34. Consider equipping 24 in. horizontal vent pipe discharge with fuel or oil detection and alarm instrumentation to detect the presence of liquid fuel. (Medium Priority.)	3
36. Consider implementing a four-gas personnel monitor PPE requirement for personnel working in any tunnels. (Medium Priority.)	3
37. Evaluate the use of the panic button and man-down feature of the intersite radio system. (Medium Priority.)	3

Recommendations for Ongoing Operations at Red Hill	Risk Ranking
39. Evaluate the reliability of the heat-activated water deluge in Upper Access Tunnel in Red Hill Tank Gallery in conjunction with the evaluation of AFFF in Lower Access Tunnel (LAT). Develop recommendations for improved reliability. (High Priority.)	3
40. Improve the reliability of draining condensed/accumulated liquid in Red Hill Tank Gallery manifolded vent piping. Options to consider include 1) manually checking and draining low points per scheduled interval and 2) adding a level detection and alarm instrumentation to alert operations to abnormal accumulation of hydrocarbon and/or water. Include all instrumentation in PM program with calibrated testing equipment. (Medium Priority.)	3
42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between the upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority.)	3
43. Install a second and independent high-level indication and alarm on TK 311 Slop Tank to reduce the likelihood of overfilling TK 311 unknowingly. (Medium Priority.)	3
44. Review current practices and operability of TK 311 Slop Tank with groundwater treatment equipment and personnel adjacent to TK 311 to evaluate the interaction of the two operations and modify practices if warranted. (Low Priority.)	3
65. Develop a SOP for dewatering Tank 47/48/54 F-76 Tank (Upper Tank Farm), Tank 46/53 F-24 Tank (Upper Tank Farm), and Tank 55 JP-5 Tank (Upper Tank Farm) to increase the likelihood of complete dewatering, not partial dewatering. (High Priority.)	3
67. Investigate anchor chair requirements for all tanks in the UTF and FORFAC, and Tank 311 at RHL. (Medium Priority.) This recommendation may be similar to a recommendation from SGH.	3
93. Consider incorporating visual strobe light with the alarm system to further increase awareness of fire suppression activation. (Medium Priority.)	3
35. Evaluate the vent piping between "P traps" in grouped tanks to determine if low point piping could accumulate trapped liquid over time due to condensing and/or undetected overfill; and if credible, identify the method to remove accumulated liquid if warranted. (Medium Priority.)	4
57. Consider installing a small platform in lieu of portable ladders for safer access to High Point Bleed (HPB) for each of the three products OR relocate HPB to ground level. Hard pipe the discharge of the HPB to the Main Sump.	4

[redacted]

Recommendations for Ongoing Operations at Red Hill	Risk Ranking
Ensure the end of the discharge piping is visible to the person(s) performing the task. (Low Priority.)	
61. Consider using nitrogen to relieve vacuum inside piping instead of air to reduce the likelihood of producing a flammable mixture. (Medium Priority.)	4
63. Ensure Operations Order for line pack include specific steps to close high point bleed valve (HPB) before completely opening ball valve. (Low Priority.)	4
89. Develop unique work orders for the vessel to vessel fuel transfers. (High Priority.)	5
23. Perform a hydraulic surge analysis. Consider integrating this recommendation with the upcoming API 570 Assessment. (High Priority.)	
54. If defueling to PAR is pursued, coordination with PAR to develop an Operations Plan which reviews safeguards at PAR for 1) maximum pressure of ~130 psig, 2) maximum flowrate, 3) overfill protection, and 4) transient surge when isolated at PAR is required. (High Priority.)	
81. Understand the multiple roles of nitrogen in the AFFF fire suppression system and evaluate safeguards and add additional safeguards if warranted. Consider the impact of nitrogen leak and potential asphyxiation. (High Priority.)	
84. Collaborate with the vendor of the AFFF system to determine all purposes of the nitrogen system, the capability of the nitrogen system (pressure), and safeguards in the current design. Identify and install additional safeguards if warranted. (High Priority.)	
85. Ensure the AFFF 175 psig components (if there are any) are adequately designed and documented for a maximum pressure of ~220 psig firewater. If they are not, add additional safeguards as warranted. (High Priority.)	
86. Ensure re-design of fire suppression system addresses dead legs, which prevent the complete transfer of foam/water mixture after activation of fire suppression system and allow potential future fuel and foam releases upon loss of containment. (High Priority.)	
87. Implement a Mechanical Integrity Inspection Program for all identified dead legs in fuel handling and fire suppression systems. (Medium Priority.)	
88. Equip AFFF sump pumps with remote start from the fire suppression SCADA system to allow for operation in case AFFF pumps cannot be operated locally due to lack of access (OPD or fire-rated door closed). (High Priority.)	
105. Ensure the closing of the oil-tight doors displayed on the control room display. (High Priority.)	
115. Consider reinforcing the window/wall facing the UGPH. (High Priority.)	

8.1.4 Planning and Schedule

It is not expected that all recommendations made as a result of the Process Hazard Analysis or Operational Readiness Assessment be implemented. Priority should be established by Navy leadership, taking into consideration, among other things, the following:

- The assigned risk ranking associated with the recommendation (i.e., 1 – 5, red to green, critical to negligible).
- Anticipated schedule for defueling Red Hill.
- Expected future use of the facility (i.e., will fuel storage at Red Hill resume).
- Technical feasibility of the recommendation.
- Financial impact of the recommendation.
- Other efforts underway or planned to address the risk.

Typically, a workshop would be held to engage all stakeholders in the review and selection of recommendations to be actioned. At this workshop, engineering solutions would not be discussed, but appropriate responsibility and schedule would be determined.

Risktec has attempted in this section to develop a preliminary implementation plan (Table 8-4) for those recommendations considered critical. This implementation plan does not consider other efforts that may be underway or planned but can be used as a go-by for the stakeholder workshop.

Table 8-4 – Proposed Implementation Plan

Timing	Recommendation
Immediate	Review third-party assessment
	Hold stakeholder meetings to review defueling recommendations and assign accountability for those to be actioned
	Develop POAM for Red Hill defueling considering recommendations selected from Table 2 in Section 4.1.1. and Table 5 in Section 4.2. of the Operational Readiness Assessment Report (Appendix C)

Timing	Recommendation
0-12 months	Implement POAM to defuel Red Hill tanks (including administrative and engineering changes)
	Revise facility risk matrix
	Train all employees on risk awareness
	Develop/revise operating orders for defueling activities
	Develop/update “life-critical” safety standards (selected for defueling operations) and other selected programs: • hot work and safe work permitting • lock-out/tag-out (energy isolation) • opening process piping and equipment • personal protective equipment • plant access and security • management of change • pre-start-up safety reviews • emergency response • incident investigation
	Implement selected life-critical safety standards and other selected programs prior to defueling
	Train all affected employees on life-critical safety standards, defueling operating orders, and other selected programs
1-2 years	Safely defuel Red Hill tanks
	Provide oversight, coaching, and mentoring for defueling activities as required
	Hold stakeholder meetings to review all other recommendations and assign accountability for those to be actioned
2-4 years	Implement selected recommendations for operational improvements to Pearl Harbor DFSP (including administrative and engineering changes)
	Develop/update EHS standards, for example: • safe work authorization/permitting • confined space entry • process safety information • process hazard analyses • corrective action tracking • etc.
	Implement EHS standards, new and existing

Timing	Recommendation
	Train all affected employees on EHS standards
Every 5 years	Conduct Process Hazard Analysis to review cumulative effect of all changes on process integrity
On-going and periodically as required	Audit process safety management system to identify continuous improvements
	Leverage operational success at JBPHH DFSP enterprise-wide

8.2 Structural and Mechanical Integrity Recommendations

Our recommendations are provided in detail in Appendix A and its five sub-appendices as follows:

Appendix A.1 – Site Visit Observations and Recommendations (Sorted by Location)
Appendix A.2 – Site Visit Observations and Recommendations (Sorted by Priority)
Appendix A.3 – Conceptual Retrofit Drawings in Lower Access Tunnel
Appendix A.4 – Repair Sketches and Photographs in Lower Access Tunnel
Appendix A.5 – Valve Equalization By-Pass Line Concept

Our most significant recommendations (and which are all required prior to defueling) are in the lower access tunnel (LAT) adjacent to the Red Hill tanks. Our structural and mechanical integrity and design improvement recommendations are as follows:

1. Performance of a surge analysis for the three fuel pipelines to determine whether a larger load than we evaluated could occur during defueling, considering the existing piping configurations and the expected sequence of valve openings associated with defueling. Based on the computed surge loads, any Dresser couplings subject to tension should be evaluated to determine whether they have sufficient capacity, with consideration to replace or strengthen the Dresser couplings.

2. Protection of Dresser couplings by ensuring cross-tunnel lateral piping is connected at tanks or provision of axial restraints at tank piping laterals. If cross-tunnel piping cannot be connected or supported with axial restraints, we recommend that any in-line Dresser couplings that could be subject to tension (e.g., if the adjacent lateral is disconnected), be evaluated to determine whether the coupling has sufficient strength to resist the tensile loads from a detailed surge analysis.

3. Provision of lateral restraint to all three main pipelines at a select number of pipe supports in the LAT and re-establishment of effective, integral cross-tunnel lateral piping at odd-numbered tanks. This includes reconnection of piping laterals to Tanks 1 and 19. This recommendation will help restrain the pipes from significant lateral movement (and the

resulting damage to the piping laterals and Dresser couplings) in the event of a high-pressure surge event, similar to that which happened in May 2021. We understand that reconnection of Tank 19 was in process during this study, but our pipe stress analysis indicates that the work that is being currently performed may still not be adequate and that additional system strengthening (axial and lateral restraints) may also be required in order to resist transient surge loads. An example of required additional axial restraint adjacent to Tank 20 is shown in Figure 8-1. Note that this restraint is suggested in addition to the ongoing repairs for the JP-5 line currently being implemented in the vicinity. A typical set of lateral restraints is shown for illustration in Figure 8-2. Appendices A.3 and A.4 provide conceptual retrofit drawings indicating the required locations of additional restraints.

4. Permanent connections of the lateral piping between the odd-numbered tanks and main pipelines. If this condition changes and odd-numbered tanks are disconnected, then additional axial and/or lateral restraints and line stops are required to restrain the pipeline movement due to the disconnected piping. The proposed lateral restraints and stops shown in Appendix A.3 are based on the assumption that piping laterals at Tanks 1 and 19 are being reinstated and that no odd-numbered tanks will ever be disconnected from the system while there is fuel in any of the tanks. In other words, all other odd-numbers tanks must be permanently connected to the main pipelines. If this condition changes and odd-numbered tanks are disconnected, then additional axial and/or lateral restraints and stops are required at other pipe supports adjacent to the lateral offtakes of those other tanks that are disconnected. The table in Appendix A.4 contains our recommendations that summarize these modifications, including pipe support numbers, photos, details, and a schematic description of the lateral restraint/stop. These restraints and stops should utilize simple and practical construction and installation methods to the extent possible. Sketches with locations and details for the proposed modifications can be found in Appendix A.4.

(b)(3)(A) [redacted]

Figure 8-1 – Additional Axial Restraint in the Vicinity of Tank 20

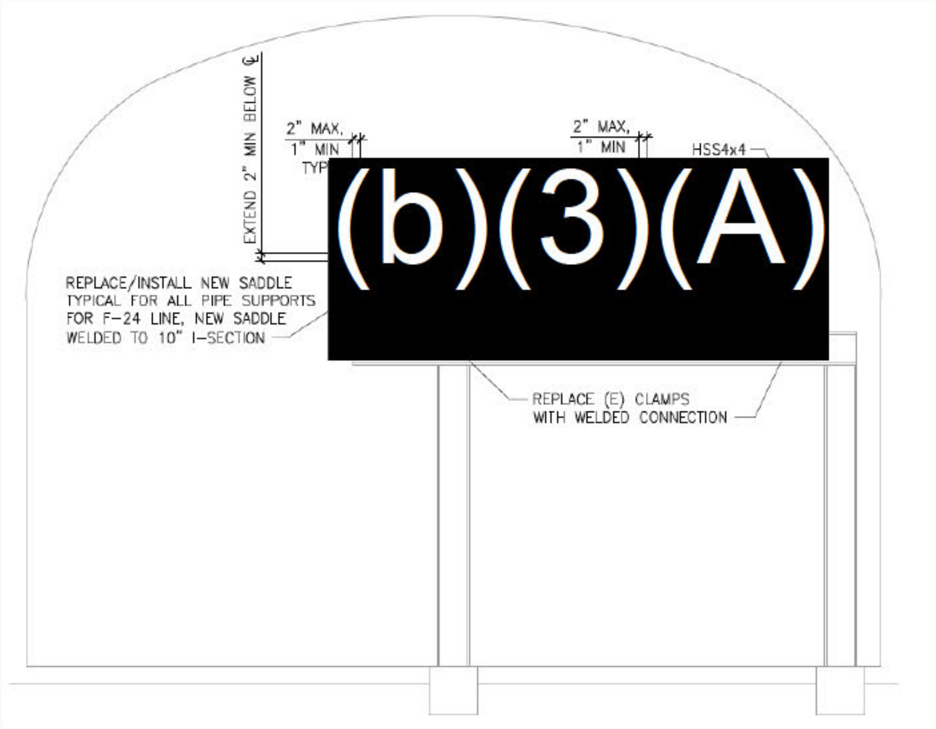

Figure 8-2 – Typical Required Lateral Restraint in Lower Access Tunnel (Appendices A.3 and A.4)

5. Provision of lateral restraints (guides) at approximately 20 locations in the LAT that can ensure the stability of the F-24 pipeline. The F-24 pipeline is presently inadequately supported and could fall from its pipe supports in the event of a high-pressure surge event or an earthquake. Figure 8-2 also shows the typical lateral restraint required for the F-24 line at approximately twenty locations in the LAT; see Appendices A.3 and A.4.

6. Provision of Pressure Equalization Across Both the Inboard (Skin) Valve and the Outboard Valve at Each Tank. This recommendation will reduce the risk of future high-pressure surge events in the event that vacuum conditions in the three main fuel pipelines occur. In terms of defueling, not all of the tanks will require pressure equalization across the valves if the Navy can plan the order in which the tanks are defueled. It is our understanding that Tanks 1, 13, 14, 17, 18, and 19 are currently out of service and will not be brought back into service. Note that if this is not the case, this recommendation will also apply to these tanks. The concept is described in detail in Appendix A.5. The bypass lines are illustrated in Figure 8-3 and should be explored during the detailed design phase. The bypass lines can:

   a) Help prevent surges by equalizing the pressure across the mainline valves prior to being opened,

   b) Protect the valve seat, actuator, and shaft against high differential pressure damage by allowing equalization, and

[redacted]

Figure 8-3 – Pressure Equalization Concept

We have many other recommendations, including a host of maintenance issues and repair of corroded piping, damaged coating, damaged/reconfigured pipe supports, missing bracing, corroded pipe supports, overconstrained piping and stairways at several aboveground storage tanks, degraded pier structures, follow-up on items previously identified as being in need of repair from past inspection reports, and others. See Appendices A.1 and A.2 for a complete description. Our recommendations are sorted by priority and location in Table 8-5 and totals are provided in Table 8-6. A number of these will require repair prior to defueling (designated as priority D1) whereas some will only be performed as part of ongoing JBPHH operations [with designated priorities as P1 (high), P2 (lower), and P3 (maintenance)].

In Table 8-5, for ease of reference, we list the item number associated with our specific observations contained in Appendices A.1 and A.2. The following legend applies to locations:

- Lower Access Tunnel (LAT)
- Piping and Mechanical (PM)
- Harbor Tunnel (HT)
- Lower Yard Tunnel (LYT)
- [redacted] Pumphouse (PH)
- Aboveground Storage Tanks (AST)
- Valve Stations (VS)
- Valve Chambers (VC)
- Hickam (HK),
- Aboveground Piping (AGP)
- Hotel Pier (HP)
- Kilo Pier (KP)
- Sierra Pier (SP)
- Mike Pier (MP)
- Bravo Pier (BP)

Table 8-5 – Summary of SGH Mitigation Recommendations

Location / Priority	Defueling	Continued Operations			
	D1 (Defueling)	P1 (High)	P2 (Lower)	P3 (Maintenance)	Observation Only
Lower Access Tunnel (LAT)	LAT-3, LAT-15, LAT-20, LAT-24, LAT-29, LAT-32, LAT-38, LAT-40, LAT-41, LAT-42, LAT-44, LAT-46, LAT-47, LAT-48, LAT-55	LAT-5, LAT-7, LAT-17, LAT-18, LAT-19, LAT-21, LAT-22, LAT-25, LAT-27, LAT-31, LAT-34, LAT-35, LAT-39, LAT-43, LAT-45	LAT-1, LAT-2, LAT-8, LAT-10, LAT-12, LAT-14, LAT-16, LAT-26, LAT-30, LAT-36, LAT-37, LAT-51, LAT-52	LAT-6, LAT-9, LAT-23, LAT-28, LAT-33, LAT-49, LAT-50, LAT-54	LAT-4, LAT-11, LAT-13, LAT-53
Piping and Mechanical (PM)	[redacted] PM-2, PM-3, PM-4, PM-5, PM-6, [redacted] PM-20, PM-21, PM-22, PM-25	PM-7, [redacted] PM-26	PM-23, PM-24	HT-16, HT-45	PM-8, PM-9
Harbor Tunnel (HT)	HT-3, HT-6, HT-12	HT-26, HT-28, HT-30, HT-32, HT-33, HT-38, HT-41, HT-44	HT-1, HT-2, HT-5, HT-7, HT-8, HT-9, HT-10, HT-11, HT-13, HT-14, HT-17, HT-19, HT-22, HT-23, HT-24, HT-34, HT-35, HT-36, HT-37, HT-40, HT-42, HT-46, HT-47, HT-48, HT-49, HT-50, HT-51, HT-52		HT-4, HT-15, HT-18, HT-20, HT-21, HT-25, HT-27, HT-29, HT-31, HT-39, HT-43
[redacted] Pumphouse (PH)		PH-1, PH-2, PH-3, PH-4			
Lower Yard Tunnel (LYT)		LYT-1, LYT-2, LYT-3, LYT-4			
Above Ground Storage Tanks (AST)		AST-3, AST-4, AST-12	AST-1, AST-2, AST-5, AST-7, AST-8, AST-9, AST-10, AST-11	AST-13, AST-14	AST-6
Valve Stations (VS)		[redacted]6, [redacted]7, [redacted]8, [redacted]1, [redacted]2, [redacted]3	[redacted]2, [redacted]3, [redacted]4, [redacted]2, [redacted]4, [redacted]5, [redacted]10, [redacted]11, [redacted]1, [redacted]2, [redacted]4, [redacted]1, [redacted]2	[redacted]1, [redacted]1, [redacted]3, [redacted]9	
Valve Chambers (VC)		[redacted]1, [redacted]2, [redacted]3, [redacted]4, [redacted]1, [redacted]1, [redacted]1	[redacted]1		
Hickam (HK)		HK-3	HK-1, HK-4	HK-2	
Above Ground Piping (AGP)	AGP-1, AGP-2		AGP-4, AGP-9	AGP-3, AGP-5, AGP-6, AGP-7, AGP-8, AGP-10	
Hotel Pier (HP)	HP-14	HP-3, HP-4, HP-5, HP-6, HP-7, HP-8, HP-11, HP-12, HP-13	HP-2, HP-10	HP-1	HP-9
Kilo Pier (KP)		KP-1, KP-2, KP-3			
Sierra Pier (SP)		SP-1, SP-2, SP-3			
Mike Pier (MP)		MP-1, MP-2, MP-3, MP-4, MP-5, MP-6, MP-7, MP-8, MP-9, MP-10, MP-11, MP-12, MP-14, MP-15, MP-17, MP-21, MP-22, MP-23	MP-13, MP-16, MP-18, MP-19, MP-20		
Bravo Pier (BP)		BP-1, BP-2, BP-3, BP-4, BP-5	BP-6		

Table 8-6 - Summary of SGH Mitigation Recommendations (Total Count)

Location / Priority (Total)	D1 (35)	P1 (94)	P2 (77)	P3 (24)	Observation Only (19)	Total (249)
Lower Access Tunnel (LAT)	15	15	13	8	4	55
Piping and Mechanical (PM)	14	8	2		2	26
Harbor Tunnel (HT)	3	8	28	2	11	52
[redacted] Pumphouse (PH)		4				4
Lower Yard Tunnel (LYT)		4				4
Above Ground Storage Tanks (AST)		3	8	2	1	14
Valve Stations (VS)		6	13	4		23
Valve Chambers (VC)		7	1			8
Hickam (HK)		1	2	1		4
Above Ground Piping (AGP)	2		2	6		10
Hotel Pier (HP)	1	9	2	1	1	14
Kilo Pier (KP)		3				3
Sierra Pier (SP)		3				3
Mike Pier (MP)		18	5			23
Bravo Pier (BP)		5	1			6

The tables in Appendix A.1 provide our recommendations ordered by location, while those in Appendix A.2 provide the same information ordered by recommendation priority. Both appendices provide our cost estimate for performing repairs, broken down by priorities – Priority D1 prior to defueling, and Priorities P1 (high), P2 (lower), and P3 (maintenance) for continuing operations.

Costs are further broken down into our recommendations that we believe are not part of existing planned/funded projects (the first column of numbers in Table 8-7) and those that are part of such projects (the second column of numbers in Table 8-7).

For example, some of our recommended priorities are already part of Pond's RMMR activities, and others are already a part of the planned structural repairs at Hotel Pier (a P1 recommendation budgeted at [redacted]). Therefore, these types of recommendations fall into the second column of numbers in Table 8-7, and in this manner, the additional projects that we are identifying are in the first column of numbers in the table and add to approximately [redacted].

Table 8-7 – Repair Cost Estimates

Priority	Recommended Repairs Not Associated with Ongoing Planned/Funded Projects	Recommended Repairs Already Associated with Ongoing Planned/Funded Projects	Total
	Construction Costs (Excludes Engineering)		
D1	[redacted]		
P1			
[redacted]			
P3			
Grand Total			

Several comments regarding the cost estimates should be noted:

[redacted]

(b)(3) [redacted]

In terms of completion schedule, the tables in Appendices A.1 and A.2 nominally assign the following implementation schedules:

- D1 – as soon as practicable.
- P1 – twelve to twenty-four months.
- (b)(3)(A [redacted] – twenty-four to forty-eight months.
- P3 – ongoing as part of maintenance activities.

Our recommendations related to maintenance of coatings and corrosion control are provided below for JBPHH's use:

- Improve the quality control procedures for the inspection and repair of fuel pipes and ASTs. The external surfaces of pipes and tanks should be inspected at least annually by a qualified Corrosion Engineer. Project specifications should be written for every coating procedure, including apparently minor repairs, and these specifications should be reviewed by a Coatings Specialist to ensure that they satisfy the requirements of UFGS-09 97 13.27 (Department of Defense, 2020).

- The fuel pipes along the piers that are located in the tidal zone, which are currently covered with a wrap coating, should be either stripped and recoated with a high-performance coating system designed for marine immersion, or the pipes relocated to above the tidal zone and coated according to UFGS-09 97 13.27 (Steel Structures).

- The stainless steel flange bands which are present at some valve stations to protect against crevice corrosion should be installed at all flanges across the facility.

- Drain holes should be added to improperly pitched surfaces to drain standing water (e.g., AST 47).

- Crevices at pipe supports should be eliminated or sealed.

- If the Harbor Tunnel pipelines are to be maintained in the long-term, the bituminous wrap coatings should be removed and replaced with a coating satisfying UFGS-09 97 13.27 (Steel Structures).

- The cathodic protection system for the buried fuel pipes and the current annual inspection system is satisfactory. However, attention should be given to the maintenance of pipe wraps at ground penetrations and the condition of isolation valves adjacent to these locations.

- The corrosion pits that we observed and measured are acceptable according to our FFS calculations. However, it is important that fuel pipes be regularly dewatered to prevent internal corrosion and that coatings are maintained to prevent external corrosion.

- The surfaces of stainless steel pipes at Hickam adjacent to welds, both in the pumphouses and at select external locations, should be inspected using die penetrant or similar to ensure that no stress corrosion cracking is occurring.

Our general recommendations for safe defueling also include the following:

- Any modifications that affect the loading or structural response of tanks, structures or piping systems should be engineered in a coordinated manner

- Independent third-party verification of design changes, repairs and modifications currently being planned and implemented should be employed

- A more robust facility specific integrity management program and anomaly tracking system should be implemented

- A risk-based process safety management system should be adopted

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APPENDIX A
Observations and Recommended Mitigation Concepts

A.1 - Site Visit Observations and Recommendations
(Sorted by Location)
A.2 - Site Visit Observations and Recommendations
(Sorted by Priority)
A.3 - Conceptual Retrofit Drawings in Lower Access Tunnel
A.4 - Repair Sketches and Photographs in Lower Access Tunnel
A.5 - Valve Equalization Bypass Line Concept

APPENDIX A.1
Site Visit Observations and Recommendations (Sorted by Location)

Lower Access Tunnel (LAT)
Piping and Mechanical (PM)
Harbor Tunnel (HT)
[redacted] Pumphouse (PH)
Lower Yard Tunnel (LYT)
Above Ground Storage Tanks (AST)
Valve Stations (VS)
Valve Chambers (VC)
Hickam (HK)
Above Ground Piping (AGP)
Hotel Pier (HP)
Kilo Pier (KP)
Sierra Pier (SP)
Mike Pier (MP)
Bravo Pier (BP)

Observation Type	CD - coating damage; CR - corrosion; DV - design variation; LI - lack of integrity; MB - missing member; PD - physical damage; WD - weld defect; LP - load path; IR - improper restraint (missing pipe supports etc.); IC - interaction of components (contact risk, over restrained pipes by the tanks, stress concentration etc.), OT - other
Severity	H - high, M - medium, L - low
Priority	D1 - defuel, P1 - high, P2 - lower, P3 - maintenance

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
LAT-1	Structural	(b)(3)(A) [redacted]	Existing beam is heavily corroded at end closer to the tunnel wall. There is also an existing adjacent pipe support.		CR	L	Replace beam with a section of similar characteristics to the existing one. There is currently work being performed but it is unclear if the corroded beam is being replaced as part of that scope.	P2	Review by SGH recommended	(b)(3) [redacted]	24-48mo	Requires lead abatement	
LAT-2	Structural	[redacted]	Existing column is heavily corroded at the base		CR	L	Replace lower section of column with a section of similar characteristics to the existing one; this will also require replacement of the anchorage. There is currently work being performed but it is unclear if the corroded beam is being replaced as part of that scope.	P2	Review by SGH recommended	[redacted]	24-48mo	Requires lead abatement	
LAT-3	Structural	[redacted]	Failure of piping system during 6 May 2021 event	(b)(3)(A) [redacted]	IR	H	Design piping system to withstand repeat of surge event	D1	Yes	[redacted]	As soon as practicable	Some modifications are being implemented, but additional repairs are required	In progress under NAVFAC JP-5 line repairs
LAT-4	Structural	[redacted]	Cracks in 6-in concrete wall, below pipe penetration, JP-5 pipeline		PD	L		None	No	[redacted]	-	Wall is adequate	
LAT-5	Structural	[redacted]	Bracing is missing, remnants of angle sections are present attached to the columns		DV	H	Install one bay of bracing at a minimum on each side of pipe supports, this can be done between pipe supports 4 and 7. See SGH conceptual retrofit drawings.	P1	Yes	[redacted]	12-24mo	Requires lead abatement	
LAT-6	Piping	[redacted]	Improperly centered pipe bearing pad	(b)(3)(A) [redacted]	OT	L	Reset pipe bearing pad under centerline of pipe, or provide a larger pad	P3	No	[redacted]	Ongoing	This pipe support has a pad between the pipe and support currently	
LAT-7	Structural	[redacted]	Pipe support not matching design drawings		DV	H	See LAT-5	P1	Yes	[redacted]	12-24mo	Requires lead abatement	
LAT-8	Structural	[redacted]	Column out of plumb		LP	M	Fix alignment	P2	No	[redacted]	24-48mo	Requires lead abatement	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
LAT-9	Structural	(b)(3)(A) [redacted]	Crack in column encasement		OT	L	Repair as needed	P3	No	(b)(3) [redacted]	Ongoing		
LAT-10	Structural	[redacted]	Crevice corrosion at column base		CR	M	Repair as needed	P2	No	[redacted]	24-48mo	Requires lead abatement	
LAT-11	Structural	[redacted]	Pipe support not matching design drawings		DV	L	Observation only	None	No	[redacted]	-	No repair	
LAT-12	Piping	[redacted]	Missing cradle/support	(b)(3)(A) [redacted]	IR	M	Provide missing cradle	P2	No	[redacted]	24-48mo	Requires lead abatement	
LAT-13	Structural	[redacted]	Pipe support not matching design drawings	(b)(3)(A) [redacted]	DV	L	Observation only	None	No	[redacted]	-	No repair	
LAT-14	Piping	[redacted]	Cradle/support not in contact with pipe	(b)(3)(A) [redacted]	IR	M	Provide positive connection between pipe and cradle	P2	No	[redacted]	24-48mo	Requires lead abatement	
LAT-15	Piping	[redacted]	Existing AFFF retention line overhead valve at risk of impact		OT	H	Provide protection to existing overhead valve to avoid damage caused by impact	D1	Review by SGH recommended	[redacted]	As soon as practicable		
LAT-16	Piping	[redacted]	The AFFF retention line changes from steel piping to PVC		DV	H	Review AFFF retention line modifications.	P2	Review by SGH recommended	[redacted]	24-48mo		Part of funded NAVFAC contract to replace PVC retention line to stainless steel

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
LAT-17	Structural	(b)(3)(A) [redacted]	Existing beam is heavily corroded at end closer to the tunnel wall		CR	H	Replace damaged section of beam and connect to tunnel wall	P1	Yes	(b)(3) [redacted]	12-24mo	Requires lead abatement	
LAT-18	Structural	[redacted]	Existing brace is damaged		PD	H	Replace brace with the original configuration	P1	No	[redacted]	12-24mo	Requires lead abatement	
LAT-19	Structural	[redacted]	Existing columns are heavily corroded at the base		CR	H	Replace column and anchorage	P1	No	[redacted]	12-24mo	Requires lead abatement	
LAT-20	Piping	[redacted]	Elevated pipe (JP-5, [redacted] has limited or no lateral restraint	(b)(3)(A) [redacted]	IR	H	Provide lateral restraint to the existing pipe at PS 18	D1	Yes	[redacted]	As soon as practicable	Requires lead abatement	
LAT-21	Structural	[redacted]	Connection to concrete wall is unclear, original design was modified	(b)(3)(A) [redacted]	DV	H	Provide an effective connection to concrete wall as per SGH retrofit concept drawings	P1	Yes	[redacted]	12-24mo		
LAT-22	Electrical	[redacted]	Transformer is located in a room that does not have positive pressure, potential fire risk		OT	H	Relocate transformer outside of tunnel system or enclose in a room with positive pressure	P1	No	[redacted]	12-24mo	We understand there may be a study underway evalutaing this condition. No construction costs herein have been assigned pending completion of this ongoing study.	
LAT-23	Structural	[redacted]	Dents in pipe supports		PD	L	Repair as needed	P3	No	[redacted]	Ongoing		
LAT-24	Piping	[redacted]	Elevated pipe (F-24, [redacted] has limited or no lateral restraint	(b)(3)(A) [redacted]	IR	H	Provide lateral stops as per SGH retrofit concept drawings	D1	Yes	[redacted]	As soon as practicable	Multiple pipe supports per SGH retrofit concept drawings. Rerouting of conduit and other elements required. Requires lead abatement.	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
LAT-25	Structural	(b)(3)(A) [redacted]	Existing beam is heavily corroded at end closer to the tunnel wall		CR	H	Replace damaged section of beam and connect to tunnel wall	P1	Yes	(b)(3) [redacted]	12-24mo	Requires lead abatement	
LAT-26	Structural	[redacted]	Water drops onto structural members of pipe supports	(b)(3)(A) [redacted]	CR	M	Redirect drainage away from structural members and repair coating	P2	No	[redacted]	24-48mo	RMMR Service Order RHL-PND-617 includes 44, 46, 73, 74, 77	
LAT-27	Structural	[redacted]	Existing beam is heavily corroded at end closer to the tunnel wall		CR	H	Replace damaged section of beam and connect to tunnel wall	P1	Yes	[redacted]	12-24mo	Requires lead abatement	
LAT-28	Structural	[redacted]	Dents in pipe supports		PD	L	Repair as needed	P3	No	[redacted]	Ongoing		RMMR Service Order RHL-PND-617 includes 44, 46, 73, 74, 77
LAT-29	Piping	[redacted]	Existing AFFF retention line overhead valve at risk of impact		OT	H	Provide protection to existing overhead valve to avoid damage caused by impact	D1	Review by SGH recommended	[redacted]	As soon as practicable		
LAT-30	Structural	[redacted]	Modified bracing	(b)(3)(A) [redacted] 	DV	H	Replace brace such that it terminates closer to work point	P2	No	[redacted]	24-48mo		RMMR Service Order RHL-PND-601
LAT-31	Structural	[redacted]	Improper vertical support of (b)(3) [redacted] pipe	(b)(3)(A) [redacted]	LP	H	Repair as per SGH retrofit concept drawings	P1	Yes	[redacted]	12-24mo		

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
LAT-32	Piping	(b)(3)(A) [redacted]	Interference of valves/pipes	(b)(3)(A) [redacted]	IC	H	Provide protection around valve to avoid unintentional damage	D1	Yes	(b)(3) [redacted]	As soon as practicable	Repairing LAT-31 will provide protection	
LAT-33	Structural	[redacted]	Coating damage at JP-5 pipeline, signs of apparent movement at interface with cradle	(b)(3)(A) [redacted]	CD	L	Repair coating	P3	No	[redacted]	Ongoing		API 570 inspection in progress
LAT-34	Piping	[redacted]	Existing overhead valve at risk of impact when door is open	(b)(3)(A) [redacted]	IC	H	Provide protection to existing overhead valve (or relocate) to avoid damage caused by impact of the door	P1	No	[redacted]	12-24mo		
LAT-35	Structural	[redacted]	Existing brace is damaged and bent out of plane	(b)(3)(A) [redacted]	PD	H	Replace brace	P1	No	[redacted]	12-24mo	Requires lead abatement	RMMR Service Order RHL-PND-619
LAT-36	Structural	[redacted]	Existing brace is damaged and bent out of plane		PD	M	Replace brace	P2	No	[redacted]	24-48mo		RMMR Service Order RHL-PND-601 (may be included)
LAT-37	Piping	[redacted]	Pipe flange bolts interfere with fire suppression valve	(b)(3)(A) [redacted]	IC	M	Reconfigure fire suppression valve to avoid unintentional damage	P2	No	[redacted]	24-48mo		
LAT-38	Structural	[redacted]	Existing brace is heavily corroded		CR	H	Replace brace as per SGH retrofit concept design	D1	No	[redacted]	As soon as practicable	Requires lead abatement	RMMR Service Order RHL-PND-617
LAT-39	Structural	[redacted]	Heavy valve is improperly supported	(b)(3)(A) [redacted]	LP	H	Reconfigure support as per SGH retrofit concept design	P1	Yes	[redacted]	12-24mo	Requires lead abatement	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation Description	Recommendation Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
LAT-40	Structural	(b)(3)(A) [redacted]	Existing column is heavily corroded at the base		CR	H	Replace column and anchorage	D1	No	(b)(3) [redacted]	As soon as practicable	Requires lead abatement	RMMR Service Order RHL-PND-601
LAT-41	Structural	[redacted]	Existing column is heavily corroded at the base		CR	H	Replace column and anchorage	D1	No	[redacted]	As soon as practicable	Requires lead abatement	RMMR Service Order RHL-PND-601
LAT-42	Structural	[redacted]	Existing beam is heavily corroded at end closer to the tunnel wall		CR	H	Replace beam	D1	No	[redacted]	As soon as practicable	Requires lead abatement	RHL-601 covers the base. Additional SO for beam
LAT-43	Structural	[redacted]	Existing brace is heavily corroded and broken		CR	H	Replace brace	P1	No	[redacted]	12-24mo	Requires lead abatement	RMMR Service Order RHL-PND-601
LAT-44	Piping	[redacted]	Interference AFFF retention line of valves/pipes	[redacted]	IC	H	Provide protection around valve to avoid unintentional damage	D1	Review by SGH recommended	[redacted]	As soon as practicable		
LAT-45	Structural	[redacted]	Existing brace is damaged and bent out of plane	(b)(3)(A) [redacted]	PD	H	Replace brace	P1	No	[redacted]	12-24mo	Requires lead abatement	
LAT-46	Structural	[redacted]	Existing beam is heavily corroded at end closer to the tunnel wall	(b)(3)(A) [redacted]	CR	H	Replace beam and connect to tunnel wall per SGH retrofit concept drawings	D1	Yes	[redacted]	As soon as practicable	Requires lead abatement	
LAT-47	Piping	[redacted]	Elevated pipe (b)(3)(A) [redacted] is not supported, pipe is not fully bearing on cradle	(b)(3)(A) [redacted]	IR	H	Provide lateral stops and reset pipe cradle as per SGH retrofit concept drawings	D1	Yes	[redacted]	As soon as practicable		RMMR Service Order RHL-PND-617

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LAT-48	Piping	(b)(3)(A) [redacted]	Elevated pipe [redacted] is not supported, cradle is missing	(b)(3)(A) [redacted]	IR	H	Provide missing cradle and lateral stops as per SGH retrofit concept drawings	D1	Yes	(b)(3) [redacted]	As soon as practicable	These fixes to include welding all pipe cradles (including those that are missing) to the pipe support for the F24 line. Lateral stops are only at a select number of locations (maximum 25 per SGH retrofit concept drawings). Requires lead abatement.	RMMR Service Order RHL-PND-617
LAT-49	Structural	[redacted]	Leakage through tunnel wall		OT	L	Wall is adequate. Continue to monitor for deterioration of concrete tunnel wall.	P3	No	[redacted]	Ongoing		
LAT-50	Piping	[redacted]	Coating failure at pipe flange	(b)(3)(A) [redacted]	CD	L	Repair coating	P3	No	[redacted]	Ongoing		API 570 inspection in progress
LAT-51	Structural	[redacted]	Missing brace between pipe supports	(b)(3)(A) [redacted]	LP	M	Add additional brace	P2	Yes	[redacted]	24-48mo	Requires lead abatement	
LAT-52	Structural	[redacted]	Missing brace between pipe supports		LP	M	Add additional brace	P2	Yes	[redacted]	24-48mo	Requires lead abatement	
LAT-53	Piping	[redacted]	Bend in pipe used to brace JP-5 trunk line	(b)(3)(A) [redacted]	LP	L	SGH analyzed the bend for overstress during a potential repeat surge event, the piping is marginally overstressed but it is just satisfactory	None	No	[redacted]	-		
LAT-54	Piping	[redacted]	Small uniform pitting on inside surface of pipe lateral (similar at trunk line)		PD	L	Monitor and perform API in line inspections at required frequency to capture unacceptable pitting	P3	No	[redacted]	Ongoing		
LAT-55	Piping	[redacted]	Missing cradle on one side of pipe	(b)(3)(A) [redacted]	IR	H	Repair pipe cradle	D1	No	[redacted]	As soon as practicable	Requires lead abatement	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation Description	Recommendation Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
[redacted]	Valve	[redacted]	Lack of bypass from Tank 20 to other side of DBB Valve on JP-5 line.	[redacted]	OT	H	Install bypass from Tank 20 to other side of DBB valve using existing sample outlets and drain line	D1	Yes	[redacted]	As soon as practicable	Install pressure equalization lines across double block and bleed valves on three different product tanks for defueling and the remaining tanks for continued operation. Swagelok fittings and stainless tubing installed using a ladder.	
PM-2	Valve		Lack of bypass from after Tank 20 DBB valve to main JP-5 lateral	[redacted]	OT	H	Install bypass from after Tank 20 ball valve to main JP-5 lateral	D1	Yes		As soon as practicable	Install pressure equalization lines across double block and bleed valves on three different product tanks for defueling and the remaining tanks for continued operation. Swagelok fittings and stainless tubing installed using a ladder.	
PM-3	Valve		Lack of bypass from Tank 15 to other side of DBB Valve on F-76 line.	[redacted]	OT	H	Install bypass from Tank 15 to other side of DBB valve using existing sample outlets and drain line, or other F-76 tank to be drained last	D1	Yes		As soon as practicable	Install pressure equalization lines across double block and bleed valves on three different product tanks for defueling and the remaining tanks for continued operation. Swagelok fittings and stainless tubing installed using a ladder.	
PM-4	Valve		Lack of bypass from after Tank 15 ball valve to main F-76 lateral.	[redacted]	OT	H	Install bypass from after Tank 15 ball valve to main F-76 lateral	D1	Yes		As soon as practicable	Install pressure equalization lines across double block and bleed valves on three different product tanks for defueling and the remaining tanks for continued operation. Swagelok fittings and stainless tubing installed using a ladder.	
PM-5	Valve		Lack of bypass from Tank 6 to other side of DBB Valve on F-24 line.	[redacted]	OT	H	Install bypass from Tank 6 to other side of DBB valve using existing sample outlets and drain line	D1	Yes		As soon as practicable	Install pressure equalization lines across double block and bleed valves on three different product tanks for defueling and the remaining tanks for continued operation. Swagelok fittings and stainless tubing installed using a ladder.	
PM-6	Valve		Lack of bypass from after Tank 6 ball valve to main F-24 lateral	[redacted]	OT	H	Install bypass from after Tank 6 ball valve to main F-24 lateral.	D1	Yes		As soon as practicable	Install pressure equalization lines across double block and bleed valves on three different product tanks for defueling and the remaining tanks for continued operation. Swagelok fittings and stainless tubing installed using a ladder.	
PM-7	Valve		Lack of bypass from after ball valve to main lateral	[redacted]	OT	H	Install bypasses from tank wall across inboard and outboard valves at the 15 tanks that do not have equalization lines that are installed for defueling	P1	Yes		12-24mo	Install pressure equalization lines across double block and bleed valves on three different product tanks for defueling and the remaining tanks for continued operation. Swagelok fittings and stainless tubing installed using a ladder.	

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PM-8	Piping	[redacted]	No supports at sectional valves and weight is fully supported by piping and could cause overstress.	[redacted]	IC	L	SGH analyzed piping segments at sectional valves between anchors to determine if overstress exists. No overstress was noted.	None	No	[redacted]	-		
PM-9	Piping	[redacted]	Weight of unsupported DBB and ball valves near pipe nozzles could cause overstress at nozzle concrete penetration.	[redacted]	IC	L	SGH analyzed piping locally at nozzle concrete penetrations to determine if overstress exists. No overstress was noted.	None	No	[redacted]	-	Additional example of unsupported valve [redacted]	
[redacted]	Piping	[redacted]	JP-5 piping is unrestrained at the end of the main [redacted] header. Pipeline is free to displace in the event of a surge and could cause overstress.	[redacted]	OT	H	Fully analyze the pipe system for surge events in light of the recent modifications being currently implemented. Provide axial restraint, as needed, per SGH retrofit concept drawings.	D1	Yes	[redacted]	As soon as practicable	Modifications are presently underway at Tanks 19 and 20, but additional engineering and provision of axial restraints in lateral pipe offtake, and at the ends of headers, are likely required. Cost estimate includes restraints at Tanks 19 / 20, 13 / 14, 1, and at the F-24 and F-76 headers at Tanks 15 / 16.	
[redacted]	Piping	[redacted]	F-24 piping is longitudinally unrestrained at the end of the main [redacted] header. Pipeline is free to displace in the event of a surge and could cause overstress.	[redacted]	OT	H	Piping analysis has determined that additional restraints may be required to prevent potential overstress during a surge event in combination with operational loads. Additional evaluation and detailed design of the mitigation (if needed) are required.	D1	Yes	[redacted]	As soon as practicable		

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
(b)(3)(A) [redacted]	Piping	(b)(3)(A) [redacted]	F-76 piping is longitudinally unrestrained at the end of the main (b)(3)(A) [redacted] header. Pipeline is free to displace in the event of a surge and could cause overstress.	(b)(3)(A) [redacted]	OT	H	Piping analysis has determined that additional restraints may be required to prevent potential overstress during a surge event in combination with operational loads. Additional evaluation and detailed design of the mitigation (if needed) are required.	D1	Yes	(b)(3) [redacted]	As soon as practicable		
(b)(3)(A) [redacted]	Valve	[redacted]	Butterfly valve is known to leak, causing vacuum and surge loads in packed F-24 product line.	(b)(3)(A) [redacted]	OT	H	Do not use butterfly valves as isolation valves. Consider using double block and bleed valves upstream.	P1	Review by SGH Recommended	[redacted]	12-24mo	Butterfly valves are used to throttle flow	
(b)(3)(A) [redacted]	Valve	[redacted]	Butterfly valve is known to leak, causing vacuum surge loads in packed F-76 product line.	(b)(3)(A) [redacted]	OT	H	Do not use butterfly valves as isolation valves. Consider using double block and bleed valves upstream.	P1	Review by SGH Recommended	[redacted]	12-24mo	Butterfly valves are used to throttle flow	
(b)(3)(A) [redacted]	Valve	[redacted]	Butterfly valve is known to leak, causing vacuum surge loads in packed JP-5 product line.	(b)(3)(A) [redacted]	OT	H	Do not use butterfly valves as isolation valves. Consider using double block and bleed valves upstream.	P1	Review by SGH Recommended	[redacted]	12-24mo	Butterfly valves are used to throttle flow	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
[redacted]	Valve	[redacted]	Butterfly valve is known to leak, causing vacuum surge loads in packed F-24 product line.	[redacted]	OT	H	Do not use butterfly valves as isolation valves. Consider using double block and bleed valves upstream.	P1	Review by SGH Recommended	[redacted]	12-24mo	Butterfly valves are used to throttle flow	
[redacted]	Valve	[redacted]	Butterfly valve is known to leak, causing vacuum surge loads in packed F-76 product line.	[redacted]	OT	H	Do not use butterfly valves as isolation valves. Consider using double block and bleed valves upstream.	P1	Review by SGH Recommended	[redacted]	12-24mo	Butterfly valves are used to throttle flow	
[redacted]	Valve	[redacted]	Butterfly valve is known to leak, causing vacuum surge loads in packed JP-5 product line.	[redacted]	OT	H	Do not use butterfly valves as isolation valves. Consider using double block and bleed valves upstream.	P1	Review by SGH Recommended	[redacted]	12-24mo	Butterfly valves are used to throttle flow	
[redacted]	Dresser Coupling	[redacted]	Dresser coupling may not have capacity to withstand surge load similar to May 6 event (if it is replaced-in-kind and laterals to Tanks 19 and 20 are not connected appropriately).	[redacted]	OT	H	See SGH recommendations if laterals to even numbered tanks are disconnected	D1	Yes	[redacted]	As soon as practicable	Some modifications are being implemented, but additional repairs are required	In progress under NAVFAC JP-5 line repairs
PM-20	Dresser Coupling	[redacted]	Dresser coupling may not have capacity to withstand surge load similar to May 6 event.	[redacted]	OT	H	See SGH recommendations if laterals to even numbered tanks are disconnected	D1	Yes	[redacted]	As soon as practicable	Some modifications are being implemented, but additional repairs are required	In progress under NAVFAC JP-5 line repairs
PM-21	Dresser Coupling	[redacted]	Dresser coupling may not have capacity to withstand surge load similar to May 6 event. (Tank 6 shown as an example)	[redacted]	OT	H	See SGH recommendations if laterals to even numbered tanks are disconnected	D1	Yes	[redacted]	As soon as practicable	Our description applies if the Dresser coupling is replaced-in-kind and laterals are not connected appropriately	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
PM-22	Dresser Coupling	(b)(3)(A) [redacted]	Dresser coupling may not have capacity to withstand surge load similar to May 6 event. (Tank 6 shown as an example)	(b)(3)(A) [redacted]	OT	H	See SGH recommendations if laterals to even numbered tanks are disconnected	D1	Yes	(b)(3) [redacted]	As soon as practicable	Our description applies if the Dresser coupling is replaced-in-kind and laterals are not connected appropriately	
PM-23	Dresser Coupling	[redacted]	Dresser coupling, some lug harnesses installed backwards, does not conform with manufacture drawings	(b)(3)(A) [redacted]	OT	M	Reverse lug harnesses where incorrectly installed	P2	No	[redacted]	24-48mo	Although we are listing this location, there are other Dresser couplings with this issue. This cost estimate is to fix 16 locations.	
PM-24	Dresser Coupling	[redacted]	Dresser coupling deflection rings not installed, does not conform with manufacture drawings		OT	M	Provide deflection ring at all lug harnesses where not installed	P2	No	[redacted]	24-48mo	Although we are listing this location, there are other Dresser couplings with this issue	
PM-25	Dresser Coupling	[redacted]	Dresser coupling thermal blanket on [redacted] line not installed	(b)(3)(A) [redacted]	OT	H	Provide thermal blanket	D1	No	[redacted]	As soon as practicable	There are three Dresser couplings without fire insulation blankets	
PM-26	High Point Vents in F-24 Line	[redacted]	No high point vents in F-24 line downstream of concrete walls	(b)(3)(A) [redacted]	OT	H	Evaluate need for high point vents as part of detailed surge analysis	P1	Yes	[redacted]	12-24mo		
HT-1	Piping	[redacted]	Coating failure and surface corrosion on fuel pipe	(b)(3)(A) [redacted]	CD/CR	L	Repair coating	P2	No	[redacted]	24-48mo	API 570 inspection and coating condition survey will determine the full scope of work	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-2	Piping	[redacted]	Tunnel wall leakage leading to coating and corrosion issues at FOR line		CD/CR	M	Repair coating	P2	No	[redacted]	24-48mo	API 570 inspection and coating condition survey will determine the full scope of work	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-3	Pipe	[redacted]	Tunnel wall leakage leading to coating and corrosion issues at FOR line		CD/CR	H	Assess pipe integrity and repair pipe as appropriate	D1	Yes	[redacted]	As soon as practicable	Expected to be included in a NAVFAC SRM Project that replaces a long length of this pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
HT-4	Piping	(b)(3)(A) [redacted]	Dents on pipe	(b)(3)(A) [redacted]	PD	L	SGH evaluated FFS for these dents and determined the dents were not critical	None	No	(b)(3) [redacted]	-		API 570 inspection in progress
HT-5	Piping	[redacted]	One pipe bears on another pipe	(b)(3)(A) [redacted]	IC	M	Analysis indicates F-76 line is adequate however reconfiguration is recommended	P2	SGH review recommended	[redacted]	24-48mo		
HT-6	Piping	[redacted]	FOR pipe with unknown crack in exterior surface		CD/CR	H	Assess pipe integrity and repair pipe as appropriate	D1	Yes	[redacted]	As soon as practicable	Expected to be included in a NAVFAC SRM Project that replaces a long length of this pipe	
HT-7	Piping	[redacted]	Tunnel wall leakage leading to coating issue at (b)(3)(A) [redacted] F76 pipeline	(b)(3)(A) [redacted]	CD/CR	L	Repair coating	P2	No	[redacted]	24-48mo		API 570 inspection in progress
HT-8	Structural	[redacted]	Tunnel wall leakage leading to corroded pipe support at (b)(3)(A) [redacted] JP5 pipeline		CR	M	Replace (in-kind) horizontal member and wall anchorage. Redirect tunnel wall leakage away from structural support member.	P2	No	[redacted]	24-48mo		
HT-9	Piping	[redacted]	Coating issue at (b)(3)(A) [redacted] F24 pipeline at anchor interface	(b)(3)(A) [redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo		API 570 inspection in progress
HT-10	Piping	[redacted]	Coating issue at (b)(3)(A) [redacted] F76 pipeline	(b)(3)(A) [redacted] 	CD	L	Repair coating	P2	No	[redacted]	24-48mo		API 570 inspection in progress
HT-11	Structural	[redacted]	Pipe support not supporting pipe, no column or tunnel wall connection, unsupported span is 28ft	(b)(3)(A) [redacted]	LI	M	Analysis indicates F-76 line is adequate however reconfiguration is recommended	P2	No	[redacted]	24-48mo		

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
HT-12	Piping	[redacted]	Interference of valves/pipes (AFFF retention line adjacent to trolley tracks)		OT	H	Provide protection to existing overhead valve to avoid damage caused by impact	D1	Review by SGH recommended	[redacted]	As soon as practicable		
HT-13	Other	[redacted]	At trolley tracks, hole in concrete floor through to substrate		PD	L	Excavate to solid material and perform a structural repair	P2	No	[redacted]	24-48mo		
HT-14	Piping	[redacted]	[redacted] F-76 fuel pipe flange in contact with tunnel wall	[redacted]	IC	L	Provide 1" separation between pipe flange and tunnel wall	P2	No	[redacted]	24-48mo		
HT-15	Piping	[redacted]	Large valves inconsistently supported	[redacted]	IR	L	None	None	No	[redacted]	-	Analysis indicates pipe system is adequate	
HT-16	Piping	[redacted]	Coating issue at pipe flange	[redacted]	CD	L	Repair coating	P3	No	[redacted]	Ongoing	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-17	Piping	[redacted]	Coating issue	[redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-18	Piping	[redacted]	Dent on pipe	[redacted]	PD	L	SGH evaluated FFS for this dent and determined the dent was not critical	None	No	[redacted]	-		API 570 inspection in progress
HT-19	Structural	[redacted]	Original anchor bolt (5/8" diameter) replaced with smaller anchor bolt (3/8" diameter) at upper brace.		DV	L	Replace with larger diameter anchor bolt	P2	No	[redacted]	24-48mo		

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HT-20	Piping	[redacted]	0.13in pit measured at F-76 [redacted] pipe outside surface, approximately 0.75in diameter		CR	L	SGH conducted FFS level I evaluation for this pit and determined it was acceptable.	None	No	[redacted]	-		API 570 inspection in progress
HT-21	Piping	[redacted]	Dent in pipe, measured 0.26in, written on pipe 0.2835in		PD	L	SGH evaluated FFS for this dent and determined the dent was not critical	None	No	[redacted]	-		API 570 inspection in progress
HT-22	Structural	[redacted]	Distorted flange at base of pipe support column	[redacted]	PD	M	Replace column section	P2	No	[redacted]	24-48mo	Submitted on Q1 RMMR RM Report Requires lead abatement	
HT-23	Piping	[redacted]	Coating issue at [redacted] (F-24) and [redacted] (JP-5) fuel pipe	[redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-24	Piping	[redacted]	Coating issue	[redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-25	Piping	[redacted]	Localized corrosion pits		CR	L	Contractor to clean pipe, then measure corrosion section loss, then FFS evaluation prior to repair and recoat	None	No	[redacted]	-		API 570 inspection in progress
HT-26	Structural	[redacted]	Pipe support horizontal angle fractured, web/flange deteriorated, anchor to tunnel wall compromised		CR	M	Replace horizontal member and wall anchorage	P1	No	[redacted]	12-24mo	PS 310 identified on RHL Q1 RMMR RM Report Requires lead abatement	
HT-27	Piping	[redacted]	0.038in pit measured at F-24 [redacted] pipe outside surface		CR	L	SGH conducted FFS level I evaluation for this pit and determined it was acceptable	None	No	[redacted]	-		API 570 inspection in progress

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HT-28	Structural	[redacted]	Pipe support column base and horizontal angle braces corroded, anchor to tunnel wall compromised		CR	M	Replace column, base plate and anchorage	P1	No	[redacted]	12-24mo	Requires lead abatement	
HT-29	Piping	[redacted]	0.119in pit measured at F-76 [redacted] pipe outside surface, approximately 1.4in diameter		CR	L	SGH conducted FFS level I evaluation for this pit and determined it was acceptable	None	No	[redacted]	-		API 570 inspection in progress
HT-30	Structural	[redacted]	Pipe support column base significantly corroded		CR	M	Replace column, base plate and anchorage	P1	No	[redacted]	12-24mo	Requires lead abatement	
HT-31	Piping	[redacted]	Dents on pipe	[redacted]	PD	L	SGH evaluated FFS for this dent and determined the dent was not critical	None	No	[redacted]	-		API 570 inspection in progress
HT-32	Structural	[redacted]	Pipe support column base and horizontal angle braces corroded, anchor to tunnel wall compromised		CR	M	Replace column, base plate and anchorage	P1	No	[redacted]	12-24mo	Submitted on Q1 RMMR RM Report Requires lead abatement	
HT-33	Structural	[redacted]	Column bases corroded (Harbor Tunnel)		CR	M	Replace column, base plate and anchorage	P1	No	[redacted]	12-24mo	Requires lead abatement	RMMR Service Order RHL-PND-618 includes 510, 600
HT-34	Piping	[redacted]	Coating issue and surface corrosion at [redacted] F-76 fuel pipe	[redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-35	Piping	[redacted]	Coating issue and surface corrosion at [redacted] F-76 fuel pipe	[redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
HT-36	Other	(b)(3)(A) [redacted]	Water ponds leading to corrosion of the base plates and lower section of columns	(b)(3)(A) [redacted]	OT	L	Elevate steel pipe support bases from tunnel floor via concrete/grout pads	P2	Yes	(b)(3) [redacted]	24-48mo	Cost for pads to elevate steel pipe supports (for [redacted] and [redacted] lines)	
HT-37	Piping	[redacted]	Coating issue and surface corrosion at [redacted] F-24 fuel pipe	(b)(3)(A) [redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-38	Structural	[redacted]	Base plate of pipe support is heavily corroded		CR	H	Replace column, base plate and anchorage	P1	No	[redacted]	12-24mo	Requires lead abatement	
HT-39	Other	[redacted]	Active leakage through floor drain		OT	M	Identify source of leakage and determine if it needs to be remediated	Observation Only	No	[redacted]	-		
HT-40	Piping	[redacted]	Coating issue and surface corrosion at [redacted] F-24 fuel pipe	(b)(3)(A) [redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-41	Piping	[redacted]	Corrosion at pipe supports for [redacted] JP-5 fuel pipe, section loss and flaking of steel layers and angle flange.		CD	M	Replace horizontal member and wall anchorage	P1	No	[redacted]	12-24mo	Requires lead abatement	
HT-42	Piping	[redacted]	Coating issue and surface corrosion at [redacted] F-76 fuel pipe	(b)(3)(A) [redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-43	Piping	[redacted]	Coating damage, surface corrosion and pit at exterior [redacted] F-76 pipe surface		CD	L	Contractor to clean pipe, then measure corrosion section loss, then FFS evaluation prior to repair and recoat	None	No	[redacted]	-		API 570 inspection in progress

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HT-44	Structural	(b)(3)(A) [redacted]	Column bases corroded (Harbor Tunnel)	(b)(3)(A) [redacted]	CR	M	Replace column, base plate and anchorage	P1	No	(b)(3) [redacted]	12-24mo		RMMR Service Order RHL-PND-618 includes 510, 600
HT-45	Piping	[redacted]	Coating damage on [redacted] F-76 fuel pipe	[redacted]	CD	L	Repair coating	P3	No	[redacted]	Ongoing	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-46	Piping	[redacted]	[redacted] (F-76), [redacted] (JP-5) and [redacted] (F-24) fuel pipes sit directly on pipe support beams without additional sacrificial friction pad	[redacted]	OT	M	Provide cradles with an effective connection to support	P2	No	[redacted]	24-48mo		
HT-47	Piping	[redacted]	Coating damage on [redacted] F-76 fuel pipe	[redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-48	Piping	[redacted]	Coating damage on [redacted] (F-76) and [redacted] (JP-5) fuel pipe	[redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-49	Piping	[redacted]	Coating damage on [redacted] F-76 fuel pipe	[redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-50	Piping	[redacted]	Coating damage on [redacted] JP-5 fuel pipe	[redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-51	Piping	[redacted]	Coating damage on [redacted] JP-5 fuel pipe	[redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector

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HT-52	Piping	(b)(3)(A) [redacted]	Coating damage on [redacted] JP-5 fuel pipe	(b)(3)(A) [redacted]	CD	L	Repair coating	P2	No	(b)(3) [redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
PH-1	Window		Control room window facing pumphouse gallery is not blast-resistant		OT	H	Provide blast and fire-resistant door, window and framing to protect operators	P1	Yes		12-24mo	Building wall and door can also be critical. There is also fire risk in this area.	
PH-2	Other		Cabinets with flammable materials are unanchored	 	IR	M	Provide adequate anchorage or lateral restraint at cabinet so it does not fall during an earthquake, impact, blast or fire	P1	Review by SGH recommended		12-24mo	There are multiple such cabinets in the facility	
PH-3	Flange		Flange bolts are not fully engaged	(b)(3)(A) [redacted]	OT	H	Bolts should have full engagement. Replaced with longer bolts of same grade and diameter	P1	No		12-24mo	Located near to the harbor tunnel entrance (b)(3)(A) [redacted]	
PH-4	Diesel Tank for Emergency Generator		Tank is likely unanchored. Emergency generator may lose functionality in an earthquake.		IR	H	Anchor or restrain diesel tank for emergency generator	P1	Yes		12-24mo		
LYT-1	Piping		Undisturbed dust on fuel pipe in lower yard tunnel. Six fuel pipelines routed through lower yard tunnel.	(b)(3)(A) [redacted]	OT	M	Contractor to conduct API 570 pipe inspection to catalogue condition and execute necessary repairs for pipe and coating	P1	SGH review recommended		12-24mo	It is our understanding these pipes may not be included in the ongoing API 570 inspection program	
LYT-2	Piping		Dent in pipe, F-76 fuel pipe		PD	M	Contractor to conduct API 570 pipe inspection, then evaluate FFS to determine if dent is acceptable	P1	SGH review recommended		12-24mo	It is our understanding these pipes may not be included in the ongoing API 570 inspection program	

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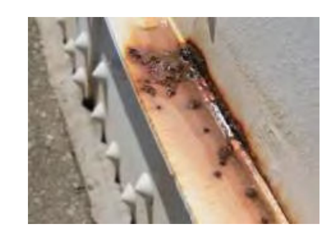
LYT-3	Piping	[redacted]	Sump water line is corroded and apparently cracking		CR	H	Replace water pipe	P1	No	[redacted]	12-24mo	It is our understanding these pipes may not be included in the ongoing API 570 inspection program	
LYT-4	Piping		Surface corrosion, apparent bulging under wrap, and coating damage at F-24 fuel pipe	[redacted]	CR/CD	H	Remove wrap, clean pipe, inspect for pits and determine acceptability of pipe section, then repair as appropriate	P1	SGH review recommended		12-24mo	It is our understanding these pipes may not be included in the ongoing API 570 inspection program	
AST-1	Stairway Support		Overconstrained stairway attachment between stair and adjacent concrete pad. Note the stairway is attached to both the tank and concrete pad, and could damage the tank due to uplift during an earthquake.	 	IR	L	Provide flexibility at stairway. Retrofit (detach the stair support from the concrete pad so that the stair structure can move together with the tank during an earthquake. See the stair support of Tank 55 which is a good example.	P2	Review by SGH recommended		24-48mo	Tanks 46, 53, and 54 have similar overconstrained stairway attachments. The stair landing at Tank 55 (below) and at Tank 1 at Hickam is a good example. 	
AST-2	Electrical Control Panel Support Attachments		The panel support is attached to both the tank and the concrete walkway. During an earthquake the tank may uplift, and the control panel could potentially be damaged and lose function.	 	IR	L	Independently support the control panel, either on the tank or on the concrete walkway, but not on both	P2	Review by SGH recommended		24-48mo	Tanks 46, 48, 53, and 54 have similar issues. The control panel support for Tank 55 has more flexibility to accommodate tank uplift. 	
AST-3	Tank Shell and New Double Bottom Plate		Corrosion could cause loss of product if not addressed	 	CR	M	Repair and re-coat; allow for water to drain. FFS evaluation determined the current tank wall loss was acceptable.	P1	No		12-24mo	Several other locations at Tank 47 have similar corrosion issues 	

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AST-4	Pipe Supports	(b)(3)(A) [redacted]	Overconstrained piping. First pipe support (two locations) adjacent to tank constrains uplift of the attached piping and is bolted to the concrete.	(b)(3)(A) [redacted] (b)(3)(A) [redacted]	IR	H	Provide flexibility to accommodate potential uplift of the tank during an earthquake	P1	Yes	(b)(3) [redacted]	12-24mo	See additional photo below. 	
AST-5	Walkway	[redacted]	There is 1" clearance between the walkway and pipe. Potential for impact between pipe, walkway and tank during an earthquake.	(b)(3)(A) [redacted]	IC	L	Increase the clearance (minimum 3" clearance is recommended) between the walkway and the pipe	P2	Review by SGH recommended	[redacted]	24-48mo		
AST-6	Overflow pipe connecting Tanks B1 & B2	[redacted]	Overconstrained piping (pipe could be potentially damaged during earthquake)		IR	L	There could be damage to the piping during tank uplift. However, since piping is near roof level there is minimal release potential and loss of product. Retrofit is not needed.	None	No	[redacted]	-	Tanks B1 & B2 are currently in NAVFAC CIR. The contractor recommended removing this pipe, but the recommendation was rejected.	
AST-7	Pipe support	[redacted]	Overconstrained piping with insufficient clearance between the pipe and the vertical restraint (Dirty Ballast piping)		IR	L	Increase the clearance (minimum 3" clearance is recommended) between the pipe and the vertical restraint	P2	No	[redacted]	24-48mo	Tanks B1 & B2 are currently in NAVFAC CIR. Pipe support and adjustments are included in scope.	
AST-8	Pipe vertical restraint	[redacted]	There is not sufficient clearance between the pipe and the vertical restraint (Shell Low Point Drain side)		IR	L	Increase the clearance (minimum 3" clearance is recommended) between the pipe and the vertical restraint	P2	No	[redacted]	24-48mo	Tanks B1 & B2 are currently in NAVFAC CIR. Pipe support and adjustments are included in scope.	
AST-9	Stairway Support	[redacted]	Overconstrained stairway attachment between stair and adjacent concrete pad.		IR	L	Repair the concrete and provide flexibility at stairway. Retrofit (detach the stair support from the concrete pad so that the stair structure can move together with the tank during an earthquake. (See the stair support of Tank 55 which is a good example.)	P2	No	[redacted]	24-48mo	Tanks B1 & B2 are currently in NAVFAC CIR. This repair is currently not in scope. 	
AST-10	Stair Support	[redacted]	Overconstrained stairway attachment between stair and adjacent concrete pad.		IR	L	Retrofit (detach the stair support from the concrete pad so that the stair structure can move together with the tank during an earthquake)	P2	No	[redacted]	24-48mo	Tanks B1 & B2 are currently in NAVFAC CIR. Tank B1 has not been inspected. It is expected that this will be included in the CIR.	

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AST-11	Valves	[redacted]	Corrosion issues	 	CR	M	Maintenance is needed (replace significantly corroded valves as necessary)	P2	No	[redacted]	24-48mo	Tanks B1 & B2 are currently in NAVFAC CIR. Tank B1 has not been inspected. It is expected that this will be included in the CIR.	
AST-12	Pipe Supports	[redacted]	Overconstrained piping.	[redacted]	IR	H	Provide flexibility to accommodate potential uplift of the tank during an earthquake	P1	Yes	[redacted]	12-24mo	First pipe support (two locations) adjacent to tank constrains uplift of the attached piping since it provides vertical restraint. Note that it does allow for longitudinal movement but it constrains vertical movement if the tank uplifts. Includes Tanks 11-1 and 11-2. [redacted]	
AST-13	Pipe Support	[redacted]	Minor corrosion Issues	[redacted]	CR	L	Maintenance as needed	P3	No	[redacted]	Ongoing	[redacted]	
AST-14	Tank Shell and New Double Bottom Plate	[redacted]	Localized sealant Failure and Crevice Corrosion Below Ledge		CR	L	Repair sealant and local coating	P3	No	[redacted]	Ongoing		
[redacted]1	Valve	[redacted]	Flange protection clamps inconsistently installed	[redacted]	LI	L	Evaluate maintenance requirements and balance with installation of protective flange clamps	P3	No	[redacted]	Ongoing		
[redacted]2	Valve	[redacted]	Crevice corrosion leading to pitting under name plate at globe valve [redacted]		CD/CR	L	Local coating repair	P2	No	[redacted]	24-48mo		

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(b)(3)(A) [redacted]3	Pipe	(b)(3)(A) [redacted]	Wrap failure at pipe ground penetration	(b)(3)(A) [redacted]	CD	L	Repair wrap at ground penetration	P2	No	(b)(3) [redacted]	24-48mo		
(b)(3)(A) [redacted]4	Flange	[redacted]	Coating failure and flange crevice corrosion	(b)(3)(A) [redacted]	CR	L	Clean to determine if section loss is acceptable for performance, recoat or replace	P2	No	[redacted]	24-48mo		
(b)(3)(A) [redacted]1	Pipe	[redacted]	JP-5, F-24, F-76 and Waste Oil pipe bedded on gravel in some locations	(b)(3)(A) [redacted]	LI	L	Elevate pipe from grade and support pipe as necessary	P3	No	[redacted]	Ongoing		
(b)(3)(A) [redacted]2	Pipe	[redacted]	Multi-product line without ground penetration wrapping	(b)(3)(A) [redacted]	LI	L	Install wrap at ground penetration and repair pipe as required	P2	No	[redacted]	24-48mo		
(b)(3)(A) [redacted]3	Valve	[redacted]	Flange protection clamps inconsistently installed, crevice corrosion between horizontal and vertical flange interfaces	(b)(3)(A) [redacted]	LI	L	Evaluate maintenance requirements and balance with installation of protective flange clamps	P3	No	[redacted]	Ongoing		
(b)(3)(A) [redacted]4	Valve	[redacted]	Crevice corrosion at flange bolt		CD/CR	L	Replace bolt	P2	No	[redacted]	24-48mo		
(b)(3)(A) [redacted]5	Valve	[redacted]	Crevice corrosion under name plate led to pitting and coating damage	(b)(3)(A) [redacted]	CD/CR	M	Repair coating and/or valve	P2	No	[redacted]	24-48mo		
(b)(3)(A) [redacted]6	Valve	[redacted]	Leakage at valve riser		LI	H	Repair valve and coating as needed	P1	No	[redacted]	12-24mo		

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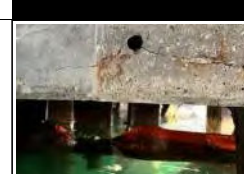
[redacted]7	Valve	[redacted]	Leakage at valve riser		LI	H	Repair valve and coating as needed	P1	No	[redacted]	12-24mo		
[redacted]8	Valve		Leakage at valve riser		LI	H	Repair valve and coating as needed	P1	No		12-24mo		
[redacted]9	Other		Ladder propped against fuel line	[redacted]	OT	L	Use alternate ladder/working at height access without supporting on piping	P3	No		Ongoing		
[redacted]10	Valve		Coating issue on F-24 valve, corrosion at flange		CD/CR	L	Repair coating	P2	No		24-48mo		
[redacted]11	Pipe		Coating issue on F-24 crown, visible from elevated steel grating/platform		CD	L	Repair coating	P2	No		24-48mo		
[redacted]1	Flange		Coating failure and flange crevice corrosion	[redacted]	CR	L	Clean to determine if section loss is acceptable for performance, recoat or replace	P2	No		24-48mo		RMMR Service Order PRL-PND-692
[redacted]2	Pipe		Wrap and coating failure at pipe ground penetration	[redacted]	CD	L	Local coating repair; repair wrap at ground penetration	P2	No		24-48mo		RMMR Service Order PRL-PND-692
[redacted]1	Pipe		Pipe corrosion behind wall penetration	[redacted]	CR	M	Explore cause of corrosion behind wall and repair corroded pipe and damaged coating	P1	Review by SGH recommended		12-24mo		RMMR Service Order PRL-PND-688

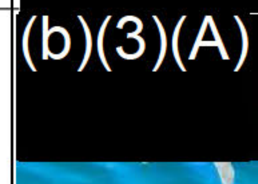
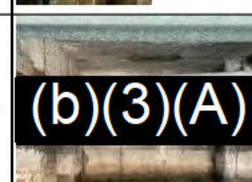
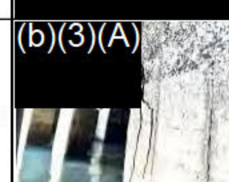
Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
[redacted] 2	Pipe	[redacted]	Pipe coating failure and local pitting	[redacted]	CR	M	FFS evaluation conducted and current corrosion loss is acceptable. Repair coating.	P1	No	[redacted]	12-24mo		RMMR Service Order PRL-PND-688
[redacted] 3	Pipe	[redacted]	Crevice corrosion of pipe at pipe support contact	[redacted]	CR	M	Clean pipe and repair damaged coating	P1	No	[redacted]	12-24mo		RMMR Service Order PRL-PND-688
[redacted] 4	Valve/Flange	[redacted]	Corrosion of valve/ equipment flanges	[redacted]	CR	L	Clean to determine if section loss is acceptable for performance, recoat or replace	P2	No	[redacted]	24-48mo		
[redacted] 1	Valve	[redacted]	Corrosion of valve stem	[redacted]	CR	L	Disassemble flange, recoat	P2	No	[redacted]	24-48mo		
[redacted] 2	Pipe	[redacted]	No wrap at pipe ground penetration	[redacted]	OT	L	Install wrap at ground penetration and repair pipe as required	P2	No	[redacted]	24-48mo		
[redacted] 1	Piping	[redacted]	Corrosion on valve, valve appears to have been submerged, steel appears to have lamellar corrosion	[redacted]	CR	H	Clean to determine if section loss is acceptable for performance, recoat or replace	P1	No	[redacted]	12-24mo		Understood to be part of a POND RMMR contract
[redacted] 2	Piping	[redacted]	Crevice corrosion between pipe and pipe support, apparent lamellar corrosion	[redacted]	CR	M	Provide protection between pipe and concrete support, to prevent crevice corrosion	P1	SGH review recommended	[redacted]	12-24mo		Understood to be part of a POND RMMR contract
[redacted] 3	Piping	[redacted]	Corrosion on low point drain, F-76 pipe	[redacted]	CR	H	Clean low point drain and recoat	P1	N	[redacted]	12-24mo		Understood to be part of a POND RMMR contract

							Recommendation						
Item	Component	Location	Description	Photograph	Observation Type	Severity	Description	Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
[redacted]4	Structural	[redacted]	Base of ladder access platform columns are corroded		CR	H	Repair column supports	P1	N	[redacted]	12-24mo		Understood to be part of a POND RMMR contract
[redacted]1	Valve	[redacted]	Coating failure on valve	[redacted]	CD	L	Local coating repair	P2	No	[redacted]	24-48mo		
[redacted]1	Pipe	[redacted]	Uncoated and pitting corrosion at elbow		CR	M	FFS evaluation conducted and corrosion section loss is acceptable. Local coating repair	P1	No	[redacted]	Completed		Completed under RMMR Service Order PRL-PND-639
[redacted]1	Pipe	[redacted]	Uncoated and pitted corrosion		CR	M	FFS evaluation conducted and corrosion section loss is acceptable. Local coating repair	P1	No	[redacted]	Completed		Completed under RMMR Service Order PRL-PND-639
[redacted]1	Pipe	[redacted]	Indications of pipe corrosion behind wall penetration	[redacted]	CR	M	Explore cause of corrosion behind wall and repair corroded pipe and damaged coating	P1	Review by SGH recommended	[redacted]	12-24mo		
HK-1	Valve	[redacted]	Corrosion of valve/equipment flanges		CR	L	Clean to determine if section loss is acceptable for performance, recoat or replace	P2	No	[redacted]	24-48mo		
HK-2	Valve	[redacted]	Deterioration of Isolation Joints	[redacted]	OT	L	Replace isolation joint seal	P3	No	[redacted]	Ongoing		
HK-3	Pipe	[redacted]	Surface corrosion on [redacted] in pumphouse	[redacted]	CR	M	We recommend additional inspection and testing (NDT) to determine if stress corrosion cracking is a concern. Clean pipe and establish a maintenance program to mitigate surface corrosion.	P1	Review by SGH recommended	[redacted]	12-24mo		

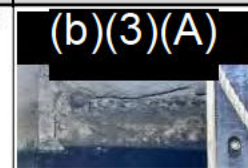
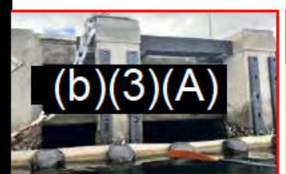
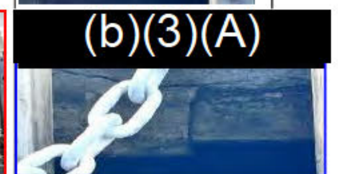
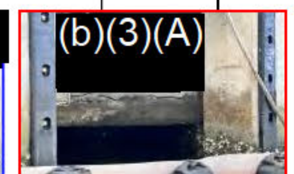
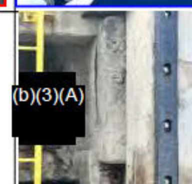
Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
HK-4	Pipe	(b)(3)(A) [redacted]	Surface corrosion on (b)(3)(A) [redacted] in pumphouse	(b)(3)(A) [redacted]	CR	L	We recommend additional inspection and testing (NDT) to determine if stress corrosion cracking is a concern. Clean pipe and establish a maintenance program to mitigate surface corrosion.	P2	Review by SGH recommended	(b)(3) [redacted]	24-48mo		
AGP-1	Pipe	[redacted]	Crevice corrosion and deep pits at pipe support contact	(b)(3)(A) [redacted]	CR	H	Repair pipe sections	D1	No	[redacted]	As soon as practicable	The worst section loss location was inaccessible; we understand that POND conducted in line inspection (ILI) and determined that local section loss greater than 50% requires local replacement.	RMMR Service Order PRL-PND-677N & PRL-PND-683E
AGP-2	Pipe	[redacted]	Crevice corrosion and deep pits at pipe support contact		CR	H	Repair pipe sections	D1	No	[redacted]	As soon as practicable	The worst section loss location was inaccessible; we understand that POND conducted in line inspection (ILI) and determined that local section loss greater than 50% requires local replacement.	RMMR Service Order PRL-PND-677N & PRL-PND-683E
AGP-3	Pipe	[redacted]	Historical corrosion pits coated over		CR	L	We measured historical pit depths and conducted FFS evaluation to determine that these pit depths are acceptable	P3	No	[redacted]	Ongoing		RMMR Service Order PRL-PND-677N & PRL-PND-683E
AGP-4	Pipe	[redacted]	Coating failure	(b)(3)(A) [redacted]	CD	L	Local coating repair	P2	No	[redacted]	Completed		Completed under RMMR Service Order PRL-PND-607
AGP-5	Pipe	[redacted]	Pipe penetration wrap damaged	(b)(3)(A) [redacted]	OT	L	Put protective shield around pipe	P3	No	[redacted]	Ongoing	Possibly damaged by mowing equipment	
AGP-6	Pipe	[redacted]	Pipe lying on soil and located in a trench	(b)(3)(A) [redacted]	OT	L	Elevate pipe from trench and support pipe as necessary	P3	No	[redacted]	Ongoing		
AGP-7	Pipe	[redacted]	Pipe ground penetration coating failing	(b)(3)(A) [redacted]	OT	L	Repair wrap and pipe as required	P3	No	[redacted]	Ongoing		

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
AGP-8	Pipe	(b)(3)(A) [redacted]	No wrap at ground penetration	(b)(3)(A) [redacted]	OT	L	Add protective wrap at ground penetration and repair pipe as required	P3	No	(b)(3) [redacted]	Ongoing		
AGP-9	Pipe	[redacted]	Localized coating failure		CR	L	Local coating repair	P2	No	[redacted]	24-48mo		
AGP-10	Pipe	[redacted]	Wrap failure at ground penetration	(b)(3)(A) [redacted]	OT	L	Repair wrap and pipe as required	P3	No	[redacted]	Ongoing		RMMR Service Order PRL-PND-692
HP-1	Pipe	[redacted]	Pipe ground penetration wrap failure	(b)(3)(A) [redacted]	OT	L	Repair wrap and pipe as required	P3	No	[redacted]	Ongoing		
HP-2	Pipe	[redacted]	Local coating failure and localized corrosion	(b)(3)(A) [redacted]	CR	L	Local coating repair.	P2	No	[redacted]	24-48mo	Whole length of pipe needs to be inspected, but this could not be accessed during our inspection	RMMR Service Order PRL-PND-625
HP-3	Pipe and Support	[redacted]	Crevice corrosion at pipe support	(b)(3)(A) [redacted]	CR	M	At corroded areas, contractor to remove corrosion products with needle gun, corrosion loss to be measured, then FFS evaluation prior to repair	P1	Review by SGH recommended	[redacted]	12-24mo	Whole length of pipe needs to be inspected, but this could not be accessed during our inspection	RMMR Service Order PRL-PND-625
HP-4	Valve	[redacted]	Crevice corrosion in pipe flanges	[redacted]	CR	M	Clean to determine if section loss is acceptable for performance, recoat or replace	P1	No	[redacted]	12-24mo	Entire length of pipe needs to be inspected, but this could not be accessed during our inspection. It is important to check bottom surface of flanges - these were the areas most corroded from the valves removed in January 2022.	RMMR Service Order PRL-PND-625
HP-5	Structural	[redacted]	Concrete cracking in bent cap		PD	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however, we recommend further evaluation.	P1	Review by SGH recommended	[redacted]	12-24mo	Likely under NAVFAC Triton contract	Project Number RM17-1369

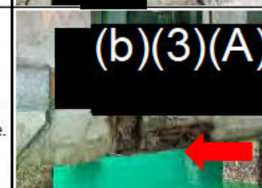
Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
HP-6	Structural	(b)(3)(A) [redacted]	Concrete cracking in bent cap		PD	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P1	Review by SGH recommended	(b)(3) [redacted]	12-24mo	Concrete cracking in bent cap, possible delamination and evidence of corrosion. Spray paint indicates previous observation and documentation by others (timeline unclear). Likely under NAVFAC Triton contract.	
HP-7	Structural	[redacted]	Concrete delamination at the underside of the deck		PD	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P1	Review by SGH recommended	[redacted]	12-24mo	Likely under NAVFAC Triton contract	
HP-8	Structural	[redacted]	Broken FOR hanging pipe support		PD	H	Repair pipe support hanger	P1	Review by SGH recommended	[redacted]	12-24mo		FY23 NAVFAC SRM project
HP-9	Structural	[redacted]	Pipe outlet drains to ocean, unclear if this is part of the FOR system		OT	L	Concern about potential environmental effects. However, this is a water drain.	None	No	[redacted]	-	This is acceptable. Water drain from 3-way valve.	
HP-10	Structural	[redacted]	Bottom face of beam	 (b)(3)(A) [redacted]	PD	L	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P2	Review by SGH recommended	[redacted]	24-48mo	Apparent consolidation issue from construction (bug hole with exposed rebar). Likely under NAVFAC Triton contract.	
HP-11	Structural	[redacted]	Concrete cracking in bent cap	(b)(3)(A) [redacted] 	PD	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P1	Review by SGH recommended	[redacted]	12-24mo	Spray paint indicates previous observation and documentation by others (timeline unclear). Likely under NAVFAC Triton contract.	
HP-12	Structural	[redacted]	Concrete cracking in bent cap	(b)(3)(A) [redacted] 	PD	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P1	Review by SGH recommended	[redacted]	12-24mo	Spray paint indicates previous observation and documentation by others (timeline unclear). Likely under NAVFAC Triton contract.	
HP-13	Structural	[redacted]	Concrete cracking in bent cap	(b)(3)(A) [redacted] 	PD	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P1	Review by SGH recommended	[redacted]	12-24mo	Spray paint indicates previous observation and documentation by others (timeline unclear). Likely under NAVFAC Triton contract.	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
HP-14	Pipe	(b)(3)(A) [redacted]	PVC FOR line potentially with Nitrile seals (blue)		LI	H	Replace PVC with appropriate materials	D1	Review by SGH recommended	(b)(3) [redacted]	As soon as practicable	Condition looks unchanged from 2016 observation report. Conduit box and cable are hanging off the front side of Hotel Pier (red).	FY23 NAVFAC SRM project
KP-1	Pipe		Fuel pipe in tidal zone and covered in PVC/Bitumous pipe wrap	(b)(3)(A) [redacted]	CD	H	Contractor to remove wrap, then clean pipe, then measure corrosion section loss and conduct FFS evaluation prior to repair and recoating with marine grade coating	P1	Review by SGH recommended		12-24mo	Wrap coating will trap water when it starts to debond	
KP-2	Pipe		Local coating failure	(b)(3)(A) [redacted] 	CD	H	Contractor to remove wrap, then clean pipe, then measure corrosion section loss and conduct FFS evaluation prior to repair and recoating with marine grade coating	P1	Review by SGH recommended		12-24mo	Wrap coating will trap water when it starts to debond	
KP-3	Structural		Concrete cracking, spalling and exposed reinforcing		PD/CR	H	Repair pile. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P1	Yes		12-24mo	Significant work is planned for Kilo pier (K-10 and K-11). If the piles we observed are not included in the project scope then additional work is required. Marine Solutions Inc. 2018 Inspection Report.	
SP-1	Pipe		Fuel pipe in tidal zone and covered in PVC/Bitumous pipe wrap	 (b)(3)(A) [redacted]	CD	H	Contractor to remove wrap/existing coating, then clean pipe, then measure corrosion section loss and conduct FFS evaluation prior to repair and recoating with marine grade coating	P1	No		12-24mo	Cannot visually inspect the pipe surface of a wrap coating. Also wrap coating will trap water when it starts to debond.	
SP-2	Pipe		Local coating failure	(b)(3)(A) [redacted]	CD	H	Contractor to remove wrap/existing coating, then clean pipe, then measure corrosion section loss and conduct FFS evaluation prior to repair and recoating with marine grade coating	P1	No		12-24mo		
SP-3	Structural		Concrete cracking and spalling	(b)(3)(A) [redacted] 	PD/CR	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P1	Yes		12-24mo		

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
MP-1	Pipe	[redacted]	Local coating failure	[redacted]	CD	M	Contractor to remove existing coating, then clean pipe, then measure corrosion section loss and conduct FFS evaluation prior to repair and recoating with marine grade coating	P1	Review by SGH recommended	[redacted]	12-24mo		RMMR Service Order PRL-PND-693E through PRL-PND-696E
MP-2	Valve	[redacted]	Surface and crevice corrosion	[redacted]	CR	M	Disassemble flange, evaluate corrosion loss, and possibly replace valve	P1	No	[redacted]	12-24mo		RMMR Service Order PRL-PND-675E
MP-3	Pipe	[redacted]	Spalled concrete and exposed reinforcing	[redacted]	PD/CR	H	Repair as appropriate to re-establish design margin	P1	Yes	[redacted]	12-24mo	Note that the Marine Solutions Inc. 2018 Pier Inspection report classifies the system as fair, however,we recommend further evaluation	
MP-4	Structural	[redacted]	Spalled concrete and exposed reinforcing		PD/CR	H	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however, we recommend further evaluation.	P1	Yes	[redacted]	12-24mo		
MP-5	Structural	[redacted]	Spalled concrete at the underside of deck (blue)	 [redacted]	PD/CR	H	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however, we recommend further evaluation.	P1	Yes	[redacted]	12-24mo	Other pipes (not fuel line) heavily corroded and wrap is damaged (red)	
MP-6	Structural	[redacted]	Spalled concrete at the underside of deck	 [redacted]	PD/CR	H	Repair as appropriate to re-establish design margin	P1	Yes	[redacted]	As soon as possible	Note that the 2018 Pier Inspection report classifies the system as fair, however, we recommend further evaluation.	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
MP-7	Structural	(b)(3)(A) [redacted]	Cracked concrete and exposed reinforcing	(b)(3)(A) [redacted]  (b)(3)(A) [redacted]  (b)(3)(A) [redacted]  (b)(3)(A) [redacted]  [redacted]  [redacted]  [redacted]  [redacted]	PD/CR/CD	H	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however, we recommend further evaluation.	P1	Yes	(b)(3) [redacted]	12-24mo	Tie beams between bents consistently cracked, spalled, delaminated, with exposed rebar. Pipe coating damage.	
MP-8	Structural	[redacted]	Delaminated concrete	 (b)(3)(A) [redacted]	PD/CR	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however, we recommend further evaluation.	P1	Yes	[redacted]	12-24mo	Delaminated concrete at pile cap, exposed rebar at spalled concrete at tie beam between bents	
MP-9	Structural	[redacted]	Delaminated concrete underside of deck edge	(b)(3)(A) [redacted]	PD	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however, we recommend further evaluation.	P1	Yes	[redacted]	12-24mo		
MP-10	Structural	[redacted]	Spalled concrete and exposed rebar	(b)(3)(A) [redacted]	PD/CR	H	Repair as appropriate to re-establish design margin	P1	Yes	[redacted]	As soon as possible	Note that the 2018 Pier Inspection report classifies the system as fair, however, we recommend further evaluation.	
MP-11	Structural	[redacted]	Pipe support and coating failure	(b)(3)(A) [redacted]	PD/CR/CD	H	Repair pipe support and pipe coating. Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however,we recommend further evaluation.	P1	Yes	[redacted]	12-24mo	Roller support appears disengaged/unevenly supported at pier beam, spalled concrete and exposed rebar at pipe support beam. Pipe coating issue.	RMMR Service Order PRL-PND-693E through PRL-PND-696E
MP-12	Pipe	[redacted]	Pipe support and coating failure	(b)(3)(A) [redacted]	PD/CR/CD	H	Repair pipe support and pipe coating. Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however,we recommend further evaluation.	P1	Yes	[redacted]	12-24mo	Roller support appears disengaged/unevenly supported at pier beam, spalled concrete and exposed rebar at pipe support beam. Pipe coating issue.	RMMR Service Order PRL-PND-693E through PRL-PND-696E
MP-13	Pipe	[redacted]	Crevice corrosion at fuel pipe springline, coating issue	(b)(3)(A) [redacted]	CD/CR	L	Repair coating, separate pipe from vertical element to limit crevice corrosion	P2	No	[redacted]	24-48mo		RMMR Service Order PRL-PND-693E

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation Description	Recommendation Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
MP-14	Structural	(b)(3)(A) [redacted]	Spalled concrete and exposed rebar		PD/CR	H	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however,we recommend further evaluation.	P1	Yes	(b)(3) [redacted]	12-24mo		
MP-15	Structural	[redacted]	Spalled concrete and exposed rebar	 (b)(3)(A) [redacted]	PD/CR	H	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however,we recommend further evaluation.	P1	Review by SGH recommended	[redacted]	As soon as possible	Spray paint markings indicate previous observations	
MP-16	Other	[redacted]	Ladder base, cross section 100% corroded		PD/CR	H	Repair access ladder	P2	No	[redacted]	24-48mo		
MP-17	Pipe	[redacted]	Coating damage and surface corrosion	(b)(3)(A) [redacted]	CR	M	Repair pipe and coating	P1	No	[redacted]	12-24mo		RMMR Service Order PRL-PND-693E through PRL-PND-696E
MP-18	Pipe	[redacted]	Conduit box resting on fuel pipe	 (b)(3)(A) [redacted]	IC	M	Reattach conduit box and remove from pipe	P2	No	[redacted]	24-48mo		RMMR Service Order PRL-PND-693E through PRL-PND-696E
MP-19	Pipe	[redacted]	Corrosion bulges on fuel pipe, damaged coating	(b)(3)(A) [redacted]	CR	M	Repair pipe and coating	P2	No	[redacted]	24-48mo		RMMR Service Order PRL-PND-693E through PRL-PND-696E
MP-20	Pipe	[redacted]	Pipe support pad between pipe and roller is missing, surface corrosion at pipe invert	(b)(3)(A) [redacted]	IC	M	Replace pipe pad between pipe and roller support	P2	No	[redacted]	24-48mo		RMMR Service Order PRL-PND-693E through PRL-PND-696E
MP-21	Structural	[redacted]	Delaminated and spalled concrete at the underside of the deck, exposed and corroded reinforcing		PD	H	There is significant concern with heavy loading on the deck. Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however,we recommend further evaluation.	P1	Yes	[redacted]	12-24mo	Additional Photo - delamination below deck. Marine Solutions Inc. 2018 Inspection Report 	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
MP-22	Structural	(b)(3)(A) [redacted]	Spalled concrete at the underside of the deck, exposed and corroded reinforcing	 (b)(3)(A) [redacted]	PD	H	There is significant concern with heavy loading on the deck. Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however,we recommend further evaluation.	P1	Yes	(b)(3) [redacted]	12-24mo	Marine Solutions Inc. 2018 Inspection Report	
MP-23	Structural	[redacted]	Significant crack in concrete beam spanning between piles, this beam supports the fuel pipe.	 (b)(3)(A) [redacted]	PD	H	There is significant concern with heavy loading on the deck. Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however,we recommend further evaluation.	P1	Yes	[redacted]	12-24mo	Marine Solutions Inc. 2018 Inspection Report	
BP-1	Pipe	[redacted]	Fuel pipe in splash zone and covered in Bitumous pipe wrap	(b)(3)(A) [redacted]	CD	H	Replace wrap with marine grade coating and perform API 570 inspection	P1	Review by SGH recommended	[redacted]	12-24mo	Cannot visually inspect the pipe surface of a wrap coating. Also wrap coating will trap water when it starts to debond.	
BP-2	Pipe	[redacted]	Local coating failure	(b)(3)(A) [redacted]	CD	H	Replace wrap with marine grade coating and perform API 570 inspection	P1	Review by SGH recommended	[redacted]	12-24mo		RMMR Service Order PRL-PND-675E
BP-3	Pipe	[redacted]	Local coating failure	(b)(3)(A) [redacted]	CD	H	FFS evaluation has been conducted and section loss is unacceptable. Repair pipe and marine grade coating.	P1	Review by SGH recommended	[redacted]	12-24mo	Does not include additional scaffolding	RMMR Service Order PRL-PND-675E for NDT
BP-4	Pipe	[redacted]	Severe local pitting corrosion		CR	H	FFS evaluation has been conducted and section loss is unacceptable. Repair with marine grade coating.	P1	Review by SGH recommended	[redacted]	12-24mo		RMMR Service Order PRL-PND-675E
BP-5	Pipe	[redacted]	Severe local pitting corrosion		CR	H	FFS evaluation conducted at locally exposed area and section loss is acceptable. Repair with marine grade coating.	P1	Review by SGH recommended	[redacted]	12-24mo		RMMR Service Order PRL-PND-675E
BP-6	Structural	[redacted]	Spalled concrete and exposed rebar		PD/CR	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P2	Review by SGH recommended	[redacted]	24-48mo	Repair estimate from Marine Solutions Inc. 2018 Inspection Report	

APPENDIX A.2
Site Visit Observations and Recommendations (Sorted by Priority)

Lower Access Tunnel (LAT)
Piping and Mechanical (PM)
Harbor Tunnel (HT)
(b)(3)(A) [redacted] Pumphouse (PH)
Lower Yard Tunnel (LYT)
Above Ground Storage Tanks (AST)
Valve Stations (VS)
Valve Chambers (VC)
Hickam (HK)
Above Ground Piping (AGP)
Hotel Pier (HP)
Kilo Pier (KP)
Sierra Pier (SP)
Mike Pier (MP)
Bravo Pier (BP)

Observation Type	CD - coating damage; CR - corrosion; DV - design variation; LI - lack of integrity; MB - missing member; PD - physical damage; WD - weld defect; LP - load path; IR - improper restraint (missing pipe supports etc.); IC - interaction of components (contact risk, over restrained pipes by the tanks, stress concentration etc.), OT - other
Severity	H - high, M - medium, L - low
Priority	D1 - defuel, P1 - high, P2 - lower, P3 - maintenance

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
LAT-3	Structural	(b)(3)(A) [redacted]	Failure of piping system during 6 May 2021 event	(b)(3)(A) [redacted]	IR	H	Design piping system to withstand repeat of surge event	D1	Yes	(b)(3) [redacted]	As soon as practicable	Some modifications are being implemented, but additional repairs are required	In progress under NAVFAC JP-5 line repairs
LAT-15	Piping		Existing AFFF retention line overhead valve at risk of impact		OT	H	Provide protection to existing overhead valve to avoid damage caused by impact	D1	Review by SGH recommended		As soon as practicable		
LAT-20	Piping		Elevated pipe (JP-5, (b)(3)(A) [redacted] has limited or no lateral restraint	(b)(3)(A) [redacted]	IR	H	Provide lateral restraint to the existing pipe at PS 18	D1	Yes		As soon as practicable	Requires lead abatement	
LAT-24	Piping		Elevated pipe (F-24, (b)(3)(A) [redacted] has limited or no lateral restraint	(b)(3)(A) [redacted]	IR	H	Provide lateral stops as per SGH retrofit concept drawings	D1	Yes		As soon as practicable	Multiple pipe supports per SGH retrofit concept drawings. Rerouting of conduit and other elements required. Requires lead abatement.	
LAT-29	Piping		Existing AFFF retention line overhead valve at risk of impact		OT	H	Provide protection to existing overhead valve to avoid damage caused by impact	D1	Review by SGH recommended		As soon as practicable		
LAT-32	Piping		Interference of valves/pipes	(b)(3)(A) [redacted]	IC	H	Provide protection around valve to avoid unintentional damage	D1	Yes		As soon as practicable	Repairing LAT-31 will provide protection	
LAT-38	Structural		Existing brace is heavily corroded		CR	H	Replace brace as per SGH retrofit concept design	D1	No		As soon as practicable	Requires lead abatement	RMMR Service Order RHL-PND-617
LAT-40	Structural		Existing column is heavily corroded at the base		CR	H	Replace column and anchorage	D1	No		As soon as practicable	Requires lead abatement	RMMR Service Order RHL-PND-601

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
LAT-41	Structural	[redacted]	Existing column is heavily corroded at the base		CR	H	Replace column and anchorage	D1	No	[redacted]	As soon as practicable	Requires lead abatement	RMMR Service Order RHL-PND-601
LAT-42	Structural	[redacted]	Existing beam is heavily corroded at end closer to the tunnel wall		CR	H	Replace beam	D1	No	[redacted]	As soon as practicable	Requires lead abatement	RHL-601 covers the base. Additional SO for beam
LAT-44	Piping	[redacted]	Interference AFFF retention line of valves/pipes	[redacted]	IC	H	Provide protection around valve to avoid unintentional damage	D1	Review by SGH recommended	[redacted]	As soon as practicable		
LAT-46	Structural	[redacted]	Existing beam is heavily corroded at end closer to the tunnel wall	[redacted]	CR	H	Replace beam and connect to tunnel wall per SGH retrofit concept drawings	D1	Yes	[redacted]	As soon as practicable	Requires lead abatement	
LAT-47	Piping	[redacted]	Elevated pipe [redacted] is not supported, pipe is not fully bearing on cradle	[redacted]	IR	H	Provide lateral stops and reset pipe cradle as per SGH retrofit concept drawings	D1	Yes	[redacted]	As soon as practicable		RMMR Service Order RHL-PND-617
LAT-48	Piping	[redacted]	Elevated pipe [redacted] is not supported, cradle is missing	[redacted]	IR	H	Provide missing cradle and lateral stops as per SGH retrofit concept drawings	D1	Yes	[redacted]	As soon as practicable	These fixes to include welding all pipe cradles (including those that are missing) to the pipe support for the F24 line. Lateral stops are only at a select number of locations (maximum 25 per SGH retrofit concept drawings). Requires lead abatement.	RMMR Service Order RHL-PND-617
LAT-55	Piping	[redacted]	Missing cradle on one side of pipe	[redacted]	IR	H	Repair pipe cradle	D1	No	[redacted]	As soon as practicable	Requires lead abatement	
[redacted]	Valve	[redacted]	Lack of bypass from Tank 20 to other side of DBB Valve on JP-5 line.	[redacted]	OT	H	Install bypass from Tank 20 to other side of DBB valve using existing sample outlets and drain line	D1	Yes	[redacted]	As soon as practicable	Install pressure equalization lines across double block and bleed valves on three different product tanks for defueling and the remaining tanks for continued operation. Swagelok fittings and stainless tubing installed using a ladder.	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
PM-2	Valve	(b)(3)(A) [redacted]	Lack of bypass from after Tank 20 DBB valve to main JP-5 lateral	(b)(3)(A) [redacted]	OT	H	Install bypass from after Tank 20 ball valve to main JP-5 lateral	D1	Yes	(b)(3) [redacted]	As soon as practicable	Install pressure equalization lines across double block and bleed valves on three different product tanks for defueling and the remaining tanks for continued operation. Swagelok fittings and stainless tubing installed using a ladder.	
PM-3	Valve		Lack of bypass from Tank 15 to other side of DBB Valve on F-76 line.	(b)(3)(A) [redacted]	OT	H	Install bypass from Tank 15 to other side of DBB valve using existing sample outlets and drain line, or other F-76 tank to be drained last	D1	Yes		As soon as practicable	Install pressure equalization lines across double block and bleed valves on three different product tanks for defueling and the remaining tanks for continued operation. Swagelok fittings and stainless tubing installed using a ladder.	
PM-4	Valve		Lack of bypass from after Tank 15 ball valve to main F-76 lateral.	(b)(3)(A) [redacted]	OT	H	Install bypass from after Tank 15 ball valve to main F-76 lateral	D1	Yes		As soon as practicable	Install pressure equalization lines across double block and bleed valves on three different product tanks for defueling and the remaining tanks for continued operation. Swagelok fittings and stainless tubing installed using a ladder.	
PM-5	Valve		Lack of bypass from Tank 6 to other side of DBB Valve on F-24 line.	(b)(3)(A) [redacted]	OT	H	Install bypass from Tank 6 to other side of DBB valve using existing sample outlets and drain line	D1	Yes		As soon as practicable	Install pressure equalization lines across double block and bleed valves on three different product tanks for defueling and the remaining tanks for continued operation. Swagelok fittings and stainless tubing installed using a ladder.	
PM-6	Valve		Lack of bypass from after Tank 6 ball valve to main F-24 lateral	(b)(3)(A) [redacted]	OT	H	Install bypass from after Tank 6 ball valve to main F-24 lateral.	D1	Yes		As soon as practicable	Install pressure equalization lines across double block and bleed valves on three different product tanks for defueling and the remaining tanks for continued operation. Swagelok fittings and stainless tubing installed using a ladder.	
(b)(3)(A) [redacted]	Piping		JP-5 piping is unrestrained at the end of the main (b)(3)(A) [redacted] header. Pipeline is free to displace in the event of a surge and could cause overstress.	(b)(3)(A) [redacted] (b)(3)(A) [redacted]	OT	H	Fully analyze the pipe system for surge events in light of the recent modifications being currently implemented. Provide axial restraint, as needed, per SGH retrofit concept drawings.	D1	Yes		As soon as practicable	Modifications are presently underway at Tanks 19 and 20, but additional engineering and provision of axial restraints in lateral pipe offtake, and at the ends of headers, are likely required. Cost estimate includes restraints at Tanks 19 / 20, 13 / 14, 1, and at the F-24 and F-76 headers at Tanks 15 / 16.	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
(b)(3)(A) [redacted]	Piping	(b)(3)(A) [redacted]	F-24 piping is longitudinally unrestrained at the end of the main (b)(3)(A) [redacted] header. Pipeline is free to displace in the event of a surge and could cause overstress.	(b)(3)(A) [redacted]	OT	H	Piping analysis has determined that additional restraints may be required to prevent potential overstress during a surge event in combination with operational loads. Additional evaluation and detailed design of the mitigation (if needed) are required.	D1	Yes	(b)(3) [redacted]	As soon as practicable		
(b)(3)(A) [redacted]	Piping	[redacted]	F-76 piping is longitudinally unrestrained at the end of the main (b)(3)(A) [redacted] header. Pipeline is free to displace in the event of a surge and could cause overstress.	[redacted]	OT	H	Piping analysis has determined that additional restraints may be required to prevent potential overstress during a surge event in combination with operational loads. Additional evaluation and detailed design of the mitigation (if needed) are required.	D1	Yes	[redacted]	As soon as practicable		
(b)(3)(A) [redacted]	Dresser Coupling	[redacted]	Dresser coupling may not have capacity to withstand surge load similar to May 6 event (if it is replaced-in-kind and laterals to Tanks 19 and 20 are not connected appropriately).	[redacted]	OT	H	See SGH recommendations if laterals to even numbered tanks are disconnected	D1	Yes	[redacted]	As soon as practicable	Some modifications are being implemented, but additional repairs are required	In progress under NAVFAC JP-5 line repairs
PM-20	Dresser Coupling	[redacted]	Dresser coupling may not have capacity to withstand surge load similar to May 6 event.	[redacted]	OT	H	See SGH recommendations if laterals to even numbered tanks are disconnected	D1	Yes	[redacted]	As soon as practicable	Some modifications are being implemented, but additional repairs are required	In progress under NAVFAC JP-5 line repairs
PM-21	Dresser Coupling	[redacted]	Dresser coupling may not have capacity to withstand surge load similar to May 6 event. (Tank 6 shown as an example)	(b)(3)(A) [redacted]	OT	H	See SGH recommendations if laterals to even numbered tanks are disconnected	D1	Yes	[redacted]	As soon as practicable	Our description applies if the Dresser coupling is replaced-in-kind and laterals are not connected appropriately	
PM-22	Dresser Coupling	[redacted]	Dresser coupling may not have capacity to withstand surge load similar to May 6 event. (Tank 6 shown as an example)	[redacted]	OT	H	See SGH recommendations if laterals to even numbered tanks are disconnected	D1	Yes	[redacted]	As soon as practicable	Our description applies if the Dresser coupling is replaced-in-kind and laterals are not connected appropriately	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
PM-25	Dresser Coupling	(b)(3)(A) [redacted]	Dresser coupling thermal blanket on 12-in line not installed	(b)(3)(A) [redacted]	OT	H	Provide thermal blanket	D1	No	(b)(3) [redacted]	As soon as practicable	There are three Dresser couplings without fire insulation blankets	
HT-3	Pipe	[redacted]	Tunnel wall leakage leading to coating and corrosion issues at FOR line		CD/CR	H	Assess pipe integrity and repair pipe as appropriate	D1	Yes	[redacted]	As soon as practicable	Expected to be included in a NAVFAC SRM Project that replaces a long length of this pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-6	Piping	[redacted]	FOR pipe with unknown crack in exterior surface		CD/CR	H	Assess pipe integrity and repair pipe as appropriate	D1	Yes	[redacted]	As soon as practicable	Expected to be included in a NAVFAC SRM Project that replaces a long length of this pipe	
HT-12	Piping	[redacted]	Interference of valves/pipes (AFFF retention line adjacent to trolley tracks)		OT	H	Provide protection to existing overhead valve to avoid damage caused by impact	D1	Review by SGH recommended	[redacted]	As soon as practicable		
AGP-1	Pipe	[redacted]	Crevice corrosion and deep pits at pipe support contact	(b)(3)(A) [redacted]	CR	H	Repair pipe sections	D1	No	[redacted]	As soon as practicable	The worst section loss location was inaccessible; we understand that POND conducted in line inspection (ILI) and determined that local section loss greater than 50% requires local replacement.	RMMR Service Order PRL-PND-677N & PRL-PND-683E
AGP-2	Pipe	[redacted]	Crevice corrosion and deep pits at pipe support contact		CR	H	Repair pipe sections	D1	No	[redacted]	As soon as practicable	The worst section loss location was inaccessible; we understand that POND conducted in line inspection (ILI) and determined that local section loss greater than 50% requires local replacement.	RMMR Service Order PRL-PND-677N & PRL-PND-683E
HP-14	Pipe	[redacted]	PVC FOR line potentially with Nitrile seals (blue)		LI	H	Replace PVC with appropriate materials	D1	Review by SGH recommended	[redacted]	As soon as practicable	Condition looks unchanged from 2016 observation report. Conduit box and cable are hanging off the front side of Hotel Pier (red).	FY23 NAVFAC SRM project
LAT-5	Structural	[redacted]	Bracing is missing, remnants of angle sections are present attached to the columns		DV	H	Install one bay of bracing at a minimum on each side of pipe supports, this can be done between pipe supports 4 and 7. See SGH conceptual retrofit drawings.	P1	Yes	[redacted]	12-24mo	Requires lead abatement	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
LAT-7	Structural	(b)(3)(A) [redacted]	Pipe support not matching design drawings		DV	H	See LAT-5	P1	Yes	(b)(3) [redacted]	12-24mo	Requires lead abatement	
LAT-17	Structural	[redacted]	Existing beam is heavily corroded at end closer to the tunnel wall		CR	H	Replace damaged section of beam and connect to tunnel wall	P1	Yes	[redacted]	12-24mo	Requires lead abatement	
LAT-18	Structural	[redacted]	Existing brace is damaged		PD	H	Replace brace with the original configuration	P1	No	[redacted]	12-24mo	Requires lead abatement	
LAT-19	Structural	[redacted]	Existing columns are heavily corroded at the base		CR	H	Replace column and anchorage	P1	No	[redacted]	12-24mo	Requires lead abatement	
LAT-21	Structural	[redacted]	Connection to concrete wall is unclear, original design was modified	(b)(3)(A) [redacted]	DV	H	Provide an effective connection to concrete wall as per SGH retrofit concept drawings	P1	Yes	[redacted]	12-24mo		
LAT-22	Electrical	[redacted]	Transformer is located in a room that does not have positive pressure, potential fire risk		OT	H	Relocate transformer outside of tunnel system or enclose in a room with positive pressure	P1	No	[redacted]	12-24mo	We understand there may be a study underway evalutaing this condition. No construction costs herein have been assigned pending completion of this ongoing study.	
LAT-25	Structural	[redacted]	Existing beam is heavily corroded at end closer to the tunnel wall		CR	H	Replace damaged section of beam and connect to tunnel wall	P1	Yes	[redacted]	12-24mo	Requires lead abatement	
LAT-27	Structural	[redacted]	Existing beam is heavily corroded at end closer to the tunnel wall		CR	H	Replace damaged section of beam and connect to tunnel wall	P1	Yes	[redacted]	12-24mo	Requires lead abatement	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
LAT-31	Structural	(b)(3)(A) [redacted]	Improper vertical support of [redacted] pipe	(b)(3)(A) [redacted]	LP	H	Repair as per SGH retrofit concept drawings	P1	Yes	(b)(3) [redacted]	12-24mo		
LAT-34	Piping	[redacted]	Existing overhead valve at risk of impact when door is open	[redacted]	IC	H	Provide protection to existing overhead valve (or relocate) to avoid damage caused by impact of the door	P1	No	[redacted]	12-24mo		
LAT-35	Structural	[redacted]	Existing brace is damaged and bent out of plane	(b)(3)(A) [redacted]	PD	H	Replace brace	P1	No	[redacted]	12-24mo	Requires lead abatement	RMMR Service Order RHL-PND-619
LAT-39	Structural	[redacted]	Heavy valve is improperly supported	(b)(3)(A) [redacted]	LP	H	Reconfigure support as per SGH retrofit concept design	P1	Yes	[redacted]	12-24mo	Requires lead abatement	
LAT-43	Structural	[redacted]	Existing brace is heavily corroded and broken		CR	H	Replace brace	P1	No	[redacted]	12-24mo	Requires lead abatement	RMMR Service Order RHL-PND-601
LAT-45	Structural	[redacted]	Existing brace is damaged and bent out of plane	(b)(3)(A) [redacted]	PD	H	Replace brace	P1	No	[redacted]	12-24mo	Requires lead abatement	
PM-7	Valve	[redacted]	Lack of bypass from after ball valve to main lateral	(b)(3)(A) [redacted]	OT	H	Install bypasses from tank wall across inboard and outboard valves at the 15 tanks that do not have equalization lines that are installed for defueling	P1	Yes	[redacted]	12-24mo	Install pressure equalization lines across double block and bleed valves on three different product tanks for defueling and the remaining tanks for continued operation. Swagelok fittings and stainless tubing installed using a ladder.	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
(b)(3)(A) [redacted]	Valve	(b)(3)(A) [redacted]	Butterfly valve is known to leak, causing vacuum and surge loads in packed F-24 product line.	(b)(3)(A) [redacted]	OT	H	Do not use butterfly valves as isolation valves. Consider using double block and bleed valves upstream.	P1	Review by SGH Recommended	(b)(3) [redacted]	12-24mo	Butterfly valves are used to throttle flow	
(b)(3)(A) [redacted]	Valve		Butterfly valve is known to leak, causing vacuum surge loads in packed F-76 product line.		OT	H	Do not use butterfly valves as isolation valves. Consider using double block and bleed valves upstream.	P1	Review by SGH Recommended		12-24mo	Butterfly valves are used to throttle flow	
(b)(3)(A) [redacted]	Valve		Butterfly valve is known to leak, causing vacuum surge loads in packed JP-5 product line.		OT	H	Do not use butterfly valves as isolation valves. Consider using double block and bleed valves upstream.	P1	Review by SGH Recommended		12-24mo	Butterfly valves are used to throttle flow	
(b)(3)(A) [redacted]	Valve		Butterfly valve is known to leak, causing vacuum surge loads in packed F-24 product line.		OT	H	Do not use butterfly valves as isolation valves. Consider using double block and bleed valves upstream.	P1	Review by SGH Recommended		12-24mo	Butterfly valves are used to throttle flow	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
(b)(3)(A) [redacted]	Valve	(b)(3)(A) [redacted]	Butterfly valve is known to leak, causing vacuum surge loads in packed F-76 product line.	(b)(3)(A) [redacted]	OT	H	Do not use butterfly valves as isolation valves. Consider using double block and bleed valves upstream.	P1	Review by SGH Recommended	(b)(3) [redacted]	12-24mo	Butterfly valves are used to throttle flow	
(b)(3)(A) [redacted]	Valve	[redacted]	Butterfly valve is known to leak, causing vacuum surge loads in packed JP-5 product line.	[redacted]	OT	H	Do not use butterfly valves as isolation valves. Consider using double block and bleed valves upstream.	P1	Review by SGH Recommended	[redacted]	12-24mo	Butterfly valves are used to throttle flow	
PM-26	High Point Vents in F-24 Line	[redacted]	No high point vents in F-24 line downstream of concrete walls	[redacted]	OT	H	Evaluate need for high point vents as part of detailed surge analysis	P1	Yes	[redacted]	12-24mo		
HT-26	Structural	[redacted]	Pipe support horizontal angle fractured, web/flange deteriorated, anchor to tunnel wall compromised		CR	M	Replace horizontal member and wall anchorage	P1	No	[redacted]	12-24mo	PS 310 identified on RHL Q1 RMMR RM Report Requires lead abatement	
HT-28	Structural	[redacted]	Pipe support column base and horizontal angle braces corroded, anchor to tunnel wall compromised		CR	M	Replace column, base plate and anchorage	P1	No	[redacted]	12-24mo	Requires lead abatement	
HT-30	Structural	[redacted]	Pipe support column base significantly corroded		CR	M	Replace column, base plate and anchorage	P1	No	[redacted]	12-24mo	Requires lead abatement	

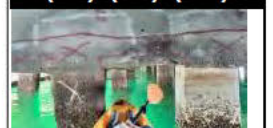
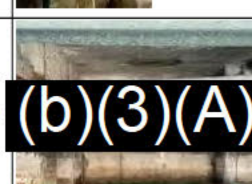
Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
HT-32	Structural	(b)(3)(A) [redacted]	Pipe support column base and horizontal angle braces corroded, anchor to tunnel wall compromised		CR	M	Replace column, base plate and anchorage	P1	No	(b)(3) [redacted]	12-24mo	Submitted on Q1 RMMR RM Report Requires lead abatement	
HT-33	Structural	[redacted]	Column bases corroded (Harbor Tunnel)		CR	M	Replace column, base plate and anchorage	P1	No	[redacted]	12-24mo	Requires lead abatement	RMMR Service Order RHL-PND-618 includes 510, 600
HT-38	Structural	[redacted]	Base plate of pipe support is heavily corroded		CR	H	Replace column, base plate and anchorage	P1	No	[redacted]	12-24mo	Requires lead abatement	
HT-41	Piping	[redacted]	Corrosion at pipe supports for [redacted] JP-5 fuel pipe, section loss and flaking of steel layers and angle flange.		CD	M	Replace horizontal member and wall anchorage	P1	No	[redacted]	12-24mo	Requires lead abatement	
HT-44	Structural	[redacted]	Column bases corroded (Harbor Tunnel)	(b)(3)(A) [redacted]	CR	M	Replace column, base plate and anchorage	P1	No	[redacted]	12-24mo		RMMR Service Order RHL-PND-618 includes 510, 600
PH-1	Window	[redacted]	Control room window facing pumphouse gallery is not blast-resistant		OT	H	Provide blast and fire-resistant door, window and framing to protect operators	P1	Yes	[redacted]	12-24mo	Building wall and door can also be critical. There is also fire risk in this area.	
PH-2	Other	[redacted]	Cabinets with flammable materials are unanchored	 	IR	M	Provide adequate anchorage or lateral restraint at cabinet so it does not fall during an earthquake, impact, blast or fire	P1	Review by SGH recommended	[redacted]	12-24mo	There are multiple such cabinets in the facility	

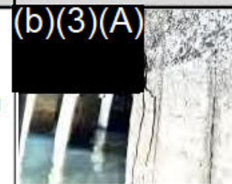
Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
PH-3	Flange	(b)(3)(A) [redacted]	Flange bolts are not fully engaged	(b)(3)(A) [redacted]	OT	H	Bolts should have full engagement. Replaced with longer bolts of same grade and diameter	P1	No	(b)(3) [redacted]	12-24mo	Located near to the harbor tunnel entrance [redacted]	
PH-4	Diesel Tank for Emergency Generator	[redacted]	Tank is likely unanchored. Emergency generator may lose functionality in an earthquake.		IR	H	Anchor or restrain diesel tank for emergency generator	P1	Yes	[redacted]	12-24mo		
LYT-1	Piping	[redacted]	Undisturbed dust on fuel pipe in lower yard tunnel. Six fuel pipelines routed through lower yard tunnel.	(b)(3)(A) [redacted]	OT	M	Contractor to conduct API 570 pipe inspection to catalogue condition and execute necessary repairs for pipe and coating	P1	SGH review recommended	[redacted]	12-24mo	It is our understanding these pipes may not be included in the ongoing API 570 inspection program	
LYT-2	Piping	[redacted]	Dent in pipe, F-76 fuel pipe	[redacted]	PD	M	Contractor to conduct API 570 pipe inspection, then evaluate FFS to determine if dent is acceptable	P1	SGH review recommended	[redacted]	12-24mo	It is our understanding these pipes may not be included in the ongoing API 570 inspection program	
LYT-3	Piping	[redacted]	Sump water line is corroded and apparently cracking		CR	H	Replace water pipe	P1	No	[redacted]	12-24mo	It is our understanding these pipes may not be included in the ongoing API 570 inspection program	
LYT-4	Piping	[redacted]	Surface corrosion, apparent bulging under wrap, and coating damage at F-24 fuel pipe	(b)(3)(A) [redacted]	CR/CD	H	Remove wrap, clean pipe, inspect for pits and determine acceptability of pipe section, then repair as appropriate	P1	SGH review recommended	[redacted]	12-24mo	It is our understanding these pipes may not be included in the ongoing API 570 inspection program	
AST-3	Tank Shell and New Double Bottom Plate	[redacted]	Corrosion could cause loss of product if not addressed	 	CR	M	Repair and re-coat; allow for water to drain. FFS evaluation determined the current tank wall loss was acceptable.	P1	No	[redacted]	12-24mo	Several other locations at Tank 47 have similar corrosion issues 	

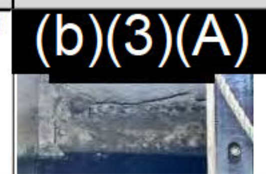
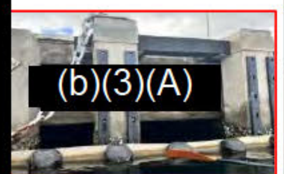
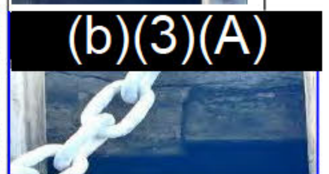
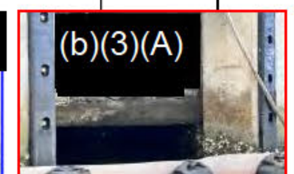
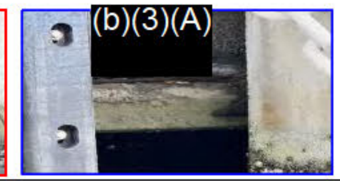
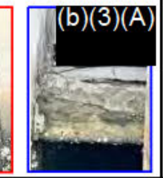
Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
AST-4	Pipe Supports	(b)(3)(A) [redacted]	Overconstrained piping. First pipe support (two locations) adjacent to tank constrains uplift of the attached piping and is bolted to the concrete.	(b)(3)(A) [redacted]	IR	H	Provide flexibility to accommodate potential uplift of the tank during an earthquake	P1	Yes	(b)(3) [redacted]	12-24mo	See additional photo below. 	
AST-12	Pipe Supports	[redacted]	Overconstrained piping.	[redacted]	IR	H	Provide flexibility to accommodate potential uplift of the tank during an earthquake	P1	Yes	[redacted]	12-24mo	First pipe support (two locations) adjacent to tank constrains uplift of the attached piping since it provides vertical restraint. Note that it does allow for longitudinal movement but it constrains vertical movement if the tank uplifts. Includes Tanks 11-1 and 11-2. [redacted]	
(b)(3)(A) [redacted]6	Valve	[redacted]	Leakage at valve riser		LI	H	Repair valve and coating as needed	P1	No	[redacted]	12-24mo		
(b)(3)(A) [redacted]7	Valve	[redacted]	Leakage at valve riser		LI	H	Repair valve and coating as needed	P1	No	[redacted]	12-24mo		
(b)(3)(A) [redacted]8	Valve	[redacted]	Leakage at valve riser		LI	H	Repair valve and coating as needed	P1	No	[redacted]	12-24mo		
(b)(3)(A) [redacted]1	Pipe	[redacted]	Pipe corrosion behind wall penetration	(b)(3)(A) [redacted]	CR	M	Explore cause of corrosion behind wall and repair corroded pipe and damaged coating	P1	Review by SGH recommended	[redacted]	12-24mo		RMMR Service Order PRL-PND-688

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
[redacted]2	Pipe	(b)(3)(A) [redacted]	Pipe coating failure and local pitting	[redacted]	CR	M	FFS evaluation conducted and current corrosion loss is acceptable. Repair coating.	P1	No	(b)(3) [redacted]	12-24mo		RMMR Service Order PRL-PND-688
[redacted]3	Pipe	[redacted]	Crevice corrosion of pipe at pipe support contact	(b)(3)(A) [redacted]	CR	M	Clean pipe and repair damaged coating	P1	No	[redacted]	12-24mo		RMMR Service Order PRL-PND-688
[redacted]1	Piping	[redacted]	Corrosion on valve, valve appears to have been submerged, steel appears to have lamellar corrosion	[redacted]	CR	H	Clean to determine if section loss is acceptable for performance, recoat or replace	P1	No	[redacted]	12-24mo		Understood to be part of a POND RMMR contract
[redacted]2	Piping	[redacted]	Crevice corrosion between pipe and pipe support, apparent lamellar corrosion	[redacted]	CR	M	Provide protection between pipe and concrete support, to prevent crevice corrosion	P1	SGH review recommended	[redacted]	12-24mo		Understood to be part of a POND RMMR contract
[redacted]3	Piping	[redacted]	Corrosion on low point drain, F-76 pipe	[redacted]	CR	H	Clean low point drain and recoat	P1	N	[redacted]	12-24mo		Understood to be part of a POND RMMR contract
[redacted]4	Structural	[redacted]	Base of ladder access platform columns are corroded		CR	H	Repair column supports	P1	N	[redacted]	12-24mo		Understood to be part of a POND RMMR contract
[redacted]1	Pipe	[redacted]	Uncoated and pitting corrosion at elbow		CR	M	FFS evaluation conducted and corrosion section loss is acceptable. Local coating repair	P1	No	[redacted]	Completed		Completed under RMMR Service Order PRL-PND-639
[redacted]1	Pipe	[redacted]	Uncoated and pitted corrosion		CR	M	FFS evaluation conducted and corrosion section loss is acceptable. Local coating repair	P1	No	[redacted]	Completed		Completed under RMMR Service Order PRL-PND-639

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
(b)(3)(A) [redacted]1	Pipe	(b)(3)(A) [redacted]	Indications of pipe corrosion behind wall penetration	(b)(3)(A) [redacted]	CR	M	Explore cause of corrosion behind wall and repair corroded pipe and damaged coating	P1	Review by SGH recommended	(b)(3) [redacted]	12-24mo		
HK-3	Pipe		Surface corrosion on SS304 in pumphouse		CR	M	We recommend additional inspection and testing (NDT) to determine if stress corrosion cracking is a concern. Clean pipe and establish a maintenance program to mitigate surface corrosion.	P1	Review by SGH recommended		12-24mo		
HP-3	Pipe and Support		Crevice corrosion at pipe support		CR	M	At corroded areas, contractor to remove corrosion products with needle gun, corrosion loss to be measured, then FFS evaluation prior to repair	P1	Review by SGH recommended		12-24mo	Whole length of pipe needs to be inspected, but this could not be accessed during our inspection	RMMR Service Order PRL-PND-625
HP-4	Valve		Crevice corrosion in pipe flanges		CR	M	Clean to determine if section loss is acceptable for performance, recoat or replace	P1	No		12-24mo	Entire length of pipe needs to be inspected, but this could not be accessed during our inspection. It is important to check bottom surface of flanges - these were the areas most corroded from the valves removed in January 2022.	RMMR Service Order PRL-PND-625
HP-5	Structural		Concrete cracking in bent cap		PD	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however, we recommend further evaluation.	P1	Review by SGH recommended		12-24mo	Likely under NAVFAC Triton contract	Project Number RM17-1369
HP-6	Structural		Concrete cracking in bent cap		PD	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P1	Review by SGH recommended		12-24mo	Concrete cracking in bent cap, possible delamination and evidence of corrosion. Spray paint indicates previous observation and documentation by others (timeline unclear). Likely under NAVFAC Triton contract.	
HP-7	Structural		Concrete delamination at the underside of the deck		PD	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P1	Review by SGH recommended		12-24mo	Likely under NAVFAC Triton contract	
HP-8	Structural		Broken FOR hanging pipe support		PD	H	Repair pipe support hanger	P1	Review by SGH recommended		12-24mo		FY23 NAVFAC SRM project

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
HP-11	Structural	(b)(3)(A) [redacted]	Concrete cracking in bent cap	(b)(3)(A) [redacted] 	PD	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P1	Review by SGH recommended	(b)(3) [redacted]	12-24mo	Spray paint indicates previous observation and documentation by others (timeline unclear). Likely under NAVFAC Triton contract.	
HP-12	Structural	[redacted]	Concrete cracking in bent cap	(b)(3)(A) [redacted] 	PD	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P1	Review by SGH recommended	[redacted]	12-24mo	Spray paint indicates previous observation and documentation by others (timeline unclear). Likely under NAVFAC Triton contract.	
HP-13	Structural	[redacted]	Concrete cracking in bent cap	(b)(3)(A) [redacted] 	PD	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P1	Review by SGH recommended	[redacted]	12-24mo	Spray paint indicates previous observation and documentation by others (timeline unclear). Likely under NAVFAC Triton contract.	
KP-1	Pipe	[redacted]	Fuel pipe in tidal zone and covered in PVC/Bitumous pipe wrap	(b)(3)(A) [redacted]	CD	H	Contractor to remove wrap, then clean pipe, then measure corrosion section loss and conduct FFS evaluation prior to repair and recoating with marine grade coating	P1	Review by SGH recommended	[redacted]	12-24mo	Wrap coating will trap water when it starts to debond	
KP-2	Pipe	[redacted]	Local coating failure	[redacted]	CD	H	Contractor to remove wrap, then clean pipe, then measure corrosion section loss and conduct FFS evaluation prior to repair and recoating with marine grade coating	P1	Review by SGH recommended	[redacted]	12-24mo	Wrap coating will trap water when it starts to debond	
KP-3	Structural	[redacted]	Concrete cracking, spalling and exposed reinforcing		PD/CR	H	Repair pile. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P1	Yes	[redacted]	12-24mo	Significant work is planned for Kilo pier (K-10 and K-11). If the piles we observed are not included in the project scope then additional work is required. Marine Solutions Inc. 2018 Inspection Report.	
SP-1	Pipe	[redacted]	Fuel pipe in tidal zone and covered in PVC/Bitumous pipe wrap	 (b)(3)(A) [redacted]	CD	H	Contractor to remove wrap/existing coating, then clean pipe, then measure corrosion section loss and conduct FFS evaluation prior to repair and recoating with marine grade coating	P1	No	[redacted]	12-24mo	Cannot visually inspect the pipe surface of a wrap coating. Also wrap coating will trap water when it starts to debond.	
SP-2	Pipe	[redacted]	Local coating failure	(b)(3)(A) [redacted]	CD	H	Contractor to remove wrap/existing coating, then clean pipe, then measure corrosion section loss and conduct FFS evaluation prior to repair and recoating with marine grade coating	P1	No	[redacted]	12-24mo		

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
SP-3	Structural	[redacted]	Concrete cracking and spalling	[redacted] 	PD/CR	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P1	Yes	[redacted]	12-24mo		
MP-1	Pipe	[redacted]	Local coating failure [redacted]	[redacted] [redacted]	CD [redacted]	M [redacted]	Contractor to remove existing coating, then clean pipe, then measure corrosion section loss and conduct FFS evaluation prior to repair and recoating with marine grade coating [redacted]	P1	Review by SGH recommended	[redacted]	12-24mo		RMMR Service Order PRL-PND-693E through PRL-PND-696E
MP-2	Valve	[redacted]	Surface and crevice corrosion	[redacted]	CR	M	Disassemble flange, evaluate corrosion loss, and possibly replace valve	P1	No	[redacted]	12-24mo		RMMR Service Order PRL-PND-675E
MP-3	Pipe	[redacted]	Spalled concrete and exposed reinforcing	[redacted]	PD/CR	H	Repair as appropriate to re-establish design margin	P1	Yes	[redacted]	12-24mo	Note that the Marine Solutions Inc. 2018 Pier Inspection report classifies the system as fair, however,we recommend further evaluation	
MP-4	Structural	[redacted]	Spalled concrete and exposed reinforcing		PD/CR	H	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however, we recommend further evaluation.	P1	Yes	[redacted]	12-24mo		
MP-5	Structural	[redacted]	Spalled concrete at the underside of deck (blue)	 [redacted]	PD/CR	H	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however, we recommend further evaluation.	P1	Yes	[redacted]	12-24mo	Other pipes (not fuel line) heavily corroded and wrap is damaged (red)	
MP-6	Structural	[redacted]	Spalled concrete at the underside of deck	 [redacted]	PD/CR	H	Repair as appropriate to re-establish design margin	P1	Yes	[redacted]	As soon as possible	Note that the 2018 Pier Inspection report classifies the system as fair, however, we recommend further evaluation.	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
MP-7	Structural	[redacted]	Cracked concrete and exposed reinforcing	[redacted]   [redacted]  [redacted]  [redacted]  [redacted]  [redacted]  [redacted]	PD/CR/CD	H	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however, we recommend further evaluation.	P1	Yes	[redacted]	As soon as possible	Tie beams between bents consistently cracked, spalled, delaminated, with exposed rebar. Pipe coating damage.	
MP-8	Structural	[redacted]	Delaminated concrete	 [redacted]	PD/CR	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however, we recommend further evaluation.	P1	Yes	[redacted]	12-24mo	Delaminated concrete at pile cap, exposed rebar at spalled concrete at tie beam between bents	
MP-9	Structural	[redacted]	Delaminated concrete underside of deck edge	[redacted]	PD	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however, we recommend further evaluation.	P1	Yes	[redacted]	12-24mo		
MP-10	Structural	[redacted]	Spalled concrete and exposed rebar	[redacted]	PD/CR	H	Repair as appropriate to re-establish design margin	P1	Yes	[redacted]	As soon as possible	Note that the 2018 Pier Inspection report classifies the system as fair, however, we recommend further evaluation.	
MP-11	Structural	[redacted]	Pipe support and coating failure	[redacted]	PD/CR/CD	H	Repair pipe support and pipe coating. Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however,we recommend further evaluation.	P1	Yes	[redacted]	12-24mo	Roller support appears disengaged/unevenly supported at pier beam, spalled concrete and exposed rebar at pipe support beam. Pipe coating issue.	RMMR Service Order PRL-PND-693E through PRL-PND-696E
MP-12	Pipe	[redacted]	Pipe support and coating failure	[redacted]	PD/CR/CD	H	Repair pipe support and pipe coating. Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however,we recommend further evaluation.	P1	Yes	[redacted]	12-24mo	Roller support appears disengaged/unevenly supported at pier beam, spalled concrete and exposed rebar at pipe support beam. Pipe coating issue.	RMMR Service Order PRL-PND-693E through PRL-PND-696E
MP-14	Structural	[redacted]	Spalled concrete and exposed rebar		PD/CR	H	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however,we recommend further evaluation.	P1	Yes	[redacted]	12-24mo		

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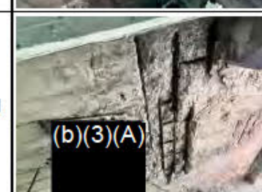
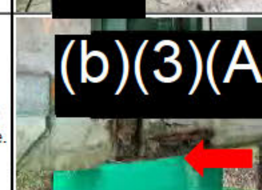
MP-15	Structural	(b)(3)(A) [redacted]	Spalled concrete and exposed rebar	 (b)(3)(A) [redacted]	PD/CR	H	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however,we recommend further evaluation.	P1	Review by SGH recommended	(b)(3) [redacted]	As soon as possible	Spray paint markings indicate previous observations	
MP-17	Pipe	[redacted]	Coating damage and surface corrosion	[redacted]	CR	M	Repair pipe and coating	P1	No	[redacted]	12-24mo		RMMR Service Order PRL-PND-693E through PRL-PND-696E
MP-21	Structural	[redacted]	Delaminated and spalled concrete at the underside of the deck, exposed and corroded reinforcing		PD	H	There is significant concern with heavy loading on the deck. Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however,we recommend further evaluation.	P1	Yes	[redacted]	12-24mo	Additional Photo - delamination below deck. Marine Solutions Inc. 2018 Inspection Report 	
MP-22	Structural	[redacted]	Spalled concrete at the underside of the deck, exposed and corroded reinforcing	 (b)(3)(A) [redacted]	PD	H	There is significant concern with heavy loading on the deck. Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however,we recommend further evaluation.	P1	Yes	[redacted]	12-24mo	Marine Solutions Inc. 2018 Inspection Report	
MP-23	Structural	[redacted]	Significant crack in concrete beam spanning between piles, this beam supports the fuel pipe.	 (b)(3)(A) [redacted]	PD	H	There is significant concern with heavy loading on the deck. Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as fair, however,we recommend further evaluation.	P1	Yes	[redacted]	12-24mo	Marine Solutions Inc. 2018 Inspection Report	
BP-1	Pipe	[redacted]	Fuel pipe in splash zone and covered in Bitumous pipe wrap	(b)(3)(A) [redacted]	CD	H	Replace wrap with marine grade coating and perform API 570 inspection	P1	Review by SGH recommended	[redacted]	12-24mo	Cannot visually inspect the pipe surface of a wrap coating. Also wrap coating will trap water when it starts to debond.	
BP-2	Pipe	[redacted]	Local coating failure	(b)(3)(A) [redacted]	CD	H	Replace wrap with marine grade coating and perform API 570 inspection	P1	Review by SGH recommended	[redacted]	12-24mo		RMMR Service Order PRL-PND-675E
BP-3	Pipe	[redacted]	Local coating failure	(b)(3)(A) [redacted]	CD	H	FFS evaluation has been conducted and section loss is unacceptable. Repair pipe and marine grade coating.	P1	Review by SGH recommended	[redacted]	12-24mo	Does not include additional scaffolding	RMMR Service Order PRL-PND-675E for NDT

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
BP-4	Pipe	[redacted]	Severe local pitting corrosion		CR	H	FFS evaluation has been conducted and section loss is unacceptable. Repair with marine grade coating.	P1	Review by SGH recommended	[redacted]	12-24mo		RMMR Service Order PRL-PND-675E
BP-5	Pipe	[redacted]	Severe local pitting corrosion		CR	H	FFS evaluation conducted at locally exposed area and section loss is acceptable. Repair with marine grade coating.	P1	Review by SGH recommended	[redacted]	12-24mo		RMMR Service Order PRL-PND-675E
LAT-1	Structural	[redacted]	Existing beam is heavily corroded at end closer to the tunnel wall. There is also an existing adjacent pipe support.		CR	L	Replace beam with a section of similar characteristics to the existing one. There is currently work being performed but it is unclear if the corroded beam is being replaced as part of that scope.	P2	Review by SGH recommended	[redacted]	24-48mo	Requires lead abatement	
LAT-2	Structural	[redacted]	Existing column is heavily corroded at the base		CR	L	Replace lower section of column with a section of similar characteristics to the existing one; this will also require replacement of the anchorage. There is currently work being performed but it is unclear if the corroded beam is being replaced as part of that scope.	P2	Review by SGH recommended	[redacted]	24-48mo	Requires lead abatement	
LAT-8	Structural	[redacted]	Column out of plumb		LP	M	Fix alignment	P2	No	[redacted]	24-48mo	Requires lead abatement	
LAT-10	Structural	[redacted]	Crevice corrosion at column base		CR	M	Repair as needed	P2	No	[redacted]	24-48mo	Requires lead abatement	
LAT-12	Piping	[redacted]	Missing cradle/support	[redacted]	IR	M	Provide missing cradle	P2	No	[redacted]	24-48mo	Requires lead abatement	
LAT-14	Piping	[redacted]	Cradle/support not in contact with pipe	[redacted]	IR	M	Provide positive connection between pipe and cradle	P2	No	[redacted]	24-48mo	Requires lead abatement	

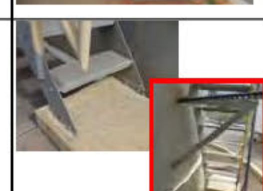
Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
LAT-16	Piping	(b)(3)(A) [redacted]	The AFFF retention line changes from steel piping to PVC		DV	H	Review AFFF retention line modifications.	P2	Review by SGH recommended	(b)(3) [redacted]	24-48mo		Part of funded NAVFAC contract to replace PVC retention line to stainless steel
LAT-26	Structural	[redacted]	Water drops onto structural members of pipe supports	[redacted]	CR	M	Redirect drainage away from structural members and repair coating	P2	No	[redacted]	24-48mo	RMMR Service Order RHL-PND-617 includes 44, 46, 73, 74, 77	
LAT-30	Structural	[redacted]	Modified bracing	(b)(3)(A) [redacted] 	DV	H	Replace brace such that it terminates closer to work point	P2	No	[redacted]	24-48mo		RMMR Service Order RHL-PND-601
LAT-36	Structural	[redacted]	Existing brace is damaged and bent out of plane		PD	M	Replace brace	P2	No	[redacted]	24-48mo		RMMR Service Order RHL-PND-601 (may be included)
LAT-37	Piping	[redacted]	Pipe flange bolts interfere with fire suppression valve	(b)(3)(A) [redacted]	IC	M	Reconfigure fire suppression valve to avoid unintentional damage	P2	No	[redacted]	24-48mo		
LAT-51	Structural	[redacted]	Missing brace between pipe supports	(b)(3)(A) [redacted]	LP	M	Add additional brace	P2	Yes	[redacted]	24-48mo	Requires lead abatement	
LAT-52	Structural	[redacted]	Missing brace between pipe supports		LP	M	Add additional brace	P2	Yes	[redacted]	24-48mo	Requires lead abatement	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
PM-23	Dresser Coupling	(b)(3)(A) [redacted]	Dresser coupling, some lug harnesses installed backwards, does not conform with manufacture drawings	(b)(3)(A) [redacted]	OT	M	Reverse lug harnesses where incorrectly installed	P2	No	(b)(3) [redacted]	24-48mo	Although we are listing this location, there are other Dresser couplings with this issue. This cost estimate is to fix 16 locations.	
PM-24	Dresser Coupling	[redacted]	Dresser coupling deflection rings not installed, does not conform with manufacture drawings		OT	M	Provide deflection ring at all lug harnesses where not installed	P2	No	[redacted]	24-48mo	Although we are listing this location, there are other Dresser couplings with this issue	
HT-1	Piping	[redacted]	Coating failure and surface corrosion on fuel pipe	(b)(3)(A) [redacted]	CD/CR	L	Repair coating	P2	No	[redacted]	24-48mo	API 570 inspection and coating condition survey will determine the full scope of work	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-2	Piping	[redacted]	Tunnel wall leakage leading to coating and corrosion issues at FOR line		CD/CR	M	Repair coating	P2	No	[redacted]	24-48mo	API 570 inspection and coating condition survey will determine the full scope of work	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-5	Piping	[redacted]	One pipe bears on another pipe	(b)(3)(A) [redacted]	IC	M	Analysis indicates F-76 line is adequate however reconfiguration is recommended	P2	SGH review recommended	[redacted]	24-48mo		
HT-7	Piping	[redacted]	Tunnel wall leakage leading to coating issue at [redacted] F76 pipeline	[redacted]	CD/CR	L	Repair coating	P2	No	[redacted]	24-48mo		API 570 inspection in progress
HT-8	Structural	[redacted]	Tunnel wall leakage leading to corroded pipe support at [redacted] JP5 pipeline		CR	M	Replace (in-kind) horizontal member and wall anchorage. Redirect tunnel wall leakage away from structural support member.	P2	No	[redacted]	24-48mo		
HT-9	Piping	[redacted]	Coating issue at [redacted] F24 pipeline at anchor interface	(b)(3)(A) [redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo		API 570 inspection in progress

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
HT-10	Piping	(b)(3)(A) [redacted]	Coating issue at [redacted] F76 pipeline	[redacted] 	CD	L	Repair coating	P2	No	(b)(3) [redacted]	24-48mo		API 570 inspection in progress
HT-11	Structural		Pipe support not supporting pipe, no column or tunnel wall connection, unsupported span is 28ft	(b)(3)(A) [redacted]	LI	M	Analysis indicates F-76 line is adequate however reconfiguration is recommended	P2	No		24-48mo		
HT-13	Other		At trolley tracks, hole in concrete floor through to substrate		PD	L	Excavate to solid material and perform a structural repair	P2	No		24-48mo		
HT-14	Piping		[redacted] F-76 fuel pipe flange in contact with tunnel wall	(b)(3)(A) [redacted]	IC	L	Provide 1" separation between pipe flange and tunnel wall	P2	No		24-48mo		
HT-17	Piping		Coating issue		CD	L	Repair coating	P2	No		24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-19	Structural		Original anchor bolt (5/8" diameter) replaced with smaller anchor bolt (3/8" diameter) at upper brace.		DV	L	Replace with larger diameter anchor bolt	P2	No		24-48mo		
HT-22	Structural		Distorted flange at base of pipe support column	[redacted]	PD	M	Replace column section	P2	No		24-48mo	Submitted on Q1 RMMR RM Report Requires lead abatement	
HT-23	Piping		Coating issue at [redacted] (F-24) and [redacted] (JP-5) fuel pipe	(b)(3)(A) [redacted]	CD	L	Repair coating	P2	No		24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector

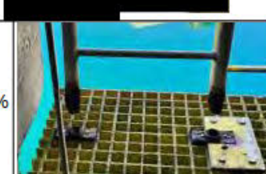
Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
HT-24	Piping	(b)(3)(A) [redacted]	Coating issue	(b)(3)(A) [redacted]	CD	L	Repair coating	P2	No	(b)(3) [redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-34	Piping		Coating issue and surface corrosion at [redacted] F-76 fuel pipe		CD	L	Repair coating	P2	No		24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-35	Piping		Coating issue and surface corrosion at [redacted] F-76 fuel pipe		CD	L	Repair coating	P2	No		24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-36	Other		Water ponds leading to corrosion of the base plates and lower section of columns		OT	L	Elevate steel pipe support bases from tunnel floor via concrete/grout pads	P2	Yes		24-48mo	Cost for pads to elevate steel pipe supports (for [redacted] and [redacted] lines)	
HT-37	Piping		Coating issue and surface corrosion at [redacted] F-24 fuel pipe		CD	L	Repair coating	P2	No		24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-40	Piping		Coating issue and surface corrosion at [redacted] F-24 fuel pipe		CD	L	Repair coating	P2	No		24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-42	Piping		Coating issue and surface corrosion at [redacted] F-76 fuel pipe		CD	L	Repair coating	P2	No		24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-46	Piping		[redacted] (F-76), [redacted] (JP-5) and [redacted] (F-24) fuel pipes sit directly on pipe support beams without additional sacrificial friction pad		OT	M	Provide cradles with an effective connection to support	P2	No		24-48mo		

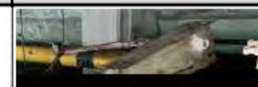
Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
HT-47	Piping	[redacted]	Coating damage on [redacted] F-76 fuel pipe	[redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-48	Piping	[redacted]	Coating damage on [redacted] (F-76) and [redacted] (JP-5) fuel pipe	[redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-49	Piping	[redacted]	Coating damage on [redacted] F-76 fuel pipe	[redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-50	Piping	[redacted]	Coating damage on [redacted] JP-5 fuel pipe	[redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-51	Piping	[redacted]	Coating damage on [redacted] JP-5 fuel pipe	[redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-52	Piping	[redacted]	Coating damage on [redacted] JP-5 fuel pipe	[redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
AST-1	Stairway Support	[redacted]	Overconstrained stairway attachment between stair and adjacent concrete pad. Note the stairway is attached to both the tank and concrete pad, and could damage the tank due to uplift during an earthquake.	 	IR	L	Provide flexibility at stairway. Retrofit (detach the stair support from the concrete pad so that the stair structure can move together with the tank during an earthquake. See the stair support of Tank 55 which is a good example.	P2	Review by SGH recommended	[redacted]	24-48mo	Tanks 46, 53, and 54 have similar overconstrained stairway attachments. The stair landing at Tank 55 (below) and at Tank 1 at Hickam is a good example. 	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
AST-2	Electrical Control Panel Support Attachments	(b)(3)(A) [redacted]	The panel support is attached to both the tank and the concrete walkway. During an earthquake the tank may uplift, and the control panel could potentially be damaged and lose function.	 	IR	L	Independently support the control panel, either on the tank or on the concrete walkway, but not on both	P2	Review by SGH recommended	(b)(3) [redacted]	24-48mo	Tanks 46, 48, 53, and 54 have similar issues. The control panel support for Tank 55 has more flexibility to accommodate tank uplift. 	
AST-5	Walkway		There is 1" clearance between the walkway and pipe. Potential for impact between pipe, walkway and tank during an earthquake.	(b)(3)(A) [redacted]	IC	L	Increase the clearance (minimum 3" clearance is recommended) between the walkway and the pipe	P2	Review by SGH recommended		24-48mo		
AST-7	Pipe support		Overconstrained piping with insufficient clearance between the pipe and the vertical restraint (Dirty Ballast piping)		IR	L	Increase the clearance (minimum 3" clearance is recommended) between the pipe and the vertical restraint	P2	No		24-48mo	Tanks B1 & B2 are currently in NAVFAC CIR. Pipe support and adjustments are included in scope.	
AST-8	Pipe vertical restraint		There is not sufficient clearance between the pipe and the vertical restraint (Shell Low Point Drain side)		IR	L	Increase the clearance (minimum 3" clearance is recommended) between the pipe and the vertical restraint	P2	No		24-48mo	Tanks B1 & B2 are currently in NAVFAC CIR. Pipe support and adjustments are included in scope.	
AST-9	Stairway Support		Overconstrained stairway attachment between stair and adjacent concrete pad.		IR	L	Repair the concrete and provide flexibility at stairway. Retrofit (detach the stair support from the concrete pad so that the stair structure can move together with the tank during an earthquake. (See the stair support of Tank 55 which is a good example.)	P2	No		24-48mo	Tanks B1 & B2 are currently in NAVFAC CIR. This repair is currently not in scope. 	
AST-10	Stair Support		Overconstrained stairway attachment between stair and adjacent concrete pad.		IR	L	Retrofit (detach the stair support from the concrete pad so that the stair structure can move together with the tank during an earthquake)	P2	No		24-48mo	Tanks B1 & B2 are currently in NAVFAC CIR. Tank B1 has not been inspected. It is expected that this will be included in the CIR.	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
AST-11	Valves	[redacted]	Corrosion issues	 	CR	M	Maintenance is needed (replace significantly corroded valves as necessary)	P2	No	[redacted]	24-48mo	Tanks B1 & B2 are currently in NAVFAC CIR. Tank B1 has not been inspected. It is expected that this will be included in the CIR.	
[redacted]2	Valve		Crevice corrosion leading to pitting under name plate at globe valve V1AXC1		CD/CR	L	Local coating repair	P2	No		24-48mo		
[redacted]3	Pipe		Wrap failure at pipe ground penetration	[redacted]	CD	L	Repair wrap at ground penetration	P2	No		24-48mo		
[redacted]4	Flange		Coating failure and flange crevice corrosion	[redacted]	CR	L	Clean to determine if section loss is acceptable for performance, recoat or replace	P2	No		24-48mo		
[redacted]2	Pipe		Multi-product line without ground penetration wrapping	[redacted]	LI	L	Install wrap at ground penetration and repair pipe as required	P2	No		24-48mo		
[redacted]4	Valve		Crevice corrosion at flange bolt		CD/CR	L	Replace bolt	P2	No		24-48mo		
[redacted]5	Valve		Crevice corrosion under name plate led to pitting and coating damage	[redacted]	CD/CR	M	Repair coating and/or valve	P2	No		24-48mo		

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation: Description	Recommendation: Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
[redacted] 10	Valve	[redacted]	Coating issue on F-24 valve, corrosion at flange		CD/CR	L	Repair coating	P2	No	[redacted]	24-48mo		
[redacted] 11	Pipe	[redacted]	Coating issue on F-24 crown, visible from elevated steel grating/platform	[redacted]	CD	L	Repair coating	P2	No	[redacted]	24-48mo		
[redacted] 1	Flange	[redacted]	Coating failure and flange crevice corrosion	[redacted]	CR	L	Clean to determine if section loss is acceptable for performance, recoat or replace	P2	No	[redacted]	24-48mo		RMMR Service Order PRL-PND-692
[redacted] 2	Pipe	[redacted]	Wrap and coating failure at pipe ground penetration	[redacted]	CD	L	Local coating repair; repair wrap at ground penetration	P2	No	[redacted]	24-48mo		RMMR Service Order PRL-PND-692
[redacted] 4	Valve/Flange	[redacted]	Corrosion of valve/ equipment flanges	[redacted]	CR	L	Clean to determine if section loss is acceptable for performance, recoat or replace	P2	No	[redacted]	24-48mo		
[redacted] 1	Valve	[redacted]	Corrosion of valve stem	[redacted]	CR	L	Disassemble flange, recoat	P2	No	[redacted]	24-48mo		
[redacted] 2	Pipe	[redacted]	No wrap at pipe ground penetration	[redacted]	OT	L	Install wrap at ground penetration and repair pipe as required	P2	No	[redacted]	24-48mo		
[redacted] 1	Valve	[redacted]	Coating failure on valve	[redacted]	CD	L	Local coating repair	P2	No	[redacted]	24-48mo		

							Recommendation						
Item	Component	Location	Description	Photograph	Observation Type	Severity	Description	Priority	Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
HK-1	Valve	(b)(3)(A) [redacted]	Corrosion of valve/equipment flanges		CR	L	Clean to determine if section loss is acceptable for performance, recoat or replace	P2	No	(b)(3) [redacted]	24-48mo		
HK-4	Pipe	[redacted]	Surface corrosion on (b)(3)(A) [redacted]	(b)(3)(A) [redacted]	CR	L	We recommend additional inspection and testing (NDT) to determine if stress corrosion cracking is a concern. Clean pipe and establish a maintenance program to mitigate surface corrosion.	P2	Review by SGH recommended	[redacted]	24-48mo		
AGP-4	Pipe	[redacted]	Coating failure	[redacted]	CD	L	Local coating repair	P2	No	[redacted]	Completed		Completed under RMMR Service Order PRL-PND-607
AGP-9	Pipe	[redacted]	Localized coating failure		CR	L	Local coating repair	P2	No	[redacted]	24-48mo		
HP-2	Pipe	[redacted]	Local coating failure and localized corrosion	(b)(3)(A) [redacted]	CR	L	Local coating repair.	P2	No	[redacted]	24-48mo	Whole length of pipe needs to be inspected, but this could not be accessed during our inspection	RMMR Service Order PRL-PND-625
HP-10	Structural	[redacted]	Bottom face of beam	 (b)(3)(A) [redacted]	PD	L	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P2	Review by SGH recommended	[redacted]	24-48mo	Apparent consolidation issue from construction (bug hole with exposed rebar). Likely under NAVFAC Triton contract.	
MP-13	Pipe	[redacted]	Crevice corrosion at fuel pipe springline, coating issue	(b)(3)(A) [redacted]	CD/CR	L	Repair coating, separate pipe from vertical element to limit crevice corrosion	P2	No	[redacted]	24-48mo		RMMR Service Order PRL-PND-693E
MP-16	Other	[redacted]	Ladder base, cross section 100% corroded		PD/CR	H	Repair access ladder	P2	No	[redacted]	24-48mo		

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
MP-18	Pipe	(b)(3)(A) [redacted]	Conduit box resting on fuel pipe	 (b)(3)(A) [redacted]	IC	M	Reattach conduit box and remove from pipe	P2	No	(b)(3) [redacted]	24-48mo		RMMR Service Order PRL-PND-693E through PRL-PND-696E
MP-19	Pipe	[redacted]	Corrosion bulges on fuel pipe, damaged coating	[redacted]	CR	M	Repair pipe and coating	P2	No	[redacted]	24-48mo		RMMR Service Order PRL-PND-693E through PRL-PND-696E
MP-20	Pipe	[redacted]	Pipe support pad between pipe and roller is missing, surface corrosion at pipe invert	[redacted]	IC	M	Replace pipe pad between pipe and roller support	P2	No	[redacted]	24-48mo		RMMR Service Order PRL-PND-693E through PRL-PND-696E
BP-6	Structural	[redacted]	Spalled concrete and exposed rebar		PD/CR	M	Repair as appropriate to re-establish design margin. Note that the 2018 Pier Inspection report classifies the system as satisfactory, however,we recommend further evaluation.	P2	Review by SGH recommended	[redacted]	24-48mo	Repair estimate from Marine Solutions Inc. 2018 Inspection Report	
LAT-6	Piping	[redacted]	Improperly centered pipe bearing pad	(b)(3)(A) [redacted]	OT	L	Reset pipe bearing pad under centerline of pipe, or provide a larger pad	P3	No	[redacted]	Ongoing	This pipe support has a pad between the pipe and support currently	
LAT-9	Structural	[redacted]	Crack in column encasement		OT	L	Repair as needed	P3	No	[redacted]	Ongoing		
LAT-23	Structural	[redacted]	Dents in pipe supports		PD	L	Repair as needed	P3	No	[redacted]	Ongoing		
LAT-28	Structural	[redacted]	Dents in pipe supports		PD	L	Repair as needed	P3	No	[redacted]	Ongoing		RMMR Service Order RHL-PND-617 includes 44, 46, 73, 74, 77

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
LAT-33	Structural	[redacted]	Coating damage at JP-5 pipeline, signs of apparent movement at interface with cradle	[redacted]	CD	L	Repair coating	P3	No	[redacted]	Ongoing		API 570 inspection in progress
LAT-49	Structural	[redacted]	Leakage through tunnel wall		OT	L	Wall is adequate. Continue to monitor for deterioration of concrete tunnel wall.	P3	No	[redacted]	Ongoing		
LAT-50	Piping	[redacted]	Coating failure at pipe flange	[redacted]	CD	L	Repair coating	P3	No	[redacted]	Ongoing		API 570 inspection in progress
LAT-54	Piping	[redacted]	Small uniform pitting on inside surface of pipe lateral (similar at trunk line)		PD	L	Monitor and perform API in line inspections at required frequency to capture unacceptable pitting	P3	No	[redacted]	Ongoing		
HT-16	Piping	[redacted]	Coating issue at pipe flange	[redacted]	CD	L	Repair coating	P3	No	[redacted]	Ongoing	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
HT-45	Piping	[redacted]	Coating damage on [redacted] F-76 fuel pipe	[redacted]	CD	L	Repair coating	P3	No	[redacted]	Ongoing	Might be more efficient to recoat the entire pipe	RMMR Service Order RHL-PND-612 is a Coatings Condition Survey by a NACE Inspector
AST-13	Pipe Support	[redacted]	Minor corrosion Issues	[redacted]	CR	L	Maintenance as needed	P3	No	[redacted]	Ongoing	[redacted]	
AST-14	Tank Shell and New Double Bottom Plate	[redacted]	Localized sealant Failure and Crevice Corrosion Below Ledge		CR	L	Repair sealant and local coating	P3	No	[redacted]	Ongoing		

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[redacted]1	Valve	(b)(3)(A) [redacted]	Flange protection clamps inconsistently installed	(b)(3)(A) [redacted]	LI	L	Evaluate maintenance requirements and balance with installation of protective flange clamps	P3	No	(b)(3) [redacted]	Ongoing		
[redacted]1	Pipe	[redacted]	JP-5, F-24, F-76 and Waste Oil pipe bedded on gravel in some locations	[redacted]	LI	L	Elevate pipe from grade and support pipe as necessary	P3	No	[redacted]	Ongoing		
[redacted]3	Valve	[redacted]	Flange protection clamps inconsistently installed, crevice corrosion between horizontal and vertical flange interfaces	[redacted]	LI	L	Evaluate maintenance requirements and balance with installation of protective flange clamps	P3	No	[redacted]	Ongoing		
[redacted]9	Other	[redacted]	Ladder propped against fuel line	[redacted]	OT	L	Use alternate ladder/working at height access without supporting on piping	P3	No	[redacted]	Ongoing		
HK-2	Valve	[redacted]	Deterioration of Isolation Joints	[redacted]	OT	L	Replace isolation joint seal	P3	No	[redacted]	Ongoing		
AGP-3	Pipe	[redacted]	Historical corrosion pits coated over		CR	L	We measured historical pit depths and conducted FFS evaluation to determine that these pit depths are acceptable	P3	No	[redacted]	Ongoing		RMMR Service Order PRL-PND-677N & PRL-PND-683E
AGP-5	Pipe	[redacted]	Pipe penetration wrap damaged	(b)(3)(A) [redacted]	OT	L	Put protective shield around pipe	P3	No	[redacted]	Ongoing	Possibly damaged by mowing equipment	
AGP-6	Pipe	[redacted]	Pipe lying on soil and located in a trench	[redacted]	OT	L	Elevate pipe from trench and support pipe as necessary	P3	No	[redacted]	Ongoing		

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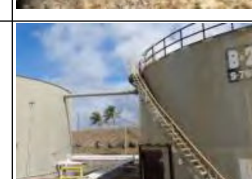
							Description	Priority					
AGP-7	Pipe	(b)(3)(A) [redacted]	Pipe ground penetration coating failing	(b)(3)(A) [redacted]	OT	L	Repair wrap and pipe as required	P3	No	(b)(3) [redacted]	Ongoing		
AGP-8	Pipe	[redacted]	No wrap at ground penetration	[redacted]	OT	L	Add protective wrap at ground penetration and repair pipe as required	P3	No	[redacted]	Ongoing		
AGP-10	Pipe	[redacted]	Wrap failure at ground penetration	[redacted]	OT	L	Repair wrap and pipe as required	P3	No	[redacted]	Ongoing		RMMR Service Order PRL-PND-692
HP-1	Pipe	[redacted]	Pipe ground penetration wrap failure	[redacted]	OT	L	Repair wrap and pipe as required	P3	No	[redacted]	Ongoing		
LAT-4	Structural	[redacted]	Cracks in 6-in concrete wall, below pipe penetration, JP-5 pipeline		PD	L		None	No	[redacted]	-	Wall is adequate	
LAT-11	Structural	[redacted]	Pipe support not matching design drawings		DV	L	Observation only	None	No	[redacted]	-	No repair	
LAT-13	Structural	[redacted]	Pipe support not matching design drawings	(b)(3)(A) [redacted]	DV	L	Observation only	None	No	[redacted]	-	No repair	
LAT-53	Piping	[redacted]	Bend in pipe used to brace JP-5 trunk line	[redacted]	LP	L	SGH analyzed the bend for overstress during a potential repeat surge event, the piping is marginally overstressed but it is just satisfactory	None	No	[redacted]	-		

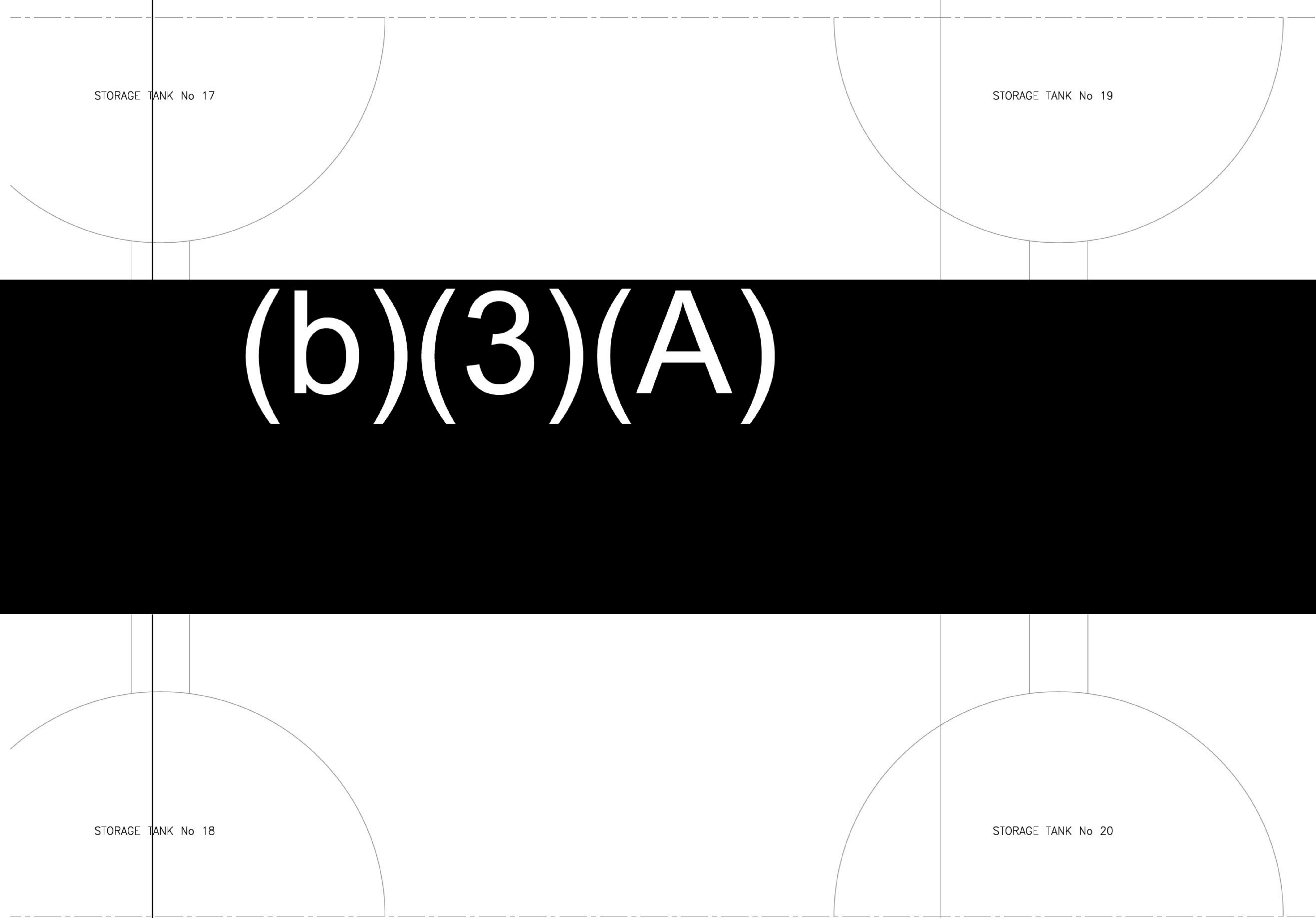
Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
PM-8	Piping	(b)(3)(A) [redacted]	No supports at sectional valves and weight is fully supported by piping and could cause overstress.	(b)(3)(A) [redacted]	IC	L	SGH analyzed piping segments at sectional valves between anchors to determine if overstress exists. No overstress was noted.	None	No	(b)(3) [redacted]	-		
PM-9	Piping		Weight of unsupported DBB and ball valves near pipe nozzles could cause overstress at nozzle concrete penetration.		IC	L	SGH analyzed piping locally at nozzle concrete penetrations to determine if overstress exists. No overstress was noted.	None	No		-	Additional example of unsupported valve (b)(3)(A) [redacted]	
HT-4	Piping		Dents on pipe		PD	L	SGH evaluated FFS for these dents and determined the dents were not critical	None	No		-		API 570 inspection in progress
HT-15	Piping		Large valves inconsistently supported		IR	L	None	None	No		-	Analysis indicates pipe system is adequate	
HT-18	Piping		Dent on pipe		PD	L	SGH evaluated FFS for this dent and determined the dent was not critical	None	No		-		API 570 inspection in progress
HT-20	Piping		0.13in pit measured at F-76(b)(3) [redacted] pipe outside surface, approximately 0.75in diameter		CR	L	SGH conducted FFS level I evaluation for this pit and determined it was acceptable.	None	No		-		API 570 inspection in progress

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
HT-21	Piping	(b)(3)(A) [redacted]	Dent in pipe, measured 0.26in, written on pipe 0.2835in		PD	L	SGH evaluated FFS for this dent and determined the dent was not critical	None	No	(b)(3) [redacted]	-		API 570 inspection in progress
HT-25	Piping	[redacted]	Localized corrosion pits		CR	L	Contractor to clean pipe, then measure corrosion section loss, then FFS evaluation prior to repair and recoat	None	No	[redacted]	-		API 570 inspection in progress
HT-27	Piping	[redacted]	0.038in pit measured at F-24 [redacted] pipe outside surface		CR	L	SGH conducted FFS level I evaluation for this pit and determined it was acceptable	None	No	[redacted]	-		API 570 inspection in progress
HT-29	Piping	[redacted]	0.119in pit measured at F-76 [redacted] pipe outside surface, approximately 1.4in diameter	 (b)(3)(A) [redacted]	CR	L	SGH conducted FFS level I evaluation for this pit and determined it was acceptable	None	No	[redacted]	-		API 570 inspection in progress
HT-31	Piping	[redacted]	Dents on pipe	[redacted]	PD	L	SGH evaluated FFS for this dent and determined the dent was not critical	None	No	[redacted]	-		API 570 inspection in progress
HT-43	Piping	[redacted]	Coating damage, surface corrosion and pit at exterior [redacted] F-76 pipe surface		CD	L	Contractor to clean pipe, then measure corrosion section loss, then FFS evaluation prior to repair and recoat	None	No	[redacted]	-		API 570 inspection in progress
AST-6	Overflow pipe connecting Tanks B1 & B2	[redacted]	Overconstrained piping (pipe could be potentially damaged during earthquake)		IR	L	There could be damage to the piping during tank uplift. However, since piping is near roof level there is minimal release potential and loss of product. Retrofit is not needed.	None	No	[redacted]	-	Tanks B1 & B2 are currently in NAVFAC CIR. The contractor recommended removing this pipe, but the recommendation was rejected.	

Item	Component	Location	Description	Photograph	Observation Type	Severity	Recommendation		Additional Engineering (Detailed Design) Required	Construction Cost Est. (Engineering Costs Excluded)	Completion Schedule	Additional Comments	Ongoing Projects
							Description	Priority					
HP-9	Structural	(b)(3)(A) [redacted]	Pipe outlet drains to ocean, unclear if this is part of the FOR system		OT	L	Concern about potential environmental effects. However, this is a water drain.	None	No	(b)(3) [redacted]	-	This is acceptable. Water drain from 3-way valve.	
HT-39	Other	[redacted]	Active leakage through floor drain		OT	M	Identify source of leakage and determine if it needs to be remediated	None	No	[redacted]	-		

APPENDIX A.3

Conceptual Retrofit Drawings in Lower Access Tunnel



[redacted] (b)(3)(A)

1 PARTIAL PLAN – STORAGE TANK LAYOUT – LATERAL RESTRAINTS

1/16" = 1'-0"

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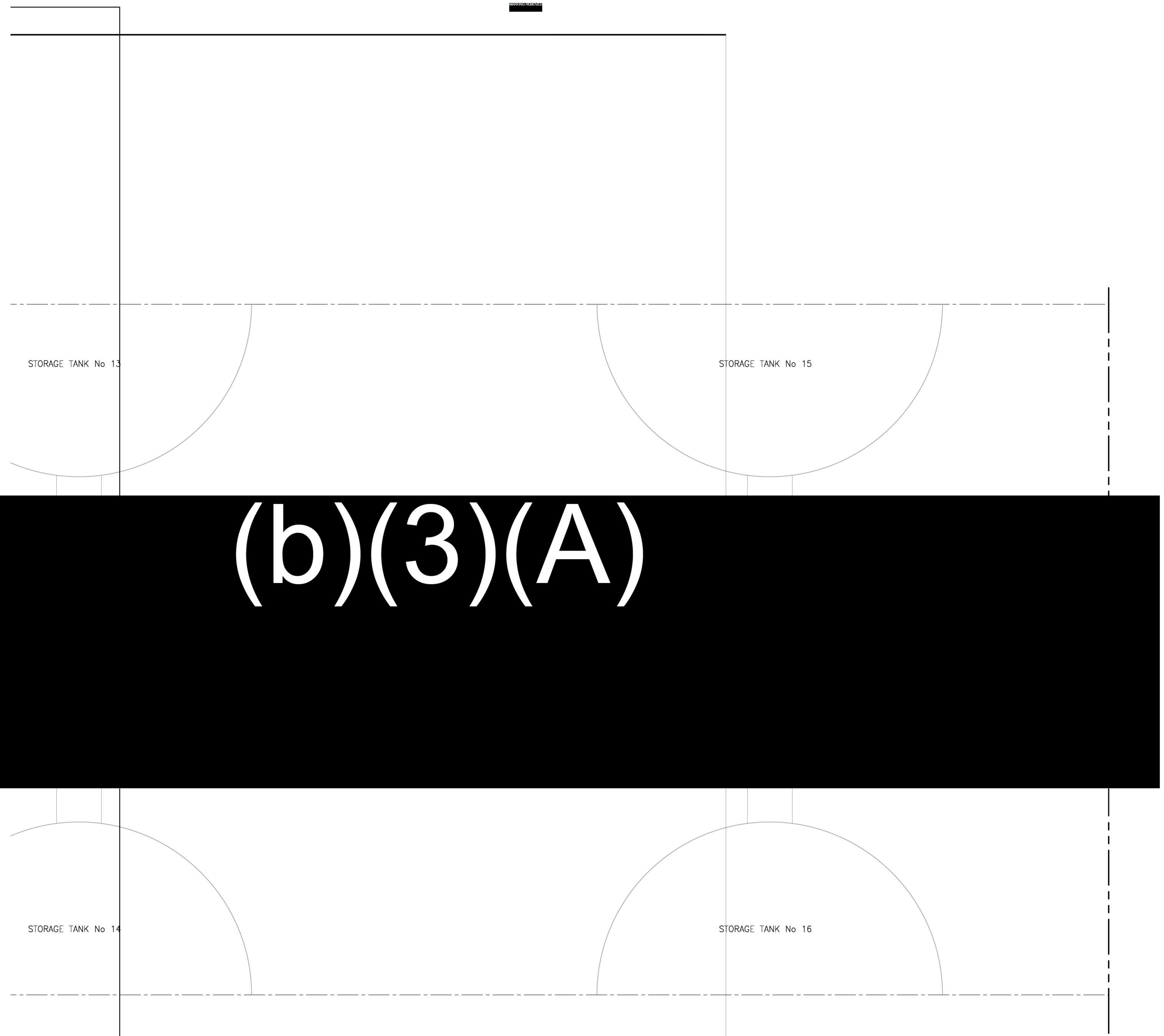
Drawing Title

Project No. 220064.00	Checked	Date 04/28/22
Drawn CB	Approved	Scale

Seal

Drawing No.
S1.1



[redacted] (b)(3)(A)

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Drawing Title

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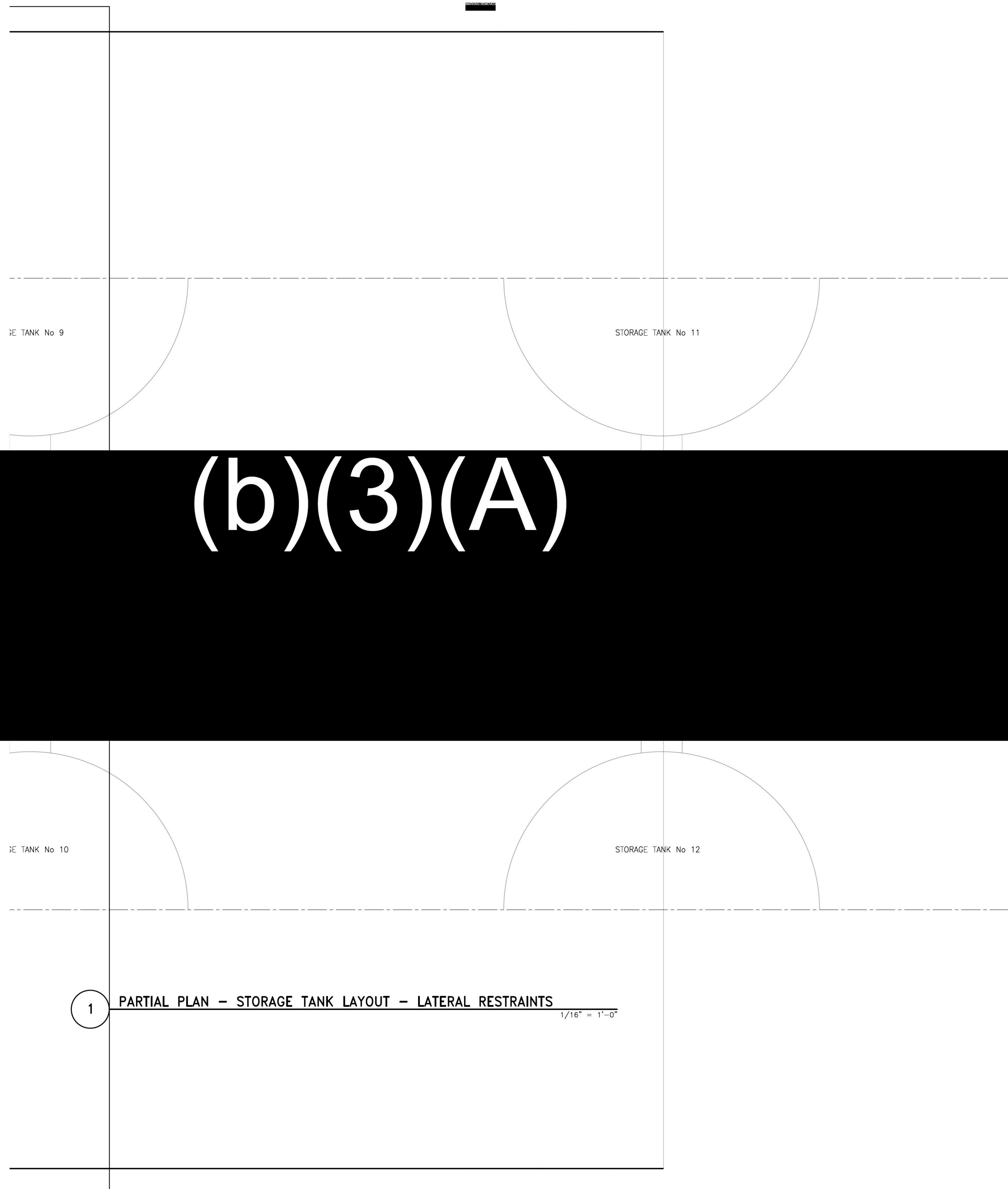
Seal

Drawing No.
S1.2



(b)(3)(A)
[redacted]

1 PARTIAL PLAN – STORAGE TANK LAYOUT – LATERAL RESTRAINTS
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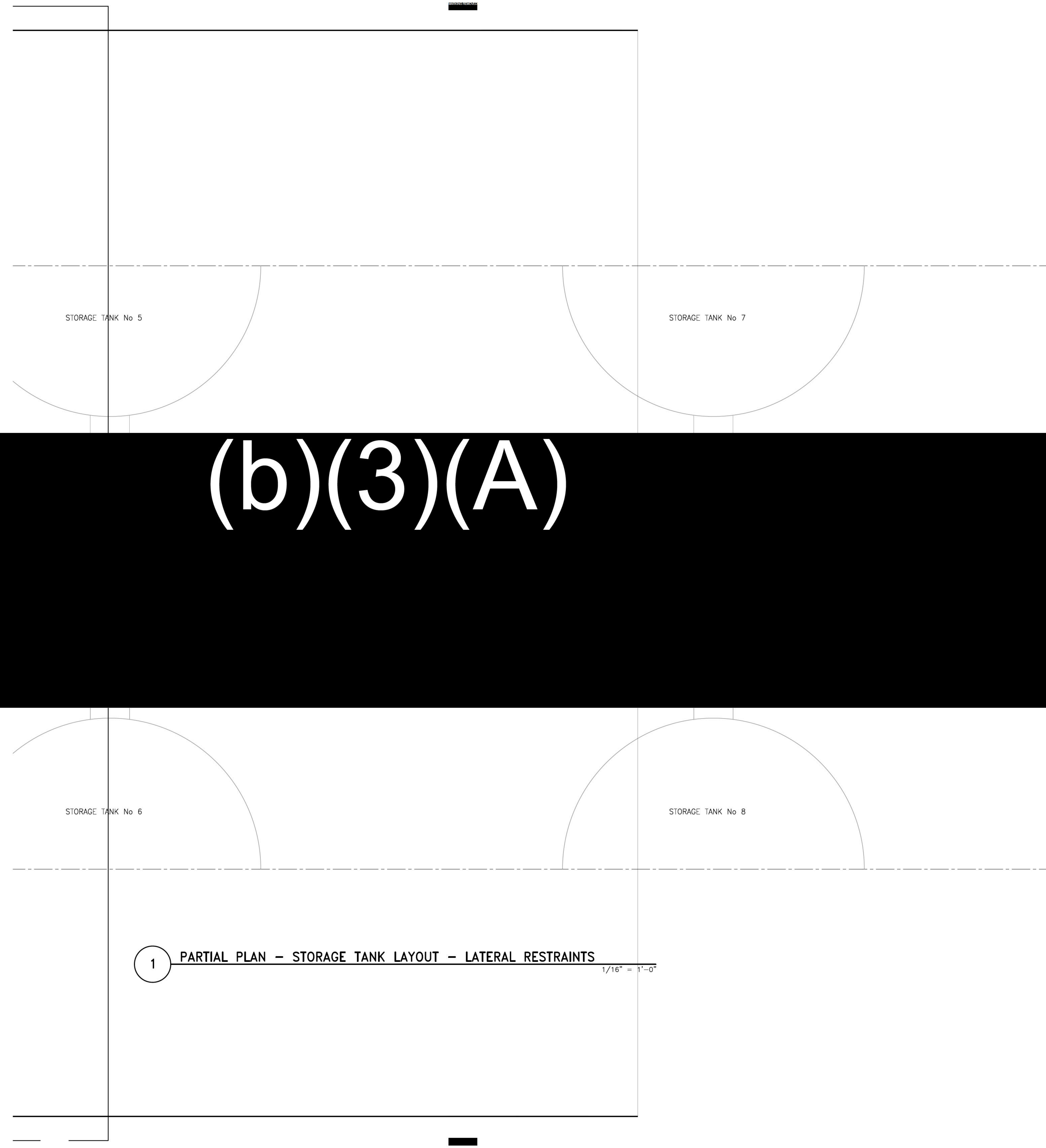
Seal

Drawing No.

S1.3



1 PARTIAL PLAN – STORAGE TANK LAYOUT – LATERAL RESTRAINTS
1/16" = 1'-0"

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Drawing Title

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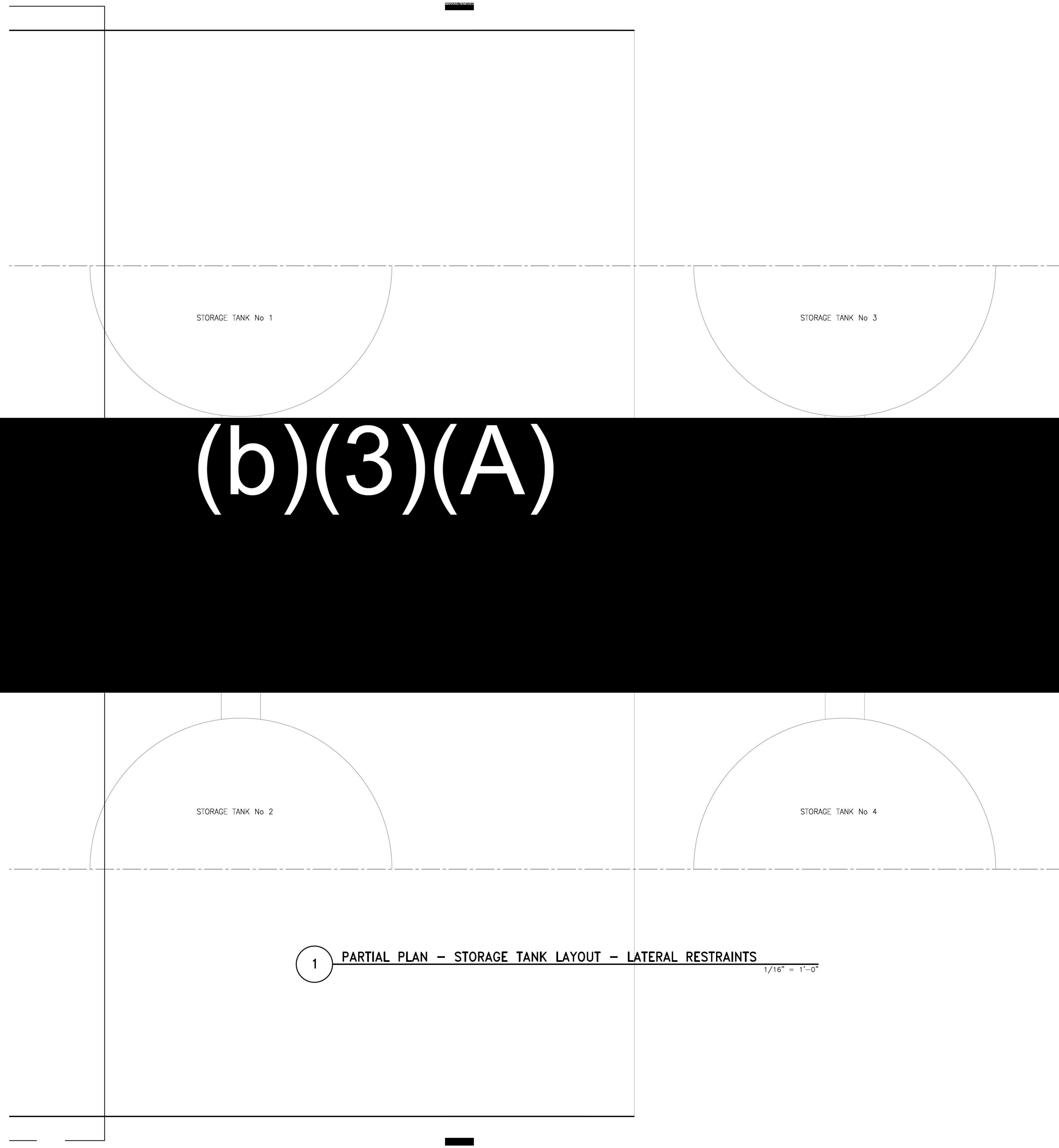
Drawn CB	Approved	Scale

Seal

Drawing No.

S1.4



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1/16" = 1'-0"

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Drawing Title

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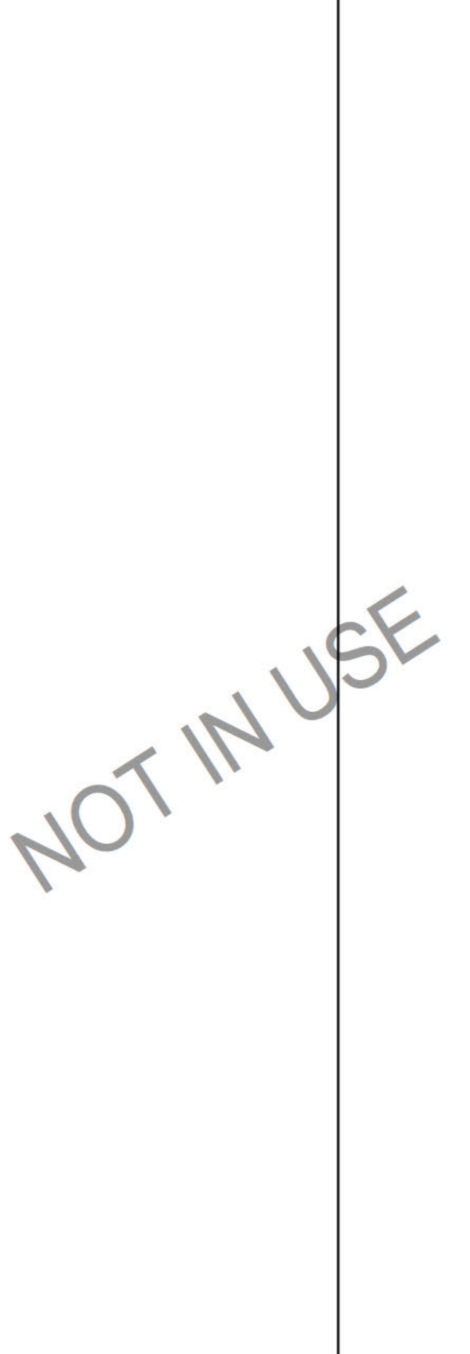
Drawn	Approved	Scale
CB		

Seal

Drawing No.
S1.5

NOT IN USE



1 TYPE I
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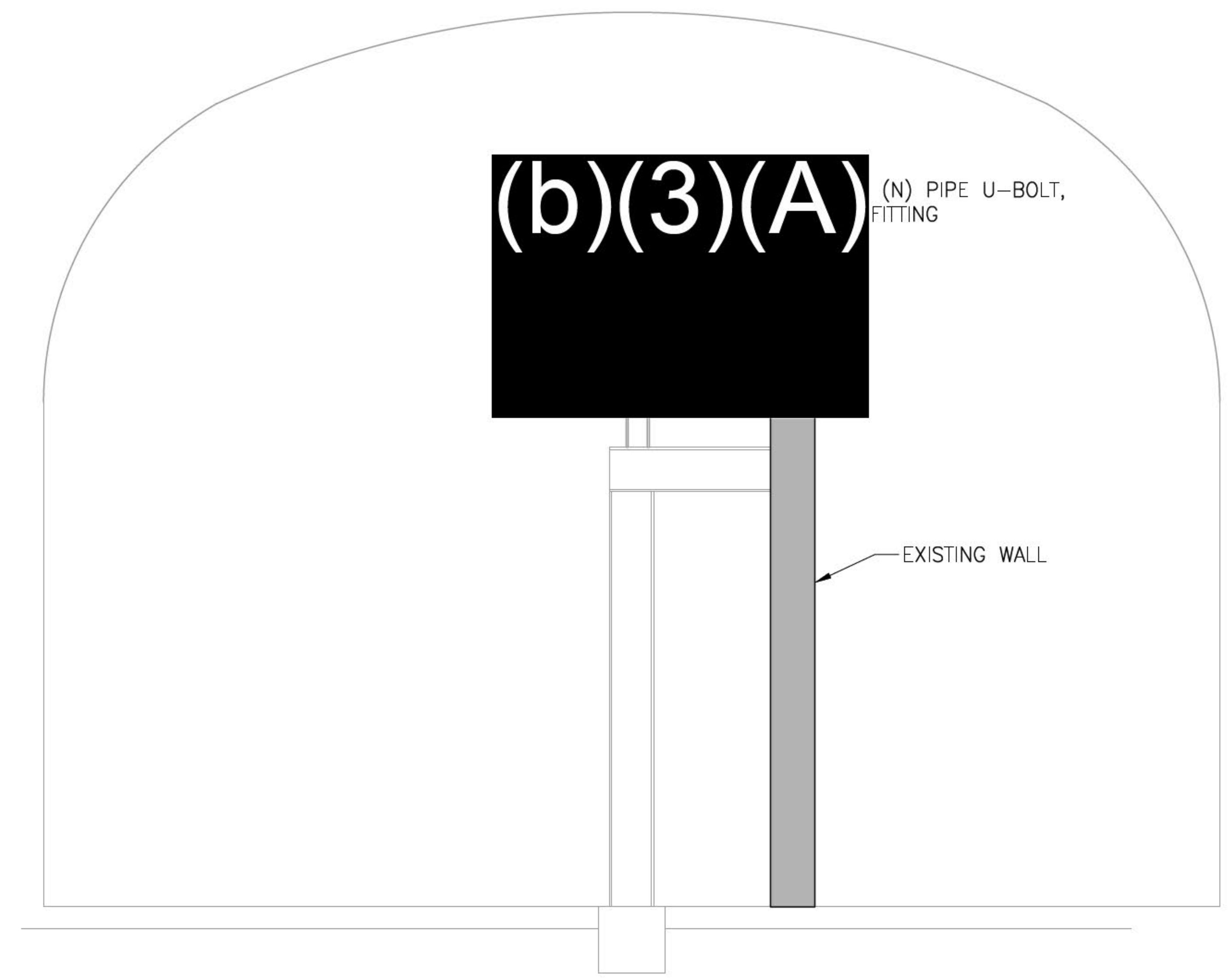

2 TYPE II
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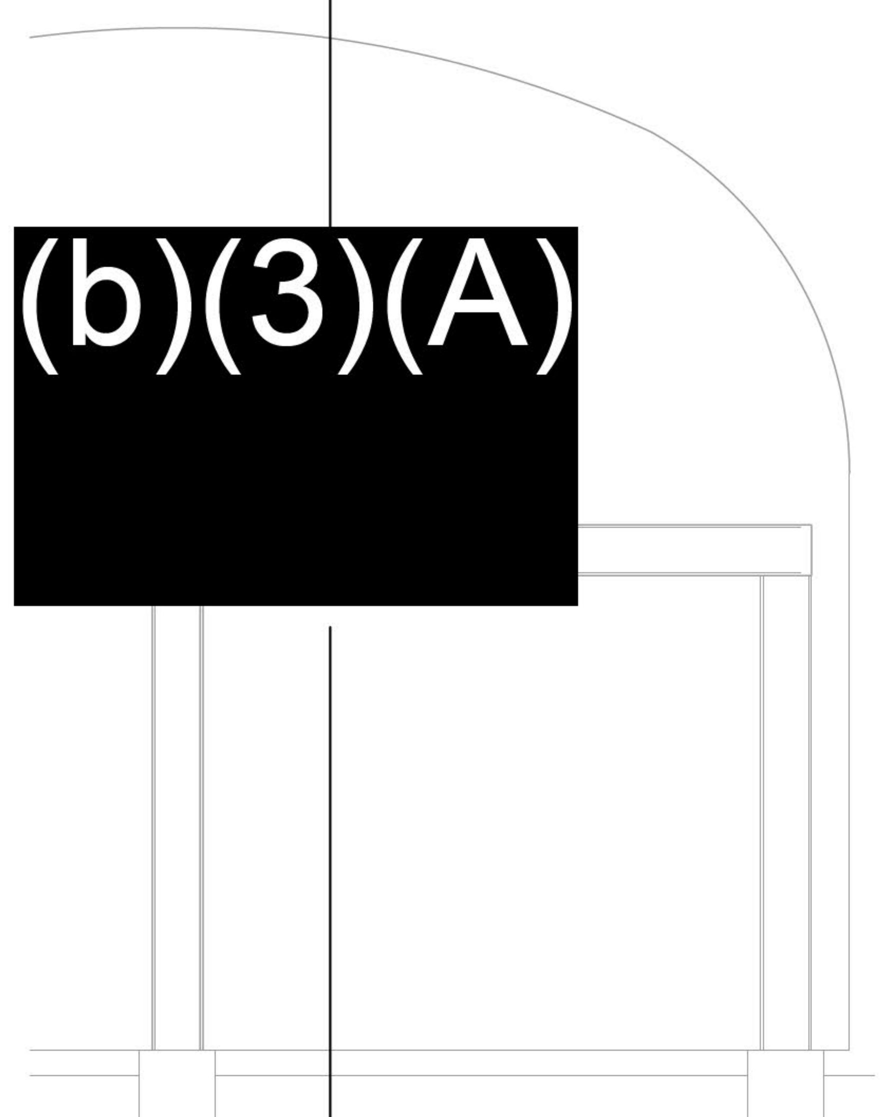

3 TYPE III
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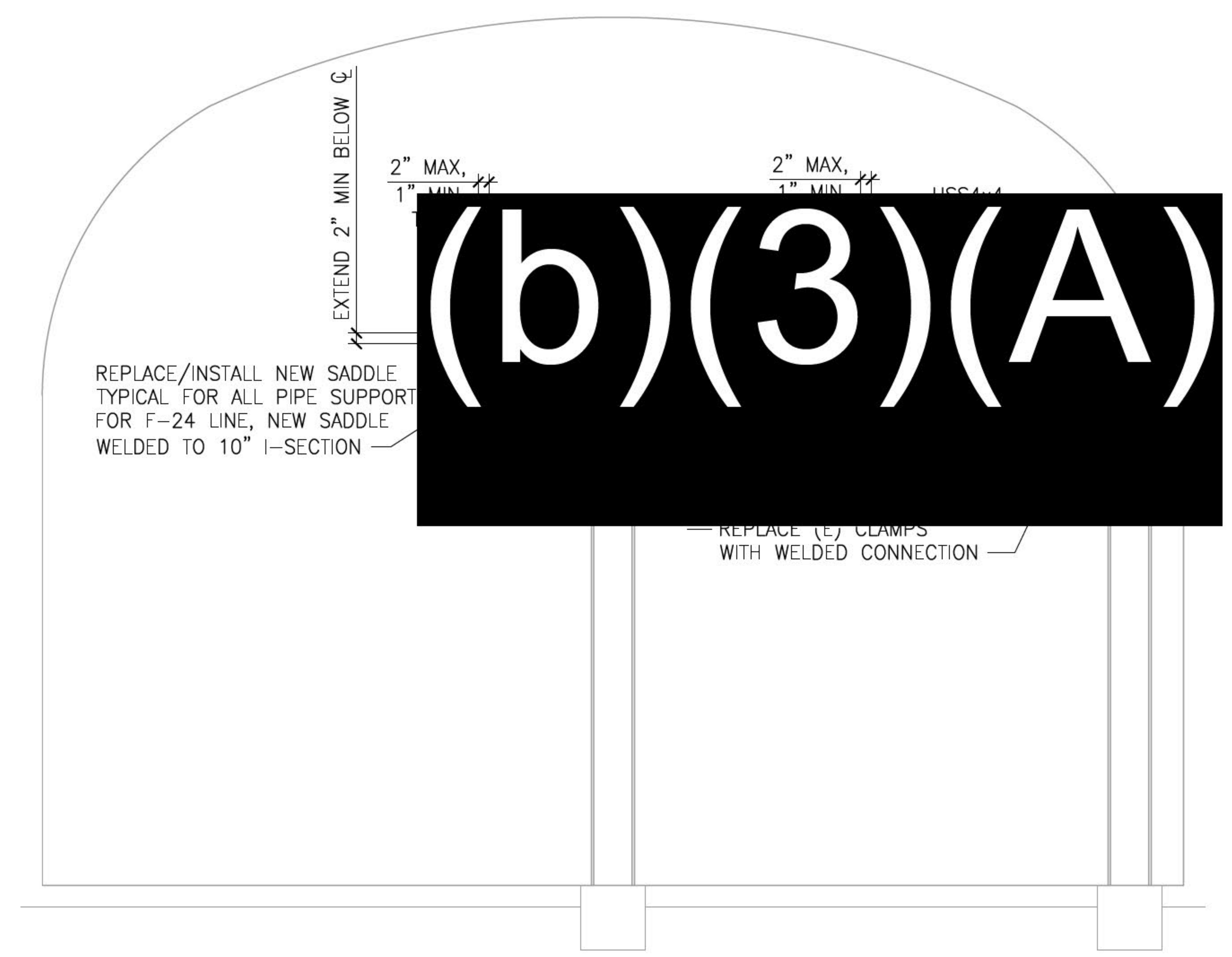

4 TYPE IV
1/2" = 1'-0"

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DETAILS - NEW LATERAL RESTRAINTS ON PIPE SUPPORTS, LOWER ACCESS TUNNEL

Drawing Title

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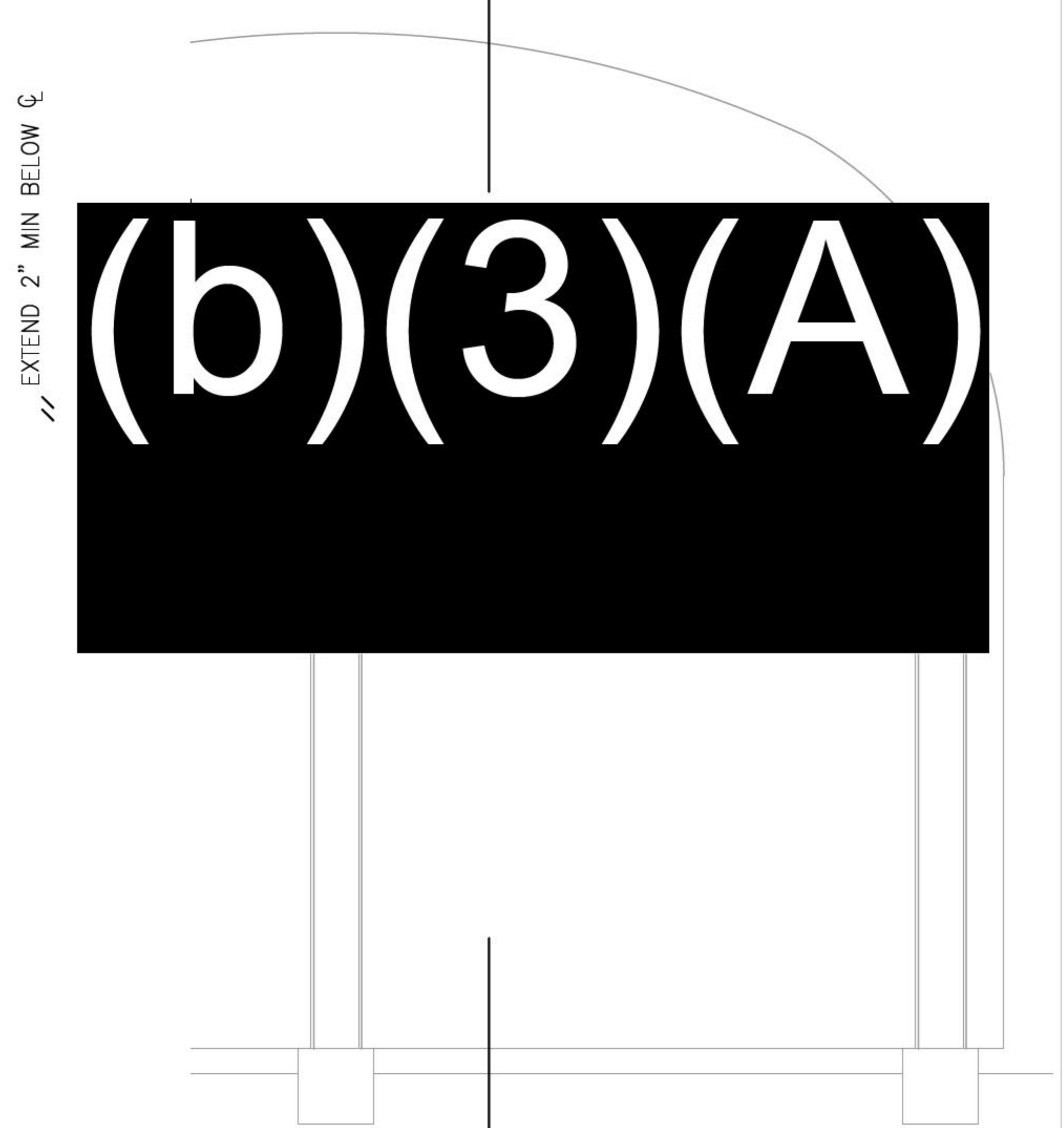
Drawn CB	Approved	Scale

Seal

Drawing No.
S2.1



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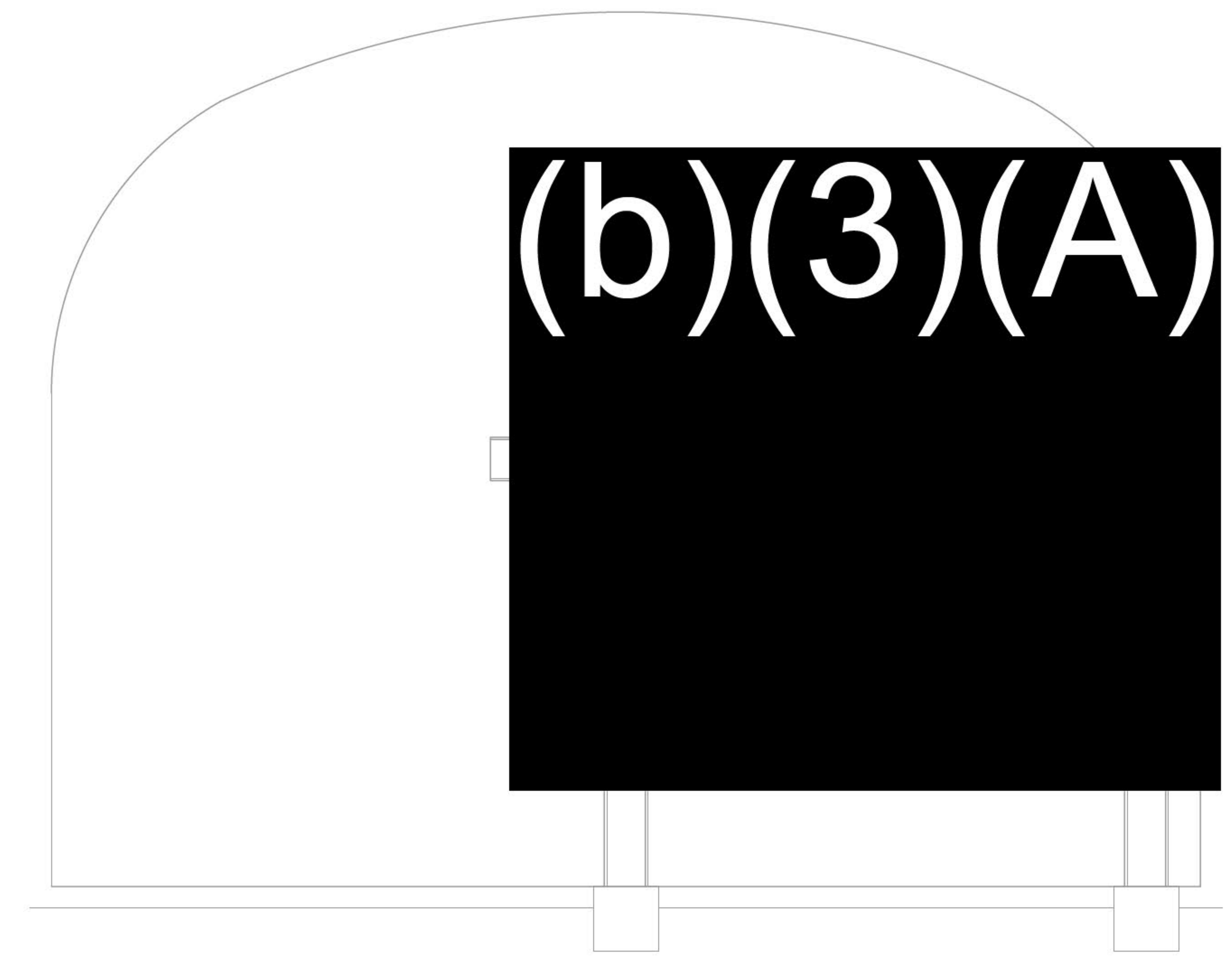

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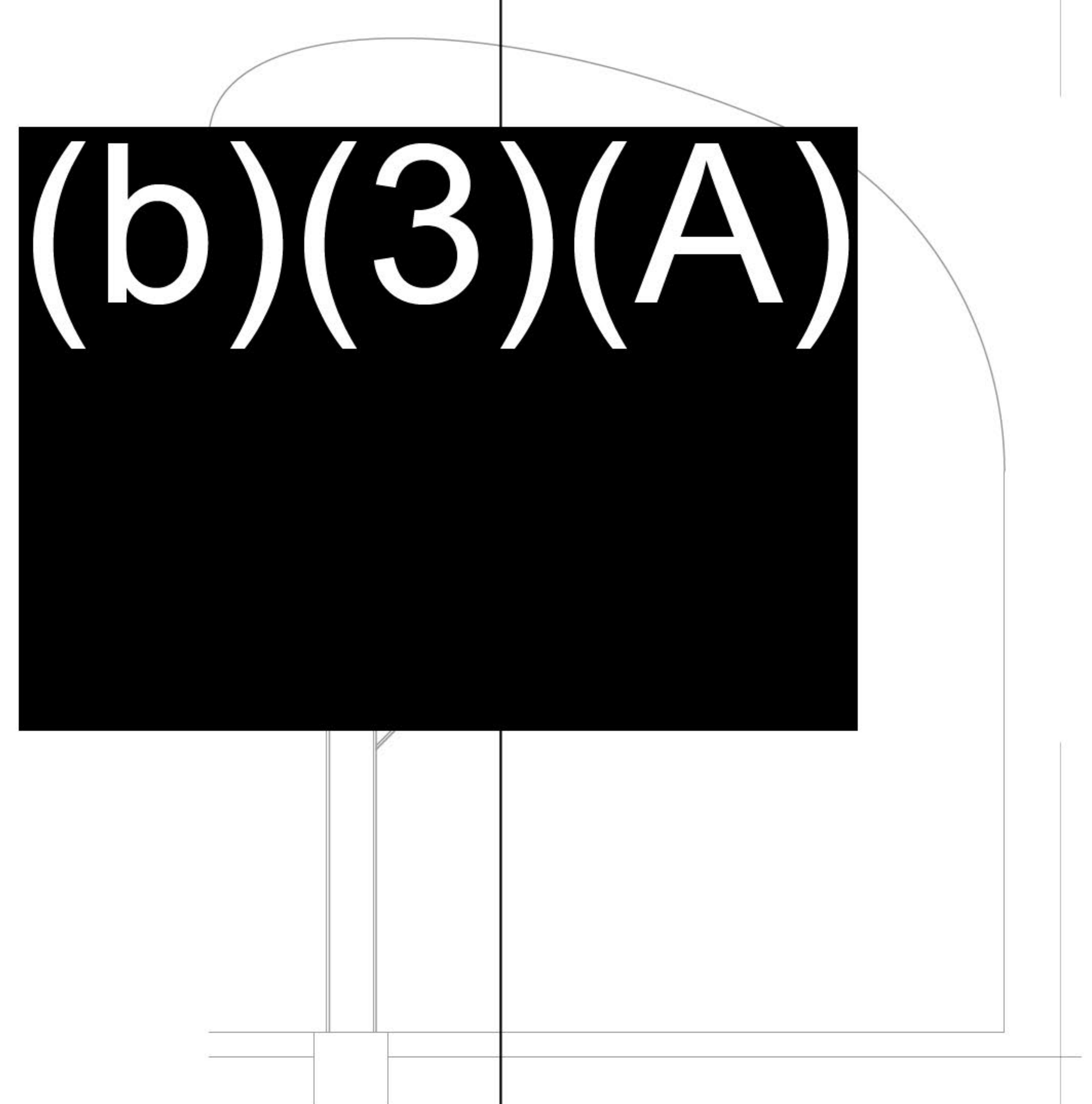
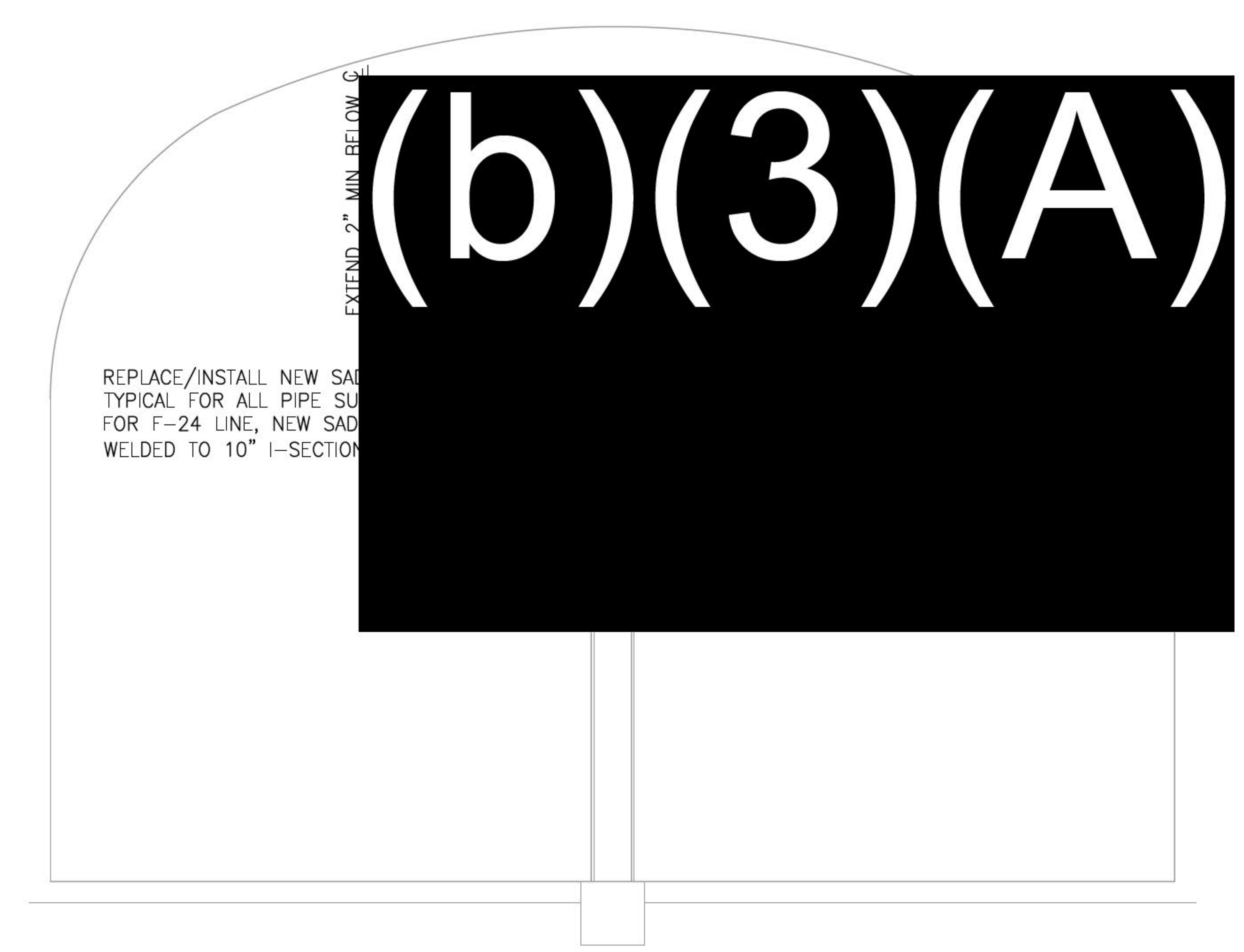
1/2" = 1'-0"



7 TYPE VII
1/2" = 1'-0"



8 TYPE VIII
1/2" = 1'-0"

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Drawing Title

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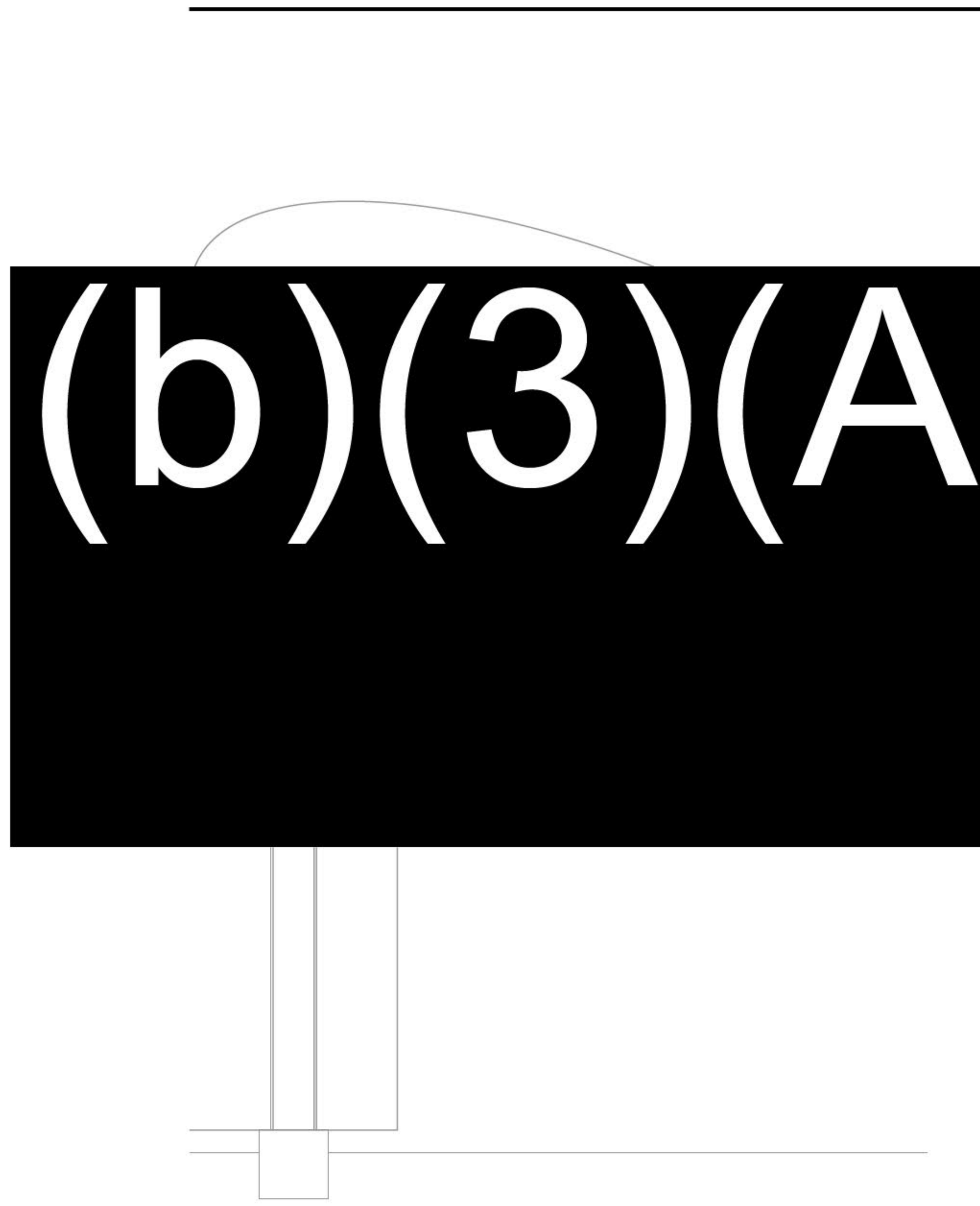
Drawn	Approved	Scale
CB		

Seal

Drawing No.

S2.2



9 TYPE IX
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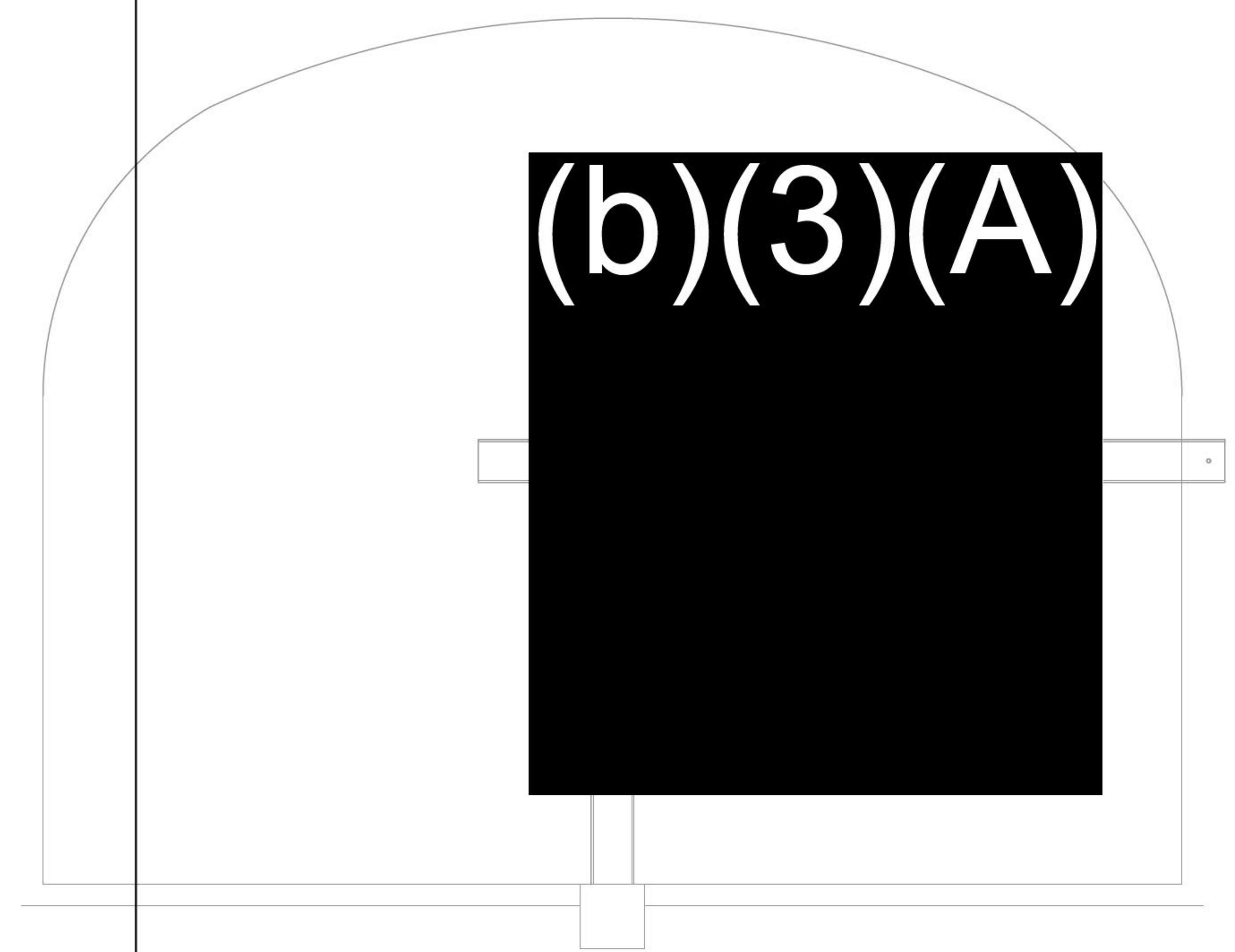
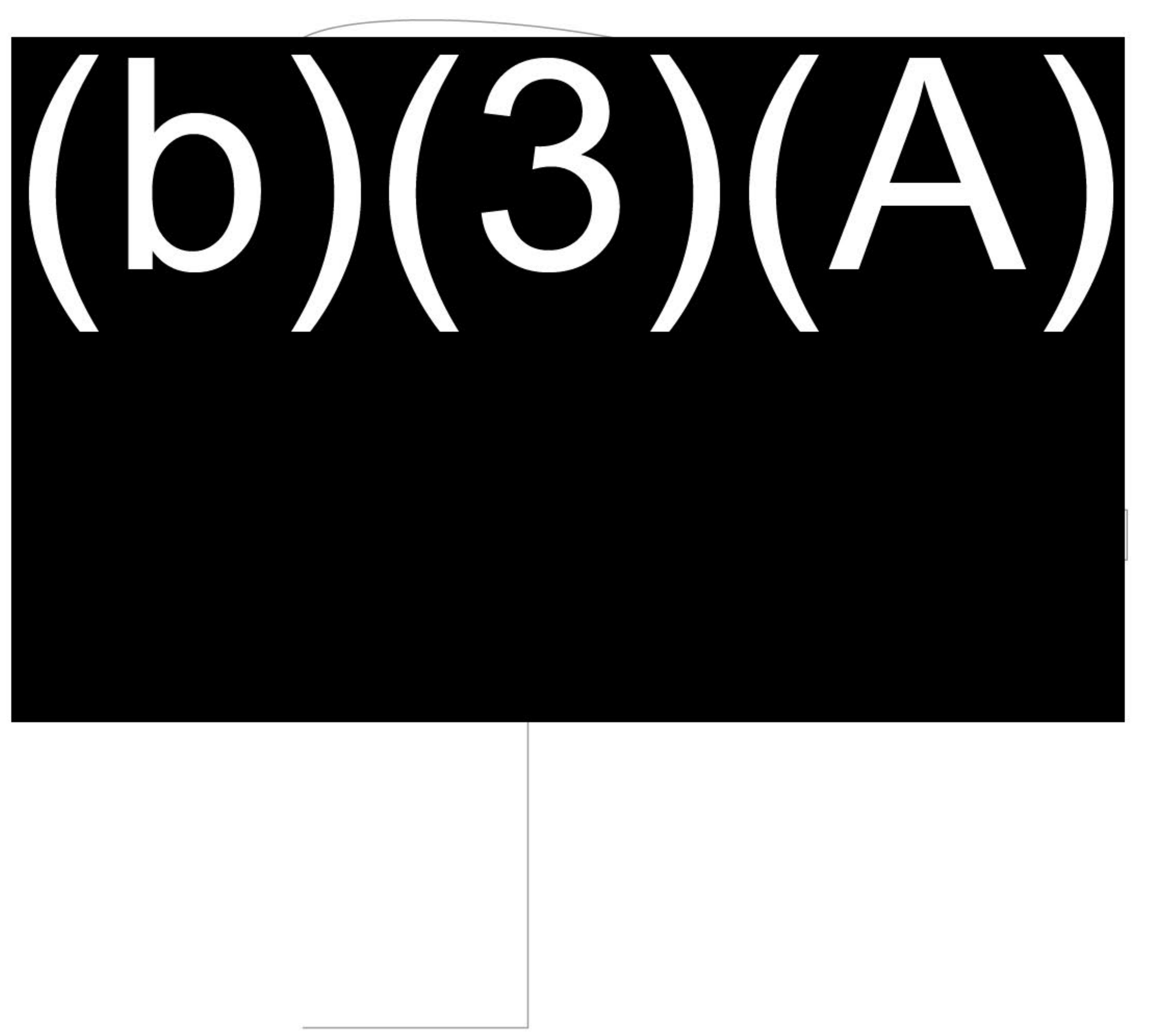
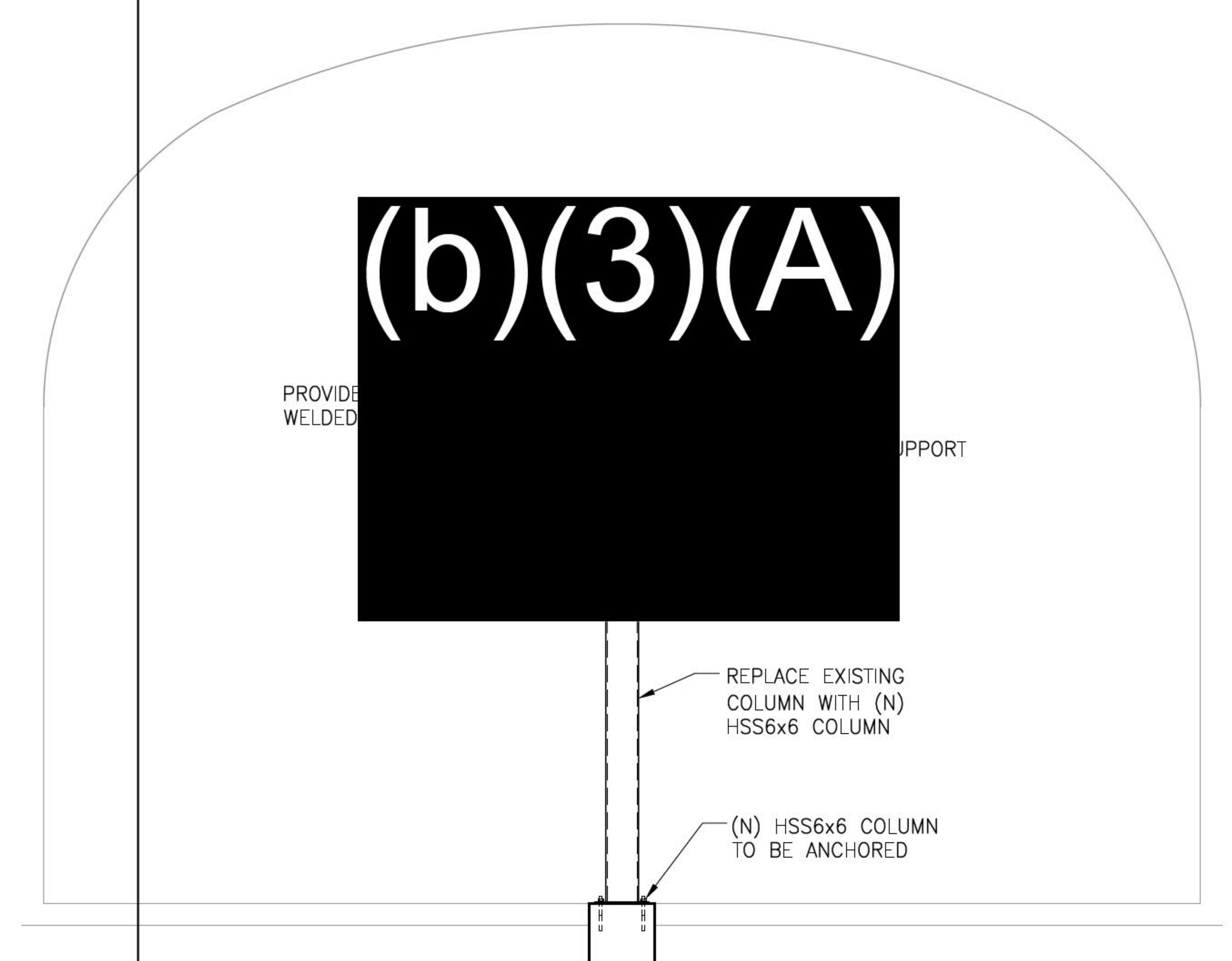


10 TYPE X
1/2" = 1'-0"



11 TYPE XI
1/2" = 1'-0"



12 TYPE XII
1/2" = 1'-0"

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Drawing Title

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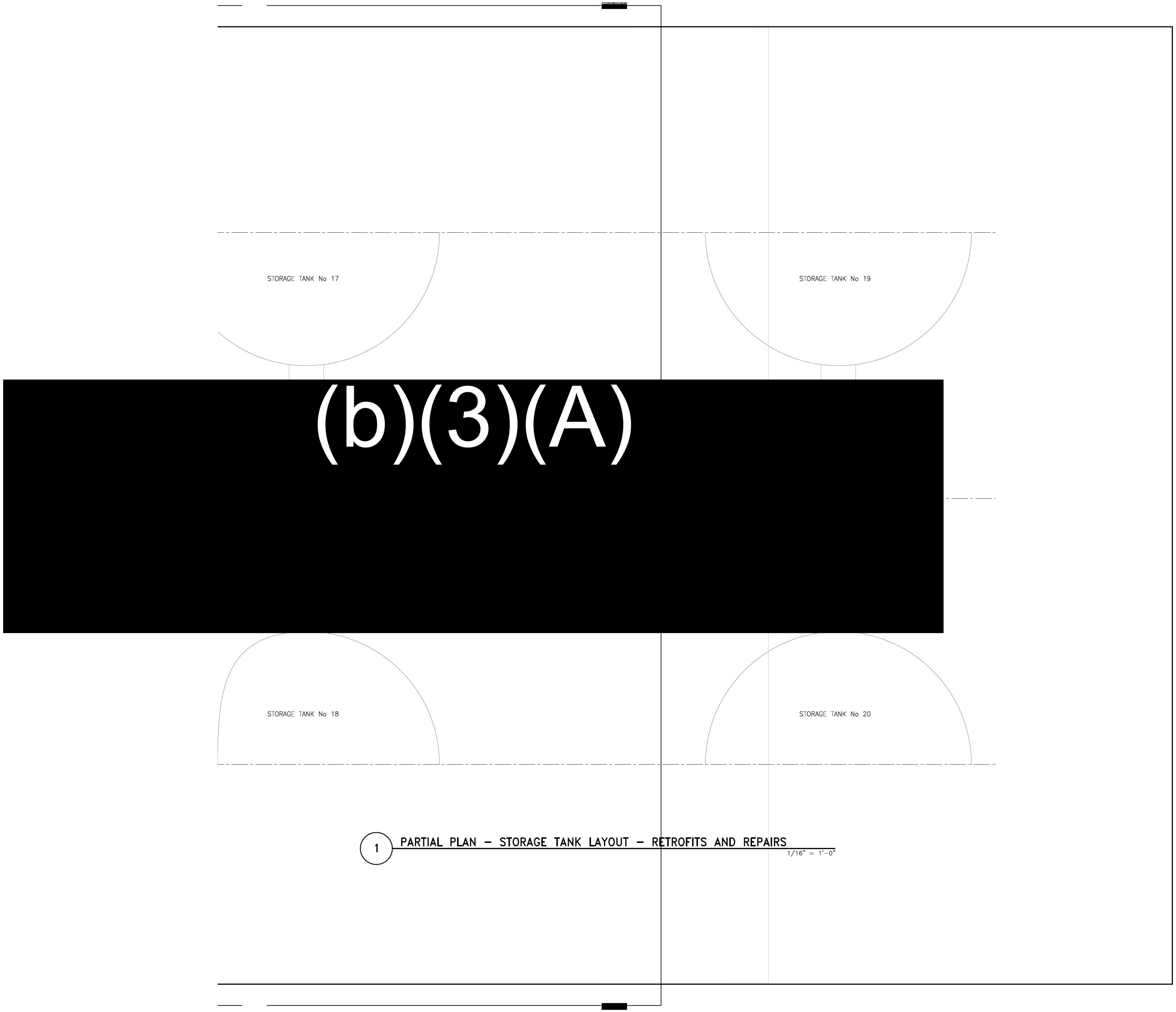
Seal

Drawing No.
S2.3



1 PARTIAL PLAN – STORAGE TANK LAYOUT – RETROFITS AND REPAIRS
1/16" = 1'-0"

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Drawing Title

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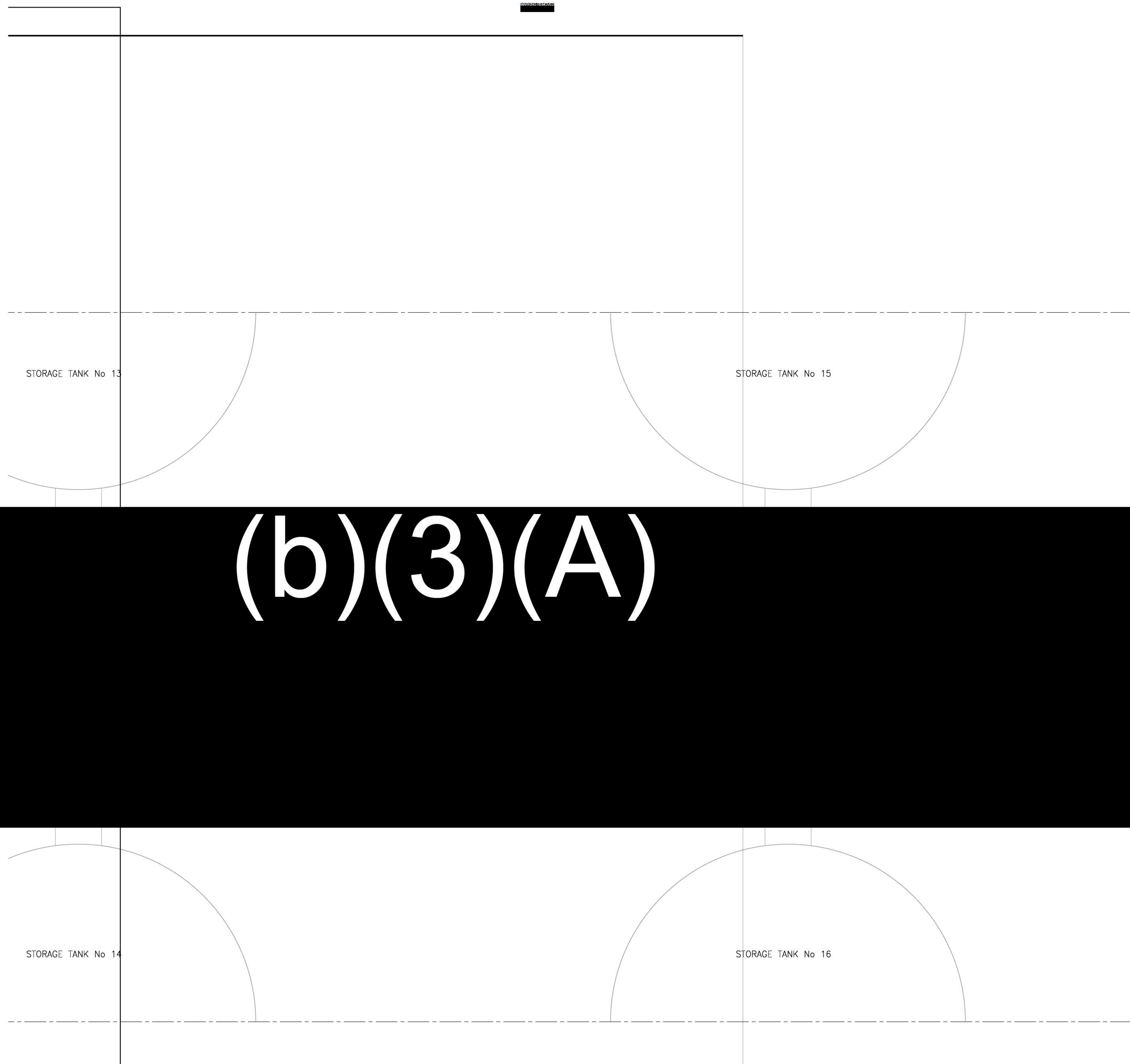
Drawn CB	Approved	Scale

Seal

Drawing No. **S3.1**



[redacted]

(b)(3)(A)

1 PARTIAL PLAN – STORAGE TANK LAYOUT – RETROFITS AND REPAIRS
1/16" = 1'-0"

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Drawing Title

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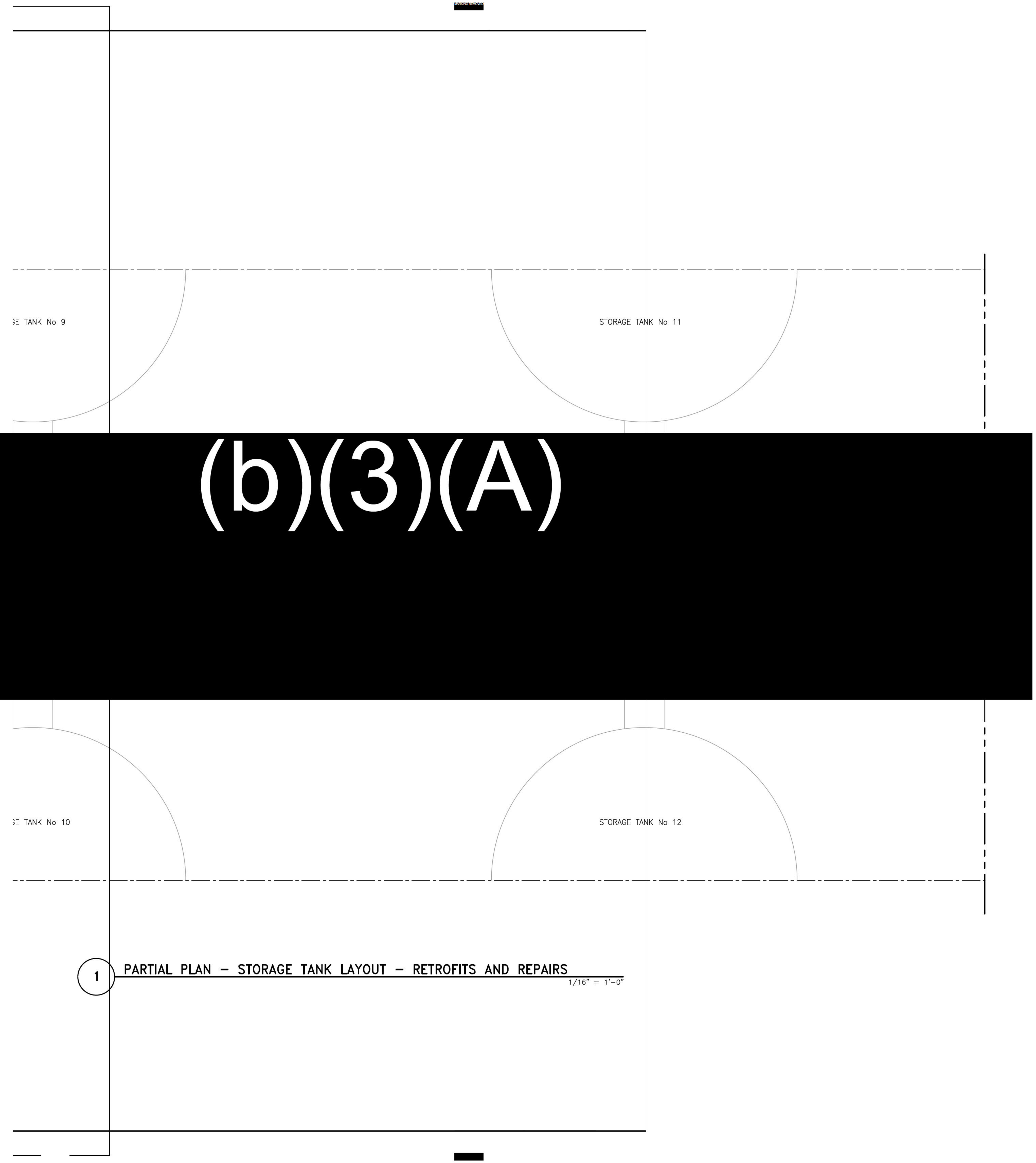
Drawn CB	Approved	Scale

Seal

Drawing No.

S3.2



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1/16" = 1'-0"

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Drawing Title

Project No.	Checked	Date
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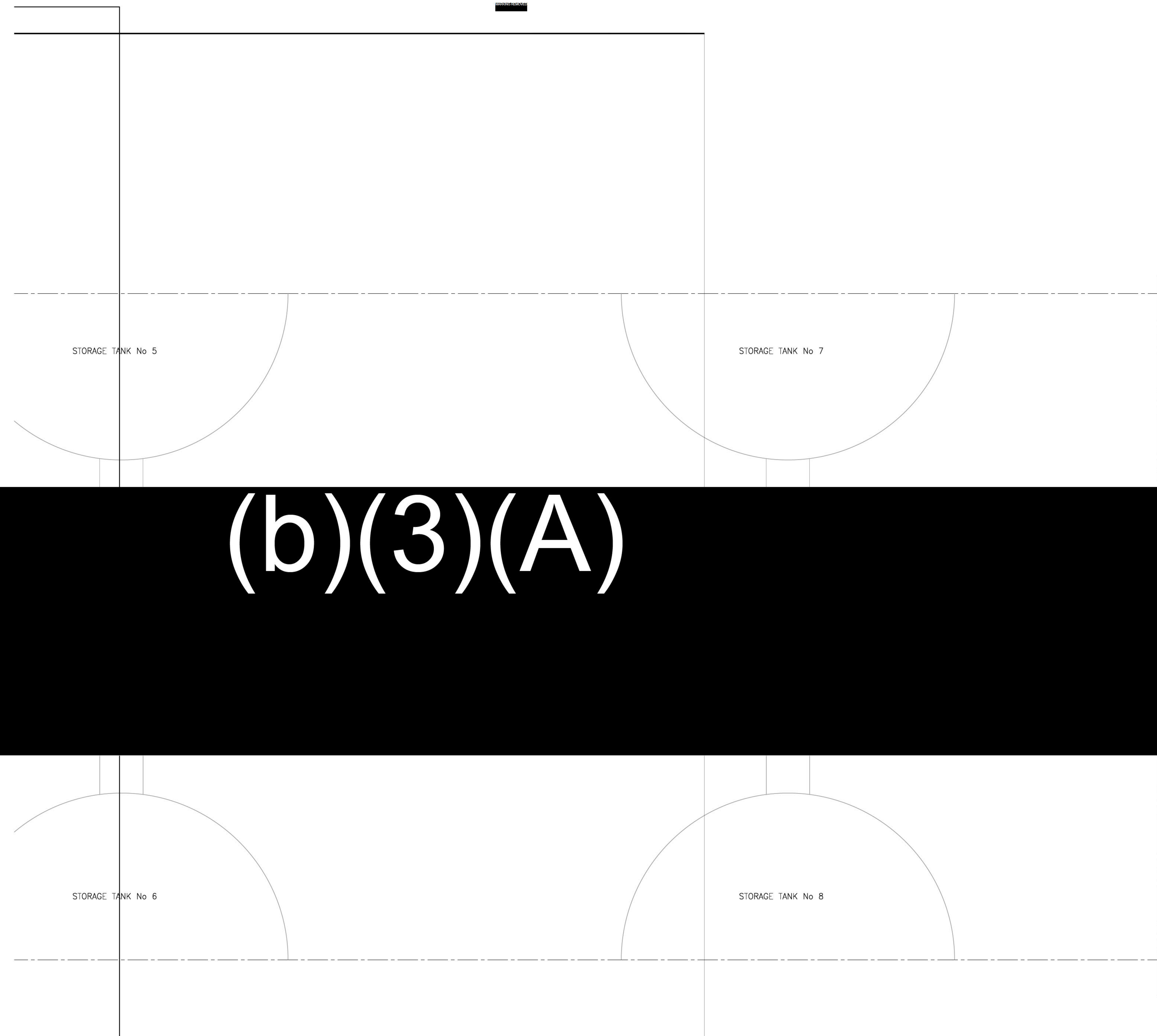
Drawn	Approved	Scale
CB		

Seal

Drawing No.
S3.3



[redacted]

1 PARTIAL PLAN – STORAGE TANK LAYOUT – RETROFITS AND REPAIRS
1/16" = 1'–0"

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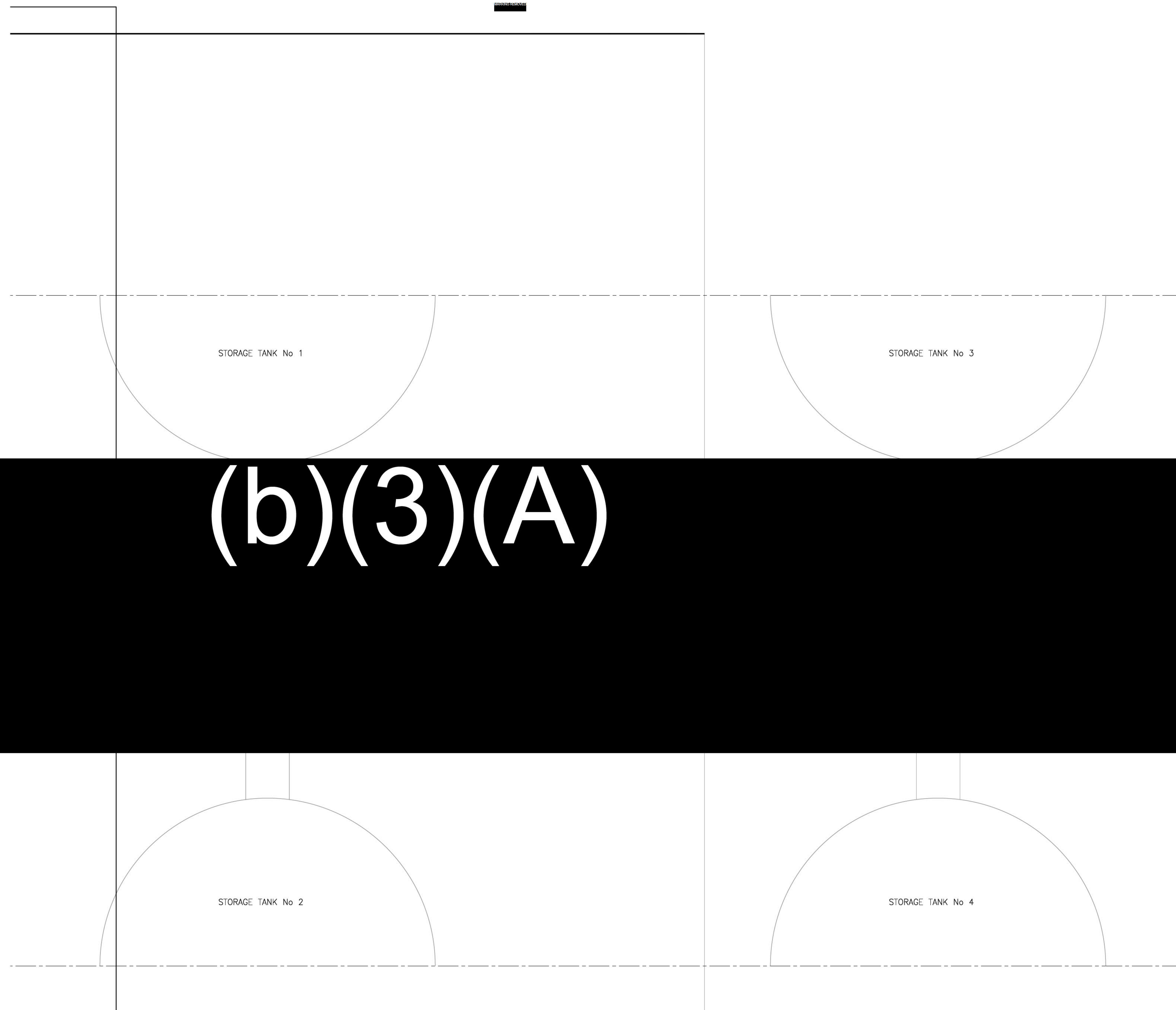
Drawing Title

Project No.	Checked	Date
220064.00		04/28/22
Drawn	Approved	Scale
CB		

Seal

Drawing No.

S3.4



1 PARTIAL PLAN – STORAGE TANK LAYOUT – RETROFITS AND REPAIRS
1/16" = 1'-0"

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Drawing Title

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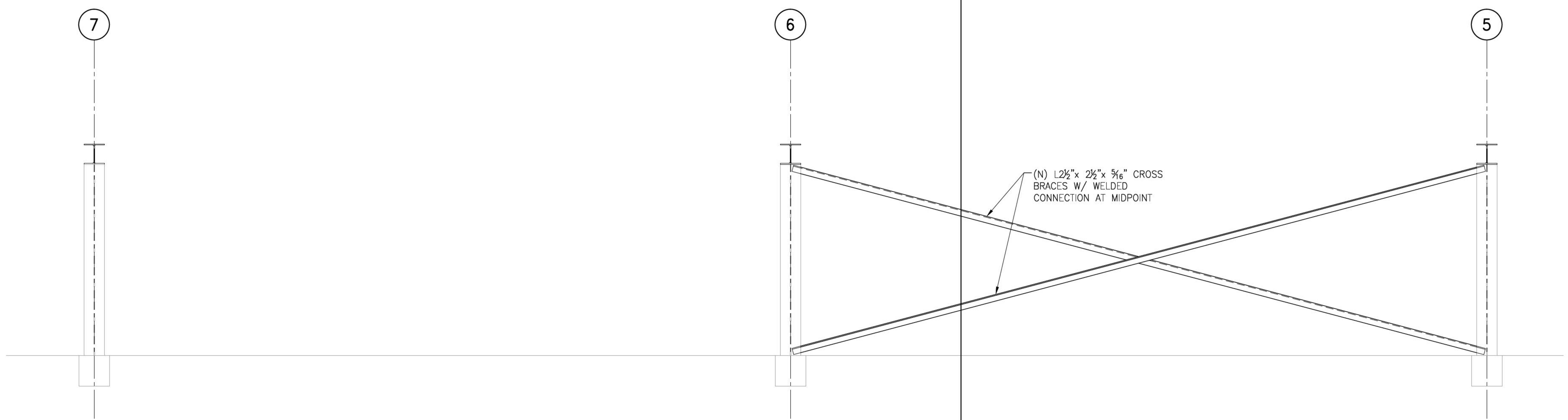
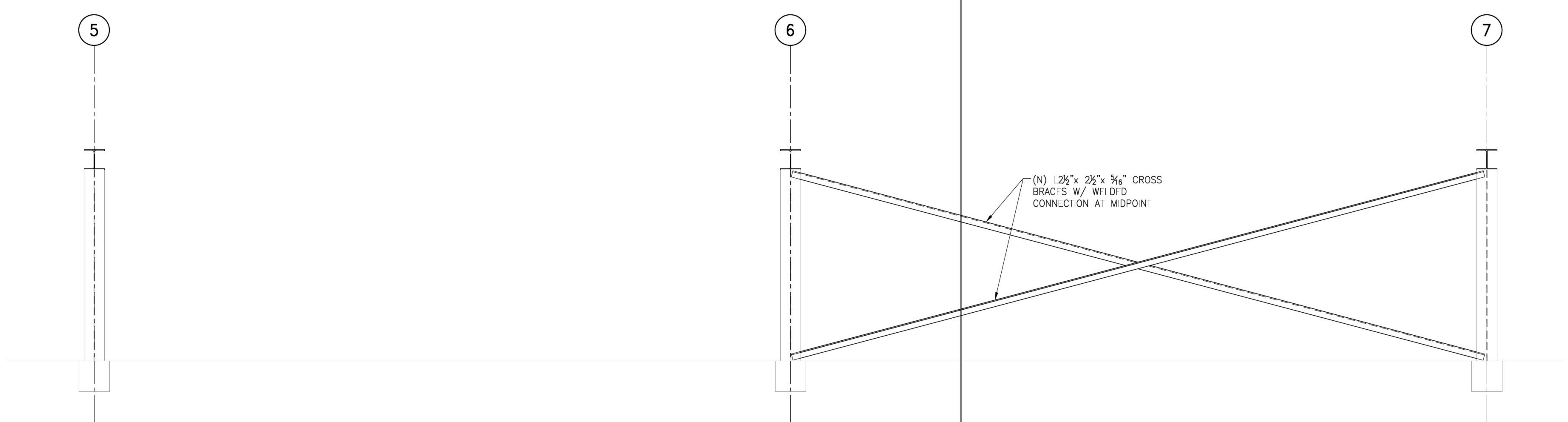
Drawn CB	Approved	Scale
Seal		Drawing No. S3.5



1 NEW BRACES
1/2" = 1'-0"



2 NEW BRACES
1/2" = 1'-0"

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Drawing Title

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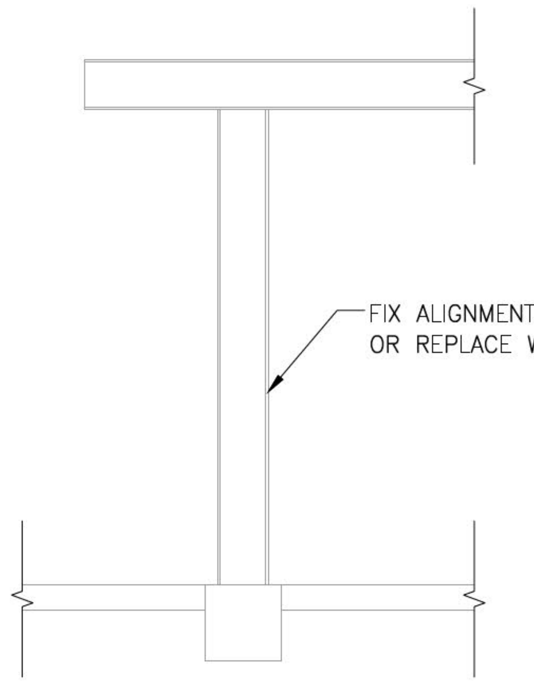
Drawn CB	Approved	Scale

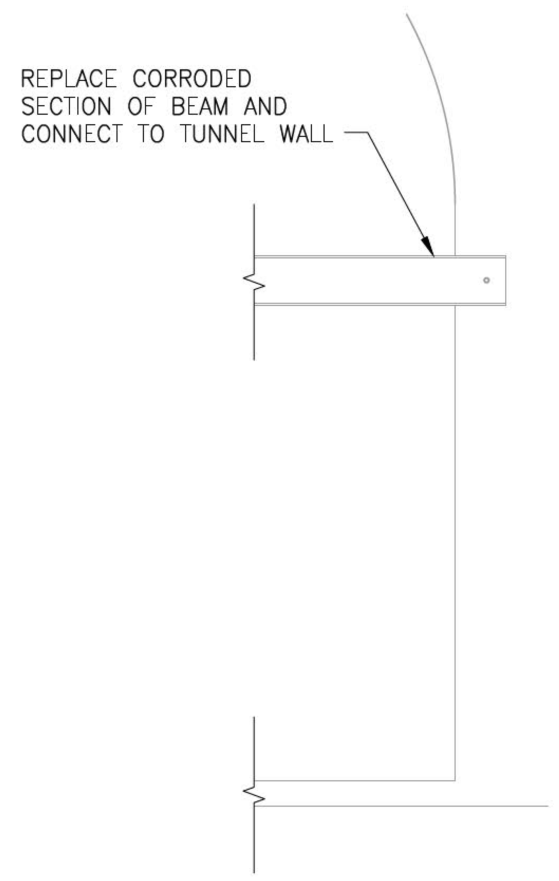
Seal

Drawing No.

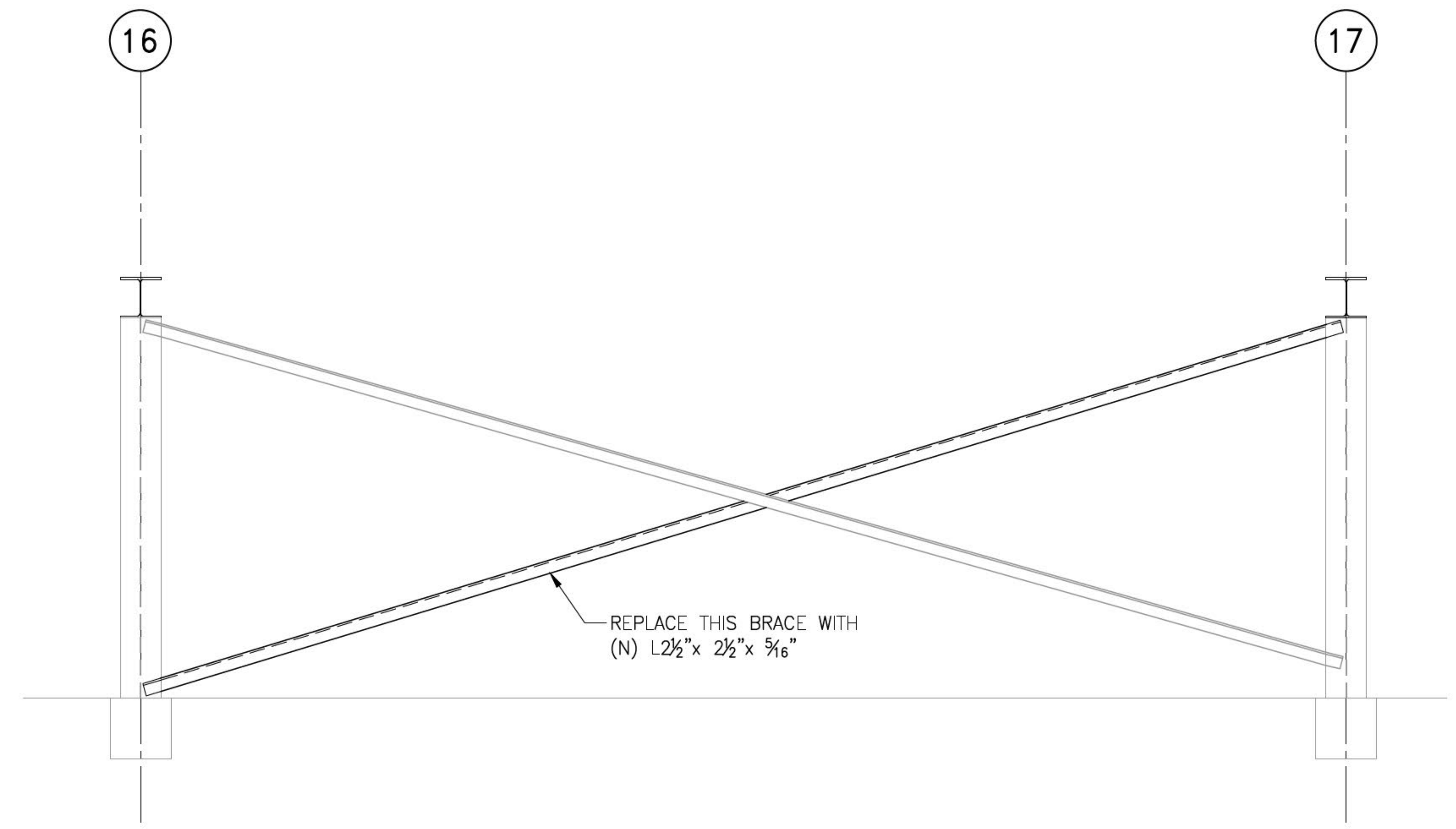
S4.1



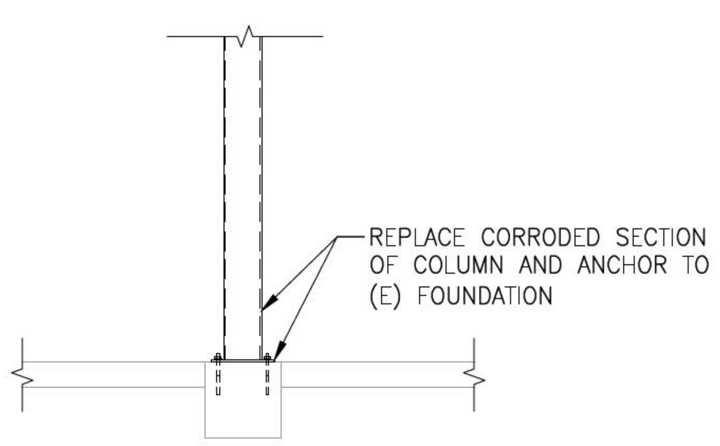
3 ALINGMENT REPAIR
1/2" = 1'-0"



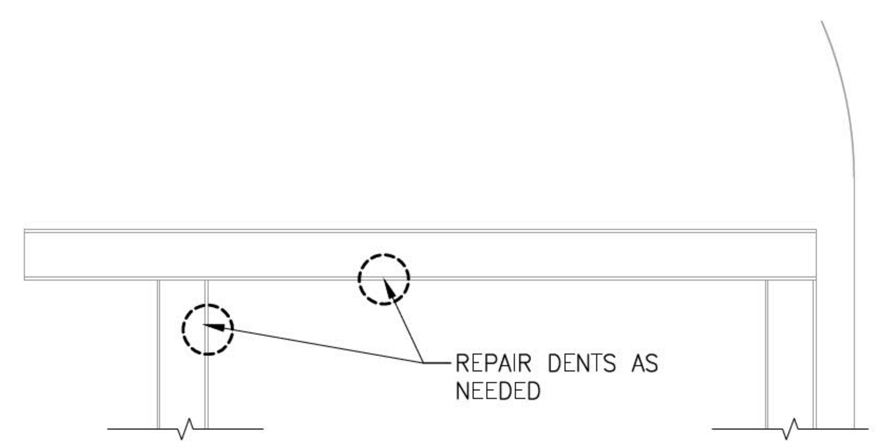
4 CORRODED BEAM SECTION REPLACEMENT
1/2" = 1'-0"



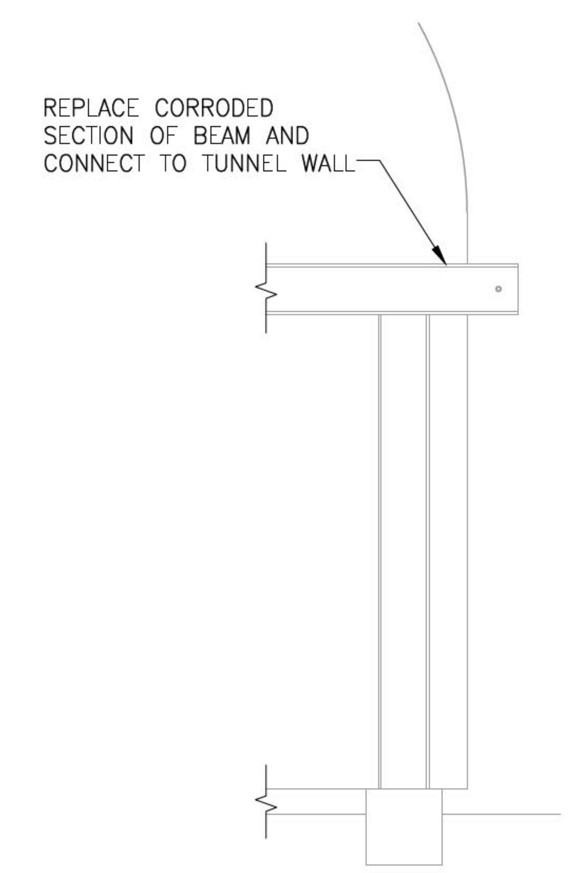
5 BRACE REPLACEMENT
1/2" = 1'-0"



6 REPLACE COLUMN AND ANCHORAGE
1/2" = 1'-0"



7 DENT REPAIRS
1/2" = 1'-0"



8 CORRODED BEAM SECTION REPLACEMENT
1/2" = 1'-0"

SGH

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PRELIMINARY
NOT FOR
CONSTRUCTION

No.	Date	Description	By

RED HILL UNDERGROUND FUEL STORAGE FACILITY, HAWAII

Project

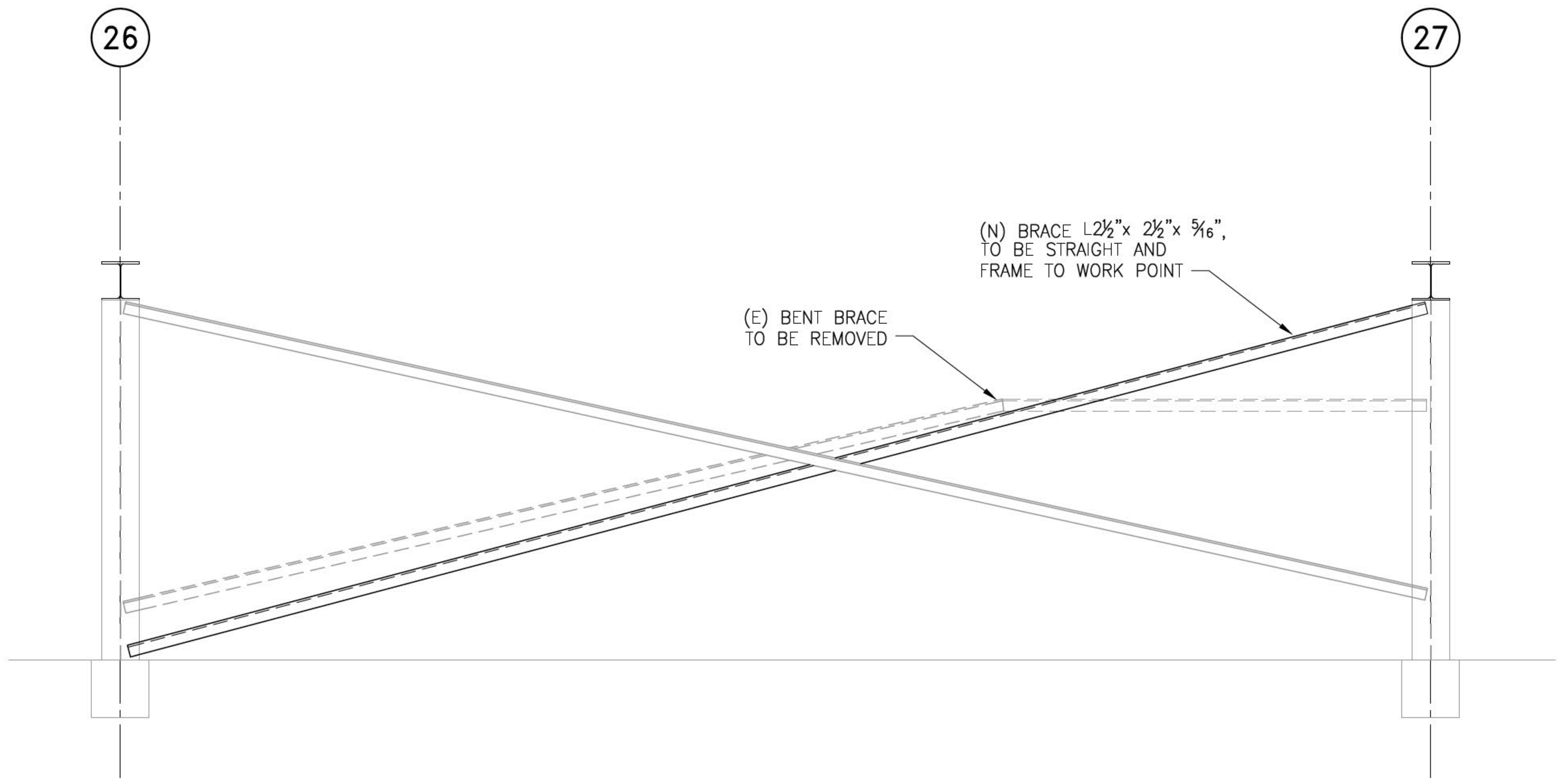
DETAILS - RETROFITS AND REPAIRS

Drawing Title

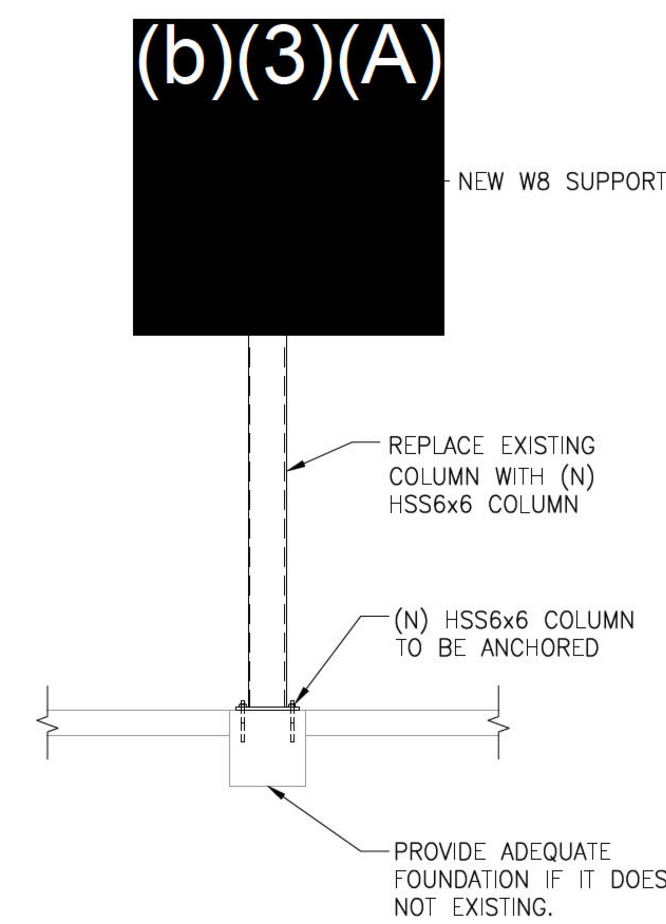
Project No.	Checked	Date
220064.00		04/28/22
Drawn	Approved	Scale
CB		

Drawing No.
S4.2

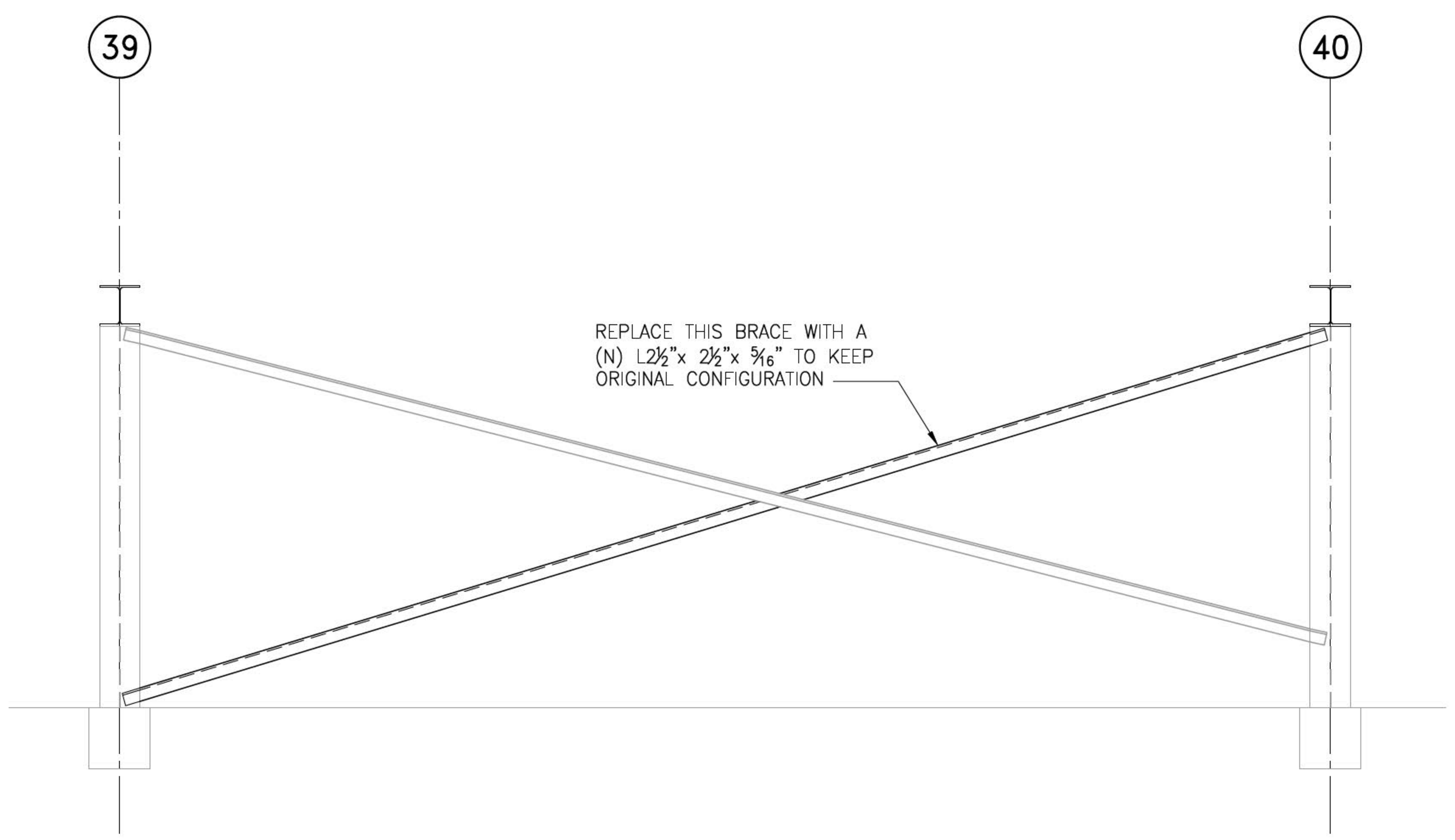
Seal



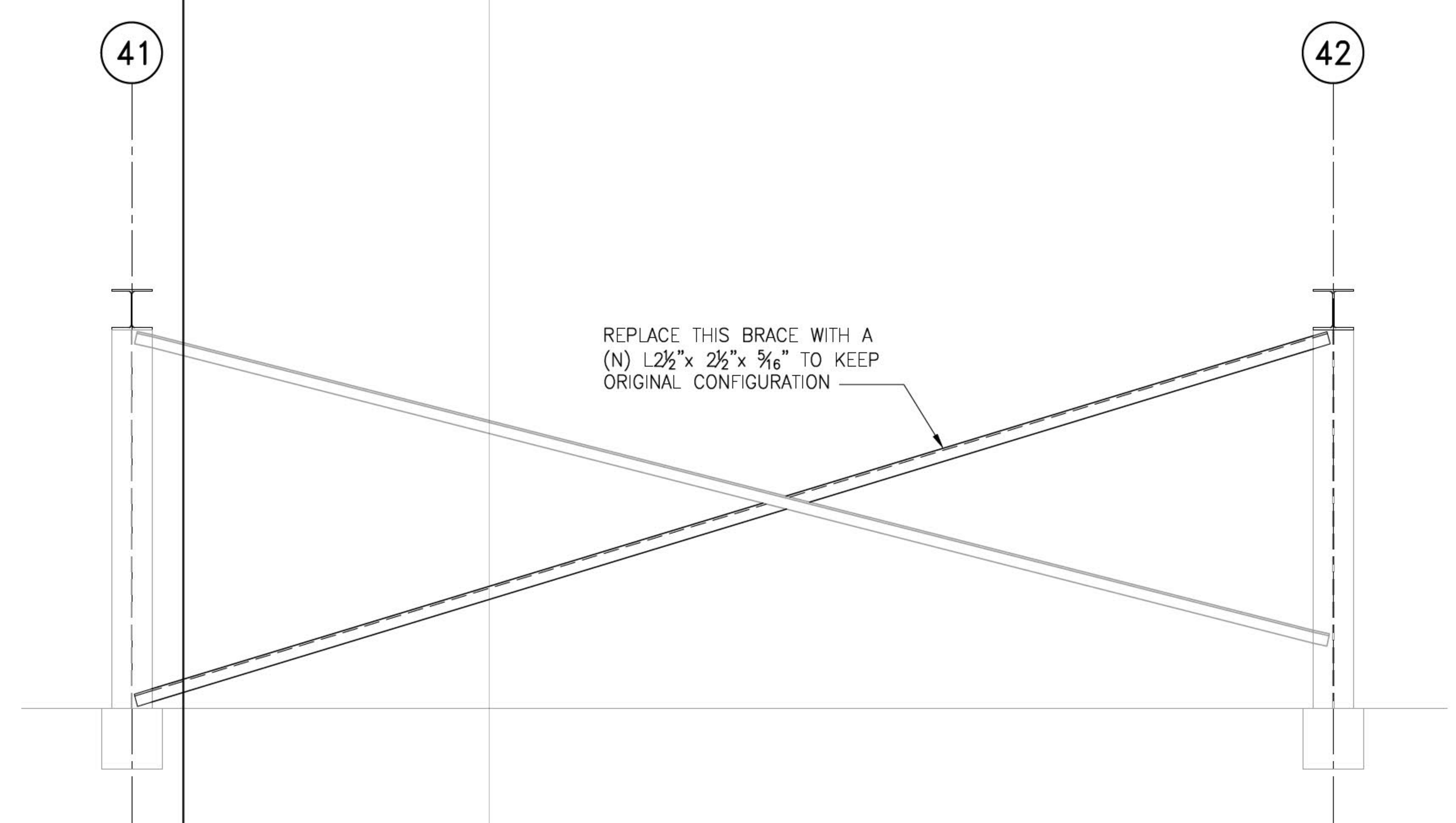
9 BRACE REPLACEMENT
1/2" = 1'-0"



10 COLUMN & ANCHORAGE UPGRADE
1/2" = 1'-0"



11 BRACE REPLACEMENT
1/2" = 1'-0"



12 BRACE REPLACEMENT
1/2" = 1'-0"

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No.	Date	Description	By

RED HILL UNDERGROUND FUEL STORAGE FACILITY, HAWAII

Project

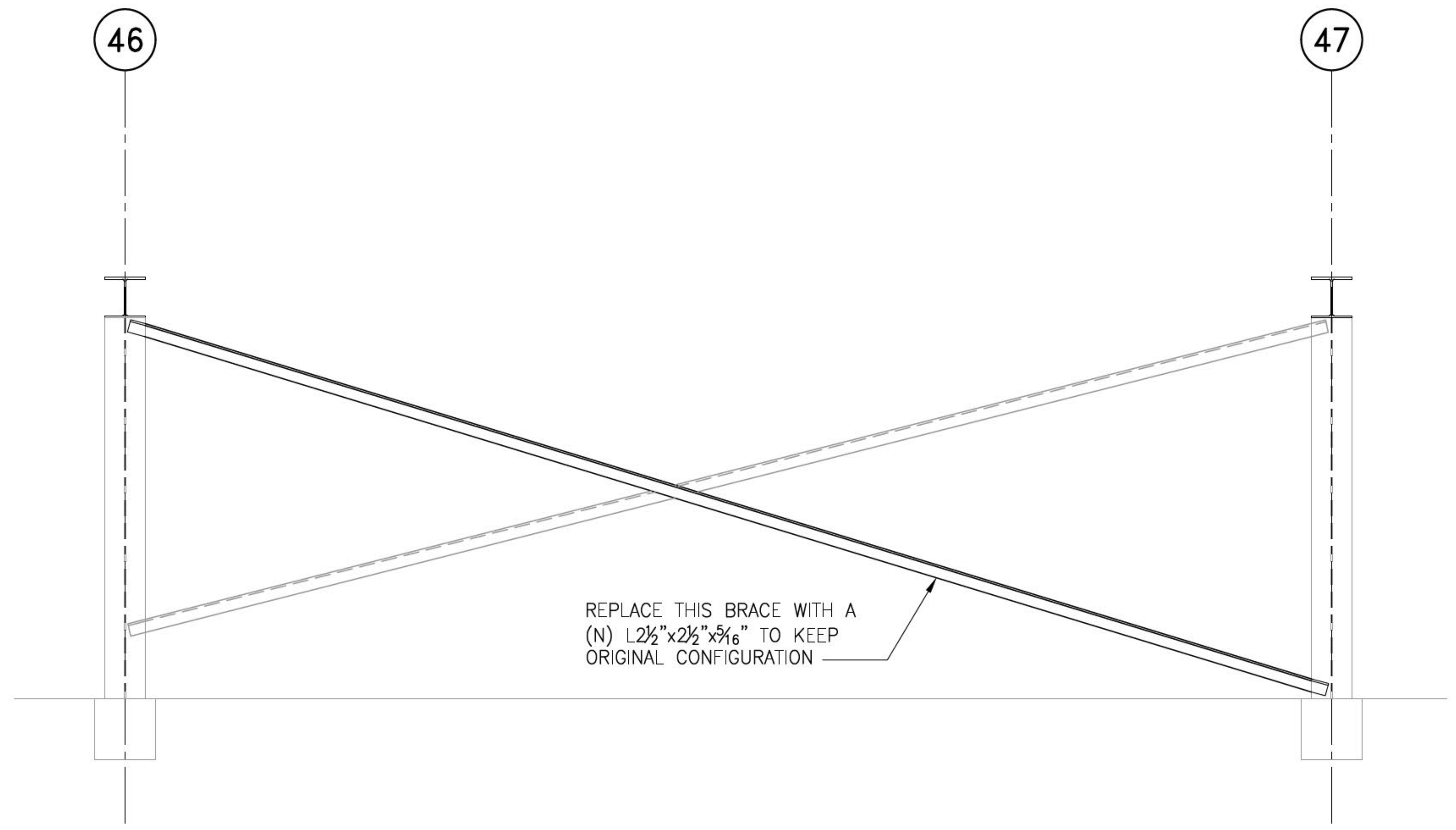
DETAILS - RETROFITS AND REPAIRS

Drawing Title

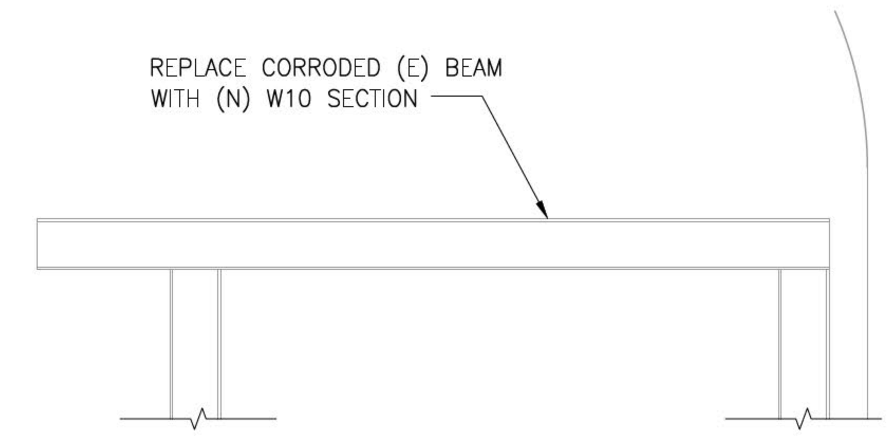
Project No. 220064.00	Checked	Date 04/28/22
Drawn CB	Approved	Scale

Seal

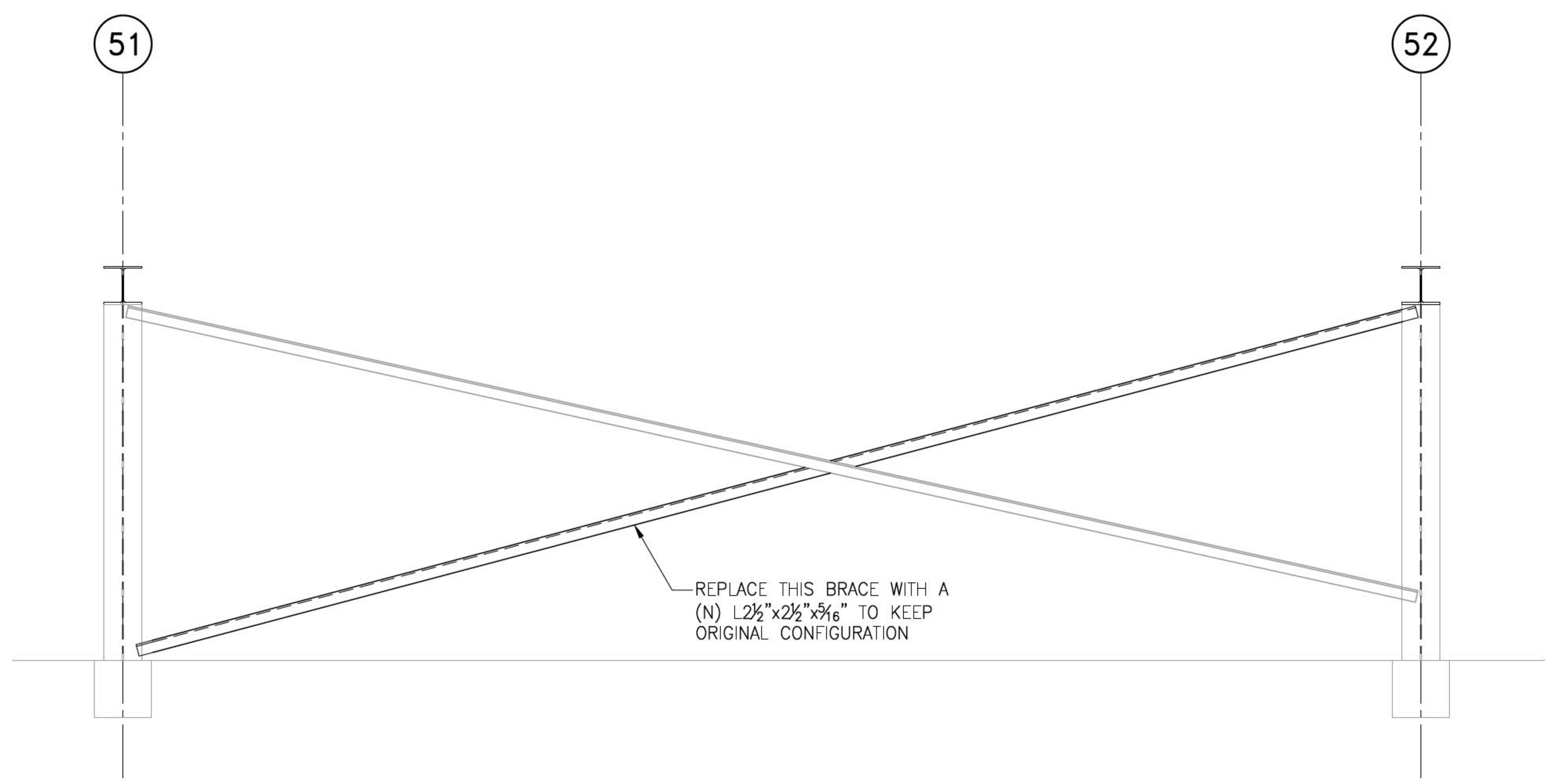
Drawing No.
S4.3



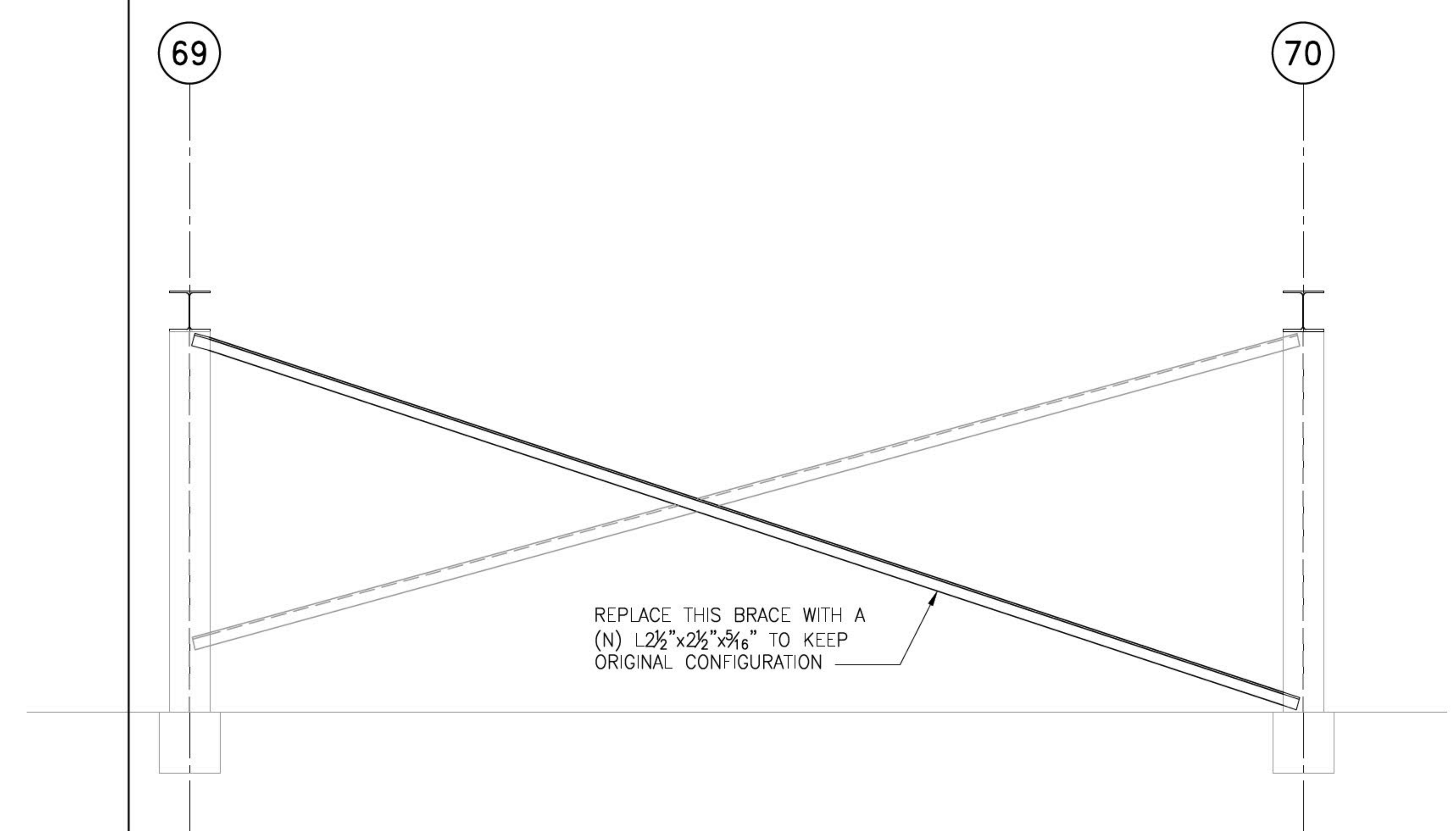
13 BRACE REPLACEMENT
1/2" = 1'-0"



14 REPLACE BEAM
1/2" = 1'-0"



15 BRACE REPLACEMENT
1/2" = 1'-0"



16 BRACE REPLACEMENT
1/2" = 1'-0"

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DETAILS - RETROFITS AND REPAIRS

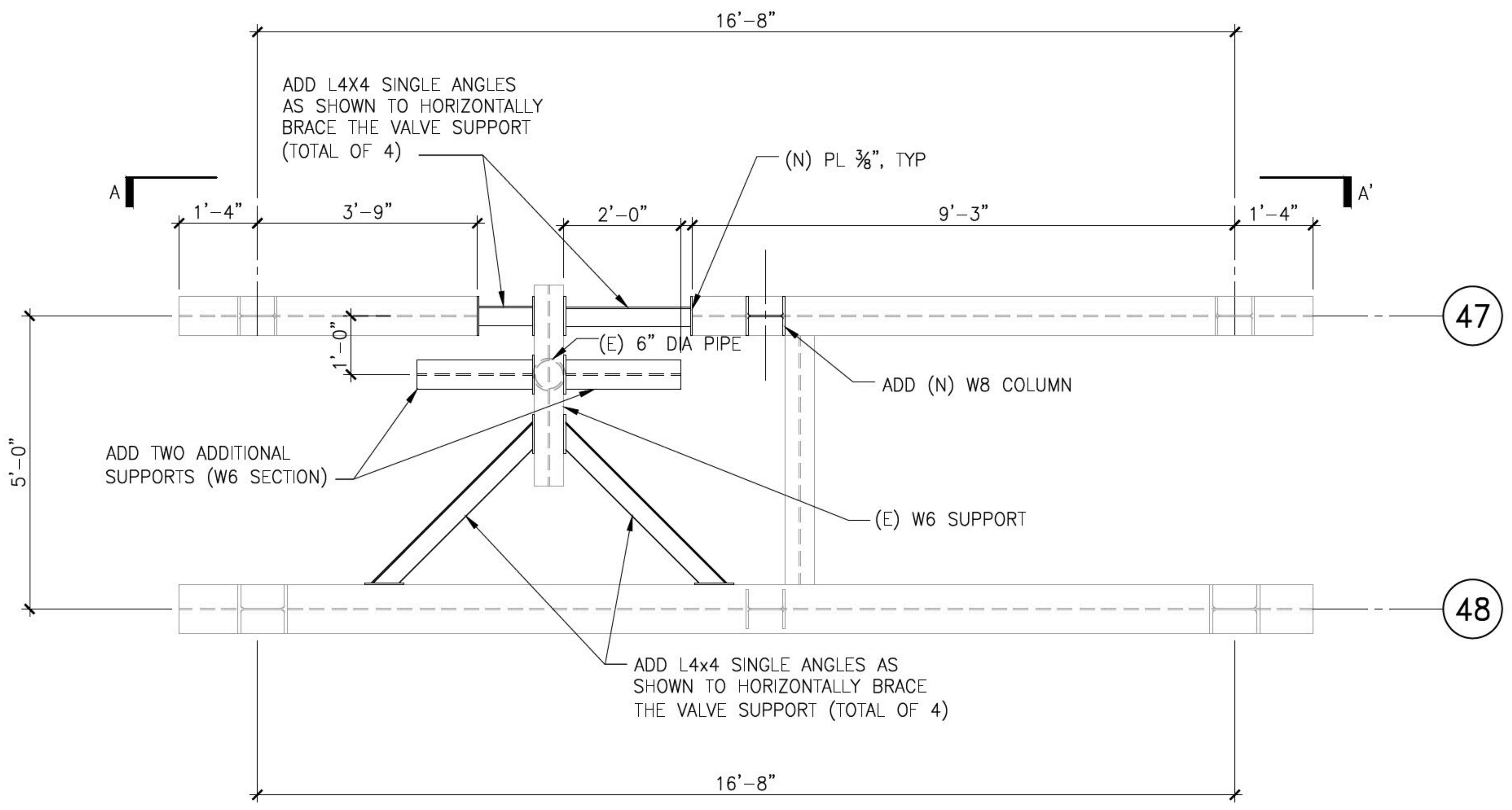
Drawing Title

Project No.	Checked	Date
220064.00		04/28/22
Drawn	Approved	Scale
CB		

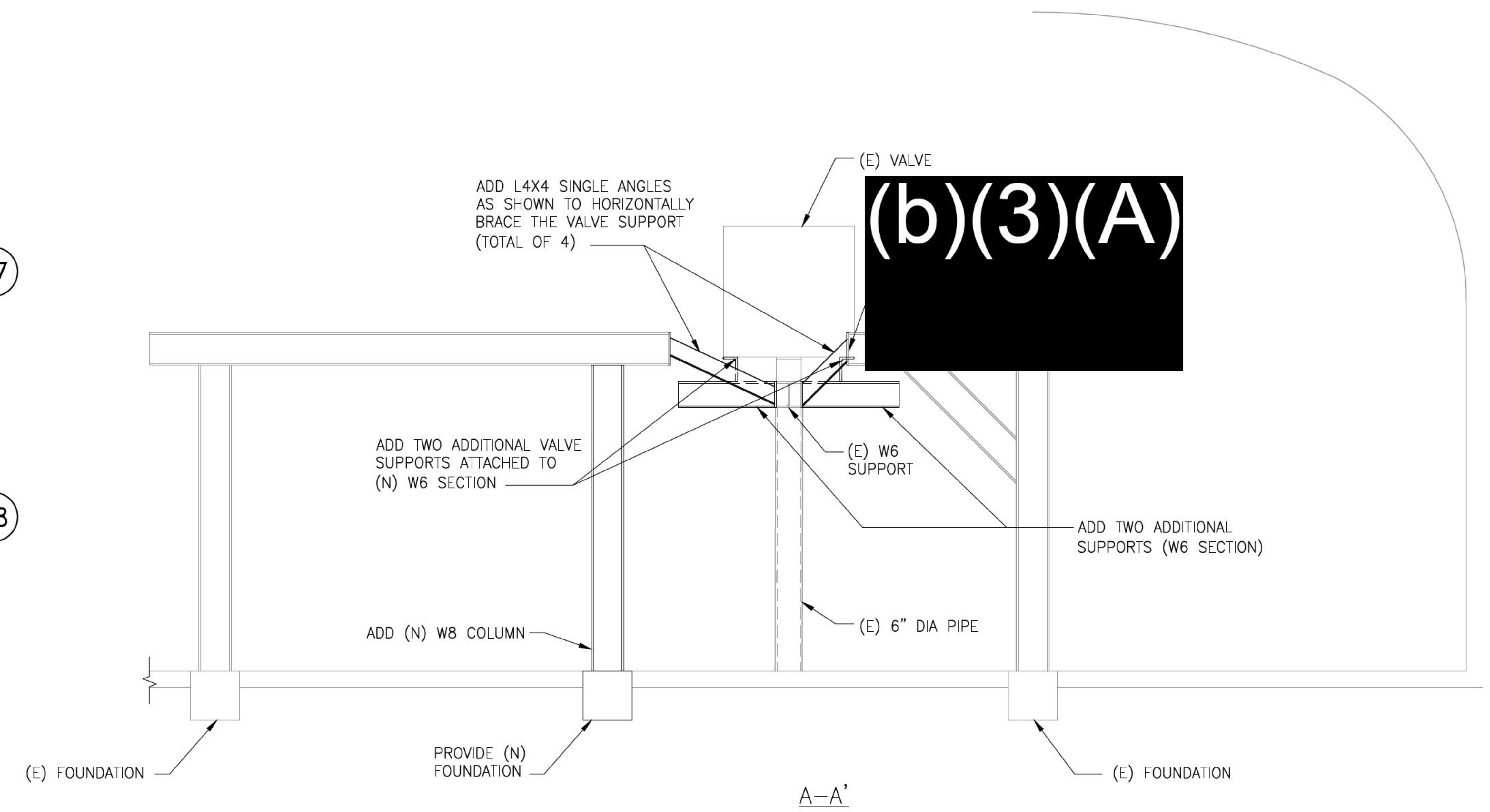
Drawing No.

S4.4

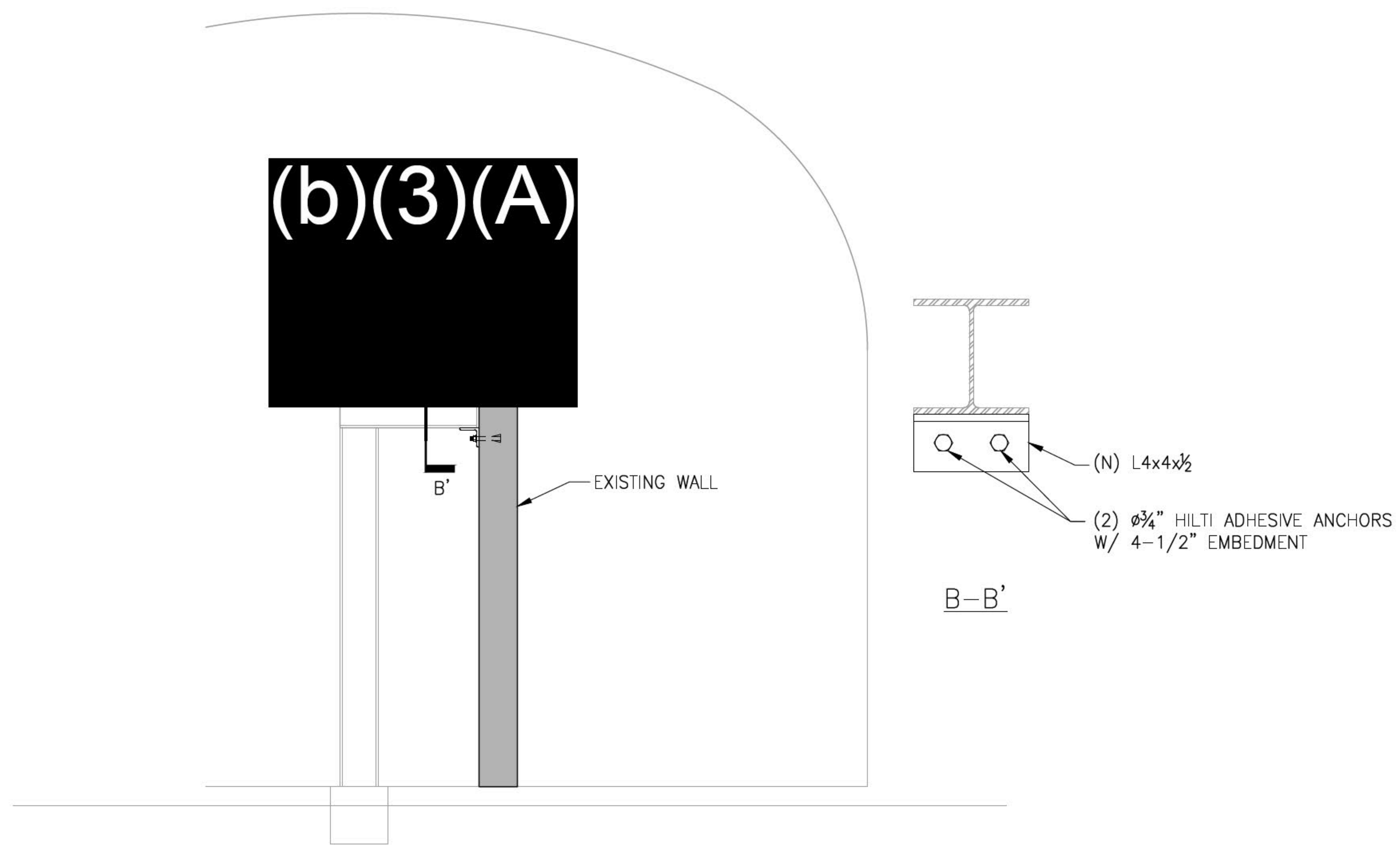
Seal



17 VALVE SUPPORT UPGRADE
1/2" = 1'-0"



A–A'



18 ANCHORAGE TO WALL
1/2" = 1'-0"

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Project

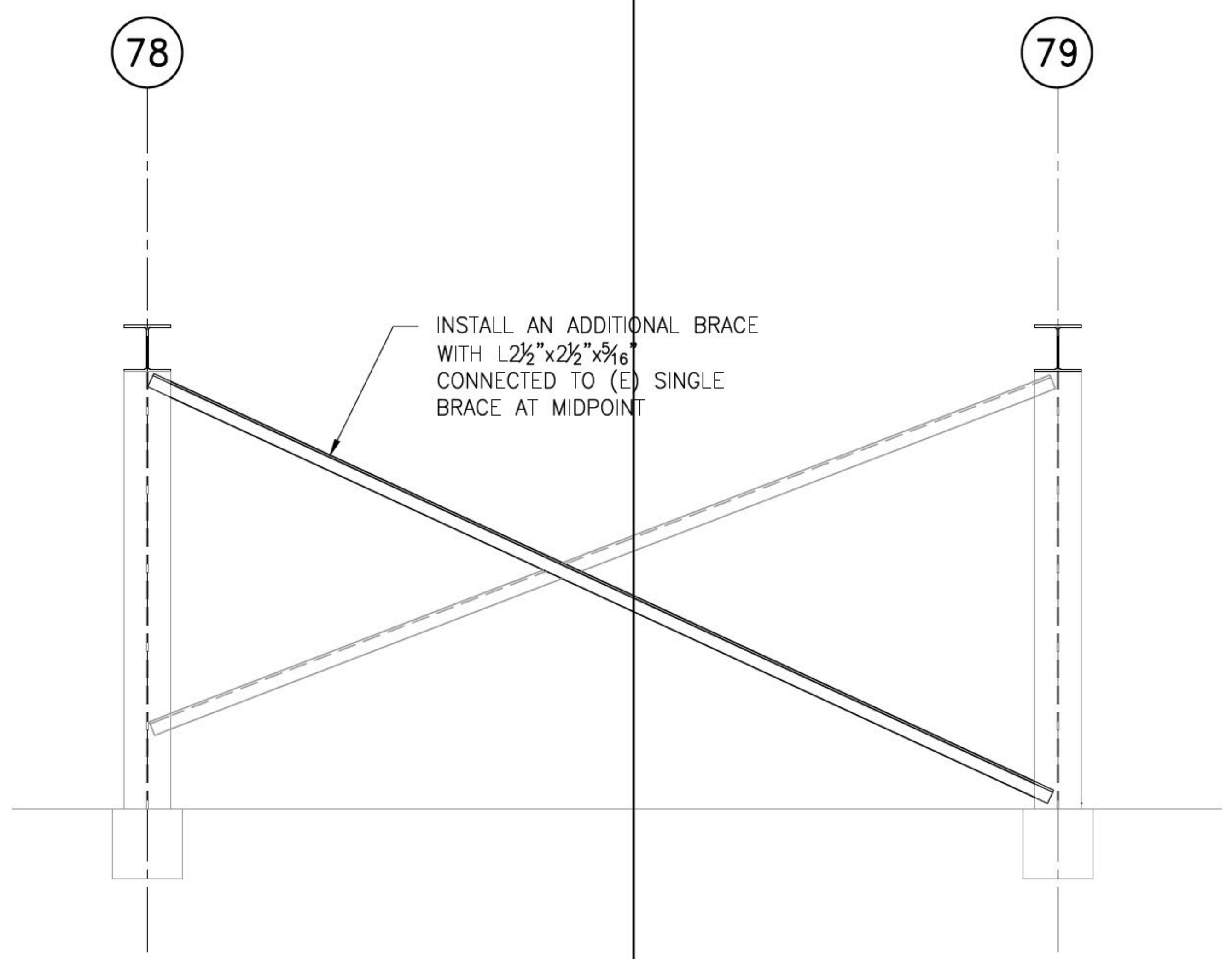
DETAILS - RETROFITS AND REPAIRS

Drawing Title

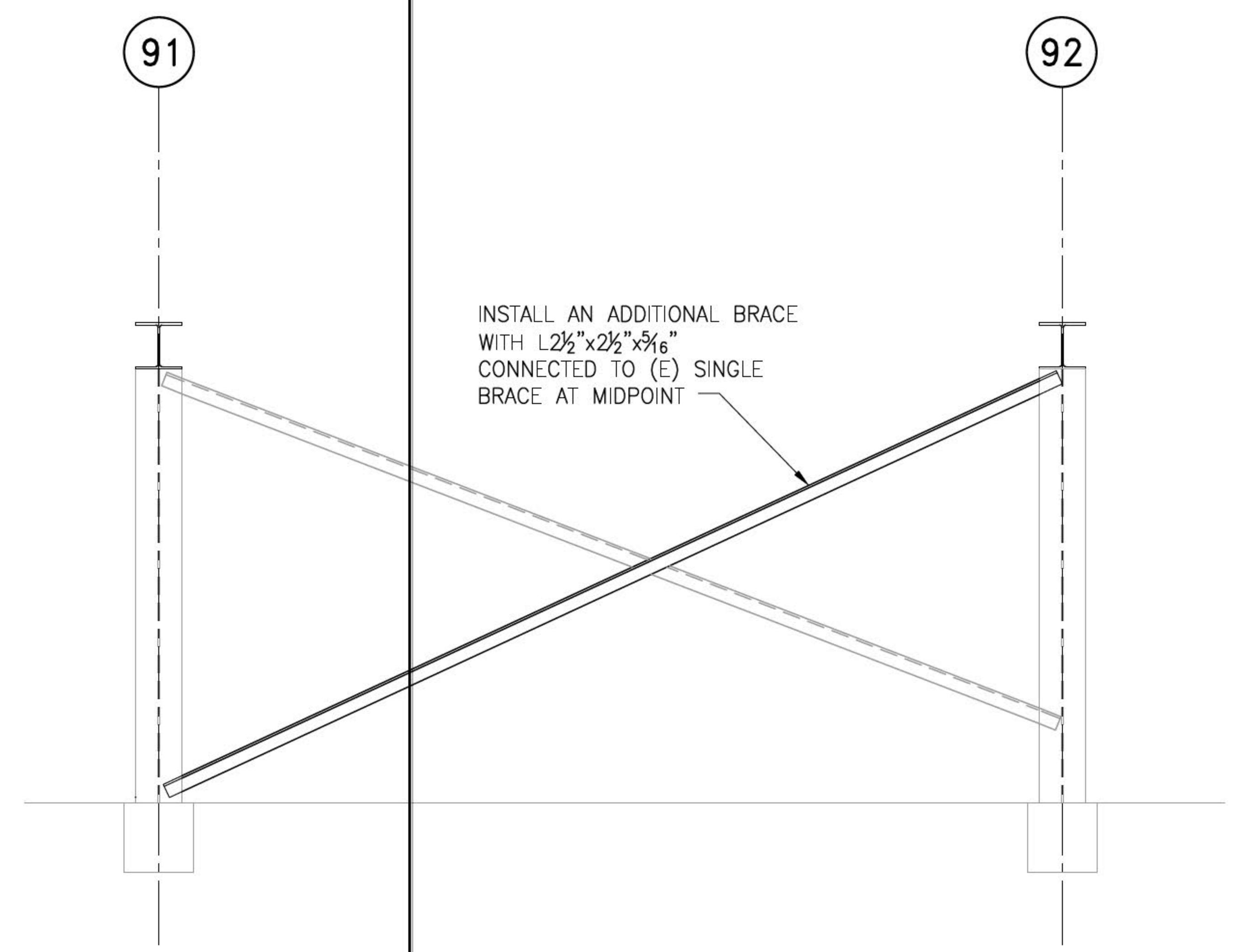
Project No.	Checked	Date
220064.00		04/28/22
Drawn	Approved	Scale
CB		

Drawing No.
S4.5

Seal



19 BRACE ADDITION
1/2" = 1'-0"



20 BRACE ADDITION
1/2" = 1'-0"

[redacted]
(b)(3)(A)

[redacted]
(b)(3)(A)

21 AXIAL PIPE RESTRAINT DETAIL
1/2" = 1'-0"

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**RED HILL
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STORAGE FACILITY,
HAWAII**

Project

DETAILS - RETROFITS
AND REPAIRS

Drawing Title

Project No.	Checked	Date
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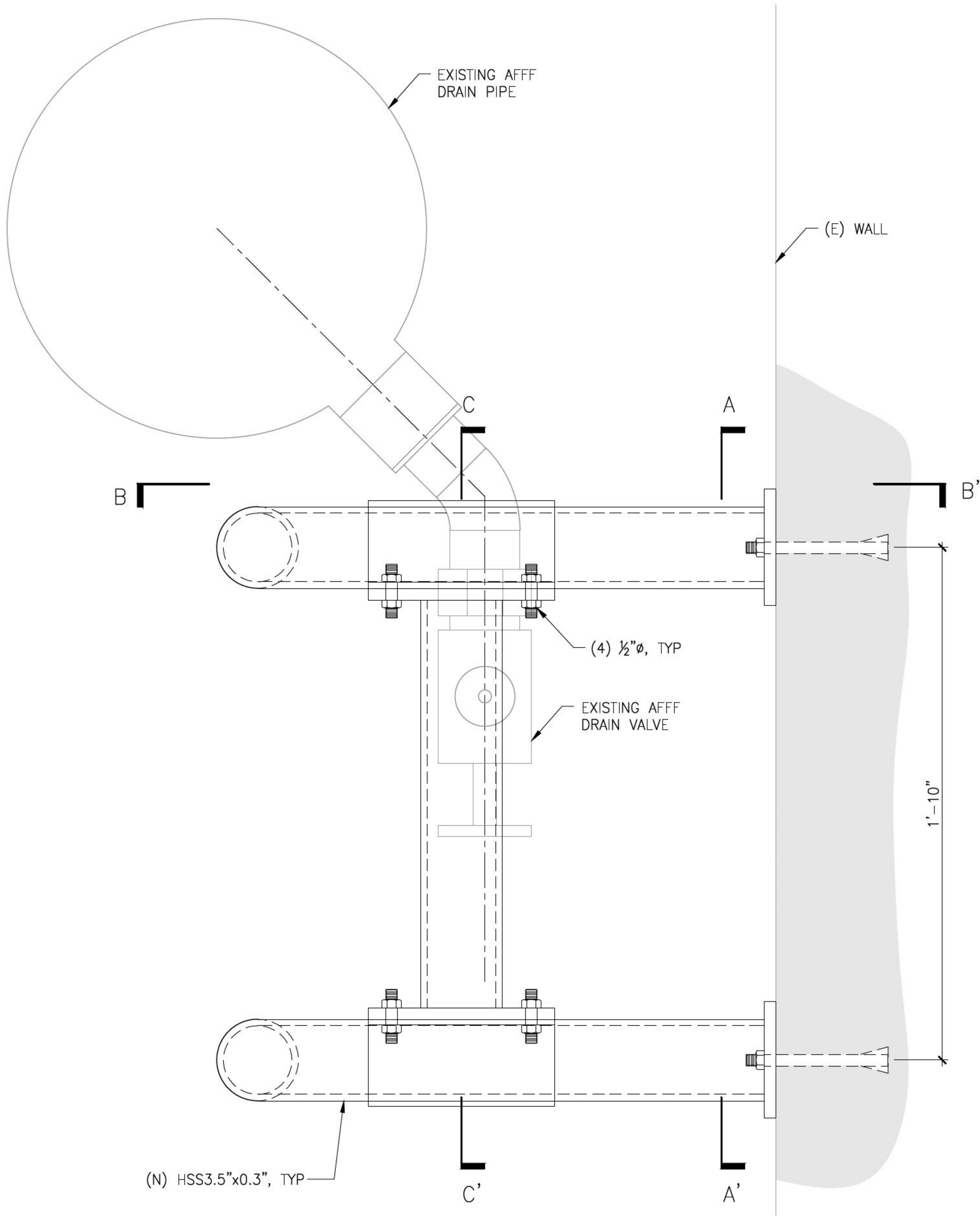
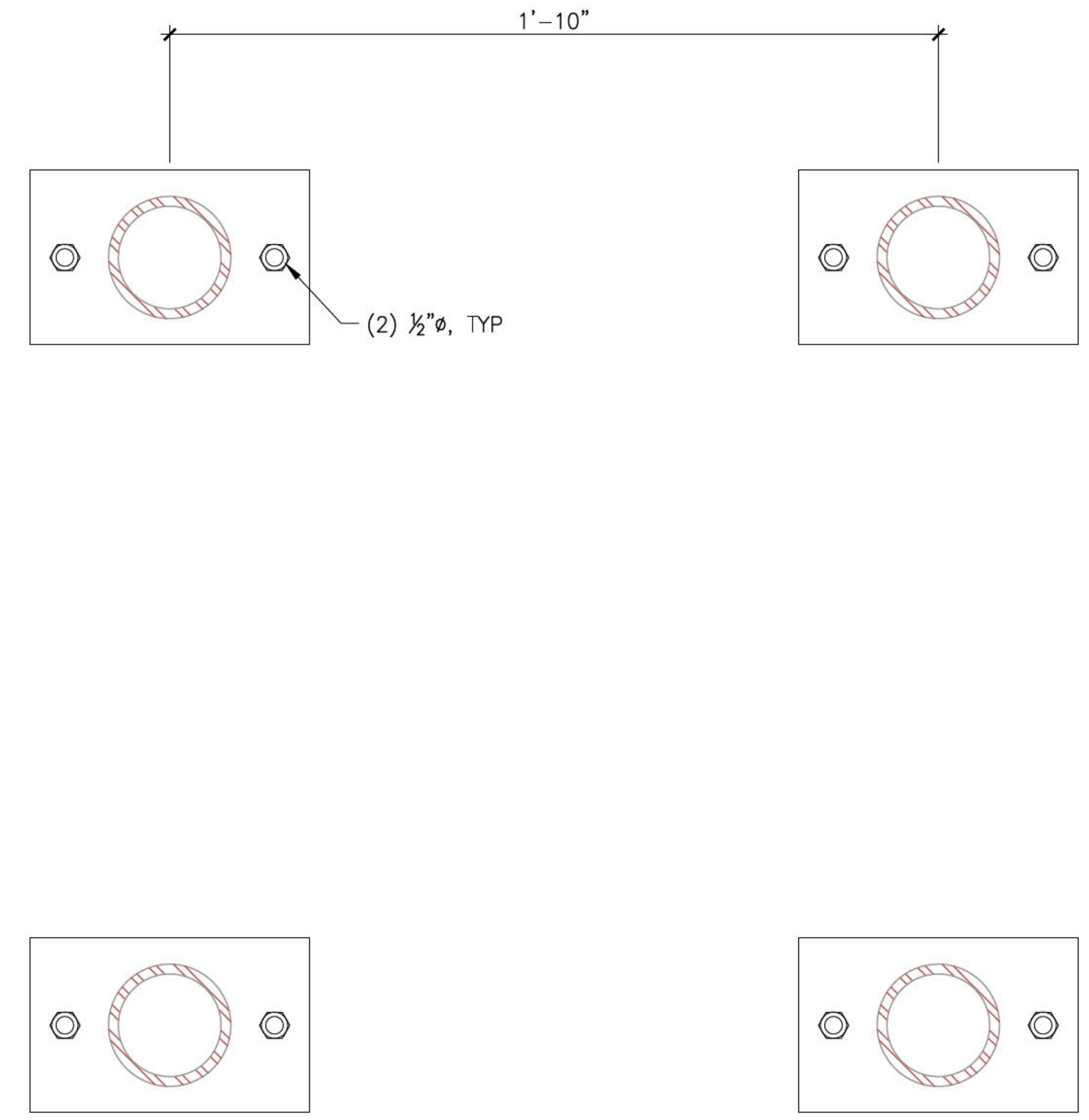
Drawn	Approved	Scale
CB		

Seal

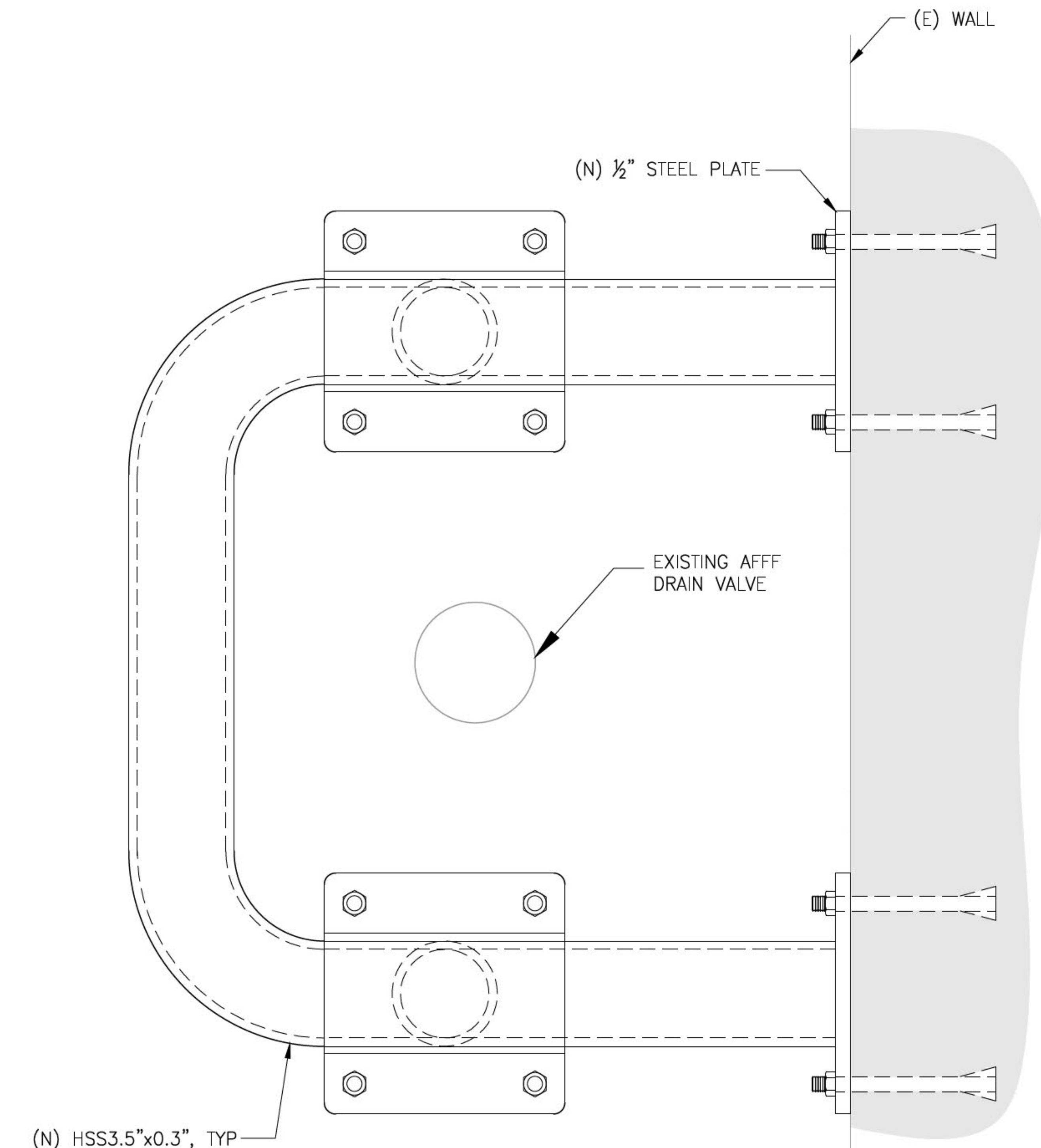
Drawing No.
S4.6



22 OVERHEAD DRAIN VALVE – ELEVATION
3" = 1'-0"

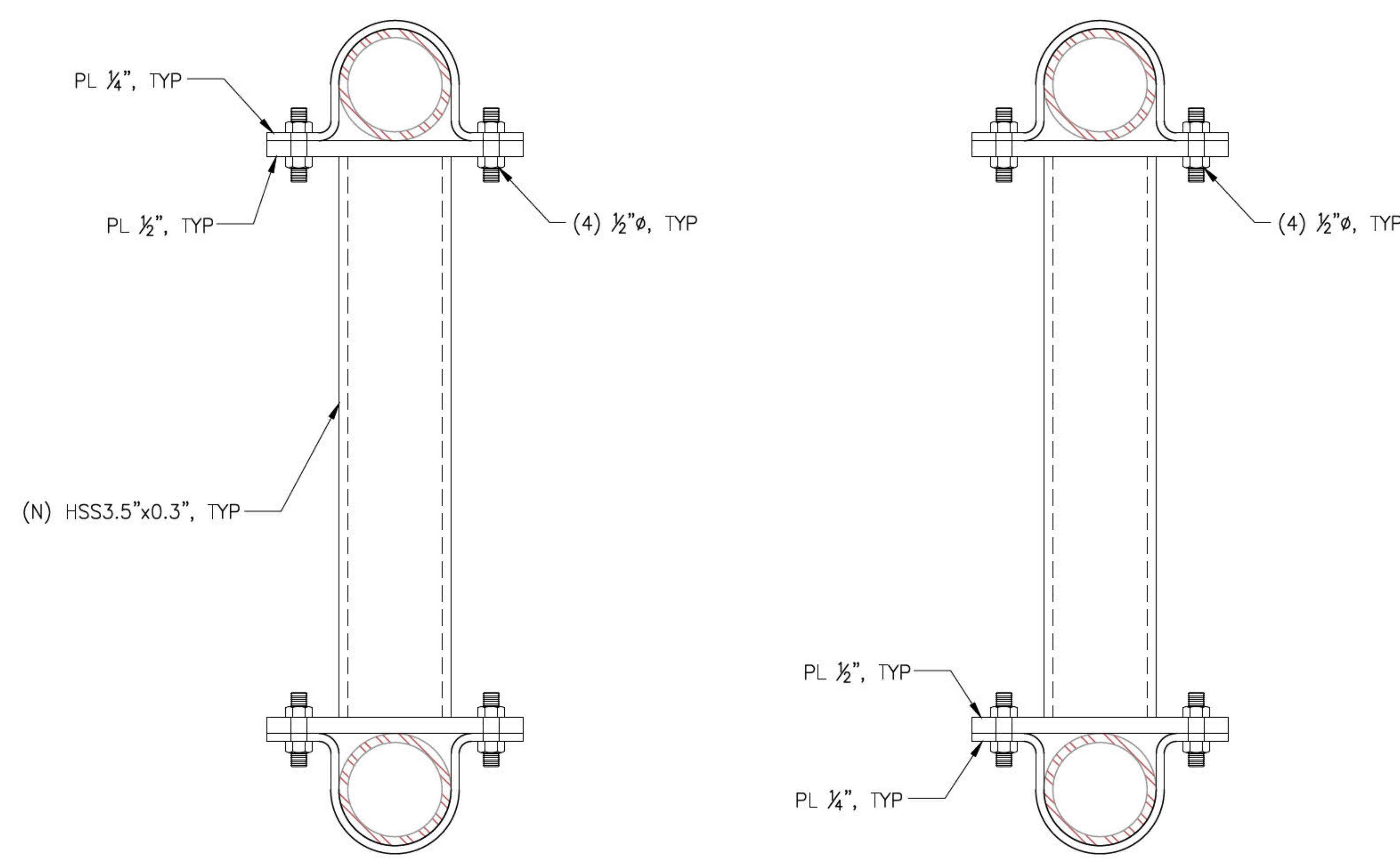


A–A'



B–B'

23 OVERHEAD DRAIN VALVE – PLAN
3" = 1'-0"



C–C'

NOTES:

1. DIMENSIONS SHALL BE FIELD VERIFIED.
2. PERFORM CLASH CHECK PRIOR TO FABRICATION OF NEW ELEMENTS.

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DETAILS - AFFF DRAIN LINE VALVE PROTECTION STRUCTURE

Drawing Title

Project No.	Checked	Date
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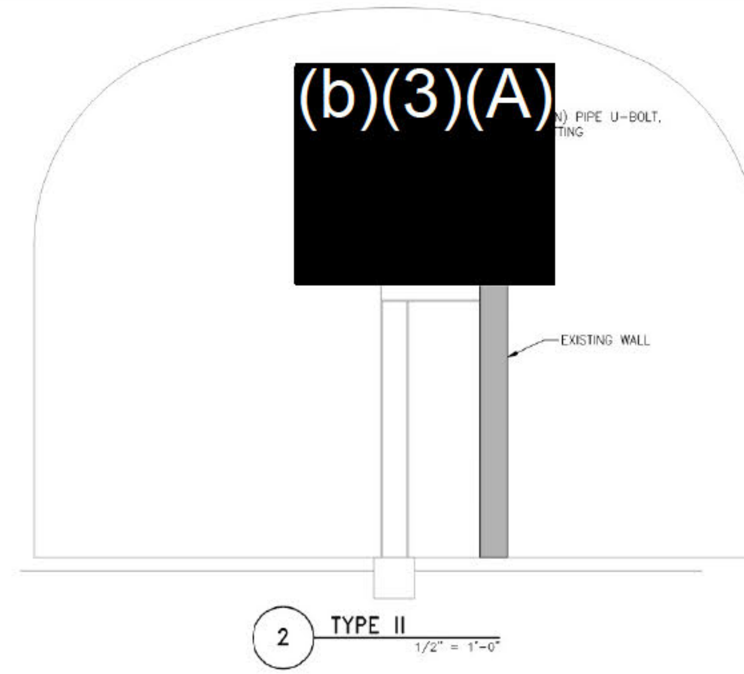
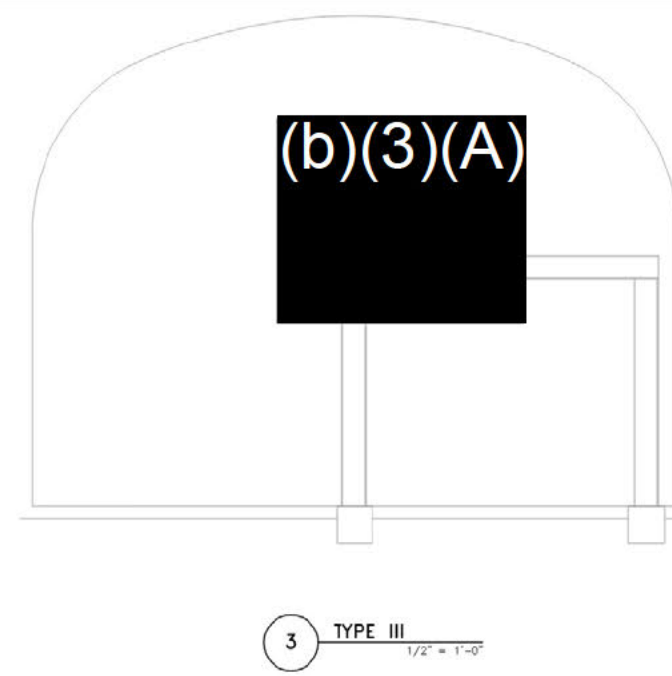
Drawn	Approved	Scale
CB		

Drawing No.
S4.7

Seal

APPENDIX A.4
Repair Sketches and Photographs in Lower Access Tunnel

Lateral Restraints			
Pipe Support No.	**Photo**	**Detail**	**Description**
[redacted] (b)(3)(A)	[redacted]	[redacted] (b)(3)(A) 	Install new U-bolt clamp on JP-5 pipeline to limit its lateral movement, as shown in the detail. The U-bolt is to be bolted to the flange of the existing beam.
		[redacted] (b)(3)(A) 	Install lateral restraint on both sides of the JP-5 pipeline to limit its lateral movement. This alternative is proposed to avoid a reconfiguration of the existing pipes and conduits. The new members are to be welded to the existing beam.

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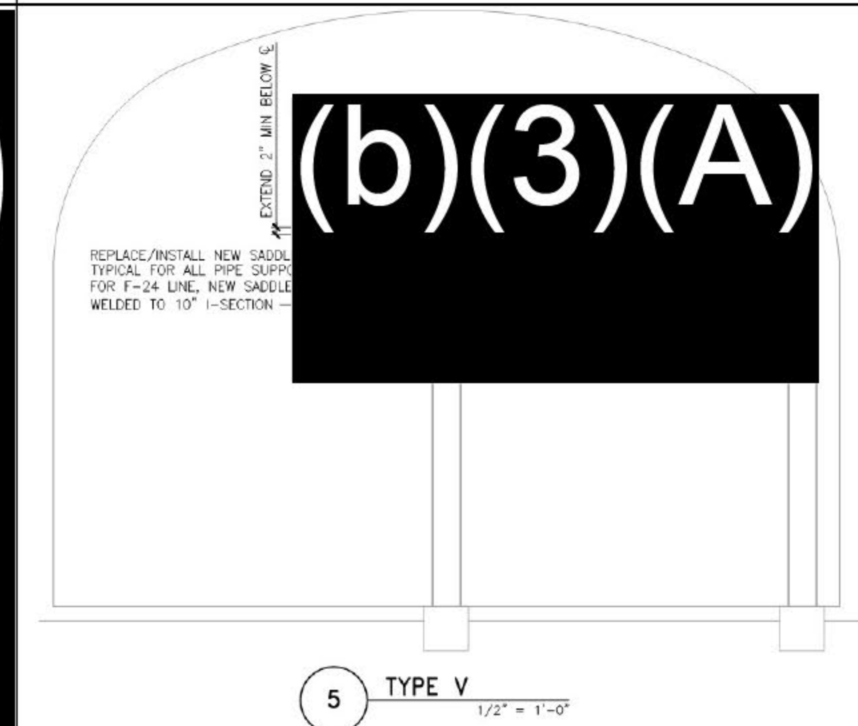
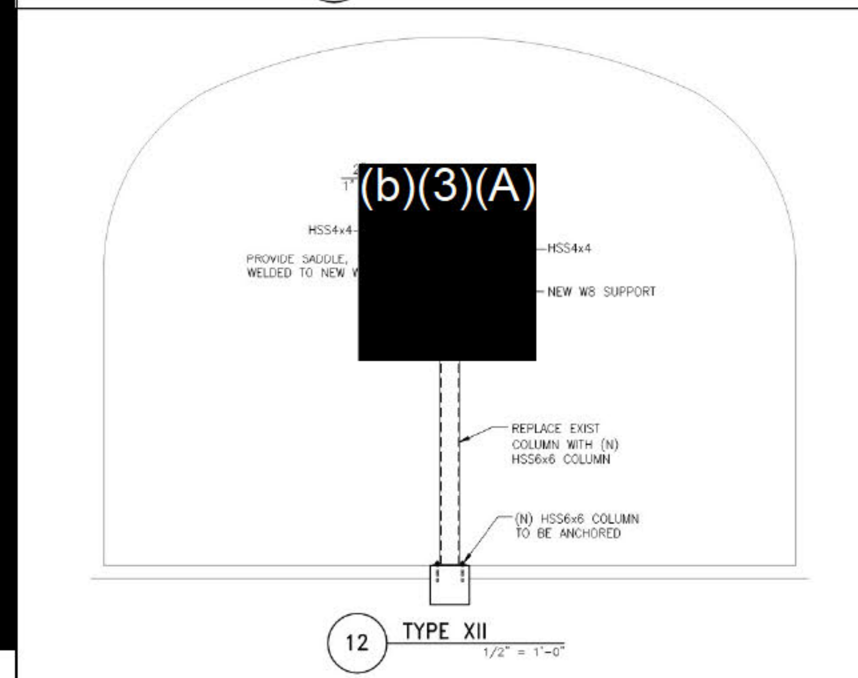
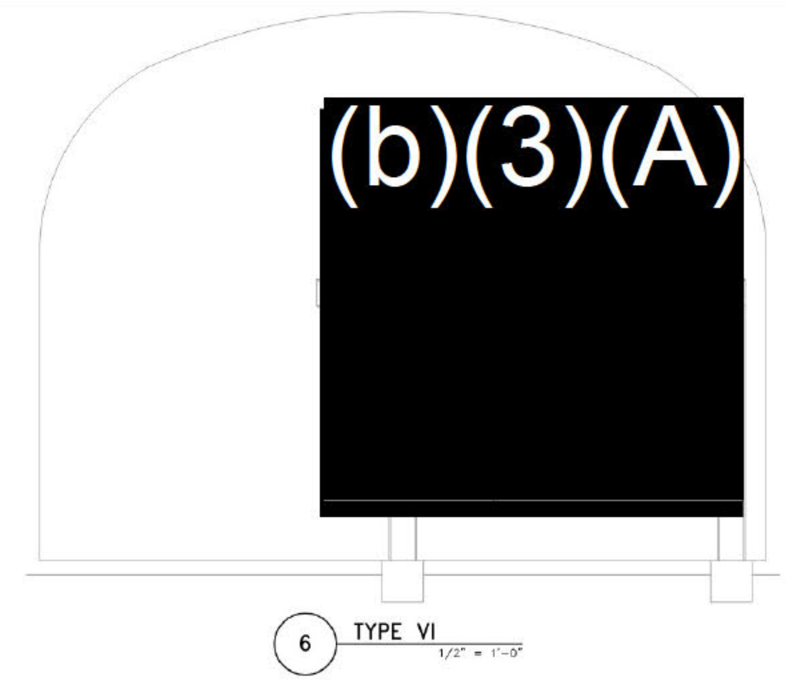
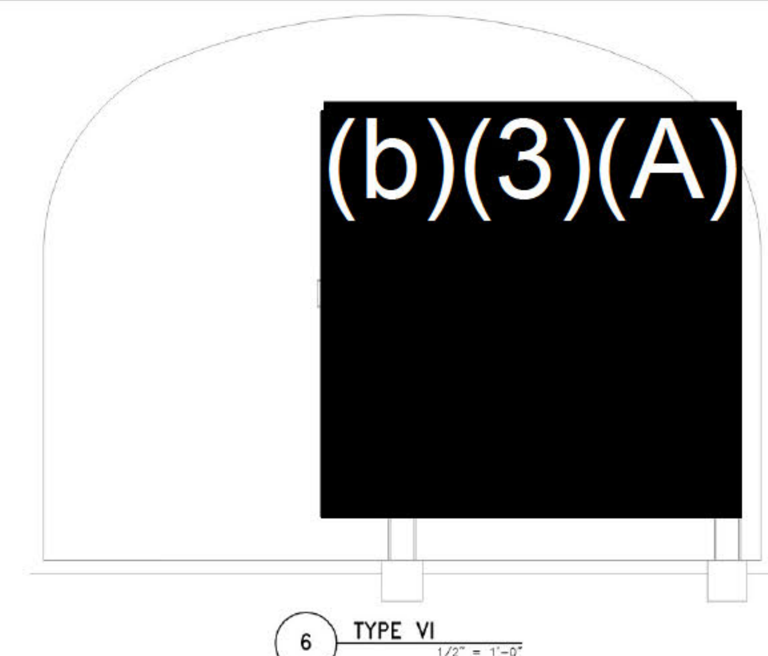
Lateral Restraints			
Pipe Support No.	**Photo**	**Detail**	**Description**
[redacted]	[redacted]	 [redacted]	Install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.
		 [redacted]	Replace the existing column as shown in the detail. This new vertical support is to be anchored to the existing slab-on-grade. The beam will be built with two vertical members, one on each side of the F-24 pipeline to limit its lateral movement.

PRELIMINARY – NOT FOR CONSTRUCTION

[redacted]

Lateral Restraints			
Pipe Support No.	Photo	Detail	Description
[redacted] (b)(3)(A)			Install a new vertical member on the free end of the F-24 pipeline to limit its lateral movement, as shown in the detail. This member is to be welded to the existing horizontal beam. If there is not sufficient space, the beam needs to be extended.
			Install a new vertical member on the free end of the F-24 pipeline to limit its lateral movement, as shown in the detail. This member is to be welded to the existing beam. If there is not sufficient space, the horizontal beam needs to be extended.

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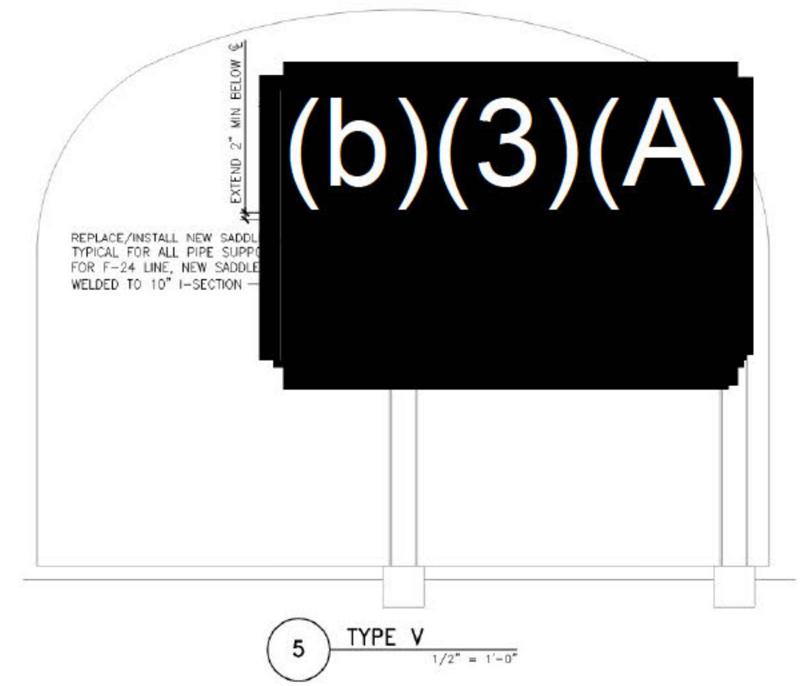
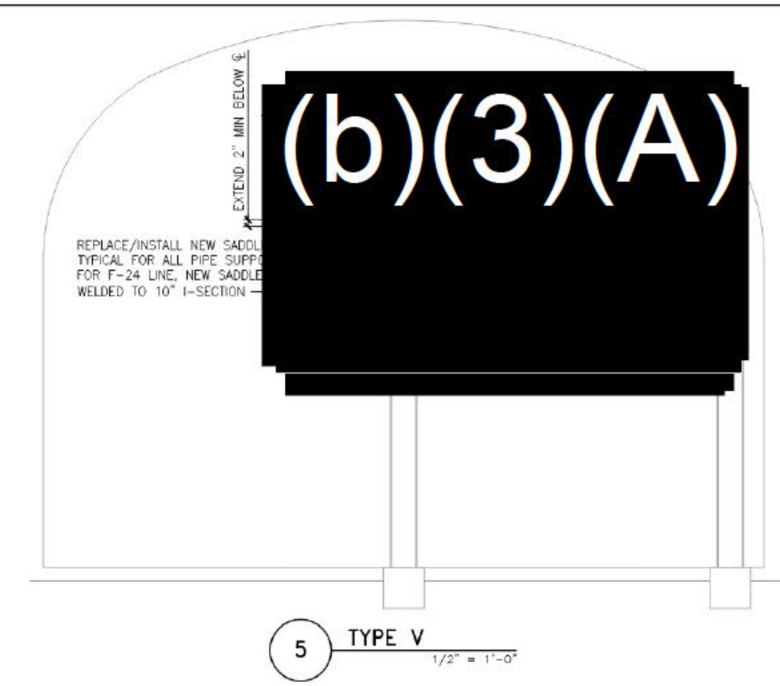
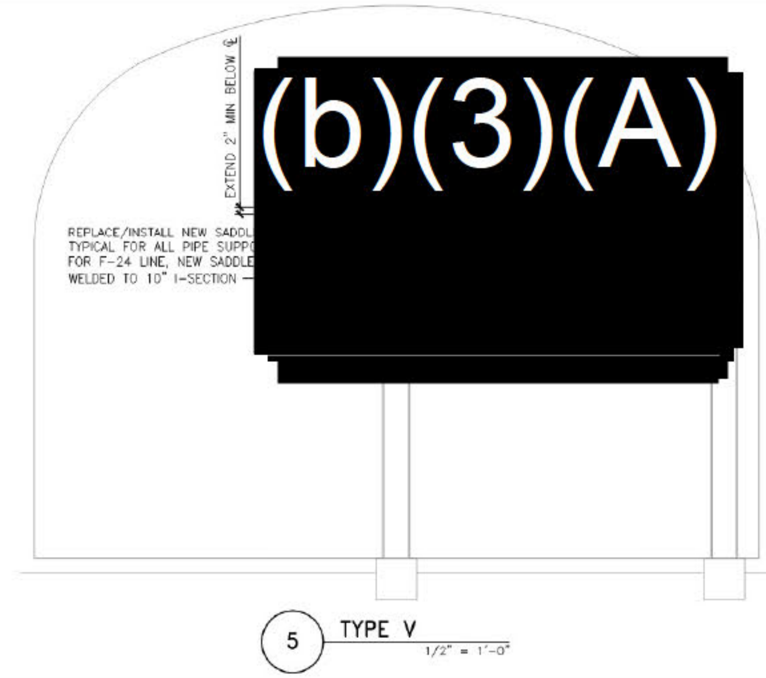
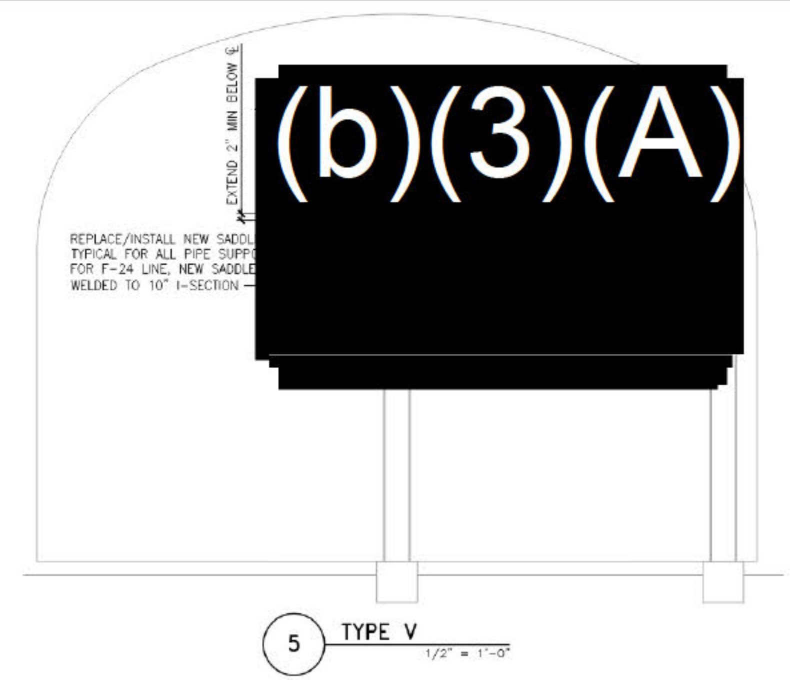
Lateral Restraints			
Pipe Support No.	**Photo**	**Detail**	**Description**
[redacted] (b)(3)(A)		 [redacted] (b)(3)(A)	Install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.
		 [redacted] (b)(3)(A)	Install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.

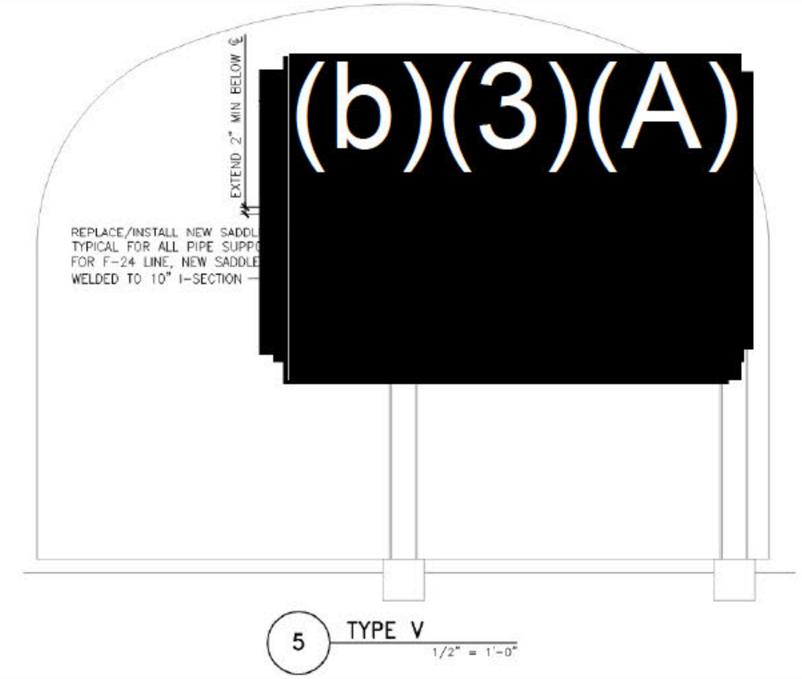
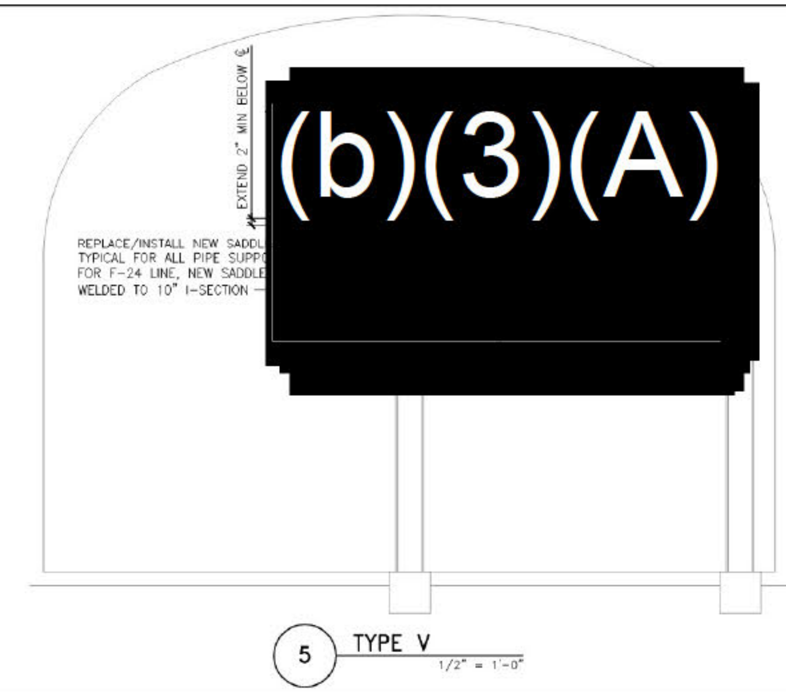
PRELIMINARY – NOT FOR CONSTRUCTION

[redacted]

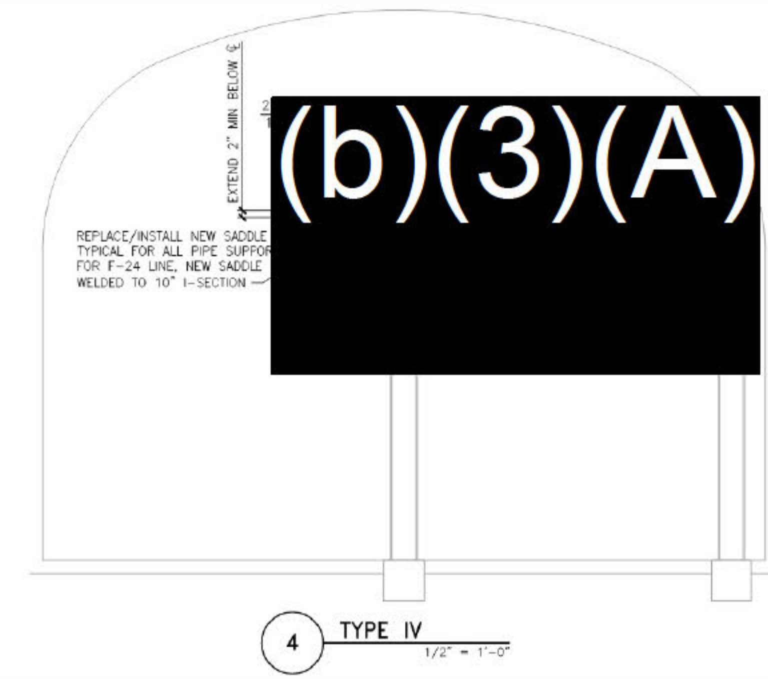
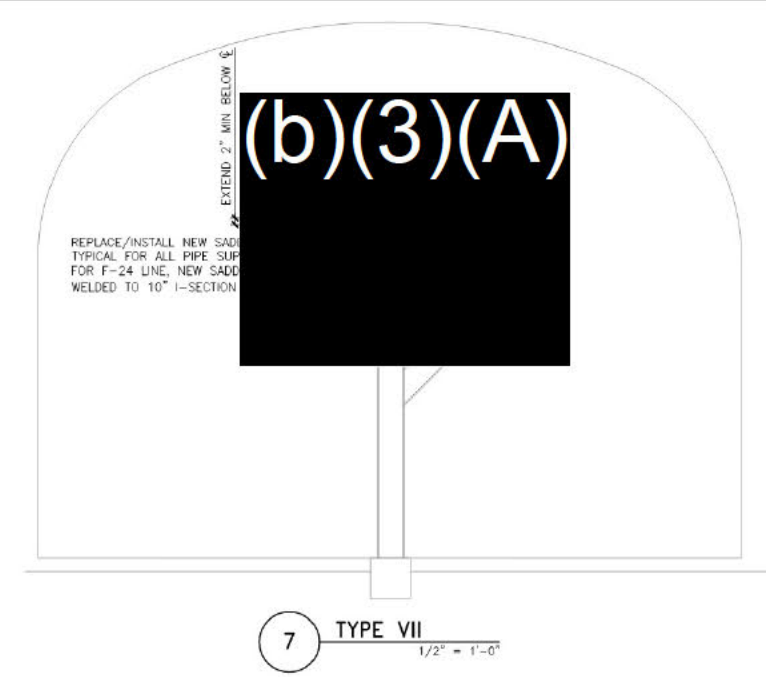
Lateral Restraints			
Pipe Support No.	**Photo**	**Detail**	**Description**
[redacted] (b)(3)(A)			Install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.
			Install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.

PRELIMINARY – NOT FOR CONSTRUCTION

[redacted]

Lateral Restraints			
Pipe Support No.	**Photo**	**Detail**	**Description**
[redacted]	[redacted]		Install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.
			Install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.

PRELIMINARY – NOT FOR CONSTRUCTION

Lateral Restraints			
Pipe Support No.	**Photo**	**Detail**	**Description**
(b)(3)(A) [redacted]	(b)(3)(A) [redacted]		Install a pair of new vertical members on each side of the JP-5 and F-76 pipelines to limit their lateral movement, as shown in the detail. Additionally, install lateral stops shown in the detail adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.
[redacted]	[redacted]		Install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.

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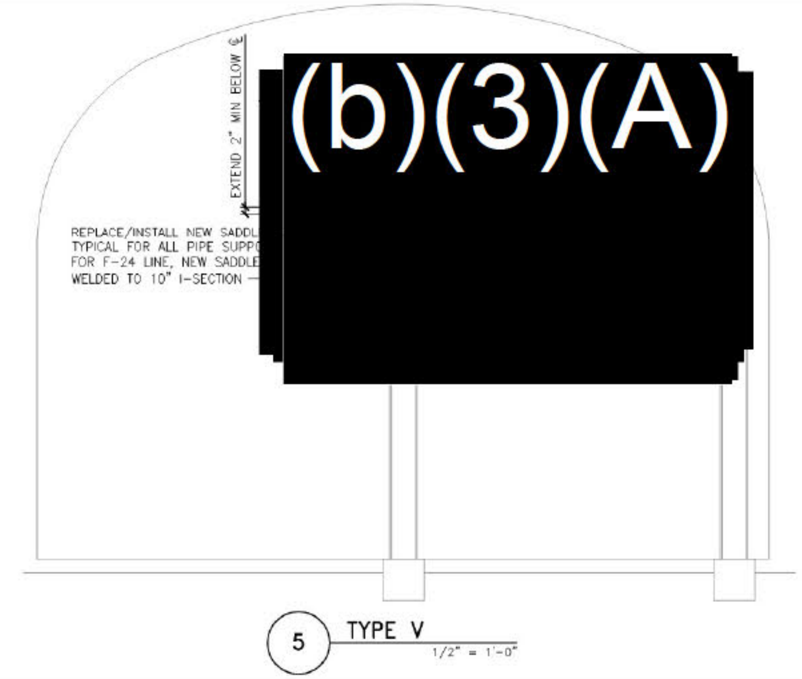
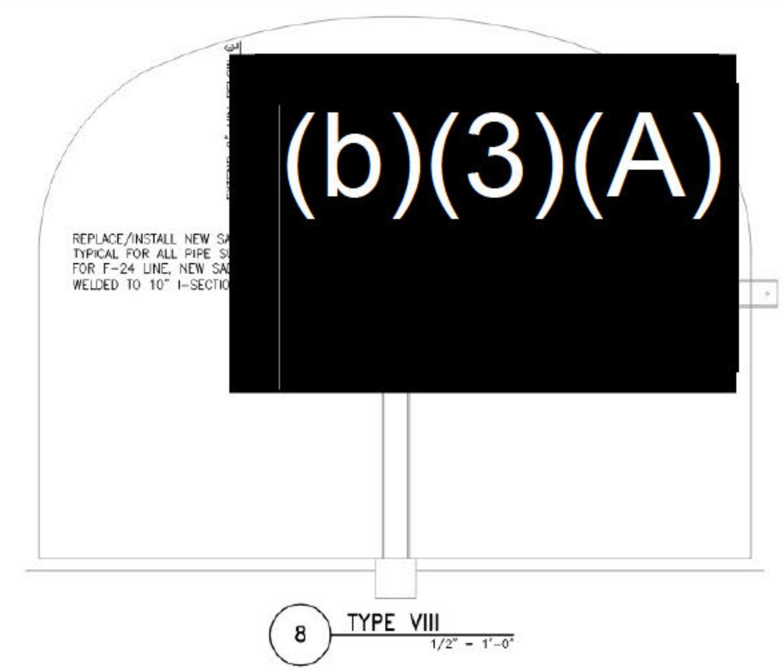
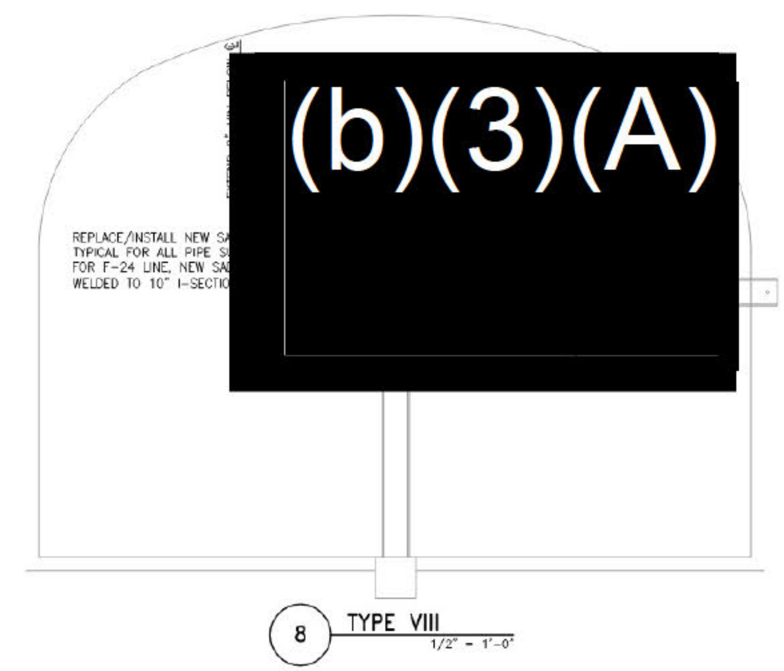
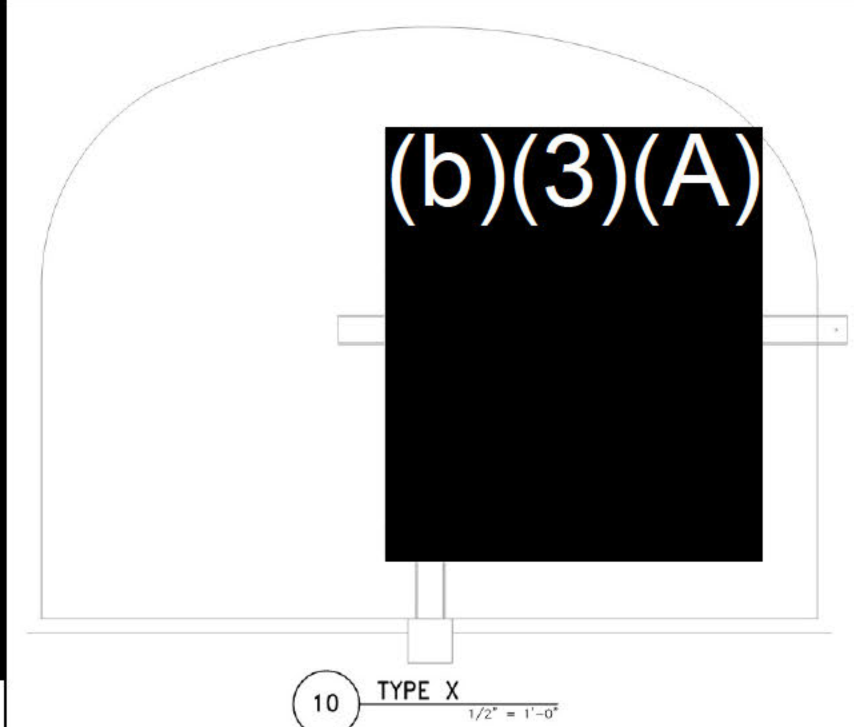
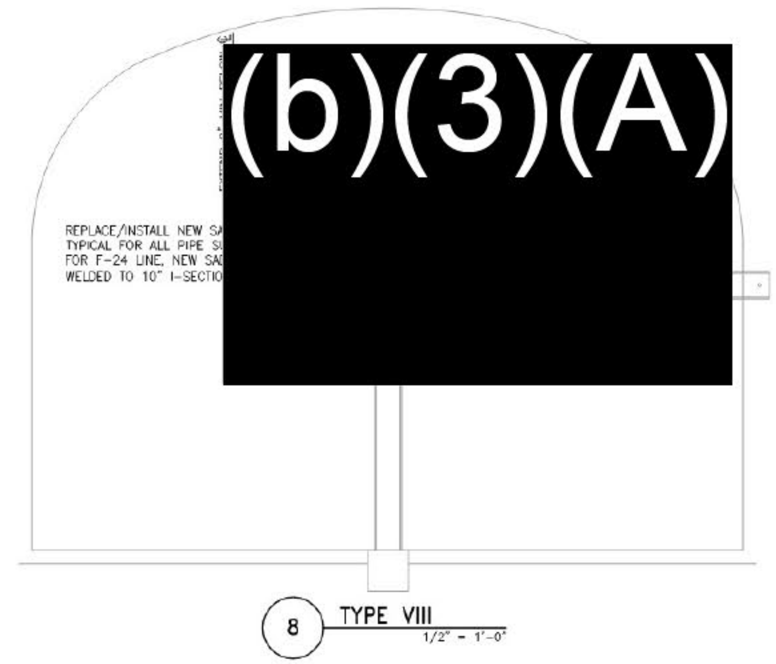
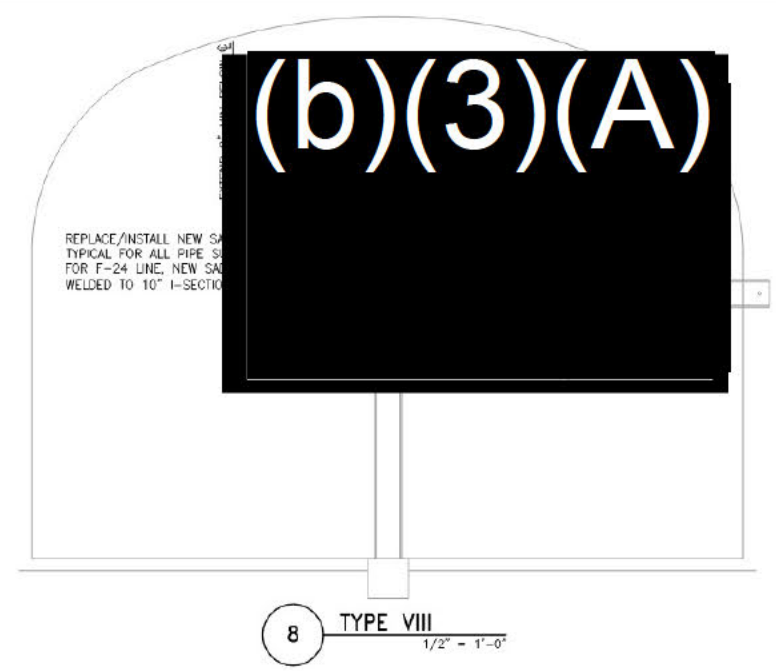
Lateral Restraints			
Pipe Support No.	**Photo**	**Detail**	**Description**
[redacted] (b)(3)(A)	[redacted] (b)(3)(A)		Install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.
[redacted]	[redacted]		Install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.

PRELIMINARY – NOT FOR CONSTRUCTION

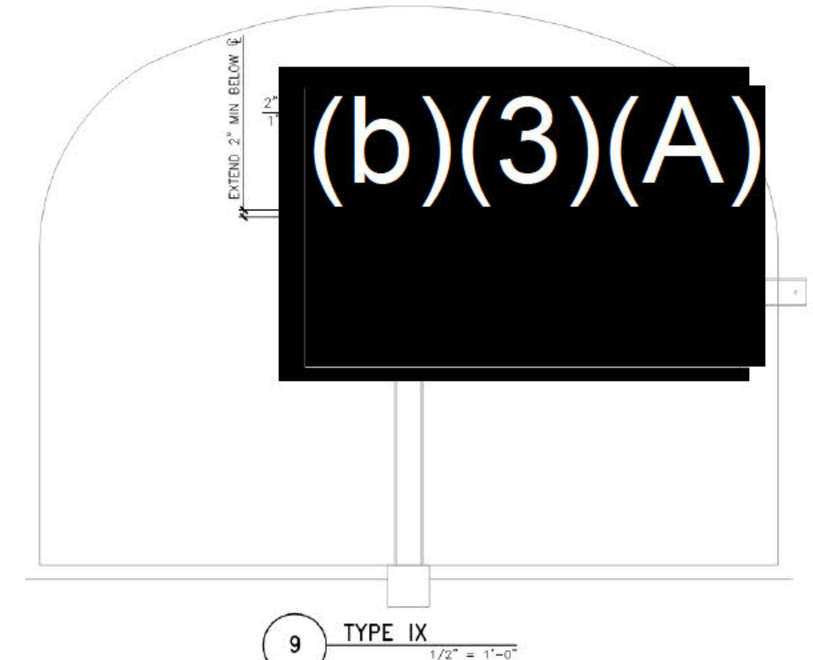
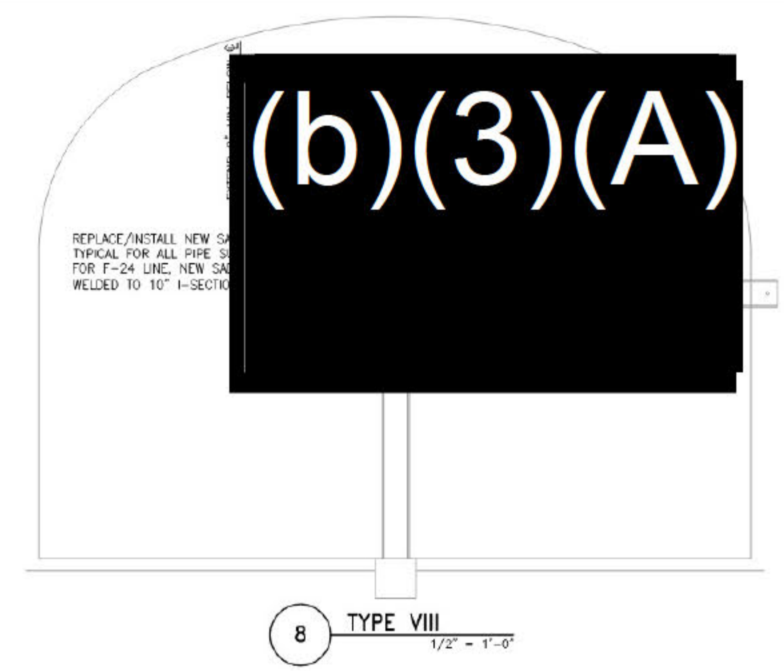
Lateral Restraints			
Pipe Support No.	Photo	Detail	Description
[redacted]	[redacted]		Install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.
[redacted]	(b)(3)(A) 		Install a new vertical member on the free end of the F-24 pipeline to limit its lateral movement, as shown in the detail. This member is to be welded to the existing beam. If there is not sufficient space, the horizontal beam needs to be extended.

PRELIMINARY – NOT FOR CONSTRUCTION

[redacted]

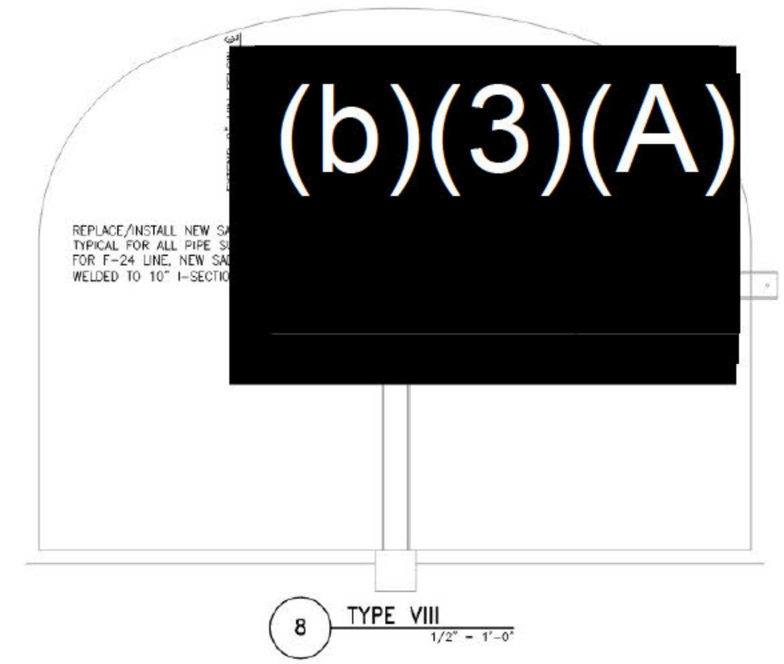
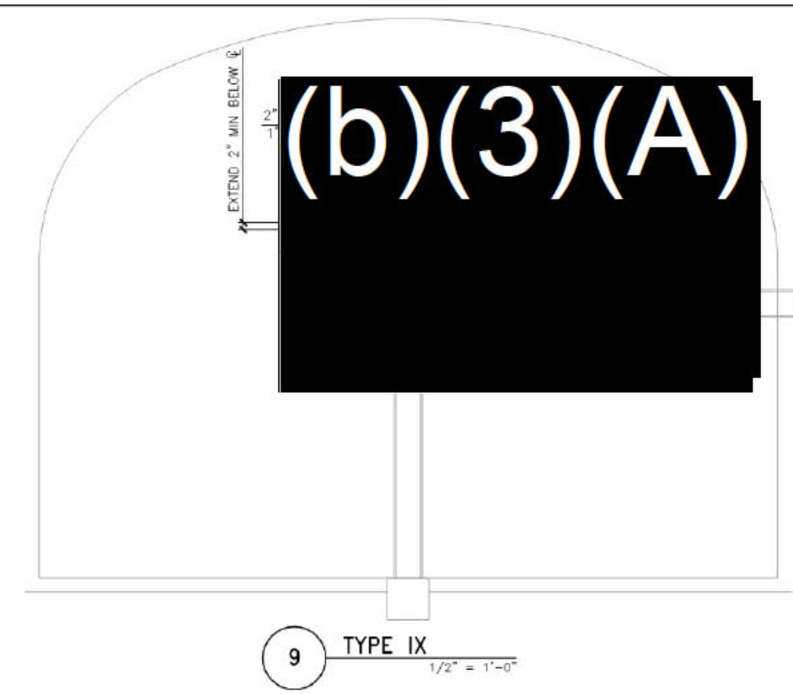
Lateral Restraints			
Pipe Support No.	**Photo**	**Detail**	**Description**
(b)(3)(A) [redacted]	(b)(3)(A) [redacted]		Install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.
[redacted]	[redacted]		Install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.

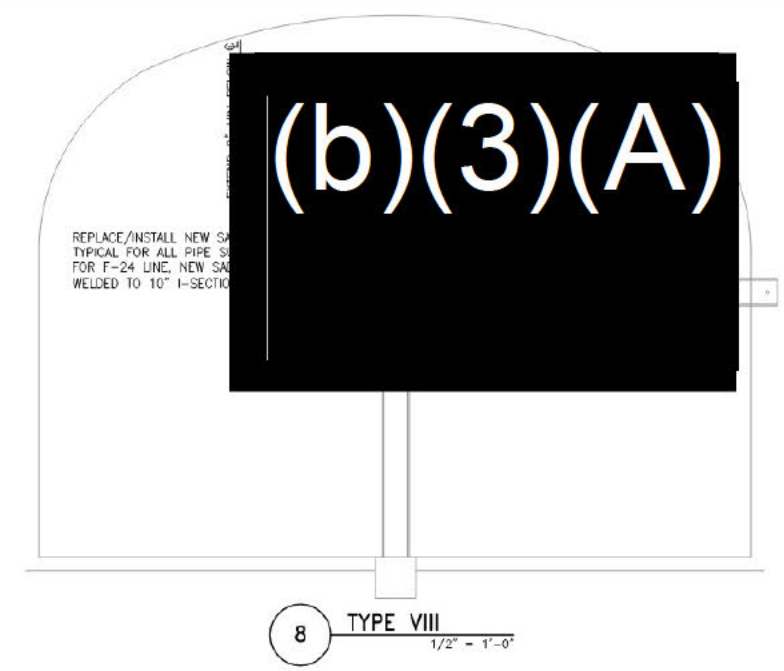
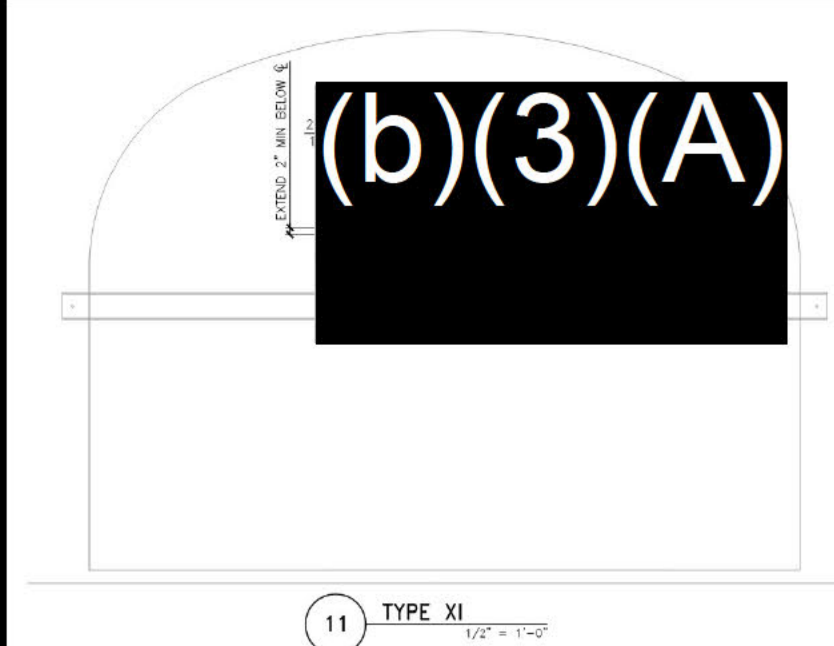
PRELIMINARY – NOT FOR CONSTRUCTION

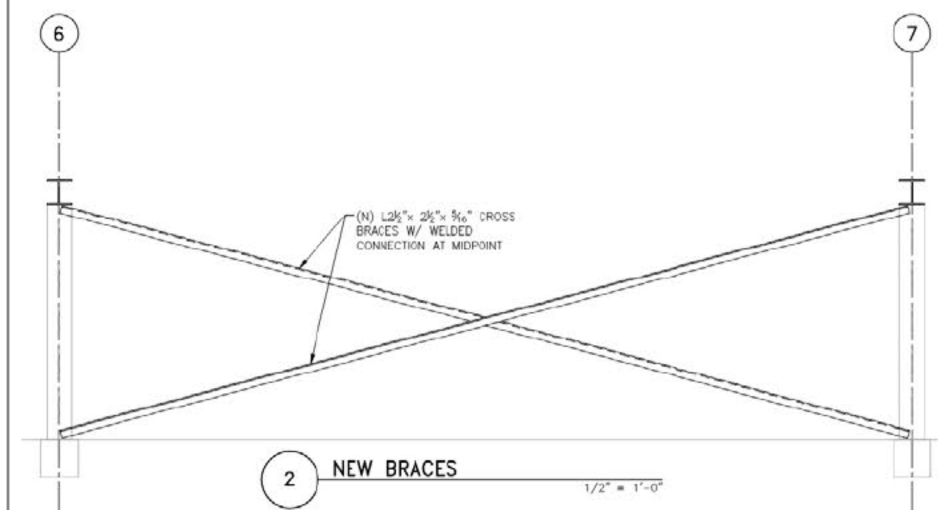
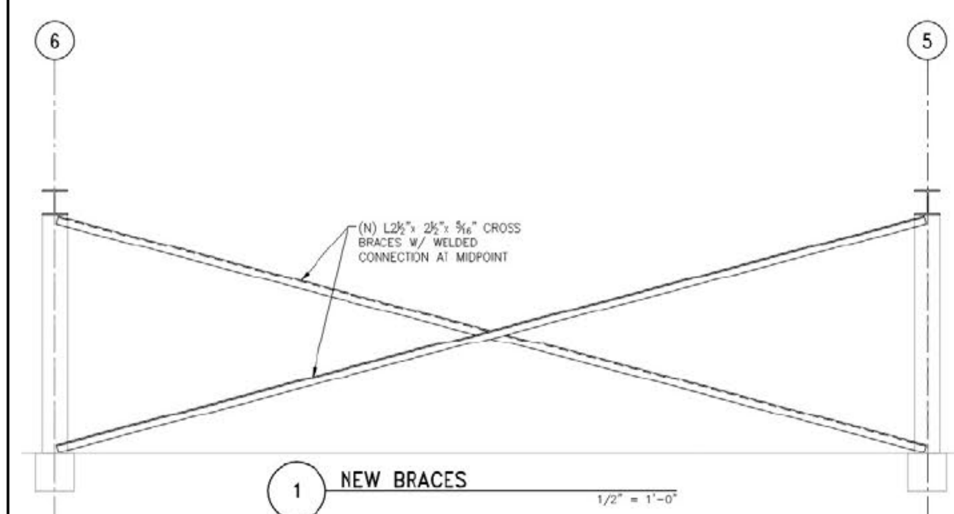
Lateral Restraints			
Pipe Support No.	**Photo**	**Detail**	**Description**
[redacted] (b)(3)(A)			Install a pair of new vertical members on each side of the JP-5 and F-76 pipelines to limit their lateral movement, as shown in the detail. Additionally, install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.
			Install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.

PRELIMINARY – NOT FOR CONSTRUCTION

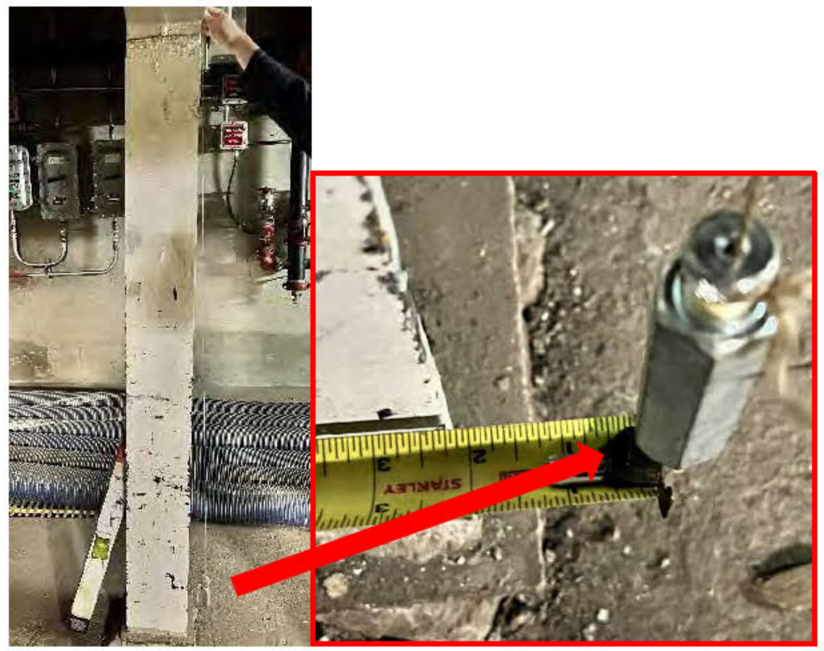
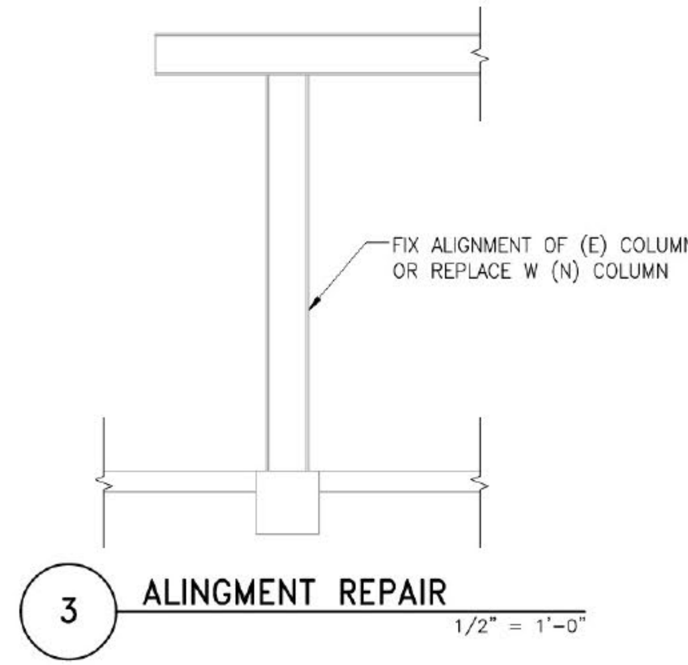
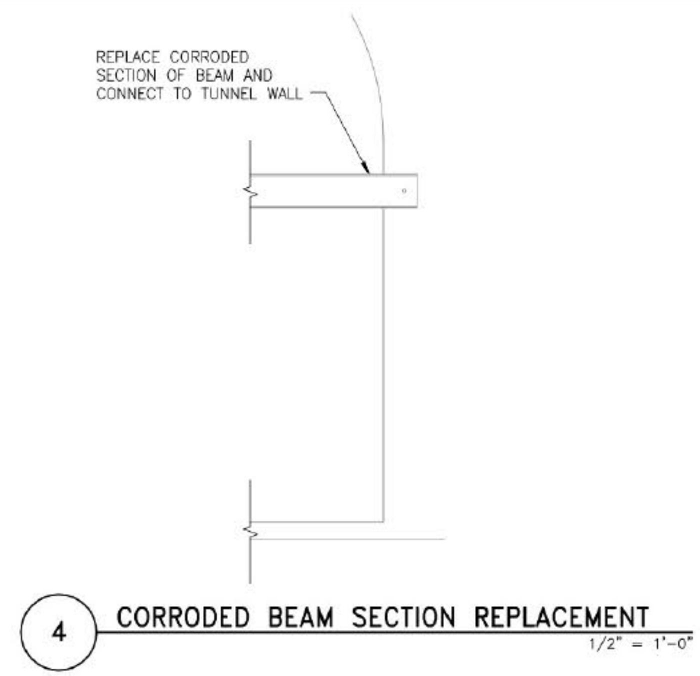
[redacted]

Lateral Restraints			
Pipe Support No.	**Photo**	**Detail**	**Description**
[redacted] (b)(3)(A)	[redacted]		Install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.
			Install a pair of new vertical members on each end of the JP-5 and F-76 pipelines to limit their lateral movement, as shown in the detail. Additionally, install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.

Lateral Restraints			
Pipe Support No.	**Photo**	**Detail**	**Description**
(b)(3)(A) [redacted]	[redacted]		Install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.
[redacted]	[redacted]		Install a pair of new vertical members on each end of the JP-5 and F-76 pipelines to limit their lateral movement, as shown in the detail. Additionally, install lateral stops adjacent to the F-24 pipeline. The objective of the stops is to reduce the risk that the pipeline falls off its support, caused by a large and sudden lateral displacement. The members are to be welded to the existing 10-inch I-beam. Additionally, a new cradle for the F-24 pipeline needs to be installed at all pipe supports, and is to be welded to the existing support.

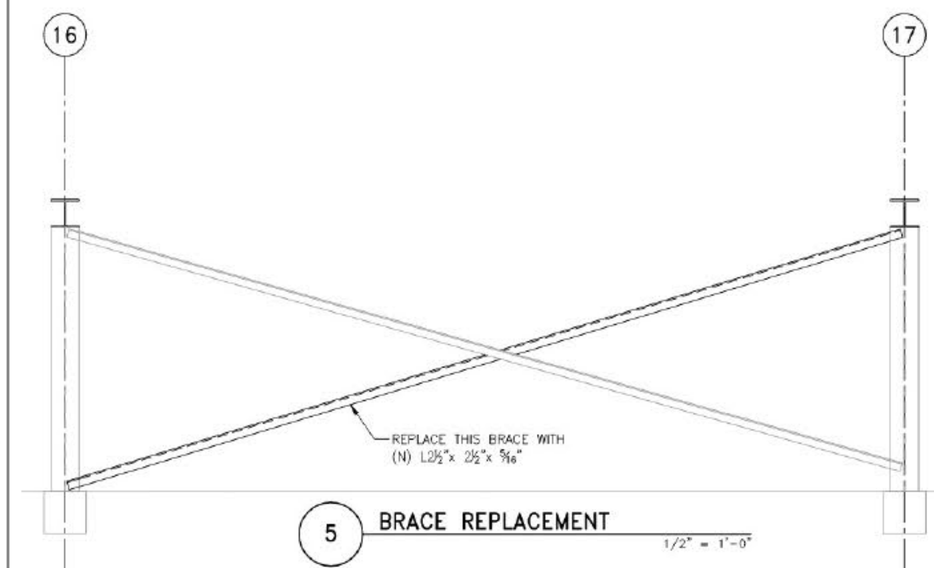
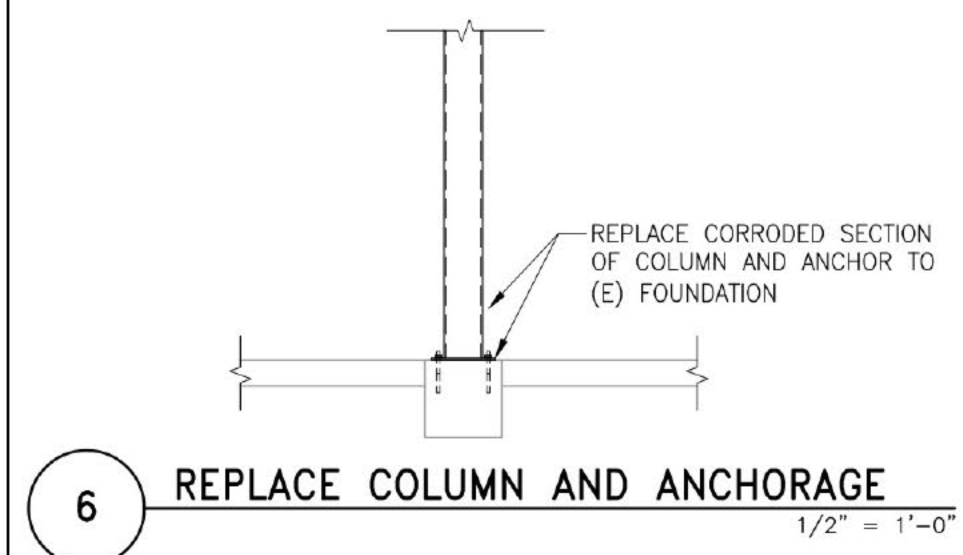
Retrofits and Repairs				
Item	**Pipe Support No.**	**Photo**	**Detail**	**Description**
LAT-5	(b)(3)(A) [redacted]			Replace cut braces in-kind.
LAT-5				Replace cut braces in-kind.

PRELIMINARY – NOT FOR CONSTRUCTION

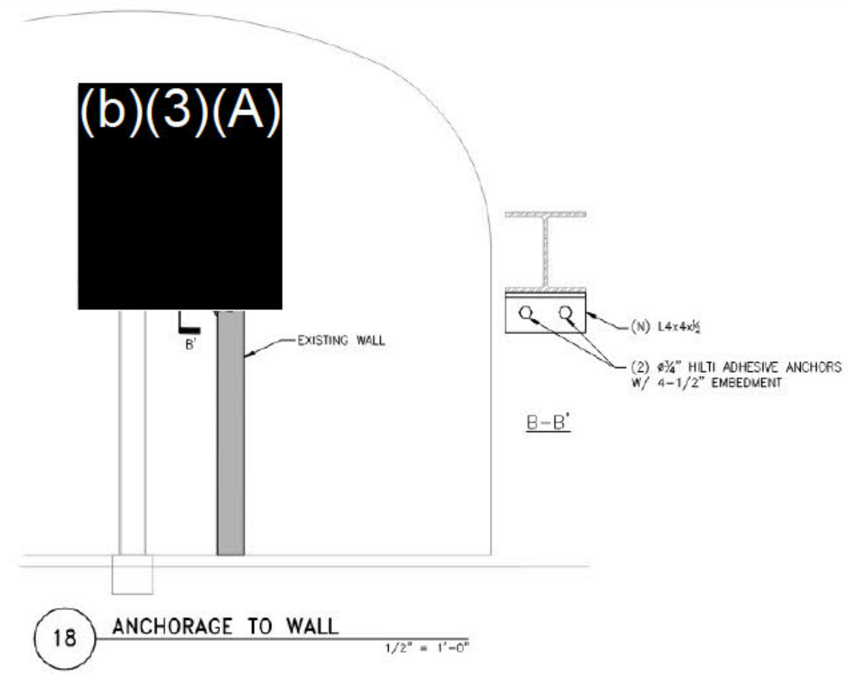
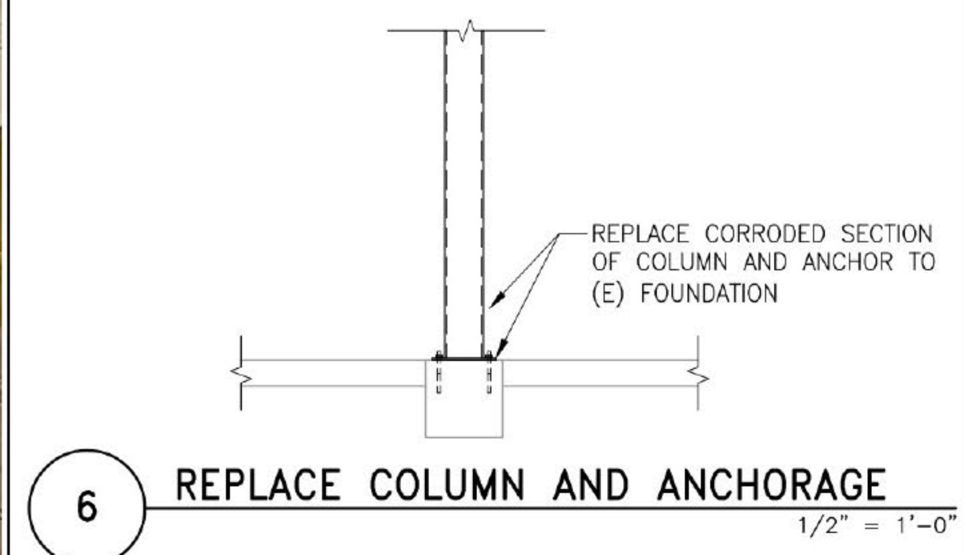
Retrofits and Repairs				
Item	**Pipe Support No.**	**Photo**	**Detail**	**Description**
LAT-8	(b)(3)(A) [redacted]			Fix aligment of the existing column or replace with a new column.
LAT-17	[redacted]			Replace corroded beam section and connect to tunnel wall.

PRELIMINARY – NOT FOR CONSTRUCTION

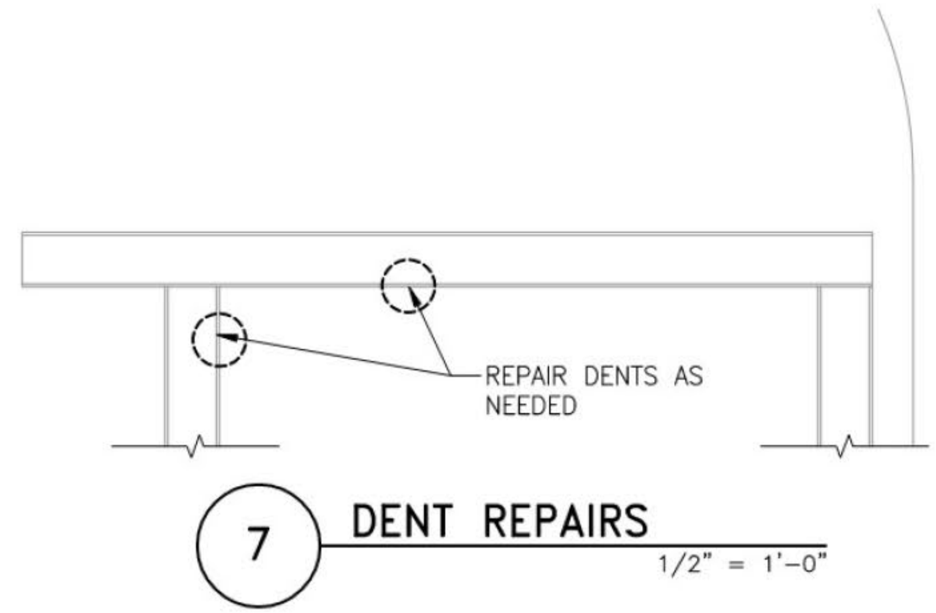
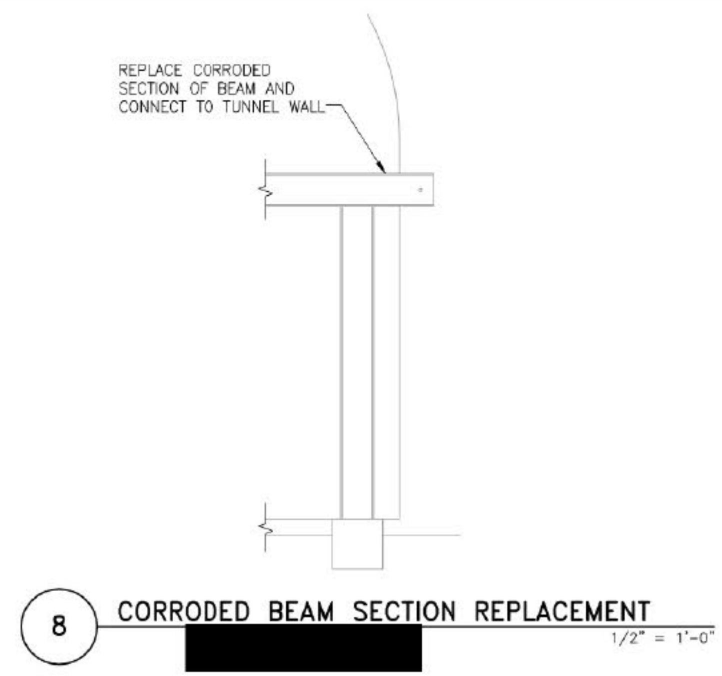
[redacted]

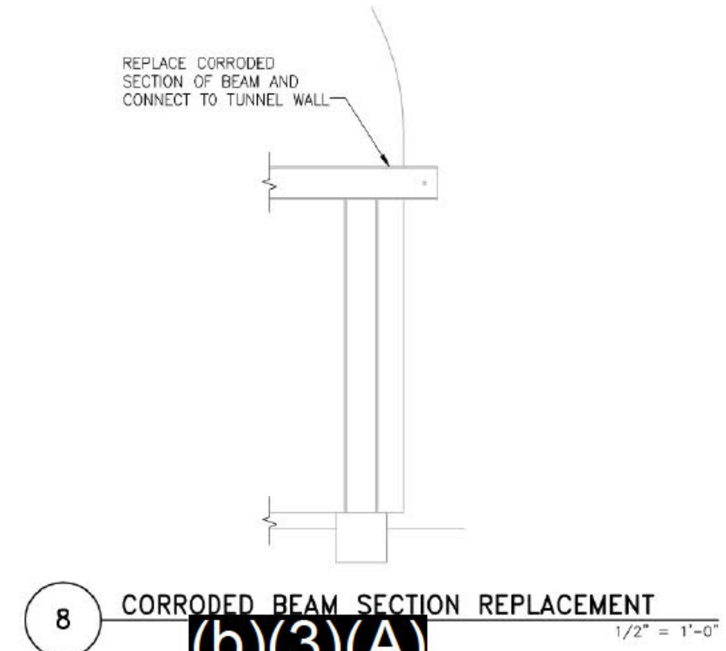
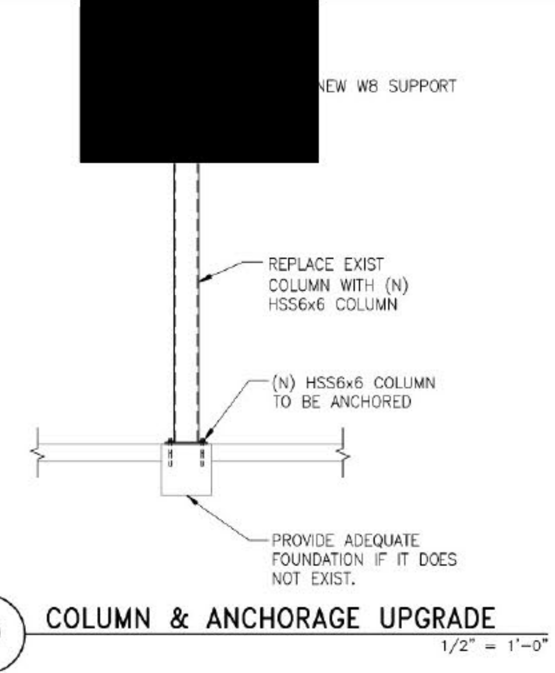
Retrofits and Repairs				
Item	Pipe Support No.	Photo	Detail	Description
LAT-18	(b)(3)(A) [redacted]			Replace bent brace with a new brace.
LAT-19	[redacted]			Replace corroded section of column and anchor to existing foundation.

PRELIMINARY – NOT FOR CONSTRUCTION

Retrofits and Repairs				
Item	**Pipe Support No.**	**Photo**	**Detail**	**Description**
LAT-21	[redacted]	[redacted]		Connection of support 19 beam to the wall.
LAT-22				Replace corroded section of column and anchor to existing foundation.

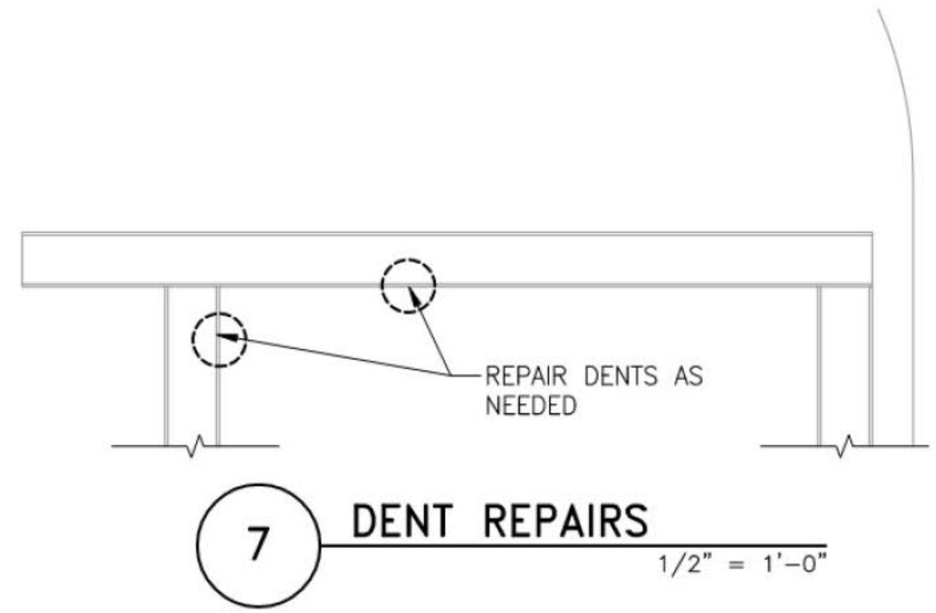
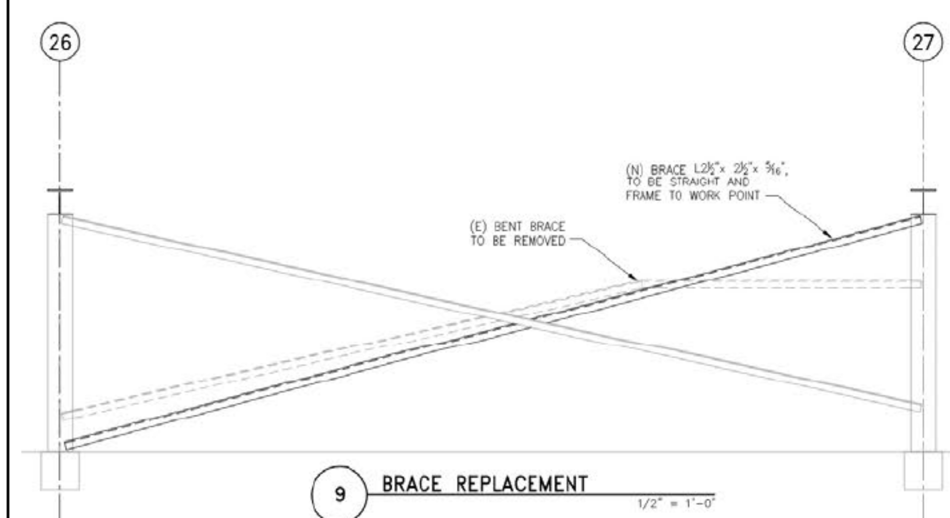
PRELIMINARY – NOT FOR CONSTRUCTION

Retrofits and Repairs				
Item	**Pipe Support No.**	**Photo**	**Detail**	**Description**
LAT-23	(b)(3)(A) [redacted]			Repair dents on flanges as needed.
LAT-25	[redacted]			Replace corroded section of beam and connect to tunnel wall.

Retrofits and Repairs				
Item	**Pipe Support No.**	**Photo**	**Detail**	**Description**
LAT-27	[redacted]		 [redacted]	Replace corroded section of beam and connect to tunnel wall.
LAT-31		[redacted]		Replace existing column with an upgraded column per drawing detail.

PRELIMINARY – NOT FOR CONSTRUCTION

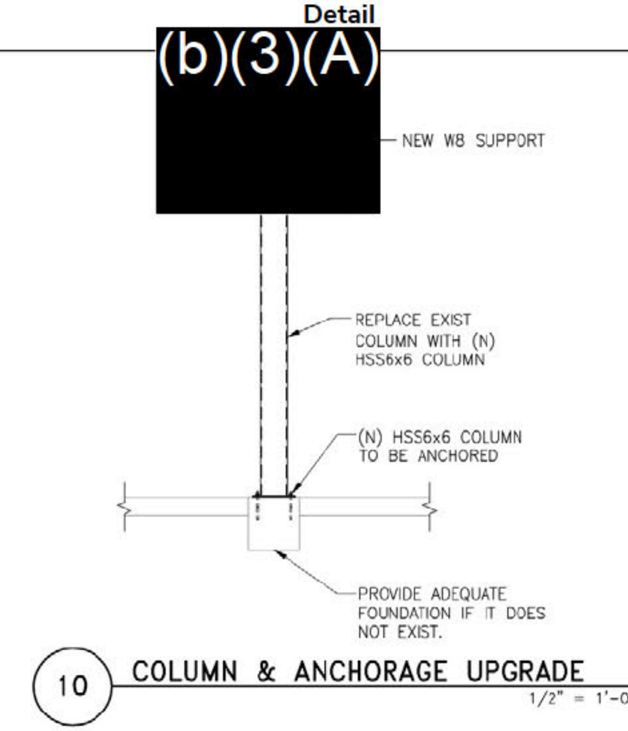
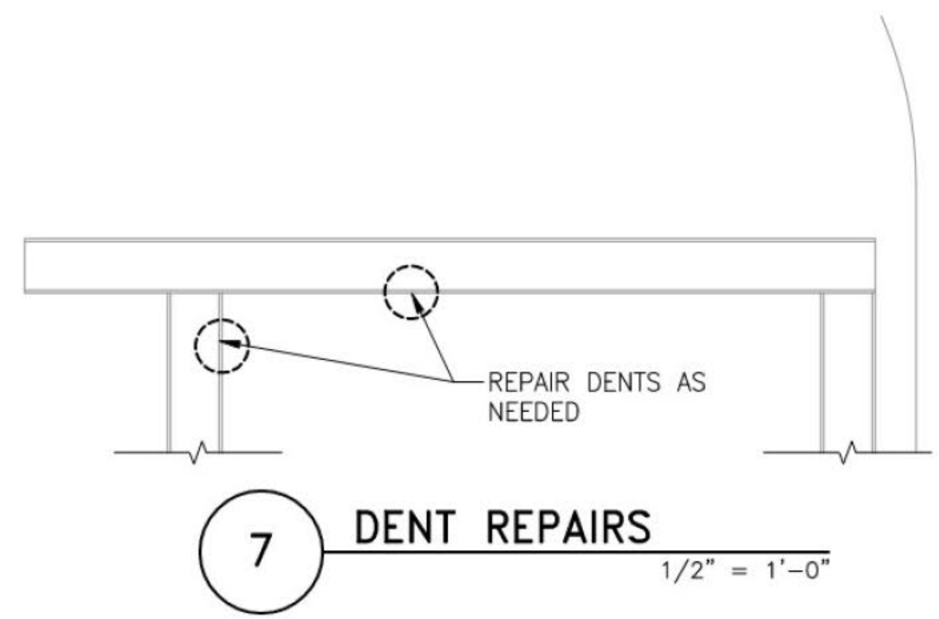
[redacted]

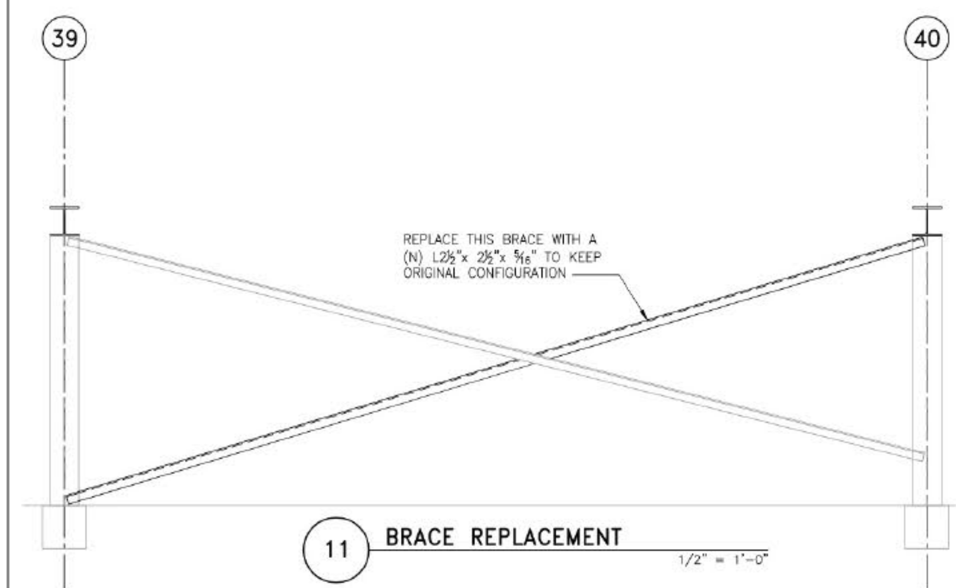
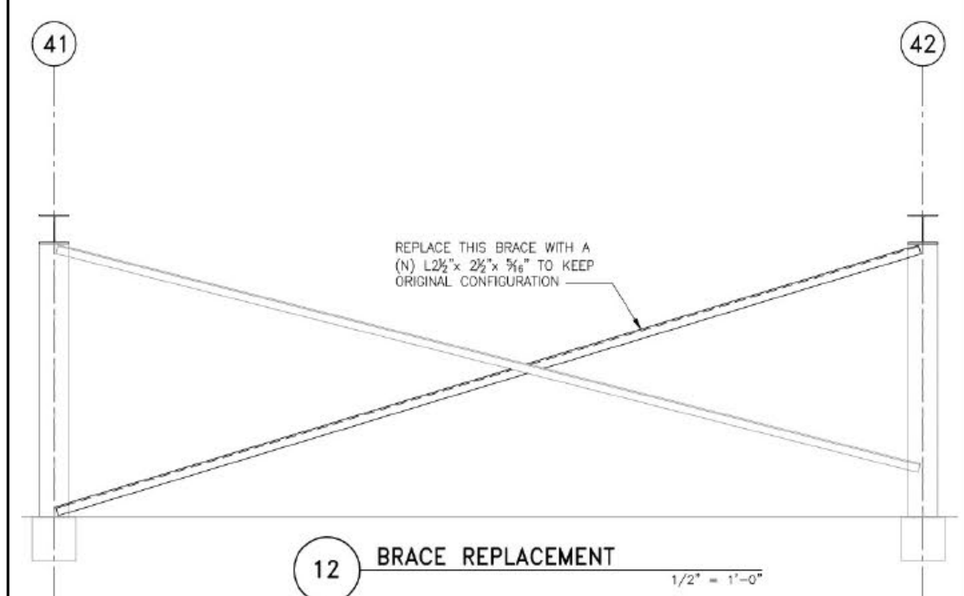
<table>
<tr><th colspan="5">Retrofits and Repairs</th></tr>
<tr><th>Item</th><th>Pipe Support No.</th><th>Photo</th><th>Detail</th><th>Description</th></tr>
<tr><td>LAT-28</td><td rowspan="2">(b)(3)(A) [redacted]</td><td></td><td></td><td>Repair dents on flanges as needed.</td></tr>
<tr><td>LAT-30</td><td>(b)(3)(A) [redacted]</td><td></td><td>Replace bent brace with a new brace.</td></tr>
</table>

PRELIMINARY – NOT FOR CONSTRUCTION

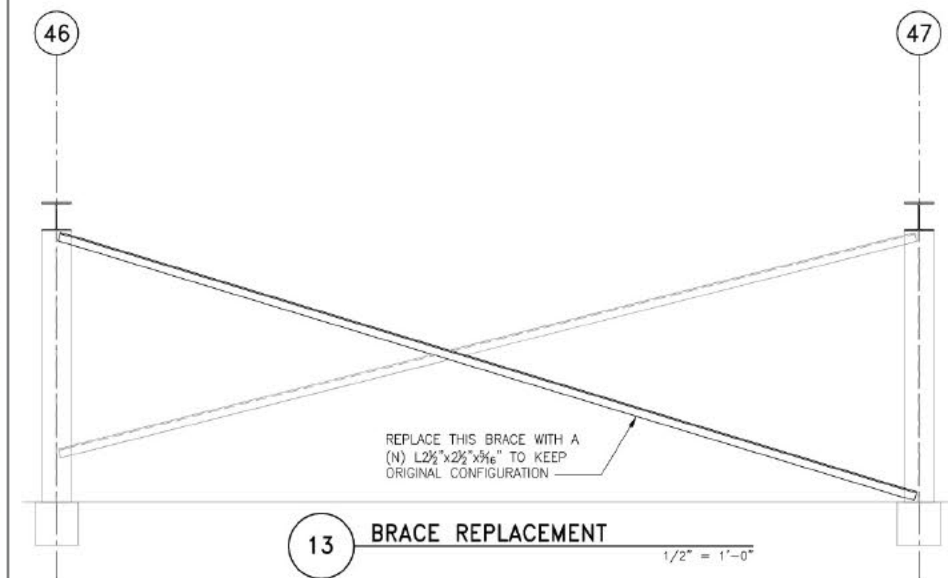
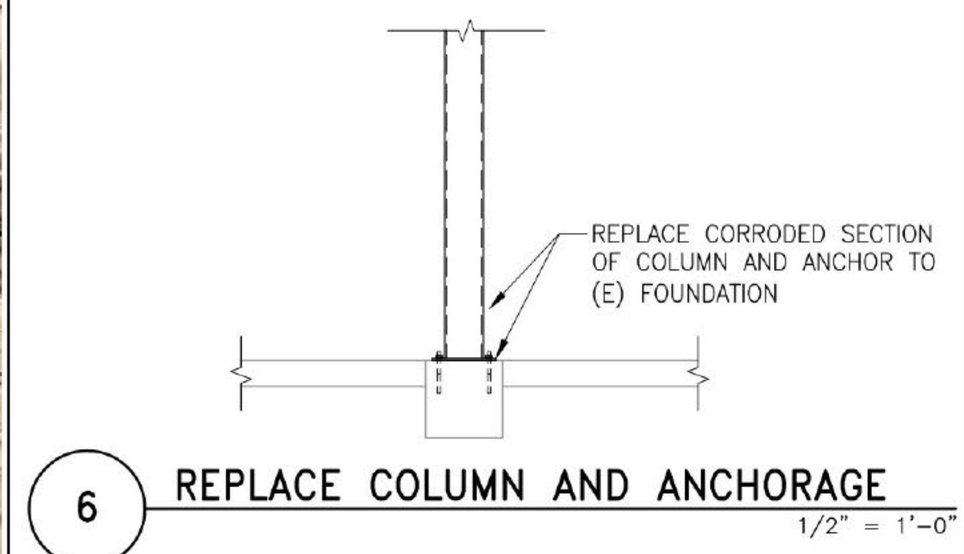
[redacted]

Retrofits and Repairs

Item	Pipe Support No.	Photo	Detail	Description
LAT-31	[redacted]	[redacted]		Replace existing column with an upgraded column per drawing detail.
LAT-28		[redacted]		Repair dents on flanges as needed.

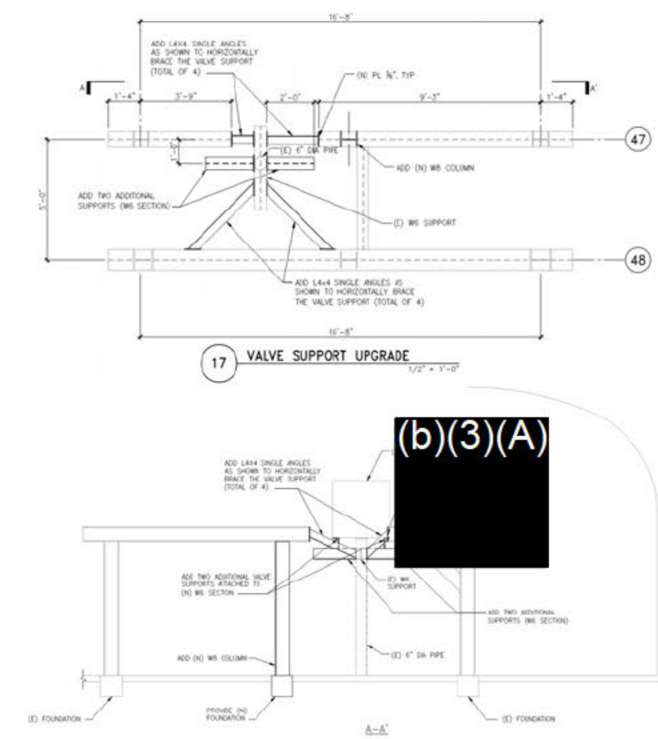
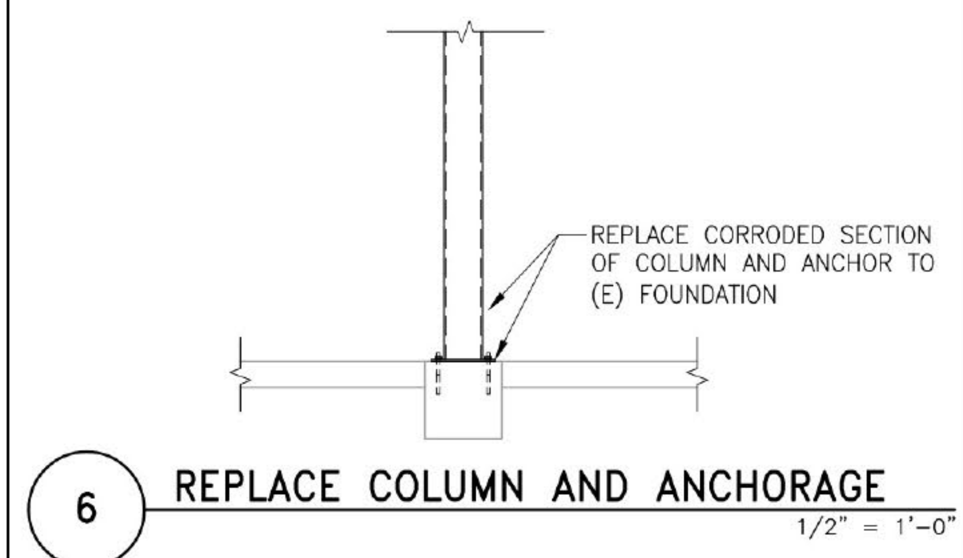
Retrofits and Repairs				
Item	Pipe Support No.	Photo	Detail	Description
LAT-35	(b)(3)(A) [redacted]	(b)(3)(A) [redacted]		Replace brace to restore original configuration.
LAT-36				Replace bent brace with new element.

PRELIMINARY – NOT FOR CONSTRUCTION

Retrofits and Repairs				
Item	**Pipe Support No.**	**Photo**	**Detail**	**Description**
LAT-38	(b)(3)(A) [redacted]			Replace brace to restore original configuration.
LAT-40				Replace corroded section of existing column and anchor to existing foundation.

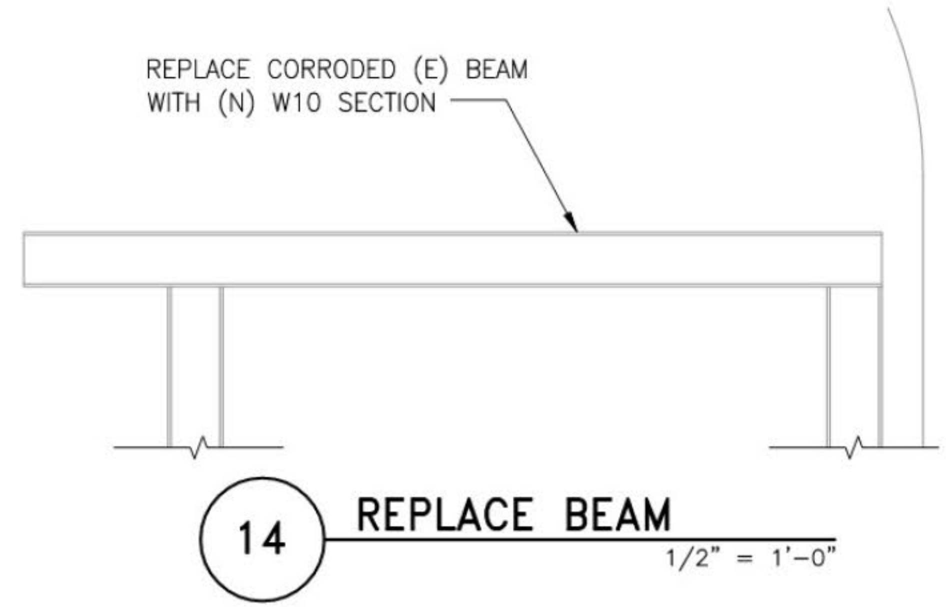
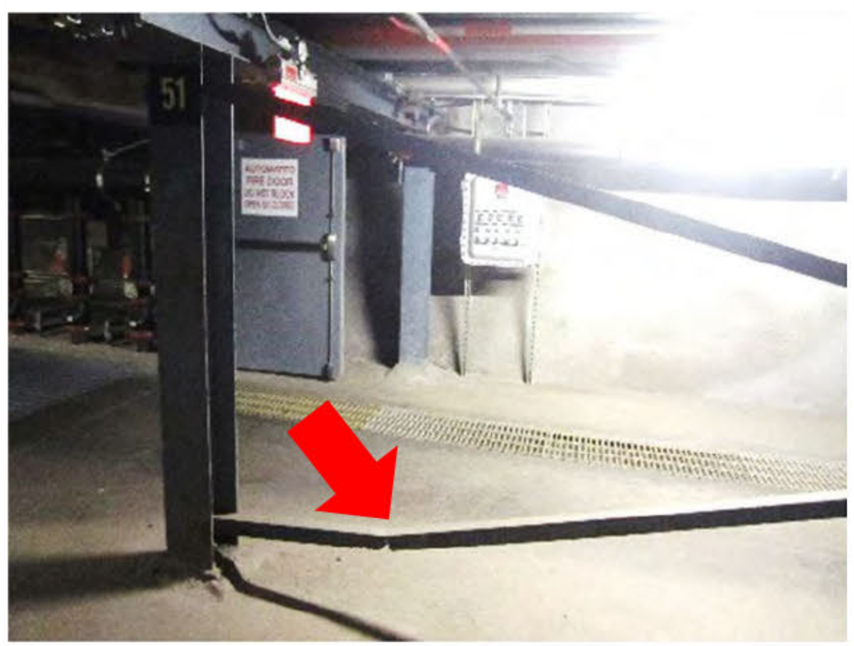
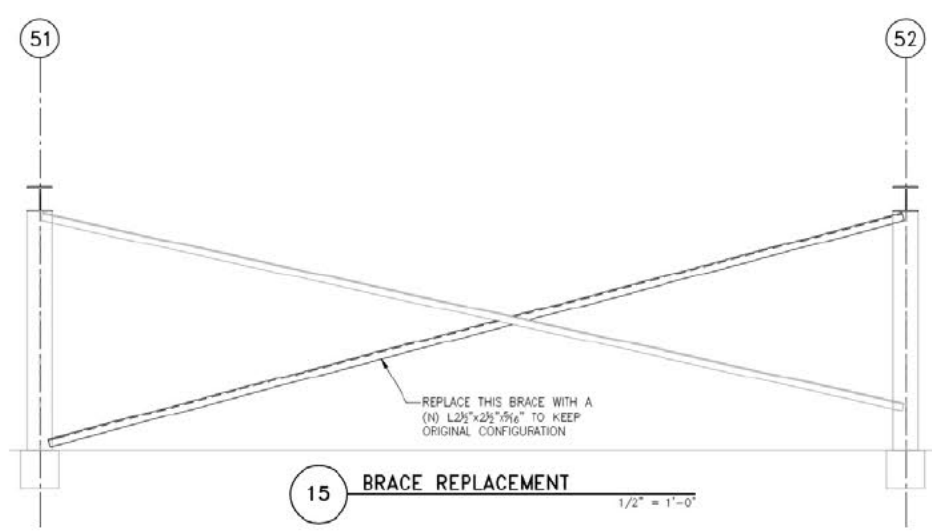
PRELIMINARY – NOT FOR CONSTRUCTION

[redacted]

Retrofits and Repairs				
Item	**Pipe Support No.**	**Photo**	**Detail**	**Description**
LAT-39	(b)(3)(A) [redacted]	(b)(3)(A) [redacted]	 (b)(3)(A) [redacted]	Retrofit pipe supports to improve valve support.
LAT-41				Replace corroded section of existing column and anchor to existing foundation.

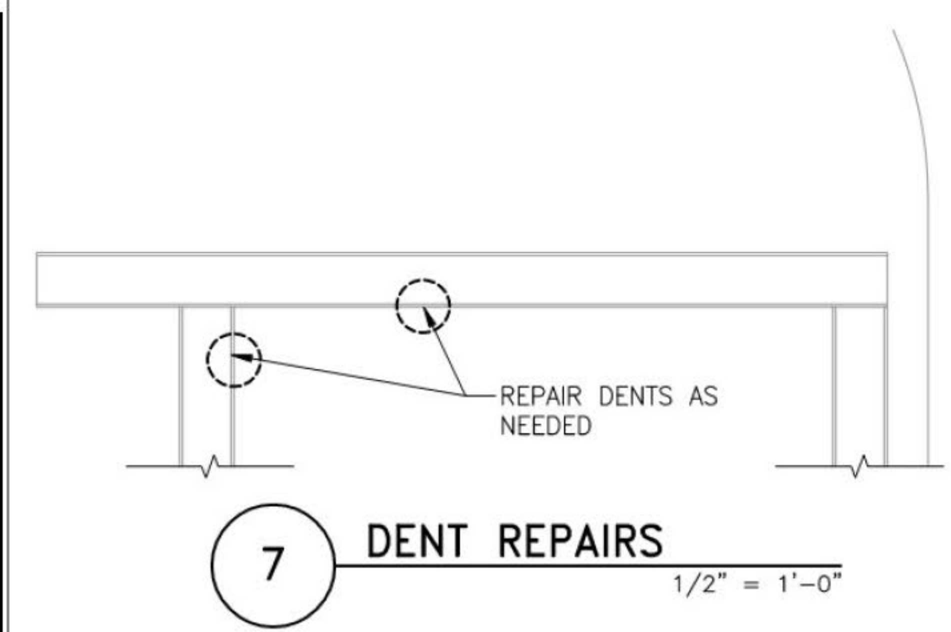
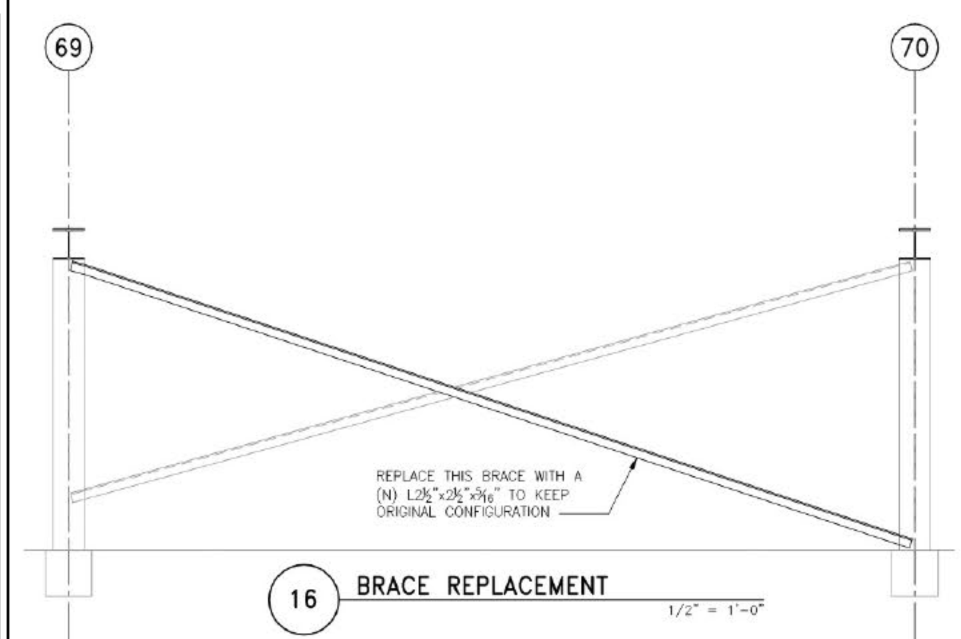
PRELIMINARY – NOT FOR CONSTRUCTION

[redacted]

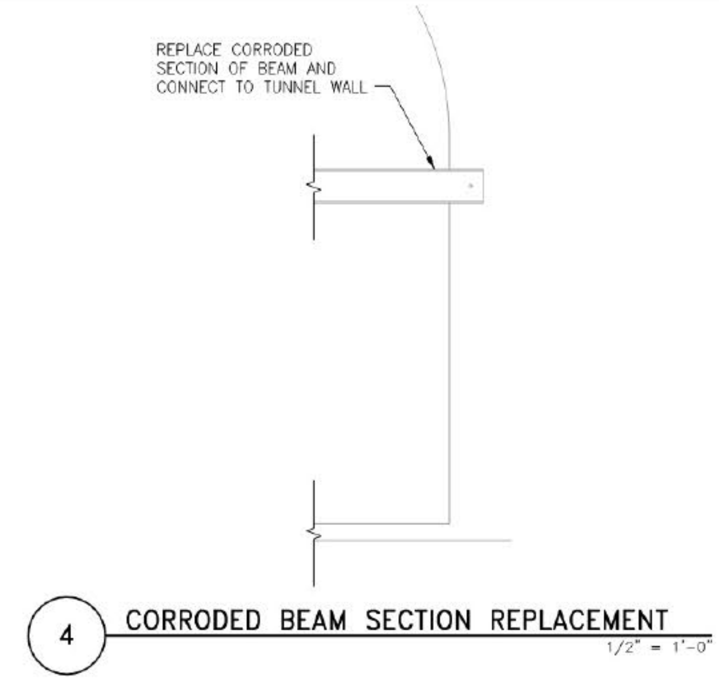
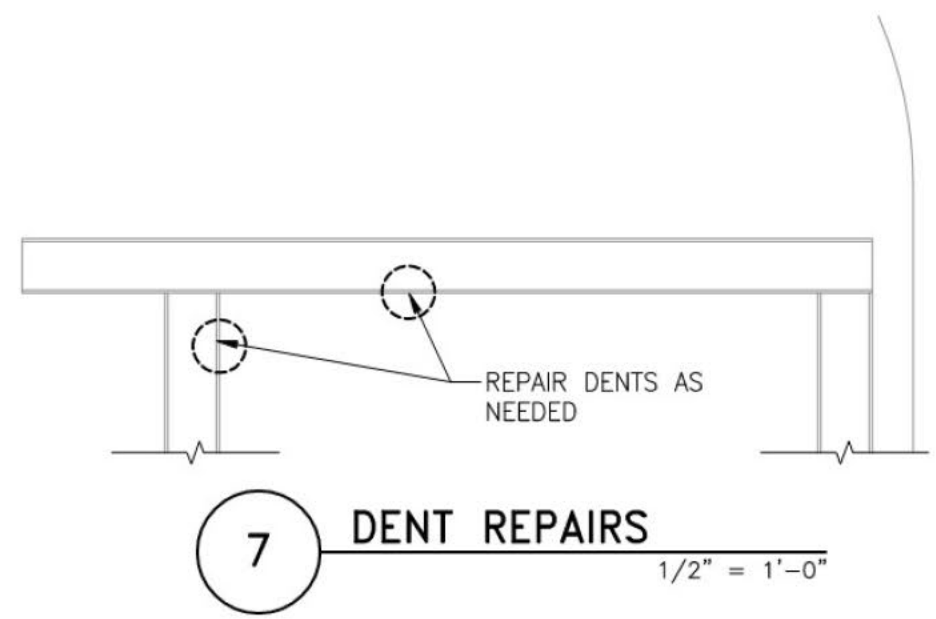
<table>
<tr><th colspan="5">Retrofits and Repairs</th></tr>
<tr><th>Item</th><th>Pipe Support No.</th><th>Photo</th><th>Detail</th><th>Description</th></tr>
<tr><td>LAT-42</td><td>(b)(3)(A) [redacted]</td><td></td><td>
</td><td>Replace corroded beam in-kind.</td></tr>
<tr><td>LAT-43</td><td>[redacted]</td><td>
</td><td>
</td><td>Replace damaged brace to restore original configuration.</td></tr>
</table>

PRELIMINARY – NOT FOR CONSTRUCTION

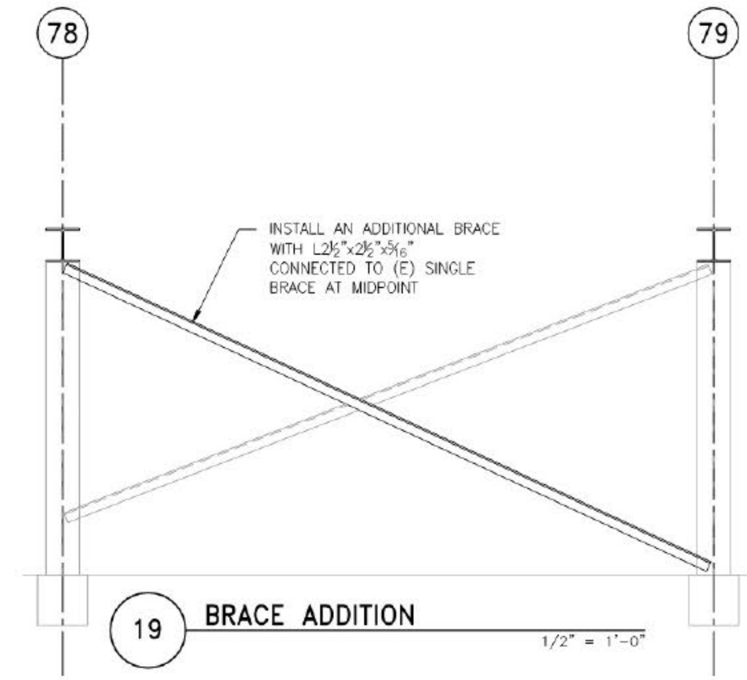
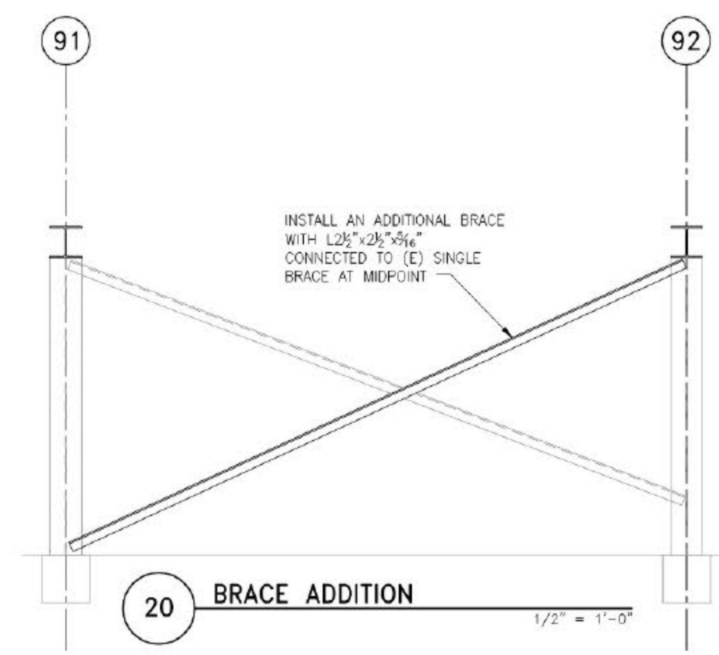
[redacted]

Retrofits and Repairs				
Item	**Pipe Support No.**	**Photo**	**Detail**	**Description**
LAT-28	(b)(3)(A) [redacted]	(b)(3)(A) [redacted]		Repair dents on flanges as needed.
LAT-45		(b)(3)(A) [redacted]		Replace brace to restore original configuration.

PRELIMINARY – NOT FOR CONSTRUCTION

Retrofits and Repairs				
Item	Pipe Support No.	Photo	Detail	Description
LAT-46	(b)(3)(A) [redacted]	(b)(3)(A) [redacted]		Replace corroded section of beam and connect to tunnel wall.
LAT-28	[redacted]			Repair dents on flanges as needed.

PRELIMINARY – NOT FOR CONSTRUCTION

Retrofits and Repairs				
Item	Pipe Support No.	Photo	Detail	Description
LAT-51	(b)(3)(A) [redacted]	(b)(3)(A) [redacted]		Add brace to improve seismic performance,
LAT-52				Add brace to improve seismic performance,

PRELIMINARY – NOT FOR CONSTRUCTION

Retrofits and Repairs				
Item	**Pipe Support No.**	**Photo**	**Detail**	**Description**
LAT-53	(b)(3)(A) [redacted]	(b)(3)(A) [redacted]	(b)(3)(A) [redacted]	Retrofit support to better resist surge load.

PRELIMINARY – NOT FOR CONSTRUCTION

APPENDIX A.5
Valve Equalization Bypass Line Concept

Valve Pressure Equalization using Bypass Line

Pressure equalization across a valve is commonly used in the oil, gas, and chemicals industry to avoid opening a valve with high differential pressure. This design feature increases the sealing surface life and provides a safe method to pressurize the section of piping downstream of the valve. Figure 1 illustrates some examples of pressure equalization bypass valves installed across various valves.

Proprietary Information [redacted]

Figure 1 – Pressure Equalization Line Examples at Existing Facilities

Proprietary Information [redacted]

Wear and tear on a valve may increase when the valve is repeatedly opened and closed with high differential pressure, as this can damage the sealing surfaces. This effect is illustrated in

Figure 2, where high pressure is imposed on the upstream side of a closed ball valve, and a resultant net force is exerted on the sealing surfaces. When the valve is opened (or closed), the force on the sealing surfaces can wear over time and lead to a "leak-by" condition allowing the fluid to pass to the downstream side of the valve when it is closed. In addition, this situation may also require more than anticipated torque to rotate the valve stem to open or close the valve and may lead to a failed valve actuator or failed valve stem.

Proprietary Information [redacted]

Figure 2 – Typical Ball Valve Cross Section

This situation can be avoided by allowing the fluid pressure to equalize across the valve before it is opened by installing a pressure equalization line across the valve. A typical pressure equalization arrangement is illustrated in Figure 3. Pressure equalization allows the pressure differential across the valve to be zero, thus reducing the valve wear and tear and reducing the torque on the valve stem when operating the valve.

Proprietary Information

[redacted]

Figure 3 – Typical Ball Valve Cross Section with Pressure Equalization

The pressure equalization arrangement also reduces hydraulic erosion of the sealing surfaces if the valve is “cracked” open to allow the downstream piping segment to be pressurized.

Hydraulic erosion occurs where high-velocity fluid flows over the sealing surfaces of the valve. Over time, this situation can lead to the sealing surface wear in the localized area of the high-velocity fluid and cause “leak-by” of the valve when it is closed.

Using the pressurization line also allows for an opportunity to check for leaks in the downstream pipe segment without opening the main valve. In this case, if a leak is detected or observed in the downstream segment, the equalization valve is the only valve that needs to be closed. If the main valve is used for this purpose, the time to close the main valve may be longer as compared to a relatively smaller valve and could lead to an increased fluid leak volume.

Application to Red Hill Facility

At Red Hill, there can be a specific issue that is suspected of forming when the butterfly valves in the Underground Pump House “leak-by,” causing line “sag” and allowing a vacuum to form in the resultant void space at the upper end of the main product lines. This vacuum is believed to be a contributor to the JP-5 line movement that occurred on 6 May 2021 and the surge load that led to the Dresser coupling separation.

Since that time, the Red Hill fuel team has adopted a procedure to clear this vacuum by attaching a flexible hose to the high point vent (Figure 4A) of the product line and to the FOR-sump system (Figure 4B). The high point vent valve is opened to relieve the vacuum with ambient air. Once the vacuum is relieved, the main tank valve is slowly “cracked” open or “throttled” to allow fuel to enter the product line and displace the air from the high point vent and into the FOR-sump system. Once fuel is observed through a sight glass in the vent line, the high point vent valve and the main fuel valve are closed.

(b)(3)(A) [redacted]

Figure 4 – High Point Vent Connection (A) and Vent Connection to FOR Sump System (B)

The main tank valves do not have pressure equalization and are opened manually at the various valve locations. This process has three main risk factors: 1) opening the main valves manually and not filling the product line too fast requires specialized hands-on training and a “feel” for how much is too much to open these valves, 2) if this manual operation of the main tank valves is not managed correctly, control of the fuel flow into the product line is lost thus creating a potential for product line pipe movement and a Dresser coupling separation, and 3) if there is a loss of containment, the personnel in the area are exposed to this hazard.

Pressure equalization can mitigate these risks by allowing a controlled flow of fuel into the product line to clear the vacuum in the product line. Since the equalization valve is small compared to the main tank valves, the valve can be fully opened with only standard valve operation training. This will mitigate the chance of pipe movement and loss of containment if the product line (void space) is “filled” too fast. If a leak is detected, the only valve that needs to be closed is the pressure equalization valve, which reduces the exposure risk of personnel to a large loss of containment. The installation of the pressure equalization lines is a recommendation, and further engineering and risk assessment needs to be completed during the detailed design phase.

Pressure Equalization Line Concept for Installation Before Defueling

Before defueling the Red Hill storage tanks, the one proposed approach is to install pressure equalization on the tank valves on each of the fuel product tanks. These three product tanks should be the last tanks to be defueled so that they are the source of fuel to clear the vacuum/void space in the product lines. These tanks should also be the tanks that are at the highest elevation possible for each product type.

The procedure to clear the vacuum/void space is required to be completed each time fuel is removed from the storage tanks. It is also assumed that the defueling of each tank will not be a continuous process in that the process may be stopped and restarted as the various defueling vessels arrive and depart, and the time in between may be long enough to allow for a vacuum to form in the fuel lines.

Installation of pressure equalization and differential pressure gauges on the three selected fuel tank valves can utilize some of the existing valves with minimal modifications to the piping contingent upon qualification of these components for the operating pressure and other applicable loads.

At each tank location, there is a manifold that is used for fuel sampling and dewatering. One of the outlets at these manifolds can be used to pressurize the in-board fuel valve (Figure 5). The in-board valve would then be pressurized by routing the fuel to the drain location in the pipe segment between the inboard and outboard tank valves. These drain valves are encircled in Figure 6.

(b)(3)(A)

[redacted]

Figure 5 – Typical Sampling Point of an Underground Storage Tank

[redacted]

(b)(3)(A)

Figure 6 – Typical Drain Valves on Piping by the Underground Storage Tanks

These drain valves will need to be modified for the pressurization piping and valving (Figure 7), where the existing drain valve remains, and a pipe “cross” is added with valves added on three connections for drain, fuel source, and connection to the outboard valve downstream piping.

The proposed modifications for the connections to the fuel source and connection to the pipe downstream of the outboard valve are sketched in Figure 8 in red color. Flanged valves should be considered to improve the constructability and maintenance of the valves.

[redacted] (b)(3)(A)

Figure 7 – Drain Valve Modification Concept

[redacted] (b)(3)(A)

Figure 8 – Typical Pressurization Bypass Line Modification Concept

The line size from the tank manifold to the drain valve location should be the same size as the existing manifold pipe size, which is approximately 1 in. diameter pipe. The line size that connects from the drain location to the downstream side of the outboard tank should be the same size as the pipe at the drain location, which is approximately 2 in. diameter pipe.

The pipe segment between the inboard and outboard main tank valves is relatively small (approximately 10 ft long), and a 1 in. diameter pipe is expected to fill and pressurize the pipe segment in a relatively short period of time. According to the flow rates available in the literature, fuel flow through a 1 in. pipe with 139 ft of the head would be approximately 47 gpm. The downstream portion of the outboard main tank valve has a much larger volume compared to the upstream portion. Therefore, a 2 in. diameter pipe is expected to allow the downstream piping to fill and pressurize faster compared to 1 in. diameter line. The actual duration will depend on the vacuum/void space volume that is recommended to be calculated during the detailed design stage.

The piping on the downstream side of the outboard main tank valve will require a 2 in. pipe tap to be installed in the piping. This modification may require a segment of the pipe to be removed.

Differential pressure gauges are also needed to verify that each valve has been pressure equalized before the main valve is opened. The current main tank valves have “taps” in the valve flanges that can be used to connect a differential pressure gauge. These “taps” are encircled in red in Figure 9 and are common for the main tank valves. Small diameter tubing (typically 1/2 in.) would be installed and connected at the tap locations and the gauge connection points. Two valves should be installed to isolate the gauge for repairs and full isolation (Figure 10).

(b)(3)(A) [redacted]

Figure 9 – Typical Main Tank Valve Taps

(b)(3)(A) [redacted]

Figure 10 – Main Tank Valve Pressure Equalization Gauge Installation Concept

It is recommended to verify the existing sampling piping as fit for purpose with respect to internal pressure, temperature, and dynamic forces for this option.

Permanent Pressure Equalization Installation Concept for Continuing Operations

After defueling, the pressure equalization lines at each of the storage tanks' main valves can be installed using dedicated piping instead of utilizing the drain valve on the pipe segment between the inboard and outboard main tank valves if the underground fuel storage tanks were to remain in service.

For the inboard main tank valve, the pressure equalization source is from the sampling manifold but should be routed to a new location on the pipe segment just downstream of the in-board valve (Figure 11). The pipe tap connection to the pipe segments and the valve should be flanged connections. The connection to the tank manifold should be consistent with the pipe and valving that is currently installed. The pressure equalization piping and valves should be 1 in.

A pressure equalization gauge should be installed at the main valve flanges using existing pipe tap locations (Figure 10). A valve should be installed at each tap location so that the valve can be removed for servicing. The piping for the pressure equalization gauge should be 1/2 in. tubing and valves.

For the outboard main, the pressure equalization line source will be the pipe segment upstream of the outboard valve (Figure 11). New pipe taps need to be installed in the upstream and downstream piping of the outboard valve. The connection to the pipe segments and the valve should be flanged connections. The pressure equalization piping and valves should be 2 in.

A pressure equalization gauge should be installed at the main valve flanges using existing pipe tap locations (Figure 10). A valve should be installed at each tap location so that the valve can be removed for servicing. The piping for the pressure equalization gauge should be 1/2 in tubing and valves.

(b)(3)(A)

[redacted]

Figure 11 – Permanent Pressure Equalization Bypass Line Concept

APPENDIX B
Process Hazard Analysis Report

MARKING REMOVED

TÜVRheinland®

Risktec

Report

Pearl Harbor & Red Hill Fuel Supply Point Process Hazard Analysis (PHA)

Prepared for NAVSUP Fleet Logistics Pearl Harbor

Document Number: 22-SGH-01-1

Issue: 3.0

Date: March 31, 2022

risktec.tuv.com

[redacted]

EXECUTIVE SUMMARY

This report documents a Process Hazard Analysis (PHA) for Pearl Harbor and Red Hill Fuel Supply Point for NAVSUP FLCPH. The review was conducted using the Hazard and Operability (HAZOP) and What-If? methodologies. The methodologies employed in this study meet the requirements of the Occupational Safety and Health Administration (OSHA) rule, Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119) and the Environmental Protection Agency's rule 40 CFR Part 68, Accidental Release Prevention Requirements, Risk Management Program Under the Clean Air Act, Section 112(r)(7).

The PHA was conducted in-person on dates February 7, 2022 through February 11, 2022 and on February 21, 2022 through February 25, 2022. The PHA Team met for a total of ten (10) days. The PHA was facilitated and documented by Risktec with key participation from Navy Supply Fleet Logistics Center Pearl Harbor personnel and support personnel. The multidisciplinary team identified process hazards associated with the Pearl Harbor & Red Hill Fuel Supply Point. The team focused on those process hazards that could lead to significant impact on mission readiness, safety or health, public, and/or environment during routine and non-routine operations.

The PHA Team identified one hundred twenty (120) recommendations for reducing the likelihood and/or severity of potential consequences associated with the Pearl Harbor & Red Hill Fuel Supply Point. Since defueling was a key discussion during the PHA, the recommendations suggested for implementation before defueling were identified separately and may be found in the Results Section in Table 7. Table 8 in the Results Section represents all the Critical/Red color coded recommendations associated with critical tolerability risks for ongoing operations, excluding those listed for defueling. A complete list of the PHA recommendations is contained in Appendix A. The PHA worksheets may be found in Appendix B.

ISSUE RECORD

Issue	Date	Revision History	Authored By	Reviewed By	Approved By
1.0	March 8, 2022	Submitted to Client for inclusion in Red Hill Assessment Report	[redacted]		
2.0	March 21, 2022	Minor Updates, Submitted to Client for inclusion in Red Hill Assessment Report			
3.0	March 31, 2022	Edited Report Number			

DISTRIBUTION

[redacted]	Simpson Gumpertz & Heger
File	Risktec Solutions, Inc.

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TABLES

FIGURES

1 INTRODUCTION

1.1 Overview

Risktec Solutions, Inc. (Risktec) was contracted by Simpson, Gumpertz & Heger (SGH) to conduct a Process Hazard Analysis (PHA) of the Pearl Harbor & Red Hill Fuel Supply Point. The PHA was conducted in-person on dates February 7, 2022 through February 11, 2022 and on February 21, 2022 through February 25, 2022. The PHA Team met for a total of ten (10) days.

The PHA was facilitated and documented by Risktec with key participation from Navy Supply Fleet Logistics Center Pearl Harbor personnel and support personnel. The multidisciplinary team identified process hazards associated with the Pearl Harbor & Red Hill Fuel Supply Point. The PHA Team focused on those process hazards that could lead to significant safety or health consequences during routine and non-routine operations.

The PHA was conducted using the Hazard and Operability (HAZOP) and What-If? methodologies. The PHA team used the supplied DFSP Pearl Harbor Risk Matrix to assess risk. The methodologies employed in this study meet the requirements of the Occupational Safety and Health Administration (OSHA) rule, Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119) and the Environmental Protection Agency's rule 40 CFR Part 68, Accidental Release Prevention Requirements, Risk Management Program Under the Clean Air Act, Section 112(r)(7).

2 PROCESS HAZARD ANALYSIS (PHA)

2.1 Hazard and Operability (HAZOP) Analysis

The HAZOP technique is used to identify credible process hazards that could affect the employees' and/or public safety, the environment, or result in equipment damage or reliability event (lost production), so that these risks can be minimized or eliminated. It is a rigorous examination of process hazards as well as potential serious operational problems.

A HAZOP study identifies how a process may deviate from the operational and design intent. The HAZOP technique is both thorough and systematic and examines the process and/or operations utilizing a multi-disciplinary team of experienced personnel to review deviations from the design intent. The team generally consists of a trained leader, a scribe and three to five resource people knowledgeable in the process being analyzed

The HAZOP analysis technique provides a structured framework, which directs the HAZOP team to study various deviations from the normal operating intent of the facility (see Figure 1)

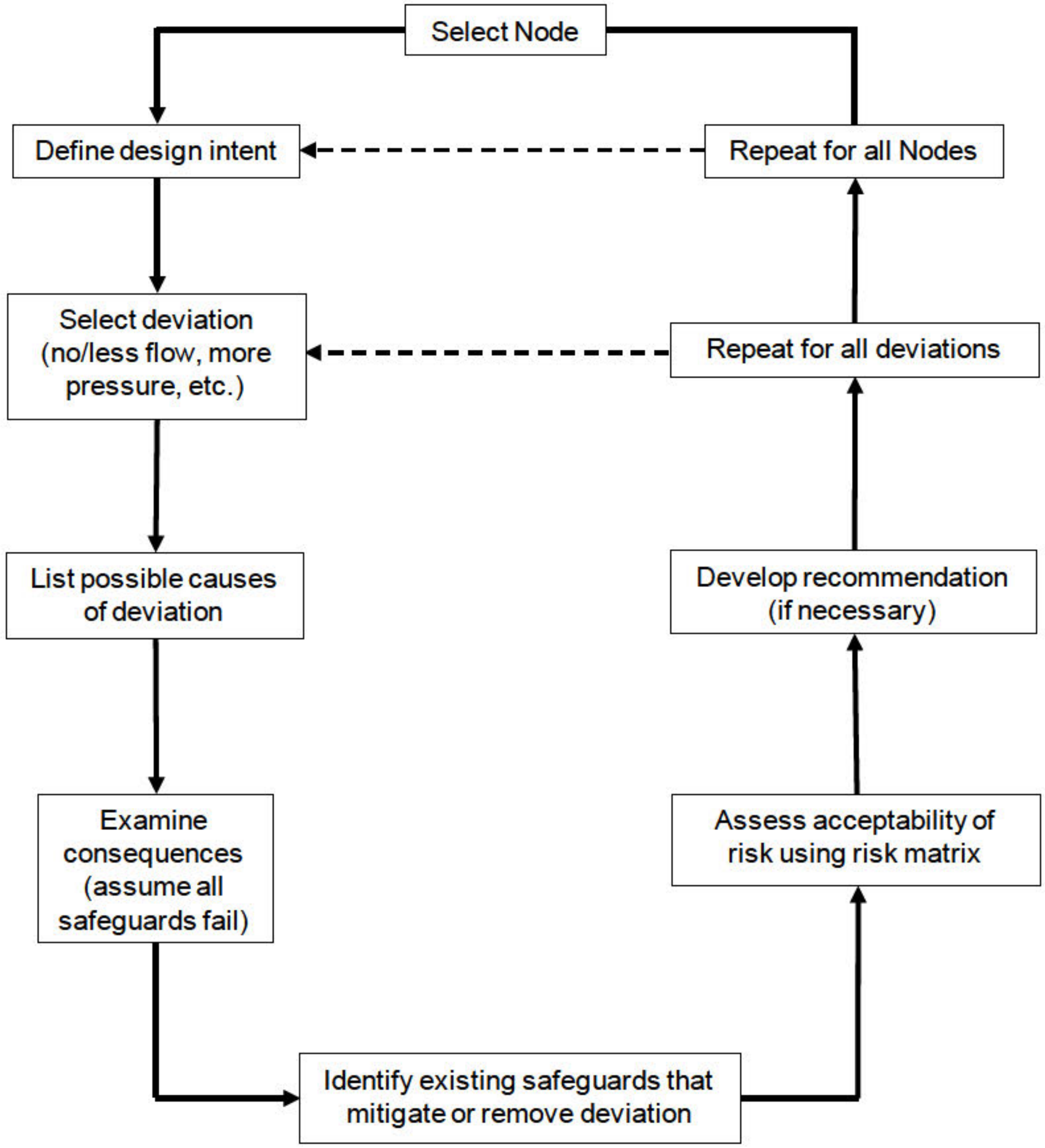

Figure 1: HAZOP Flow Chart

In HAZOP terminology, a deviation is anything that is a departure from the design intention. The deviations are discovered by applying the guidewords in the following table to applicable process conditions for every process section. Standard deviations used during the study are included in Table 1.

Table 1: Standard Deviations

Design Parameters	Guidewords			
	No/Low	**More/High**	**Reverse**	**Misdirected**
Flow	No/Low Flow	More Flow	Reverse Flow	Misdirected Flow
Pressure	Less Pressure	More Pressure		
Temperature	Less Temperature	More Temperature		
Level	No/Less Level	More Level		
Composition				
Leak/Rupture				
Start-up				
Shutdown				
Maintenance				
Relief				

Additional deviations may be applied depending on the nature of the system / process under review. A partial list of additional deviations is included in Table 2.

Table 2: Additional Deviations

Additional Deviations	
Corrosion / Erosion	Contamination
Sampling	Seal Leak
Human Factors	Facility Siting

The guideword approach often results in redundancies. For example, failure of a pump to operate may be the cause for "No Flow" in a line segment. It may also be the cause for "Less Pressure" or "High Level". When this occurs, the scenario is discussed fully under the first deviation and additional documentation under the second (third, etc.) deviation is not necessary. For completeness, however, it will be noted there were "no new causes identified" under the second (third, etc.) deviation.

2.2 What-If? Analysis

The What-If? method is recognized by OSHA as an acceptable method of evaluating process hazards. The What-If? method involves asking questions that require the team to evaluate deviations from the norm. An example is, "What if the steam flow to the reboiler stops?" The team then develops consequences of this action (or inaction) and documents the safeguards in a manner similar to the HAZOP analysis. The What-If? scenario is then ranked for risk, and recommendations are made if appropriate, similar to the HAZOP analysis. Figure 2 illustrates the steps taken during a What-If? Study.

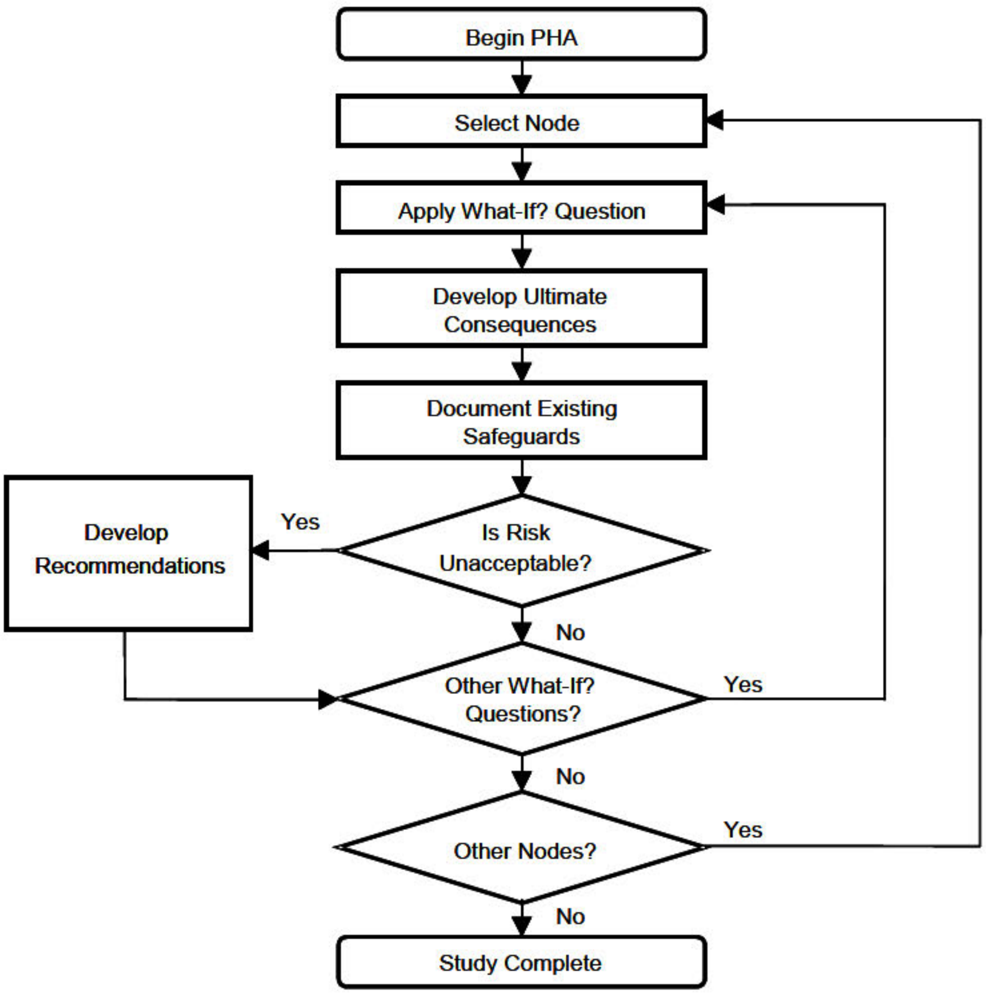

Figure 2: What-If? Flow Chart

2.3 Assumptions

The study team members made several assumptions when assessing the effectiveness of engineering and administrative safeguards:

- Operators are trained in the duties of their area with initial training
- Vehicular traffic is restricted to certain areas within the facility.
- Emergency response plans are written and communicated to all employees and contractors.
- Evacuation routes are established and available.
- Local fire departments are trained with sufficient equipment available

Note: Misdirected flow was not normally considered credible if the line was blinded or plugged.

2.4 Risk Ranking Assessment

Prior to the start of the PHA, the PHA Team expanded the existing NAVSUP's Risk Ranking Matrix to include consequence categories for environmental and public impacts (in line with the consequences for Mission Readiness and Safety), for the purpose of the HAZOP. The PHA Team members used the expanded NAVSUP's Risk Ranking Matrix, presented in Figure 3, to qualitatively assess the risk associated with each cause/consequence scenario.

The scenario was evaluated based on the severity of the consequences in the absence of safeguards and the *likelihood* or *frequency* that the scenario would fully develop to those consequences based on the existing safeguards. The severity ranking (I to IV) and likelihood ranking (A-D) were combined using the risk ranking matrix to provide a qualitative risk ranking (Negligible, Minor, Moderate, Serious, and Critical). Each developed causes/consequences scenario was ranked with an CLR with C representing severity of occurrence, L representing likelihood, and R representing risk. Consequences were evaluated in the areas of Mission Readiness (MR), Health/Safety (H/S), Environmental Impact (E), and Public Disruption (P).

For scenarios with installed risk rankings in the "Critical" and "Serious" areas, the PHA Team was required to suggest recommendations that they felt would eliminate the potential cause of the scenario or reduce the frequency that the scenario would fully develop to the ultimate consequences predicted. For scenarios with installed risk rankings of "Moderate" or "Minor", the risk was considered to be acceptable but risk reduction, where feasible, was encouraged. As a result, the need for a recommendation was left to the discretion of the PHA Team. Scenarios with installed risk ranking of "Negligible" are managed for continuous improvement.

Figure 3: Risk Matrix

Risk Assessment Matrix		Probability			
		Frequency of Occurrence Over Time			
		A Likely	B Probable	C May	D Unlikely
I	M: Loss of Mission Capability; Unit Readiness or Asset S: Fatality E: Major/Extended Duration Full Scale Response P: Large Community (Off-Base)	1	1	2	3
II	M: Significantly Degraded Mission Capabilityor Unit Readiness S: Severe Injury E: Serious/Significant Resource Commitment P: Small Community (On-Base)	1	2	3	4
III	M: Degraded Mission Capability or Unit Readiness S: Minor Injury E: Moderate/Limited Response of Short Duration P: Minor	2	3	4	5
IV	M: Little or No Impact to Mission Capability or Unit Readiness S: Minimal Injury E: Minor/Little or No Response Need P: Minimal to None	3	4	5	5
Risk Assessment Codes 1 - Critical 2 - Serious 3 - Moderate 4 - Minor 5 - Negligible					

PHA: Impact of Risk on Operation

Critical	The operation or activity shall not start or continue until an alternative method has been developed, or until additional controls are implemented to reduce risks to acceptable levels.
Serious	The operation or activity should not start or proceed unless risk-reducing measures are in operation to reduce risks.
Moderate	The operation or activity may start or proceed. It is up to the discretion of the PHA Team to determine if a recommendation is required or only desired.
Minor	Manage for continuous improvement, although may set a medium priority for further risk reduction.
Negligible	Manage for continuous improvement, although may set a lower priority for further risk reduction.

3 STUDY INFORMATION

3.1 Process Description

The Red Hill complex consists of 20 fuel tanks that were constructed between August 1940 and September 1943. The Red Hill tanks are the primary bulk storage tanks for the three major products handled at Pearl Harbor (F-24, JP-5, and F-76). The bottom of these tanks range in elevation from [redacted] feet above sea level, and the tanks range from 235 feet to 250 feet tall. Each Tank (1-16) has two common fill and issue lines that branches off the three main transfer lines. Tanks 17-20 have one common fill and issue line connected to the JP-5 line.

There are three main transfer lines that carry fuel to and from Red Hill (a [redacted] F-76 line, an [redacted] JP-5 line, and a [redacted] F-24 line). The fuel lines are approximately 3 miles in length spanning from the Red Hill Tank Gallery to the UGPH.

The Upper Tank Farm is the second bulk storage facility and located at Pearl Harbor. The tank farm consists of six vertical 150,000 Bbl atmospheric storage tanks (ASTs). F-24, JP-5, and F-76 are stored at the UTF. [redacted]

The UGPH is located [redacted] four underground "Surge Tanks." These tanks act as atmospheric buffer tanks during receipt pumping operations and are used for temporary operational storage when required.

Hotel Pier is currently the sole marine receipt point (ship or barge) for all fuels and the primary bulk issue point. The pier piping is connected to the facility at [redacted] Each of the three products (F-76, F-24, and JP-5) has a dedicated piping loop around the pier. Multiple piping risers with [redacted] ball valves allow vessels to be connected to the fuel system through non-collapsible hoses. There are also defuel and dirty ballast water/waste oil lines associated with Hotel Pier that are not currently in service. Pearl Harbor Fuel Supply Point also has the ability to load tank trucks, load and unload barges/YONs including vessel to vessel transfers.

Since defueling was a key discussion during the PHA, the defueling plan includes use of existing piping and valve stations at RHL and PRL to safely transfer (by gravity) inventory currently in TK 102/103/104/105/106 F-24 Tank (Red Hill), TK 107/108/109/110/111/112/120 JP-5 Tank (Red Hill), and TK 115/116 F-76 Tank (Red Hill) (~110 MM gal. total) to PAR, UTF, Hickam; and/or load ship/barge using existing in-service piers/docks to transfer to off-island destinations.

Defueling includes packing the pipeline between evolutions before transferring from Red Hill Storage. Demonstrated de-inventory rates are [redacted]. Specific Operational Procedures with valve alignment tables exist in the OMES Manual to transfer to UTF, Hickam, and piers/docks; and have been used safely in the past. A one-time use Operational Procedure with valve alignment table was developed in ~2016 to transfer to PAR.

3.2 PHA Team Study Dates

The PHA was conducted in-person on dates February 7, 2022 through February 11, 2022 and on February 21, 2022 through February 25, 2022. The PHA Team met for a total of ten (10) days.

[redacted] of Risktec facilitated the study with key participation from Navy Supply Fleet Logistics Center Pearl Harbor personnel and support personnel. [redacted] served as the scribe for the review. Participants for the PHA are included in Table 3. In addition to the PHA Participant Team, a number of Observers were also in attendance. The list of Observers are included in Table 4. The PHA Participant attendance is included in Appendix D.

Table 3: PHA Participant Members

Name	Company	Title	Years of Experience
(b)(6) [redacted]	Risktec Solutions	Facilitator	30+
	Risktec Solutions	Scribe	2
	Risktec Solutions	Process Safety Consultant	30+
	Risktec Solutions	Process Safety Consultant	30+
	NAVFAC HI	Red Hill PMO Director	3.5
	FLCPH	Deputy Director	42
	WCS	Rotating/Static Equipment	25+
	FLC Code 701	General Engineer	33
	703	Operator	8
	FLCPH	Operations Work Lead	20
	ENGLOBAL	Technician	10
	NIWC	Technician	17
	FLCPH	General Engineer	17
	FLCPH	General Engineer	0
	FLCPH	FPSO Supervisor	28
	FLCPH	Barge Mechanic	25
	FLCPH	Mechanical Supervisor	

Table 4: PHA Observers

Name	Company
(b)(6) [redacted]	Risktec Solutions
	Pond/OMES
	FLCPH
	SGH
	SGH
	NAVSUP
	NAVSUP
	NAVSUP
	NPO
	DLA
	SGH
	FLC PH

Name	Company
[redacted]	ENGLOBAL
[redacted]	ENGLOBAL
[redacted]	ENG GOV SERV
[redacted]	ENG GOV SERV
[redacted]	FLC PH

3.3 Acronyms & Drawing List

The PHA Team used many DFSP Pearl Harbor Bulk Terminal common acronyms. Appendix E contains the official DFSP Pearl Harbor Bulk Terminal Acronym list. A summary of the Flow Diagrams used during the study can be found in Table 5. In addition to the Flow Diagrams a number of supplementary pages and sketches were provided during the study and can be found in Table 5. Appendix F contains the Facilitator's copy of the Flow Diagrams, which are color-coded by product, and the four (4) supplemental pages and seven (7) sketches.

Table 5: Drawing List

Drawing Number	Drawing Title	Date
[redacted]	Legend	8/22/2018
[redacted]	Overall Facility	8/22/2018
[redacted]	Red Hill Tanks 113-120	8/22/2018
[redacted]	Red Hill Tanks 105-112	8/22/2018
[redacted]	Red Hill Tanks 101-104	8/22/2018
[redacted]	Red Hill Tunnel	8/22/2018
[redacted]	Underground Pumphouse	8/22/2018
[redacted]	Underground Pumphouse	8/22/2018
[redacted]	Surge Tanks	8/22/2018
[redacted]	[redacted]	8/22/2018
[redacted]	Truck Rack and Lube Oil Tanks	8/22/2018
[redacted]	Truck Rack and Lube Oil Tanks	8/22/2018
[redacted]	[redacted]	8/22/2018
[redacted]	[redacted]	8/22/2018
[redacted]	[redacted]	8/22/2018
[redacted]	Hotel Pier	8/22/2018
[redacted]	Hotel Pier	8/22/2018
[redacted]	Kilo Pier	8/22/2018
[redacted]	FOR Facility	8/22/2018
[redacted]	FOR Facility	8/22/2018
[redacted]	[redacted]	8/22/2018

Drawing Number	Drawing Title	Date
[redacted]	[redacted] Pump House	8/22/2018
[redacted]	[redacted]	8/22/2018
[redacted]	Upper Tank Farm	8/22/2018
[redacted]	Upper Tank Farm	8/22/2018
[redacted]	Upper Tank Farm	8/22/2018
[redacted]	[redacted]	8/22/2018
[redacted]	[redacted]	8/22/2018
[redacted]	Mike Dock	8/22/2018
[redacted]	Bravo Dock	8/22/2018
[redacted]	Bravo Dock	8/22/2018
[redacted]	YON [redacted]	8/22/2018
[redacted]	YON [redacted] and [redacted]	8/22/2018
[redacted]	AFFF System Information	-
[redacted]	Cause & Effect Diagram	-
[redacted]	UGPH Diagram	-
[redacted]	Storage Tank Information	-
[redacted]	Tank Venting SHT 1	-
[redacted]	Tank Venting SHT 2	-
[redacted]	Red Hill Diagram SHT 1	-
[redacted]	Red Hill Diagram SHT 1	-
[redacted]	Key Plan Upper & Lower Tunnel Wet Risers	-
[redacted]	YON [redacted] Pump	-
[redacted]	AFFF System	-

3.4 Node List

The nodes used during the PHA are identified in Table 6.

Table 6: Node List

Node #	Node Description	Drawing(s) Used
1	Routine Operations: Supplying Red Hill Storage from Hotel Pier	(b)(3)(A) [redacted]
2	Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier	[redacted]

Node #	Node Description	Drawing(s) Used
3	Routine Operations: Supplying Storage from PAR pipeline, including Intermix Tank	(b)(3)(A) [redacted]
4	Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam	[redacted]
5	Routine Operations: Transferring from UTF Storage to Marine Piers/Docks or Hickam	[redacted]

Node #	Node Description	Drawing(s) Used
6	Routine Operations: Transferring from Storage to Storage in PRL and RHL	(b)(3)(A) [redacted]
7	Routine Operations: Reclaim System	
8	Routine Operations: Aqueous Film Forming Foam (AFFF) Fire Suppression System	
9	Routine Operations: Vessel to Vessel Transfer	
10	Routine Operations: SIMOPS Multiple Product Movements Simultaneously	
11	Routine Operations: Truck Loading	

Node #	Node Description	Drawing(s) Used
12	Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges	(b)(3)(A) [redacted]

3.5 Results

There were one hundred twenty (120) PHA recommendations generated during the PHA. The PHA recommendations showing their associated scenario(s) are contained in Appendix A. There is a risk ranking associated with the majority of recommendations but not all, as sometimes there was insufficient information available to the PHA Team at the time of the PHA to assess consequences and/or consequence severity/likelihood or if the recommendation was generated in a checklist (Human Factors & Facility Siting). For this reason all recommendations were given a priority (High, Medium, or Low) by the PHA Team to assist in execution of the recommendations. The higher risk recommendations should be given the higher priority on recommendation closure. The PHA worksheets may be found in Appendix B.

Since defueling was a key discussion during the PHA, recommendations suggested for implementation before defueling may be found in Table 7.

Table 7: Defueling Recommendations

Recommendation #	Recommendation
1	To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).
6	Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority)
8	Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around pumps installed in UGPH and Red Hill Tank Gallery. Consider modifying design if manufacturer has alternate sealing system and Dresser Couplings remain part of design. (High Priority)
9	Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling. (High Priority)
14	Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)
25	Include verification step in Operations Order that piping is restrained before starting any evolution involving transferring liquid from any tank in Red Hill Tank Gallery. (High Priority)
27	If possible, add a equalization line across the outboard main tank valve <u>prior to defueling</u> to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority)
28	Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority)
31	Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)

Recommendation #	Recommendation
32	Evaluate the need for Dresser Couplings in the [redacted] and [redacted] main distribution piping in Red Hill Tank Gallery between TK 114 JP-5 Tank (Red Hill) and TK 116 F-76 Tank (Red Hill), shown on Drawing [redacted] If they can be removed safely, remove the Dresser Couplings. JP-5 Emergent Pipeline Repairs were underway at the time of the PHA and will include eliminating old Dresser Coupling on [redacted] JP-5 piping. This recommendation should be completed prior to returning JP-5 piping to service. (High Priority)
38	Develop a car-seal or lock administrative control system and identify safety-critical manual valves which should be controlled to reduce the likelihood of human error. Valves to consider include but are not limited to 24" butterfly tank vent valves at RHL, manual block valves on the inlet or discharge of relief devices, manual block valves on bleed of body cavity of twin-seal DBB device, key firewater supply and distribution valves. (High Priority)
99	The Navy policy is to use the Incident Command System (ICS)/Unified Command (UC) for structuring Navy spill response management organizations. The NAVSUP FLCPH fuel personnel manages the initial response. If additional resources are needed, the Federal Fire Department Incident Commander will establish an emergency command post and assume responsibility for the response. The Emergency Spill Coordinator or the Commanding Officer can contact the Region Navy On-Scene Coordinator to activate the Region Spill Management Team (SMT). The Region SMT will then establish other ICS functions. Port Operations is the coordinator for the Facility Response Team (FRT), an on-water contractor resource based on Ford Island. The roles, staffing and resources for each organization needs to be clearly defined, drilled and aligned prior to defueling operations. (High Priority)
107	Consider additional operators and technical support for defueling operations. (High Priority)

Table 8 represents all the Critical/Red color coded recommendations associated with critical tolerability risks for ongoing operations, excluding those listed for defueling.

Table 8: PHA Recommendations Associated with Critical Tolerability Risks for Ongoing Operations

Recommendation #	Recommendation
2	Ensure the PITs located [redacted] (b)(3)(A) are in a scheduled PM system using certified and calibrated test equipment. The calibration should meet the requirements of OPNAV Instruction 3960.16B.
3	Consider installing local ESD on refueling piers and docks at PRL Ensure ESD actions are consistent with Coast Guard requirements and do not create additional hazards.
4	If additional safeguards are warranted, design and install automation to safely shutdown refueling piers and docks at PRL in event of emergency or loss of containment, including isolation of sectional valves to minimize quantity of loss of containment.
5	Consider equipping [redacted] (b)(3)(A) with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System.
10	Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] (b)(3)(A) are in a scheduled PM system using certified and calibrated test equipment.
15	Install ESD functionality to both suction and discharge MOVs to [redacted] (b)(3) to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump.
17	Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump.
18	Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump.

Recommendation #	Recommendation
19	Ensure OCVs on the discharge of each (b)(3)(A) [redacted] are pressure or leak tested per schedule and records retained for auditing.
21	Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment.
24	Modify CIR contracts to include restraining pipe between blanked sections when taking tank out of service for maintenance or inspection.
26	Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline.
29	Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure.
30	Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear (b)(3)(A) [redacted] and consider relocation to an area external to tunnel system, similar to (b)(3)(A) [redacted] Electrical Room Relocation Project MILCON P-8006.
41	Add testing for sulfur compounds (or other credible toxic compounds) as part of pre-offloading analysis for fuel receipts at PRL.
45	Ensure run status indication on all pumps inside all AFFF Sumps (20 pumps) is integrated with the AFHE SCADA to alert Control Room Operator (CRO) to potential release of fuel and/or AFFF.
46	Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and (b)(3)(A) [redacted] Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel.
47	Evaluate the design of the 14" AFFF discharge line piping on the discharge of 20 AFFF Sumps pumps as part of the current project to upgrade PVC to CS. The PHA Team is concerned about 1) the volume flow and separately, 2) line slope or configuration to trap liquid in retention line, and 3) lack of damage control isolation in long-run of piping.
48	Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed.
49	Train all affected personnel on the design, intent, and operation of the AFFF System, including refresher training.
50	Consider equipping AFFF Retention Tank with reliable level indication and level alarm to alert Control Room Operator (CRO) to presence of level in AFFF Retention Tank

Recommendation #	Recommendation
51	Consider designing a system to separate oil and water to reduce the likelihood of discharging flammable liquid to environment from Adit 3 Groundwater Sump.
52	Provide means to remove contamination from water supply.
53	Evaluate an emergency breathing air supply for Harbor Tunnel due to its long length, limited egress, and reduced ventilation.
66	Design and install interlock and permissive systems for all fuel movements to/from RHL and UGPH, to reduce the likelihood of human error of sequencing valves during lineup. Design should consider use of the manual clutch to bypass MOV operation.
74	Remove electrical connections and sockets from the inside of FORFAC containment area to reduce the likelihood of electrocution during periods of heavy rain or spill in secondary containment. If not feasible, install protective safeguards to reduce the risk of electrocution.
75	As an interim recommendation, 1) replace sockets with GFCI sockets inside the FORFAC secondary containment, 2) develop an SOP to engage NAVFAC prior to predicted heavy rainfall and include emergency phone numbers for power company contact, 3) provide access to breaker box near Tank 1301 Reclaim (B1) Tank, and 4) install signage that specifies "do not enter during periods of heavy rain or standing water" and includes a phone number contact to de-energize the area.

APPENDIX A PHA RECOMMENDATIONS

PHA Recommendations

PHA Recommendations	Place(s) Used	Risk Ranking
1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	Consequences: 1.1.1.2, 1.14.1.1, 1.14.1.2, 1.14.1.3, 1.14.1.4, 1.14.1.5, 1.14.1.6, 1.14.1.7, 1.14.1.8, 1.14.1.9, 1.14.1.10, 2.1.1.2, 2.1.2.4, 2.1.3.5, 2.1.4.6, 2.1.5.6, 2.1.6.6, 2.1.7.7, 4.1.1.1, 6.14.1.1, 8.1.1.1, 8.1.2.1, 8.1.3.2, 8.4.2.1, 8.9.1.1, 8.9.3.2, 10.1.1.1, 10.1.1.2, 10.1.1.3, 10.1.6.1, 10.1.6.2, 12.1.1.1 Observation: 7.1.1, 7.2.1, 7.3.1, 8.2.1, 8.8.1	1
2. Ensure the PITs located [redacted] are in a scheduled PM system using certified and calibrated test equipment. The calibration should meet the requirements of OPNAV Instruction 3960.16B. (High Priority)	Consequences: 1.1.1.2, 2.1.1.2, 2.1.2.4, 2.1.3.5, 2.1.4.6, 2.1.5.6, 2.1.6.6, 2.1.7.7	1
3. Consider installing local ESD on refueling piers and docks at PRL Ensure ESD actions are consistent with Coast Guard requirements and do not create additional hazards. (Medium Priority)	Consequences: 1.1.1.2, 2.1.1.2, 2.1.2.4, 2.1.3.5, 2.1.4.6, 2.1.5.6, 2.1.6.6, 2.1.7.7 Observation: 4.5.1	1
4. If additional safeguards are warranted, design and install automation to safely shutdown refueling piers and docks at PRL in event of emergency or loss of containment, including isolation of sectional valves to minimize quantity of loss of containment. (High Priority)	Consequences: 1.1.1.2, 2.1.1.2, 2.1.2.4, 2.1.3.5, 2.1.4.6, 2.1.5.6, 2.1.6.6, 2.1.7.7 Observation: 4.5.1	1
5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	Consequences: 1.1.1.3, 1.1.1.4, 1.1.9.3, 1.1.9.4, 1.1.9.5, 1.1.9.6, 1.1.9.7, 1.1.15.5, 1.1.16.4, 1.4.12.3, 1.5.1.1, 1.5.1.2, 1.9.3.3, 1.10.1.1, 1.10.1.2, 1.10.1.3, 1.14.1.1, 1.14.1.6, 1.14.1.7, 1.14.1.8, 1.14.1.9, 1.14.1.10, 2.1.1.3, 2.1.2.5, 2.1.3.6, 2.1.4.7, 2.1.5.7, 2.1.6.7, 2.1.7.8, 3.1.4.6, 4.1.2.1, 4.1.2.2, 4.1.2.3, 4.1.2.8, 4.1.2.9, 4.1.2.10, 4.1.2.11, 4.1.2.12, 4.1.3.2, 4.1.5.2, 4.1.6.2, 4.1.8.1, 4.1.9.3, 4.1.9.4, 4.1.9.5, 4.1.9.10, 4.1.9.11, 4.1.9.12, 4.1.9.13, 4.1.9.14, 6.1.2.2, 6.14.1.1, 6.14.1.6, 6.14.1.7, 6.14.1.8, 6.14.1.9, 6.14.1.10, 6.14.2.1, 6.14.2.2, 6.14.2.3, 6.14.2.8, 6.14.2.9, 6.14.2.10, 6.14.2.11, 6.14.2.12, 7.1.2.2, 7.1.3.1, 7.1.3.2, 7.1.4.2, 7.1.5.1, 12.1.2.1, 12.1.2.2, 12.1.2.3, 12.1.2.8, 12.1.2.9, 12.1.2.10, 12.1.2.11, 12.1.2.12, 12.1.3.2, 12.1.5.2, 12.1.6.2, 12.1.8.1, 12.1.9.3, 12.1.9.4, 12.1.9.5, 12.1.9.10, 12.1.9.11, 12.1.9.12, 12.1.9.13, 12.1.9.14 Observation: 4.5.1 Observation: 4.7.1, 9.3.1	1
6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority)	Consequences: 1.1.1.3, 1.1.1.4, 1.1.15.5, 1.1.16.4, 1.14.1.1, 1.14.1.3, 1.14.1.4, 1.14.1.5, 2.1.1.3, 2.1.2.5, 2.1.3.6, 2.1.4.7, 2.1.5.7, 2.1.6.7, 2.1.7.8, 4.1.2.1, 4.1.2.2, 4.1.2.3, 4.1.2.5, 4.1.2.6, 4.1.2.7, 4.1.9.3, 4.1.9.4, 4.1.9.5, 4.1.9.7, 4.1.9.8, 4.1.9.9, 6.14.1.1, 6.14.1.3, 6.14.1.4, 6.14.1.5, 6.14.2.1, 6.14.2.2, 6.14.2.3, 6.14.2.5, 6.14.2.6, 6.14.2.7, 12.1.2.1, 12.1.2.2, 12.1.2.3, 12.1.2.5, 12.1.2.6, 12.1.2.7, 12.1.9.3, 12.1.9.4, 12.1.9.5, 12.1.9.7, 12.1.9.8, 12.1.9.9 Observation: 4.14.1, 5.6.1, 5.7.1	1
7. Perform a Pipe Collapse Pressure Study to determine the pressure required to collapse the existing pipe and identify and install safeguard(s) as warranted. Consider integrating this recommendation with upcoming API 570 Assessment. (High Priority)	Consequences: 1.1.1.3, 4.1.2.2, 4.1.9.4, 6.14.2.2, 12.1.2.2, 12.1.9.4	2
8. Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around pumps installed in UGPH and Red Hill Tank Gallery. Consider modifying design if manufacturer has alternate sealing system and Dresser Couplings remain part of design. (High Priority)	Consequences: 1.1.1.4, 2.1.1.3, 2.1.2.5, 2.1.3.6, 2.1.4.7, 2.1.5.7, 2.1.6.7, 2.1.7.8, 4.1.2.3, 4.1.9.5, 6.14.2.3, 12.1.2.3, 12.1.9.5	2
9. Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling. (High Priority)	Consequences: 1.1.1.4, 2.1.1.3, 2.1.2.5, 2.1.3.6, 2.1.4.7, 2.1.5.7, 2.1.6.7, 2.1.7.8, 4.1.2.3, 4.1.9.5, 6.14.2.3, 12.1.2.3, 12.1.9.5	2
10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	Consequences: 1.1.1.6, 1.1.2.5, 1.1.3.6, 1.1.4.6, 1.1.5.6, 1.1.6.6, 1.1.7.6, 1.1.8.5, 1.1.9.2, 1.1.9.3, 1.1.9.4, 1.1.9.5, 1.1.9.6, 1.1.9.7, 1.1.11.2, 1.1.12.2, 1.1.13.2, 1.1.14.2, 1.1.15.2, 1.1.16.2, 1.2.1.2, 1.2.2.1, 1.10.1.1, 1.10.1.2, 1.10.1.3, 4.1.2.8, 4.1.2.9, 4.1.2.10, 4.1.2.11, 4.1.2.12, 4.1.9.10, 4.1.9.11, 4.1.9.12, 4.1.9.13, 4.1.9.14, 5.1.1.1, 5.1.3.1, 5.1.5.1, 5.1.6.1, 6.1.1.1, 6.1.3.1, 6.14.1.6, 6.14.1.7, 6.14.1.8, 6.14.1.9, 6.14.1.10, 6.14.2.8, 6.14.2.9, 6.14.2.10, 6.14.2.11, 6.14.2.12, 7.1.2.2, 7.1.3.2, 7.1.4.2, 12.1.2.8, 12.1.2.9, 12.1.2.10, 12.1.2.11, 12.1.2.12, 12.1.9.10, 12.1.9.11, 12.1.9.12, 12.1.9.13, 12.1.9.14 Observation: 5.6.1, 5.7.1	[redacted]
11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	Consequences: 1.1.1.7, 1.1.2.6, 1.1.3.7, 1.1.5.7, 1.1.6.7, 1.1.7.7, 1.1.9.1, 1.1.10.1, 1.1.12.1, 1.1.13.1, 1.1.14.1, 1.1.15.1, 1.1.16.1, 1.2.1.3, 1.2.2.2, 1.4.6.1, 1.4.11.1, 1.4.12.1, 1.4.12.2, 1.4.12.3, 1.9.1.1, 1.9.3.1, 1.9.3.2, 1.9.3.3, 1.14.1.2, 2.4.1.1, 2.4.1.2, 2.7.1.1, 2.7.1.2, 2.7.1.3, 3.1.4.1, 3.1.4.2, 3.1.4.3, 3.1.4.4, 3.1.4.5, 3.1.4.6, 3.1.4.7, 3.1.6.1, 4.1.2.4, 4.1.9.6, 4.2.2.1, 4.3.2.1, 4.4.1.1, 6.14.1.2, 6.14.2.4, 6.15.2.2, 6.15.2.3, 8.2.1.2, 8.4.1.1, 12.1.2.4,	3

PHA Recommendations	Place(s) Used	Risk Ranking
	12.1.9.6, 12.2.1.1, 12.3.2.1, 12.5.1.1, 12.6.3.1	
12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	Consequences: 1.1.2.1, 1.1.2.2, 1.1.3.1, 1.1.3.2, 1.1.4.1, 1.1.4.2, 1.1.5.1, 1.1.5.2, 1.1.6.1, 1.1.6.2, 1.1.7.1, 1.1.7.2, 1.12.1.1, 2.1.2.2, 2.1.2.3, 2.1.3.2, 2.1.3.3, 2.1.3.4, 2.1.4.2, 2.1.4.3, 2.1.4.4, 2.1.5.2, 2.1.5.3, 2.1.5.4, 2.1.6.2, 2.1.6.3, 2.1.6.4, 2.1.7.2, 2.1.7.3, 2.1.7.4, 2.10.1.1, 10.1.1.3	
13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	Consequences: 1.1.2.2, 1.1.3.2, 1.1.4.2, 1.1.5.2, 1.1.6.2, 1.1.7.2, 1.12.1.1, 2.1.3.3, 2.1.4.3, 2.1.5.3, 2.1.6.3, 2.1.7.3, 2.10.1.1, 5.1.6.4, 9.1.1.3, 9.10.1.1, 12.2.4.1	2
14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	Consequences: 1.1.3.3, 1.1.4.3, 1.1.5.3, 1.1.6.3, 1.1.7.3, 1.1.13.3, 1.1.14.3, 1.1.15.3, 1.1.16.3, 1.4.8.1, 1.4.9.1, 1.4.10.1, 2.1.2.3, 2.1.3.4, 2.1.4.4, 2.1.5.4, 2.1.6.4, 2.1.6.11, 2.1.7.4, 2.1.7.12, 2.1.7.13, 4.1.9.2, 5.1.5.2, 5.1.5.3, 5.1.6.2, 5.1.6.3, 12.1.9.2, 12.2.4.1	
15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	Consequences: 1.1.9.3, 1.1.9.4, 1.1.9.5, 1.1.9.6, 1.1.9.7, 1.1.10.2, 1.1.12.2, 1.1.13.2, 1.1.14.2, 1.1.15.2, 1.1.16.2, 1.10.1.1, 1.10.1.2, 1.10.1.3, 4.1.2.8, 4.1.2.9, 4.1.2.10, 4.1.2.11, 4.1.2.12, 4.1.9.10, 4.1.9.11, 4.1.9.12, 4.1.9.13, 4.1.9.14, 6.14.1.6, 6.14.1.7, 6.14.1.8, 6.14.1.9, 6.14.1.10, 6.14.2.8, 6.14.2.9, 6.14.2.10, 6.14.2.11, 6.14.2.12, 6.15.2.1, 12.1.2.8, 12.1.2.9, 12.1.2.10, 12.1.2.11, 12.1.2.12, 12.1.9.10, 12.1.9.11, 12.1.9.12, 12.1.9.13, 12.1.9.14	1
16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority)	Consequences: 1.1.9.3, 1.1.9.4, 1.1.9.5, 1.1.9.6, 1.1.9.7, 1.1.12.2, 1.1.13.2, 1.1.14.2, 1.1.15.2, 1.1.16.2, 1.10.1.1, 1.10.1.2, 1.10.1.3, 4.1.2.8, 4.1.2.9, 4.1.2.10, 4.1.2.11, 4.1.2.12, 4.1.9.10, 4.1.9.11, 4.1.9.12, 4.1.9.13, 4.1.9.14, 6.14.1.6, 6.14.1.7, 6.14.1.8, 6.14.1.9, 6.14.1.10, 6.14.2.8, 6.14.2.9, 6.14.2.10, 6.14.2.11, 6.14.2.12, 12.1.2.8, 12.1.2.9, 12.1.2.10, 12.1.2.11, 12.1.2.12, 12.1.9.10, 12.1.9.11, 12.1.9.12, 12.1.9.13, 12.1.9.14	1
17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	Consequences: 1.1.9.3, 1.1.9.4, 1.1.9.5, 1.1.9.6, 1.1.9.7, 1.4.8.3, 1.10.1.1, 1.10.1.2, 1.10.1.3, 1.12.3.2, 1.14.1.2, 1.14.1.3, 1.14.1.4, 1.14.1.5, 1.14.1.6, 1.14.1.7, 1.14.1.8, 1.14.1.9, 1.14.1.10, 4.1.2.4, 4.1.2.5, 4.1.2.6, 4.1.2.7, 4.1.2.8, 4.1.2.9, 4.1.2.10, 4.1.2.11, 4.1.2.12, 4.1.9.6, 4.1.9.7, 4.1.9.8, 4.1.9.9, 4.1.9.10, 4.1.9.11, 4.1.9.12, 4.1.9.13, 4.1.9.14, 4.2.4.2, 6.14.1.2, 6.14.1.3, 6.14.1.4, 6.14.1.5, 6.14.1.6, 6.14.1.7, 6.14.1.8, 6.14.1.9, 6.14.1.10, 6.14.2.4, 6.14.2.5, 6.14.2.6, 6.14.2.7, 6.14.2.8, 6.14.2.9, 6.14.2.10, 6.14.2.11, 6.14.2.12, 8.2.1.1, 8.2.1.2, 11.1.3.2, 12.1.2.4, 12.1.2.5, 12.1.2.6, 12.1.2.7, 12.1.2.8, 12.1.2.9, 12.1.2.10, 12.1.2.11, 12.1.2.12, 12.1.9.6, 12.1.9.7, 12.1.9.8, 12.1.9.9, 12.1.9.10, 12.1.9.11, 12.1.9.12, 12.1.9.13, 12.1.9.14, 12.2.3.2, 12.4.5.2	1
18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	Consequences: 1.1.9.3, 1.1.9.4, 1.1.9.5, 1.1.9.6, 1.1.9.7, 1.1.10.2, 1.1.12.2, 1.1.13.2, 1.1.14.2, 1.1.15.2, 1.1.16.2, 1.4.12.1, 1.4.12.2, 1.4.12.3, 1.9.3.1, 1.9.3.2, 1.9.3.3, 1.10.1.1, 1.10.1.2, 1.10.1.3, 1.14.1.6, 1.14.1.7, 1.14.1.8, 1.14.1.9, 1.14.1.10, 3.1.4.4, 3.1.4.5, 3.1.4.6, 4.1.2.8, 4.1.2.9, 4.1.2.10, 4.1.2.11, 4.1.2.12, 4.1.9.10, 4.1.9.11, 4.1.9.12, 4.1.9.13, 4.1.9.14, 6.14.1.6, 6.14.1.7, 6.14.1.8, 6.14.1.9, 6.14.1.10, 6.14.2.8, 6.14.2.9, 6.14.2.10, 6.14.2.11, 6.14.2.12, 6.15.2.1, 12.1.2.8, 12.1.2.9, 12.1.2.10, 12.1.2.11, 12.1.2.12, 12.1.9.10, 12.1.9.11, 12.1.9.12, 12.1.9.13, 12.1.9.14	1
19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	Consequences: 1.1.9.3, 1.1.9.4, 1.1.9.5, 1.1.9.6, 1.1.9.7, 1.10.1.1, 1.10.1.2, 1.10.1.3, 1.14.1.8, 1.14.1.9, 1.14.1.10, 4.1.2.8, 4.1.2.9, 4.1.2.10, 4.1.2.11, 4.1.2.12, 4.1.9.10, 4.1.9.11, 4.1.9.12, 4.1.9.13, 4.1.9.14, 6.14.1.6, 6.14.1.7, 6.14.1.8, 6.14.1.9, 6.14.1.10, 6.14.2.8, 6.14.2.9, 6.14.2.10, 6.14.2.11, 6.14.2.12, 12.1.2.8, 12.1.2.9, 12.1.2.10, 12.1.2.11, 12.1.2.12, 12.1.9.10, 12.1.9.11, 12.1.9.12, 12.1.9.13, 12.1.9.14	1
20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority)	Consequences: 1.1.9.5, 1.4.8.3, 1.10.1.1, 1.12.3.2, 1.14.1.8, 4.1.2.10, 4.1.9.12, 4.2.4.2, 6.14.1.8, 6.14.2.10, 7.1.3.2, 7.1.5.1, 12.1.2.10, 12.1.9.12, 12.2.3.2, 12.4.5.2	2
21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority)	Consequences: 1.1.9.6, 1.10.1.2, 1.14.1.4, 1.14.1.5, 1.14.1.9, 4.1.2.6, 4.1.2.7, 4.1.2.11, 4.1.9.8, 4.1.9.9, 4.1.9.13, 6.14.1.4, 6.14.1.5, 6.14.1.9, 6.14.2.6, 6.14.2.7, 6.14.2.11, 12.1.2.6, 12.1.2.7, 12.1.2.11, 12.1.9.8, 12.1.9.9, 12.1.9.13	1
22. Ensure new replacement pumps for [redacted] are equipped with 1) appropriate seal materials for the resulting temperatures of periods of lower than normal flow operation and 2) minimum flow recirculation protection to reduce the likelihood of increased temperature during periods of lower than normal flow operation. (High Priority)	Consequences: 1.1.11.2, 1.1.12.2, 1.1.13.2, 1.1.14.2, 1.1.15.2, 1.1.16.2	3
23. Perform a hydraulic surge analysis. Consider integrating this recommendation with upcoming API 570 Assessment. (High Priority)	Consequences: 1.1.15.4	
24. Modify CIR contracts to include restraining pipe between blanked sections when taking tank out of service for maintenance or inspection. (High Priority)	Consequences: 1.1.15.5, 1.1.16.4, 4.1.2.1, 4.1.9.3, 6.14.1.1, 6.14.2.1, 12.1.2.1, 12.1.9.3	1

PHA Recommendations	Place(s) Used	Risk Ranking
25. Include verification step in Operations Order that piping is restrained before starting any evolution involving transferring liquid from any tank in Red Hill Tank Gallery. (High Priority)	Consequences: 1.1.15.5, 1.1.16.4, 4.1.2.1, 4.1.9.3, 6.14.1.1, 6.14.2.1, 12.1.2.1, 12.1.9.3	1
26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority)	Consequences: 1.1.15.5, 1.1.16.4, 1.14.1.3, 1.14.1.4, 1.14.1.5, 4.1.2.1, 4.1.2.5, 4.1.2.6, 4.1.2.7, 4.1.9.3, 4.1.9.7, 4.1.9.8, 4.1.9.9, 6.14.1.1, 6.14.1.3, 6.14.1.4, 6.14.1.5, 6.14.2.1, 6.14.2.5, 6.14.2.6, 6.14.2.7, 12.1.2.1, 12.1.2.5, 12.1.2.6, 12.1.2.7, 12.1.9.3, 12.1.9.7, 12.1.9.8, 12.1.9.9	1
27. If possible, add a equalization line across the outboard main tank valve <u>prior to defueling</u> to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority)	Consequences: 1.1.15.5, 1.1.16.4, 1.14.1.3, 1.14.1.4, 1.14.1.5, 4.1.2.1, 4.1.2.5, 4.1.2.6, 4.1.2.7, 4.1.9.3, 4.1.9.7, 4.1.9.8, 4.1.9.9, 6.14.1.1, 6.14.1.3, 6.14.1.4, 6.14.1.5, 6.14.2.1, 6.14.2.5, 6.14.2.6, 6.14.2.7, 12.1.2.1, 12.1.2.5, 12.1.2.6, 12.1.2.7, 12.1.9.3, 12.1.9.7, 12.1.9.8, 12.1.9.9	1
28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority)	Consequences: 1.1.15.5, 1.1.16.4, 1.14.1.1, 1.14.1.2, 1.14.1.4, 1.14.1.5, 1.14.1.6, 1.14.1.7, 1.14.1.8, 1.14.1.9, 1.14.1.10, 4.1.2.1, 4.1.2.4, 4.1.2.6, 4.1.2.7, 4.1.9.3, 4.1.9.6, 4.1.9.8, 4.1.9.9, 6.14.1.1, 6.14.1.2, 6.14.1.4, 6.14.1.5, 6.14.2.1, 6.14.2.4, 6.14.2.6, 6.14.2.7, 8.2.1.2, 12.1.2.1, 12.1.2.4, 12.1.2.6, 12.1.2.7, 12.1.9.3, 12.1.9.6, 12.1.9.8, 12.1.9.9	1
29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority)	Consequences: 1.1.15.5, 1.1.16.4, 1.14.1.1, 1.14.1.2, 1.14.1.4, 1.14.1.5, 1.14.1.6, 1.14.1.7, 1.14.1.8, 1.14.1.9, 1.14.1.10, 4.1.2.1, 4.1.2.4, 4.1.2.6, 4.1.2.7, 4.1.9.3, 4.1.9.6, 4.1.9.8, 4.1.9.9, 6.14.1.1, 6.14.1.2, 6.14.1.4, 6.14.1.5, 6.14.2.1, 6.14.2.4, 6.14.2.6, 6.14.2.7, 8.2.1.2, 12.1.2.1, 12.1.2.4, 12.1.2.6, 12.1.2.7, 12.1.9.3, 12.1.9.6, 12.1.9.8, 12.1.9.9	1
30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear [redacted] and consider relocation to an area external to tunnel system, similar to [redacted] Electrical Room Relocation Project MILCON P-8006. (High Priority)	Consequences: 1.1.15.5, 1.1.16.4, 1.14.1.1, 4.1.2.1, 4.1.3.2, 4.1.5.2, 4.1.6.2, 4.1.8.1, 4.1.9.3, 6.14.1.1, 6.14.2.1, 12.1.2.1, 12.1.3.2, 12.1.5.2, 12.1.6.2, 12.1.8.1, 12.1.9.3 Observation: 8.2.1	1
31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	Consequences: 1.1.15.5, 1.1.16.4, 1.14.1.3, 1.14.1.4, 1.14.1.5, 1.14.1.6, 4.1.2.1, 4.1.2.5, 4.1.2.6, 4.1.2.7, 4.1.2.8, 4.1.9.3, 4.1.9.7, 4.1.9.8, 4.1.9.9, 4.1.9.10, 4.1.9.11, 4.1.9.15, 6.14.1.1, 6.14.1.3, 6.14.1.4, 6.14.1.5, 6.14.1.6, 6.14.2.1, 6.14.2.5, 6.14.2.6, 6.14.2.7, 6.14.2.8, 12.1.2.1, 12.1.2.5, 12.1.2.6, 12.1.2.7, 12.1.2.8, 12.1.9.3, 12.1.9.7, 12.1.9.8, 12.1.9.9, 12.1.9.10, 12.1.9.11, 12.1.9.15	1
32. Evaluate the need for Dresser Couplings in the [redacted] and [redacted] main distribution piping in Red Hill Tank Gallery between TK 114 JP-5 Tank (Red Hill) and TK 116 F-76 Tank (Red Hill), shown on Drawing [redacted]. If they can be removed safely, remove the Dresser Couplings. JP-5 Emergent Pipeline Repairs were underway at the time of the PHA and will include eliminating old Dresser Coupling on [redacted] JP-5 piping. This recommendation should be completed prior to returning JP-5 piping to service. (High Priority)	Consequences: 1.1.15.5, 1.1.16.4, 4.1.2.1, 6.14.1.1, 6.14.2.1, 12.1.2.1	1
33. Evaluate lighting at the discharge location of the 24" horizontal vent pipe to increase the likelihood of detection by camera in area, and improve lighting if warranted. (Medium Priority)	Consequences: 1.4.12.1, 1.4.12.2, 1.4.12.3, 1.9.3.1, 1.9.3.2, 1.9.3.3, 3.1.4.4, 3.1.4.5, 3.1.4.6	3
34. Consider equipping 24" horizontal vent pipe discharge with fuel or oil detection and alarm instrumentation to detect the presence of liquid fuel. (Medium Priority)	Consequences: 1.4.12.1, 1.4.12.2, 1.4.12.3, 1.9.3.1, 1.9.3.2, 1.9.3.3, 3.1.4.4, 3.1.4.5, 3.1.4.6	3
35. Evaluate the vent piping between "P traps" in grouped tanks to determine if low point piping could accumulate trapped liquid over time due to condensing and/or undetected overfill; and if credible identify method to remove accumulated liquid if warranted. (Medium Priority)	Consequences: 1.4.12.2, 1.9.3.2, 3.1.4.5	4
36. Consider implementing four-gas personnel monitor PPE requirement for personnel working in any tunnels. (Medium Priority)	Consequences: 1.4.12.3, 1.9.3.3, 3.1.4.6	3
37. Evaluate use of panic button and man-down feature of intersite radio system. (Medium Priority)	Consequences: 1.4.12.3, 1.9.3.3, 3.1.4.6	3
38. Develop a car-seal or lock administrative control system and identify safety-critical manual valves which should be controlled to reduce the likelihood of human error. Valves to consider include but are not limited to 24" butterfly tank vent valves at RHL, manual block valves on the inlet or discharge of relief devices, manual block valves on bleed of body cavity of twin-seal DBB device, key firewater supply and distribution valves. (High Priority)	Consequences: 1.4.12.3, 1.5.1.1, 1.5.1.2, 1.9.3.3, 1.12.2.1, 3.1.4.6, 8.1.1.1, 8.1.2.1, 8.4.2.1, 8.9.1.1	3
39. Evaluate the reliability of the heat activated water deluge in Upper Access Tunnel in Red Hill Tank Gallery in conjunction with the evaluation of AFFF in Lower Access Tunnel (LAT). Develop recommendations for improved reliability. (High Priority)	Consequences: 1.5.1.1, 1.5.1.2	3
40. Improve the reliability of draining condensed/accumulated liquid in Red Hill Tank Gallery manifolded vent piping. Options to consider include 1) manually checking and draining low point per scheduled interval, and 2) adding a level detection and alarm instrumentation to alert operations to abnormal accumulation of hydrocarbon and/or water. Include all instrumentation in PM program with calibrated testing equipment. (Medium Priority)	Consequences: 1.5.1.2	3
41. Add testing for sulfur compounds (or other credible toxic compounds) as part of pre-offloading analysis for fuel receipts at PRL. (Medium Priority)	Consequences: 1.11.1.2, 2.9.1.2	1
42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority)	Consequences: 1.14.1.2, 1.14.1.3, 1.14.1.5, 4.1.2.4, 4.1.2.5, 4.1.2.7, 4.1.9.6, 4.1.9.7, 4.1.9.9, 6.14.1.2, 6.14.1.3, 6.14.1.5, 6.14.2.4, 6.14.2.5, 6.14.2.7, 7.1.2.2, 7.1.3.2, 7.1.4.2, 8.2.1.1, 8.2.1.2, 12.1.2.4, 12.1.2.5, 12.1.2.7, 12.1.9.6, 12.1.9.7, 12.1.9.9	3
43. Install a second and independent high level indication and alarm on TK 311 Slop Tank to reduce the likelihood of overfilling TK 311 unknowingly. (Medium Priority)	Consequences: 1.14.1.2, 4.1.2.4, 4.1.9.6, 6.14.1.2, 6.14.2.4, 8.2.1.2, 8.4.1.1, 12.1.2.4, 12.1.9.6	3

PHA Recommendations	Place(s) Used	Risk Ranking
44. Review current practices and operability of TK 311 Slop Tank with groundwater treatment equipment and personnel adjacent to TK 311 to evaluate the interaction of the two operations and modify practices if warranted. (Low Priority)	Consequences: 1.14.1.2, 4.1.2.4, 4.1.9.6, 6.14.1.2, 6.14.2.4, 8.2.1.2, 12.1.2.4, 12.1.9.6	3
45. Ensure run status indication on all pumps inside all AFFF Sumps (20 pumps) is integrated with the AFHE SCADA to alert Control Room Operator (CRO) to potential release of fuel and/or AFFF. (High Priority)	Consequences: 1.14.1.3, 4.1.2.5, 4.1.9.7, 6.14.1.3, 6.14.2.5, 8.1.1.1, 8.1.2.1, 8.2.1.1, 8.4.2.1, 8.9.1.1, 12.1.2.5, 12.1.9.7	1
46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority)	Consequences: 1.14.1.3, 1.14.1.4, 1.14.1.5, 4.1.2.5, 4.1.2.6, 4.1.2.7, 4.1.9.7, 4.1.9.8, 4.1.9.9, 6.14.1.3, 6.14.1.4, 6.14.1.5, 6.14.2.5, 6.14.2.6, 6.14.2.7, 8.1.1.1, 8.1.2.1, 8.2.1.1, 8.4.2.1, 8.9.1.1, 12.1.2.5, 12.1.2.6, 12.1.2.7, 12.1.9.7, 12.1.9.8, 12.1.9.9	1
47. Evaluate the design of the 14" AFFF discharge line piping on the discharge of 20 AFFF Sumps pumps as part of the current project to upgrade PVC to CS. The PHA Team is concerned about 1) the volume flow and separately, 2) line slope or configuration to trap liquid in retention line, and 3) lack of damage control isolation in long-run of piping. (High Priority)	Consequences: 1.14.1.3, 4.1.2.5, 4.1.9.7, 6.14.1.3, 6.14.2.5, 8.1.1.1, 8.1.2.1, 8.2.1.1, 8.4.2.1, 8.9.1.1, 12.1.2.5, 12.1.9.7	1
48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High Priority)	Consequences: 1.14.1.3, 4.1.2.5, 4.1.9.7, 6.14.1.3, 6.14.2.5, 8.1.1.1, 8.1.2.1, 8.1.4.1, 8.2.1.1, 8.4.1.2, 8.4.2.1, 8.5.3.1, 8.9.1.1, 12.1.2.5, 12.1.9.7	1
49. Train all affected personnel on the design, intent, and operation of the AFFF System, including refresher training. (High Priority)	Consequences: 1.14.1.3, 4.1.2.5, 4.1.9.7, 6.14.1.3, 6.14.2.5, 8.1.1.1, 8.1.2.1, 8.2.1.1, 8.4.2.1, 8.9.1.1, 12.1.2.5, 12.1.9.7	1
50. Consider equipping AFFF Retention Tank with reliable level indication and level alarm to alert Control Room Operator (CRO) to presence of level in AFFF Retention Tank. (Medium Priority)	Consequences: 1.14.1.3, 4.1.2.5, 4.1.9.7, 6.14.1.3, 6.14.2.5, 8.2.1.1, 12.1.2.5, 12.1.9.7	1
51. Consider designing a system to separate oil and water to reduce the likelihood of discharging flammable liquid to environment from Adit 3 Groundwater Sump. (Medium Priority)	Consequences: 1.14.1.4, 4.1.2.6, 4.1.9.8, 6.14.1.4, 6.14.2.6, 12.1.2.6, 12.1.9.8	1
52. Provide means to remove contamination from water supply. (High Priority)	Consequences: 1.14.1.4, 4.1.2.6, 6.14.1.4, 6.14.2.6, 12.1.2.6	1
53. Evaluate an emergency breathing air supply for Harbor Tunnel due to its long length, limited egress, and reduced ventilation. (Medium Priority)	Consequences: 1.14.1.5, 4.1.2.7, 4.1.9.9, 6.14.1.5, 6.14.2.7, 12.1.2.7, 12.1.9.9	1
54. If defueling to PAR is pursued, coordination with PAR to develop an Operations Plan which reviews safeguards at PAR for 1) maximum pressure of ~130 psig, 2) maximum flowrate, 3) overfill protection, and 4) transient surge when isolated at PAR is required. (High Priority)	Consequences: 3.1.2.2	
55. Determine the maximum pressure that can be provided by PAR if the pressure control valve malfunctions open and ensure piping at PRL and RHL is adequate for resultant pressure, and if not implement safeguards to reduce the likelihood of overpressuring PRL and RHL piping. (High Priority)	Consequences: 3.1.3.1	
56. Implement a document control system to generate unique, trackable operations orders and log revisions. (Low Priority)	Consequences: 4.1.1.1, 12.1.1.1	5
57. Consider installing small platform in lieu of portable ladders for safer access to HPB for each of the three products OR relocate HPB to ground level. Hard pipe the discharge of the HPB to Main Sump. Ensure the end of the discharge piping is visible to person(s) performing task. (Low Priority)	Consequences: 4.1.3.1, 12.1.3.1 Observation: 2.6.1	4
58. Perform Job Safety Analysis (JSA) on high-risk tasks to address human factors and PPE requirements. (Medium Priority)	Consequences: 4.1.3.1, 12.1.3.1 Observation: 2.6.1	4
59. Ensure seals and enclosures necessary to maintain electrical area classification Class 1 Div I are included in PM program. (Medium Priority)	Consequences: 4.1.3.2, 4.1.5.2, 4.1.6.2, 4.1.8.1, 12.1.3.2, 12.1.5.2, 12.1.6.2, 12.1.8.1 Observation: 8.1.1	4
60. Ensure transformers, switch gear, automatic transfer switch (ATS), and other equipment in Switch Gear Room meets requirements of Class 1 Div I. (High Priority)	Consequences: 4.1.3.2, 4.1.5.2, 4.1.6.2, 4.1.8.1, 12.1.3.2, 12.1.5.2, 12.1.6.2, 12.1.8.1 Observation: 8.1.1	4
61. Consider using nitrogen to relieve vacuum inside piping instead of air to reduce the likelihood of producing a flammable mixture. (Medium Priority)	Consequences: 4.1.3.2, 4.1.5.2, 4.1.6.2, 4.1.8.1, 12.1.3.2, 12.1.5.2, 12.1.6.2, 12.1.8.1	4
62. Ensure Area Classification boundaries are clearly denoted in written PSI and understood by impacted personnel. (High Priority)	Consequences: 4.1.3.2, 4.1.5.2, 4.1.6.2, 4.1.8.1, 12.1.3.2, 12.1.5.2, 12.1.6.2, 12.1.8.1 Observation: 8.1.1	
63. Ensure Operations Order for line pack include specific step to close high point bleed valve (HPB) before completely opening ball valve. (Low Priority)	Consequences: 4.1.8.1, 12.1.8.1	4
64. Consider testing for fluorides and chlorides in all liquids either before defueling if possible or after receipt and consider alternatives to receiving defeuls from Navy vessels if data warrants. (Medium Priority)	Consequences: 6.9.1.1	3
65. Develop a SOP for dewatering Tank 47/48/54 F-76 Tank (Upper Tank Farm), Tank 46/53 F-24 Tank (Upper Tank Farm) and Tank 55 JP-5 Tank (Upper Tank Farm) to increase the likelihood of complete dewatering not partial dewatering. (High Priority)	Consequences: 6.9.1.1	3
66. Design and install interlock and permissive systems for all fuel movements to/from RHL and UGPH, to reduce the likelihood of human error of sequencing valves during lineup. Design should consider use of the manual clutch to bypass MOV operation. (High Priority) Some action is already underway as the result of AB&A Root Cause Analysis into the May 6, 2021 Mishap.	Consequences: 6.14.2.1 Observation: 4.5.1	1
67. Investigate anchor chair requirements for all tanks in the UTF and FORFAC, and Tank 311 at RHL. (Medium Priority) This recommendation may be similar to a recommendation from SGH.	Consequences: 7.1.1.2, 7.2.1.1, 7.2.2.1, 7.9.3.2	3

PHA Recommendations	Place(s) Used	Risk Ranking
68. Install a differential pressure transmitter/switch and alarm across Duplex strainer on the suction of [redacted] Pump to decrease the likelihood of cavitation of [redacted] (Medium Priority)	Consequences: 7.1.2.2	4
69. Install PITs on the suction and discharge of [redacted] Pump to allow CRO to monitor [redacted] performance. (Medium Priority)	Consequences: 7.1.2.2, 7.1.3.1, 7.1.3.2, 7.1.4.2	3
70. Include all PRL cameras in scheduled PM program. (Medium Priority)	Consequences: 7.1.2.2, 7.1.3.2, 7.1.4.2, 12.4.4.1, 12.6.2.1	4
71. Consider installing a second dissimilar check valve adjacent to 6" check valve on the discharge of [redacted] Pump to reduce the likelihood and quantity of reverse flow. (Low Priority)	Consequences: 7.1.3.1, 7.1.3.2	3
72. Use the existing level switch to activate a new, local audible and visual alarm with LSH-1328. (Medium Priority)	Consequences: 7.1.3.2	3
73. Install a pressure relief device on the discharge of [redacted] Pump, sized and documented for blocked outlet and discharges to a safe location. (Medium Priority)	Consequences: 7.1.4.2	4
74. Remove electrical connections and sockets from the inside of FORFAC containment area to reduce the likelihood of electrocution during periods of heavy rain or spill in secondary containment. If not feasible, install protective safeguards to reduce the risk of electrocution. (High Priority)	Consequences: 7.2.1.2, 7.2.2.2	1
75. As an interim recommendation, 1) replace sockets with GFCI sockets inside the FORFAC secondary containment, 2) develop an SOP to engage NAVFAC prior to predicted heavy rainfall and include emergency phone numbers for power company contact, 3) provide access to breaker box near Tank 1301 Reclaim (B1) Tank, and 4) install signage that specifies "do not enter during periods of heavy rain or standing water" and includes a phone number contact to de-energize the area. (High Priority)	Consequences: 7.2.1.2, 7.2.2.2	1
76. Develop full documentation package with P&IDs for the fire suppression system for RHL. (High Priority)	Consequences: 8.1.1.1, 8.1.2.1, 8.4.2.1, 8.9.1.1	2
77. Ensure firewater and AFFF main and jockey pumps are on a PM schedule and automatic transfer switch to emergency diesel-driven generators are tested periodically at load to meet requirements of NFPA. (Medium Priority)	Consequences: 8.1.1.1, 8.1.2.1, 8.4.2.1, 8.9.1.1	2
78. Establish a stand alone maintenance contract apart from other base facilities with documented maintenance standards. (High Priority)	Consequences: 8.1.1.1, 8.1.2.1, 8.4.2.1, 8.9.1.1 Observation: 4.16.1	2
79. Evaluate the available inventory of AFFF on site and determine if additional quantities are desired. NFPA 30 Chapter 16 requires 15 minutes of foam concentrate inventory based on design flow rate. (Low Priority)	Consequences: 8.1.2.1, 8.9.1.1	2
80. Evaluate combining the SCADA systems for AFHE and fire suppression for ease of CRO monitoring or consider a Smart Grid system solution. (Low Priority)	Consequences: 8.1.2.1, 8.9.1.1	2
81. Understand the multiple roles of nitrogen in the AFFF fire suppression system and evaluate safeguards and add additional safeguards if warranted. Consider the impact of nitrogen leak and potential asphyxiation. (High Priority)	Consequences: 8.1.3.2, 8.9.3.2	
82. Identify an alternative to AFFF that does not contain PFAS or PFOA to eliminate exposure potential to humans or environment. (High Priority)	Consequences: 8.1.4.1, 8.2.2.1, 8.4.1.2, 8.5.3.1	2
83. Consider a SOP for all individuals in tunnels to have a 15 minute escape air bottle system for emergency egress during activation of fire suppression system, which shuts down ventilation. (Medium Priority)	Consequences: 8.4.1.2	2
84. Collaborate with vendor of AFFF system to determine all purposes of nitrogen system, capability of nitrogen system (pressure), and safeguards in the current design. Identify and install additional safeguards if warranted. (High Priority)	Consequences: 8.5.1.1	
85. Ensure the AFFF 175 psig components (if there are any) are adequately designed and documented for maximum pressure of ~220 psig fire water. If they are not, add additional safeguards as warranted. (High Priority)	Consequences: 8.5.2.1	
86. Ensure re-design of fire suppression system addresses deadlegs which prevent complete transfer of foam/water mixture after activation of fire suppression system and allow potential future fuel and foam releases upon loss of containment. (High Priority)	Consequences: 8.11.1.1	
87. Implement a Mechanical Integrity Inspection Program for all identified deadlegs in fuel handling and fire suppression systems. (Medium Priority)	Consequences: 8.11.1.1	
88. Equip AFFF sump pumps with remote start from the fire suppression SCADA system to allow for operation in case AFFF pumps cannot be operated locally due to lack of access (OPD or fire rated door closed). (High Priority)	Consequences: 8.11.1.1	
89. Develop unique work orders for vessel to vessel fuel transfers. (High Priority)	Consequences: 9.1.1.1, 9.1.2.1, 9.5.1.2, 9.8.1.1, 9.9.2.1, 9.11.1.1	5
90. Ensure scupper plugs in secondary containment coamings are verified in place prior to transfer as part of work order for both vessel to vessel and barge/YON to shore transfers. (High Priority)	Consequences: 9.1.1.1, 9.1.2.1, 9.5.1.2, 9.8.1.1, 9.9.2.1, 9.11.1.1	5
91. Develop a procedure for verifying the presence of water in all cargo tanks, and if water is present, a procedure for removing water contaminated fuel with vacuum truck. (High Priority)	Consequences: 9.9.2.1	5
92. Consider treating the engine compartment as a confined space which would include controlled access, deactivation of fire suppression system while inside, and reactivation of system when entry is complete. (High Priority)	Consequences: 9.12.1.1	3
93. Consider incorporating visual strobe light with the alarm system to further increase awareness of fire suppression activation. (Medium Priority)	Consequences: 9.12.1.1	3
94. Develop a procedure that outlines the specific manpower requirements for multiple, simultaneous operations as the number of operations increased and that requires written approval for SIMOPS by appropriate level of management. (High Priority)	Consequences: 10.1.1.1, 10.1.1.2, 10.1.1.3, 10.1.2.1, 10.1.2.2, 10.1.2.3, 10.1.3.1, 10.1.4.1, 10.1.4.2, 10.1.5.1, 10.1.6.1, 10.1.6.2, 10.1.7.1 Observation: 6.5.1	
95. Consider adding additional AFHE workstations and larger monitors to accomplish need for visibility of more quadrants simultaneously. (Medium Priority)	Consequences: 10.1.1.1, 10.1.1.2, 10.1.1.3 Observation: 4.14.1	
96. Evaluate the size and location of current backup control room to better accommodate additional CROs and reduce access and distractions. (High Priority)	Consequences: 10.1.1.1, 10.1.1.2, 10.1.1.3 Observation: 4.14.1	
97. Provide government smart phones to all Rovers for improved communications due to current radio reliability and that some communications are lengthy and better suited for cell phone instead of radio. (High Priority)	Consequences: 10.1.2.1, 10.1.2.2, 10.1.2.3	

PHA Recommendations	Place(s) Used	Risk Ranking
98. Create a fatigue policy for all Fuels Distributions System workers, operators, and maintainers that limits hours worked in a day and days worked consecutively. (High Priority)	Consequences: 10.1.4.1, 10.1.4.2	
99. The Navy policy is to use the Incident Command System (ICS)/Unified Command (UC) for structuring Navy spill response management organizations. The NAVSUP FLCPH fuel personnel manages the initial response. If additional resources are needed, the Federal Fire Department Incident Commander will establish an emergency command post and assume responsibility for the response. The Emergency Spill Coordinator or the Commanding Officer can contact the Region Navy On-Scene Coordinator to activate the Region Spill Management Team (SMT). The Region SMT will then establish other ICS functions. Port Operations is the coordinator for the Facility Response Team (FRT), an on-water contractor resource based on Ford Island. The roles, staffing and resources for each organization needs to be clearly defined, drilled and aligned prior to defueling operations. (High Priority)	Consequences: 10.1.5.1	
100. Review current sampling schedule and identify opportunities for optimization and eliminating non-required sampling and analysis. (Medium Priority)	Consequences: 10.1.7.1	
101. Improve communications between fuel laboratory and CROs after analysis is complete for increased efficiency during multiple simultaneous operations. (Medium Priority)	Consequences: 10.1.7.1	
102. Ensure safeguards are adequate for [redacted] (b)(3)(A) cavitation or deadheading due to closed valve during loading process. If not, add additional safeguards as warranted. (Medium Priority)	Consequences: 11.1.1.2	
103. Consider requirement for flame retardant clothing while working in hydrocarbon environment. (High Priority)	Observation: 2.1.1	
104. Consider installing emergency PPE throughout the facility. (High Priority)	Observation: 2.7.1	
105. Ensure the closing of the oil tight doors displays on the control room display. (High Priority)	Observation: 4.15.1	
106. Consider inventorying spare parts/replacements for critical instrumentation to reduce the wait time for repairs. (Medium Priority)	Observation: 4.16.1	
107. Consider additional operators and technical support for defueling operations. (High Priority)	Observation: 6.5.1	
108. Implement Management of Change Program. (High Priority)	Observation: 8.5.1	
109. Develop Incident Investigation Program that includes Incident Investigation techniques and near miss reporting and investigation, and sharing of lessons. (High Priority)	Observation: 8.7.1	
110. Implement a tunnel sign-in/sign-out process to be able to account for all personnel within the tunnel at any time. (Medium Priority)	Observation: 1.1.1	
111. Require guides and all groups to have at least one form of emergency communication – likely a radio. (Medium Priority)	Observation: 1.1.1	
112. Post signs periodically indicating the distance to the nearest emergency phone and instructions to dial “99” then “911”. (Medium Priority)	Observation: 1.1.1	
113. Locating and tracking people is crucial for underground working conditions. Traditional technologies such as GPS and WiFi tracking do not work underground. Consider implementation of a system designed to locate and track personnel while in the tunnel. (Low Priority)	Observation: 1.1.1	
114. Consider requiring SCBA, emergency air packs, installing SCBA station(s) or breathing airline throughout tunnel. (Medium Priority)	Observation: 1.1.1	
115. Consider reinforcing the window/wall facing the UGPH. (High Priority)	Observation: 4.2.1, 4.3.1, 4.6.1	
116. Consider providing appropriate PPE, for example bunker gear, and safeguards to allow CROs ample time to escape the area during an emergency. (High Priority)	Observation: 4.2.1, 4.3.1, 4.6.1	
117. Consider relocation of the control room from the UGPH to the back control room located in the Fuels Distribution Building. (Low Priority)	Observation: 4.2.1, 4.3.1, 4.6.1	
118. Review the need for emergency stations (safety shower and eye wash) and first aid stations throughout the facility in proximity to fuel piping. (Low Priority)	Observation: 7.1.1, 7.2.1	
119. Due to the geographical vastness of this facility, review the need for installing alarms on safety showers and eyewash stations. (Low Priority)	Observation: 7.4.1	
120. Implement a formal safe work system, which includes coordination and control of all “intervention” work on the process and references all Life Critical standards, such as hot work, confined space, lock-out/tag-out, etc. (High Priority)	Observation: 8.4.1	

Recommendations 103-120 were not risk ranked as part of the supplemental Human Factors and Facility Siting checklists. The PHA team and Risktec personnel completed these checklists and associated recommendations to accompany the PHA.

APPENDIX B PHA WORKSHEETS

PHA Worksheets

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]
Components: Tank 0221 F-24 Surge Tank 1; Tank 0222 JP-5 Surge Tank 2; Tank 0223/0224 F-76 Surge Tank; [redacted]
Design Intention/Parameters: Hotel Pier is currently the sole marine receipt point (ship or barge) for all fuels and the primary bulk issue point. The pier piping is connected to the facility at [redacted] Each of the three products (F-76, F-24, and JP-5) has a dedicated piping loop around the pier. Multiple piping risers with [redacted] ball valves allow vessels to be connected to the fuel system through non-collapsible hoses.

The UGPH is located [redacted] "Surge Tanks." These tanks act as atmospheric buffer tanks during receipt pumping operations and are used for temporary operational storage when required.

There are three main transfer lines that carry fuel to and from Red Hill (a [redacted] F-76 line, an [redacted] JP-5 line, and a [redacted] F-24 line). The [redacted] fuel lines are in a tunnel [redacted].

The Red Hill complex consists of 20 fuel tanks that were constructed circa 1943. The Red Hill tanks are the primary bulk storage tanks for the three major products handled at Pearl Harbor (F-24, JP-5, and F-76). The bottom of these tanks range in elevation from [redacted] above sea level, and the tanks range from 235 feet to 250 feet tall. Each Tank (1-16) has two common fill and issue lines that branches off the three main transfer lines. Tanks 17-20 have one common fill and issue line connected to the JP-5 line.

There are also defuel and dirty ballast water/waste oil lines associated with Hotel Pier that are not currently in service.
Operating Conditions: 1. Flow: [redacted]; 2. Pressure: 0 to 125 psi; 3. Temperature: 60 to 80°F

Deviation	Cause	Consequence	CAT	Risk Matrix C	L	RR	Safeguards	PHA Recommendation	Comments
1.1. No / Less Flow	1. Ship pump not running. (Outside of Node)	1. Potential delay in offloading ship. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.		
		2. Potential sagging of pipeline between Hotel Pier and UGPH. Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential line transient surge in piping when flow is re-established. Potential gasket leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	3 3 4 2	B B B B	3 3 4 2	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders. Some flows are measured through meter skids during discharge and alarm on deviation from source to destination. Meters are calibrated biannually. Operator response to alarm is not currently part of Operations Orders. Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11). 2. Ensure the PITs located [redacted] are in a scheduled PM system using certified and calibrated test equipment. The calibration should meet the requirements of OPNAV Instruction 3960.16B. (High Priority) 3. Consider installing local ESD on refueling piers and docks at PRL Ensure ESD actions are consistent with Coast Guard requirements and do not create additional hazards. (Medium Priority) 4. If additional safeguards are warranted, design and install automation to safely shutdown refueling piers and docks at PRL in event of emergency or loss of containment, including isolation of sectional valves to minimize quantity of loss of containment. (High Priority)	
		3. Potential sagging of pipeline between Hotel Pier and UGPH, and between UGPH and RHL. Potential to draw vacuum in piping between Hotel Pier and UGPH, and between UGPH and RHL. Potential to collapse piping. Potential loss of containment. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to	MR H/S E P	2 1 2 1	C C C C	3 2 3 2	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		mission capability or unit readiness.					part of calibration system. Operator response to alarm is not currently part of Operations Orders. Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	7. Perform a Pipe Collapse Pressure Study to determine the pressure required to collapse the existing pipe and identify and install safeguard(s) as warranted. Consider integrating this recommendation with upcoming API 570 Assessment. (High Priority)	
		4. Potential sagging of pipeline between Hotel Pier and UGPH, and between UGPH and RHL. Potential to draw vacuum in piping between Hotel Pier and UGPH, and between UGPH and RHL. Potential to damage seals in Dresser Coupling. Potential loss of containment when flow is re-established. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 1 2 1	C C C C	3 2 3 2	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders. Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 8. Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around pumps installed in UGPH and Red Hill Tank Gallery. Consider modifying design if manufacturer has alternate sealing system and Dresser Couplings remain part of design. (High Priority) 9. Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling. (High Priority)	
		5. Potential sagging of pipeline between Hotel Pier and UGPH. Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank to atmosphere through open vent. No hazardous consequences identified.							
		6. Potential decreased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to cavitate [redacted] Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	4 3 4 4	C C C C	5 4 5 5	[redacted] low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							[redacted] (b)(3)(A) high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system.		
							[redacted] (b)(3)(A) low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system.		
							TT-[redacted] (b)(3)(A) high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system.		
							CT-[redacted] (b)(3)(A) high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.		
		7. Potential reverse flow from Red Hill Tank Gallery to UGPH and Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential increased level in Tank 0221/0222/0223/0224 over time (reverse flow through down pump rotating backwards). Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
			H/S	3	D	5	OCV on the discharge of each [redacted] (b)(3)(A) (b)(3)(A) acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.		
			E	3	D	5	SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] (b)(3)(A)		
			P	1	D	3	LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		8. Potential reverse flow from Red Hill Tank Gallery to UGPH and Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank to ship (reverse flow through down pump rotating backwards). Potential to overfill ship tank. Potential release of ambient flammable liquid to ship and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public	MR	2	D	4	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer.		PHA Team concluded safeguards are adequate.
			H/S	3	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.		
			E	1	D	3	OCV on the discharge of each [redacted] (b)(3)(A) (b)(3)(A)		
			P	1	D	3			

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		impact. Potential impact to mission capability or unit readiness.					[redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] High and high high level alarms, and/or high pressure trips on ship tanks/piping.		
	2. Pier riser station manual valve closed. [redacted]	1. Potential to deadhead ship offloading pumps. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.					Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	
		2. Potential increased pressure in fuel transfer hose. Potential hose rupture or gasket failure. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. 33 CFR Part 154 Coast Guard requires testing hoses to 1.5 x deadhead pressure. PHA Team concluded the highest pressure expected in a marine transfer that is deadheaded is the UTF pump for product F-76 at **219 psig**. This pressure is greater than 1) the gravity head from the highest tank at RHL to the dock, 2) the available deadhead from the YON pumps, 3) deadhead pressure of ship pump, and 4) any single pump in UGPH. However, should two pumps in series ever be considered to be included in an Operations Order, the highest deadhead pressure to be considered is **268 psig**. PHA Team discussed the fact that both the pump discharge pressure and hose life/condition impacts hose failure likelihood. To be conservative, consequences were developed assuming failure of hose independent of pump deadhead pressure.	MR H/S E P	4 1 2 2	B C B B	4 2 2 2	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Pre-Plan Meeting includes visual inspection of all fuel transfer hoses and hose integrity test witnessed by both PICs prior to initiating any fuel transfer. All hoses are hydrostatically tested to 150 psig annually. Coast Guard verifies hose labeling and record-keeping annually. Hose rating is 200 to 250 psig depending on manufacturer. Hose test pressure per manufacturer is 300 psig. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Operational practice is to start fuel transfer and slowly increase pressure in increments until full flow is established. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority) 13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	
		3. Potential delay in offloading ship. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.		
		4. Potential sagging of pipeline between Hotel Pier and UGPH. Potential to draw vacuum in							

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		piping between Hotel Pier and UGPH. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank to atmosphere through open vent. No hazardous consequences identified.							
		5. Potential decreased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to cavitate [redacted] Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	C	5	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	
			H/S	3	C	4			
			E	4	C	5			
			P	4	C	5			
		6. Potential reverse flow from Red Hill Tank Gallery to UGPH and Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential increased level in Tank 0221/0222/0223/0224 over time (reverse flow through down pump rotating backwards). Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LAH-0221/0222/0223/0224 high level (ATG) alarm alerts	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.
			H/S	3	D	5			
			E	3	D	5			
			P	1	D	3			

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		7. Potential to pack JP-5 line from surge tank piping manifold to Tank 55 JP-5 Tank (Upper Tank Farm). No hazardous consequences identified.							
	3. MOV pier sectional valve closed. [redacted] (b)(3)(A) At the time of the 2022 PHA, MOV pier sectional valves [redacted] (b)(3)(A)) in F-76 Marine Diesel piping were removed and replaced with a spool.	1. Potential to deadhead ship offloading pumps. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.					Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	
		2. Potential increased pressure in fuel transfer hose. Potential hose rupture or gasket failure. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. 33 CFR Part 154 Coast Guard requires testing hoses to 1.5 x deadhead pressure. PHA Team concluded the highest pressure expected in a marine transfer that is deadheaded is the UTF pump for product F-76 at **219 psig**. This pressure is greater than 1) the gravity head from the highest tank at RHL to the dock, 2) the available deadhead from the YON pumps, 3) deadhead pressure of ship pump, and 4) any single pump in UGPH. However, should two pumps in series ever be considered to be included in an Operations Order, the highest deadhead pressure to be considered is **268 psig**. PHA Team discussed the fact that both the pump discharge pressure and hose life/condition impacts hose failure likelihood. To be conservative, consequences were developed assuming failure of hose	MR H/S E P	4 1 2 2	B C B B	4 2 2 2	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Pre-Plan Meeting includes visual inspection of all fuel transfer hoses and hose integrity test witnessed by both PICs prior to initiating any fuel transfer. All hoses are hydrostatically tested to 150 psig annually. Coast Guard verifies hose labeling and record-keeping annually. Hose rating is 200 to 250 psig depending on manufacturer. Hose test pressure per manufacturer is 300 psig. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Operational practice is to start fuel transfer and slowly increase pressure in increments until full flow is established. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority) 13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		independent of pump deadhead pressure.							
		3. Potential increased pressure in piping from Hotel Pier. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		4. Potential delay in offloading ship. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.		
		5. Potential sagging of pipeline between Hotel Pier and UGPH. Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank to atmosphere through open vent. No hazardous consequences identified.							
		6. Potential decreased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to cavitate [redacted] Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	C	5	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	
			H/S	3	C	4	[redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system.		
			E	4	C	5	[redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system.		
			P	4	C	5	TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.		

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		7. Potential reverse flow from Red Hill Tank Gallery to UGPH and Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential increased level in Tank 0221/0222/0223/0224 over time (reverse flow through down pump rotating backwards). Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.
			H/S	3	D	5	OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.		
			E	3	D	5	SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]		
			P	1	D	3	LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		8. Potential to pack JP-5 line from surge tank piping manifold to Tank 55 JP-5 Tank (Upper Tank Farm). No hazardous consequences identified.							
	4. MOV in [redacted] closed. [redacted]	1. Potential to deadhead ship offloading pumps. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.					Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	
		2. Potential increased pressure in fuel transfer hose. Potential hose rupture or gasket failure. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. 33 CFR Part 154 Coast Guard requires testing hoses to 1.5 x deadhead pressure. PHA Team concluded the highest pressure expected in a marine transfer that is deadheaded is the UTF pump for product F-76	MR	4	B	4	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	
			H/S	1	C	2	Pre-Plan Meeting includes visual inspection of all fuel transfer hoses and hose integrity test witnessed by both PICs prior to initiating any fuel transfer.	13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	
			E	2	B	2	All hoses are hydrostatically tested to 150 psig annually. Coast Guard verifies hose labeling and record-keeping annually.		
			P	2	B	2	Hose rating is 200 to 250 psig depending on manufacturer. Hose test pressure per manufacturer is 300 psig.		
							DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks,		

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		at **219 psig**. This pressure is greater than 1) the gravity head from the highest tank at RHL to the dock, 2) the available deadhead from the YON pumps, 3) deadhead pressure of ship pump, and 4) any single pump in UGPH. However, should two pumps in series ever be considered to be included in an Operations Order, the highest deadhead pressure to be considered is **268 psig**. PHA Team discussed the fact that both the pump discharge pressure and hose life/condition impacts hose failure likelihood. To be conservative, consequences were developed assuming failure of hose independent of pump deadhead pressure.					pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Operational practice is to start fuel transfer and slowly increase pressure in increments until full flow is established. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Ship should have safeguards for their pump.		
		3. Potential increased pressure in piping from Hotel Pier to [redacted] PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		4. Potential delay in offloading ship. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.		
		5. Potential sagging of pipeline between Hotel Pier and UGPH. Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank to atmosphere through open vent. No hazardous consequences identified.							
		6. Potential decreased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to cavitate [redacted] Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	4 3 4 4	C C C C	5 4 5 5	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. VS-	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							[redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.		
		7. Potential reverse flow from Red Hill Tank Gallery to UGPH and Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential increased level in Tank 0221/0222/0223/0224 over time (reverse flow through down pump rotating backwards). Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	4 3 3 1	D D D D	5 5 5 3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		PHA Team concluded safeguards are adequate.
		8. Potential to pack JP-5 line from surge tank piping manifold to Tank 55 JP-5 Tank (Upper Tank Farm). No hazardous consequences identified.							
	5. MOV in [redacted] closed. [redacted]	1. Potential to deadhead ship offloading pumps. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the					Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		PHA.							
		2. Potential increased pressure in fuel transfer hose. Potential hose rupture or gasket failure. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. 33 CFR Part 154 Coast Guard requires testing hoses to 1.5 x deadhead pressure. PHA Team concluded the highest pressure expected in a marine transfer that is deadheaded is the UTF pump for product F-76 at **219 psig**. This pressure is greater than 1) the gravity head from the highest tank at RHL to the dock, 2) the available deadhead from the YON pumps, 3) deadhead pressure of ship pump, and 4) any single pump in UGPH. However, should two pumps in series ever be considered to be included in an Operations Order, the highest deadhead pressure to be considered is **268 psig**. PHA Team discussed the fact that both the pump discharge pressure and hose life/condition impacts hose failure likelihood. To be conservative, consequences were developed assuming failure of hose independent of pump deadhead pressure.	MR H/S E P	4 1 2 2	B C B B	4 2 2 2	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Pre-Plan Meeting includes visual inspection of all fuel transfer hoses and hose integrity test witnessed by both PICs prior to initiating any fuel transfer. All hoses are hydrostatically tested to 150 psig annually. Coast Guard verifies hose labeling and record-keeping annually. Hose rating is 200 to 250 psig depending on manufacturer. Hose test pressure per manufacturer is 300 psig. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Operational practice is to start fuel transfer and slowly increase pressure in increments until full flow is established. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority) 13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	
		3. Potential increased pressure in piping from Hotel Pier to [redacted] (b)(3)(A) PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		4. Potential delay in offloading ship. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.		
		5. Potential sagging of pipeline between Hotel Pier and UGPH. Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank to atmosphere through open vent. No hazardous							

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		consequences identified.							
		6. Potential decreased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to cavitate [redacted] Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	C	5	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	
			H/S	3	C	4			
			E	4	C	5			
			P	4	C	5			
		7. Potential reverse flow from Red Hill Tank Gallery to UGPH and Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential increased level in Tank 0221/0222/0223/0224 over time (reverse flow through down pump rotating backwards). Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.
			H/S	3	D	5			
			E	3	D	5			
			P	1	D	3			

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		8. Potential to pack JP-5 line from surge tank piping manifold to Tank 55 JP-5 Tank (Upper Tank Farm). No hazardous consequences identified.							
	6. Fire valve [redacted] (b)(3)(A)	1. Potential to deadhead ship offloading pumps. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.					Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	
		2. Potential increased pressure in fuel transfer hose. Potential hose rupture or gasket failure. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. 33 CFR Part 154 Coast Guard requires testing hoses to 1.5 x deadhead pressure. PHA Team concluded the highest pressure expected in a marine transfer that is deadheaded is the UTF pump for product F-76 at **219 psig**. This pressure is greater than 1) the gravity head from the highest tank at RHL to the dock, 2) the available deadhead from the YON pumps, 3) deadhead pressure of ship pump, and 4) any single pump in UGPH. However, should two pumps in series ever be considered to be included in an Operations Order, the highest deadhead pressure to be considered is **268 psig**. PHA Team discussed the fact that both the pump discharge pressure and hose life/condition impacts hose failure likelihood. To be conservative, consequences were developed assuming failure of hose independent of pump deadhead pressure.	MR H/S E P	4 1 2 2	B C B B	4 2 2 2	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Pre-Plan Meeting includes visual inspection of all fuel transfer hoses and hose integrity test witnessed by both PICs prior to initiating any fuel transfer. All hoses are hydrostatically tested to 150 psig annually. Coast Guard verifies hose labeling and record-keeping annually. Hose rating is 200 to 250 psig depending on manufacturer. Hose test pressure per manufacturer is 300 psig. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Operational practice is to start fuel transfer and slowly increase pressure in increments until full flow is established. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority) 13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	
		3. Potential increased pressure in piping from Hotel Pier to Lower Yard Tunnel. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		PHA.							
		4. Potential delay in offloading ship. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.		
		5. Potential sagging of pipeline between Hotel Pier and UGPH. Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank to atmosphere through open vent. No hazardous consequences identified.							
		6. Potential decreased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to cavitate [redacted] Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	C	5	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	
			H/S	3	C	4			
			E	4	C	5			
			P	4	C	5			
		7. Potential reverse flow from Red Hill Tank Gallery to UGPH and Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential increased level in Tank 0221/0222/0223/0224 over time (reverse flow through down pump rotating backwards). Potential to overfill Tank	MR	4	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. OCV on the discharge of each [redacted]	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.
			H/S	3	D	5			
			E	3	D	5			
			P	1	D	3			

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix			Safeguards	PHA Recommendation	Comments
				C	L	RR			
		0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.					[redacted] (b)(3)(A) acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] (b)(3)(A) LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		8. Potential to pack JP-5 line from surge tank piping manifold to Tank 55 JP-5 Tank (Upper Tank Farm). No hazardous consequences identified.							
	7. MOV DBB [redacted] (b)(3)(A)	1. Potential to deadhead ship offloading pumps. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.					Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	
		2. Potential increased pressure in fuel transfer hose. Potential hose rupture or gasket failure. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. 33 CFR Part 154 Coast Guard requires testing hoses to 1.5 x deadhead pressure. PHA Team concluded the highest pressure expected in a marine transfer that is deadheaded is the UTF pump for product F-76 at **219 psig**. This pressure is greater than 1) the gravity head from the highest tank at RHL to the dock, 2) the available deadhead from the YON pumps, 3) deadhead pressure of ship pump, and 4) any single pump in UGPH. However, should two pumps in series ever be	MR H/S E P	4 1 2 2	B C B B	4 2 2 2	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Pre-Plan Meeting includes visual inspection of all fuel transfer hoses and hose integrity test witnessed by both PICs prior to initiating any fuel transfer. All hoses are hydrostatically tested to 150 psig annually. Coast Guard verifies hose labeling and record-keeping annually. Hose rating is 200 to 250 psig depending on manufacturer. Hose test pressure per manufacturer is 300 psig. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Operational practice is to start fuel transfer and slowly increase pressure in increments until full flow is established. Rover Checklist requires walking the line during offloading,	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority) 13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix			Safeguards	PHA Recommendation	Comments
				C	L	RR			
		considered to be included in an Operations Order, the highest deadhead pressure to be considered is **268 psig**. PHA Team discussed the fact that both the pump discharge pressure and hose life/condition impacts hose failure likelihood. To be conservative, consequences were developed assuming failure of hose independent of pump deadhead pressure.					loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Ship should have safeguards for their pump.		
		3. Potential increased pressure in piping from Hotel Pier to Lower Yard Tunnel. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		4. Potential delay in offloading ship. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.		
		5. Potential sagging of pipeline between Hotel Pier and UGPH. Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank to atmosphere through open vent. No hazardous consequences identified.							
		6. Potential decreased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to cavitate [redacted] Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	4 3 4 4	C C C C	5 4 5 5	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted]	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system.		
							TT [redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system.		
							CT [redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.		
		7. Potential reverse flow from Red Hill Tank Gallery to UGPH and Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential increased level in Tank 0221/0222/0223/0224 over time (reverse flow through down pump rotating backwards). Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.
			H/S	3	D	5	OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.		
			E	3	D	5	SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]		
			P	1	D	3	LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		8. Potential to pack JP-5 line from surge tank piping manifold to Tank 55 JP-5 Tank (Upper Tank Farm). No hazardous consequences identified.							
	8. Skin valve at inlet/outlet of Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, or Tank 0223/0224 F-76 Surge Tank closed. (Don't forget line pack at UTF 55) [redacted]	1. No hazardous consequences identified to ship offloading pumps.							
		2. No hazardous consequences identified to fuel transfer hose.							
		3. No hazardous consequences identified to piping in Lower Yard Tunnel.							
		4. Potential sagging of pipeline between Hotel Pier and UGPH. Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential							

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank to atmosphere through open vent. No hazardous consequences identified.							
		5. Potential to cavitate [redacted] Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	4 3 4 4	C C C C	5 4 5 5	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	
		6. Potential reverse flow from Red Hill Tank Gallery to UGPH to ship (reverse flow through down pump rotating backwards). Potential to overfill ship tank. Potential release of ambient flammable liquid to ship and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 3 1 1	D D D D	4 5 3 3	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]		PHA Team concluded safeguards are adequate.

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							High and high high level alarms, and/or high pressure trips on ship tanks/piping.		
		7. Potential to pack JP-5 line from surge tank piping manifold to Tank 55 JP-5 Tank (Upper Tank Farm). No hazardous consequences identified.							
	9. Suction MOV [redacted]	1. Potential increased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	4 3 3 1	D D D D	5 5 5 3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
		2. Potential to cavitate [redacted] Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	4 3 4 4	C C C C	5 4 5 5	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix			Safeguards	PHA Recommendation	Comments
				C	L	RR			
							motor in MCC stops respective pump. CTs are not currently part of calibration system.		
		3. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH. Potential fire and/or explosion. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Currently [redacted]	MR H/S E P	2 1 2 1	B B B B	2 1 2 1	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. [redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. [redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
		4. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential to overfill UGPH to Lower Yard Tunnel (LYT) and/or Harbor Tunnel and/or Surge Tank Tunnel. Potential to overfill tunnels and/or sumps to	MR H/S E P	2 1 2 1	B B B B	2 1 2 1	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		surrounding area and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.					[redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT [redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. [redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LSH high level (switch) in Harbor Tunnel Sump with local audible alarm alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
		5. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank (normal lineup, B1 and B2 are sluiced). Potential to overfill Tank 1301/1302 to containment area. Potential release to soil below containment area (due to leaking containment) and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 1 2 1	C C C C	3 2 3 2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Potential overfill to Lower Yard Tunnel (LYT) may accelerate this consequence (abnormal lineup).					[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. [redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LAH-B1/B2 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-B1/B2 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
		6. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to Adit 1 Sump (abnormal lineup). Potential to overfill Adit 1, Harbor Tunnel, and/or Adit 2 (including french drain systems). Potential release to soil and/or groundwater and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential overfill to Lower Yard Tunnel (LYT) may accelerate this consequence.	MR	2	C	3	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT[redacted] high temperature	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL	
			H/S	1	C	2			
			E	1	C	2			
			P	1	C	2			

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Potential to overfill to Harbor Tunnel may accelerate this consequence.					transmitter on pump stops respective pump. TTs are not currently part of calibration system.	to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
							[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority)	
							OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.	19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
							SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]		
							LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		7. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential to overfill UGPH to Lower Yard Tunnel (LYT) and/or Harbor Tunnel and/or Surge Tank Tunnel. Potential release to soil and/or groundwater below Surge Tank Tunnel (due to leaking tunnel) and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	C	3	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	
			H/S	1	C	2	[redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve.	15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
			E	1	C	2	[redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system.	16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority)	
			P	1	C	2	[redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
							TT [redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
							CT [redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
							OCV on the discharge of each [redacted]	19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							[redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		8. Potential delay in resupplying Red Hill. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5			
	10. Any one of [redacted] not running. [redacted]	1. Potential increased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Reverse flow from Red Hill may accelerate this consequence.	MR	4	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
			H/S	3	D	5			
			E	3	D	5			
			P	1	D	3			
		2. Potential reverse rotation of [redacted] Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	C	5	OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.	15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
			H/S	3	C	4			
			E	4	C	5			
			P	4	C	5			
		3. Potential reverse flow from Red Hill Tank Gallery to UGPH and Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank to ship (reverse flow through down pump rotating backwards). Potential to overfill ship tank. Potential release of ambient flammable liquid to ship and/or	MR	2	D	4	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.		PHA Team concluded safeguards are adequate.
			H/S	3	D	5			
			E	1	D	3			
			P	1	D	3			

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.					OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] High and high high level alarms, and/or high pressure trips on ship tanks/piping.		
		4. Potential delay in resupplying Red Hill. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5			
	11. Not operating two pumps in series in UGPH as level rises (increased static head) in receiving tank. [redacted]	1. Potential decreased rate of filling TK 102/103/104/105/106 F-24 Tank (Red Hill), TK 107/108/109/110/111/112/113/114/117/118/120 JP-5 Tank (Red Hill), TK 115/116 F-76 Tank (Red Hill). Potential little or no impact to mission capability or unit readiness.	MR	4	C	5			
		2. Potential increased temperature of pump fluid in [redacted] Potential increased temperature of fluid up to flash point. Potential seal damage. Potential seal leak. Potential release of flammable liquid above flash point. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	B	4	[redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. [redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 22. Ensure new replacement pumps for [redacted] are equipped with 1) appropriate seal materials for the resulting temperatures of periods of lower than normal flow operation and 2) minimum flow recirculation protection to reduce the likelihood of increased temperature during periods of lower than normal flow operation. (High Priority)	
			H/S	3	B	3			
			E	4	B	4			
			P	4	B	4			
	12. OCV or discharge [redacted] closed. Note: Valve [redacted] would have same consequences if operating in series. [redacted]	1. Potential increased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
			H/S	3	D	5			
			E	3	D	5			
			P	1	D	3			

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		2. Potential to deadhead [redacted] Potential increased temperature of fluid up to flash point. Potential seal damage. Potential seal leak. Potential release of flammable liquid above flash point. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. If two pumps are operated in series, and the discharge valve between the two pumps is closed, the upstream pump is deadheaded and the downstream pump is cavitated. Consequences of cavitation resulting in separation of Dresser Coupling are listed above in Node 1 Deviation No Flow Cause 9. (1.1.9)	MR H/S E P	4 3 4 4	B B B B	4 3 4 4	[redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. [redacted] 1 high pressure (switch) on the discharge of pump stops respective pump. PSHs are not currently part of calibration system. [redacted] high pressure (transmitter) on the discharge of pump stops respective pump. PITs are not currently part of calibration system. PSH and PIT share common root valve. [redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 22. Ensure new replacement pumps for [redacted] are equipped with 1) appropriate seal materials for the resulting temperatures of periods of lower than normal flow operation and 2) minimum flow recirculation protection to reduce the likelihood of increased temperature during periods of lower than normal flow operation. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority)	
		3. Potential delay in resupplying Red Hill. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5			
	13. Manual block valve [redacted] closed or [redacted] closed or [redacted] closed. [redacted])	1. Potential increased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	4 3 3 1	D D D D	5 5 5 3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
		2. Potential to deadhead [redacted]	MR	4	B	4	FS-	15. Install ESD functionality to both suction and discharge MOVs to [redacted]	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		[redacted] Potential increased temperature of fluid up to flash point. Potential seal damage. Potential seal leak. Potential release of flammable liquid above flash point. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	H/S	3	B	3	[redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. [redacted] 1 high pressure (switch) on the discharge of pump stops respective pump. PSHs are not currently part of calibration system. [redacted] high pressure (transmitter) on the discharge of pump stops respective pump. PITs are not currently part of calibration system. PSH and PIT share common root valve. [redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	[redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 22. Ensure new replacement pumps for [redacted] are equipped with 1) appropriate seal materials for the resulting temperatures of periods of lower than normal flow operation and 2) minimum flow recirculation protection to reduce the likelihood of increased temperature during periods of lower than normal flow operation. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority)	
			E	4	B	4			
			P	4	B	4			
		3. Potential increased pressure in piping from Hotel Pier through UGPH. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		4. Potential delay in resupplying Red Hill. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5			
	14. Fire valve MOV DBB [redacted] closed or sectional MOV DBB [redacted] closed. [redacted])	1. Potential increased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
			H/S	3	D	5			
			E	3	D	5			
			P	1	D	3			

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		2. Potential to deadhead [redacted] Potential increased temperature of fluid up to flash point. Potential seal damage. Potential seal leak. Potential release of flammable liquid above flash point. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	4 3 4 4	B B B B	4 3 4 4	[redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. [redacted] 1 high pressure (switch) on the discharge of pump stops respective pump. PSHs are not currently part of calibration system. [redacted] high pressure (transmitter) on the discharge of pump stops respective pump. PITs are not currently part of calibration system. PSH and PIT share common root valve. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 22. Ensure new replacement pumps for [redacted] are equipped with 1) appropriate seal materials for the resulting temperatures of periods of lower than normal flow operation and 2) minimum flow recirculation protection to reduce the likelihood of increased temperature during periods of lower than normal flow operation. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority)	
		3. Potential increased pressure in piping from Hotel Pier through RHL Tank Gallery. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		4. Potential delay in resupplying Red Hill. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5			
	15. MOV or MOV DBB (skin) tank valves closed. [redacted]	1. Potential increased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to	MR H/S E P	4 3 3 1	D D D D	5 5 5 3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		mission capability or unit readiness.					All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		2. Potential to deadhead [redacted] Potential increased temperature of fluid up to flash point. Potential seal damage. Potential seal leak. Potential release of flammable liquid above flash point. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	4 3 4 4	B B B B	4 3 4 4	[redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. [redacted] 1 high pressure (switch) on the discharge of pump stops respective pump. PSHs are not currently part of calibration system. [redacted] high pressure (transmitter) on the discharge of pump stops respective pump. PITs are not currently part of calibration system. PSH and PIT share common root valve. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 22. Ensure new replacement pumps for [redacted] are equipped with 1) appropriate seal materials for the resulting temperatures of periods of lower than normal flow operation and 2) minimum flow recirculation protection to reduce the likelihood of increased temperature during periods of lower than normal flow operation. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority)	
		3. Potential increased pressure in piping from Hotel Pier through RHL Tank Gallery. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		4. Potential transient surge wave if valve closed while transferring fuel. PHA Team had insufficient information to determine the consequence and likelihood of						23. Perform a hydraulic surge analysis. Consider integrating this recommendation with upcoming API 570 Assessment. (High Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		this cause/consequence pair at the time of the PHA.							
		5. Potential transient surge wave if valve closed while transferring fuel. Potential line movement as result of a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Lower Access Tunnel. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: Transformer, primary disconnects, and MCC switch gear are currently located in electrical room inside Lower Tunnel. Consistent with May 6, 2021 incident and September 29, 2021 near-miss.	MR H/S E P	2 1 1 1	B B B B	2 1 1 1	High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	24. Modify CIR contracts to include restraining pipe between blanked sections when taking tank out of service for maintenance or inspection. (High Priority) 25. Include verification step in Operations Order that piping is restrained before starting any evolution involving transferring liquid from any tank in Red Hill Tank Gallery. (High Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear [redacted] and consider relocation to an area external to tunnel system, similar to [redacted] Electrical Room Relocation Project MILCON P-8006. (High Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority) 32. Evaluate the need for Dresser Couplings in the [redacted] and [redacted] main distribution piping in Red Hill Tank Gallery between TK 114 JP-5 Tank (Red Hill) and TK 116 F-76 Tank (Red Hill), shown on Drawing [redacted] If they can be removed safely, remove the Dresser Couplings. JP-5 Emergent Pipeline Repairs were underway at the time of the PHA and will include eliminating old Dresser Coupling on [redacted] JP-5 piping. This recommendation should be completed prior to returning JP-5 piping to service. (High Priority)	
		6. Potential delay in resupplying Red Hill. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5			
	16. Sectional MOV DBB [redacted] closed. [redacted]	1. Potential increased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to	MR H/S E P	4 3 3 1	D D D D	5 5 5 3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		mission capability or unit readiness.					All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		2. Potential to deadhead [redacted] Potential increased temperature of fluid up to flash point. Potential seal damage. Potential seal leak. Potential release of flammable liquid above flash point. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	B	4	[redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. [redacted] 1 high pressure (switch) on the discharge of pump stops respective pump. PSHs are not currently part of calibration system. [redacted] high pressure (transmitter) on the discharge of pump stops respective pump. PITs are not currently part of calibration system. PSH and PIT share common root valve. TT[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 22. Ensure new replacement pumps for [redacted] are equipped with 1) appropriate seal materials for the resulting temperatures of periods of lower than normal flow operation and 2) minimum flow recirculation protection to reduce the likelihood of increased temperature during periods of lower than normal flow operation. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority)	
			H/S	3	B	3			
			E	4	B	4			
			P	4	B	4			
		3. Potential increased pressure in piping from Hotel Pier through RHL Tank Gallery. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		4. Potential transient surge wave if valve closed while transferring fuel. Potential line movement as result of a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Lower	MR	2	B	2	High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically.	24. Modify CIR contracts to include restraining pipe between blanked sections when taking tank out of service for maintenance or inspection. (High Priority) 25. Include verification step in Operations Order that piping is restrained before starting any evolution involving transferring liquid from any tank in Red Hill Tank Gallery. (High Priority)	
			H/S	1	B	1			
			E	1	B	1			
			P	1	B	1			

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Access Tunnel. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: Transformer, primary disconnects, and MCC switch gear are currently located in electrical room inside Lower Tunnel. Consistent with May 6, 2021 incident and September 29, 2021 near-miss.					Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear [redacted] and consider relocation to an area external to tunnel system, similar to [redacted] Electrical Room Relocation Project MILCON P-8006. (High Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority) 32. Evaluate the need for Dresser Couplings in the [redacted] and [redacted] main distribution piping in Red Hill Tank Gallery between TK 114 JP-5 Tank (Red Hill) and TK 116 F-76 Tank (Red Hill), shown on Drawing [redacted] If they can be removed safely, remove the Dresser Couplings. JP-5 Emergent Pipeline Repairs were underway at the time of the PHA and will include eliminating old Dresser Coupling on [redacted] JP-5 piping. This recommendation should be completed prior to returning JP-5 piping to service. (High Priority)	
		5. Potential delay in resupplying Red Hill TK 111/112/113/114/117/118/120 JP-5 Tank (Red Hill), TK 115/116 F-76 Tank (Red Hill), and TK 119 00S Tank (Red Hill). Potential little or no impact to mission capability or unit readiness.	MR	4	C	5			
1.2. More Flow	1. MOV 216T1/216T2/218T1/218T2/232T1/232T2 open more than desired. [redacted]	1. Potential to operate [redacted] off their curves (at end of curve-overload). Potential motor damage over time. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5			
		2. Potential decreased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to cavitate [redacted] Potential seal damage. Potential seal leak. Potential	MR H/S E P	4 3 4 4	C C C C	5 4 5 5	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. PIT-	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.					[redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve.		
							[redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system.		
							[redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system.		
							TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system.		
							CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.		
		3. Potential reverse flow from Red Hill Tank Gallery to UGPH and Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential increased level in Tank 0221/0222/0223/0224 over time (reverse flow through down pump rotating backwards). Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
			H/S	3	D	5	OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.		
			E	3	D	5	SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]		
			P	1	D	3	LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		4. Potential reverse flow from Red Hill Tank Gallery to UGPH and Tank 0221 F-24 Surge	MR	2	D	4	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer.		PHA Team concluded safeguards are adequate.
			H/S	3	D	5			

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank to ship (reverse flow through down pump rotating backwards). Potential to overfill ship tank. Potential release of ambient flammable liquid to ship and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	E	1	D	3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] High and high high level alarms, and/or high pressure trips on ship tanks/piping.		
			P	1	D	3			
	2. An additional of [redacted] running. [redacted]	1. Potential decreased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to cavitate [redacted] Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	C	5	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	
			H/S	3	C	4			
			E	4	C	5			
			P	4	C	5			
		2. Potential reverse flow from Red Hill Tank Gallery to UGPH and Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential increased level in Tank 0221/0222/0223/0224 over time (reverse flow through down pump rotating backwards). Potential to overfill Tank 0221/0222/0223/0224. Potential release of	MR	4	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. OCV on the discharge of each [redacted] acts as a dual check valve,	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
			H/S	3	D	5			
			E	3	D	5			
			P	1	D	3			

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.					is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		3. Potential reverse flow from Red Hill Tank Gallery to UGPH and Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank to ship (reverse flow through down pump rotating backwards). Potential to overfill ship tank. Potential release of ambient flammable liquid to ship and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 3 1 1	D D D D	4 5 3 3	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] High and high high level alarms, and/or high pressure trips on ship tanks/piping.		PHA Team concluded safeguards are adequate.
1.3. Reverse Flow	1. No new causes identified.								
1.4. Misdirected Flow	1. Any manual block valve [redacted] lineup misaligned in [redacted] to/from Kilo Pier crossover. [redacted]	1. No hazardous consequences identified. Line to/from Kilo Pier is LOTO (operations lock only at the time of the PHA).							
	2. Any MOV valve lineup misaligned in [redacted] to return to same product loop. [redacted]	1. Potential delay in offloading ship. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5			
	3. Strainers lined up in [redacted] At the time of the PHA, both the	1. Potential delay in offloading ship. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5			

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
	strainers and meters are bypassed. Strainers were installed upstream of meters to prevent fouling of metering device.	2. Potential damage to strainers. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5			
	4. Any valve lineup misaligned in [redacted] to [redacted] [redacted]	1. Potential cross-contamination of products. Potential off-spec product. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5			
	5. Any valve lineup misaligned in [redacted] to [redacted] and [redacted]	1. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5			
	6. Any valve lineup misaligned in [redacted] to [redacted] and Tank 301 Intermix Tank. [redacted] (b)(3)(A)	1. Potential increased level in Tank 301 Intermix Tank. Potential to overfill Tank 301. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	3	D	5	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
			H/S	3	D	5	LAH-301 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
			E	3	D	5	LSHH-301 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
			P	2	D	4			
	7. Any valve lineup misaligned in [redacted] to Truck Rack when not loading same product trucks. [redacted]	1. Potential increased pressure in truck loading piping and/or loading arm. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.							
	8. Any valve lineup misaligned in [redacted] to Truck Fill Station (TFS) when loading same product truck. [redacted] (b)(3)(A)	1. Potential increased pressure in piping from Hotel Pier to TFS. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		2. Potential to load truck at abnormally high rate. Potential to exceed design conditions of truck loading flow meter. Potential to overfill tank truck. Potential release of ambient flammable liquid to a concrete contained area. Potential pool fire. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	C	5	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.		PHA Team concluded safeguards are adequate.
			H/S	3	C	4	All loading stations in the Truck Loading Rack are equipped with Overfill Protection Equipment (OPE) including dead-man switch. OPE is included in quarterly recurring maintenance program.		
			P	2	C	3	Emergency stop switch located at loading spot and at safe location away from loading spot.		

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		3. Potential to load truck at abnormally high rate. Potential to exceed design conditions of truck loading flow meter. Potential to overfill tank truck. Potential release of ambient flammable liquid to a concrete contained area. Potential increased level in Load Rack Sump. Potential for Load Rack Sump Pump to introduce ambient flammable liquid to Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank (normal lineup, B1 and B2 are sluiced). Potential to overfill Tank 1301/1302 to containment area. Potential release to soil below containment area (due to leaking containment) and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	4 3 3 2	D D D D	5 5 5 4	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. All loading stations in the Truck Loading Rack are equipped with Overfill Protection Equipment (OPE) including dead-man switch. OPE is included in quarterly recurring maintenance program. Emergency stop switch located at loading spot and at safe location away from loading spot. LAH-B1/B2 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-B1/B2 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority)	
	9. Any valve lineup misaligned in [redacted] to UTF. [redacted]	1. Potential increased pressure in piping to UTF. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		2. Potential increased level in unintended tank in UTF. Potential to exceed high operating limit in unintended tank in UTF. No hazardous consequences identified. Ullage between high operating limit and rated tank capacity is approximately 3,000 barrels (126,000 gal). Largest tank truck loaded at Truck Loading Rack is approximately 8,000 gal.							
	10. Any valve lineup misaligned in [redacted] to UTF and North Road. [redacted]	1. Potential increased pressure in piping to [redacted] PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
	11. Skin valve at Tank 55 JP-5 Tank (Upper Tank Farm) open when offloading JP-5 at Hotel Pier. [redacted]	1. Potential to overpressure and/or overfill Tank 55 JP-5 Tank. Potential release of ambient flammable liquid to a lined containment area. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S P	2 3 2	C C C	3 4 3	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. LAH-55 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Tank 55 is the only JP-5 storage tank in UTF.					All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-55 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
	12. Any valve lineup misaligned in Red Hill Tank Farm (unscheduled fuel movement (UFM)) open to unintended tank only. (b)(3)(A) [redacted] PHA Team concluded any valve lineup misaligned in Red Hill Tank Farm (unscheduled fuel movement (UFM)) open to both intended and unintended tank simultaneously would result in the same consequence over a longer time period.	1. Potential increased level in unintended tank. Potential to overfill unintended tank. Potential release of ambient flammable liquid from Adit 5 (lowest elevation) to Halawa stream and Pearl Harbor waterways. Potential release to soil, groundwater, and/or waterway. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Consequence similar to incident of November 20, 2021.	MR	4	D	5	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.	18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
			H/S	3	D	5	Unscheduled Fuel Movement (UFM) alarm alerts operator to investigate and take action per UFM SOP.	33. Evaluate lighting at the discharge location of the 24" horizontal vent pipe to increase the likelihood of detection by camera in area, and improve lighting if warranted. (Medium Priority)	
			E	1	D	3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.	34. Consider equipping 24" horizontal vent pipe discharge with fuel or oil detection and alarm instrumentation to detect the presence of liquid fuel. (Medium Priority)	
			P	1	D	3	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
							LAH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks 101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks 101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration. [redacted] (b)(3)(A) (b)(3)(A) (b)(3)(A)		
							Inventory of dome is not used in calculation high operating limit. Available ullage in dome is ~1.5 MM gal, resulting in > 4		

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							hours between LSH setpoint and entering vent line. Camera coverage for Adit 5 outside area. Cameras are included in scheduled PM program.		
		2. Potential increased level in unintended tank. Potential to overfill unintended tank through the vent piping (not designed for liquid fill) to the vent piping of grouped tanks (tank 1 and 2 are grouped, tanks 3-16 are grouped, and tanks 17-20 are grouped). Potential cross-contamination of fuels. Potential increased level in multiple unintended tanks. Potential impact to mission capability or unit readiness. PHA Team concluded due to the additional vertical rise from the vent piping to grade at ridgeline (>100 ft.) and the 24" piping to Adit 5 with no block valves in line, release from tank vents S-197, S-213, S-348, or 12" pipe vent adjacent to elevator 73 shaft is not considered credible.	MR	2	D	4	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. Unscheduled Fuel Movement (UFM) alarm alerts operator to investigate and take action per UFM SOP. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. LAH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks 101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks 101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration. [redacted] Inventory of dome is not used in calculation high operating limit. Available ullage in dome is ~1.5 MM gal, resulting in > 4 hours between LSH setpoint and entering vent line. Camera coverage for Adit 5 outside area. Cameras are included in scheduled PM program.	18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 33. Evaluate lighting at the discharge location of the 24" horizontal vent pipe to increase the likelihood of detection by camera in area, and improve lighting if warranted. (Medium Priority) 34. Consider equipping 24" horizontal vent pipe discharge with fuel or oil detection and alarm instrumentation to detect the presence of liquid fuel. (Medium Priority) 35. Evaluate the vent piping between "P traps" in grouped tanks to determine if low point piping could accumulate trapped liquid over time due to condensing and/or undetected overfill; and if credible identify method to remove accumulated liquid if warranted. (Medium Priority) 11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
		3. Potential increased level in unintended tank.	MR	2	D	4	Pipeline animation indicates correct and misdirected flow valve	18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Potential to overfill unintended tank through the vent piping (not designed for liquid fill) to the vent piping of grouped tanks (tank 1 and 2 are grouped, tanks 3-16 are grouped, and tanks 17-20 are grouped). Potential release of ambient flammable liquid through deteriorated vent piping into upper tunnel. Potential personnel hazard (asphyxiation). Potential fire. Potential release from vent to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Clean Inspect Repair (CIR) Project for RHL includes replacing tank vent piping and butterfly valves with SS piping to reduce the likelihood of release of ambient flammable liquid or vapor to Upper Access Tunnel. At the time of the 2022 PHA, three tanks were completed and two more in progress, and three additional tanks are pending award.	H/S E P	1 1 1	D D D	3 3 3	alignments by color-coding. Unscheduled Fuel Movement (UFM) alarm alerts operator to investigate and take action per UFM SOP. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. LAH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks 101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks 101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration. [redacted] (b)(3)(A) (b)(3)(A) (b)(3)(A) Inventory of dome is not used in calculation high operating limit. Available ullage in dome is ~1.5 MM gal, resulting in > 4 hours between LSH setpoint and entering vent line. Camera coverage for Adit 5 outside area. Cameras are included in scheduled PM program.	to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 33. Evaluate lighting at the discharge location of the 24" horizontal vent pipe to increase the likelihood of detection by camera in area, and improve lighting if warranted. (Medium Priority) 5. Consider equipping [redacted] (b)(3)(A) with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 34. Consider equipping 24" horizontal vent pipe discharge with fuel or oil detection and alarm instrumentation to detect the presence of liquid fuel. (Medium Priority) 36. Consider implementing four-gas personnel monitor PPE requirement for personnel working in any tunnels. (Medium Priority) 37. Evaluate use of panic button and man-down feature of intersite radio system. (Medium Priority) 38. Develop a car-seal or lock administrative control system and identify safety-critical manual valves which should be controlled to reduce the likelihood of human error. Valves to consider include but are not limited to 24" butterfly tank vent valves at RHL, manual block valves on the inlet or discharge of relief devices, manual block valves on bleed of body cavity of twin-seal DBB device, key firewater supply and distribution valves. (High Priority) 11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
1.5. High Pressure	1. 24" butterfly vent valve open less than required or closed. [redacted]	1. Potential increased pressure in impacted tank and overhead vent piping upstream of 24" butterfly vent valve in Red Hill Tank Gallery during level increase. Potential loss of containment of ambient flammable hydrocarbon vapors. Potential fire. Potential personnel injury. Potential impact to mission capability or	MR H/S	4 1	D D	5 3	Robust ventilation system, required electricity. Heat activated water deluge in Upper Access Tunnel in Red Hill Tank Gallery, also triggered by fire (IR detectors). Detectors are serviced by outside contractor. Sensors are currently unreliable and have initiated false positives,	5. Consider equipping [redacted] (b)(3)(A) with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 39. Evaluate the reliability of the heat activated water deluge in Upper Access Tunnel in Red Hill Tank Gallery in conjunction with the evaluation of AFFF in Lower Access Tunnel (LAT). Develop	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	L	RR	Safeguards	PHA Recommendation	Comments
		unit readiness.					desensitizing response to alarm.	recommendations for improved reliability. (High Priority)	
								38. Develop a car-seal or lock administrative control system and identify safety-critical manual valves which should be controlled to reduce the likelihood of human error. Valves to consider include but are not limited to 24" butterfly tank vent valves at RHL, manual block valves on the inlet or discharge of relief devices, manual block valves on bleed of body cavity of twin-seal DBB device, key firewater supply and distribution valves. (High Priority)	
		2. Potential decreased pressure in impacted tank and overhead vent piping upstream of 24" butterfly vent valve in Red Hill Tank Gallery during level decrease. Potential reduced pressure in vent piping for impacted tank and other tanks in same manifolded vent piping group when level is decreasing due to the presence of liquid in the manifolded vent piping. Potential loss of containment of ambient flammable hydrocarbon vapors. Potential fire. Potential personnel injury. Potential impact to mission capability or unit readiness.	MR	4	D	5	Robust ventilation system, required electricity.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
			H/S	1	D	3	Heat activated water deluge in Upper Access Tunnel in Red Hill Tank Gallery, also triggered by fire (IR detectors). Detectors are serviced by outside contractor. Sensors are currently unreliable and have initiated false positives, desensitizing response to alarm.	39. Evaluate the reliability of the heat activated water deluge in Upper Access Tunnel in Red Hill Tank Gallery in conjunction with the evaluation of AFFF in Lower Access Tunnel (LAT). Develop recommendations for improved reliability. (High Priority)	
							Low point in manifolded vent piping is periodically checked and drained.	38. Develop a car-seal or lock administrative control system and identify safety-critical manual valves which should be controlled to reduce the likelihood of human error. Valves to consider include but are not limited to 24" butterfly tank vent valves at RHL, manual block valves on the inlet or discharge of relief devices, manual block valves on bleed of body cavity of twin-seal DBB device, key firewater supply and distribution valves. (High Priority)	
								40. Improve the reliability of draining condensed/accumulated liquid in Red Hill Tank Gallery manifolded vent piping. Options to consider include 1) manually checking and draining low point per scheduled interval, and 2) adding a level detection and alarm instrumentation to alert operations to abnormal accumulation of hydrocarbon and/or water. Include all instrumentation in PM program with calibrated testing equipment. (Medium Priority)	
	2. DBB tell-tale closed. PHA Team concluded bleed valves are used for testing integrity of the DB and are normally closed.	1. No hazardous consequences identified.							
	3. Isolated section of above ground, hydrocarbon-filled piping.	1. Potential thermal expansion of trapped liquid. Potential gasket leak. Potential release of small amount of ambient flammable liquid. Potential environmental impact.	E	4	C	5	Most line segments are equipped with thermal relief devices which vent to common manifold to Multi-Product Drain Line, some of which are currently blocked in due to Multi-Product Drain Line leaking. There is currently a project in funded, pre-award stage to add additional thermal relief devices and incorporate in new 1407 Product Recovery Tank (PRT).		
1.6. Low Pressure	1. Thermal contraction at [redacted] or [redacted]	1. Potential slight decreased pressure in piping in [redacted] or [redacted] due to day/night temperature swings. No hazardous consequences identified.							
1.7. High Temperature	1. No causes identified. Note: Due to small variability in ambient temperature, ambient temperature will not be addressed in future nodes.								
	2. Loss of cooling water to [redacted]	1. Potential loss of cooling water to bearings. Potential increased temperature of bearings.							

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
	[redacted]	Potential fire in bearing housing (contains oil). No hazardous consequences identified.							
1.8. Low Temperature	1. No causes identified. Note: Due to small variability in ambient temperature, ambient temperature will not be addressed in future nodes.								
1.9. High Level	1. Higher than normal level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank when offloading to Red Hill. [redacted]	1. Potential increased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
			H/S	3	D	5	LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
			E	3	D	5	LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
			P	1	D	3			
	2. Higher than desired level in intended receiving storage tank. [redacted]	1. Potential decreased unloading rate due to increased head pressure in storage tank. Potential higher than desired unloading time. Operability issue. No hazardous consequences identified.							
	3. Insufficient ullage in intended receiving storage tank. [redacted]	1. Potential increased level in intended tank. Potential to overfill intended tank. Potential release of ambient flammable liquid from Adit 5 (lowest elevation) to Halawa stream and Pearl Harbor waterways. Potential release to soil, groundwater, and/or waterway. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Consequence similar to incident of November 20, 2021.	MR	4	D	5	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
			H/S	3	D	5	LAH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks 101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	33. Evaluate lighting at the discharge location of the 24" horizontal vent pipe to increase the likelihood of detection by camera in area, and improve lighting if warranted. (Medium Priority)	
			E	1	D	3	LSHH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks	34. Consider equipping 24" horizontal vent pipe discharge with fuel or oil detection and alarm instrumentation to detect the presence of liquid fuel. (Medium Priority)	
			P	1	D	3		11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration. (b)(3)(A) (b)(3)(A) (b)(3)(A) [redacted]		
							Inventory of dome is not used in calculation high operating limit. Available ullage in dome is ~1.5 MM gal, resulting in > 4 hours between LSH setpoint and entering vent line.		
							Camera coverage for Adit 5 outside area. Cameras are included in scheduled PM program.		
		2. Potential increased level in intended tank. Potential to overfill intended tank through the vent piping (not designed for liquid fill) to the vent piping of grouped tanks (tank 1 and 2 are grouped, tanks 3-16 are grouped, and tanks 17-20 are grouped). Potential cross-contamination of fuels. Potential increased level in multiple unintended tanks. Potential impact to mission capability or unit readiness. PHA Team concluded due to the additional vertical rise from the vent piping to grade at ridgeline (>100 ft.) and the 24" piping to Adit 5 with no block valves in line, release from tank vents S-197, S-213, S-348, or 12" pipe vent adjacent to elevator 73 shaft is not considered credible.	MR	2	D	4	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
							LAH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks 101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	33. Evaluate lighting at the discharge location of the 24" horizontal vent pipe to increase the likelihood of detection by camera in area, and improve lighting if warranted. (Medium Priority)	
							LSHH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks 101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration. (b)(3)(A) (b)(3)(A) (b)(3)(A) [redacted]	34. Consider equipping 24" horizontal vent pipe discharge with fuel or oil detection and alarm instrumentation to detect the presence of liquid fuel. (Medium Priority)	
							Inventory of dome is not used in calculation high operating limit. Available ullage in dome is ~1.5 MM gal, resulting in > 4	35. Evaluate the vent piping between "P traps" in grouped tanks to determine if low point piping could accumulate trapped liquid over time due to condensing and/or undetected overfill; and if credible identify method to remove accumulated liquid if warranted. (Medium Priority)	
								11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							hours between LSH setpoint and entering vent line. Camera coverage for Adit 5 outside area. Cameras are included in scheduled PM program.		
		3. Potential increased level in intended tank. Potential to overfill intended tank through the vent piping (not designed for liquid fill) to the vent piping of grouped tanks (tank 1 and 2 are grouped, tanks 3-16 are grouped, and tanks 17-20 are grouped). Potential release of ambient flammable liquid through deteriorated vent piping into upper tunnel. Potential personnel hazard (asphyxiation). Potential fire. Potential release from vent to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Clean Inspect Repair (CIR) Project for RHL includes replacing tank vent piping and butterfly valves with SS piping to reduce the likelihood of release of ambient flammable liquid or vapor to Upper Access Tunnel. At the time of the 2022 PHA, three tanks were completed and two more in progress, and three additional tanks are pending award.	MR	2	D	4	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. LAH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks 101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks 101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration. [redacted] Inventory of dome is not used in calculation high operating limit. Available ullage in dome is ~1.5 MM gal, resulting in > 4 hours between LSH setpoint and entering vent line. Camera coverage for Adit 5 outside area. Cameras are included in scheduled PM program.	18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 33. Evaluate lighting at the discharge location of the 24" horizontal vent pipe to increase the likelihood of detection by camera in area, and improve lighting if warranted. (Medium Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 34. Consider equipping 24" horizontal vent pipe discharge with fuel or oil detection and alarm instrumentation to detect the presence of liquid fuel. (Medium Priority) 36. Consider implementing four-gas personnel monitor PPE requirement for personnel working in any tunnels. (Medium Priority) 37. Evaluate use of panic button and man-down feature of intersite radio system. (Medium Priority) 38. Develop a car-seal or lock administrative control system and identify safety-critical manual valves which should be controlled to reduce the likelihood of human error. Valves to consider include but are not limited to 24" butterfly tank vent valves at RHL, manual block valves on the inlet or discharge of relief devices, manual block valves on bleed of body cavity of twin-seal DBB device, key firewater supply and distribution valves. (High Priority) 11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
			H/S	1	D	3			
			E	1	D	3			
			P	1	D	3			
1.10. Low Level	1. No level or lower than normal level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank when offloading to Red Hill. [redacted]	1. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to Tank 1301 Reclaim (B1)	MR	2	C	3	LAL/LALL-0221/0222/0223/0224 low and low low level alarms located on Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, and Tank 0223/0224 F-76 Surge Tank alerts operator to investigate ad take action. [redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. PIT-	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
			H/S	1	C	2			
			E	2	C	3			
			P	1	C	2			

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Tank and Tank 1302 Reclaim (B2) Tank (normal lineup, B1 and B2 are sluiced). Potential to overfill Tank 1301/1302 to containment area. Potential release to soil below containment area (due to leaking containment) and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential overfill to Lower Yard Tunnel (LYT) may accelerate this consequence (abnormal lineup).					[redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LAH-B1/B2 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-B1/B2 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
		2. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient	MR	2	C	3	LAL/LALL-0221/0222/0223/0224 low and low low level alarms located on Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, and Tank 0223/0224 F-76 Surge Tank alerts operator to investigate ad take action. [redacted] 1 low pressure (switch) on the suction of pump stops	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted]	
			H/S	1	C	2			
			E	1	C	2			
			P	1	C	2			

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Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to Adit 1 Sump (abnormal lineup). Potential to overfill Adit 1, Harbor Tunnel, and/or Adit 2 (including french drain systems). Potential release to soil and/or groundwater and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential overfill to Lower Yard Tunnel (LYT) may accelerate this consequence. Potential to overfill to Harbor Tunnel may accelerate this consequence.					respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	Pump (UGPH)) to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
		3. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential to overfill UGPH to Lower Yard Tunnel (LYT) and/or Harbor Tunnel and/or Surge Tank Tunnel.	MR	2	C	3	LAL/LALL-0221/0222/0223/0224 low and low low level alarms located on Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, and Tank 0223/0224 F-76 Surge Tank alerts operator to investigate ad take action. [redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. PIT-	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
			H/S	1	C	2			
			E	1	C	2			
			P	1	C	2			

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Deviation	Cause	Consequence	CAT	Risk Matrix			Safeguards	PHA Recommendation	Comments
				C	L	RR			
		Potential release to soil and/or groundwater below Surge Tank Tunnel (due to leaking tunnel) and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.					[redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
		4. Potential delay in resupplying Red Hill. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5			
1.11. Composition	1. Receipt of off-spec material.	1. Potential off-spec product in storage and/or piping at PRL or PAR. Potential impact to mission capability or unit readiness. With Red Hill in service, the mission capability or unit readiness impact is degraded. With Red Hill out of service, the mission capability or unit readiness impact is significantly degraded.	MR	2	D	4	Material is sampled at point of shipment, prior to offloading, and during offloading using well established and effective administrative procedures. Valving allows segregation of tank if off-spec material is inadvertently offloaded.		
		2. Potential to introduce hazardous component to normal fuel composition (H2S, benzene). Potential personnel injury during normal	H/S	1	B	1	None identified.	41. Add testing for sulfur compounds (or other credible toxic compounds) as part of pre-offloading analysis for fuel receipts at PRL. (Medium Priority)	

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Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		operations on shore or ship.							
		3. Potential to use contaminated fuel in end user equipment (ships, aircraft, etc.). Potential impact to mission capability or unit readiness. Potential personnel injury.	MR H/S	3 1	D D	5 3	Material is sampled at point of shipment, prior to offloading, and during offloading using well established and effective administrative procedures.		PHA Team concluded safeguards are adequate.
1.12. Leak / Rupture	1. Fuel transfer hose leak or rupture.	1. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness 33 CFR Part 154 Coast Guard requires testing hoses to 1.5 x deadhead pressure. PHA Team concluded the highest pressure expected in a marine transfer that is deadheaded is the UTF pump for product F-76 at **219 psig**. This pressure is greater than 1) the gravity head from the highest tank at RHL to the dock, 2) the available deadhead from the YON pumps, 3) deadhead pressure of ship pump, and 4) any single pump in UGPH. However, should two pumps in series ever be considered to be included in an Operations Order, the highest deadhead pressure to be considered is **268 psig**.	MR H/S E P	4 1 2 2	B C B B	4 2 2 2	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Pre-Plan Meeting includes visual inspection of all fuel transfer hoses and hose integrity test witnessed by both PICs prior to initiating any fuel transfer. All hoses are hydrostatically tested to 150 psig annually. Coast Guard verifies hose labeling and record-keeping annually. Hose rating is 200 to 250 psig depending on manufacturer. Hose test pressure per manufacturer is 300 psig. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Operational practice is to start fuel transfer and slowly increase pressure in increments until full flow is established. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority) 13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	
	2. PRVs open or leaking by in UGPH. [redacted] (b)(3)(A)	1. Potential increased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	4 3 3 1	D D D D	5 5 5 3	PRVs in UGPH are bench tested annually. Unscheduled Fuel Movement (UFM) alarm alerts operator to investigate and take action per UFM SOP. LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	38. Develop a car-seal or lock administrative control system and identify safety-critical manual valves which should be controlled to reduce the likelihood of human error. Valves to consider include but are not limited to 24" butterfly tank vent valves at RHL, manual block valves on the inlet or discharge of relief devices, manual block valves on bleed of body cavity of twin-seal DBB device, key firewater supply and distribution valves. (High Priority)	PHA Team concluded safeguards are adequate.
	3. PRVs open or leaking by on pipeline. Thermal relief devices vent to common manifold to Multi-Product Drain Line, some of which are currently blocked in due to Multi-Product Drain Line leaking.	1. Potential to relieve to secondary containment at Hotel Pier. Potential pool fire. Potential personnel injury. Potential impact to mission capability or unit readiness. There is currently a project in funded, pre-award stage to add additional thermal relief devices and incorporate in new 1407 Product Recovery Tank (PRT).	MR H/S	3 3	D D	5 5	PRVs at Hotel Pier are bench tested annually. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
		2. Potential for Hotel Pier Sump Pump to	MR	4	D	5	LSH-801 high level (switch) in Hotel Pier (HP) Sump starts	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with	

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Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		introduce ambient flammable liquid to Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank (normal lineup, B1 and B2 are sluiced). Potential to overfill Tank 1301/1302 to containment area. Potential release to soil below containment area (due to leaking containment) and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	H/S E P	3 3 2	D D D	5 5 4	both HP1 and HP2 Hotel Pier Sump Pumps and alerts operator to investigate source of level and intervene. LSH-801 is not currently part of a PM program. Hotel Pier (HP) Sump level switch high is on UPS backup power, and is operated by diesel-driven emergency generators at Building 1757. Pumps are PM'ed by RMMR at least quarterly. Emergency generators autostart and are tested periodically LAH-B1/B2 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-B1/B2 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority)	
1.13. Start-up / Shutdown	1. No new causes identified.								
1.14. Maintenance / Inspection	1. LP drain left open after slacking/packing/maintenance. [redacted]	1. Potential to introduce ambient flammable liquid to Lower Access Tunnel. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: Transformer, primary disconnects, and MCC switch gear are currently located in electrical room inside Lower Tunnel. Consistent with May 6, 2021 incident and September 29, 2021 near-miss.	MR H/S E P	2 1 1 1	B B B B	2 1 1 1	Return to Service (RTS) Operations Order requires walking the pipeline and monitoring presence. Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. LSH-0195/0197/0198 high level (switch) in FOR Trench alerts operator to investigate cause of high level and take action, including pumping to safe location. All high level switches are on UPS backup power with 4 hour duration. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear [redacted] and consider relocation to an area external to tunnel system, similar to [redacted] Electrical Room Relocation Project MILCON P-8006. (High Priority) 1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	

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Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							included in scheduled PM program.		
		2. Potential to introduce ambient flammable liquid to Zone 7 Sump and/or Main Sump (fuel sumps). Potential rapid release of very large quantity of ambient flammable liquid to TK 311 Slop Tank. Potential increased level in TK 311. Potential to overfill TK 311. Potential increased level in secondary containment (> 6ft deep, one set of stairs in corner, vertical side walls). Potential pool fire. Potential release to soil, groundwater and/or Halawa stream. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: Pumps at Main Sump have a combined capacity of ~300 gpm. TK 311 is not equipped with pumps to remove level. A vacuum truck is brought in when needed to remove level. TK 311 is in an isolated area not near through traffic roads. Inside the containment there are no sources of ignition. Isolation valve at the tank can be closed outside of containment area. At the time of the PHA the area adjacent to TK 311 is in use for groundwater treatment. Flow from Groundwater Sump Pump inside AFFF Sump (typical of five) may accelerate this consequence.	MR	4	D	5	Return to Service (RTS) Operations Order requires walking the pipeline and monitoring presence.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
			H/S	1	D	3	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021).	28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority)	
			E	1	D	3	PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program.	29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority)	
			P	1	D	3	High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically.	42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority)	
							Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	43. Install a second and independent high level indication and alarm on TK 311 Slop Tank to reduce the likelihood of overfilling TK 311 unknowingly. (Medium Priority)	
							Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	44. Review current practices and operability of TK 311 Slop Tank with groundwater treatment equipment and personnel adjacent to TK 311 to evaluate the interaction of the two operations and modify practices if warranted. (Low Priority)	
							LSH-100 high level (switch) in Main Sump starts Main Sump Pump A and alerts operator to investigate source of level and intervene. LSHH-100 high high level (switch) Main Sump starts Main Sump Pump A and Main Sump Pump B and alerts operator to investigate source of level and intervene. Both LSH-100 and LSHH-100 share a sensor. They are part of a PM program but not using certified or calibrated test equipment. Main Sump level switches high and low are not on UPS backup power, but are operated by (b)(3)(A) [redacted] (b)(3)(A)	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority) 1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	
							LSH-0197 high level (switch) in Zone 7 area alerts operator to investigate cause of presence of liquid level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-311 high level alarm on TK 311 Slop Tank alerts operator to investigate source of level and intervene. LSHH-311 is calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		3. Potential to introduce ambient flammable liquid	MR	4	B	4	Return to Service (RTS) Operations Order requires walking the	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional	

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Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		to AFFF Sump (typical of five). Potential to pump ambient flammable liquid to AFFF Retention Tank. Potential to overfill AFFF Retention Tank. Potential to introduce ambient flammable liquid to secondary containment (sloped sides). Potential ambient flammable liquid carryover to GAC and Halawa stream. Potential pool fire. Potential release to soil, groundwater and/or Halawa stream. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: AFFF System Project was completed in 2019. The AFFF Retention Tank has a capacity of 153,000 gal. and was sized to hold 20 minutes of fire fighting foam and water plus 80,000 gal. of fuel from a leak. The AFFF system is currently made of PVC and CS. There is currently only local level indication in the five AFFF Sumps. There is currently no level indication on the AFFF Retention Tank. At the time of the PHA, the motors to the pumps from AFFF Sumps were LOTO to reduce the likelihood of autostart. Currently, the AFFF System is contractually maintained by a company responsible for multiple JBPHH entities. Consequence similar to May 6, 2021 incident and November 20, 2021 incident.	H/S E P	2 1 1	B B B	2 1 1	pipeline and monitoring presence. Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program. Each of the five AFFF Sumps contain four pumps intended for staggered start (local level switch) to pump to AFFF Retention Tank. The AFFF Sump pumps were recently added to a PM schedule.	valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 45. Ensure run status indication on all pumps inside all AFFF Sumps (20 pumps) is integrated with the AFHE SCADA to alert Control Room Operator (CRO) to potential release of fuel and/or AFFF. (High Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and [redacted] (b)(3)(A) Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 47. Evaluate the design of the 14" AFFF discharge line piping on the discharge of 20 AFFF Sumps pumps as part of the current project to upgrade PVC to CS. The PHA Team is concerned about 1) the volume flow and separately, 2) line slope or configuration to trap liquid in retention line, and 3) lack of damage control isolation in long-run of piping. (High Priority) 48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High Priority) 49. Train all affected personnel on the design, intent, and operation of the AFFF System, including refresher training. (High Priority) 50. Consider equipping AFFF Retention Tank with reliable level indication and level alarm to alert Control Room Operator (CRO) to presence of level in AFFF Retention Tank. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority) 1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	
		4. Potential to introduce ambient flammable liquid to Water Shaft, Adit 3 Ground Water Sump and/or Septic Sump. Potential personnel hazard (asphyxiation). Potential fire/explosion.	MR H/S E	3 1 1	B B B	3 1 1	Return to Service (RTS) Operations Order requires walking the pipeline and monitoring presence. Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021).	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority)	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Potential release to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Consistent with May 6, 2021 incident and November 20, 2021 incident.	P	1	B	1	PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 51. Consider designing a system to separate oil and water to reduce the likelihood of discharging flammable liquid to environment from Adit 3 Groundwater Sump. (Medium Priority) 52. Provide means to remove contamination from water supply. (High Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority) 1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	
		5. Potential to introduce ambient flammable liquid to Harbor Tunnel. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil, groundwater, and/or Pearl Harbor waterways. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	3	B	3	Return to Service (RTS) Operations Order requires walking the pipeline and monitoring presence. Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
			H/S	1	B	1			
			E	1	B	1			
			P	1	B	1			

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically.	28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority)	
							Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority)	
								21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority)	
								46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority)	
								42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority)	
								53. Evaluate an emergency breathing air supply for Harbor Tunnel due to its long length, limited egress, and reduced ventilation. (Medium Priority)	
								31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
								1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	
		6. Potential increased level in UGPH. Potential fire and/or explosion. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	B	2	Return to Service (RTS) Operations Order requires walking the pipeline and monitoring presence.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
			H/S	1	B	1	High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically.	5. Consider equipping [redacted] (b)(3)(A) with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
			E	2	B	2		28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority)	
			P	1	B	1		29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority)	
								18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
								31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
								1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
								materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	
		7. Potential increased level in UGPH Main Sump. Potential to overfill UGPH to Lower Yard Tunnel (LYT) and/or Harbor Tunnel and/or Surge Tank Tunnel. Potential to overfill tunnels and/or sumps to surrounding area and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 1 2 1	B B B B	2 1 2 1	Return to Service (RTS) Operations Order requires walking the pipeline and monitoring presence. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	
		8. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank (normal lineup, B1 and B2 are sluiced). Potential to overfill Tank 1301/1302 to containment area. Potential release to soil below containment area (due to leaking containment) and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential overfill to Lower Yard Tunnel (LYT) may accelerate this consequence (abnormal lineup).	MR H/S E P	2 1 2 1	C C C C	3 2 3 2	Return to Service (RTS) Operations Order requires walking the pipeline and monitoring presence. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. LAH-B1/B2 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority) 19. Ensure OCVs on the discharge of each [redacted]	

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
								[redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
								1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	
		9. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to Adit 1 Sump (abnormal lineup). Potential to overfill Adit 1, Harbor Tunnel, and/or Adit 2 (including french drain systems). Potential release to soil and/or groundwater and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential overfill to Lower Yard Tunnel (LYT) may accelerate this consequence. Potential to overfill to Harbor Tunnel may accelerate this consequence.	MR	2	C	3	Return to Service (RTS) Operations Order requires walking the pipeline and monitoring presence.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
			H/S	1	C	2	High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
			E	1	C	2	LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority)	
			P	1	C	2		29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority)	
								18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
								21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority)	
								19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
								1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	
		10. Potential increased level in UGPH Main Sump. Potential to overfill UGPH to Lower Yard Tunnel (LYT) and/or Harbor Tunnel and/or Surge Tank Tunnel. Potential release to soil and/or groundwater below Surge Tank Tunnel (due to leaking tunnel) and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	C	3	Return to Service (RTS) Operations Order requires walking the pipeline and monitoring presence.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
			H/S	1	C	2	High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
			E	1	C	2	LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including	28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority)	
			P	1	C	2			

Node: 1. Routine Operations: Supplying Red Hill Storage from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	L	RR	Safeguards	PHA Recommendation	Comments
							pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority) 1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	
1.15. Corrosion / Erosion	1. External corrosion on piping. Since a full structural integrity was in progress at the time of the PHA, Team did not develop this cause further.								

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted]
Components: Tank 46/53 F-24 Tank (Upper Tank Farm); Tank 47/48/54 F-76 Tank (Upper Tank Farm); Tank 55 JP-5 Tank (Upper Tank Farm)
Design Intention/Parameters: Hotel Pier is currently [redacted] Multiple piping risers with [redacted] ball valves allow vessels to be connected to the fuel system through non-collapsible hoses. [redacted]

The UTF is the second bulk storage facility located at Pearl Harbor. The tank farm consists of six vertical 150,000 Bbl atmospheric storage tanks (ASTs). F-24, JP-5, and F-76 are stored at the UTF. Tank 55 is [redacted]

There are also defuel and dirty ballast water/waste oil lines associated with Hotel Pier that are not currently in service.
Operating Conditions: 1. [redacted]; 2. Pressure: 0 to 125 psi; 3. Temperature: 60 to 80°F

Deviation	Cause	Consequence	CAT	Risk Matrix C	L	RR	Safeguards	PHA Recommendation	Comments
2.1. No / Less Flow	1. Ship pump not running. (Outside of Node)	1. Potential delay in offloading ship. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.		
		2. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential line transient surge in piping when flow is re-established. Potential gasket leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	3 3 4 2	B B B B	3 3 4 2	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders.	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11). 2. Ensure the PITs located [redacted] are in a scheduled PM system using certified and calibrated test equipment. The calibration should meet the requirements of OPNAV Instruction 3960.16B. (High Priority)	

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							Some flows are measured through meter skids during discharge and alarm on deviation from source to destination. Meters are calibrated biannually. Operator response to alarm is not currently part of Operations Orders.	3. Consider installing local ESD on refueling piers and docks at PRL Ensure ESD actions are consistent with Coast Guard requirements and do not create additional hazards. (Medium Priority)	
							Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump.	4. If additional safeguards are warranted, design and install automation to safely shutdown refueling piers and docks at PRL in event of emergency or loss of containment, including isolation of sectional valves to minimize quantity of loss of containment. (High Priority)	
							Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
		3. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential to damage seals in Dresser Coupling. Potential loss of containment when flow is re-established. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	C	3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
			H/S	1	C	2	PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority)	
			E	2	C	3	Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump.	8. Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around pumps installed in UGPH and Red Hill Tank Gallery. Consider modifying design if manufacturer has alternate sealing system and Dresser Couplings remain part of design. (High Priority)	
			P	1	C	2	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	9. Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling. (High Priority)	
		4. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 55 JP-5 Tank (Upper Tank Farm) to atmosphere through open vent. No hazardous consequences identified.							
		5. Potential sagging of pipeline between Hotel Pier and UTF. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 46/53 F-24 Tank (Upper Tank Farm) or Tank 47/48/54 F-76 Tank (Upper Tank Farm) to atmosphere through open vent. No hazardous consequences identified.							
	2. Pier riser station manual valve closed. [redacted]	1. Potential delay in offloading ship. Potential little or no impact to mission capability or unit	MR	4	C	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and		

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		readiness.					pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.		
		2. Potential to deadhead ship offloading pumps. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.					Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	
		3. Potential increased pressure in piping from Hotel Pier. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority) 14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		4. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential line transient surge in piping when flow is re-established. Potential gasket leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	3 3 4 2	B B B B	3 3 4 2	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders. Some flows are measured through meter skids during discharge and alarm on deviation from source to destination. Meters are calibrated biannually. Operator response to alarm is not currently part of Operations Orders. Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11). 2. Ensure the PITs located [redacted] are in a scheduled PM system using certified and calibrated test equipment. The calibration should meet the requirements of OPNAV Instruction 3960.16B. (High Priority) 3. Consider installing local ESD on refueling piers and docks at PRL Ensure ESD actions are consistent with Coast Guard requirements and do not create additional hazards. (Medium Priority) 4. If additional safeguards are warranted, design and install automation to safely shutdown refueling piers and docks at PRL in event of emergency or loss of containment, including isolation of sectional valves to minimize quantity of loss of containment. (High Priority)	
		5. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential to damage seals in Dresser Coupling. Potential loss of containment when flow is re-established. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 1 2 1	C C C C	3 2 3 2	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders. Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 8. Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around pumps installed in UGPH and Red Hill Tank Gallery. Consider modifying design if manufacturer has alternate sealing system and Dresser Couplings remain part of design. (High Priority)	

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	9. Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling. (High Priority)	
		6. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 55 JP-5 Tank (Upper Tank Farm) to atmosphere through open vent. No hazardous consequences identified.							
		7. Potential sagging of pipeline between Hotel Pier and UTF. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 46/53 F-24 Tank (Upper Tank Farm) or Tank 47/48/54 F-76 Tank (Upper Tank Farm) to atmosphere through open vent. No hazardous consequences identified.							
	3. MOV pier sectional valve closed. ([redacted] At the time of the 2022 PHA, MOV pier sectional valves [redacted]) in F-76 Marine Diesel piping were removed and replaced with a spool.	1. Potential delay in offloading ship. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.		
		2. Potential to deadhead ship offloading pumps. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.					Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	
		3. Potential increased pressure in fuel transfer hose. Potential hose rupture or gasket failure. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness 33 CFR Part 154 Coast Guard requires testing hoses to 1.5 x deadhead pressure. PHA Team concluded the highest pressure expected in a marine transfer that is deadheaded is the UTF pump for product F-76 at **219 psig**. This pressure is greater than 1) the gravity head from the highest tank at RHL to the dock, 2) the available deadhead from the	MR H/S E P	4 1 2 2	B C B B	4 2 2 2	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Pre-Plan Meeting includes visual inspection of all fuel transfer hoses and hose integrity test witnessed by both PICs prior to initiating any fuel transfer. All hoses are hydrostatically tested to 150 psig annually. Coast Guard verifies hose labeling and record-keeping annually. Hose rating is 200 to 250 psig depending on manufacturer. Hose test pressure per manufacturer is 300 psig. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority) 13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		YON pumps, 3) deadhead pressure of ship pump, and 4) any single pump in UGPH. However, should two pumps in series ever be considered to be included in an Operations Order, the highest deadhead pressure to be considered is **268 psig**.					Operational practice is to start fuel transfer and slowly increase pressure in increments until full flow is established. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Ship should have safeguards for their pump.		
		4. Potential increased pressure in piping from Hotel Pier. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority) 14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		5. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential line transient surge in piping when flow is re-established. Potential gasket leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	3 3 4 2	B B B B	3 3 4 2	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders. Some flows are measured through meter skids during discharge and alarm on deviation from source to destination. Meters are calibrated biannually. Operator response to alarm is not currently part of Operations Orders. Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11). 2. Ensure the PITs located [redacted] are in a scheduled PM system using certified and calibrated test equipment. The calibration should meet the requirements of OPNAV Instruction 3960.16B. (High Priority) 3. Consider installing local ESD on refueling piers and docks at PRL Ensure ESD actions are consistent with Coast Guard requirements and do not create additional hazards. (Medium Priority) 4. If additional safeguards are warranted, design and install automation to safely shutdown refueling piers and docks at PRL in event of emergency or loss of containment, including isolation of sectional valves to minimize quantity of loss of containment. (High Priority)	
		6. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential to damage seals in Dresser Coupling. Potential loss of containment when flow is re-established. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 1 2 1	C C C C	3 2 3 2	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders. Operating practice if aware of vacuum in piping would to be to	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 8. Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around pumps installed in UGPH and Red Hill Tank Gallery. Consider modifying design if manufacturer has alternate sealing system and Dresser Couplings remain part of design. (High Priority)	

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: (b)(3)(A) [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							re-pack the line before restarting the pump. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	9. Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling. (High Priority)	
		7. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 55 JP-5 Tank (Upper Tank Farm) to atmosphere through open vent. No hazardous consequences identified.							
		8. Potential sagging of pipeline between Hotel Pier and UTF. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 46/53 F-24 Tank (Upper Tank Farm) or Tank 47/48/54 F-76 Tank (Upper Tank Farm) to atmosphere through open vent. No hazardous consequences identified.							
	4. MOV in (b)(3)(A) [redacted] closed. ((b)(3)(A) [redacted]	1. Potential delay in offloading ship. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.		
		2. Potential to deadhead ship offloading pumps. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.					Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	
		3. Potential increased pressure in fuel transfer hose. Potential hose rupture or gasket failure. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness 33 CFR Part 154 Coast Guard requires testing hoses to 1.5 x deadhead pressure. PHA Team concluded the highest pressure expected in a marine transfer that is deadheaded is the UTF pump for product F-76 at 219 psig. This pressure is greater than 1)	MR H/S E P	4 1 2 2	B C B B	4 2 2 2	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Pre-Plan Meeting includes visual inspection of all fuel transfer hoses and hose integrity test witnessed by both PICs prior to initiating any fuel transfer. All hoses are hydrostatically tested to 150 psig annually. Coast Guard verifies hose labeling and record-keeping annually. Hose rating is 200 to 250 psig depending on manufacturer. Hose test pressure per manufacturer is 300 psig. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority) 13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		the gravity head from the highest tank at RHL to the dock, 2) the available deadhead from the YON pumps, 3) deadhead pressure of ship pump, and 4) any single pump in UGPH. However, should two pumps in series ever be considered to be included in an Operations Order, the highest deadhead pressure to be considered is **268 psig**.					and Vessel PIC to include confirmation of flow. Operational practice is to start fuel transfer and slowly increase pressure in increments until full flow is established. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Ship should have safeguards for their pump.		
		4. Potential increased pressure in piping from Hotel Pier. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority) 14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		5. Potential increased pressure in piping from Hotel Pier to [redacted] PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.							
		6. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential line transient surge in piping when flow is re-established. Potential gasket leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	3 3 4 2	B B B B	3 3 4 2	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders. Some flows are measured through meter skids during discharge and alarm on deviation from source to destination. Meters are calibrated biannually. Operator response to alarm is not currently part of Operations Orders. Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11). 2. Ensure the PITs located [redacted] are in a scheduled PM system using certified and calibrated test equipment. The calibration should meet the requirements of OPNAV Instruction 3960.16B. (High Priority) 3. Consider installing local ESD on refueling piers and docks at PRL Ensure ESD actions are consistent with Coast Guard requirements and do not create additional hazards. (Medium Priority) 4. If additional safeguards are warranted, design and install automation to safely shutdown refueling piers and docks at PRL in event of emergency or loss of containment, including isolation of sectional valves to minimize quantity of loss of containment. (High Priority)	
		7. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and	MR H/S	2 1	C C	3 2	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD	

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		UGPH. Potential to damage seals in Dresser Coupling. Potential loss of containment when flow is re-established. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	E	2	C	3	agreed upon by terminal PIC and vessel PIC.	and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
			P	1	C	2	PIT located [redacted] (b)(3)(A) (b)(3)(A) (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority)	
							Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump.	8. Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around pumps installed in UGPH and Red Hill Tank Gallery. Consider modifying design if manufacturer has alternate sealing system and Dresser Couplings remain part of design. (High Priority)	
							Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	9. Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling. (High Priority)	
		8. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 55 JP-5 Tank (Upper Tank Farm) to atmosphere through open vent. No hazardous consequences identified.							
		9. Potential sagging of pipeline between Hotel Pier and UTF. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 46/53 F-24 Tank (Upper Tank Farm) or Tank 47/48/54 F-76 Tank (Upper Tank Farm) to atmosphere through open vent. No hazardous consequences identified.							
	5. MOV in [redacted] closed. [redacted]	1. Potential delay in offloading ship. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.		
		2. Potential to deadhead ship offloading pumps. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.					Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	
		3. Potential increased pressure in fuel transfer hose. Potential hose rupture or gasket failure. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to	MR	4	B	4	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	
			H/S	1	C	2	Pre-Plan Meeting includes visual inspection of all fuel transfer hoses and hose integrity test witnessed by both PICs prior to initiating any fuel transfer.	13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the	
			E	2	B	2			
			P	2	B	2			

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		mission capability or unit readiness 33 CFR Part 154 Coast Guard requires testing hoses to 1.5 x deadhead pressure. PHA Team concluded the highest pressure expected in a marine transfer that is deadheaded is the UTF pump for product F-76 at **219 psig**. This pressure is greater than 1) the gravity head from the highest tank at RHL to the dock, 2) the available deadhead from the YON pumps, 3) deadhead pressure of ship pump, and 4) any single pump in UGPH. However, should two pumps in series ever be considered to be included in an Operations Order, the highest deadhead pressure to be considered is **268 psig**.					All hoses are hydrostatically tested to 150 psig annually. Coast Guard verifies hose labeling and record-keeping annually. Hose rating is 200 to 250 psig depending on manufacturer. Hose test pressure per manufacturer is 300 psig. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Operational practice is to start fuel transfer and slowly increase pressure in increments until full flow is established. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Ship should have safeguards for their pump.	significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	
		4. Potential increased pressure in piping from Hotel Pier. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority) 14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		5. Potential increased pressure in piping from Hotel Pier to [redacted] (b)(3)(A) PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.							
		6. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential line transient surge in piping when flow is re-established. Potential gasket leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	3 3 4 2	B B B B	3 3 4 2	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. PIT located [redacted] (b)(3)(A) (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders. Some flows are measured through meter skids during discharge and alarm on deviation from source to destination. Meters are calibrated biannually. Operator response to alarm is not currently part of Operations Orders. Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump.	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11). 2. Ensure the PITs located [redacted] (b)(3)(A) are in a scheduled PM system using certified and calibrated test equipment. The calibration should meet the requirements of OPNAV Instruction 3960.16B. (High Priority) 3. Consider installing local ESD on refueling piers and docks at PRL Ensure ESD actions are consistent with Coast Guard requirements and do not create additional hazards. (Medium Priority) 4. If additional safeguards are warranted, design and install automation to safely shutdown refueling piers and docks at PRL in event of emergency or loss of containment, including isolation of sectional valves to minimize quantity of loss of containment. (High Priority)	

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
		7. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential to damage seals in Dresser Coupling. Potential loss of containment when flow is re-established. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	C	3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
			H/S	1	C	2			
			E	2	C	3	PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority)	
			P	1	C	2		8. Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around pumps installed in UGPH and Red Hill Tank Gallery. Consider modifying design if manufacturer has alternate sealing system and Dresser Couplings remain part of design. (High Priority)	
							Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump.	9. Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling. (High Priority)	
							Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
		8. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 55 JP-5 Tank (Upper Tank Farm) to atmosphere through open vent. No hazardous consequences identified.							
		9. Potential sagging of pipeline between Hotel Pier and UTF. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 46/53 F-24 Tank (Upper Tank Farm) or Tank 47/48/54 F-76 Tank (Upper Tank Farm) to atmosphere through open vent. No hazardous consequences identified.							
	6. Any manual block valve or MOV in line sequence thru [redacted] in route to UTF closed [redacted]	1. Potential delay in offloading ship. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.		
		2. Potential to deadhead ship offloading pumps. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the					Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	

MARKING REMOVED

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		PHA.							
		3. Potential increased pressure in fuel transfer hose. Potential hose rupture or gasket failure. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness 33 CFR Part 154 Coast Guard requires testing hoses to 1.5 x deadhead pressure. PHA Team concluded the highest pressure expected in a marine transfer that is deadheaded is the UTF pump for product F-76 at **219 psig**. This pressure is greater than 1) the gravity head from the highest tank at RHL to the dock, 2) the available deadhead from the YON pumps, 3) deadhead pressure of ship pump, and 4) any single pump in UGPH. However, should two pumps in series ever be considered to be included in an Operations Order, the highest deadhead pressure to be considered is **268 psig**.	MR	4	B	4	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	
			H/S	1	C	2	Pre-Plan Meeting includes visual inspection of all fuel transfer hoses and hose integrity test witnessed by both PICs prior to initiating any fuel transfer.	13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	
			E	2	B	2	All hoses are hydrostatically tested to 150 psig annually. Coast Guard verifies hose labeling and record-keeping annually.		
			P	2	B	2	Hose rating is 200 to 250 psig depending on manufacturer. Hose test pressure per manufacturer is 300 psig.		
							DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow.		
							Operational practice is to start fuel transfer and slowly increase pressure in increments until full flow is established.		
							Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
							Ship should have safeguards for their pump.		
		4. Potential increased pressure in piping from Hotel Pier. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	
								14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		5. Potential increased pressure in piping from Hotel Pier to [redacted] (b)(3)(A) PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.							
		6. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential line transient surge in piping when flow is re-established. Potential gasket leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	3	B	3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	
			H/S	3	B	3	PIT located [redacted] (b)(3)(A) (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not	2. Ensure the PITs located [redacted] (b)(3)(A) are in a scheduled PM system using certified and calibrated test equipment. The calibration should meet the requirements of	
			E	4	B	4			
			P	2	B	2			

MARKING REMOVED

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							currently part of Operations Orders.	OPNAV Instruction 3960.16B. (High Priority)	
							Some flows are measured through meter skids during discharge and alarm on deviation from source to destination. Meters are calibrated biannually. Operator response to alarm is not currently part of Operations Orders.	3. Consider installing local ESD on refueling piers and docks at PRL Ensure ESD actions are consistent with Coast Guard requirements and do not create additional hazards. (Medium Priority)	
							Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump.	4. If additional safeguards are warranted, design and install automation to safely shutdown refueling piers and docks at PRL in event of emergency or loss of containment, including isolation of sectional valves to minimize quantity of loss of containment. (High Priority)	
							Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
		7. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential to damage seals in Dresser Coupling. Potential loss of containment when flow is re-established. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	C	3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
			H/S	1	C	2			
			E	2	C	3			
			P	1	C	2	PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority)	
								8. Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around pumps installed in UGPH and Red Hill Tank Gallery. Consider modifying design if manufacturer has alternate sealing system and Dresser Couplings remain part of design. (High Priority)	
							Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump.	9. Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling. (High Priority)	
							Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
		8. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 55 JP-5 Tank (Upper Tank Farm) to atmosphere through open vent. No hazardous consequences identified.							
		9. Potential sagging of pipeline between Hotel Pier and UTF. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 46/53 F-24 Tank (Upper Tank Farm) or Tank 47/48/54 F-76 Tank (Upper Tank Farm) to atmosphere through open vent. No hazardous consequences identified.							

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix			Safeguards	PHA Recommendation	Comments
				C	L	RR			
		10. Potential to pack JP-5 line from surge tank piping manifold to Tank 55 JP-5 Tank (Upper Tank Farm). No hazardous consequences identified.							
		11. Potential increased pressure in piping to [redacted] (b)(3)(A) PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
	7. Any UTF Tank Skin valve closed. [redacted] (b)(3)(A)	1. Potential delay in offloading ship. Potential little or no impact to mission capability or unit readiness.	MR	4	C	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.		
		2. Potential to deadhead ship offloading pumps. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.					Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	
		3. Potential increased pressure in fuel transfer hose. Potential hose rupture or gasket failure. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness 33 CFR Part 154 Coast Guard requires testing hoses to 1.5 x deadhead pressure. PHA Team concluded the highest pressure expected in a marine transfer that is deadheaded is the UTF pump for product F-76 at **219 psig**. This pressure is greater than 1) the gravity head from the highest tank at RHL to the dock, 2) the available deadhead from the YON pumps, 3) deadhead pressure of ship pump, and 4) any single pump in UGPH. However, should two pumps in series ever be considered to be included in an Operations Order, the highest deadhead pressure to be considered is **268 psig**.	MR H/S E P	4 1 2 2	B C B B	4 2 2 2	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Pre-Plan Meeting includes visual inspection of all fuel transfer hoses and hose integrity test witnessed by both PICs prior to initiating any fuel transfer. All hoses are hydrostatically tested to 150 psig annually. Coast Guard verifies hose labeling and record-keeping annually. Hose rating is 200 to 250 psig depending on manufacturer. Hose test pressure per manufacturer is 300 psig. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Operational practice is to start fuel transfer and slowly increase pressure in increments until full flow is established. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority) 13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	
		4. Potential increased pressure in piping from Hotel Pier. PHA Team had insufficient information to						12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		5. Potential increased pressure in piping from Hotel Pier to [redacted] PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.							
		6. Potential increased pressure in piping to and/or in UTF. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.							
		7. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential line transient surge in piping when flow is re-established. Potential gasket leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	3	B	3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	
			H/S	3	B	3			
			E	4	B	4			
			P	2	B	2	PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders.	2. Ensure the PITs located [redacted] are in a scheduled PM system using certified and calibrated test equipment. The calibration should meet the requirements of OPNAV Instruction 3960.16B. (High Priority)	
							Some flows are measured through meter skids during discharge and alarm on deviation from source to destination. Meters are calibrated biannually. Operator response to alarm is not currently part of Operations Orders.	3. Consider installing local ESD on refueling piers and docks at PRL Ensure ESD actions are consistent with Coast Guard requirements and do not create additional hazards. (Medium Priority)	
							Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump.	4. If additional safeguards are warranted, design and install automation to safely shutdown refueling piers and docks at PRL in event of emergency or loss of containment, including isolation of sectional valves to minimize quantity of loss of containment. (High Priority)	
							Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
		8. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential to damage seals in Dresser Coupling. Potential loss of containment when flow is re-established. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	C	3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
			H/S	1	C	2			
			E	2	C	3			
			P	1	C	2	PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority)	
								8. Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around pumps installed in UGPH and Red Hill Tank Gallery. Consider modifying design if manufacturer has	

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	alternate sealing system and Dresser Couplings remain part of design. (High Priority) 9. Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling. (High Priority)	
		9. Potential sagging of pipeline between Hotel Pier and UGPH (JP-5 only). Potential to draw vacuum in piping between Hotel Pier and UGPH. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 55 JP-5 Tank (Upper Tank Farm) to atmosphere through open vent. No hazardous consequences identified.							
		10. Potential sagging of pipeline between Hotel Pier and UTF. Potential air ingress. Potential for flammable mixture in piping. Potential for flammable mixture to move downstream when flow is re-established. Potential venting from Tank 46/53 F-24 Tank (Upper Tank Farm) or Tank 47/48/54 F-76 Tank (Upper Tank Farm) to atmosphere through open vent. No hazardous consequences identified.							
		11. Potential to pack JP-5 line from surge tank piping manifold to Tank 55 JP-5 Tank (Upper Tank Farm). No hazardous consequences identified.							
		12. Potential increased pressure in piping to [redacted] (b)(3)(A) PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		13. Potential increased pressure in piping to and/or in UTF. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
2.2. More Flow	1. No causes identified.								
2.3. Reverse Flow	1. No new causes identified.								
2.4. Misdirected Flow	1. Any manual block valve misaligned and Tank Skin valve open in unintended tank in UTF.	1. Potential to overpressure and/or overfill unintended Tank 46/53 F-24 Tank (Upper Tank Farm). Potential release of ambient flammable	MR H/S	2 3	C C	3 4	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
	[redacted] (b)(3)(A) PHA Team concluded this is possible only with F-24 and F-76, as they have multiple tanks storing same product in UTF.	liquid to a lined containment area. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	P	2	C	3	LAH-46/53 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-46/53 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		2. Potential to overpressure and/or overfill unintended Tank 47/48/54 F-76 Tanks (Upper Tank Farm). Potential release of ambient flammable liquid to a lined containment area. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	C	3	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. LAH-47/48/54 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-47/48/54 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.
			H/S	3	C	4			
			P	2	C	3			
2.5. High Pressure	1. Isolated section of above ground, hydrocarbon-filled piping.	1. Potential thermal expansion of trapped liquid. Potential gasket leak. Potential release of small amount of ambient flammable liquid. Potential environmental impact.	E	4	C	5	Most line segments are equipped with thermal relief devices which vent to common manifold to Multi-Product Drain Line, some of which are currently blocked in due to Multi-Product Drain Line leaking. There is currently a project in funded, pre-award stage to add additional thermal relief devices and incorporate in new 1407 Product Recovery Tank (PRT).		
2.6. Low Pressure	1. Thermal contraction at [redacted] (b)(3)(A) or [redacted] (b)(3)(A)	1. Potential slight decreased pressure in piping in [redacted] (b)(3)(A) or [redacted] (b)(3)(A) due to day/night temperature swings. No hazardous consequences identified.							
2.7. High Level	1. Insufficient ullage in intended receiving storage tank. [redacted] (b)(3)(A)	1. Potential to overpressure and/or overfill Tank 55 JP-5 Tank. Potential release of ambient flammable liquid to a lined containment area. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	C	3	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. LAH-55 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-55 high high level (switch) stops all transfer pumps in	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.
			H/S	3	C	4			
			P	2	C	3			

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		2. Potential to overpressure and/or overfill Tank 46/53 F-24 Tank. Potential release of ambient flammable liquid to a lined containment area. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	C	3	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.
			H/S	3	C	4	LAH-46/53 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
			P	2	C	3	LSHH-46/53 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		3. Potential to overpressure and/or overfill Tank 47/48/54 F-76 Tanks. Potential release of ambient flammable liquid to a lined containment area. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	C	3	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.
			H/S	3	C	4	LAH-47/48/54 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
			P	2	C	3	LSHH-47/48/54 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
2.8. Low Level	1. No causes identified.								
2.9. Composition	1. Receipt of off-spec material.	1. Potential off-spec product in storage and/or piping at PRL. Potential impact to mission capability or unit readiness. With Red Hill in service, the mission capability or unit readiness impact is degraded. With Red Hill out of service, the mission capability or unit readiness impact is significantly degraded.	MR	2	D	4	Material is sampled at point of shipment, prior to offloading, and during offloading using well established and effective administrative procedures. Valving allows segregation of tank if off-spec material is inadvertently offloaded.		
		2. Potential to introduce hazardous component to normal fuel composition (H2S, benzene). Potential personnel injury during normal operations on shore or ship.	H/S	1	B	1	None identified.	41. Add testing for sulfur compounds (or other credible toxic compounds) as part of pre-offloading analysis for fuel receipts at PRL. (Medium Priority)	

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		3. Potential to use contaminated fuel in end user equipment (ships, aircraft, etc.). Potential impact to mission capability or unit readiness. Potential personnel injury.	MR H/S	3 1	D D	5 3	Material is sampled at point of shipment, prior to offloading, and during offloading using well established and effective administrative procedures.		PHA Team concluded safeguards are adequate.
2.10. Leak / Rupture	1. Fuel transfer hose leak or rupture.	1. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness 33 CFR Part 154 Coast Guard requires testing hoses to 1.5 x deadhead pressure. PHA Team concluded the highest pressure expected in a marine transfer that is deadheaded is the UTF pump for product F-76 at 219 psig. This pressure is greater than 1) the gravity head from the highest tank at RHL to the dock, 2) the available deadhead from the YON pumps, 3) deadhead pressure of ship pump, and 4) any single pump in UGPH. However, should two pumps in series ever be considered to be included in an Operations Order, the highest deadhead pressure to be considered is 268 psig.	MR H/S E P	4 1 2 2	B C B B	4 2 2 2	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Pre-Plan Meeting includes visual inspection of all fuel transfer hoses and hose integrity test witnessed by both PICs prior to initiating any fuel transfer. All hoses are hydrostatically tested to 150 psig annually. Coast Guard verifies hose labeling and record-keeping annually. Hose rating is 200 to 250 psig depending on manufacturer. Hose test pressure per manufacturer is 300 psig. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Operational practice is to start fuel transfer and slowly increase pressure in increments until full flow is established. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Ship should have safeguards for their pump.	12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority) 13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	
	2. PRVs open or leaking by on pipeline.	1. Potential to relieve to opposite side of valve inside pipeline (cascade from North Road Pipeline).							
	3. PRVs open or leaking by in PH [redacted] ([redacted]	1. Potential increased level in 1407 Product Recovery Tank (PRT). Potential to overfill PRT (located inside PH [redacted]) to concrete flooring. Potential accumulation of hydrocarbon fuel in PH [redacted] Potential fire. Potential personnel injury. Potential impact to mission capability or unit readiness. With Red Hill in service, the mission capability or unit readiness impact is degraded. With Red Hill out of service, the mission capability or unit readiness impact is significantly degraded.	MR H/S	2 2	D D	4 4	PRVs in PH [redacted] are bench tested annually. LSH/LSHH-1407 located in 1407 Product Recovery Tank alerts operator to investigate source of level and intervene. LSH/LSHH is calibrated at least annually. Rover Checklist requires recording level in 1407 Product Recovery Tank at least once a shift. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can order a vacuum truck. Rover Checklists are maintained for at least 3 years.		
2.11. Start-up / Shutdown	1. No new causes identified.								
2.12. Maintenance / Inspection	1. No new causes identified.								
2.13. Corrosion /	1. External corrosion on piping.								

Node: 2. Routine Operations: Supplying Upper Tank Farm (UTF) from Hotel Pier
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix			Safeguards	PHA Recommendation	Comments
				C	L	RR			
Erosion	Since a full structural integrity was in progress at the time of the PHA, Team did not develop this cause further.								

Node: 3. Routine Operations: Supplying Storage from PAR pipeline, including Intermix Tank
Drawings: [redacted]
Components: [redacted]; Tank 301 Intermix Tank; TK 101/119 00S Tank (Red Hill); TK 102/103/104/105/106 F-24 Tank (Red Hill); TK 107/108/109/110/111/112/113/114/117/118/120 JP-5 Tank (Red Hill); TK 115/116 F-76 Tank (Red Hill)
Design Intention/Parameters: The facility can receive fuel (F-76, F-24, and JP-5) through a commercial multi-product pipeline from a local refinery. A pressure reducing valve located at the refinery tie-in limits the pressure to 260 psig at [redacted]. A Coriolis meter is installed at [redacted] to meter the incoming fuel. Capability to separate the cuts between different types of fuels delivered through the multi-product line also exists.
Operating Conditions: 1. Flow: [redacted]; 2. Pressure: 190 to 200 psi max; 3. Temperature: 80 to 90°F

Deviation	Cause	Consequence	CAT	Risk Matrix			Safeguards	PHA Recommendation	Comments
				C	L	RR			
3.1. What If...?	1. Incorrect line sequence at startup or during the operation which required a change in the Operations Order (valve closed during transfer, including control valve or either valve operated by PAR)?	1. Potential to deadhead PAR system. PHA Team had insufficient information at the time of the PHA to develop cause/consequence pair. Discussions between PRL and PAR personnel have validated the listed safeguards at PAR.					PAR Hawaii control room alarm system will activate at high pressure (above NOP) and shut the transfer pumps down at 225 psi. PAR Hawaii control room will notify PRL Control Room for a system safety check before restarting the operation PAR may have additional safeguards. Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Numerous PITs installed at [redacted] FQYT-[redacted] flow computer monitors flow from PAR at [redacted]		
		2. Potential delay in resupplying Red Hill, UTF, and/or Hickam Airfield. Potential impact to mission capability or unit readiness.	MR	3	D	5	Numerous PITs installed at [redacted] FQYT-[redacted] flow computer monitors flow from PAR at [redacted]		
	2. Pump(s) at PAR trips during transfer (outside of node)? At the time of the PHA, PAR would be operating two pumps in series if transferring to PRL or RHL.	1. Potential delay in resupplying Red Hill, UTF, and/or Hickam Airfield. Potential impact to mission capability or unit readiness.	MR	3	D	5	Numerous PITs installed at [redacted] FQYT-[redacted] flow computer monitors flow from PAR at [redacted]		
		2. Potential rapid flow of very large quantity of ambient flammable liquid to PAR tank(s). Potential increased level in PAR tank(s). Potential to overfill PAR tank(s). PHA Team had insufficient information at the time of the PHA to develop cause/consequence pair.					OCV in [redacted] acts as a dual check valve and is scheduled for routine maintenance but not pressure or leak tested. At the time of the PHA, PAR identified multiple check valves in piping to PRL and RHL.	54. If defueling to PAR is pursued, coordination with PAR to develop an Operations Plan which reviews safeguards at PAR for 1) maximum pressure of ~130 psig, 2) maximum flowrate, 3) overfill protection, and 4) transient surge when isolated at PAR is required. (High Priority)	
	3. Control valve open more than required during transfer?	1. Potential increased pressure in PRL and RHL piping. Potential to exceed design pressure of PRL and RHL piping.						55. Determine the maximum pressure that can be provided by PAR if the pressure control valve malfunctions open and ensure piping at PRL and RHL is adequate for resultant pressure, and if not implement safeguards to reduce the likelihood of overpressuring PRL and RHL piping. (High Priority)	

Node: 3. Routine Operations: Supplying Storage from PAR pipeline, including Intermix Tank
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		PHA Team had insufficient information at the time of the PHA to develop cause/consequence pair.							
	4. Valves misaligned into unintended tank?	1. Potential to overpressure and/or overfill Tank 55 JP-5 Tank. Potential release of ambient flammable liquid to a lined containment area. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S P	2 3 2	C C C	3 4 3	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. LAH-55 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-55 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.
		2. Potential to overpressure and/or overfill Tank 46/53 F-24 Tank. Potential release of ambient flammable liquid to a lined containment area. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S P	2 3 2	C C C	3 4 3	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. LAH-46/53 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-46/53 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.
		3. Potential to overpressure and/or overfill Tank 47/48/54 F-76 Tanks. Potential release of ambient flammable liquid to a lined containment area. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S P	2 3 2	C C C	3 4 3	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. LAH-47/48/54 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-47/48/54 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.

Node: 3. Routine Operations: Supplying Storage from PAR pipeline, including Intermix Tank
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		4. Potential increased level in unintended tank. Potential to overfill unintended tank. Potential release of ambient flammable liquid from Adit 5 (lowest elevation) to Halawa stream and Pearl Harbor waterways. Potential release to soil, groundwater, and/or waterway. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Consequence similar to incident of November 20, 2021.	MR	4	D	5	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
			H/S	3	D	5		33. Evaluate lighting at the discharge location of the 24" horizontal vent pipe to increase the likelihood of detection by camera in area, and improve lighting if warranted. (Medium Priority)	
			E	1	D	3	LAH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks 101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	34. Consider equipping 24" horizontal vent pipe discharge with fuel or oil detection and alarm instrumentation to detect the presence of liquid fuel. (Medium Priority)	
			P	1	D	3		11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
							LSHH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks 101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration. [redacted] (b)(3)(A) (b)(3)(A) (b)(3)(A)		
							Inventory of dome is not used in calculation high operating limit. Available ullage in dome is ~1.5 MM gal, resulting in > 4 hours between LSH setpoint and entering vent line.		
							Camera coverage for Adit 5 outside area. Cameras are included in scheduled PM program.		
		5. Potential increased level in unintended tank. Potential to overfill unintended tank through the vent piping (not designed for liquid fill) to the vent piping of grouped tanks (tank 1 and 2 are grouped, tanks 3-16 are grouped, and tanks 17-20 are grouped). Potential cross-contamination of fuels. Potential increased level in multiple unintended tanks. Potential impact to mission capability or unit readiness. PHA Team concluded due to the additional vertical rise from the vent piping to grade at ridgeline (>100 ft.) and the 24" piping to Adit 5 with no block valves in line, release from tank vents S-197, S-213, S-348, or 12" pipe vent adjacent to elevator 73 shaft is not considered	MR	2	D	4	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
								33. Evaluate lighting at the discharge location of the 24" horizontal vent pipe to increase the likelihood of detection by camera in area, and improve lighting if warranted. (Medium Priority)	
							LAH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks 101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	34. Consider equipping 24" horizontal vent pipe discharge with fuel or oil detection and alarm instrumentation to detect the presence of liquid fuel. (Medium Priority)	
								35. Evaluate the vent piping between "P traps" in grouped tanks to determine if low point piping could accumulate trapped liquid over time due to condensing and/or undetected overfill; and if credible identify method to remove accumulated liquid if warranted. (Medium Priority)	
								11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	

Node: 3. Routine Operations: Supplying Storage from PAR pipeline, including Intermix Tank
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		credible.					LSHH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks 101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration. [redacted]		
							Inventory of dome is not used in calculation high operating limit. Available ullage in dome is ~1.5 MM gal, resulting in > 4 hours between LSH setpoint and entering vent line.		
							Camera coverage for Adit 5 outside area. Cameras are included in scheduled PM program.		
		6. Potential increased level in unintended tank. Potential to overfill unintended tank through the vent piping (not designed for liquid fill) to the vent piping of grouped tanks (tank 1 and 2 are grouped, tanks 3-16 are grouped, and tanks 17-20 are grouped). Potential release of ambient flammable liquid through deteriorated vent piping into upper tunnel. Potential personnel hazard (asphyxiation). Potential fire. Potential release from vent to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Clean Inspect Repair (CIR) Project for RHL includes replacing tank vent piping and butterfly valves with SS piping to reduce the likelihood of release of ambient flammable liquid or vapor to Upper Access Tunnel. At the time of the 2022 PHA, three tanks were completed and two more in progress, and three additional tanks are pending award.	MR	2	D	4	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
			H/S	1	D	3		33. Evaluate lighting at the discharge location of the 24" horizontal vent pipe to increase the likelihood of detection by camera in area, and improve lighting if warranted. (Medium Priority)	
			E	1	D	3	LAH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks 101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
			P	1	D	3		34. Consider equipping 24" horizontal vent pipe discharge with fuel or oil detection and alarm instrumentation to detect the presence of liquid fuel. (Medium Priority)	
								36. Consider implementing four-gas personnel monitor PPE requirement for personnel working in any tunnels. (Medium Priority)	
							LSHH-01/02/03/04/05/06/07/08/09/10/11/12/13/14/15/16/17/18/19/20 in Red Hill tanks 101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration. [redacted]	37. Evaluate use of panic button and man-down feature of intersite radio system. (Medium Priority)	
								38. Develop a car-seal or lock administrative control system and identify safety-critical manual valves which should be controlled to reduce the likelihood of human error. Valves to consider include but are not limited to 24" butterfly tank vent valves at RHL, manual block valves on the inlet or discharge of relief devices, manual block valves on bleed of body cavity of twin-seal DBB device, key firewater supply and distribution valves. (High Priority)	
								11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	

Node: 3. Routine Operations: Supplying Storage from PAR pipeline, including Intermix Tank
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							Inventory of dome is not used in calculation high operating limit. Available ullage in dome is ~1.5 MM gal, resulting in > 4 hours between LSH setpoint and entering vent line.		
							Camera coverage for Adit 5 outside area. Cameras are included in scheduled PM program.		
		7. Potential increased level in misaligned Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, or Tank 0223/0224 F-76 Surge Tank. Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
			H/S	3	D	5			
			E	3	D	5			
			P	1	D	3	LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
	5. Insufficient flushing between transfers on different products?	1. Potential contamination in destination tank. Potential impact to mission capability or unit readiness.	MR	3	D	5	Mil-STD-3004/Class B Laboratory.		
	6. Flushing too long into Tank 301 Intermix Tank?	1. Potential increased level in Tank 301 Intermix Tank. Potential to overfill Tank 301. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	3	D	5	CRO monitors level in Tank 301 Intermix Tank during flushing.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
			H/S	3	D	5	DLA QAR and PAR lineman will be present during flushing.		
			E	3	D	5	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
			P	2	D	4			
							LAH-301 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-301 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		2. Potential to damage and/or sink internal floating roof in Tank 301 Intermix Tank. Potential	MR	4	D	5			

Node: 3. Routine Operations: Supplying Storage from PAR pipeline, including Intermix Tank
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		impact to mission capability or unit readiness.							

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]
Components: TK 101/119 00S Tank (Red Hill); TK 102/103/104/105/106 F-24 Tank (Red Hill); TK 107/108/109/110/111/112/113/114/117/118/120 JP-5 Tank (Red Hill); TK 115/116 F-76 Tank (Red Hill); [redacted] VQ1 PIG Launcher 1
Design Intention/Parameters: Fuel from Red Hill Bulk Fuel Storage Facility (Red Hill) flows by gravity to Joint Base Pearl Harbor Hickam (JBPHH) can be transferred to load ship/barge using existing piers/docks. Twenty underground tanks are manifolded to a [redacted] F-76 line, an [redacted] JP-5 line, and a [redacted] F-24 line. Three pipelines run through tunnel to Underground Pump House (UGPH) for alignment to intended distribution location. There are multiple sumps in segregated sections of Red Hill and UGPH.

Demonstrated transfer rates are [redacted]. Specific Operational Procedures with valve alignment tables exist in the OMES Manual to transfer to UTF, Hickam, and piers/docks; and have been used safely in the past.

Transferring to PAR is controlled by a LC valve owned by PAR.

Operating Conditions: 1. Flow: See Intention; 2. Pressure: 0 to 125 psig; 3. Temperature: 60 to 80°F

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
4.1. What If ...Transferring RHL to UGPH?	1. Incorrect or missing Creation of Evolution of movement or Operations Order?	1. Potential delay in transferring from TK 102/103/104/105/106 F-24 Tank (Red Hill), TK 107/108/109/110/111/112/120 JP-5 Tank (Red Hill), and TK 115/116 F-76 Tank (Red Hill). Potential little or no impact to mission capability or unit readiness. PHA Team concluded the evolution would not proceed without an Operations Order and signed-off by the operations supervisor.	MR	4	D	5	Supervisor's responsible for developing and issuing Operations Orders. Any needed modifications are discussed with supervisor and approved before use (operations practice).	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11). 56. Implement a document control system to generate unique, trackable operations orders and log revisions. (Low Priority)	
	2. Multiple tanks in same tank group out-of-service with unrestrained piping? OR Line is not packed and not detected to be not packed? OR High point bleed closed too early?	1. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Lower Access Tunnel. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: Transformer, primary disconnects, and MCC switch gear are currently located in electrical room inside Lower Tunnel. Consistent with May 6, 2021 incident and September 29, 2021 near-miss.	MR H/S E P	2 1 1 1	B B B B	2 1 1 1	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	24. Modify CIR contracts to include restraining pipe between blanked sections when taking tank out of service for maintenance or inspection. (High Priority) 25. Include verification step in Operations Order that piping is restrained before starting any evolution involving transferring liquid from any tank in Red Hill Tank Gallery. (High Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority)	

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
								30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear [redacted] and consider relocation to an area external to tunnel system, similar to [redacted] Electrical Room Relocation Project MILCON P-8006. (High Priority)	
								31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
								32. Evaluate the need for Dresser Couplings in the [redacted] and [redacted] main distribution piping in Red Hill Tank Gallery between TK 114 JP-5 Tank (Red Hill) and TK 116 F-76 Tank (Red Hill), shown on Drawing [redacted] If they can be removed safely, remove the Dresser Couplings. JP-5 Emergent Pipeline Repairs were underway at the time of the PHA and will include eliminating old Dresser Coupling on [redacted] JP-5 piping. This recommendation should be completed prior to returning JP-5 piping to service. (High Priority)	
		2. Potential sagging of pipeline between UGPH and RHL. Potential to draw vacuum in piping between Hotel Pier and UGPH, and between UGPH and RHL. Potential to collapse piping. Potential loss of containment. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	C	3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
			H/S	1	C	2	PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority)	
			E	2	C	3	Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump.	7. Perform a Pipe Collapse Pressure Study to determine the pressure required to collapse the existing pipe and identify and install safeguard(s) as warranted. Consider integrating this recommendation with upcoming API 570 Assessment. (High Priority)	
			P	1	C	2	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
		3. Potential sagging of pipeline between UGPH and RHL. Potential to draw vacuum in piping between Hotel Pier and UGPH, and between UGPH and RHL. Potential to damage seals in Dresser Coupling. Potential loss of containment when flow is re-established. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	C	3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
			H/S	1	C	2	PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority)	
			E	2	C	3	Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump.	8. Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around pumps installed in UGPH and Red Hill Tank Gallery. Consider modifying design if manufacturer has alternate sealing system and Dresser Couplings remain part of design. (High Priority)	
			P	1	C	2	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	9. Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling. (High Priority)	
		4. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser	MR	4	D	5	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021).	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
			H/S	1	D	3	PITs used to sense pressure in piping are located several		

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Zone 7 Sump and/or Main Sump (fuel sumps). Potential rapid release of very large quantity of ambient flammable liquid to TK 311 Slop Tank. Potential increased level in TK 311. Potential to overfill TK 311. Potential increased level in secondary containment (> 6ft deep, one set of stairs in corner, vertical side walls). Potential pool fire. Potential release to soil, groundwater and/or Halawa stream. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: Pumps at Main Sump have a combined capacity of ~300 gpm. TK 311 is not equipped with pumps to remove level. A vacuum truck is brought in when needed to remove level. TK 311 is in an isolated area not near through traffic roads. Inside the containment there are no sources of ignition. Isolation valve at the tank can be closed outside of containment area. At the time of the PHA the area adjacent to TK 311 is in use for groundwater treatment. Flow from Groundwater Sump Pump inside AFFF Sump (typical of five) may accelerate this consequence.	E P	1 1	D D	3 3	miles from Red Hill Tank Gallery and are not currently part of a PM program. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program. LSH-100 high level (switch) in Main Sump starts Main Sump Pump A and alerts operator to investigate source of level and intervene. LSHH-100 high high level (switch) Main Sump starts Main Sump Pump A and Main Sump Pump B and alerts operator to investigate source of level and intervene. Both LSH-100 and LSHH-100 share a sensor. They are part of a PM program but not using certified or calibrated test equipment. Main Sump level switches high and low are not on UPS backup power, but are operated by [redacted] (b)(3)(A) [redacted] (b)(3)(A) LSH-0197 high level (switch) in Zone 7 area alerts operator to investigate cause of presence of liquid level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-311 high level alarm on TK 311 Slop Tank alerts operator to investigate source of level and intervene. LSHH-311 is calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 43. Install a second and independent high level indication and alarm on TK 311 Slop Tank to reduce the likelihood of overfilling TK 311 unknowingly. (Medium Priority) 44. Review current practices and operability of TK 311 Slop Tank with groundwater treatment equipment and personnel adjacent to TK 311 to evaluate the interaction of the two operations and modify practices if warranted. (Low Priority) 11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
		5. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to AFFF Sump (typical of five). Potential to pump ambient flammable liquid to AFFF Retention Tank. Potential to overfill AFFF Retention Tank. Potential to introduce ambient flammable liquid	MR H/S E P	4 2 1 1	B B B B	4 2 1 1	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across	

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		to secondary containment (sloped sides). Potential ambient flammable liquid carryover to GAC and Halawa stream. Potential pool fire. Potential release to soil, groundwater and/or Halawa stream. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: AFFF System Project was completed in 2019. The AFFF Retention Tank has a capacity of 153,000 gal. and was sized to hold 20 minutes of fire fighting foam and water plus 80,000 gal. of fuel from a leak. The AFFF system is currently made of PVC and CS. There is currently only local level indication in the five AFFF Sumps. There is currently no level indication on the AFFF Retention Tank. At the time of the PHA, the motors to the pumps from AFFF Sumps were LOTO to reduce the likelihood of autostart. Currently, the AFFF System is contractually maintained by a company responsible for multiple JBPHH entities. Consequence similar to May 6, 2021 incident and November 20, 2021 incident.					emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program. Each of the five AFFF Sumps contain four pumps intended for staggered start (local level switch) to pump to AFFF Retention Tank. The AFFF Sump pumps were recently added to a PM schedule.	both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 45. Ensure run status indication on all pumps inside all AFFF Sumps (20 pumps) is integrated with the AFHE SCADA to alert Control Room Operator (CRO) to potential release of fuel and/or AFFF. (High Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 47. Evaluate the design of the 14" AFFF discharge line piping on the discharge of 20 AFFF Sumps pumps as part of the current project to upgrade PVC to CS. The PHA Team is concerned about 1) the volume flow and separately, 2) line slope or configuration to trap liquid in retention line, and 3) lack of damage control isolation in long-run of piping. (High Priority) 48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High Priority) 49. Train all affected personnel on the design, intent, and operation of the AFFF System, including refresher training. (High Priority) 50. Consider equipping AFFF Retention Tank with reliable level indication and level alarm to alert Control Room Operator (CRO) to presence of level in AFFF Retention Tank. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		6. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Water Shaft, Adit 3 Ground Water Sump and/or Septic Sump. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Consistent with May 6, 2021 incident and November 20, 2021 incident.	MR H/S E P	3 1 1 1	B B B B	3 1 1 1	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Camera coverage in Lower Access Tunnel. Cameras are	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust	

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							included in scheduled PM program.	accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 51. Consider designing a system to separate oil and water to reduce the likelihood of discharging flammable liquid to environment from Adit 3 Groundwater Sump. (Medium Priority) 52. Provide means to remove contamination from water supply. (High Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		7. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Harbor Tunnel. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil, groundwater, and/or Pearl Harbor waterways. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	3	B	3	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 53. Evaluate an emergency breathing air supply for Harbor Tunnel due to its long length, limited egress, and reduced ventilation. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
			H/S	1	B	1			
			E	1	B	1			
			P	1	B	1			

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam [redacted]
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		8. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling. Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH. Potential fire and/or explosion. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Currently [redacted] The type of casing material is unknown. There is currently an awarded project to replace [redacted]	MR	2	B	2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
			H/S	1	B	1			
			E	2	B	2			
			P	1	B	1			
		9. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential to overfill UGPH to Lower Yard Tunnel (LYT) and/or Harbor Tunnel and/or Surge Tank Tunnel. Potential to overfill tunnels and/or sumps to surrounding area and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact.	MR	2	B	2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted]	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with	
			H/S	1	B	1			
			E	2	B	2			
			P	1	B	1			

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Potential impact to mission capability or unit readiness.					1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LSH high level (switch) in Harbor Tunnel Sump with local audible alarm alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
		10. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank (normal lineup, B1 and B2 are sluiced). Potential to overfill Tank 1301/1302 to containment area. Potential release to soil below containment area (due to leaking containment) and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential overfill to Lower Yard Tunnel (LYT) may accelerate this consequence (abnormal	MR H/S E P	2 1 2 1	C C C C	3 2 3 2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL	

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam [redacted]
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		lineup).					transmitter on pump stops respective pump. TTs are not currently part of calibration system.	to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
							CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority)	
							OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.	19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
							SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]		
							LAH-B1/B2 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-B1/B2 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		11. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to Adit 1 Sump (abnormal lineup). Potential to overfill Adit 1, Harbor Tunnel, and/or Adit 2 (including french drain systems). Potential release to soil and/or groundwater and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential overfill to Lower Yard Tunnel (LYT) may accelerate this consequence. Potential to overfill to Harbor Tunnel may	MR	2	C	3	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	
			H/S	1	C	2	[redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve.	15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
			E	1	C	2		16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority)	
			P	1	C	2	[redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
							[redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
							TT[redacted] high temperature transmitter on pump stops respective pump. TTs are not	18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser	

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		accelerate this consequence.					currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	Coupling(s) adjacent to pump. (High Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
		12. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential to overfill UGPH to Lower Yard Tunnel (LYT) and/or Harbor Tunnel and/or Surge Tank Tunnel. Potential release to soil and/or groundwater below Surge Tank Tunnel (due to leaking tunnel) and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 1 1 1	C C C C	3 2 2 2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve,	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							is scheduled for routine maintenance but not pressure or leak tested.		
							SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]		
							LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
	3. High point bleed opened too quickly during line pack?	1. Potential release of ambient flammable liquid to atmosphere. Potential personnel injury. Operator works from portable ladder to open HPB. Procedure does not state to connect hose to bleed and other end of hose to Main Sump, but some operators practice that. Often, two people are involved but not required in procedure. Prior to current curtailment of red Hill use, this task was performed frequently (daily).	H/S	3	C	4	Current operator practice of connecting hose from main bleed to Main Sump.	57. Consider installing small platform in lieu of portable ladders for safer access to HPB for each of the three products OR relocate HPB to ground level. Hard pipe the discharge of the HPB to Main Sump. Ensure the end of the discharge piping is visible to person(s) performing task. (Low Priority)	
							Operator practice is for additional operator to be present for task.	58. Perform Job Safety Analysis (JSA) on high-risk tasks to address human factors and PPE requirements. (Medium Priority)	
		2. Potential to introduce air to a flammable liquid pipeline. Potential release of flammable mixture from HPB which may be routed to Main Sump, Zone 7 Sump, or release at HPB location when line is packed from tank. Potential flash fire. Potential personnel injury. Potential impact to mission capability or unit readiness.	MR	4	D	5	Robust ventilation system, required electricity.	59. Ensure seals and enclosures necessary to maintain electrical area classification Class 1 Div I are included in PM program. (Medium Priority)	
			H/S	2	D	4	Electrical area classification reduces the likelihood of ignition.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
								60. Ensure transformers, switch gear, automatic transfer switch (ATS), and other equipment in Switch Gear Room meets requirements of Class 1 Div I. (High Priority)	
								30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear [redacted] and consider relocation to an area external to tunnel system, similar to [redacted] Electrical Room Relocation Project MILCON P-8006. (High Priority)	
								61. Consider using nitrogen to relieve vacuum inside piping instead of air to reduce the likelihood of producing a flammable mixture. (Medium Priority)	
								62. Ensure Area Classification boundaries are clearly denoted in written PSI and understood by impacted personnel. (High Priority)	
	4. Failure to settle line after packing before proceeding?	1. No hazardous consequences identified.							
	5. Tank skin DBB valve not opened before opening ball valve?	1. Potential damage over time to DBB valve. No hazardous consequences identified.							
		2. Potential release of flammable liquid from HPB which may be routed to Main Sump, Zone 7 Sump, or release at HPB location when line is packed from tank. Potential fire. Potential personnel injury. Potential impact to mission	MR	4	D	5	Robust ventilation system, required electricity.	59. Ensure seals and enclosures necessary to maintain electrical area classification Class 1 Div I are included in PM program. (Medium Priority)	
			H/S	2	D	4	Electrical area classification reduces the likelihood of ignition.	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted]	

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		capability or unit readiness.						[redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
								60. Ensure transformers, switch gear, automatic transfer switch (ATS), and other equipment in Switch Gear Room meets requirements of Class 1 Div I. (High Priority)	
								30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear [redacted] and consider relocation to an area external to tunnel system, similar to [redacted] Electrical Room Relocation Project MILCON P-8006. (High Priority)	
								61. Consider using nitrogen to relieve vacuum inside piping instead of air to reduce the likelihood of producing a flammable mixture. (Medium Priority)	
								62. Ensure Area Classification boundaries are clearly denoted in written PSI and understood by impacted personnel. (High Priority)	
	6. Ball valve opened too quickly?	1. Potential damage over time to ball valve. No hazardous consequences identified.							
		2. Potential release of flammable liquid from HPB which may be routed to Main Sump, Zone 7 Sump, or release at HPB location when line is packed from tank. Potential fire. Potential personnel injury. Potential impact to mission capability or unit readiness.	MR	4	D	5	Robust ventilation system, required electricity.	59. Ensure seals and enclosures necessary to maintain electrical area classification Class 1 Div I are included in PM program. (Medium Priority)	
			H/S	2	D	4	Electrical area classification reduces the likelihood of ignition.	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
								60. Ensure transformers, switch gear, automatic transfer switch (ATS), and other equipment in Switch Gear Room meets requirements of Class 1 Div I. (High Priority)	
								30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear [redacted] and consider relocation to an area external to tunnel system, similar to [redacted] Electrical Room Relocation Project MILCON P-8006. (High Priority)	
								61. Consider using nitrogen to relieve vacuum inside piping instead of air to reduce the likelihood of producing a flammable mixture. (Medium Priority)	
								62. Ensure Area Classification boundaries are clearly denoted in written PSI and understood by impacted personnel. (High Priority)	
	7. Failure to return the DBB and skin valve to auto position?	1. Potential loss of remote operability from control room. Potential escalation of event.					Control room operator (CRO) monitors position of DBB and skin valves.		
	8. High point bleed left open?	1. Potential release of flammable liquid from HPB which may be routed to Main Sump, Zone 7 Sump, or release at HPB location when line is packed from tank. Potential fire. Potential personnel injury. Potential impact to mission capability or unit readiness.	MR	4	D	5	Robust ventilation system, required electricity.	59. Ensure seals and enclosures necessary to maintain electrical area classification Class 1 Div I are included in PM program. (Medium Priority)	
			H/S	2	D	4	Electrical area classification reduces the likelihood of ignition.	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
								60. Ensure transformers, switch gear, automatic transfer switch (ATS), and other equipment in Switch Gear Room meets requirements of Class 1 Div I. (High Priority)	
								30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear [redacted] and consider relocation to an area external to tunnel system, similar to [redacted] Electrical Room Relocation Project MILCON P-8006. (High Priority)	
								61. Consider using nitrogen to relieve vacuum inside piping instead of air to reduce the likelihood of producing a flammable mixture. (Medium Priority)	

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
								63. Ensure Operations Order for line pack include specific step to close high point bleed valve (HPB) before completely opening ball valve. (Low Priority)	
								62. Ensure Area Classification boundaries are clearly denoted in written PSI and understood by impacted personnel. (High Priority)	
	9. Sectional valves in RHL tunnel not open?	1. Potential delay in transferring from TK 102/103/104/105/106 F-24 Tank (Red Hill), TK 107/108/109/110/111/112/120 JP-5 Tank (Red Hill), and TK 115/116 F-76 Tank (Red Hill). Potential little or no impact to mission capability or unit readiness.	MR	4	B	4			
		2. Potential increased pressure in piping in RHL Tank Gallery. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		3. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Lower Access Tunnel. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: Transformer, primary disconnects, and MCC switch gear are currently located in electrical room inside Lower Tunnel. Consistent with May 6, 2021 incident and September 29, 2021 near-miss.	MR	2	B	2	High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically.	24. Modify CIR contracts to include restraining pipe between blanked sections when taking tank out of service for maintenance or inspection. (High Priority)	
			H/S	1	B	1		25. Include verification step in Operations Order that piping is restrained before starting any evolution involving transferring liquid from any tank in Red Hill Tank Gallery. (High Priority)	
			E	1	B	1	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority)	
			P	1	B	1	Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
								26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority)	
								27. If possible, add a equalization line across the outboard main tank valve <u>prior to defueling</u> to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority)	
								28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority)	
								29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority)	
								30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear [redacted] and consider relocation to an area external to tunnel system, similar to [redacted] Electrical Room Relocation Project MILCON P-8006. (High Priority)	
								31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		4. Potential sagging of pipeline between UGPH and RHL. Potential to draw vacuum in piping	MR	2	C	3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted]	

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam [redacted]
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	C	L	RR	Safeguards	PHA Recommendation	Comments
		between Hotel Pier and UGPH, and between UGPH and RHL. Potential to collapse piping. Potential loss of containment. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	H/S E P	1 2 1	C C C	2 3 2	pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders. Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	[redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 7. Perform a Pipe Collapse Pressure Study to determine the pressure required to collapse the existing pipe and identify and install safeguard(s) as warranted. Consider integrating this recommendation with upcoming API 570 Assessment. (High Priority)	
		5. Potential sagging of pipeline between UGPH and RHL. Potential to draw vacuum in piping between Hotel Pier and UGPH, and between UGPH and RHL. Potential to damage seals in Dresser Coupling. Potential loss of containment when flow is re-established. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 1 2 1	C C C C	3 2 3 2	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders. Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 8. Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around pumps installed in UGPH and Red Hill Tank Gallery. Consider modifying design if manufacturer has alternate sealing system and Dresser Couplings remain part of design. (High Priority) 9. Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling. (High Priority)	
		6. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Zone 7 Sump and/or Main Sump (fuel sumps). Potential rapid release of very large quantity of ambient flammable liquid to TK 311 Slop Tank. Potential increased level in TK 311. Potential to overfill TK 311. Potential increased level in secondary containment (> 6ft deep, one set of stairs in corner, vertical side walls). Potential pool fire. Potential release to soil, groundwater and/or Halawa stream. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	4 1 1 1	D D D D	5 3 3 3	High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program. LSH-100 high level (switch) in Main Sump starts Main Sump Pump A and alerts operator to investigate source of level and intervene.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 43. Install a second and independent high level indication and alarm on TK 311 Slop Tank to reduce the	

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Note: Pumps at Main Sump have a combined capacity of ~300 gpm. TK 311 is not equipped with pumps to remove level. A vacuum truck is brought in when needed to remove level. TK 311 is in an isolated area not near through traffic roads. Inside the containment there are no sources of ignition. Isolation valve at the tank can be closed outside of containment area. At the time of the PHA the area adjacent to TK 311 is in use for groundwater treatment. Flow from Groundwater Sump Pump inside AFFF Sump (typical of five) may accelerate this consequence.					LSHH-100 high high level (switch) Main Sump starts Main Sump Pump A and Main Sump Pump B and alerts operator to investigate source of level and intervene. Both LSH-100 and LSHH-100 share a sensor. They are part of a PM program but not using certified or calibrated test equipment. Main Sump level switches high and low are not on UPS backup power, but are operated by (b)(3)(A) [redacted] (b)(3)(A) LSH-0197 high level (switch) in Zone 7 area alerts operator to investigate cause of presence of liquid level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-311 high level alarm on TK 311 Slop Tank alerts operator to investigate source of level and intervene. LSHH-311 is calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	likelihood of overfilling TK 311 unknowingly. (Medium Priority) 44. Review current practices and operability of TK 311 Slop Tank with groundwater treatment equipment and personnel adjacent to TK 311 to evaluate the interaction of the two operations and modify practices if warranted. (Low Priority) 11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
		7. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to AFFF Sump (typical of five). Potential to pump ambient flammable liquid to AFFF Retention Tank. Potential to overfill AFFF Retention Tank. Potential to introduce ambient flammable liquid to secondary containment (sloped sides). Potential ambient flammable liquid carryover to GAC and Halawa stream. Potential pool fire. Potential release to soil, groundwater and/or Halawa stream. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: AFFF System Project was completed in 2019. The AFFF Retention Tank has a capacity of 153,000 gal. and was sized to hold 20 minutes of fire fighting foam and water plus 80,000 gal. of fuel from a leak. The AFFF system is currently made of PVC and CS. There is currently only local level indication in the five AFFF Sumps. There is currently no level indication on the AFFF Retention Tank. At the time of the PHA, the motors to the pumps from AFFF Sumps were LOTO to reduce the	MR H/S E P	4 2 1 1	B B B B	4 2 1 1	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program. Each of the five AFFF Sumps contain four pumps intended for staggered start (local level switch) to pump to AFFF Retention Tank. The AFFF Sump pumps were recently added to a PM schedule.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 45. Ensure run status indication on all pumps inside all AFFF Sumps (20 pumps) is integrated with the AFHE SCADA to alert Control Room Operator (CRO) to potential release of fuel and/or AFFF. (High Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 47. Evaluate the design of the 14" AFFF discharge line piping on the discharge of 20 AFFF Sumps pumps as part of the current project to upgrade PVC to CS. The PHA Team is concerned about 1) the volume flow and separately, 2) line slope or configuration to trap liquid in retention line, and 3) lack of damage control isolation in long-run of piping. (High Priority) 48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High	

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		likelihood of autostart. Currently, the AFFF System is contractually maintained by a company responsible for multiple JBPHH entities. Consequence similar to May 6, 2021 incident and November 20, 2021 incident.						Priority) 49. Train all affected personnel on the design, intent, and operation of the AFFF System, including refresher training. (High Priority) 50. Consider equipping AFFF Retention Tank with reliable level indication and level alarm to alert Control Room Operator (CRO) to presence of level in AFFF Retention Tank. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		8. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Water Shaft, Adit 3 Ground Water Sump and/or Septic Sump. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Consistent with May 6, 2021 incident and November 20, 2021 incident.	MR	3	B	3	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 51. Consider designing a system to separate oil and water to reduce the likelihood of discharging flammable liquid to environment from Adit 3 Groundwater Sump. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
			H/S	1	B	1			
			E	1	B	1			
			P	1	B	1			
		9. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Harbor Tunnel. Potential personnel hazard	MR	3	B	3	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. High level in sump adjacent to the Oil Tight Door or initiation of	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority)	
			H/S	1	B	1			
			E	1	B	1			
			P	1	B	1			

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		(asphyxiation). Potential fire/explosion. Potential release to soil, groundwater, and/or Pearl Harbor waterways. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.					fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 53. Evaluate an emergency breathing air supply for Harbor Tunnel due to its long length, limited egress, and reduced ventilation. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		10. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling. Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH. Potential fire and/or explosion. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Currently [redacted] The type of casing material is unknown. There is currently an awarded project to replace [redacted]	MR H/S E P	2 1 2 1	B B B B	2 1 2 1	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank [redacted] Tunnel [redacted] Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system.	18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
							CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
							OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.	31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
							SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]		
		11. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential to overfill UGPH to Lower Yard Tunnel (LYT) and/or Harbor Tunnel and/or Surge Tank Tunnel. Potential to overfill tunnels and/or sumps to surrounding area and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	B	2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	
			H/S	1	B	1	[redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system.	15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
			E	2	B	2	PSL and PIT share common root valve.	16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority)	
			P	1	B	1	[redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
							[redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system.	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
							TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system.	18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
							CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
							OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.	31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
							SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including		

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							slowly closing [redacted]		
							LSH high level (switch) in Harbor Tunnel Sump with local audible alarm alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		12. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank (normal lineup, B1 and B2 are sluiced). Potential to overfill Tank 1301/1302 to containment area. Potential release to soil below containment area (due to leaking containment) and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential overfill to Lower Yard Tunnel (LYT) may accelerate this consequence (abnormal lineup).	MR	2	C	3	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	
			H/S	1	C	2	[redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve.	15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
			E	2	C	3	[redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system.	16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority)	
			P	1	C	2	[redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
							TT [redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system.	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
							CT [redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
							OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.	20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority)	
							SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]	19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
							LAH-B1/B2 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							LSHH-B1/B2 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		13. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to [redacted] Sump (abnormal lineup). Potential to overfill [redacted] Harbor Tunnel, and/or Adit 2 (including french drain systems). Potential release to soil and/or groundwater and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential overfill to Lower Yard Tunnel (LYT) may accelerate this consequence. Potential to overfill to Harbor Tunnel may accelerate this consequence.	MR	2	C	3	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
			H/S	1	C	2			
			E	1	C	2			
			P	1	C	2			
		14. Potential to cavitate [redacted]	MR	2	C	3	PSL-	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted]	

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		[redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential to overfill UGPH to Lower Yard Tunnel (LYT) and/or Harbor Tunnel and/or Surge Tank Tunnel. Potential release to soil and/or groundwater below Surge Tank Tunnel (due to leaking tunnel) and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	H/S E P	1 1 1	C C C	2 2 2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	[redacted]) are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
		15. Potential line movement when undetected pipeline pressure sag (downstream of sectional valves 0154, 0158, and 0162) followed by collapse of vacuum when opening sectional valve which creates a transient pressure surge. PHA Team had insufficient information to determine the consequence.						31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
4.2. What If ...Transferring from UGPH to Hotel Pier or Kilo Pier?	1. Valves misaligned to unintended pier?	1. No hazardous consequences identified.							
	2. Valves misaligned to Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, or Tank 0223/0224 F-76 Surge Tank (b)(3)(A) [redacted] open)?	1. Potential increased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	D	5	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
			H/S	3	D	5	Unscheduled Fuel Movement (UFM) alarm alerts operator to investigate and take action per UFM SOP.		
			E	3	D	5	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
			P	1	D	3	LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
	3. Crossing over interior piping in (b)(3)(A) [redacted] en route to Hotel Pier?	1. Operability issue. No hazardous consequences identified.							
	4. Valves misaligned to Truck Loading Rack (b)(3)(A) [redacted] open)?	1. Potential to load truck at abnormally high rate. Potential to exceed design conditions of truck loading flow meter. Potential to overfill tank truck. Potential release of ambient flammable liquid to a concrete contained area. Potential pool fire. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	C	5	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.		PHA Team concluded safeguards are adequate.
			H/S	3	C	4	All loading stations in the Truck Loading Rack are equipped with Overfill Protection Equipment (OPE) including dead-man switch. OPE is included in quarterly recurring maintenance program.		
			P	2	C	3	Emergency stop switch located at loading spot and at safe location away from loading spot.		
		2. Potential to load truck at abnormally high rate. Potential to exceed design conditions of truck loading flow meter. Potential to overfill tank truck. Potential release of ambient flammable liquid to a concrete contained area. Potential increased level in Load Rack Sump. Potential for Load Rack Sump Pump to introduce ambient flammable liquid to Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank (normal lineup, B1 and B2 are sluiced). Potential to overfill Tank 1301/1302 to containment area. Potential release to soil below containment area (due to leaking	MR	4	D	5	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
			H/S	3	D	5	All loading stations in the Truck Loading Rack are equipped with Overfill Protection Equipment (OPE) including dead-man switch. OPE is included in quarterly recurring maintenance program.	20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority)	
			E	3	D	5	Emergency stop switch located at loading spot and at safe location away from loading spot.		
			P	2	D	4	LAH-B1/B2 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly.		

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: (b)(3)(A) [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		containment) and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential to lift PRVs at Truck Loading Rack may accelerate this consequence.					All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-B1/B2 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
4.3. What If ...Transferring from UGPH to Sierra Pier, Mike Dock, or Bravo Dock?	1. Valves misaligned to unintended pier or dock?	1. No hazardous consequences identified.							
	2. Valves misaligned to UTF?	1. Potential to overpressure and/or overfill Tank 55 JP-5 Tank,Tank 46/53 F-24 Tank, or Tank 47/48/54 F-76 Tanks (Upper Tank Farm). Potential release of ambient flammable liquid to a lined containment area. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S P	2 3 2	C C C	3 4 3	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. LAH-55 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-55 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LAH-46/53 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-46/53 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LAH-47/48/54 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-47/48/54 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.

Node: 4. Routine Operations: Transferring from Red Hill Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
	3. Valves misaligned to Hickam (valve in [redacted] is chain-locked closed) [redacted] 2 open)?	1. No hazardous consequences identified. Note: Multiple block valves between PRL and Hickam are closed.					Supervisor's responsible for developing and issuing Operations Orders. Any needed modifications are discussed with supervisor and approved before use (operations practice). Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. Unscheduled Fuel Movement (UFM) alarm alerts operator to investigate and take action per UFM SOP.		
	4. Valves misaligned to PAR [redacted] open)?	1. No hazardous consequences identified. Note: PHA Team concluded cause is not credible.					Supervisor's responsible for developing and issuing Operations Orders. Any needed modifications are discussed with supervisor and approved before use (operations practice). Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. Unscheduled Fuel Movement (UFM) alarm alerts operator to investigate and take action per UFM SOP. Manual valve 391 at [redacted] is chain-locked closed and owned by PAR.		
4.4. What If ...Transferring F-24 from UGPH to Hickam?	1. Valves misaligned to UTF [redacted] open)?	1. Potential to overpressure and/or overfill Tank 46/53 F-24 Tank (Upper Tank Farm). Potential release of ambient flammable liquid to a lined containment area. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S P	2 3 2	C C C	3 4 3	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. LAH-46/53 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-46/53 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.

Node: 5. Routine Operations: Transferring from UTF Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]
Components: [redacted] Tank 46/53 F-24 Tank (Upper Tank Farm); Tank 47/48/54 F-76 Tank (Upper Tank Farm); Tank 55 JP-5 Tank (Upper Tank Farm); [redacted]
Design Intention/Parameters: Fuel from the Upper Tank Farm flows [redacted] for distribution to multiple sites. Six aboveground tanks are connected to the areas in various [redacted] lines routing through Valve Stations [redacted]
Operating Conditions: 1. Flow: ~2000 gpm; 2. Pressure: 0 to 100 psi; 3. Temperature: 60 to 80°F

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
5.1. What If...?	1. Any valve closed between UTF Tank and suction of [redacted]	1. Potential to cavitate [redacted] Potential seal damage. Potential seal leak. Potential release of ambient	MR H/S E	3 2 4	D D D	5 4 5	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test	

Node: 5. Routine Operations: Transferring from UTF Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
	[redacted]	flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	P	4	D	5	maintained for at least 3 years.	equipment. (High Priority)	
							PRL Control Room utilizes AFHE to confirm valve alignment.		
							Control room operator (CRO) monitors position of DBB and skin valves.		
							[redacted]) stops respective pump. FSs are not currently part of calibration system.		
							[redacted] high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration.		
							[redacted] high pressure (switch) (1oo2) on the discharge of pumps stops respective pump. PSHs are not currently part of calibration system. [redacted] high pressure (transmitter) on the discharge of pump stops respective pump. PITs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration.		
							[redacted] low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pumps stops respective pump. PITs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration.		
							[redacted] high bearing temperature on pump stops respective pump. TEs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration.		
							Pump is equipped with an OCV-like control valve for minimum flow.		
							Pump from another product could be utilized by rotating spec blinds and flushing lines.		
		2. Potential delay in product movement. Potential impact to mission capability or unit readiness.	MR	3	C	4	Large storage systems and redundant capability.		
	2. [redacted]	1. Potential delay in product movement. Potential impact to mission capability or unit readiness.	MR	3	C	4	Large storage systems and redundant capability.		

Node: 5. Routine Operations: Transferring from UTF Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
	[redacted]								
	3. Any valve closed between Tank 55 JP-5 Tank (Upper Tank Farm) and suction of [redacted]	1. Potential to cavitate [redacted] 207/208 JP-5 Pump (UGPH). Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential to separate Dresser Coupling may accelerate this consequence.	MR	4	C	5	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	
			H/S	3	C	4	[redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve.		
			E	4	C	5	[redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system.		
			P	4	C	5	[redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system.		
							TT[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system.		
							CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.		
		2. Potential delay in product movement. Potential impact to mission capability or unit readiness.	MR	3	C	4	Large storage systems and redundant capability.		
	4. [redacted] not running?	1. Potential delay in product movement. Potential impact to mission capability or unit readiness.	MR	3	C	4	Large storage systems and redundant capability.		
	5. Any shore-side valve closed on discharge of [redacted] during transfer?	1. Potential to deadhead [redacted] Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	3	D	5	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	
			H/S	2	D	4	PRL Control Room utilizes AFHE to confirm valve alignment.		
			E	4	D	5	Control room operator (CRO) monitors position of DBB and skin valves.		
			P	4	D	5	[redacted] low flow (switch) on [redacted] tops respective pump. FSs are not currently part of calibration system.		
							[redacted] high vibration on pump and motor stops respective pump. VSs are not currently part of calibration		

Node: 5. Routine Operations: Transferring from UTF Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							system. All pump safeguards are on UPS backup power with 4 hour duration.		
							[redacted] high pressure (switch) (1oo2) on the discharge of pumps stops respective pump. PSHs are not currently part of calibration system.		
							[redacted] high pressure (transmitter) on the discharge of pump stops respective pump. PITs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration.		
							[redacted] high bearing temperature on pump stops respective pump. TEs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration.		
							Pump is equipped with an OCV-like control valve for minimum flow.		
							Pump from another product could be utilized by rotating spec blinds and flushing lines.		
		2. Potential increased pressure in piping to and/or in UTF. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		3. Potential increased pressure in piping from UTF to Hotel Pier. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		4. Potential delay in product movement. Potential impact to mission capability or unit readiness.	MR	3	C	4	Large storage systems and redundant capability.		
	6. Any ship-side valve closed on discharge of [redacted] during transfer?	1. Potential to deadhead [redacted]. Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	3	D	5	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	
			H/S	2	D	4			
			E	4	D	5			
			P	4	D	5	PRL Control Room utilizes AFHE to confirm valve alignment.		
							Control room operator (CRO) monitors position of DBB and skin valves.		

Node: 5. Routine Operations: Transferring from UTF Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							[redacted] low flow (switch) on [redacted] stops respective pump. FSs are not currently part of calibration system. [redacted] high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration. [redacted] high pressure (switch) (1oo2) on the discharge of pumps stops respective pump. PSHs are not currently part of calibration system. [redacted] high pressure (transmitter) on the discharge of pump stops respective pump. PITs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration. [redacted] high bearing temperature on pump stops respective pump. TEs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration. Pump is equipped with an OCV-like control valve for minimum flow. Pump from another product could be utilized by rotating spec blinds and flushing lines.		
		2. Potential increased pressure in piping to and/or in UTF. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		3. Potential increased pressure in piping from UTF to Hotel Pier. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		4. Potential increased pressure in fuel transfer hose. Potential hose rupture or gasket failure. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury.	MR H/S E P	4 1 2 2	B C B B	4 2 2 2	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Pre-Plan Meeting includes visual inspection of all fuel transfer hoses and hose integrity test witnessed by both PICs prior to initiating any fuel transfer.	13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	

Node: 5. Routine Operations: Transferring from UTF Storage to Marine Piers/Docks or Hickam
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Potential public impact. Potential impact to mission capability or unit readiness. 33 CFR Part 154 Coast Guard requires testing hoses to 1.5 x deadhead pressure. PHA Team concluded the highest pressure expected in a marine transfer that is deadheaded is the UTF pump for product F-76 at **219 psig**. This pressure is greater than 1) the gravity head from the highest tank at RHL to the dock, 2) the available deadhead from the YON pumps, 3) deadhead pressure of ship pump, and 4) any single pump in UGPH. However, should two pumps in series ever be considered to be included in an Operations Order, the highest deadhead pressure to be considered is **268 psig**. PHA Team discussed the fact that both the pump discharge pressure and hose life/condition impacts hose failure likelihood. To be conservative, consequences were developed assuming failure of hose independent of pump deadhead pressure.					All hoses are hydrostatically tested to 150 psig annually. Coast Guard verifies hose labeling and record-keeping annually. Hose rating is 200 to 250 psig depending on manufacturer. Hose test pressure per manufacturer is 300 psig. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Operational practice is to start fuel transfer and slowly increase pressure in increments until full flow is established. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Ship should have safeguards for their pump.		
		5. Potential delay in product movement. Potential impact to mission capability or unit readiness.	MR	3	C	4	Large storage systems and redundant capability.		
	7. Transferring more fuel than desired to receiving vessel?	1. Potential to overfill ship tank. Potential release of ambient flammable liquid to ship and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 3 1 1	D D D D	4 5 3 3	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. High and high high level alarms, and/or high pressure trips on ship tanks/piping.		PHA Team concluded safeguards are adequate.

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted]
Components:
Design Intention/Parameters: Six aboveground atmospheric storage tanks are connected to the areas in various [redacted] lines routing through Valve Stations [redacted]. Remaining fuels from the Upper Tank Farm flow via Pumphouse [redacted] for distribution to multiple sites.

Tank to tank transfers at Red Hill are accomplished by moving one tank via UGPH, addressed in Node 5, and transferring to the new tank from UGPH, addressed in Node 1. An additional parameter (What if?) is included in this node for unique concerns in these two incremental moves.

JP-5 is in a single tank in UTF and could be transferred to or from RHL via UGPH. Transfer from RHL to Tank 55 JP-5 Tank (Upper Tank Farm) is addressed in Node 23. An additional parameter (What if?) is included in this node for unique concerns in these two incremental moves.
Operating Conditions: 1. Flow: [redacted]; 2. Pressure: 0 to 100 psi; 3. Temperature: 60 to 80°F

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
6.1. No / Less Flow (PRL)	1. Any manual block valve or MOV closed in line sequence at startup or during the operation which required a change in the	1. Potential to cavitate/deadhead [redacted] Potential seal damage. Potential seal leak. Potential release	MR H/S	3 2	D D	5 4	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test	

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
	Operations Order.	of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	E	4	D	5	maintained for at least 3 years.	equipment. (High Priority)	
			P	4	D	5	PRL Control Room utilizes AFHE to confirm valve alignment.		
							Control room operator (CRO) monitors position of DBB and skin valves.		
							[redacted] low flow (switch) on [redacted] stops respective pump. FSs are not currently part of calibration system.		
							VS-[redacted] high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration.		
							[redacted] high pressure (switch) (1oo2) on the discharge of pumps stops respective pump. PSHs are not currently part of calibration system. [redacted] high pressure (transmitter) on the discharge of pump stops respective pump. PITs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration.		
							PSL-[redacted] low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. PIT-P1411B/P1412B/P1413B low pressure (transmitter) on the suction of pumps stops respective pump. PITs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration.		
							[redacted] high bearing temperature on pump stops respective pump. TEs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration.		
							Pump is equipped with an OCV-like control valve for minimum flow.		
							Pump from another product could be utilized by rotating spec blinds and flushing lines.		
		2. Potential delay in product movement. Potential impact to mission capability or unit readiness.	MR	3	C	4	Large storage systems and redundant capability.		
	2. [redacted]	1. Potential delay in product movement. Potential impact to mission capability or unit readiness.	MR	3	C	4	Large storage systems and redundant capability.		

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
	[redacted]	2. Potential reverse flow through down pump rotating backwards. Potential equalization of tank levels. Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	3	C	4	OCV on the discharge of each [redacted] Pumphouse) acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	PHA Team concluded safeguards are adequate.
			H/S	2	C	3			
			E	4	C	5			
			P	4	C	5			
	3. OCV set pressure on the discharge of [redacted] higher than desired. [redacted]	1. Potential to deadhead [redacted]). Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	3	D	5	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. PRL Control Room utilizes AFHE to confirm valve alignment. Control room operator (CRO) monitors position of DBB and skin valves. [redacted] low flow (switch) on [redacted] stops respective pump. FSs are not currently part of calibration system. VS [redacted] high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration. [redacted] high pressure (switch) (1oo2) on the discharge of pumps stops respective pump. PSHs are not currently part of calibration system. [redacted] high pressure (transmitter) on the discharge of pump stops respective pump. PITs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration. [redacted] high bearing temperature on pump stops respective pump. TEs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration. Pump is equipped with an OCV-like control valve for minimum flow. Pump from another product could be utilized by rotating spec blinds and flushing lines.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	
			H/S	2	D	4			
			E	4	D	5			
			P	4	D	5			
		2. Potential delay in product movement. Potential	MR	3	C	4	Large storage systems and redundant capability.		

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		impact to mission capability or unit readiness.							
6.2. More Flow (PRL)	1. OCV set pressure on the discharge of [redacted] lower than desired. [redacted])	1. Potential increased fuel level in receipt tank faster than expected. No hazardous consequences identified.							
6.3. Reverse Flow (PRL)	1. No new causes identified.								
6.4. Misdirected Flow (PRL)	1. Tank 47/48/54 F-76 Tank (Upper Tank Farm) skin valve fails to seat during transfer. (F-76 tanks only) [redacted]	1. Potential to overpressure and/or overfill unintended Tank 47/48/54 F-76 Tanks (Upper Tank Farm). Potential release of ambient flammable liquid to a lined containment area. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	D	4	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.		
			H/S	3	D	5	LAH-47/48/54 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
			P	2	D	4	LSHH-47/48/54 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
6.5. High Pressure (PRL)	1. No causes identified. PHA Team concluded API 650 Atmospheric Storage Tank inbreathing and outbreathing requirements are met with multiple breathing/vents.								
6.6. Low Pressure (PRL)	1. No causes identified. PHA Team concluded API 650 Atmospheric Storage Tank inbreathing and outbreathing requirements are met with multiple breathing/vents.								
6.7. High Level (PRL)	1. No new causes identified.								
6.8. Low Level (PRL)	1. Failure to stop transfer when needed.	1. Potential to cavitate [redacted] Pumphouse). Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	3	D	5	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
			H/S	2	D	4	[redacted] low flow (switch) on [redacted] stops respective pump. FSs are not currently part of calibration system.		
			E	4	D	5	VS [redacted] high vibration on pump and motor		
			P	4	D	5			

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							stops respective pump. VSs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration. PSL-[redacted] (b)(3)(A) low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. PIT[redacted] (b)(3)(A) low pressure (transmitter) on the suction of pumps stops respective pump. PITs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration. [redacted] (b)(3)(A) high bearing temperature on pump stops respective pump. TEs are not currently part of calibration system. All pump safeguards are on UPS backup power with 4 hour duration. Pump from another product could be utilized by rotating spec blinds and flushing lines.		
		2. Potential delay in product movement. Potential impact to mission capability or unit readiness.	MR	3	C	4	Large storage systems and redundant capability.		
6.9. Composition (PRL)	1. Failure to dewater Tank 47/48/54 F-76 Tank (Upper Tank Farm) or Tank 46/53 F-24 Tank (Upper Tank Farm) or Tank 55 JP-5 Tank (Upper Tank Farm) bottom drain. [redacted] (b)(3)(A)	1. Potential accelerated corrosion in Tank 47/48/54 F-76 Tank (Upper Tank Farm) or Tank 46/53 F-24 Tank (Upper Tank Farm) or Tank 55 JP-5 Tank (Upper Tank Farm) floors. Potential loss of containment. Potential to release ambient flammable liquid to surrounding area and/or groundwater. Potential environmental impact. Potential public impact. Potential impact to mission capability or unit readiness. PHA Team discussed an emerging issue of accelerated corrosion due to fluorides and chlorides measured in sample during dewatering. fluorides and chlorides were traced back to defueled liquids from Navy vessels.	MR E P	2 2 2	C C C	3 3 3	Unscheduled Fuel Movement (UFM) alarm alerts operator to investigate and take action per UFM SOP. Inventory Trend Analysis reviewed every 4 hours by CRO. UFC 460-3 has requirement to dewater Tank 47/48/54 F-76 Tank (Upper Tank Farm), Tank 46/53 F-24 Tank (Upper Tank Farm) and Tank 55 JP-5 Tank (Upper Tank Farm) monthly. Tank 47/48/54 F-76 Tank (Upper Tank Farm), Tank 46/53 F-24 Tank (Upper Tank Farm) and Tank 55 JP-5 Tank (Upper Tank Farm) are equipped with double-bottoms. BS&W alarm set at 9" on each of Tank 47/48/54 F-76 Tank (Upper Tank Farm), Tank 46/53 F-24 Tank (Upper Tank Farm) and Tank 55 JP-5 Tank (Upper Tank Farm) will alert operator to initiate dewatering of tank.	64. Consider testing for fluorides and chlorides in all liquids either before defueling if possible or after receipt and consider alternatives to receiving defuels from Navy vessels if data warrants. (Medium Priority) 65. Develop a SOP for dewatering Tank 47/48/54 F-76 Tank (Upper Tank Farm), Tank 46/53 F-24 Tank (Upper Tank Farm) and Tank 55 JP-5 Tank (Upper Tank Farm) to increase the likelihood of complete dewatering not partial dewatering. (High Priority)	
6.10. Leak / Rupture (PRL)	1. No new causes identified.								
6.11. Start-up / Shutdown (PRL)	1. No causes identified.								
6.12. Maintenance / Inspection (PRL)	1. Preparing equipment for maintenance and coordinating maintenance activities within the required inspection schedule	1. Out of compliance, component failure, increase maintenance/repair costs/release to environment					Regulatory oversight/Mission priority-leadership engagement		

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
	(Mechanical Integrity Program). Since an Operational Readiness Review was in progress at the time of the PHA, Team did not develop this cause further.								
6.13. Corrosion / Erosion (PRL)	1. Coating failure or cathodic protection failure. Since a full structural integrity was in progress at the time of the PHA, Team did not develop this cause further.	1. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.					Annual Leak Detection/API 570/API 653/Coating Survey/CP Survey Secondary Containment Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. PH Fire Department		
6.14. What If...Tank to tank transfer in RHL?	1. Failure to slowly throttle ball valve at destination tank during sluicing? ([redacted]	1. Potential introduction of turbulent flow to lateral piping and inside destination tank. Potential vibration and line movement. Potential to dislodge diffuser, lateral piping, and/or Dresser Coupling. Potential to introduce ambient flammable liquid to Lower Access Tunnel. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: Transformer, primary disconnects, and MCC switch gear are currently located in electrical room inside Lower Tunnel.	MR H/S E P	2 1 1 1	C C C C	3 2 2 2	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11). 24. Modify CIR contracts to include restraining pipe between blanked sections when taking tank out of service for maintenance or inspection. (High Priority) 25. Include verification step in Operations Order that piping is restrained before starting any evolution involving transferring liquid from any tank in Red Hill Tank Gallery. (High Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers ([redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC	

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
								switch gear [redacted] and consider relocation to an area external to tunnel system, similar to [redacted] Electrical Room Relocation Project MILCON P-8006. (High Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority) 32. Evaluate the need for Dresser Couplings in the [redacted] and [redacted] main distribution piping in Red Hill Tank Gallery between TK 114 JP-5 Tank (Red Hill) and TK 116 F-76 Tank (Red Hill), shown on Drawing [redacted] If they can be removed safely, remove the Dresser Couplings. JP-5 Emergent Pipeline Repairs were underway at the time of the PHA and will include eliminating old Dresser Coupling on [redacted] JP-5 piping. This recommendation should be completed prior to returning JP-5 piping to service. (High Priority)	
		2. Potential introduction of turbulent flow to lateral piping and inside destination tank. Potential vibration and line movement. Potential to dislodge diffuser, lateral piping, and/or Dresser Coupling. Potential to introduce ambient flammable liquid to Zone 7 Sump and/or Main Sump (fuel sumps). Potential rapid release of very large quantity of ambient flammable liquid to TK 311 Slop Tank. Potential increased level in TK 311. Potential to overfill TK 311. Potential increased level in secondary containment (> 6ft deep, one set of stairs in corner, vertical side walls). Potential pool fire. Potential release to soil, groundwater and/or Halawa stream. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: Pumps at Main Sump have a combined capacity of ~300 gpm. TK 311 is not equipped with pumps to remove level. A vacuum truck is brought in when needed to remove level. TK 311 is in an isolated area not near through traffic roads. Inside the containment there are no sources of ignition. Isolation valve at the tank can be closed outside of containment area. At the time of the PHA the area adjacent to TK 311 is in use for groundwater treatment. Flow from Groundwater Sump Pump inside AFFF Sump (typical of five) may accelerate this consequence.	MR H/S E P	4 1 1 1	D D D D	5 3 3 3	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program. LSH-100 high level (switch) in Main Sump starts Main Sump Pump A and alerts operator to investigate source of level and intervene. LSHH-100 high high level (switch) Main Sump starts Main Sump Pump A and Main Sump Pump B and alerts operator to investigate source of level and intervene. Both LSH-100 and LSHH-100 share a sensor. They are part of a PM program but not using certified or calibrated test equipment. Main Sump level switches high and low are not on UPS backup power, but are operated by [redacted] LSH-0197 high level (switch) in Zone 7 area alerts operator to investigate cause of presence of liquid level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-311 high level alarm on TK 311 Slop Tank alerts	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 43. Install a second and independent high level indication and alarm on TK 311 Slop Tank to reduce the likelihood of overfilling TK 311 unknowingly. (Medium Priority) 44. Review current practices and operability of TK 311 Slop Tank with groundwater treatment equipment and personnel adjacent to TK 311 to evaluate the interaction of the two operations and modify practices if warranted. (Low Priority) 11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							operator to investigate source of level and intervene. LSHH-311 is calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		3. Potential introduction of turbulent flow to lateral piping and inside destination tank. Potential vibration and line movement. Potential to dislodge diffuser, lateral piping, and/or Dresser Coupling. Potential to introduce ambient flammable liquid to AFFF Sump (typical of five). Potential to pump ambient flammable liquid to AFFF Retention Tank. Potential to overfill AFFF Retention Tank. Potential to introduce ambient flammable liquid to secondary containment (sloped sides). Potential ambient flammable liquid carryover to GAC and Halawa stream. Potential pool fire. Potential release to soil, groundwater and/or Halawa stream. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: AFFF System Project was completed in 2019. The AFFF Retention Tank has a capacity of 153,000 gal. and was sized to hold 20 minutes of fire fighting foam and water plus 80,000 gal. of fuel from a leak. The AFFF system is currently made of PVC and CS. There is currently only local level indication in the five AFFF Sumps. There is currently no level indication on the AFFF Retention Tank. At the time of the PHA, the motors to the pumps from AFFF Sumps were LOTO to reduce the likelihood of autostart. Currently, the AFFF System is contractually maintained by a company responsible for multiple JBPHH entities. Consequence similar to May 6, 2021 incident and November 20, 2021 incident.	MR H/S E P	4 2 1 1	C C C C	5 3 2 2	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program. Each of the five AFFF Sumps contain four pumps intended for staggered start (local level switch) to pump to AFFF Retention Tank. The AFFF Sump pumps were recently added to a PM schedule.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 45. Ensure run status indication on all pumps inside all AFFF Sumps (20 pumps) is integrated with the AFHE SCADA to alert Control Room Operator (CRO) to potential release of fuel and/or AFFF. (High Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 47. Evaluate the design of the 14" AFFF discharge line piping on the discharge of 20 AFFF Sumps pumps as part of the current project to upgrade PVC to CS. The PHA Team is concerned about 1) the volume flow and separately, 2) line slope or configuration to trap liquid in retention line, and 3) lack of damage control isolation in long-run of piping. (High Priority) 48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High Priority) 49. Train all affected personnel on the design, intent, and operation of the AFFF System, including refresher training. (High Priority) 50. Consider equipping AFFF Retention Tank with reliable level indication and level alarm to alert Control Room Operator (CRO) to presence of level in AFFF Retention Tank. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		4. Potential introduction of turbulent flow to lateral piping and inside destination tank. Potential vibration and line movement. Potential to dislodge diffuser, lateral piping, and/or Dresser Coupling. Potential to introduce ambient	MR H/S E	3 1 1	C C C	4 2 2	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of	

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix			Safeguards	PHA Recommendation	Comments
				C	L	RR			
		flammable liquid to Water Shaft, Adit 3 Ground Water Sump and/or Septic Sump. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Consistent with May 6, 2021 incident and November 20, 2021 incident.	P	1	C	2	PM program.	vacuum/lack of fluid in pipeline. (Medium Priority)	
							Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority)	
							High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
							Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority)	
								29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority)	
								21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority)	
								46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority)	
								51. Consider designing a system to separate oil and water to reduce the likelihood of discharging flammable liquid to environment from Adit 3 Groundwater Sump. (Medium Priority)	
								52. Provide means to remove contamination from water supply. (High Priority)	
								31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		5. Potential introduction of turbulent flow to lateral piping and inside destination tank. Potential vibration and line movement. Potential to dislodge diffuser, lateral piping, and/or Dresser Coupling. Potential to introduce ambient flammable liquid to Harbor Tunnel. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil, groundwater, and/or Pearl Harbor waterways. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	3	C	4	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority)	
			H/S	1	C	2			
			E	1	C	2		26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority)	
			P	1	C	2	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority)	
							High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
								28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority)	
							Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority)	
								21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority)	

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
								46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 53. Evaluate an emergency breathing air supply for Harbor Tunnel due to its long length, limited egress, and reduced ventilation. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		6. Potential introduction of turbulent flow to lateral piping and inside destination tank. Potential vibration and line movement. Potential to dislodge diffuser, lateral piping, and/or Dresser Coupling. Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH. Potential fire and/or explosion. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Currently [redacted] The type of casing material is unknown. There is currently an awarded project to replace [redacted]	MR H/S E P	2 1 2 1	C C C C	3 2 3 2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		7. Potential introduction of turbulent flow to lateral piping and inside destination tank. Potential	MR	2	C	3	[redacted]	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] P-	

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		vibration and line movement. Potential to dislodge diffuser, lateral piping, and/or Dresser Coupling. Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential to overfill UGPH to Lower Yard Tunnel (LYT) and/or Harbor Tunnel and/or Surge Tank Tunnel. Potential to overfill tunnels and/or sumps to surrounding area and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	H/S	1	C	2	1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LSH high level (switch) in Harbor Tunnel Sump with local audible alarm alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	1411/1412 F-24 Pump [redacted] Pumphouse), P-1413 F-76 Pump [redacted] Pumphouse), P-1414 Multi-Product Pump [redacted] Pumphouse) are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
			E	2	C	3			
			P	1	C	2			
		8. Potential introduction of turbulent flow to lateral piping and inside destination tank. Potential vibration and line movement. Potential to dislodge diffuser, lateral piping, and/or Dresser Coupling. Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank (normal lineup, B1 and B2	MR	2	D	4	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
			H/S	1	D	3			
			E	2	D	4			
			P	1	D	3			

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Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		are sluiced). Potential to overfill Tank 1301/1302 to containment area. Potential release to soil below containment area (due to leaking containment) and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential overfill to Lower Yard Tunnel (LYT) may accelerate this consequence (abnormal lineup).					PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LAH-B1/B2 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-B1/B2 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
		9. Potential introduction of turbulent flow to lateral piping and inside destination tank. Potential vibration and line movement. Potential to dislodge diffuser, lateral piping, and/or Dresser Coupling. Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to Adit 1 Sump (abnormal lineup). Potential to overfill Adit 1, Harbor Tunnel, and/or Adit 2 (including french drain systems). Potential release to soil	MR H/S E P	2 1 1 1	D D D D	4 3 3 3	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High	

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		and/or groundwater and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential overfill to Lower Yard Tunnel (LYT) may accelerate this consequence. Potential to overfill to Harbor Tunnel may accelerate this consequence.					PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
		10. Potential introduction of turbulent flow to lateral piping and inside destination tank. Potential vibration and line movement. Potential to dislodge diffuser, lateral piping, and/or Dresser Coupling. Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential to overfill UGPH to Lower Yard Tunnel (LYT) and/or Harbor Tunnel and/or Surge Tank Tunnel. Potential release to soil and/or groundwater below Surge Tank Tunnel (due to leaking tunnel) and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 1 1 1	D D D D	4 3 3 3	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted]	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted]	

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT [redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT [redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	[redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
	2. Failure to re-align manual block valves during repeat cycles of Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank filling and pumping? [redacted]	1. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Lower Access Tunnel. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: Transformer, primary disconnects, and MCC switch gear are currently located in electrical room inside Lower Tunnel. Consistent with May 6, 2021 incident and September 29, 2021 near-miss.	MR	2	B	2	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	24. Modify CIR contracts to include restraining pipe between blanked sections when taking tank out of service for maintenance or inspection. (High Priority) 25. Include verification step in Operations Order that piping is restrained before starting any evolution involving transferring liquid from any tank in Red Hill Tank Gallery. (High Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC	
			H/S	1	B	1			
			E	1	B	1			
			P	1	B	1			

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
								switch gear [redacted] and consider relocation to an area external to tunnel system, similar to [redacted] Electrical Room Relocation Project MILCON P-8006. (High Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority) 32. Evaluate the need for Dresser Couplings in the [redacted] and [redacted] main distribution piping in Red Hill Tank Gallery between TK 114 JP-5 Tank (Red Hill) and TK 116 F-76 Tank (Red Hill), shown on Drawing [redacted] If they can be removed safely, remove the Dresser Couplings. JP-5 Emergent Pipeline Repairs were underway at the time of the PHA and will include eliminating old Dresser Coupling on [redacted] JP-5 piping. This recommendation should be completed prior to returning JP-5 piping to service. (High Priority) 66. Design and install interlock and permissive systems for all fuel movements to/from RHL and UGPH, to reduce the likelihood of human error of sequencing valves during lineup. Design should consider use of the manual clutch to bypass MOV operation. (High Priority) Some action is already underway as the result of AB&A Root Cause Analysis into the May 6, 2021 Mishap.	
		2. Potential sagging of pipeline between UGPH and RHL. Potential to draw vacuum in piping between Hotel Pier and UGPH, and between UGPH and RHL. Potential to collapse piping. Potential loss of containment. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 1 2 1	C C C C	3 2 3 2	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders. Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 7. Perform a Pipe Collapse Pressure Study to determine the pressure required to collapse the existing pipe and identify and install safeguard(s) as warranted. Consider integrating this recommendation with upcoming API 570 Assessment. (High Priority)	
		3. Potential sagging of pipeline between UGPH and RHL. Potential to draw vacuum in piping between Hotel Pier and UGPH, and between UGPH and RHL. Potential to damage seals in Dresser Coupling. Potential loss of containment when flow is re-established. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 1 2 1	C C C C	3 2 3 2	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders. Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 8. Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around pumps installed in UGPH and Red Hill Tank Gallery. Consider modifying design if manufacturer has alternate sealing system and Dresser Couplings remain part of design. (High Priority) 9. Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling. (High Priority)	

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	L	RR	Safeguards	PHA Recommendation	Comments
							maintained for at least 3 years.		
		4. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Zone 7 Sump and/or Main Sump (fuel sumps). Potential rapid release of very large quantity of ambient flammable liquid to TK 311 Slop Tank. Potential increased level in TK 311. Potential to overfill TK 311. Potential increased level in secondary containment (> 6ft deep, one set of stairs in corner, vertical side walls). Potential pool fire. Potential release to soil, groundwater and/or Halawa stream. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: Pumps at Main Sump have a combined capacity of ~300 gpm. TK 311 is not equipped with pumps to remove level. A vacuum truck is brought in when needed to remove level. TK 311 is in an isolated area not near through traffic roads. Inside the containment there are no sources of ignition. Isolation valve at the tank can be closed outside of containment area. At the time of the PHA the area adjacent to TK 311 is in use for groundwater treatment. Flow from Groundwater Sump Pump inside AFFF Sump (typical of five) may accelerate this consequence.	MR	4	D	5	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021).	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
			H/S	1	D	3	PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program.	28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority)	
			E	1	D	3	High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically.	29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority)	
			P	1	D	3	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority)	
							Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	43. Install a second and independent high level indication and alarm on TK 311 Slop Tank to reduce the likelihood of overfilling TK 311 unknowingly. (Medium Priority)	
							LSH-100 high level (switch) in Main Sump starts Main Sump Pump A and alerts operator to investigate source of level and intervene. LSHH-100 high high level (switch) Main Sump starts Main Sump Pump A and Main Sump Pump B and alerts operator to investigate source of level and intervene. Both LSH-100 and LSHH-100 share a sensor. They are part of a PM program but not using certified or calibrated test equipment. Main Sump level switches high and low are not on UPS backup power, but are operated by (b)(3)(A) [redacted] (b)(3)(A)	44. Review current practices and operability of TK 311 Slop Tank with groundwater treatment equipment and personnel adjacent to TK 311 to evaluate the interaction of the two operations and modify practices if warranted. (Low Priority) 11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
							LSH-0197 high level (switch) in Zone 7 area alerts operator to investigate cause of presence of liquid level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-311 high level alarm on TK 311 Slop Tank alerts operator to investigate source of level and intervene. LSHH-311 is calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		5. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser	MR	4	B	4	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021).	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority)	
			H/S	2	B	2	PITs used to sense pressure in piping are located several		

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to AFFF Sump (typical of five). Potential to pump ambient flammable liquid to AFFF Retention Tank. Potential to overfill AFFF Retention Tank. Potential to introduce ambient flammable liquid to secondary containment (sloped sides). Potential ambient flammable liquid carryover to GAC and Halawa stream. Potential pool fire. Potential release to soil, groundwater and/or Halawa stream. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: AFFF System Project was completed in 2019. The AFFF Retention Tank has a capacity of 153,000 gal. and was sized to hold 20 minutes of fire fighting foam and water plus 80,000 gal. of fuel from a leak. The AFFF system is currently made of PVC and CS. There is currently only local level indication in the five AFFF Sumps. There is currently no level indication on the AFFF Retention Tank. At the time of the PHA, the motors to the pumps from AFFF Sumps were LOTO to reduce the likelihood of autostart. Currently, the AFFF System is contractually maintained by a company responsible for multiple JBPHH entities. Consequence similar to May 6, 2021 incident and November 20, 2021 incident.	E P	1 1	B B	1 1	miles from Red Hill Tank Gallery and are not currently part of a PM program. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program. Each of the five AFFF Sumps contain four pumps intended for staggered start (local level switch) to pump to AFFF Retention Tank. The AFFF Sump pumps were recently added to a PM schedule.	26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve <u>prior to defueling</u> to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 45. Ensure run status indication on all pumps inside all AFFF Sumps (20 pumps) is integrated with the AFHE SCADA to alert Control Room Operator (CRO) to potential release of fuel and/or AFFF. (High Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 47. Evaluate the design of the 14" AFFF discharge line piping on the discharge of 20 AFFF Sumps pumps as part of the current project to upgrade PVC to CS. The PHA Team is concerned about 1) the volume flow and separately, 2) line slope or configuration to trap liquid in retention line, and 3) lack of damage control isolation in long-run of piping. (High Priority) 48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High Priority) 49. Train all affected personnel on the design, intent, and operation of the AFFF System, including refresher training. (High Priority) 50. Consider equipping AFFF Retention Tank with reliable level indication and level alarm to alert Control Room Operator (CRO) to presence of level in AFFF Retention Tank. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		6. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Water Shaft, Adit 3 Ground Water Sump and/or Septic Sump. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Consistent with May 6, 2021 incident and	MR H/S E P	3 1 1 1	B B B B	3 1 1 1	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve <u>prior to defueling</u> to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		November 20, 2021 incident.					hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 51. Consider designing a system to separate oil and water to reduce the likelihood of discharging flammable liquid to environment from Adit 3 Groundwater Sump. (Medium Priority) 52. Provide means to remove contamination from water supply. (High Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		7. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Harbor Tunnel. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil, groundwater, and/or Pearl Harbor waterways. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	3	B	3	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 53. Evaluate an emergency breathing air supply for Harbor Tunnel due to its long length, limited egress,	
			H/S	1	B	1			
			E	1	B	1			
			P	1	B	1			

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
								and reduced ventilation. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		8. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling. Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH. Potential fire and/or explosion. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Currently [redacted] The type of casing material is unknown. There is currently an awarded project to replace [redacted]	MR H/S E P	2 1 2 1	B B B B	2 1 2 1	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank [redacted] Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		9. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential to overfill UGPH to Lower Yard Tunnel (LYT) and/or Harbor Tunnel and/or Surge Tank Tunnel.	MR H/S E P	2 1 2 1	B B B B	2 1 2 1	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High	

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Potential to overfill tunnels and/or sumps to surrounding area and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.					PSL and PIT share common root valve.	Priority)	
							[redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
							[redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system.	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
							TT[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system.	18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
							CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
							OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.		
							SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]		
							LSH high level (switch) in Harbor Tunnel Sump with local audible alarm alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		10. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank (normal lineup, B1 and B2 are sluiced). Potential to overfill Tank 1301/1302 to containment area. Potential release to soil below containment area (due to leaking containment) and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit	MR	2	C	3	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	
			H/S	1	C	2	[redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve.	15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
			E	2	C	3		16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority)	
			P	1	C	2	[redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
							[redacted]	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted]	

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		readiness. Potential overfill to Lower Yard Tunnel (LYT) may accelerate this consequence (abnormal lineup).					1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT [redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT [redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LAH-B1/B2 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-B1/B2 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	[redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
		11. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to [redacted] Sump (abnormal lineup). Potential to overfill [redacted] Harbor Tunnel, and/or Adit 2 (including french drain systems). Potential release to soil and/or groundwater and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential overfill to Lower Yard Tunnel (LYT)	MR H/S E P	2 1 1 1	C C C C	3 2 2 2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD	

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		may accelerate this consequence. Potential to overfill to Harbor Tunnel may accelerate this consequence.					not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
		12. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential to overfill UGPH to Lower Yard Tunnel (LYT) and/or Harbor Tunnel and/or Surge Tank Tunnel. Potential release to soil and/or groundwater below Surge Tank Tunnel (due to leaking tunnel) and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 1 1 1	C C C C	3 2 2 2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank [redacted] Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.		
							SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]		
							LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
6.15. What If...Tank 55 JP-5 Tank (Upper Tank Farm) to RHL transfer?	1. Valve 222A open during transfer? [redacted]	1. Potential to pump contents of both Tank 55 JP-5 Tank (Upper Tank Farm) and Tank 0222 JP-5 Surge Tank 2 to RHL. Potential air entrainment in [redacted] 207/208 JP-5 Pump (UGPH). Potential slight decreased pump flowrate and discharge pressure. No hazardous consequences identified.							
	2. [redacted] 207/208 JP-5 Pump (UGPH) not running during transfer? [redacted]	1. Potential reverse rotation of [redacted] 207/208 JP-5 Pump (UGPH). Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	C	5	OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.	15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
			H/S	3	C	4		18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
			E	4	C	5			
			P	4	C	5			
		2. Potential reverse flow through down pump rotating backwards. Potential to overpressure and/or overfill Tank 55 JP-5 Tank. Potential release of ambient flammable liquid to a lined containment area. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	D	4	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
			H/S	3	D	5	OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.		
			P	2	D	4	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
							LAH-55 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-55 high high level (switch) stops all transfer pumps in		

Node: 6. Routine Operations: Transferring from Storage to Storage in PRL and RHL
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		3. Potential reverse flow through down pump rotating backwards. Potential increased level in Tank 0222 JP-5 Surge Tank 2 if valve 0222A is open. Potential to overfill Tank 0222. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	D	5	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.
			H/S	3	D	5	Unscheduled Fuel Movement (UFM) alarm alerts operator to investigate and take action per UFM SOP.		
			E	3	D	5			
			P	1	D	3	OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.		
							Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
							LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							Camera coverage above Adit 1 shows vent line on all four Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Cameras are included in scheduled PM program.		

Node: 7. Routine Operations: Reclaim System
Drawings: M-100; M-104; M-114A; M-114B
Components: Skimmer 1; Skimmer 2; Tank 1301 Reclaim (B1) Tank; Tank 1302 Reclaim (B2) Tank; Tank 1303 DAF Tank; TK 311 Slop Tank
Design Intention/Parameters: There are two FOR systems at this facility. The system at Red Hill is currently used to collect sump water from the Red Hill Tunnel Tank Gallery and bottom water from the Red Hill Storage Tanks. Product is stored in TK 311 Slop Tank (1,000 Bbl AST), located adjacent to the Adit 3 entrance. The FOR system at Pearl Harbor has Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank (12,000 Bbl ASTs) and various associated piping for processing FOR. Material from Tank 1301/1302 can be processed through skimmers and sent to BOWTS for more processing or sent to Tank 1303 DAF Tank or released to streets, sewer, or ocean if there is no sheen and sample is approved. The reclaimed fuel can be issued to the Truck Fill Station or into the F-76 header.
Operating Conditions: 1. Flow: 600 gpm (to BOWTS); 2. Pressure: atm; 50 psi (pump discharge); 3. Temperature: 80 to 85°F

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
7.1. No / Less Flow	1. Any valve closed between Reclaim Pit and V12. (M-114B)	1. Potential increased level in Reclaim Pit. Potential to overfill Reclaim Pit. Potential liquid	MR	4	C	5	Supervisor's responsible for developing and issuing Operations Orders. Any needed modifications are discussed		

Node: 7. Routine Operations: Reclaim System
Drawings: M-100; M-104; M-114A; M-114B

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		carryover to concrete secondary containment area. Potential release of oily water to surrounding area and/or groundwater. Potential environmental impact. Potential impact to mission capability or unit readiness.	E	4	C	5	with supervisor and approved before use (operations practice). Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. LSH-1328 high level (switch) in Reclaim Pit alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		2. Potential to introduce oily water from any spill inside FORFAC containment to FORFAC Storm Drain Pit. Potential inability to drain UTF berm areas to the ocean. Potential increased level inside UTF berm area. Potential to float tanks in UTF off of foundation. Potential loss of containment. Potential release of ambient flammable liquid. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. At the time of the PHA, none of the tanks in UTF are anchored.	MR H/S E P	1 2 1 1	D D D D	3 4 3 3	None identified.	67. Investigate anchor chair requirements for all tanks in the UTF and FORFAC, and Tank 311 at RHL. (Medium Priority) This recommendation may be similar to a recommendation from SGH.	
	2. Duplex strainer on the suction of [redacted] Pump plugged. (M-114B)	1. Potential increased level in Reclaim Pit. Potential to overfill Reclaim Pit. Potential liquid carryover to concrete secondary containment area. Potential release of oily water to surrounding area and/or groundwater. Potential environmental impact. Potential impact to mission capability or unit readiness.	MR E	4 4	C C	5 5	Supervisor's responsible for developing and issuing Operations Orders. Any needed modifications are discussed with supervisor and approved before use (operations practice). LSH-1328 high level (switch) in Reclaim Pit alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		2. Potential to cavitate [redacted] Pump. Potential to damage [redacted] seals. Potential seal leak. Potential release of oily water to surrounding area and/or groundwater. Potential environmental impact. Potential impact to mission capability or unit readiness.	MR E	3 4	C C	4 5	PSL-P1303 low pressure (switch) on the suction of pump stops pump. PSLs are not currently part of calibration system. VS-P1303 high vibration on pump stops pump. VSs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and ESs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 68. Install a differential pressure transmitter/switch and alarm across Duplex strainer on the suction of [redacted] Pump to decrease the likelihood of cavitation of [redacted] (Medium Priority) 69. Install PITs on the suction and discharge of [redacted] Pump to allow CRO to monitor [redacted] performance. (Medium Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of	

Node: 7. Routine Operations: Reclaim System
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
								Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 70. Include all PRL cameras in scheduled PM program. (Medium Priority)	
	3. [redacted] Pump not running when needed. (M-114B) PHA Team concluded anything that can flow into Tank 1302 Reclaim (B2) Tank or Tank 1301 Reclaim (B1) Tank can flow back out due to gravity as manual block valves are normally open due to autostart pumps.	1. Potential reverse rotation of [redacted] Pump. Potential seal damage. Potential seal leak. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	B	4	Single check valve in [redacted] Pump discharge.	5. Consider equipping [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 69. Install PITs on the suction and discharge of [redacted] Pump to allow CRO to monitor [redacted] performance. (Medium Priority) 71. Consider installing a second dissimilar check valve adjacent to 6" check valve on the discharge of [redacted] Pump to reduce the likelihood and quantity of reverse flow. (Low Priority)	
			H/S	3	B	3			
			E	4	B	4			
			P	4	B	4			
		2. Potential reverse flow due to gravity head from Tank 1301 Reclaim (B1) Tank or Tank 1302 Reclaim (B2) Tank through 6" check valve and [redacted] Pump and duplex strainer to Reclaim Pit. Potential to overfill Tank Reclaim Pit to containment area. Potential release to soil below containment area (due to leaking containment) and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. PHA Team concluded fire was a potential consequence since Tank 1302 contains a large quantity of oil, however the rate of reverse flow is limited by the restrictions due to check valve, pump, and strainer.	MR	2	C	3	Run status indication on [redacted] Pump status screen.	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority) 10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 69. Install PITs on the suction and discharge of [redacted] Pump to allow CRO to monitor [redacted] performance. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 70. Include all PRL cameras in scheduled PM program. (Medium Priority) 71. Consider installing a second dissimilar check valve adjacent to 6" check valve on the discharge of [redacted] Pump to reduce the likelihood and quantity of reverse flow. (Low Priority) 72. Use the existing level switch to activate a new, local audible and visual alarm with LSH-1328. (Medium Priority)	
			H/S	3	C	4	Operator in attendance during all transfers in FOR.		
			E	4	C	5	LSH-1328 high level (switch) in Reclaim Pit alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
			P	4	C	5			
	4. Either 6" or 8" manual block valve on the discharge of [redacted] Pump closed. (M-114B, M-114A)	1. Potential increased level in Reclaim Pit. Potential to overfill Reclaim Pit. Potential liquid carryover to concrete secondary containment area. Potential release of oily water to surrounding area and/or groundwater. Potential environmental impact. Potential impact to mission capability or unit readiness.	MR	4	C	5	Supervisor's responsible for developing and issuing Operations Orders. Any needed modifications are discussed with supervisor and approved before use (operations practice).		
			E	4	C	5	LSH-1328 high level (switch) in Reclaim Pit alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		2. Potential to deadhead [redacted] Pump. Potential	MR	3	C	4	PSH-P1303 high pressure (switch) on the discharge of pump	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted]	

Node: 7. Routine Operations: Reclaim System
Drawings: M-100; M-104; M-114A; M-114B

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		loss of containment. Potential release of oily water to surrounding area and/or groundwater. Potential environmental impact. Potential impact to mission capability or unit readiness.	E	4	C	5	upstream of check valve stops pump. PSHs are not currently part of calibration system. VS-P1303 high vibration on pump stops pump. VSs are not currently part of calibration system. Internal relief device integral to (b)(3)(A) [redacted] Pump, not included in calibration program.	(b)(3)(A) [redacted] (b)(3)(A) [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 69. Install PITs on the suction and discharge of (b)(3)(A) [redacted] Pump to allow CRO to monitor (b)(3)(A) [redacted] performance. (Medium Priority) 5. Consider equipping UGPH, (b)(3)(A) [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers (b)(3)(A) [redacted] (b)(3)(A) [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 70. Include all PRL cameras in scheduled PM program. (Medium Priority) 73. Install a pressure relief device on the discharge of (b)(3)(A) [redacted] Pump, sized and documented for blocked outlet and discharges to a safe location. (Medium Priority)	
	5. Any manual block valve on the outlet of Tank 1301 Reclaim (B1) Tank/Tank 1302 Reclaim (B2) Tank closed. (M-114A, M-114B)	1. Potential increased level in Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank (normal lineup, B1 and B2 are sluiced). Potential to overfill Tank 1301/1302 to containment area. Potential release to soil below containment area (due to leaking containment) and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 3 4 4	D D D D	4 5 5 5	Inventory Trend Analysis reviewed every 4 hours by CRO. LAH-B1/B2 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-B1/B2 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	5. Consider equipping UGPH, (b)(3)(A) [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers (b)(3)(A) [redacted] (b)(3)(A) [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority)	
	6. Any manual block valve on the outlet of Skimmer 1/2 closed. (M-114B)	1. Potential increased level in Skimmer 1/2. Potential to overfill Skimmer 1/2. Potential liquid carryover to concrete secondary containment area. Potential release of oily water to surrounding area and/or groundwater. Potential environmental impact. Potential impact to mission capability or unit readiness.	MR E	4 4	C C	5 5	Supervisor's responsible for developing and issuing Operations Orders. Any needed modifications are discussed with supervisor and approved before use (operations practice). Operator in attendance during all transfers in FOR.		
	7. Influent Sump Pump not running when needed. (M-114A) At the time of the PHA, only one Influent Sump Pump was installed.	1. Potential increased level in Influent Sump. Potential to overfill Influent Sump. Potential liquid carryover to concrete secondary containment area. Potential release of DAF influent to surrounding area and/or groundwater. Potential environmental impact. Potential impact to mission capability or unit readiness.	MR E	4 4	C C	5 5	Operator in attendance during all transfers in FOR.		
	8. Any manual block valve on the	1. Potential increased level in Influent Sump.	MR	4	C	5	Operator in attendance during all transfers in FOR.		

Node: 7. Routine Operations: Reclaim System
Drawings: M-100; M-104; M-114A; M-114B

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
	outlet of Influent Sump closed. (M-114A)	Potential to overfill Influent Sump. Potential liquid carryover to concrete secondary containment area. Potential release of DAF influent to surrounding area and/or groundwater. Potential environmental impact. Potential impact to mission capability or unit readiness.	E	4	C	5			
		2. Potential to deadhead Influent Sump Pump. Potential impact to mission capability or unit readiness. At the time of the PHA, only one Influent Sump Pump was installed. Second replacement pump is expected in September 2022 (long lead item, under project PRL-PND-640). In the interim, a temporary pump could be used.	MR	3	C	4			
	9. Valves on the outlet of Tank 1303 DAF Tank closed. (M-114B)	1. Potential to overfill Tank 1303 Dissolved Air Floatation (DAF) Tank. Potential liquid carryover to concrete secondary containment area. Potential release of DAF influent to surrounding area and/or groundwater. Potential environmental impact. Potential impact to mission capability or unit readiness.	MR	4	C	5			
			E	4	C	5			
	10. Slurry Pump not running when needed. (M-114B)	1. Potential delay in transferring DAF to Fort KAM. No hazardous consequences identified.							
	11. Filters on discharge of Slurry Pump plugged. (M-114B)	1. Potential delay in transferring DAF to Fort KAM. No hazardous consequences identified.							
		2. Potential to deadhead Slurry Pump. Potential to damage Slurry Pump seals. Potential seal leak. Potential release of DAF to surrounding area and/or groundwater. Potential environmental impact.	E	4	D	5			
	12. Any manual block valve to BOWTS closed. (M-114B)	1. Potential delay in transferring DAF to BOWTS. No hazardous consequences identified.							
		2. Potential to deadhead Slurry Pump. Potential to damage Slurry Pump seals. Potential seal leak. Potential release of DAF to surrounding area and/or groundwater. Potential environmental impact.	E	4	D	5			
7.2. More Flow	1. Heavy rainfall event or fire main break. Site experienced a fire main break in this area in 2021.	1. Potential increased level inside FORFAC containment. Potential inability to drain UTF berm areas to the ocean. Potential increased level inside UTF berm area. Potential to float tanks in UTF off of foundation. Potential loss of containment. Potential release of ambient flammable liquid. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	1	D	3		67. Investigate anchor chair requirements for all tanks in the UTF and FORFAC, and Tank 311 at RHL. (Medium Priority) This recommendation may be similar to a recommendation from SGH.	
			H/S	2	D	4			
			E	1	D	3			
			P	1	D	3			

Node: 7. Routine Operations: Reclaim System
Drawings: M-100; M-104; M-114A; M-114B

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		At the time of the PHA, none of the tanks in UTF are anchored and Tank 1301 Reclaim (B1) Tank/Tank 1302 Reclaim (B2) Tank in FORFAC are also not anchored.							
		2. Potential increased level inside FORFAC containment. Potential inability to drain UTF berm areas to the ocean. Potential increased level inside UTF berm area. Potential for water to make contact with electrical wiring in conduit. Potential electrocution. Potential personnel injury. Conduit containing high and low voltage wiring runs along the ground and walls in FORFAC area, including open sockets.	H/S	1	B	1	None identified.	74. Remove electrical connections and sockets from the inside of FORFAC containment area to reduce the likelihood of electrocution during periods of heavy rain or spill in secondary containment. If not feasible, install protective safeguards to reduce the risk of electrocution. (High Priority) 75. As an interim recommendation, 1) replace sockets with GFCI sockets inside the FORFAC secondary containment, 2) develop an SOP to engage NAVFAC prior to predicted heavy rainfall and include emergency phone numbers for power company contact, 3) provide access to breaker box near Tank 1301 Reclaim (B1) Tank, and 4) install signage that specifies "do not enter during periods of heavy rain or standing water" and includes a phone number contact to de-energize the area. (High Priority)	
	2. Drains from UTF tank berms open and storm drain outlet closed. (M-118A, M-118B, M-118C, M-114B)	1. Potential increased level inside FORFAC containment. Potential inability to drain UTF berm areas to the ocean. Potential increased level inside UTF berm area. Potential to float tanks in UTF off of foundation. Potential loss of containment. Potential release of ambient flammable liquid. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. At the time of the PHA, none of the tanks in UTF are anchored and Tank 1301 Reclaim (B1) Tank/Tank 1302 Reclaim (B2) Tank in FORFAC are also not anchored.	MR	1	D	3		67. Investigate anchor chair requirements for all tanks in the UTF and FORFAC, and Tank 311 at RHL. (Medium Priority) This recommendation may be similar to a recommendation from SGH.	
			H/S	2	D	4			
			E	1	D	3			
			P	1	D	3			
		2. Potential increased level inside FORFAC containment. Potential inability to drain UTF berm areas to the ocean. Potential increased level inside UTF berm area. Potential for water to make contact with electrical wiring in conduit. Potential electrocution. Potential personnel injury. Conduit containing high and low voltage wiring runs along the ground and walls in FORFAC area, including open sockets.	H/S	1	B	1	None identified.	74. Remove electrical connections and sockets from the inside of FORFAC containment area to reduce the likelihood of electrocution during periods of heavy rain or spill in secondary containment. If not feasible, install protective safeguards to reduce the risk of electrocution. (High Priority) 75. As an interim recommendation, 1) replace sockets with GFCI sockets inside the FORFAC secondary containment, 2) develop an SOP to engage NAVFAC prior to predicted heavy rainfall and include emergency phone numbers for power company contact, 3) provide access to breaker box near Tank 1301 Reclaim (B1) Tank, and 4) install signage that specifies "do not enter during periods of heavy rain or standing water" and includes a phone number contact to de-energize the area. (High Priority)	
7.3. Reverse Flow	1. No new causes identified.								
7.4. Misdirected Flow	1. Valve misaligned to unintended Skimmer. (M-114B)	1. Potential increased level in Skimmer 1/2. Potential to overfill Skimmer 1/2. Potential liquid carryover to concrete secondary containment area. Potential release of oily water to surrounding area and/or groundwater. Potential environmental impact. Potential impact to mission capability or unit readiness.	MR	4	C	5	Supervisor's responsible for developing and issuing Operations Orders. Any needed modifications are discussed with supervisor and approved before use (operations practice). Operator in attendance during all transfers in FOR.		
			E	4	C	5			
	2. Valve misaligned from DAF Tank to Fort KAM. (M-114B)	1. Potential to introduce untreated water to Fort KAM. Potential permit exceedance. Potential	E	3	C	4			

Node: 7. Routine Operations: Reclaim System
Drawings: M-100; M-104; M-114A; M-114B

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		environmental impact.							
	3. All valves 1447, 1453, 1445, and 1446 open. (M-115)	1. Potential to introduce reclaim material to Tank 48 F-76 Tank (Upper Tank Farm). Potential off-spec material in Tank 48. Potential impact to mission capability or unit readiness.	MR	3	D	5	COMNAVBASEPEARLINST 11345.5 order supports the current Industrial Waste Water Discharge Permit. Supervisor's responsible for developing and issuing Operations Orders. Any needed modifications are discussed with supervisor and approved before use (operations practice). Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. Unscheduled Fuel Movement (UFM) alarm alerts operator to investigate and take action per UFM SOP. Mil-STD-3004/Class B Laboratory.		
	4. Valve 1447 open and valves 1453 and 1461 closed. (M-115)	1. Potential to introduce reclaim material to VC-38 and/or Sierra Pier. Potential off-spec material to VC-38 and/or Sierra Pier. Potential contamination of vessel at Sierra Pier. Potential impact to mission capability or unit readiness.	MR	4	D	5	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. Mil-STD-3004/Class B Laboratory.		
7.5. High Pressure	1. No new causes identified. PHA Team concluded API 650 Atmospheric Storage Tank inbreathing and outbreathing requirements are met with multiple breathing/vents.								
7.6. Low Pressure	1. No causes identified. PHA Team concluded API 650 Atmospheric Storage Tank inbreathing and outbreathing requirements are met with multiple breathing/vents.								
7.7. High Level	1. No new causes identified.								
7.8. Low Level	1. No new causes identified.								
7.9. Composition	1. AFFF present in Reclaim Pit. (M-114B)	1. Potential process upset in FORFAC. No hazardous consequences identified.							
	2. Retention time in Tank 1303 DAF Tank shorter than desired. (M-114A)	1. Potential to introduce off-spec water to BOWTS. No hazardous consequences identified.							
	3. Debris/soil from erosion in Reclaim Pit. (M-114B)	1. Potential increased level in Reclaim Pit. Potential to overfill Reclaim Pit. Potential liquid carryover to concrete secondary containment area. Potential release of oily water to surrounding area and/or groundwater. Potential environmental impact. Potential impact to mission capability or unit readiness.	MR E	4 4	C C	5 5	Supervisor's responsible for developing and issuing Operations Orders. Any needed modifications are discussed with supervisor and approved before use (operations practice). Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. LSH-1328 high level (switch) in Reclaim Pit alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS		

Node: 7. Routine Operations: Reclaim System
Drawings: M-100; M-104; M-114A; M-114B

Deviation	Cause	Consequence	CAT	Risk Matrix			Safeguards	PHA Recommendation	Comments
				C	L	RR			
							backup power with 4 hour duration.		
		2. Potential to introduce oily water from any spill inside FORFAC containment to FORFAC Storm Drain Pit. Potential inability to drain UTF berm areas to the ocean. Potential increased level inside UTF berm area. Potential to float tanks in UTF off of foundation. Potential loss of containment. Potential release of ambient flammable liquid. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. At the time of the PHA, none of the tanks in UTF are anchored.	MR	1	D	3	None identified.	67. Investigate anchor chair requirements for all tanks in the UTF and FORFAC, and Tank 311 at RHL. (Medium Priority) This recommendation may be similar to a recommendation from SGH.	
			H/S	2	D	4			
			E	1	D	3			
			P	1	D	3			
7.10. Leak / Rupture	1. No new causes identified.								
7.11. Start-up / Shutdown	1. No new causes identified.								
7.12. Maintenance / Inspection	1. Preparing equipment for maintenance and coordinating maintenance activities within the required inspection schedule (Mechanical Integrity Program). Since an Operational Readiness Review was in progress at the time of the PHA, Team did not develop this cause further.	1. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.					Regulatory oversight/Mission priority-leadership engagement		
		2. Unresolved recommendations not corrected					Regulatory oversight/Mission priority-leadership engagement		
	2. Handover period between change of contractors, delaying activities. Since an Operational Readiness Review was in progress at the time of the PHA, Team did not develop this cause further.	1. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.					Regulatory oversight/Mission priority-leadership engagement		
7.13. Corrosion / Erosion	1. Coating failure or cathodic protection failure. (Typical for all installations at PRL) Since a full structural integrity was in progress at the time of the PHA, Team did not develop this cause further.	1. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.					Annual Leak Detection/API 570/API 653/Coating Survey/CP Survey		
							Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
							Secondary Containment		
							PH Fire Department		
	2. Soil erosion accumulating near above ground pipes. (Typical for all installations at PRL)	1. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or					Annual Leak Detection/API 570/API 653/Coating Survey/CP Survey		
							Rover Checklist requires walking the line during offloading,		

Node: 7. Routine Operations: Reclaim System
Drawings: M-100; M-104; M-114A; M-114B

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
	Since a full structural integrity was in progress at the time of the PHA, Team did not develop this cause further.	unit readiness.					loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
							Secondary Containment		
							PH Fire Department		

Node: 8. Routine Operations: Aqueous Film Forming Foam (AFFF) Fire Suppression System
Drawings: M-100; Supplemental Page 1; Supplemental Page 2; Sketch 7
Components:
Design Intention/Parameters: Two 250,000 gallon water storage tanks at RHL Ridge supply water to both RHL housing and all fire suppression systems at RHL. Two fire main booster pumps receive water from the tanks at RHL Ridge. Jockey pumps located in the fire suppression pump house at Red Hill maintain pressure in the fire main during steady state conditions.

There are seven zones associated with the fire suppression systems at the Red Hill Bulk Fuel Storage Facility. The UAT is equipped with water fire suppression only. Two zones are located in the upper access tunnel (UAT). One zone in the UAT is for tanks 1-10 and the other zone is for tanks 11-20. The LAT is equipped with both water and AFFF fire suppression. Five zones are located in the lower access tunnel (LAT). Each of the five zones corresponds to one group of four tanks (tanks 1-4, tanks 5-8, tanks 9-12, tanks 13-16 and tanks 17-20). An audible and visual alarm sounds when any one zone receives a signal from a sensor. The Federal Fire Dept. and Regional Dispatch Center (RDC) will be notified. Sensors typically consist of numerous flame (IR) and heat sensors throughout the facility in the LAT and UAT along with several smoke detectors in the underground pump house (UGPH). The fire suppression system activates when two or more flame sensors send an input to the fire alarm panel from any one zone.

If the fire suppression system in the UAT is activated:
1) Solenoid activated sprinkler valves will open in detected zone.
2) Adit 5Y and Adit 6 smoke control doors will close.
3) Ventilation system is shutdown and dampners closed.

If the fire suppression system in the LAT is activated:
1) The oil pressure door (OPD) will close, and retention line block valve will close, and operation of the AFFF sump pumps in all zones (25 pumps) will terminate in an effort to keep the flames in the LAT smothered with AFFF/water.
2) Five fire-rated doors in individual zones in LAT will close.
3) Adit 5Y and Adit 6 smoke control doors will close.
4) Ventilation system is shutdown and dampners closed.
5) Two AFFF concentrate pumps that supply AFFF liquid concentrate to five closets located in the zones in the LAT will start. The AFFF concentrate line exits the fire suppression pump house and proceeds up the hill to Adit 6 (directly below Adit 5). It then proceeds down the adit to an elevator shaft where it drops down to the LAT and supplies each one of the five AFFF fire suppression closets. NOTE: At the time of the PHA the AFFF system is manually initiated only.
6) Solenoid activated sprinkler valves will open in detected zone, release a mixture of water and AFFF.

AFFF can cause serious eye damage and skin sensitivity upon contact. It is highly corrosive in CS systems and therefore a nitrogen blanketing system is designed to keep the system oxygen free to inhibit corrosion.

Per P-1551 O&M Manual, one flame sensor and one low pressure nitrogen sensor would also initiate fire suppression system activation, however conversation with maintenance contractor for AFFF indicates this activation was not installed.
Operating Conditions: 1. Flow: 1500 gpm (one pump); 2. Pressure: 215 psi (water); (AFFF concentrate); 3. Temperature: 70 to 80°F

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
8.1. No / Less Flow	1. Loss of water supply to fire suppression system (no water in tanks, any valve closed in supply system, firewater main pumps not running, or firewater jockey pumps not running when needed).	1. Potential inability to suppress hydrocarbon fire. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential escalation of event as described in each Node where fire was a potential consequence.	MR	2	D	4	Both 250,000 gallon water storage tanks are equipped with low level alarm and low level float switch which alarm in both the DDC panel and fire alarm system. Water level is maintained in the tanks by DPW.	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	
			H/S	1	D	3	PSL on discharge of firewater starts jockey pump to maintain pressure (this safeguard is only applicable when there is water in the tank and valves are open).	38. Develop a car-seal or lock administrative control system and identify safety-critical manual valves which should be controlled to reduce the likelihood of human error. Valves to consider include but are not limited to 24" butterfly tank vent valves at RHL, manual block valves on the inlet or discharge of relief devices, manual block valves on bleed of body cavity of twin-seal DBB device, key firewater supply and distribution valves. (High Priority)	
			E	2	D	4	All of the main firewater pumps are equipped with automatic transfer switch to emergency diesel-driven generators.	76. Develop full documentation package with P&IDs for the fire suppression system for RHL. (High Priority)	
			P	1	D	3			

Node: 8. Routine Operations: Aqueous Film Forming Foam (AFFF) Fire Suppression System
Drawings: M-100; Supplemental Page 1; Supplemental Page 2; Sketch 7

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
								77. Ensure firewater and AFFF main and jockey pumps are on a PM schedule and automatic transfer switch to emergency diesel-driven generators are tested periodically at load to meet requirements of NFPA. (Medium Priority) 48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High Priority) 49. Train all affected personnel on the design, intent, and operation of the AFFF System, including refresher training. (High Priority) 78. Establish a stand alone maintenance contract apart from other base facilities with documented maintenance standards. (High Priority) 45. Ensure run status indication on all pumps inside all AFFF Sumps (20 pumps) is integrated with the AFHE SCADA to alert Control Room Operator (CRO) to potential release of fuel and/or AFFF. (High Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 47. Evaluate the design of the 14" AFFF discharge line piping on the discharge of 20 AFFF Sumps pumps as part of the current project to upgrade PVC to CS. The PHA Team is concerned about 1) the volume flow and separately, 2) line slope or configuration to trap liquid in retention line, and 3) lack of damage control isolation in long-run of piping. (High Priority)	
	2. Loss of AFFF concentrate flow (main AFFF pumps or jockey AFFF pumps not running, any valve closed in supply system) to mix AFFF concentrate and water.	1. Potential inability to suppress hydrocarbon fire. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential escalation of event as described in each Node where fire was a potential consequence. PHA Team concluded water-only fire suppression system is not effective on a hydrocarbon fire and can in fact be detrimental by spreading the fire.	MR	2	C	3	Two AFFF storage tanks, main pump systems, and jockey pump systems for redundancy. Storage tank is translucent so level is visible. All of the AFFF main and jockey pumps and control systems are equipped with automatic transfer switch to emergency diesel-driven generators.	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11). 38. Develop a car-seal or lock administrative control system and identify safety-critical manual valves which should be controlled to reduce the likelihood of human error. Valves to consider include but are not limited to 24" butterfly tank vent valves at RHL, manual block valves on the inlet or discharge of relief devices, manual block valves on bleed of body cavity of twin-seal DBB device, key firewater supply and distribution valves. (High Priority) 76. Develop full documentation package with P&IDs for the fire suppression system for RHL. (High Priority) 77. Ensure firewater and AFFF main and jockey pumps are on a PM schedule and automatic transfer switch to emergency diesel-driven generators are tested periodically at load to meet requirements of NFPA. (Medium Priority) 48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High Priority) 78. Establish a stand alone maintenance contract apart from other base facilities with documented maintenance standards. (High Priority) 49. Train all affected personnel on the design, intent, and operation of the AFFF System, including refresher training. (High Priority) 45. Ensure run status indication on all pumps inside all AFFF Sumps (20 pumps) is integrated with the AFHE SCADA to alert Control Room Operator (CRO) to potential release of fuel and/or AFFF. (High Priority)	
			H/S	1	C	2			
			E	2	C	3			
			P	1	C	2			

Node: 8. Routine Operations: Aqueous Film Forming Foam (AFFF) Fire Suppression System
Drawings: M-100; Supplemental Page 1; Supplemental Page 2; Sketch 7

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
								46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 47. Evaluate the design of the 14" AFFF discharge line piping on the discharge of 20 AFFF Sumps pumps as part of the current project to upgrade PVC to CS. The PHA Team is concerned about 1) the volume flow and separately, 2) line slope or configuration to trap liquid in retention line, and 3) lack of damage control isolation in long-run of piping. (High Priority) 79. Evaluate the available inventory of AFFF on site and determine if additional quantities are desired. NFPA 30 Chapter 16 requires 15 minutes of foam concentrate inventory based on design flow rate. (Low Priority) 80. Evaluate combining the SCADA systems for AFHE and fire suppression for ease of CRO monitoring or consider a Smart Grid system solution. (Low Priority)	
	3. Loss of nitrogen system (failure of generator, compressor, or purge valves closed).	1. Potential corrosion in CS piping and equipment. Potential impact to mission capability or unit readiness.	MR	4	C	5			
		2. Potential loss of nitrogen for any other roles of nitrogen in fire suppression system. PHA Team had insufficient information to determine the consequence and likelihood of the cause/consequence pair at the time of the PHA.						1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11). 81. Understand the multiple roles of nitrogen in the AFFF fire suppression system and evaluate safeguards and add additional safeguards if warranted. Consider the impact of nitrogen leak and potential asphyxiation. (High Priority)	
	4. Retention line motorized valve at the Oil Pressure Door (OPD) closed.	1. Potential inability to remove retention liquids after activation of fire suppression system. Potential limited egress from zone due to presence of thick foam/bubble layer (PFAS). Potential environmental impact. Potential public impact. Potential personnel injury. Potential impact to mission capability or unit readiness.	MR H/S E P	2 2 3 1	C C C C	3 3 4 2	Retention line motorized valve can be opened manually, but also opens automatically when AFFF sump pump starts.	48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High Priority) 82. Identify an alternative to AFFF that does not contain PFAS or PFOA to eliminate exposure potential to humans or environment. (High Priority)	
8.2. More Flow	1. Both main firewater pumps running and activation of fire suppression system. PHA Team concluded no hazardous consequences with running both main firewater pumps in static system without activation of fire suppression system.	1. Potential to introduce higher than design flow rate of fire suppression water to impacted zone. Potential to inundate sump in impacted zone and adjacent zones. Potential increased level in AFFF Retention Tank, Main Sump, and/or TK 311 Slop Tank. Potential to overfill AFFF Retention Tank. Potential to introduce ambient flammable liquid to secondary containment (sloped sides). Potential ambient flammable liquid carryover to GAC and Halawa stream. Potential pool fire. Potential release to soil, groundwater and/or Halawa stream. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: AFFF System Project was completed in 2019. The AFFF Retention Tank has a capacity	MR H/S E P	4 2 1 1	B B B B	4 2 1 1	Main firewater pumps are operated in lead-lag mode. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program. Each of the five AFFF Sumps contain four pumps intended for staggered start (local level switch) to pump to AFFF Retention Tank. The AFFF Sump pumps were recently added to a PM schedule.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 45. Ensure run status indication on all pumps inside all AFFF Sumps (20 pumps) is integrated with the AFHE SCADA to alert Control Room Operator (CRO) to potential release of fuel and/or AFFF. (High Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 47. Evaluate the design of the 14" AFFF discharge line piping on the discharge of 20 AFFF Sumps pumps as part of the current project to upgrade PVC to CS. The PHA Team is concerned about 1) the volume flow and separately, 2) line slope or configuration to trap liquid in retention line, and 3) lack of damage control isolation in long-run of piping. (High Priority) 48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High	

Node: 8. Routine Operations: Aqueous Film Forming Foam (AFFF) Fire Suppression System
Drawings: M-100; Supplemental Page 1; Supplemental Page 2; Sketch 7

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		of 153,000 gal. and was sized to hold 20 minutes of fire fighting foam and water plus 80,000 gal. of fuel from a leak. The AFFF system is currently made of PVC and CS. There is currently only local level indication in the five AFFF Sumps. There is currently no level indication on the AFFF Retention Tank. At the time of the PHA, the motors to the pumps from AFFF Sumps were LOTO to reduce the likelihood of autostart. Currently, the AFFF System is contractually maintained by a company responsible for multiple JBPHH entities.						Priority) 49. Train all affected personnel on the design, intent, and operation of the AFFF System, including refresher training. (High Priority) 50. Consider equipping AFFF Retention Tank with reliable level indication and level alarm to alert Control Room Operator (CRO) to presence of level in AFFF Retention Tank. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority)	
		2. Potential to introduce higher than design flow rate of fire suppression water to impacted zone. Potential to inundate sump in impacted zone and adjacent zones. Potential increased level in AFFF Retention Tank, Main Sump, and/or TK 311 Slop Tank. Potential to overfill Main Sumpor TK 311. Potential increased level in secondary containment (> 6ft deep, one set of stairs in corner, vertical side walls). Potential pool fire. Potential release to soil, groundwater and/or Halawa stream. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: Pumps at Main Sump have a combined capacity of ~300 gpm. TK 311 is not equipped with pumps to remove level. A vacuum truck is brought in when needed to remove level. TK 311 is in an isolated area not near through traffic roads. Inside the containment there are no sources of ignition. Isolation valve at the tank can be closed outside of containment area. At the time of the PHA the area adjacent to TK 311 is in use for groundwater treatment. Flow from Groundwater Sump Pump inside AFFF Sump (typical of five) may accelerate this consequence.	MR H/S E P	4 1 1 1	D D D D	5 3 3 3	High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program. LSH-100 high level (switch) in Main Sump starts Main Sump Pump A and alerts operator to investigate source of level and intervene. LSHH-100 high high level (switch) Main Sump starts Main Sump Pump A and Main Sump Pump B and alerts operator to investigate source of level and intervene. Both LSH-100 and LSHH-100 share a sensor. They are part of a PM program but not using certified or calibrated test equipment. Main Sump level switches high and low are not on UPS backup power, but are operated by (b)(3)(A) [redacted] LSH-0197 high level (switch) in Zone 7 area alerts operator to investigate cause of presence of liquid level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-311 high level alarm on TK 311 Slop Tank alerts operator to investigate source of level and intervene. LSHH-311 is calibrated annually. All level transmitters and high level switches are on UPS	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 43. Install a second and independent high level indication and alarm on TK 311 Slop Tank to reduce the likelihood of overfilling TK 311 unknowingly. (Medium Priority) 44. Review current practices and operability of TK 311 Slop Tank with groundwater treatment equipment and personnel adjacent to TK 311 to evaluate the interaction of the two operations and modify practices if warranted. (Low Priority) 11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	

Node: 8. Routine Operations: Aqueous Film Forming Foam (AFFF) Fire Suppression System
Drawings: M-100; Supplemental Page 1; Supplemental Page 2; Sketch 7

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							backup power with 4 hour duration.		
	2. Both main AFFF pumps running and activation of fire suppression system. PHA Team concluded no hazardous consequences with running both main AFFF pumps in static system without activation of fire suppression system.	1. Potential limited egress from zone due to presence of thick foam/bubble layer (PFAS). Potential environmental impact. Potential public impact. Potential personnel injury. Potential impact to mission capability or unit readiness.	MR H/S E P	2 2 3 1	C C C C	3 3 4 2		82. Identify an alternative to AFFF that does not contain PFAS or PFOA to eliminate exposure potential to humans or environment. (High Priority)	
8.3. Reverse Flow	1. Zone Shut-Off Valve closed (after mixing).	1. Potential to introduce AFFF to firewater system. Potential to contaminate two 250,000 gallon water storage tanks at RHL Ridge. Potential public impact. Potential personnel injury.	H/S P	3 1	D D	5 3	Firewater storage tanks are ~200 ft. above fire suppression system pumphouse and firewater/AFFF mixture will take the path of least resistance (downstream). Piping is equipped with a backflow prevention device.		PHA Team concluded safeguards are adequate.
		2. Potential to introduce firewater to AFFF system. Potential to overfill AFFF storage tanks. Potential to introduce AFFF to pumphouse floor. Potential to introduce AFFF (PFAS) to Halawa stream. Potential environmental impact. Potential public impact. Potential personnel injury.	H/S E P	3 2 1	D D D	5 4 3	AFFF storage tanks are ~200 ft. below high point of the supply line. Each riser is equipped with 2" check valve to reduce the likelihood of water backflowing into AFFF system.		PHA Team concluded safeguards are adequate.
8.4. Misdirected Flow	1. False activation of water suppression or AFFF suppression system.	1. Potential to inundate sump in impacted zone and adjacent zones. Potential increased level in AFFF Retention Tank, Main Sump, and/or TK 311 Slop Tank. Potential to overfill AFFF Retention Tank. Potential to introduce water containing AFFF (PFAS) to secondary containment (sloped sides). Potential water containing AFFF (PFAS) carryover to Halawa stream. Potential environmental impact. Potential public impact. Potential personnel injury.	H/S E P	3 2 1	D D D	5 4 3	LSHH-311 high level alarm on TK 311 Slop Tank alerts operator to investigate source of level and intervene. LSHH-311 is calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	43. Install a second and independent high level indication and alarm on TK 311 Slop Tank to reduce the likelihood of overfilling TK 311 unknowingly. (Medium Priority) 11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
		2. Potential inability to remove retention liquids after activation of fire suppression system. Potential limited egress from zone due to presence of thick foam/bubble layer (PFAS). Potential environmental impact. Potential public impact. Potential personnel injury. Potential impact to mission capability or unit readiness.	MR H/S E P	2 2 3 1	C C C C	3 3 4 2	There are minimum of two points of egress from each zone in both UAT and LAT.	48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High Priority) 82. Identify an alternative to AFFF that does not contain PFAS or PFOA to eliminate exposure potential to humans or environment. (High Priority) 83. Consider a SOP for all individuals in tunnels to have a 15 minute escape air bottle system for emergency egress during activation of fire suppression system, which shuts down ventilation. (Medium Priority)	
	2. Equalization line between two water storage tanks closed.	1. Potential reduced volume of available water to RHL housing and all fire suppression systems at RHL. Potential reduced ability to suppress hydrocarbon fire. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 1 2 1	D D D D	4 3 4 3	Both 250,000 gallon water storage tanks are equipped with low level alarm and low level float switch which alarm in both the DDC panel and fire alarm system. Water level is maintained in the tanks by DPW. PSL on discharge of firewater starts jockey pump to maintain pressure (this safeguard is only applicable when there is water	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	

Node: 8. Routine Operations: Aqueous Film Forming Foam (AFFF) Fire Suppression System
Drawings: M-100; Supplemental Page 1; Supplemental Page 2; Sketch 7

Deviation	Cause	Consequence	CAT	Risk Matrix			Safeguards	PHA Recommendation	Comments
				C	L	RR			
		Potential escalation of event as described in each Node where fire was a potential consequence.					in the tank and valves are open). All of the main firewater pumps are equipped with automatic transfer switch to emergency diesel-driven generators.	38. Develop a car-seal or lock administrative control system and identify safety-critical manual valves which should be controlled to reduce the likelihood of human error. Valves to consider include but are not limited to 24" butterfly tank vent valves at RHL, manual block valves on the inlet or discharge of relief devices, manual block valves on bleed of body cavity of twin-seal DBB device, key firewater supply and distribution valves. (High Priority) 76. Develop full documentation package with P&IDs for the fire suppression system for RHL. (High Priority) 77. Ensure firewater and AFFF main and jockey pumps are on a PM schedule and automatic transfer switch to emergency diesel-driven generators are tested periodically at load to meet requirements of NFPA. (Medium Priority) 48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High Priority) 49. Train all affected personnel on the design, intent, and operation of the AFFF System, including refresher training. (High Priority) 78. Establish a stand alone maintenance contract apart from other base facilities with documented maintenance standards. (High Priority) 45. Ensure run status indication on all pumps inside all AFFF Sumps (20 pumps) is integrated with the AFHE SCADA to alert Control Room Operator (CRO) to potential release of fuel and/or AFFF. (High Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 47. Evaluate the design of the 14" AFFF discharge line piping on the discharge of 20 AFFF Sumps pumps as part of the current project to upgrade PVC to CS. The PHA Team is concerned about 1) the volume flow and separately, 2) line slope or configuration to trap liquid in retention line, and 3) lack of damage control isolation in long-run of piping. (High Priority)	
8.5. High Pressure	1. Nitrogen compressor discharge pressure higher than desired.	1. See Recommendation. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						84. Collaborate with vendor of AFFF system to determine all purposes of nitrogen system, capability of nitrogen system (pressure), and safeguards in the current design. Identify and install additional safeguards if warranted. (High Priority)	
	2. Any of eight PRVs in water supply to upper or lower access tunnels open more than required. Four PRVs (two sets of two in series) feeding UAT are set at 187 psig. Four PRVs (two sets of two in series) feeding LAT are set at 112 psig. All PRVs are fail open and each access tunnel's PRVs are in series.	1. Potential higher than desired pressure in the firewater system (~220 psig). No hazardous consequences identified. Documentation of the AFFF system identifies 300# Class and 175 psi components. No 150# Class components were identified.						85. Ensure the AFFF 175 psig components (if there are any) are adequately designed and documented for maximum pressure of ~220 psig fire water. If they are not, add additional safeguards as warranted. (High Priority)	
	3. AFFF jockey pumps running when not required.	1. Potential higher than desired pressure on the discharge of AFFF system. Potential to release AFFF concentrate (PFAS) to environment at weakest point. Potential environmental impact.	MR H/S	2 2	C C	3 3	AFFF jockey pump is equipped with PSV on the discharge set at 171 psig (per field verification).	48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High Priority) 82. Identify an alternative to AFFF that does not contain PFAS or PFOA to eliminate exposure potential	

Node: 8. Routine Operations: Aqueous Film Forming Foam (AFFF) Fire Suppression System
Drawings: M-100; Supplemental Page 1; Supplemental Page 2; Sketch 7

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Potential public impact. Potential personnel injury. Potential impact to mission capability or unit readiness. PHA Team avoided recommending relief device discharge or high pressure shutdown consistent with NFPA philosophy to not shutdown or divert fire suppression systems.	E P	3 1	C C	4 2		to humans or environment. (High Priority)	
8.6. Low Pressure	1. No new causes identified.								
8.7. High Level	1. No new causes identified.								
8.8. Low Level	1. No new causes identified.								
8.9. Composition	1. Failure of AFFF concentrate pumps to mix AFFF concentrate and water at the proper mixture.	1. Potential inability to suppress hydrocarbon fire. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential escalation of event as described in each Node where fire was a potential consequence. PHA Team concluded water-only fire suppression system is not effective on a hydrocarbon fire and can in fact be detrimental by spreading the fire. PHA Team concluded AFFF concentrate-only fire suppression system is not effective on a hydrocarbon fire.	MR H/S E P	2 1 2 1	C C C C	3 2 3 2	Two AFFF storage tanks, main pump systems, and jockey pump systems for redundancy. Storage tank is translucent so level is visible. All of the AFFF main and jockey pumps and control systems are equipped with automatic transfer switch to emergency diesel-driven generators.	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11). 38. Develop a car-seal or lock administrative control system and identify safety-critical manual valves which should be controlled to reduce the likelihood of human error. Valves to consider include but are not limited to 24" butterfly tank vent valves at RHL, manual block valves on the inlet or discharge of relief devices, manual block valves on bleed of body cavity of twin-seal DBB device, key firewater supply and distribution valves. (High Priority) 76. Develop full documentation package with P&IDs for the fire suppression system for RHL. (High Priority) 77. Ensure firewater and AFFF main and jockey pumps are on a PM schedule and automatic transfer switch to emergency diesel-driven generators are tested periodically at load to meet requirements of NFPA. (Medium Priority) 48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High Priority) 78. Establish a stand alone maintenance contract apart from other base facilities with documented maintenance standards. (High Priority) 49. Train all affected personnel on the design, intent, and operation of the AFFF System, including refresher training. (High Priority) 45. Ensure run status indication on all pumps inside all AFFF Sumps (20 pumps) is integrated with the AFHE SCADA to alert Control Room Operator (CRO) to potential release of fuel and/or AFFF. (High Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 47. Evaluate the design of the 14" AFFF discharge line piping on the discharge of 20 AFFF Sumps pumps as part of the current project to upgrade PVC to CS. The PHA Team is concerned about 1) the volume flow and separately, 2) line slope or configuration to trap liquid in retention line, and 3) lack of damage control isolation in long-run of piping. (High Priority) 79. Evaluate the available inventory of AFFF on site and determine if additional quantities are desired.	

Node: 8. Routine Operations: Aqueous Film Forming Foam (AFFF) Fire Suppression System
Drawings: M-100; Supplemental Page 1; Supplemental Page 2; Sketch 7

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
								NFPA 30 Chapter 16 requires 15 minutes of foam concentrate inventory based on design flow rate. (Low Priority)	
								80. Evaluate combining the SCADA systems for AFHE and fire suppression for ease of CRO monitoring or consider a Smart Grid system solution. (Low Priority)	
	2. Hydrocarbons in the water supply system (outside of node).	1. Potential inability to suppress hydrocarbon fire. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential escalation of event as described in each Node where fire was a potential consequence.	MR	2	D	4	Two 250,000 gallon water storage tanks at RHL Ridge are sampled frequently under the current drinking water program.		
			H/S	1	D	3			
			E	2	D	4			
			P	1	D	3			
	3. Upset in nitrogen generator resulting in oxygen in the nitrogen system.	1. Potential corrosion in CS piping and equipment. Potential impact to mission capability or unit readiness.	MR	4	C	5			
		2. Potential loss of nitrogen for any other roles of nitrogen in fire suppression system. PHA Team had insufficient information to determine the consequence and likelihood of the cause/consequence pair at the time of the PHA.						1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	
								81. Understand the multiple roles of nitrogen in the AFFF fire suppression system and evaluate safeguards and add additional safeguards if warranted. Consider the impact of nitrogen leak and potential asphyxiation. (High Priority)	
8.10. Leak / Rupture	1. No new causes identified.								
8.11. Start-up / Shutdown	1. Removal of foam/water mixture after activation of fire suppression system.	1. See Recommendation.						86. Ensure re-design of fire suppression system addresses deadlegs which prevent complete transfer of foam/water mixture after activation of fire suppression system and allow potential future fuel and foam releases upon loss of containment. (High Priority)	
								87. Implement a Mechanical Integrity Inspection Program for all identified deadlegs in fuel handling and fire suppression systems. (Medium Priority)	
								88. Equip AFFF sump pumps with remote start from the fire suppression SCADA system to allow for operation in case AFFF pumps cannot be operated locally due to lack of access (OPD or fire rated door closed). (High Priority)	
8.12. Maintenance / Inspection	1. No causes identified.								
8.13. Corrosion / Erosion	1. No new causes identified.								

Node: 9. Routine Operations: Vessel to Vessel Transfer
Drawings: [redacted]
Components:
Design Intention/Parameters: Vessel to vessel transfer over water is routinely performed at PRL. Vessels can be ships, barges, or YONs. PRL has [redacted] YONs (Yard Oiler Non-self-powered), YON [redacted] and YON [redacted] have a capacity of [redacted]. YON 328 has a capacity of [redacted]. Although the YONs are owned and operated by the United States and engaged in non-commercial service and YONs [redacted] and [redacted] do not meet the minimum capacity for regulation, they are operated following the regulations as a good management practice.

The transferring vessel pump (single pump per vessel) is diesel-driven, variable speed, and used to push material to receiving vessel through marine-tested hoses. Hoses that are [redacted] are threaded connected. Hoses that are [redacted] are hard-bolted, eight bolts, to both vessels, not connected with couplers. A pre-transfer conference is held prior to each transfer. All 33 CFR Cost Guard regulations are followed during vessel to vessel transfer by PIC qualified personnel.
Operating Conditions: 1. [redacted]; 2. Pressure: Start of flow at 20 psi, then gradually increasing to a range of 50 psi to 80 psi. The fuel flow may not exceed [redacted], at maximum pressure of 100 psi and maximum pump speed of 1800 rpm.; 3. Temperature: 60 to 76°F

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
9.1. No / Less Flow	1. Any valve closed between transferring vessel and receiving vessel.	1. Potential to deadhead cargo pump. Potential cargo pump seal damage. Potential seal leak. Potential loss of containment. Potential release of ambient flammable liquid on top deck. Potential environmental impact. Potential fire on top deck. Potential personnel impact. Potential public impact. Potential impact to mission capability or unit readiness. PHA Team concluded cargo pump is a suspended, submerged pump with the pump seal above deck. During deadhead it could overpressure the above deck seal. Deadhead pressure of the 330 series cargo pumps is 355 ft per pump curve, equivalent to ~ 150 psig water. When corrected for diesel specific gravity of 0.86, deadhead pressure is ~ 130 psig. Information implies the 321 series cargo pumps are similar to the 330 series cargo pumps.	MR	3	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Relief device on discharge of cargo pump, set at 120 psig, relieves to cargo tank containing pump. Relief device is inspected and maintained every two years. Deck coamings which contain scupper plugs, designed to contain spill on deck. Coamings are part of maintenance and inspection program. NAVSUP FLC Pearl Harbor Instruction 4400.4E may be applicable.	89. Develop unique work orders for vessel to vessel fuel transfers. (High Priority) 90. Ensure scupper plugs in secondary containment coamings are verified in place prior to transfer as part of work order for both vessel to vessel and barge/YON to shore transfers. (High Priority)	
			H/S	3	D	5			
			E	3	D	5			
			P	2	D	4			
		2. No hazardous consequences identified to transfer hose. PHA Team concluded the available head from the YON pumps (~150 or ~130 psig) is less than the current hose rating and very similar to current test pressure.							
		3. Potential hose rupture or gasket failure. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness 33 CFR Part 154 Coast Guard requires testing hoses to 1.5 x deadhead pressure. PHA Team concluded the highest pressure expected in a marine transfer that is deadheaded is the UTF pump for product F-76 at 219 psig. This pressure is greater than 1) the gravity head from the highest tank at RHL to the dock, 2) the available deadhead from the YON pumps, 3) deadhead pressure of ship	MR	4	B	4	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Pre-Plan Meeting includes visual inspection of all fuel transfer hoses and hose integrity test witnessed by both PICs prior to initiating any fuel transfer. All hoses are hydrostatically tested to 150 psig annually. Coast Guard verifies hose labeling and record-keeping annually. Relief device on discharge of cargo pump, set at 120 psig, relieves to cargo tank containing pump. Relief device is inspected and maintained every two years.	13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	
			H/S	1	C	2			
			E	2	B	2			
			P	2	B	2			

Node: 9. Routine Operations: Vessel to Vessel Transfer
Drawings: (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		pump, and 4) any single pump in UGPH. However, should two pumps in series ever be considered to be included in an Operations Order, the highest deadhead pressure to be considered is **268 psig**.					Hose rating is 200 to 250 psig depending on manufacturer. Hose test pressure per manufacturer is 300 psig.		
		4. Potential delay of transfer. No hazardous consequences identified.							
	2. Suction strainer plugged during transfer.	1. Potential to cavitate cargo pump. Potential impact to mission capability or unit readiness. PHA Team concluded cargo pump is a suspended, submerged pump with the pump seal above deck, and if any vibration or pump damage occurs during cavitation it will occur inside tank.	MR	3	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Relief device on discharge of cargo pump, set at 120 psig, relieves to cargo tank containing pump. Relief device is inspected and maintained every two years. Deck coamings which contain scupper plugs, designed to contain spill on deck. Coamings are part of maintenance and inspection program. NAVSUP FLC Pearl Harbor Instruction 4400.4E may be applicable.	89. Develop unique work orders for vessel to vessel fuel transfers. (High Priority) 90. Ensure scupper plugs in secondary containment coamings are verified in place prior to transfer as part of work order for both vessel to vessel and barge/YON to shore transfers. (High Priority)	
		2. No hazardous consequences identified to suction strainer.							
		3. Potential delay of transfer. No hazardous consequences identified.							
	3. Improper valve configuration that puts cargo pump in a bypass/recirculation mode.	1. Potential delay of transfer. No hazardous consequences identified.							
	4. Transferring vessel pump stops during transfer. (PTO or pump malfunction, insufficient supply of diesel, diesel driver failure)	1. Potential delay of transfer. No hazardous consequences identified.							
		2. Potential reverse flow of a small amount of fuel from receiving vessel to transferring vessel. No hazardous consequences identified.					YON Pump PTO design and function prevents backflow. DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow.		
9.2. More Flow	1. Speed control set higher than desired.	1. Potential to overfill receiving vessel tank. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness PHA Team concluded most receiving vessels	MR H/S E P	4 1 2 2	C D C C	5 3 3 3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Receiving vessel gauger, cargo mate, or oil king continuously		PHA Team concluded safeguards are adequate.

Node: 9. Routine Operations: Vessel to Vessel Transfer
Drawings: (b)(3)(A) [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		are equipped with a cascading overflow system where only the overflow tank overflows overboard. However, some vessels do not and will overflow overboard directly from receiving tank. PHA Team discussed the likelihood of an overfill is higher than the likelihood of overfill and fire resulting in fatality.					monitors level during loading, notifies transferring vessel to reduce flowrate near end of loading. All vessels are equipped with high and high high level visual and audible alarms to alert operator and initiate appropriate action. Alarms are in a PM program Ignition sources are controlled during transfers (no hot work, no smoking, etc.).		
9.3. Reverse Flow	1. No new causes identified.								
9.4. Misdirected Flow	1. Improper valve alignment resulting causing tank to tank transfer on the receiving vessel.	1. Potential mixing of products in unintended tank. Potential impact to mission capability or unit readiness at receiving vessel. PHA Team concluded line ups on receiving vessel were outside the scope of the transferring vessel.							
		2. Potential to overfill receiving vessel tank. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness PHA Team concluded most receiving vessels are equipped with a cascading overflow system where only the overflow tank overflows overboard. However, some vessels do not and will overflow overboard directly from receiving tank. PHA Team discussed the likelihood of an overfill is higher than the likelihood of overfill and fire resulting in fatality.	MR	4	C	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Receiving vessel gauger, cargo mate, or oil king continuously monitors level during loading, notifies transferring vessel to reduce flowrate near end of loading. All vessels are equipped with high and high high level visual and audible alarms to alert operator and initiate appropriate action. Alarms are in a PM program Ignition sources are controlled during transfers (no hot work, no smoking, etc.).		PHA Team concluded safeguards are adequate.
			H/S	1	D	3			
			E	2	C	3			
			P	2	C	3			
9.5. High Pressure	1. Fueling submarine with water compensating tank outlet valve closed.	1. Potential to fill normal fuel oil (NFO) tank hydraulically full. No hazardous consequences identified to NFO tank. PHA Team was informed the design pressure of the NFO tank is significantly greater than the deadhead pressure of the cargo pump.							
		2. Potential to deadhead cargo pump. Potential cargo pump seal damage. Potential seal leak. Potential loss of containment. Potential release of ambient flammable liquid on top deck. Potential environmental impact. Potential fire on top deck. Potential personnel impact. Potential public impact. Potential impact to mission capability or unit readiness. PHA Team concluded cargo pump is a	MR	3	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Relief device on discharge of cargo pump, set at 120 psig, relieves to cargo tank containing pump. Relief device is	89. Develop unique work orders for vessel to vessel fuel transfers. (High Priority) 90. Ensure scupper plugs in secondary containment coamings are verified in place prior to transfer as part of work order for both vessel to vessel and barge/YON to shore transfers. (High Priority)	
			H/S	3	D	5			
			E	3	D	5			
			P	2	D	4			

Node: 9. Routine Operations: Vessel to Vessel Transfer
Drawings: (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		suspended, submerged pump with the pump seal above deck. During deadhead it could overpressure the above deck seal. Deadhead pressure of the 330 series cargo pumps is 355 ft per pump curve, equivalent to ~ 150 psig water. When corrected for diesel specific gravity of 0.86, deadhead pressure is ~ 130 psig. Information implies the 321 series cargo pumps are similar to the 330 series cargo pumps.					inspected and maintained every two years.		
							Deck coamings which contain scupper plugs, designed to contain spill on deck. Coamings are part of maintenance and inspection program.		
							NAVSUP FLC Pearl Harbor Instruction 4400.4E may be applicable.		
	2. Fueling non-submarine vessel with water compensating tank outlet valve closed.	1. Potential to overfill receiving vessel tank through fuel tank vent. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness PHA Team concluded most receiving vessels are equipped with a cascading overflow system where only the overflow tank overflows overboard. However, some vessels do not and will overflow overboard directly from receiving tank. PHA Team discussed the likelihood of an overfill is higher than the likelihood of overfill and fire resulting in fatality.	MR	4	C	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow.		PHA Team concluded safeguards are adequate.
			H/S	1	D	3	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer.		
			E	2	C	3	Receiving vessel gauger, cargo mate, or oil king continuously monitors level during loading, notifies transferring vessel to reduce flowrate near end of loading.		
			P	2	C	3	All vessels are equipped with high and high high level visual and audible alarms to alert operator and initiate appropriate action. Alarms are in a PM program		
							Ignition sources are controlled during transfers (no hot work, no smoking, etc.).		
9.6. Low Pressure	1. No new causes identified.								
9.7. High Level	1. Transferring more fuel than desired to receiving vessel.	1. Potential to overfill receiving vessel tank. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness PHA Team concluded most receiving vessels are equipped with a cascading overflow system where only the overflow tank overflows overboard. However, some vessels do not and will overflow overboard directly from receiving tank. PHA Team discussed the likelihood of an overfill is higher than the likelihood of overfill and fire resulting in fatality.	MR	4	C	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow.		PHA Team concluded safeguards are adequate.
			H/S	1	D	3	Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer.		
			E	2	C	3	Receiving vessel gauger, cargo mate, or oil king continuously monitors level during loading, notifies transferring vessel to reduce flowrate near end of loading.		
			P	2	C	3	All vessels are equipped with high and high high level visual and audible alarms to alert operator and initiate appropriate action. Alarms are in a PM program		
							Ignition sources are controlled during transfers (no hot work, no smoking, etc.).		
9.8. Low Level	1. Improper valve configuration aligns to incorrect issue tank or low tank inventory.	1. Potential to cavitate cargo pump. Potential impact to mission capability or unit readiness.	MR	3	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks,	89. Develop unique work orders for vessel to vessel fuel transfers. (High Priority)	
								90. Ensure scupper plugs in secondary containment coamings are verified in place prior to transfer as	

Node: 9. Routine Operations: Vessel to Vessel Transfer
Drawings: (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		PHA Team concluded cargo pump is a suspended, submerged pump with the pump seal above deck, and if any vibration or pump damage occurs during cavitation it will occur inside tank.					pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Relief device on discharge of cargo pump, set at 120 psig, relieves to cargo tank containing pump. Relief device is inspected and maintained every two years. Deck coamings which contain scupper plugs, designed to contain spill on deck. Coamings are part of maintenance and inspection program. NAVSUP FLC Pearl Harbor Instruction 4400.4E may be applicable.	part of work order for both vessel to vessel and barge/YON to shore transfers. (High Priority)	
9.9. Composition	1. Heel left in receiving vessel or load over existing dissimilar material.	1. Potential mixing of products in unintended tank. Potential impact to mission capability or unit readiness at receiving vessel. PHA Team concluded line ups on receiving vessel were outside the scope of the transferring vessel.							
		2. Potential to overfill receiving vessel tank. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness PHA Team concluded most receiving vessels are equipped with a cascading overflow system where only the overflow tank overflows overboard. However, some vessels do not and will overflow overboard directly from receiving tank. PHA Team discussed the likelihood of an overfill is higher than the likelihood of overfill and fire resulting in fatality.	MR H/S E P	4 1 2 2	C D C C	5 3 3 3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Receiving vessel gauger, cargo mate, or oil king continuously monitors level during loading, notifies transferring vessel to reduce flowrate near end of loading. All vessels are equipped with high and high high level visual and audible alarms to alert operator and initiate appropriate action. Alarms are in a PM program Ignition sources are controlled during transfers (no hot work, no smoking, etc.).		PHA Team concluded safeguards are adequate.
	2. Water in cargo compartment.	1. Potential premature failure of impellers of cargo pump. Potential impact to mission capability or unit readiness. PHA Team concluded cargo pump is a suspended, submerged pump with the pump seal above deck, and if any vibration or pump damage occurs during cavitation it will occur inside tank. YON [redacted] cargo pump was inspected in 2020 and found to have significant corrosion on impellers and pump casing due to operating with compensation water per OEM.	MR	3	D	5	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Relief device on discharge of cargo pump, set at 120 psig, relieves to cargo tank containing pump. Relief device is inspected and maintained every two years. Deck coamings which contain scupper plugs, designed to	89. Develop unique work orders for vessel to vessel fuel transfers. (High Priority) 90. Ensure scupper plugs in secondary containment coamings are verified in place prior to transfer as part of work order for both vessel to vessel and barge/YON to shore transfers. (High Priority) 91. Develop a procedure for verifying the presence of water in all cargo tanks, and if water is present, a procedure for removing water contaminated fuel with vacuum truck. (High Priority)	

Node: 9. Routine Operations: Vessel to Vessel Transfer
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							contain spill on deck. Coamings are part of maintenance and inspection program. NAVSUP FLC Pearl Harbor Instruction 4400.4E may be applicable.		
9.10. Leak / Rupture	1. Incorrect hose specification or gasket failure.	1. Potential hose rupture or gasket failure. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. 33 CFR Part 154 Coast Guard requires testing hoses to 1.5 x deadhead pressure. PHA Team concluded the highest pressure expected in a marine transfer that is deadheaded is the UTF pump for product F-76 at 219 psig. This pressure is greater than 1) the gravity head from the highest tank at RHL to the dock, 2) the available deadhead from the YON pumps, 3) deadhead pressure of ship pump, and 4) any single pump in UGPH. However, should two pumps in series ever be considered to be included in an Operations Order, the highest deadhead pressure to be considered is 268 psig. PHA Team discussed the likelihood of a hose rupture leading to an environmental event is higher than the likelihood of fire resulting in fatality, and impact of mission readiness is low as there is redundant equipment/hoses.	MR H/S E P	4 1 2 2	D D C C	5 3 3 3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Pre-Plan Meeting includes visual inspection of all fuel transfer hoses and hose integrity test witnessed by both PICs prior to initiating any fuel transfer. All hoses are hydrostatically tested to 150 psig annually. Coast Guard verifies hose labeling and record-keeping annually. Relief device on discharge of cargo pump, set at 120 psig, relieves to cargo tank containing pump. Relief device is inspected and maintained every two years. Hose rating is 200 to 250 psig depending on manufacturer. Hose test pressure per manufacturer is 300 psig.	13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	
	2. Vessel to vessel collision or vessel movement during transfer operation.	1. Potential to damage outer hull of double-hulled vessel. Potential to introduce salt water to the interstitial space. Potential accelerated corrosion. Potential impact to mission capability or unit readiness.	MR	3			6 year dry dock inspection / annual weld and hull inspection.		
		2. Potential to damage/pinch/crush transfer hose. Potential hose rupture. Potential loss of containment. Potential release of large amount of ambient flammable liquid to top deck and/or water. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness PHA Team discussed the likelihood of a hose rupture leading to an environmental event is higher than the likelihood of fire resulting in fatality, and impact of mission readiness is low as there is redundant equipment/hoses.	MR H/S E P	4 1 2 2	D D C C	5 3 3 3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Four mooring lines are used to secure vessel to vessel with fenders in between. Slack is removed from hose and tied off and managed throughout transfer.		PHA Team concluded safeguards are adequate.

Node: 9. Routine Operations: Vessel to Vessel Transfer
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
9.11. Start-up / Shutdown	1. Starting loading too quickly or failing to pack the line.	1. Potential gasket or seal leak. Potential loss of containment. Potential release of ambient flammable liquid on top deck. Potential environmental impact. Potential fire on top deck. Potential personnel impact. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	3 3 3 2	D D D D	5 5 5 4	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and YON side per 33 CFR 154 & 156. All inventory checks, pressures, stops, and starts must be agreed upon by YON PIC and Vessel PIC to include confirmation of flow. Commander Navy Region Hawaii Integrated Contingency Plan (CNRH ICP) requires pre-booming before initiating transfer. Relief device on discharge of cargo pump, set at 120 psig, relieves to cargo tank containing pump. Relief device is inspected and maintained every two years. Deck coamings which contain scupper plugs, designed to contain spill on deck. Coamings are part of maintenance and inspection program. NAVSUP FLC Pearl Harbor Instruction 4400.4E may be applicable.	89. Develop unique work orders for vessel to vessel fuel transfers. (High Priority) 90. Ensure scupper plugs in secondary containment coamings are verified in place prior to transfer as part of work order for both vessel to vessel and barge/YON to shore transfers. (High Priority)	
9.12. Maintenance / Inspection	1. Fire suppression system activating in engine compartment.	1. Potential release of CO2 in a small confined space. Potential personnel exposure to CO2. Potential asphyxiation. Potential personnel injury. Activation of the CO2 system stops engine, generator, and closes the dampners.	H/S	1	D	3	Audible alarm alerts personnel in area of CO2 fire suppression system activation in 20 seconds. Alarm is tested annually. Barge crew members are trained on Confined Space Entry.	92. Consider treating the engine compartment as a confined space which would include controlled access, deactivation of fire suppression system while inside, and reactivation of system when entry is complete. (High Priority) 93. Consider incorporating visual strobe light with the alarm system to further increase awareness of fire suppression activation. (Medium Priority)	
9.13. Corrosion / Erosion	1. Hull corrosion due to seawater exposure.	1. Potential to damage outer hull of double-hulled vessel. Potential to introduce salt water to the interstitial space. Potential accelerated corrosion. Potential impact to mission capability or unit readiness.	MR	3	D	5	6 year dry dock inspection / annual weld and hull inspection. Outer hull is equipped with cathodic protection system.		
	2. Topside corrosion due to seawater exposure.	1. No hazardous consequences identified. Topside piping and equipment is well painted and coated.							

Node: 10. Routine Operations: SIMOPS Multiple Product Movements Simultaneously
Drawings: [redacted] (b)(3)(A)
Components:
Design Intention/Parameters: RHL and PRL has historically performed simultaneous operations safely using Operations Orders. Tank pipe and pump systems could equate to 5 to 7 simultaneous movements, however constraints such as personnel, sampling, and potential for distraction increase significantly. At the time of the PHA, with RHL temporarily out of service, any simultaneous multiple evolution require approval from the Deputy Director.
Operating Conditions: 1. Flow: [redacted] (b)(3)(A) depending on source; 2. Pressure: 100 to 200 psig; 3. Temperature: 70 to 80°F

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
10.1. What If..?	1. CRO error in evolution setup due to periods of high information input, high volume of communications/distractions?	1. Potential unscheduled fuel movement (UFM). Potential overfill of unintended tank or vessel. Overfill of unintended tanks and vessels are described in multiple nodes of non-simultaneous operations and severity and likelihood are documented for each case in their respective node. The PHA Team concluded the likelihood of consequence increases during SIMOPS.	MR H/S E P				Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. Unscheduled Fuel Movement (UFM) alarm alerts operator to investigate and take action per UFM SOP. Two CROs are scheduled during all operations. Fuel transfers are normally limited to daylight hours. Permission to transfer after sunset requires JBC (if over water)	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11). 94. Develop a procedure that outlines the specific manpower requirements for multiple, simultaneous operations as the number of operations increased and that requires written approval for SIMOPS by	

Node: 10. Routine Operations: SIMOPS Multiple Product Movements Simultaneously
Drawings: (b)(3)(A) [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	L	RR	Safeguards	PHA Recommendation	Comments
							or Fuels Deputy Director (if not over water).	appropriate level of management. (High Priority)	
							Additional staffing is scheduled.	95. Consider adding additional AFHE workstations and larger monitors to accomplish need for visibility of more quadrants simultaneously. (Medium Priority) 96. Evaluate the size and location of current backup control room to better accommodate additional CROs and reduce access and distractions. (High Priority)	
		2. Potential unscheduled fuel movement (UFM). Potential to empty unintended tank or vessel. Potential to cavitate any pump in fuel service. Cavitation of all pumps are described in multiple nodes of non-simultaneous operations and severity and likelihood are documented for each case in their respective node. The PHA Team concluded the likelihood of consequence increases during SIMOPS.	MR H/S E P				Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. Unscheduled Fuel Movement (UFM) alarm alerts operator to investigate and take action per UFM SOP. Two CROs are scheduled during all operations. Fuel transfers are normally limited to daylight hours. Permission to transfer after sunset requires JBC (if over water) or Fuels Deputy Director (if not over water). Additional staffing is scheduled.	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11). 94. Develop a procedure that outlines the specific manpower requirements for multiple, simultaneous operations as the number of operations increased and that requires written approval for SIMOPS by appropriate level of management. (High Priority) 95. Consider adding additional AFHE workstations and larger monitors to accomplish need for visibility of more quadrants simultaneously. (Medium Priority) 96. Evaluate the size and location of current backup control room to better accommodate additional CROs and reduce access and distractions. (High Priority)	
		3. Potential unscheduled fuel movement (UFM). Potential to deadhead any pump in fuel service. Deadheading of all pumps is described in multiple nodes of non-simultaneous operations and severity and likelihood are documented for each case in their respective node. The PHA Team concluded the likelihood of consequence increases during SIMOPS.	MR H/S E P				Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. Unscheduled Fuel Movement (UFM) alarm alerts operator to investigate and take action per UFM SOP. Two CROs are scheduled during all operations. Fuel transfers are normally limited to daylight hours. Permission to transfer after sunset requires JBC (if over water) or Fuels Deputy Director (if not over water). Additional staffing is scheduled.	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11). 94. Develop a procedure that outlines the specific manpower requirements for multiple, simultaneous operations as the number of operations increased and that requires written approval for SIMOPS by appropriate level of management. (High Priority) 95. Consider adding additional AFHE workstations and larger monitors to accomplish need for visibility of more quadrants simultaneously. (Medium Priority) 96. Evaluate the size and location of current backup control room to better accommodate additional CROs and reduce access and distractions. (High Priority) 12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	
		4. Potential unscheduled fuel movement (UFM). Potential route fuel through unintended measuring meter. Potential delay in transfer. No hazardous consequences identified.							
	2. Rover asked to perform multiple, simultaneous tasks?	1. Potential delay in transfer (waiting for Rover to perform task). No hazardous consequences identified.						94. Develop a procedure that outlines the specific manpower requirements for multiple, simultaneous operations as the number of operations increased and that requires written approval for SIMOPS by appropriate level of management. (High Priority) 97. Provide government smart phones to all Rovers for improved communications due to current radio reliability and that some communications are lengthy and better suited for cell phone instead of	

Node: 10. Routine Operations: SIMOPS Multiple Product Movements Simultaneously
Drawings: (b)(3)(A) [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix			Safeguards	PHA Recommendation	Comments
				C	L	RR			
								radio. (High Priority)	
		2. Potential increased likelihood of human error due to rushing. Potential escalation of event.						94. Develop a procedure that outlines the specific manpower requirements for multiple, simultaneous operations as the number of operations increased and that requires written approval for SIMOPS by appropriate level of management. (High Priority)	
								97. Provide government smart phones to all Rovers for improved communications due to current radio reliability and that some communications are lengthy and better suited for cell phone instead of radio. (High Priority)	
		3. Potential personnel injury due to hurrying across site/work areas. Potential escalation of event.						94. Develop a procedure that outlines the specific manpower requirements for multiple, simultaneous operations as the number of operations increased and that requires written approval for SIMOPS by appropriate level of management. (High Priority)	
								97. Provide government smart phones to all Rovers for improved communications due to current radio reliability and that some communications are lengthy and better suited for cell phone instead of radio. (High Priority)	
	3. Need to have one PIC per task to comply with CFR 33?	1. Potential delay in transfer (waiting for PIC to perform task). No hazardous consequences identified.						94. Develop a procedure that outlines the specific manpower requirements for multiple, simultaneous operations as the number of operations increased and that requires written approval for SIMOPS by appropriate level of management. (High Priority)	
	4. Human fatigue due to high tempo operations?	1. Potential delay in transfer (waiting to perform task). No hazardous consequences identified.						94. Develop a procedure that outlines the specific manpower requirements for multiple, simultaneous operations as the number of operations increased and that requires written approval for SIMOPS by appropriate level of management. (High Priority)	
								98. Create a fatigue policy for all Fuels Distributions System workers, operators, and maintainers that limits hours worked in a day and days worked consecutively. (High Priority)	
		2. Potential increased likelihood of human error due to rushing. Potential escalation of event.						94. Develop a procedure that outlines the specific manpower requirements for multiple, simultaneous operations as the number of operations increased and that requires written approval for SIMOPS by appropriate level of management. (High Priority)	
								98. Create a fatigue policy for all Fuels Distributions System workers, operators, and maintainers that limits hours worked in a day and days worked consecutively. (High Priority)	
	5. Emergency occurs during multiple, simultaneous operations?	1. Potential inability to respond due to other simultaneous operations underway or being shutdown. Potential escalation of event.					Dedicated Facility Response Team (FRT) that is not part of the fuels team that will respond to on water events.	94. Develop a procedure that outlines the specific manpower requirements for multiple, simultaneous operations as the number of operations increased and that requires written approval for SIMOPS by appropriate level of management. (High Priority)	
								99. The Navy policy is to use the Incident Command System (ICS)/Unified Command (UC) for structuring Navy spill response management organizations. The NAVSUP FLCPH fuel personnel manages the initial response. If additional resources are needed, the Federal Fire Department Incident Commander will establish an emergency command post and assume responsibility for the response. The Emergency Spill Coordinator or the Commanding Officer can contact the Region Navy On-Scene Coordinator to activate the Region Spill Management Team (SMT). The Region SMT will then establish other ICS functions. Port Operations is the coordinator for the Facility Response Team (FRT), an on-water contractor resource based on Ford Island. The roles, staffing and resources for each organization needs to be clearly defined, drilled and aligned prior to defueling operations. (High Priority)	
	6. Modifications are required to Operating Orders during multiple, simultaneous tasks?	1. Potential delay in transfer (waiting to perform task). No hazardous consequences identified.						94. Develop a procedure that outlines the specific manpower requirements for multiple, simultaneous operations as the number of operations increased and that requires written approval for SIMOPS by appropriate level of management. (High Priority)	
								1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and	

Node: 10. Routine Operations: SIMOPS Multiple Product Movements Simultaneously
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
								refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	
		2. Potential increased likelihood of human error due to rushing. Potential escalation of event.						94. Develop a procedure that outlines the specific manpower requirements for multiple, simultaneous operations as the number of operations increased and that requires written approval for SIMOPS by appropriate level of management. (High Priority)	
								1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	
	7. Sampling and lab analysis requirements during multiple, simultaneous tasks?	1. Potential delay in transfer (waiting to perform task). No hazardous consequences identified.						94. Develop a procedure that outlines the specific manpower requirements for multiple, simultaneous operations as the number of operations increased and that requires written approval for SIMOPS by appropriate level of management. (High Priority)	
								100. Review current sampling schedule and identify opportunities for optimization and eliminating non-required sampling and analysis. (Medium Priority)	
								101. Improve communications between fuel laboratory and CROs after analysis is complete for increased efficiency during multiple simultaneous operations. (Medium Priority)	

Node: 11. Routine Operations: Truck Loading
Drawings: [redacted] (b)(3)(A)
Components: [redacted] (b)(3)(A)
Design Intention/Parameters: The TFS is used to issue fuel to tanker trucks through bottom loading connections. [redacted] (b)(3)(A).

The Lube Oil system is located adjacent to the TFS. There are two 10,000-gal horizontal lube oil ASTs, each with its own independent loading/offloading station (for tank trucks). The minimal amount of piping associated with each tank system is aboveground and easily visually inspected. The Lube Oil systems are outside the scope of the PHA as they are not considered part of the Red Hill fueling process.
Operating Conditions: 1. Flow:; 2. Pressure:; 3. Temperature:

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
11.1. What If...?	1. Closing any valve during loading?	1. Potential delay in loading truck. Potential impact to mission capability or unit readiness.	MR	4	C	5			
		2. Potential to cavitate/deadhead [redacted] (b)(3)(A) PHA Team had insufficient information to determine the consequence and/or consequence severity at the time of the PHA.						102. Ensure safeguards are adequate for [redacted] (b)(3)(A) cavitation or deadheading due to closed valve during loading process. If not, add additional safeguards as warranted. (Medium Priority)	
	2. Loading pump stops during loading?	1. Potential delay in loading truck. Potential impact to mission capability or unit readiness.	MR	4	C	5			
	3. Overloading of truck?	1. Potential to overfill tank truck. Potential release of ambient flammable liquid to a concrete contained area. Potential pool fire. Potential fire. Potential personnel injury. Potential public	MR	4	C	5	All loading stations in the Truck Loading Rack are equipped with Overfill Protection Equipment (OPE) including dead-man switch. OPE is included in quarterly recurring maintenance program.		PHA Team concluded safeguards are adequate.
			H/S	3	C	4			

Node: 11. Routine Operations: Truck Loading
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		impact. Potential impact to mission capability or unit readiness.	P	2	C	3	Emergency stop switch located at loading spot and at safe location away from loading spot.		
		2. Potential to overfill tank truck. Potential release of ambient flammable liquid to a concrete contained area. Potential increased level in Load Rack Sump. Potential for Load Rack Sump Pump to introduce ambient flammable liquid to Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank (normal lineup, B1 and B2 are sluiced). Potential to overfill Tank 1301/1302 to containment area. Potential release to soil below containment area (due to leaking containment) and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential to lift PRVs at Truck Loading Rack may accelerate this consequence.	MR	4	D	5	All loading stations in the Truck Loading Rack are equipped with Overfill Protection Equipment (OPE) including dead-man switch. OPE is included in quarterly recurring maintenance program. Emergency stop switch located at loading spot and at safe location away from loading spot. LAH-B1/B2 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-B1/B2 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
			H/S	3	D	5			
			E	3	D	5			
			P	2	D	4			
	4. Loading incorrect fuel in truck?	1. Potential to use contaminated fuel in end user equipment (ships, aircraft, etc.). Potential impact to mission capability or unit readiness. Potential personnel injury.	MR	3	D	5	Material is sampled at point of shipment, prior to offloading, and during offloading using well established and effective administrative procedures.		PHA Team concluded safeguards are adequate.
			H/S	1	D	3			

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted] (b)(3)(A)
Components:
Design Intention/Parameters: Use existing piping and valve stations at RHL and PRL to safely transfer by gravity inventory currently in TK 102/103/104/105/106 F-24 Tank (Red Hill), TK 107/108/109/110/111/112/120 JP-5 Tank (Red Hill), and TK 115/116 F-76 Tank (Red Hill) (~110 MM gal. total) to PAR, UTF, Hickam; and/or load ship/barge using existing in-service piers/docks to transfer to off-island destinations.

This node includes packing the pipeline between evolutions, before transferring from Red Hill Storage. Demonstrated de-inventory rates are [redacted] (b)(3)(A) in the [redacted] (b)(3) pipeline, [redacted] (b)(3)(A) in the [redacted] (b)(3) pipeline [redacted] (b)(3)(A) in the [redacted] (b)(3) pipeline, and [redacted] (b)(3)(A) to PAR. Specific Operational Procedures with valve alignment tables exist in the OMES Manual to transfer to UTF, Hickam, and piers/docks; and have been used safely in the past. A one-time use Operational Procedure with valve alignment table was developed in ~2016 to transfer to PAR.

Defuel Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank was not addressed by the PHA Team at this time.
Operating Conditions: 1. Flow: [redacted] (b)(3)(A); 2. Pressure: up to ~130 psig; 3. Temperature: 60 to 80°F

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
12.1. What If ...Defueling RHL to UGPH?	1. Incorrect or missing Creation of Evolution of movement or Operations Order?	1. Potential delay in defueling TK 102/103/104/105/106 F-24 Tank (Red Hill), TK 107/108/109/110/111/112/120 JP-5 Tank (Red Hill), and TK 115/116 F-76 Tank (Red Hill). Potential little or no impact to mission capability or unit readiness. PHA Team concluded the evolution would not proceed without an Operations Order and signed-off by the operations supervisor.	MR	4	D	5	Supervisor's responsible for developing and issuing Operations Orders. Any needed modifications are discussed with supervisor and approved before use (operations practice).	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11). 56. Implement a document control system to generate unique, trackable operations orders and log revisions. (Low Priority)	

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
	2. Multiple tanks in same tank group out-of-service with unrestrained piping? OR Line is not packed and not detected to be not packed? OR High point bleed closed too early?	1. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Lower Access Tunnel. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: Transformer, primary disconnects, and MCC switch gear are currently located in electrical room inside Lower Tunnel. Consistent with May 6, 2021 incident and September 29, 2021 near-miss.	MR H/S E P	2 1 1 1	B B B B	2 1 1 1	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	24. Modify CIR contracts to include restraining pipe between blanked sections when taking tank out of service for maintenance or inspection. (High Priority) 25. Include verification step in Operations Order that piping is restrained before starting any evolution involving transferring liquid from any tank in Red Hill Tank Gallery. (High Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear [redacted] and consider relocation to an area external to tunnel system, similar to [redacted] Electrical Room Relocation Project MILCON P-8006. (High Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority) 32. Evaluate the need for Dresser Couplings in the [redacted] and [redacted] main distribution piping in Red Hill Tank Gallery between TK 114 JP-5 Tank (Red Hill) and TK 116 F-76 Tank (Red Hill), shown on Drawing [redacted]. If they can be removed safely, remove the Dresser Couplings. JP-5 Emergent Pipeline Repairs were underway at the time of the PHA and will include eliminating old Dresser Coupling on [redacted] JP-5 piping. This recommendation should be completed prior to returning JP-5 piping to service. (High Priority)	
		2. Potential sagging of pipeline between UGPH and RHL. Potential to draw vacuum in piping between Hotel Pier and UGPH, and between UGPH and RHL. Potential to collapse piping. Potential loss of containment. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 1 2 1	C C C C	3 2 3 2	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders. Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump. Rover Checklist requires walking the line during offloading,	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 7. Perform a Pipe Collapse Pressure Study to determine the pressure required to collapse the existing pipe and identify and install safeguard(s) as warranted. Consider integrating this recommendation with upcoming API 570 Assessment. (High Priority)	

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix			Safeguards	PHA Recommendation	Comments
				C	L	RR			
							loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
		3. Potential sagging of pipeline between UGPH and RHL. Potential to draw vacuum in piping between Hotel Pier and UGPH, and between UGPH and RHL. Potential to damage seals in Dresser Coupling. Potential loss of containment when flow is re-established. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	C	3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC.	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers ([redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
			H/S	1	C	2	PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority)	
			E	2	C	3	Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump.	8. Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around pumps installed in UGPH and Red Hill Tank Gallery. Consider modifying design if manufacturer has alternate sealing system and Dresser Couplings remain part of design. (High Priority)	
			P	1	C	2	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	9. Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling. (High Priority)	
		4. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Zone 7 Sump and/or Main Sump (fuel sumps). Potential rapid release of very large quantity of ambient flammable liquid to TK 311 Slop Tank. Potential increased level in TK 311. Potential to overfill TK 311. Potential increased level in secondary containment (> 6ft deep, one set of stairs in corner, vertical side walls). Potential pool fire. Potential release to soil, groundwater and/or Halawa stream. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: Pumps at Main Sump have a combined capacity of ~300 gpm. TK 311 is not equipped with pumps to remove level. A vacuum truck is brought in when needed to remove level. TK 311 is in an isolated area not near through traffic roads. Inside the containment there are no sources of ignition. Isolation valve at the tank can be closed outside of containment area. At the time of the PHA the area adjacent to TK 311 is in use for groundwater treatment. Flow from Groundwater Sump Pump inside	MR	4	D	5	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
			H/S	1	D	3	High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically.	28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority)	
			E	1	D	3	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority)	
			P	1	D	3	Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority)	
							LSH-100 high level (switch) in Main Sump starts Main Sump Pump A and alerts operator to investigate source of level and intervene. LSHH-100 high high level (switch) Main Sump starts Main Sump Pump A and Main Sump Pump B and alerts operator to investigate source of level and intervene. Both LSH-100 and LSHH-100 share a sensor. They are part of	43. Install a second and independent high level indication and alarm on TK 311 Slop Tank to reduce the likelihood of overfilling TK 311 unknowingly. (Medium Priority)	
								44. Review current practices and operability of TK 311 Slop Tank with groundwater treatment equipment and personnel adjacent to TK 311 to evaluate the interaction of the two operations and modify practices if warranted. (Low Priority)	
								11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		AFFF Sump (typical of five) may accelerate this consequence.					a PM program but not using certified or calibrated test equipment. Main Sump level switches high and low are not on UPS backup power, but are operated by (b)(3)(A) [redacted] LSH-0197 high level (switch) in Zone 7 area alerts operator to investigate cause of presence of liquid level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-311 high level alarm on TK 311 Slop Tank alerts operator to investigate source of level and intervene. LSHH-311 is calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		5. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to AFFF Sump (typical of five). Potential to pump ambient flammable liquid to AFFF Retention Tank. Potential to overfill AFFF Retention Tank. Potential to introduce ambient flammable liquid to secondary containment (sloped sides). Potential ambient flammable liquid carryover to GAC and Halawa stream. Potential pool fire. Potential release to soil, groundwater and/or Halawa stream. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: AFFF System Project was completed in 2019. The AFFF Retention Tank has a capacity of 153,000 gal. and was sized to hold 20 minutes of fire fighting foam and water plus 80,000 gal. of fuel from a leak. The AFFF system is currently made of PVC and CS. There is currently only local level indication in the five AFFF Sumps. There is currently no level indication on the AFFF Retention Tank. At the time of the PHA, the motors to the pumps from AFFF Sumps were LOTO to reduce the likelihood of autostart. Currently, the AFFF System is contractually maintained by a company responsible for multiple JBPHH entities. Consequence similar to May 6, 2021 incident	MR	4	B	4	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program. Each of the five AFFF Sumps contain four pumps intended for staggered start (local level switch) to pump to AFFF Retention Tank. The AFFF Sump pumps were recently added to a PM schedule.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 45. Ensure run status indication on all pumps inside all AFFF Sumps (20 pumps) is integrated with the AFHE SCADA to alert Control Room Operator (CRO) to potential release of fuel and/or AFFF. (High Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 47. Evaluate the design of the 14" AFFF discharge line piping on the discharge of 20 AFFF Sumps pumps as part of the current project to upgrade PVC to CS. The PHA Team is concerned about 1) the volume flow and separately, 2) line slope or configuration to trap liquid in retention line, and 3) lack of damage control isolation in long-run of piping. (High Priority) 48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High Priority) 49. Train all affected personnel on the design, intent, and operation of the AFFF System, including refresher training. (High Priority) 50. Consider equipping AFFF Retention Tank with reliable level indication and level alarm to alert Control Room Operator (CRO) to presence of level in AFFF Retention Tank. (Medium Priority)	
			H/S	2	B	2			
			E	1	B	1			
			P	1	B	1			

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		and November 20, 2021 incident.						42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		6. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Water Shaft, Adit 3 Ground Water Sump and/or Septic Sump. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Consistent with May 6, 2021 incident and November 20, 2021 incident.	MR	3	B	3	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 51. Consider designing a system to separate oil and water to reduce the likelihood of discharging flammable liquid to environment from Adit 3 Groundwater Sump. (Medium Priority) 52. Provide means to remove contamination from water supply. (High Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
			H/S	1	B	1			
			E	1	B	1			
			P	1	B	1			
		7. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Harbor Tunnel. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil, groundwater, and/or Pearl Harbor waterways. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact	MR	3	B	3	Specific Operations Order for detecting vacuum and repacking the line (new procedure created after September 29, 2021). PITs used to sense pressure in piping are located several miles from Red Hill Tank Gallery and are not currently part of a PM program. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority)	
			H/S	1	B	1			
			E	1	B	1			
			P	1	B	1			

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		to mission capability or unit readiness.					High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 53. Evaluate an emergency breathing air supply for Harbor Tunnel due to its long length, limited egress, and reduced ventilation. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		8. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling. Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH. Potential fire and/or explosion. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Currently [redacted] The type of casing material is unknown. There is currently an awarded project to replace [redacted]	MR H/S E P	2 1 2 1	B B B B	2 1 2 1	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT [redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT [redacted] high current transmitter on	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted]	

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							motor in MCC stops respective pump. CTs are not currently part of calibration system.	[redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
							OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.	31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
							SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]		
		9. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential to overfill UGPH to Lower Yard Tunnel (LYT) and/or Harbor Tunnel and/or Surge Tank Tunnel. Potential to overfill tunnels and/or sumps to surrounding area and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	B	2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	
			H/S	1	B	1	[redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve.	15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
			E	2	B	2		16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority)	
			P	1	B	1	[redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
							[redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system.	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
							TT [redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system.	18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
							CT [redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system.	19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
							OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.		
							SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]		
							LSH high level (switch) in Harbor Tunnel Sump with local audible alarm alerts operator to investigate cause of high level and take action, including pumping to safe location.		

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		10. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank (normal lineup, B1 and B2 are sluiced). Potential to overfill Tank 1301/1302 to containment area. Potential release to soil below containment area (due to leaking containment) and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential overfill to Lower Yard Tunnel (LYT) may accelerate this consequence (abnormal lineup).	MR H/S E P	2 1 2 1	C C C C	3 2 3 2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LAH-B1/B2 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-B1/B2 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel [redacted] Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		11. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to [redacted] Sump (abnormal lineup). Potential to overfill [redacted] Harbor Tunnel, and/or Adit 2 (including french drain systems). Potential release to soil and/or groundwater and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential overfill to Lower Yard Tunnel (LYT) may accelerate this consequence. Potential to overfill to Harbor Tunnel may accelerate this consequence.	MR H/S E P	2 1 1 1	C C C C	3 2 2 2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
		12. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down	MR H/S E P	2 1 1 1	C C C C	3 2 2 2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential to overfill UGPH to Lower Yard Tunnel (LYT) and/or Harbor Tunnel and/or Surge Tank Tunnel. Potential release to soil and/or groundwater below Surge Tank Tunnel (due to leaking tunnel) and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.					[redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
	3. High point bleed opened too quickly during line pack?	1. Potential release of ambient flammable liquid to atmosphere. Potential personnel injury. Operator works from portable ladder to open HPB. Procedure does not state to connect hose to bleed and other end of hose to Main Sump, but some operators practice that. Often, two people are involved but not required in procedure. Prior to current curtailment of red Hill use, this task was performed frequently (daily).	H/S	3	C	4	Current operator practice of connecting hose from main bleed to Main Sump. Operator practice is for additional operator to be present for task.	57. Consider installing small platform in lieu of portable ladders for safer access to HPB for each of the three products OR relocate HPB to ground level. Hard pipe the discharge of the HPB to Main Sump. Ensure the end of the discharge piping is visible to person(s) performing task. (Low Priority) 58. Perform Job Safety Analysis (JSA) on high-risk tasks to address human factors and PPE requirements. (Medium Priority)	
		2. Potential to introduce air to a flammable liquid pipeline. Potential release of flammable mixture	MR	4	D	5	Robust ventilation system, required electricity.	59. Ensure seals and enclosures necessary to maintain electrical area classification Class 1 Div I are included in PM program. (Medium Priority)	

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		from HPB which may be routed to Main Sump, Zone 7 Sump, or release at HPB location when line is packed from tank. Potential flash fire. Potential personnel injury. Potential impact to mission capability or unit readiness.	H/S	2	D	4	Electrical area classification reduces the likelihood of ignition.	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
								60. Ensure transformers, switch gear, automatic transfer switch (ATS), and other equipment in Switch Gear Room meets requirements of Class 1 Div I. (High Priority)	
								30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear [redacted] and consider relocation to an area external to tunnel system, similar to [redacted] Electrical Room Relocation Project MILCON P-8006. (High Priority)	
								61. Consider using nitrogen to relieve vacuum inside piping instead of air to reduce the likelihood of producing a flammable mixture. (Medium Priority)	
								62. Ensure Area Classification boundaries are clearly denoted in written PSI and understood by impacted personnel. (High Priority)	
	4. Failure to settle line after packing before proceeding?	1. No hazardous consequences identified.							
	5. Tank skin DBB valve not opened before opening ball valve?	1. Potential damage over time to DBB valve. No hazardous consequences identified.							
		2. Potential release of flammable liquid from HPB which may be routed to Main Sump, Zone 7 Sump, or release at HPB location when line is packed from tank. Potential fire. Potential personnel injury. Potential impact to mission capability or unit readiness.	MR	4	D	5	Robust ventilation system, required electricity.	59. Ensure seals and enclosures necessary to maintain electrical area classification Class 1 Div I are included in PM program. (Medium Priority)	
			H/S	2	D	4	Electrical area classification reduces the likelihood of ignition.	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
								60. Ensure transformers, switch gear, automatic transfer switch (ATS), and other equipment in Switch Gear Room meets requirements of Class 1 Div I. (High Priority)	
								30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear [redacted] and consider relocation to an area external to tunnel system, similar to [redacted] Electrical Room Relocation Project MILCON P-8006. (High Priority)	
								61. Consider using nitrogen to relieve vacuum inside piping instead of air to reduce the likelihood of producing a flammable mixture. (Medium Priority)	
								62. Ensure Area Classification boundaries are clearly denoted in written PSI and understood by impacted personnel. (High Priority)	
	6. Ball valve opened too quickly?	1. Potential damage over time to ball valve. No hazardous consequences identified.							
		2. Potential release of flammable liquid from HPB which may be routed to Main Sump, Zone 7 Sump, or release at HPB location when line is packed from tank. Potential fire. Potential personnel injury. Potential impact to mission capability or unit readiness.	MR	4	D	5	Robust ventilation system, required electricity.	59. Ensure seals and enclosures necessary to maintain electrical area classification Class 1 Div I are included in PM program. (Medium Priority)	
			H/S	2	D	4	Electrical area classification reduces the likelihood of ignition.	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	
								60. Ensure transformers, switch gear, automatic transfer switch (ATS), and other equipment in Switch Gear Room meets requirements of Class 1 Div I. (High Priority)	
								30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC	

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
								switch gear [redacted] (b)(3)(A) and consider relocation to an area external to tunnel system, similar to [redacted] (b)(3)(A) Electrical Room Relocation Project MILCON P-8006. (High Priority) 61. Consider using nitrogen to relieve vacuum inside piping instead of air to reduce the likelihood of producing a flammable mixture. (Medium Priority) 62. Ensure Area Classification boundaries are clearly denoted in written PSI and understood by impacted personnel. (High Priority)	
	7. Failure to return the DBB and skin valve to auto position?	1. Potential loss of remote operability from control room. Potential escalation of event.					Control room operator (CRO) monitors position of DBB and skin valves.		
	8. High point bleed left open?	1. Potential release of flammable liquid from HPB which may be routed to Main Sump, Zone 7 Sump, or release at HPB location when line is packed from tank. Potential fire. Potential personnel injury. Potential impact to mission capability or unit readiness.	MR H/S	4 2	D D	5 4	Robust ventilation system, required electricity. Electrical area classification reduces the likelihood of ignition.	59. Ensure seals and enclosures necessary to maintain electrical area classification Class 1 Div I are included in PM program. (Medium Priority) 5. Consider equipping UGPH, [redacted] (b)(3)(A) Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] (b)(3)(A) [redacted] (b)(3)(A) with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 60. Ensure transformers, switch gear, automatic transfer switch (ATS), and other equipment in Switch Gear Room meets requirements of Class 1 Div I. (High Priority) 30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear [redacted] (b)(3)(A) and consider relocation to an area external to tunnel system, similar to [redacted] (b)(3)(A) Electrical Room Relocation Project MILCON P-8006. (High Priority) 61. Consider using nitrogen to relieve vacuum inside piping instead of air to reduce the likelihood of producing a flammable mixture. (Medium Priority) 63. Ensure Operations Order for line pack include specific step to close high point bleed valve (HPB) before completely opening ball valve. (Low Priority) 62. Ensure Area Classification boundaries are clearly denoted in written PSI and understood by impacted personnel. (High Priority)	
	9. Sectional valves in RHL tunnel not open?	1. Potential delay in defueling TK 102/103/104/105/106 F-24 Tank (Red Hill), TK 107/108/109/110/111/112/120 JP-5 Tank (Red Hill), and TK 115/116 F-76 Tank (Red Hill). Potential little or no impact to mission capability or unit readiness.	MR	4	B	4			
		2. Potential increased pressure in piping in RHL Tank Gallery. PHA Team had insufficient information to determine consequence or severity of this cause/consequence pair at the time of the PHA.						14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
		3. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Lower Access Tunnel. Potential personnel hazard (asphyxiation). Potential fire/explosion.	MR H/S E P	2 1 1 1	B B B B	2 1 1 1	High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room	24. Modify CIR contracts to include restraining pipe between blanked sections when taking tank out of service for maintenance or inspection. (High Priority) 25. Include verification step in Operations Order that piping is restrained before starting any evolution involving transferring liquid from any tank in Red Hill Tank Gallery. (High Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation.	

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Potential release to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: Transformer, primary disconnects, and MCC switch gear are currently located in electrical room inside Lower Tunnel. Consistent with May 6, 2021 incident and September 29, 2021 near-miss.					Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	(High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear [redacted] and consider relocation to an area external to tunnel system, similar to [redacted] Electrical Room Relocation Project MILCON P-8006. (High Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		4. Potential sagging of pipeline between UGPH and RHL. Potential to draw vacuum in piping between Hotel Pier and UGPH, and between UGPH and RHL. Potential to collapse piping. Potential loss of containment. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	C	3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not currently part of Operations Orders. Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 7. Perform a Pipe Collapse Pressure Study to determine the pressure required to collapse the existing pipe and identify and install safeguard(s) as warranted. Consider integrating this recommendation with upcoming API 570 Assessment. (High Priority)	
			H/S	1	C	2			
			E	2	C	3			
			P	1	C	2			
		5. Potential sagging of pipeline between UGPH and RHL. Potential to draw vacuum in piping between Hotel Pier and UGPH, and between UGPH and RHL. Potential to damage seals in Dresser Coupling. Potential loss of containment when flow is re-established. Potential release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit	MR	2	C	3	DOI Checklist initiated by Person In Charge (PIC) ensures primary and backup radio communication between ship and pier side per 33 CFR 154 & 156. All stops and starts must be agreed upon by terminal PIC and vessel PIC. PIT located [redacted] (if applicable) will alarm on low pressure and low low pressure alerts Control Room Operator (CRO) to 1) stop operations and 2) investigate cause of low pressure. PITs are not currently part of calibration system. Operator response to alarm is not	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 8. Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around	
			H/S	1	C	2			
			E	2	C	3			
			P	1	C	2			

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: (b)(3)(A) [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		readiness.					currently part of Operations Orders.	pumps installed in UGPH and Red Hill Tank Gallery. Consider modifying design if manufacturer has alternate sealing system and Dresser Couplings remain part of design. (High Priority)	
							Operating practice if aware of vacuum in piping would to be to re-pack the line before restarting the pump.	9. Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling. (High Priority)	
							Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
		6. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Zone 7 Sump and/or Main Sump (fuel sumps). Potential rapid release of very large quantity of ambient flammable liquid to TK 311 Slop Tank. Potential increased level in TK 311. Potential to overfill TK 311. Potential increased level in secondary containment (> 6ft deep, one set of stairs in corner, vertical side walls). Potential pool fire. Potential release to soil, groundwater and/or Halawa stream. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: Pumps at Main Sump have a combined capacity of ~300 gpm. TK 311 is not equipped with pumps to remove level. A vacuum truck is brought in when needed to remove level. TK 311 is in an isolated area not near through traffic roads. Inside the containment there are no sources of ignition. Isolation valve at the tank can be closed outside of containment area. At the time of the PHA the area adjacent to TK 311 is in use for groundwater treatment. Flow from Groundwater Sump Pump inside AFFF Sump (typical of five) may accelerate this consequence.	MR	4	D	5	High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
			H/S	1	D	3		28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority)	
			E	1	D	3	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.	29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority)	
			P	1	D	3		42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority)	
							Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	43. Install a second and independent high level indication and alarm on TK 311 Slop Tank to reduce the likelihood of overfilling TK 311 unknowingly. (Medium Priority)	
							LSH-100 high level (switch) in Main Sump starts Main Sump Pump A and alerts operator to investigate source of level and intervene.	44. Review current practices and operability of TK 311 Slop Tank with groundwater treatment equipment and personnel adjacent to TK 311 to evaluate the interaction of the two operations and modify practices if warranted. (Low Priority)	
							LSHH-100 high high level (switch) Main Sump starts Main Sump Pump A and Main Sump Pump B and alerts operator to investigate source of level and intervene. Both LSH-100 and LSHH-100 share a sensor. They are part of a PM program but not using certified or calibrated test equipment. Main Sump level switches high and low are not on UPS backup power, but are operated by (b)(3)(A) [redacted]	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
							LSH-0197 high level (switch) in Zone 7 area alerts operator to investigate cause of presence of liquid level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-311 high level alarm on TK 311 Slop Tank alerts operator to investigate source of level and intervene. LSHH-311 is calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		7. Potential line movement when undetected pipeline pressure sag followed by collapse of	MR	4	B	4	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure	

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to AFFF Sump (typical of five). Potential to pump ambient flammable liquid to AFFF Retention Tank. Potential to overfill AFFF Retention Tank. Potential to introduce ambient flammable liquid to secondary containment (sloped sides). Potential ambient flammable liquid carryover to GAC and Halawa stream. Potential pool fire. Potential release to soil, groundwater and/or Halawa stream. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Note: AFFF System Project was completed in 2019. The AFFF Retention Tank has a capacity of 153,000 gal. and was sized to hold 20 minutes of fire fighting foam and water plus 80,000 gal. of fuel from a leak. The AFFF system is currently made of PVC and CS. There is currently only local level indication in the five AFFF Sumps. There is currently no level indication on the AFFF Retention Tank. At the time of the PHA, the motors to the pumps from AFFF Sumps were LOTO to reduce the likelihood of autostart. Currently, the AFFF System is contractually maintained by a company responsible for multiple JBPHH entities. Consequence similar to May 6, 2021 incident and November 20, 2021 incident.	H/S E P	2 1 1	B B B	2 1 1	Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program. Each of the five AFFF Sumps contain four pumps intended for staggered start (local level switch) to pump to AFFF Retention Tank. The AFFF Sump pumps were recently added to a PM schedule.	new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 45. Ensure run status indication on all pumps inside all AFFF Sumps (20 pumps) is integrated with the AFHE SCADA to alert Control Room Operator (CRO) to potential release of fuel and/or AFFF. (High Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 47. Evaluate the design of the 14" AFFF discharge line piping on the discharge of 20 AFFF Sumps pumps as part of the current project to upgrade PVC to CS. The PHA Team is concerned about 1) the volume flow and separately, 2) line slope or configuration to trap liquid in retention line, and 3) lack of damage control isolation in long-run of piping. (High Priority) 48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High Priority) 49. Train all affected personnel on the design, intent, and operation of the AFFF System, including refresher training. (High Priority) 50. Consider equipping AFFF Retention Tank with reliable level indication and level alarm to alert Control Room Operator (CRO) to presence of level in AFFF Retention Tank. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		8. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Water Shaft, Adit 3 Ground Water Sump and/or Septic Sump. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil and/or groundwater. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit	MR H/S E P	3 1 1 1	B B B B	3 1 1 1	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Camera coverage in Lower Access Tunnel. Cameras are	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with	

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		readiness. Consistent with May 6, 2021 incident and November 20, 2021 incident.					included in scheduled PM program.	level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 51. Consider designing a system to separate oil and water to reduce the likelihood of discharging flammable liquid to environment from Adit 3 Groundwater Sump. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		9. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling in Red Hill Tank Gallery. Potential to introduce ambient flammable liquid to Harbor Tunnel. Potential personnel hazard (asphyxiation). Potential fire/explosion. Potential release to soil, groundwater, and/or Pearl Harbor waterways. Potential environmental impact. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	3 1 1 1	B B B B	3 1 1 1	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. High level in sump adjacent to the Oil Tight Door or initiation of fire suppression system closes Oil Tight Door using a counterweight mechanical system and lower the rails using a hydraulic scissor system. Door open or closed is indicated by contacts visible to Control Room Operator (CRO). Door closure is tested periodically. Camera coverage in Lower Access Tunnel. Cameras are included in scheduled PM program.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority) 27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority) 29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority) 42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority)	

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
								53. Evaluate an emergency breathing air supply for Harbor Tunnel due to its long length, limited egress, and reduced ventilation. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		10. Potential line movement when undetected pipeline pressure sag followed by collapse of vacuum which creates a transient pressure surge. Potential loss of containment at Dresser Coupling. Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH. Potential fire and/or explosion. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Currently [redacted] The type of casing material is unknown. There is currently an awarded project to replace [redacted]	MR	2	B	2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
			H/S	1	B	1			
			E	2	B	2			
			P	1	B	1			
		11. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential to overfill UGPH to Lower Yard Tunnel (LYT) and/or	MR	2	B	2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system.	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	
			H/S	1	B	1			
			E	2	B	2			
			P	1	B	1			

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Harbor Tunnel and/or Surge Tank Tunnel. Potential to overfill tunnels and/or sumps to surrounding area and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.					PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LSH high level (switch) in Harbor Tunnel Sump with local audible alarm alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority) 31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
		12. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank (normal lineup, B1 and B2 are sluiced). Potential to overfill Tank 1301/1302 to containment area. Potential release to soil below containment area (due to leaking containment) and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact.	MR H/S E P	2 1 2 1	C C C C	3 2 3 2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. FS-	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank	

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Potential impact to mission capability or unit readiness. Potential overfill to Lower Yard Tunnel (LYT) may accelerate this consequence (abnormal lineup).					[redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LAH-B1/B2 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-B1/B2 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
		13. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential for UGPH Main Sump Pump to introduce ambient flammable liquid to Adit 1 Sump (abnormal lineup). Potential to overfill Adit 1, Harbor Tunnel, and/or Adit 2 (including french drain systems). Potential release to soil and/or groundwater and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 1 1 1	C C C C	3 2 2 2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted]	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted]	

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
		Potential overfill to Lower Yard Tunnel (LYT) may accelerate this consequence. Potential to overfill to Harbor Tunnel may accelerate this consequence.					1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently part of calibration system. OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested. SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted] LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.	[redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	
		14. Potential to cavitate [redacted] Potential to separate Dresser Coupling. Potential reverse flow from Red Hill Tank Gallery to UGPH (reverse flow through down pump rotating backwards). Potential rapid release of very large quantity of ambient flammable liquid to UGPH. Potential increased level in UGPH Main Sump. Potential to overfill UGPH to Lower Yard Tunnel (LYT) and/or Harbor Tunnel and/or Surge Tank Tunnel. Potential release to soil and/or groundwater below Surge Tank Tunnel (due to leaking tunnel) and/or Pearl Harbor waterways. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	2 1 1 1	C C C C	3 2 2 2	[redacted] 1 low pressure (switch) on the suction of pump stops respective pump. PSLs are not currently part of calibration system. [redacted] low pressure (transmitter) on the suction of pump stops respective pump. PITs are not currently part of calibration system. PSL and PIT share common root valve. [redacted] 1 high vibration on pump and motor stops respective pump. VSs are not currently part of calibration system. [redacted] 1 low flow (switch) on pump stops respective pump. FSs are not currently part of calibration system. TT-[redacted] high temperature transmitter on pump stops respective pump. TTs are not currently part of calibration system. CT-[redacted] high current transmitter on motor in MCC stops respective pump. CTs are not currently	10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority) 15. Install ESD functionality to both suction and discharge MOVs to [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority) 17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority) 18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority) 19. Ensure OCVs on the discharge of each [redacted] are pressure or leak tested per schedule	

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	L	RR	Safeguards	PHA Recommendation	Comments
							part of calibration system.	and records retained for auditing. (Medium Priority)	
							OCV on the discharge of each [redacted] acts as a dual check valve, is scheduled for routine maintenance but not pressure or leak tested.		
							SCADA System AFHE flow direction alarm alerts operator to investigate cause of reverse flow and take action, including slowly closing [redacted]		
							LSH high level (switch) in Adit 2 Sump alerts operator to investigate cause of high level and take action, including pumping to safe location. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		15. Potential line movement when undetected pipeline pressure sag (downstream of sectional valves [redacted]) followed by collapse of vacuum when opening sectional valve which creates a transient pressure surge. PHA Team had insufficient information to determine the consequence.						31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	
12.2. What If ...Defueling from UGPH to Hotel Pier?	1. Valves misaligned to Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, or Tank 0223/0224 F-76 Surge Tank [redacted] open)?	1. Potential increased level in Tank 0221 F-24 Surge Tank 1, Tank 0222 JP-5 Surge Tank 2, Tank 0223/0224 F-76 Surge Tank. Potential to overfill Tank 0221/0222/0223/0224. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	D	5	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
			H/S	3	D	5	Unscheduled Fuel Movement (UFM) alarm alerts operator to investigate and take action per UFM SOP.		
			E	3	D	5	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
			P	1	D	3	LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
	2. Crossing over interior piping in	1. Operability issue. No hazardous consequences							

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: (b)(3)(A) [redacted]

Deviation	Cause	Consequence	CAT	C	L	RR	Safeguards	PHA Recommendation	Comments
	(b)(3)(A) [redacted] en route to Hotel Pier?	identified.							
	3. Valves misaligned to Truck Loading Rack (b)(3)(A) [redacted]?	1. Potential to load truck at abnormally high rate. Potential to exceed design conditions of truck loading flow meter. Potential to overfill tank truck. Potential release of ambient flammable liquid to a concrete contained area. Potential pool fire. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	C	5	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.		PHA Team concluded safeguards are adequate.
			H/S	3	C	4	All loading stations in the Truck Loading Rack are equipped with Overfill Protection Equipment (OPE) including dead-man switch. OPE is included in quarterly recurring maintenance program.		
			P	2	C	3	Emergency stop switch located at loading spot and at safe location away from loading spot.		
		2. Potential to load truck at abnormally high rate. Potential to exceed design conditions of truck loading flow meter. Potential to overfill tank truck. Potential release of ambient flammable liquid to a concrete contained area. Potential increased level in Load Rack Sump. Potential for Load Rack Sump Pump to introduce ambient flammable liquid to Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank (normal lineup, B1 and B2 are sluiced). Potential to overfill Tank 1301/1302 to containment area. Potential release to soil below containment area (due to leaking containment) and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness. Potential to lift PRVs at Truck Loading Rack may accelerate this consequence.	MR	4	D	5	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	
			H/S	3	D	5	All loading stations in the Truck Loading Rack are equipped with Overfill Protection Equipment (OPE) including dead-man switch. OPE is included in quarterly recurring maintenance program.	20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority)	
			E	3	D	5	Emergency stop switch located at loading spot and at safe location away from loading spot.		
			P	2	D	4	LAH-B1/B2 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-B1/B2 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
	4. Ship riser valve when defueling RHL to Hotel Pier closed?	1. Potential for ~130 psig static pressure at ship riser. Potential to exceed MAOP (1.1 x MAOP) of ship piping per Empire State information (120 psig). PHA Team calculated the static pressure at the ship riser based on ~350 ft elevation change between the high operating level of TK 120 JP-5 Tank and sea level. This equates to ~150 psig if fluid is water, and ~130 psig is fluid is fuel with a specific gravity of 0.86. PHA Team had insufficient information at the time of the PHA concerning the MAOP of ship riser piping. During the first week of the PHA, Empire State stated MAOP of ship piping is 120 psig, deadhead pressure of ship pump is 180 psig, and the high pressure shutdown on the ship pump is 230 psig.						13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority) 14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted]

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
12.3. What If ...Defueling JP-5 from UGPH to UTF?	1. Using exterior instead of interior piping [redacted]?	1. No hazardous consequences identified.							
	2. Valves misaligned to Tank 0222 JP-5 Surge Tank 2 [redacted] open)?	1. Potential increased level in Tank 0222 JP-5 Surge Tank 2. Potential to overfill Tank 0222. Potential release of ambient flammable liquid through open vent. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	4	D	5	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
			H/S	3	D	5	Unscheduled Fuel Movement (UFM) alarm alerts operator to investigate and take action per UFM SOP.		
			E	3	D	5	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
			P	1	D	3	LAH-0221/0222/0223/0224 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
							LSHH-0221/0222/0223/0224 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
12.4. What If ...Defueling F-24/76 from UGPH to UTF?	1. Using exterior instead of interior piping [redacted]?	1. No hazardous consequences identified.							
	2. Valves misaligned to Hickam (valve in VS-50 is chain-locked closed) [redacted]?	1. No hazardous consequences identified. Note: Multiple block valves between PRL and Hickam are closed.					Supervisor's responsible for developing and issuing Operations Orders. Any needed modifications are discussed with supervisor and approved before use (operations practice).		
							Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.		
							Unscheduled Fuel Movement (UFM) alarm alerts operator to investigate and take action per UFM SOP.		
	3. Valves misaligned to PAR [redacted]?	1. No hazardous consequences identified. Note: PHA Team concluded cause is not credible.					Supervisor's responsible for developing and issuing Operations Orders. Any needed modifications are discussed with supervisor and approved before use (operations practice).		
							Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.		
							Unscheduled Fuel Movement (UFM) alarm alerts operator to investigate and take action per UFM SOP.		
							Manual valve [redacted] at [redacted] is chain-locked closed and owned		

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
							by PAR.		
	4. Valves misaligned to Hotel Pier (b)(3)(A) [redacted] ?	1. Potential release of ambient flammable liquid to Hotel Pier, pier containment, and/or water. Potential overfill pier containment sump. Potential release of ambient flammable liquid to Pearl Harbor. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	3 3 2 2	D D D D	5 5 4 4	Supervisor's responsible for developing and issuing Operations Orders. Any needed modifications are discussed with supervisor and approved before use (operations practice). Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years. LSH-801 high level (switch) in Hotel Pier (HP) Sump starts both HP1 and HP2 Hotel Pier Sump Pumps and alerts operator to investigate source of level and intervene. LSH-801 is not currently part of a PM program. Hotel Pier (HP) Sump level switch high is on UPS backup power, and is operated by diesel-driven emergency generators at Building 1757. Pumps are PM'ed by RMMR at least quarterly. Emergency generators autostart and are tested periodically Camera coverage for Hotel Pier area. Cameras are not currently included in scheduled PM program.	70. Include all PRL cameras in scheduled PM program. (Medium Priority)	
	5. Valves misaligned to Truck Load Rack (b)(3)(A) [redacted] ?	1. Potential to load truck at abnormally high rate. Potential to exceed design conditions of truck loading flow meter. Potential to overfill tank truck. Potential release of ambient flammable liquid to a concrete contained area. Potential pool fire. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S P	4 3 2	C C C	5 4 3	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. All loading stations in the Truck Loading Rack are equipped with Overfill Protection Equipment (OPE) including dead-man switch. OPE is included in quarterly recurring maintenance program. Emergency stop switch located at loading spot and at safe location away from loading spot.		PHA Team concluded safeguards are adequate.
		2. Potential to load truck at abnormally high rate. Potential to exceed design conditions of truck loading flow meter. Potential to overfill tank truck. Potential release of ambient flammable liquid to a concrete contained area. Potential increased level in Load Rack Sump. Potential for Load Rack Sump Pump to introduce ambient flammable liquid to Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank (normal lineup, B1 and B2 are sluiced). Potential to overfill Tank 1301/1302 to containment area. Potential release to soil below containment area (due to leaking containment) and/or groundwater. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR H/S E P	4 3 3 2	D D D D	5 5 5 4	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding. All loading stations in the Truck Loading Rack are equipped with Overfill Protection Equipment (OPE) including dead-man switch. OPE is included in quarterly recurring maintenance program. Emergency stop switch located at loading spot and at safe location away from loading spot. LAH-B1/B2 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration. LSHH-B1/B2 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay,	17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority) 20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority)	

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix			Safeguards	PHA Recommendation	Comments
				C	L	RR			
		Potential to lift PRVs at Truck Loading Rack may accelerate this consequence.					currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
12.5. What If ...Defueling F-24 from UGPH to Hickam?	1. Valves misaligned to UTF [redacted] (b)(3)(A) ?	1. Potential to overpressure and/or overfill Tank 46/53 F-24 Tank (Upper Tank Farm). Potential release of ambient flammable liquid to a lined containment area. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	2	C	3	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	PHA Team concluded safeguards are adequate.
			H/S	3	C	4	LAH-46/53 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
			P	2	C	3	LSHH-46/53 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
12.6. What If ...Defueling from UGPH to PAR?	1. Wrong product valves misaligned in [redacted] (b)(3)(A) to PAR [redacted] (b)(3)(A) open)?	1. Potential off-spec product in storage at PAR. No hazardous consequences identified.							
	2. Valves misaligned in [redacted] (b)(3)(A) to [redacted] (b)(3)(A) (b)(3)(A) ?	1. Potential release of ambient flammable liquid to Hotel Pier, pier containment, and/or water. Potential overfill pier containment sump. Potential release of ambient flammable liquid to Pearl Harbor. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	MR	3	D	5	Supervisor's responsible for developing and issuing Operations Orders. Any needed modifications are discussed with supervisor and approved before use (operations practice).	70. Include all PRL cameras in scheduled PM program. (Medium Priority)	
			H/S	3	D	5	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.		
			E	2	D	4	Rover Checklist requires walking the line during offloading, loading, and any fuel transfers. Rover alerts Control Room Operator (CRO) of abnormal conditions and CRO can initiate emergency shutdown procedures. Rover Checklists are maintained for at least 3 years.		
			P	2	D	4	LSH-801 high level (switch) in Hotel Pier (HP) Sump starts both HP1 and HP2 Hotel Pier Sump Pumps and alerts operator to investigate source of level and intervene. LSH-801 is not currently part of a PM program. Hotel Pier (HP) Sump level switch high is on UPS backup power, and is operated by diesel-driven emergency generators at Building 1757. Pumps are PM'ed by RMMR at least quarterly. Emergency generators autostart and are tested periodically		
							Camera coverage for Hotel Pier area. Cameras are not currently included in scheduled PM program.		
	3. Valves misaligned in [redacted] (b)(3)(A) to Tank 301 Intermix Tank (MOV	1. Potential increased level in Tank 301 Intermix Tank. Potential to overfill Tank 301. Potential	MR	3	D	5	Pipeline animation indicates correct and misdirected flow valve alignments by color-coding.	11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	
			H/S	3	D	5			

Node: 12. Non-routine Operations: Defueling Red Hill (completely), includes transfer to other locations and/or loading ships/barges
Drawings: [redacted] (b)(3)(A)

Deviation	Cause	Consequence	CAT	Risk Matrix C	Risk Matrix L	Risk Matrix RR	Safeguards	PHA Recommendation	Comments
	[redacted] (b)(3)(A) open)?	release of ambient flammable liquid. Potential environmental impact. Potential fire. Potential personnel injury. Potential public impact. Potential impact to mission capability or unit readiness.	E	3	D	5	LAH-301 high level (ATG) alarm alerts operator to investigate source of level and intervene. ATGs are calibrated at least annually and validated monthly. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
			P	2	D	4	LSHH-301 high high level (switch) stops all transfer pumps in PRL excluding marine ship pumps and after time delay, currently five minutes, closes skin MOV on impacted tank. High high level switches are calibrated annually. All level transmitters and high level switches are on UPS backup power with 4 hour duration.		
		2. Potential to damage and/or sink internal floating roof in Tank 301 Intermix Tank. Potential impact to mission capability or unit readiness.	MR	4	C	5			
12.7. Other	1. Off-spec material in any one of TK 102/103/104/105/106 F-24 Tank (Red Hill), TK 107/108/109/110/111/112/120 JP-5 Tank (Red Hill), and TK 115/116 F-76 Tank (Red Hill)?	1. Potential off-spec product in storage at PRL or PAR. Potential impact to mission capability or unit readiness.	MR	3	D	5	Quality Surveillance Procedures with sampling matrices exist in the OMES Manual in accordance with MIL-STD-3004 and ASTM D 4057.		

APPENDIX C HUMAN FACTORS & FACILITY SITING CHECKLISTS

Human Factors Checklist

(b) (4)

[redacted]	Observation	PHA Recommendation
[redacted]	1. Signs included signs for heavy doors, hearing protection areas, tunnel signs for awareness of location, access and egress points.	
	1. Barriers were observed where Tank Clean Inspection and Repairs were being performed, and at the GAC water reclamation site.	
	1. Tunnels, UTF, Control Room observed and all are clean and orderly.	
	1. Noise is at a tolerable level. Signs are posted at hearing protection required areas.	
	1. Audible fire and emergency alarms are in place.	
	1. Lighting was generally good in the Harbor and Lower Tunnel and Tank Gallery.	
	1. Backup power is available via diesel generator.	
	1. The general environment was clean, barriers were erected for maintenance and special projects. Lighting was adequate. It was generally conducive to safe job performance.	
	1. Hard hats were available at entrances to tunnels. Flame retardant clothing is not required in the tunnels.	103. Consider requirement for flame retardant clothing while working in hydrocarbon environment. (High Priority)
	1. Spill kits were available throughout tunnels and were readily accessible.	
	1. Alarm system was located throughout the tunnel system for emergency communication. Strobes and speakers are placed incrementally throughout the tunnels. There are pull alarms and phones at some points. Operators communicate by radio and telephone.	
	1. Specialty jobs are contracted and contractors have specialty tools.	
	1. Workers were observed inside the tank 18 cleaning job and appeared to have adequate space. Some workers were on a hoist platform and could freely move while on the platform. Clearances within tunnels appear adequate for posture and space to move freely while working.	
	1. Based on observations of manual valves they appear to be accessible. Venting the vacuum from the end of the line in Red Hill Tank Gallery is by ladder. 2 people are used for the job. One throttles the valve to repack the line and one vents the line.	57. Consider installing small platform in lieu of portable ladders for safer access to HPB for each of the three products OR relocate HPB to ground level. Hard pipe the discharge of the HPB to Main Sump. Ensure the end of the discharge piping is visible to person(s) performing task. (Low Priority)
		58. Perform Job Safety Analysis (JSA) on high-risk tasks to address human factors and PPE requirements. (Medium Priority)
	1. Emergency Operations with restricted egress could pose an unsafe condition.	104. Consider installing emergency PPE throughout the facility. (High Priority)
	1. Valves were observed to be easily accessible and adjustable including chain operated valves as needed.	
	1. Piping, tanks, pumps, valves, equipment were labeled.	
	1. We observed valves associated with procedures including tank skin valves, tank DBB valves sectional valves, and T valves which were all labeled.	

[redacted]

Observation	PHA Recommendation
1. Tunnels contain signs showing location and nearest egress point. Egress points are labeled.	
1. Lines and tanks are labeled with the fuel content type. Spill equipment and water treating equipment were also labeled.	
1. Alarms are displayed on the control panel. Alarm summary shows acknowledged and unacknowledged alarms.	
1. There are 4 quadrants on two display screens from which the CRO can choose which 4 views he wants to see.	
1. There are 2 Control Room Operator screens adequately visible to the 2 Control Room Operators.	
1. Each display has quadrant 1,2,3, 4 and have consistent information available.	
1. Tank high levels on process tanks provide automatic shutdown of pumps. Non process tanks (slop and AFFF) do not currently have automation.	3. Consider installing local ESD on refueling piers and docks at PRL Ensure ESD actions are consistent with Coast Guard requirements and do not create additional hazards. (Medium Priority)
	4. If additional safeguards are warranted, design and install automation to safely shutdown refueling piers and docks at PRL in event of emergency or loss of containment, including isolation of sectional valves to minimize quantity of loss of containment. (High Priority)
	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)
	66. Design and install interlock and permissive systems for all fuel movements to/from RHL and UGPH, to reduce the likelihood of human error of sequencing valves during lineup. Design should consider use of the manual clutch to bypass MOV operation. (High Priority) Some action is already underway as the result of AB&A Root Cause Analysis into the May 6, 2021 Mishap.
1. Sump at Oil Tight Door triggers Oil Tight Door to close.	
1. Alarm summary consists of critical alarms only.	
1. Alarms are distinguished as critical and control and CRO only sees critical alarms.	
1. Alarm summary is a permanent display.	
1. Operators did not indicate they receive nuisance alarms. Alarm management cleanup in the last couple of years has improved operator response to alarm reliability. They indicated acknowledging the alarms was not overly burdensome.	
1. Operators perform a calculation to determine how much sent to each ship using tank levels before and after the loading. Strapping charts for all tanks are programmed in AFHE.	
1. Calculations are checked by the second CRO, the supervisor, and accounting.	
1. Predetermined, acceptable ranges are programmed into AFHE. For transfer sheets, calculations are performed by hand.	
1. Tank levels and pressures are shown. Valve alignments and valves open/closed are shown. The entire process is shown on the display.	95. Consider adding additional AFHE workstations and larger monitors to accomplish need for visibility of more quadrants simultaneously. (Medium Priority)

(b) (4)

[redacted]

Observation	PHA Recommendation
	96. Evaluate the size and location of current backup control room to better accommodate additional CROs and reduce access and distractions. (High Priority) 6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority)
1. It was not clear if the closing of the oil tight doors would display on the system.	105. Ensure the closing of the oil tight doors displays on the control room display. (High Priority)
1. Repair processes in place do not address malfunctions as quickly as the mission requires.	78. Establish a stand alone maintenance contract apart from other base facilities with documented maintenance standards. (High Priority) 106. Consider inventorying spare parts/replacements for critical instrumentation to reduce the wait time for repairs. (Medium Priority)
1. There are two control room consoles which are next to each other.	
1. Operators are proficient in the control system use.	
1. The control system displays meet expectations regarding color and direction of movement. Based on view of fuel transfer alignment.	
1. Confirmed by observation. Operator demonstrated fuel transfer on the display.	
1. If pumps are shutdown automatically, operators could restart them.	
1. Line packing from Red Hill tanks, and tank to tank transfers, are a challenge due to potential to form a vacuum in the line.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on (b)(3)(A) [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)
1. Fuel transfers require manual adjustment of valves. Human error could potentially be prevented with automation.	6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority) 10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on (b)(3)(A) [redacted] are in a scheduled PM system using certified and calibrated test equipment. (High Priority)
1. There are dedicated emergency shutdown screens and buttons on AFHE.	
1. Yes, there are two CROs during operations. Plans are to maintain two CROs 24/7 when staffing increases.	
1. There is little automation of fuel transfers so these are lined up manually.	
1. This is not applicable because there are currently a large number of manual adjustments required and little automation for fuel transfers.	
1. There are 2 Control Room Operators, 1 Rover at PRL, and 2-3 Rovers at Red Hill per shift. There are not additional operators available for emergency.	
1. No.	107. Consider additional operators and technical support for defueling operations. (High Priority) 94. Develop a procedure that outlines the specific manpower requirements for multiple, simultaneous operations as

(b) (4)

[redacted]

Observation	PHA Recommendation
	the number of operations increased and that requires written approval for SIMOPS by appropriate level of management. (High Priority)
1. Standing Orders Fuel Transfers became a priority in 2021. They are not clear regarding emergency operations and regarding end of the fuel transfer (closing the valves).	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).
1. Standing Orders are adjusted for each fuel transfer. They are sometimes adjusted on the day of the fuel transfer if the operator notices that a change is needed per operator interview on Feb 16. Standing Orders are not detailed enough regarding emergency shutdown and also for certain steps of operation. For example tank to tank transfer says Realign valves meaning close the valves. Evolution 3 Order from May 6 RCA. Last step says return F76 system to its standard configuration. Repack from UTF 54 to Hotel Piers. Procedures do not address PPE. Safety Plan is too generic and needs to be more specific. “Remain calm in an emergency”, “Be aware of strange sounds and smells”, “Do not become distracted”. These statements are not specific to any hazard.	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).
1. No there is not a standard template or method to incorporate notes as revisions into the Standing Orders.	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).
1. There is an operator training and progression program in place. The program is in its early stages.	
1. According to the FRP Fuels employees receive initial training on their emergency response programs.	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).
1. CROs go through annual AFHE refresher training. Fuels Distributions System workers do no undergo refresher training.	
1. No formal program	
1. There is no systematic training on changes.	108. Implement Management of Change Program. (High Priority)
1. There is not a near miss reporting system in place.	
1. There is not a near miss reporting system in place.	109. Develop Incident Investigation Program that includes Incident Investigation techniques and near miss reporting and investigation, and sharing of lessons. (High Priority)
1. There is not a clear procedure for emergency shutdown regarding the order	1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop

[redacted] (b) (4)	Observation	PHA Recommendation
	of shutting down in an emergency.	written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).

Facility Siting Checklist

[redacted]	Observation	PHA Recommendation
	1. Due to the uniqueness of this facility and the fact that much of it is underground, emergency egress poses a serious risk. The Harbor Tunnel is approximately 2.5 miles long with few entrances/exits. There is a potential for personnel to be more than a mile from an exit. Although tunnel access is controlled, there did not appear to be a personnel accountability procedure. There is no sign-in required so personnel accountability would not be available during an emergency. Additionally, it did not appear that emergency radios are required for visitors accompanied by a guide. There are land-line telephones placed periodically throughout the tunnel, but in order to reach an outside line, "99" has to be dialed first and this was not clearly posted.	110. Implement a tunnel sign-in/sign-out process to be able to account for all personnel within the tunnel at any time. (Medium Priority) 111. Require guides and all groups to have at least one form of emergency communication – likely a radio. (Medium Priority) 112. Post signs periodically indicating the distance to the nearest emergency phone and instructions to dial "99" then "911". (Medium Priority) 113. Locating and tracking people is crucial for underground working conditions. Traditional technologies such as GPS and WiFi tracking do not work underground. Consider implementation of a system designed to locate and track personnel while in the tunnel. (Low Priority) 114. Consider requiring SCBA, emergency air packs, installing SCBA station(s) or breathing airline throughout tunnel. (Medium Priority)
	1. Within the aboveground facility, there is no issue with access. There was no evidence of typical emergency vehicles being able to access the tunnels.	
	1. Yes, however due to the strategic mission of Red Hill, the inventory of fuel is set by the Navy.	
	1. Yes, however, the location of Red Hill was not determined based on this criteria. The Navy located Red Hill to protect strategic fuel reserves.	
	1. Yes, control panels are located at each pump in the UGPH.	
	1. Yes, if the situation requires it, CROs are able to safely open circuit breakers.	
	1. No.	
	1. Control Room was constructed prior to the existence of any acceptable criteria.	
	1. The control room is not blast proof and has been fitted with windows facing the UGPH. In the event of an explosion and/or jet fire, the CROs would be at risk.	115. Consider reinforcing the window/wall facing the UGPH. (High Priority) 116. Consider providing appropriate PPE, for example bunker gear, and safeguards to allow CROs ample time to escape the area during an emergency. (High Priority) 117. Consider relocation of the control room from the UGPH to the back control room located in the Fuels Distribution Building. (Low Priority)

(b) (4)

[redacted]

Observation	PHA Recommendation
1. The control room is not blast proof and has been fitted with windows facing the UGPH. In the event of an explosion and/or jet fire, the CROs would be at risk.	115. Consider reinforcing the window/wall facing the UGPH. (High Priority)
	116. Consider providing appropriate PPE, for example bunker gear, and safeguards to allow CROs ample time to escape the area during an emergency. (High Priority)
	117. Consider relocation of the control room from the UGPH to the back control room located in the Fuels Distribution Building. (Low Priority)
1. Exit from the control room appears to be adequate.	
1. There are no vessels within the UGPH.	
1. No, in the event of an explosion, it is likely the window/wall may be compromised resulting in damage to the PLC and other control room equipment, not to mention the CROs.	116. Consider providing appropriate PPE, for example bunker gear, and safeguards to allow CROs ample time to escape the area during an emergency. (High Priority)
	115. Consider reinforcing the window/wall facing the UGPH. (High Priority)
	117. Consider relocation of the control room from the UGPH to the back control room located in the Fuels Distribution Building. (Low Priority)
1. Flammable vapors could collect in the UPGH.	5. Consider equipping UGPH, [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)
1. Yes.	
1. Yes.	
1. It is unclear if a positive pressure is maintained in the control room, but ventilation appears to be adequate to prevent an accumulation of hazardous vapors.	
1. Control room is located completely underground and falling structures are not an issue.	
1. Yes.	
1. Access for emergency vehicles isn't a problem in the aboveground facility. Red Hill and the tunnels are not accessible to typical emergency vehicles.	
1. Yes.	
1. There are no vessels that pose a risk to personnel.	
1. Yes, both the Red Hill Tank Gallery and the UTF are sloped away from the tanks.	
1. Yes, to the extent practicable. But, there are sumps within the Red Hill Tank Gallery and tunnels that are designed to route hydrocarbons to storage and flammable vapors could collect in these sumps. However, ventilation with the underground facility would likely prevent accumulation of these vapors.	

[redacted] (b) (4)

Observation	PHA Recommendation
1. Yes.	
1. Yes.	
1. Yes, several sumps and dikes were observed and were equipped with stairs and ramps for access.	
1. There are very few emergency stations. The UGPH safety shower would be inaccessible to CROs in the event of a UGPH fire.	118. Review the need for emergency stations (safety shower and eye wash) and first aid stations throughout the facility in proximity to fuel piping. (Low Priority)
1. There are very few first aid stations.	118. Review the need for emergency stations (safety shower and eye wash) and first aid stations throughout the facility in proximity to fuel piping. (Low Priority)
1. N/A	
1. No.	119. Due to the geographical vastness of this facility, review the need for installing alarms on safety showers and eyewash stations. (Low Priority)
1. See Recommendations.	59. Ensure seals and enclosures necessary to maintain electrical area classification Class 1 Div I are included in PM program. (Medium Priority)
	60. Ensure transformers, switch gear, automatic transfer switch (ATS), and other equipment in Switch Gear Room meets requirements of Class 1 Div I. (High Priority)
	62. Ensure Area Classification boundaries are clearly denoted in written PSI and understood by impacted personnel. (High Priority)
1. See Recommendations.	30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear [redacted] (b)(3)(A) and consider relocation to an area external to tunnel system, similar to [redacted] (b)(3)(A) Electrical Room Relocation Project MILCON P-8006. (High Priority)
1. Yes	
1. No, work is conducted within Red Hill and the tunnels with little communication between the jurisdictional groups.	120. Implement a formal safe work system, which includes coordination and control of all "intervention" work on the process and references all Life Critical standards, such as hot work, confined space, lock-out/tag-out, etc. (High Priority)
1. Yes	
1. Yes	
1. No.	5. Consider equipping UGPH, [redacted] (b)(3)(A) Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] (b)(3)(A) with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)
1. Yes, but in an emergency you would not want to shutdown the ventilation system since it could prevent an accumulation of flammable vapors.	

APPENDIX D TEAM ATTENDANCE AND SIGN-IN SHEET

Attendance

Team Members	2/7/2022	2/8/2022	2/9/2022	2/10/2022	2/11/2022	2/21/2022	2/22/2022	2/23/2022	2/24/2022	2/25/2022
[redacted]	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent
	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
	Present	Partial	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
	Present	Present	Present	Present	Partial	Present	Present	Present	Present	Present
	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	Present	Partial	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	Present	Present	Present	Present	Present	Absent	Absent	Absent	Absent	Absent
	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
	Present	Partial	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent
	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Partial
	Present	Present	Present	Present	Present	Present	Present	Present	Partial	Present
	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Partial	Absent
	Present	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	Present	Present	Present	Present	Present	Present	Present	Present	Partial	Present
	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent
	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Partial	Absent
	Present	Partial	Absent	Present	Partial	Absent	Absent	Absent	Absent	Absent
	Absent	Absent	Absent	Partial	Partial	Absent	Absent	Absent	Absent	Absent

Team Members	2/7/2022	2/8/2022	2/9/2022	2/10/2022	2/11/2022	2/21/2022	2/22/2022	2/23/2022	2/24/2022	2/25/2022
(b)(6) [redacted]	Absent	Present	Present	Present	Present	Present	Present	Present	Present	Present
	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Partial	Absent
	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Partial	Absent
	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Partial	Partial
	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent
	Present	Present	Present	Present	Present	Present	Present	Present	Partial	Present
	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent

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PHA Team Participants

Location: Honolulu, HI Project No.: 22-SGH-01 Study Name: Red Hills PHA Week 1

NAME (Please Print)	COMPANY	TITLE	SIGNATURE	TOTAL YEARS OF EXPERIENCE		SESSIONS 2022				
				IN CURRENT POSITION	IN THE INDUSTRY	2/7	2/8	2/9	2/10	2/11
[redacted]	Risktec	Facilitator	[redacted]	15	30+	✓	✓	✓	✓	✓
[redacted]	Risktec	Scribe	[redacted]	2	2	✓	✓	✓	✓	✓
[redacted]	Risktec	Process Safety Consultant	[redacted]	1	30+	✓	✓	✓	✓	✓
[redacted]	Risktec	Process Safety Cons.	[redacted]	4	30+	✓	✓	✓	✓	✓
[redacted]	WCS	Rotating/Static Equip	[redacted]	10+	25+	✓	✓	✓	✓	✓
[redacted]	FLC CODE 701	GENERAL ENGINEER	[redacted]	1	33	✓	✓	✓	✓	✓
[redacted]	703	OPERATOR	[redacted]	4	8		✓	✓	✓	✓
[redacted]	FLCPH	DEPUTY DIRECTOR	[redacted]	7	42	2/7	✓	✓	✓	✓
[redacted]	FLC PH	OPERATIONS WORK LEAD	[redacted]	5	20	2/4	✓	✓	✓	✓
[redacted]	NAVFAC HI	Red Hill PMO Dir	[redacted]	3.5	3.5	✓	✓	✓	✓	P
[redacted]	ENGLOBAL	TECHNICIAN	[redacted]	10	10	A	✓	A	A	A
[redacted]	NIWC	Technician	[redacted]	10	17	A	✓	✓	✓	✓

✓= present, P = partial participation, A = absent

[redacted]

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PHA Team Observers (Optional)

Location: Honolulu, HI Project No.: 22-SGH-01 Study Name: Red Hills PHA Week 1

NAME (Please Print)	COMPANY	TITLE	SIGNATURE	TOTAL YEARS OF EXPERIENCE		SESSIONS 2022				
				IN CURRENT POSITION	IN THE INDUSTRY	2/7	2/8	2/9	2/10	2/11
[redacted]	Risktec	Consultant Process Safety Engr	[redacted]	3	35	✓	✓	✓	✓	✓
[redacted]	Pond / OMES	Operations Specialist	[redacted]	10	36	✓	✓	✓	✓	✓
[redacted]	FLCPH	Executive Officer	[redacted]	2	0	✓	✓	A	A	A
[redacted]	SGH	Senior Consulting Eng	[redacted]	6.5	10	✓	P	A	A	A
[redacted]	SGH	STAFF CONSULTANT	[redacted]	1	15	✓	P	A	✓	P
[redacted]	NAVSUP	ELRT	[redacted]	2 months	15	✓	A	A	A	A
[redacted]	NAVSUP	EXEC DIR	[redacted]	3½	19	✓	A	A	A	A
[redacted]	NAVSUP	FLC PH CO	[redacted]	5½	24	✓	P	A	A	A
[redacted]	NPO	Automation	[redacted]	2	26	A	P	A	A	A
[redacted]	DLA	Supervisory Engineer	[redacted]	4	13	A	A	✓	A	A
[redacted]	SGH	SR. PRINCIPAL	[redacted]	—	40	A	A	A	P	P
[redacted]	FLC PH	REGIONAL FUELS DIRECTOR	[redacted]	6 mths	8	A	A	A	A	✓
[redacted]	ENGlobal/legal	Outside counsel	[redacted]	4/2yr		A	A	A	A	✓
[redacted]	ENGLOBAL G.S.	Vice President	[redacted]	7 mths	30+	A	A	A	A	✓
[redacted]	ENG GOVSERV	ENGR/PM	[redacted]	2 YRS	16	A	A	A	A	✓
[redacted]	ENG Gov Service	Program Manager	[redacted]	12	12	A	A	A	A	✓
[redacted]			[redacted]							

✓= present, P = partial participation, A = absent

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Risktec

PHA Team Participants

Location: Honolulu, HI Project No.: 22-SGH-01 Study Name: Red Hill PHA Week 2

NAME (Please Print)	COMPANY	TITLE	SIGNATURE	TOTAL YEARS OF EXPERIENCE		SESSIONS 2022				
				IN CURRENT POSITION	IN THE INDUSTRY	2/21	2/22	2/23	2/24	2/25
[redacted]	Risktec	Facilitator	[redacted]	15	30+	✓	✓	✓	✓	✓
[redacted]	Risktec	Scribe	[redacted]	2	2	✓	✓	✓	✓	✓
[redacted]	NIWC LANT	IPT Tech Lead	[redacted]	10	17	✓	✓	✓	✓	✓
[redacted]	Risktec	Consultant	[redacted]	4	30+	✓	✓	✓	P	✓
[redacted]	Risktec	Consultant	[redacted]	1	30+	✓	✓	✓	P	✓
[redacted]	WCS/SGH	Konsultant	[redacted]	10+	25+	✓	✓	✓	✓	✓
[redacted]	Pond	Consultant	[redacted]	10	36	✓	✓	✓	✓	✓
[redacted]	FLCPH	DEPUTY DIR	[redacted]	7	42	✓	✓	✓	✓	✓
[redacted]	NAVFAC	NFH Red Hill PMO	[redacted]	3.5	3.5	✓	✓	✓	✓	✓
[redacted]	FLCPH	Bulk Ops Workleader	[redacted]	5	20	✓	✓	✓	✓	✓
[redacted]	FLCPH	SR. FDSO	[redacted]	4	8	✓	✓	✓	✓	✓
[redacted]	FLCPH	GENERAL ENGINEER	[redacted]	4	17	A	✓	P	A	✓
[redacted]	FLCPH	General Engineer	[redacted]	2.5	2.5	A	A	A	✓	A
[redacted]	FLCPH	FDSO SUPV.	[redacted]	3	28	A	A	A	P	A
[redacted]	FLCPH	Barge Mech	[redacted]	6	35	A	A	A	P	A
[redacted]	FLC PH	Mech Sup	[redacted]			A	A	A	A	P

✓ = present, P = partial participation, A = absent

MARKING REMOVED

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PHA Team Observers (Optional)

Location: Honolulu, HI Project No.: 22-SGH-01 Study Name: Red Hill PHA Week 2

NAME (Please Print)	COMPANY	TITLE	SIGNATURE	TOTAL YEARS OF EXPERIENCE		SESSIONS 2022				
				IN CURRENT POSITION	IN THE INDUSTRY	2-21	2-22	2-23	2-24	2-25
[redacted] (b)(6)	Risktec	Consultant	[redacted] (b)(6)	~~30~~ 30+	30+	/	✓	✓	P	/
	FLC PH	Lead Engineer		1yr	12yr	A	A	A	P	A

✓ = present, P = partial participation, A = absent

[redacted]

APPENDIX E DFSP PEARL HARBOR BULK TERMINAL ACRONYMS

ACRONYMS

AFCEC	Air Force Civil Engineer Center
AFFF	Aqueous-film forming foam
AFHE	Automated Fuel Handling Equipment
AGA	American Gas Association
ANSI	American National Standards Institute
AOE	Auxiliary, Oiler, Explosives
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
AST	Aboveground storage tank
ASTM	American Society for Testing and Materials (formerly)
ATG	Automatic tank gauge
BMP	Best Management Practice
BOWTS	Bilge Oily Wastewater Treatment System
BS&W	Basic Sediment and Water
CCTV	Closed circuit television
CFR	Code of Federal Regulations
CNIC	Commander, Naval Installations Command
CNRH	Commander Navy Region Hawaii
COMNAVBASEPEARLINST	Commander Naval Base Pearl Harbor Instruction
COMNAVREG	Commander, Navy Region
COMPACFLT	Commander, Pacific Fleet
CMP	Centrally Managed Program
COR	Contracting Officer Representative
COTP	Captain of the Port
CPR	Cardiopulmonary resuscitation
DD	Department of Defense (form)
DESC	Defense Energy Support Center (now DLA Energy)
DFSP	Defense Fuel Support Point
DLA	Defense Logistics Agency
DLAD	DLA Directive
DLAI	DLA Instruction
DLAR	DLA Regulation
DoD	Department of Defense

DOT	Department of Transportation
DRP	Disaster Response Plan
DS-FE	DLA Installation Support for Energy
DS-FEE	DLA Installation Support for Energy – Environmental Division
DWCF	Defense Working Capital Fund
EEBD	Emergency escape breathing device
EMA	Emergency Management Agency
EPA	Environmental Protection Agency
ESAMS	Enterprise Safety Applications Management System
e-stop	Emergency stop (button)
ETGI	Electronic Telemetered Gauging Instrument
EXWC	Engineering and Expeditionary Warfare Center
FAME	Fatty acid methyl ester
FAMMS	Fuels Asset Management Maintenance System
FDSO	Fuel Distribution System Operator
FDSW	Fuel Distribution System Worker
F&ES	Fire and Emergency Services
FISC	Fleet Industrial Supply Center
FLC	Fleet Logistics Center
FLCPH	Fleet Logistics Center Pearl Harbor
FOD	Foreign object debris
FOILS	Fuel Operations Isolation Lock System
FOR	Fuel Oil Reclaimed
FORFAC	Fuel Oil Reclaimed Facility
FSII	Fuel system icing inhibitor
GOGO	Government-owned government-operated
HAZCOM	Hazard communication
HDPE	High density polyethylene
HFRR	High Frequency Reciprocating Rig
IAW	In accordance with
ICRMP	Integrated Cultural Resources Management Plan
ICP	Integrated Contingency Plan
IDLH	Immediately Dangerous to Life and Health
IWDC	Industrial Wastewater Discharge Certificate

ISGOTT	International Safety Guide for Oil Tankers and Terminals
JBPHH	Joint Base Pearl Harbor Hickam
JHA	Job hazard analysis
LED	Light-emitting diode
MAOP	Maximum Allowable Operating Pressure
MARPOL	International Convention for the Prevention of Pollution from Ships
MAWP	Maximum Allowable Working Pressure
MILCON	Military Construction
MIL-STD	Military Standard
MOA	Memorandum of Agreement
MOP	Maximum Operating Pressure
MOV	Motor operated valve
MTR	Marine transportation-related
N/A	Not applicable
NATOPS	Naval Air Training and Operating Procedures Standardization
NAVFAC	Naval Facilities Engineering Command
NAVFACHI	Naval Facilities Engineering Command Hawaii
NAVSUP	Naval Supply Systems Command
NEPA	National Environmental Policy Act
NFIRS	National Fire Incident Reporting System
NFPA	National Fire Protection Association
NOAA	National Oceanic and Atmospheric Administration
NOP	Normal Operating Pressure
NPDES	National Pollutant Discharge Elimination System
NPMS	National Pipeline Mapping System
NRC	National Response Center
NSN	National Stock Number
NWGLDE	National Work Group on Leak Detection Evaluations
NWS	National Weather Service
OCIMF	Oil Companies International Marine Forum
OJT	On-the-job training
OMES	Operations, Maintenance, Environmental, and Safety (Plan)
OMSI	Operation and Maintenance System Instructions
OOS	Out of service

OPA 90	Oil Pollution Act of 1990
OPNAVINST	Chief of Naval Operations Instruction
OSHA	Occupational Safety and Health Administration
ORM	Other Regulated Material
OWRO	oily water/recovered oil
OWS	Oil/water separator
PHMSA	Pipeline and Hazardous Materials Safety Administration
PIC	Person-in-Charge
PFD	Personal flotation device
PLC	Programmable Logic Controller
PMP	Preventative Maintenance Plan
POL	Petroleum, oil, and lubricants
PPE	Personal protective equipment
PSV	Pressure safety valve
PTO	Power take-off
QA	Quality Assurance
QAR	Quality Assurance Representative
QI	Qualified Individual
RO	Responsible Officer
RP	Recommended Practice
RSTRENG	Remaining strength
RVP	Reid Vapor Pressure
SCADA	Supervisory Control and Data Acquisition
SDS	Safety Data Sheet
SIOATH	Source Identification and Ordering Authorization
SISA	Supply Information Systems Analyst
SITREP	Situation Report
SOP	Standard Operating Procedure
SPCC	Spill, Prevention, Control, and Countermeasures (Plan)
SRM	Sustainment, Restoration, and Modernization
STI	Steel Tank Institute
SWMP	Storm Water Management Plan
TBD	To be determined
TCCOR	Tropical Cyclone Conditions of Readiness] Checklists

UFGS	Unified Facilities Guide Specifications
UFC	Unified Facilities Criteria
UFM	Unscheduled Fuel Movement
UGPH	Underground Pump House
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
UST	Underground storage tank
VC	Valve Chamber
VS	Valve Station
WFM	Water Fuels Maintenance
YON	Yard Oiler Non-self-powered

APPENDIX F FLOW DIAGRAMS & SKETCHES USED DURING THE STUDY

(b)(3)(A)

[redacted]

Marking Removed

22-SGH-01
Initial PHA
[redacted] (b)(6)

GATE VALVE	FLOATING ARM
COCK (QUARTER TURN BALL) VALVE	HAND PUMP
BALL VALVE	FILTER
DOUBLE BLOCK AND BLEED VALVE	LOADING ARM NOZZLE
GLOBE VALVE	PIG LAUNCHER
BUTTERFLY VALVE	SPECTACLE FLANGE OPEN
CHECK VALVE	SPECTACLE FLANGE CLOSED
FLOW CONTROL VALVE	ADDITIVE INJECTOR
PINCH VALVE	FLEXIBLE HOSE
NEEDLE VALVE	TANK TOP PENETRATION
MOTORIZED VALVE	FUNNEL
ANGULAR GLOVE VALVE	GAUGE
DIAPHRAGM VALVE	END CAP
ANGULAR DIAPHRAGM VALVE	OPEN END
RELIEF VALVE	SYSTEM CONTINUATION
POSITIVE DISPLACEMENT METER	SWIVEL COUPLING
STRAINER	BLIND FLANGE
EXPANSION JOINT	CHANGE IN LINE SIZE
	AIR VENT
	AIR RELIEF TRAP
	HATCH

Coreolius meter
~~LOADING ARM NOZZLE~~

PUMP

SUBMERSIBLE PUMP

SIGHT FLOW INDICATOR

FLOW METER

TANK ACCESS

AIR FLASK

FILTER

PRODUCTS

2190
9250
ABANDONED
F-76
JP-5
F-24
JP-5 & F-24 HEADER
MULTI PRODUCT
RECLAIM/FOR
SAMPLE LINE
WATER

(TBD) TO BE DETERMINED / VALVE # NOT ASSIGNED

Marking Removed

2

DFSP PEARL HARBOR BULK
JBPHH, HAWAII
OMES PLAN

LEGEND

DRAWN BY: MRR
DRAWING NO: M - 001
DATE: 8/22/2018
SCALE: NTS
PROJECT NO: HNCJV14.0019

U.S. ARMY CORPS OF ENGINEERS
HUNTSVILLE ENGINEERING AND
SUPPORT CENTER
CONTRACT NO. W912DY-13-D-0114, TO 0019

FOR OFFICIAL USE ONLY

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EXIST FAN SCHEDULE

MARK	LOCATION	FAN TYPE	AIRFLOW (CFM)	EXT. STATIC PRESS. (IN. WG)	FAN RPM	DRIVE	BHP	HP	V/PH/HZ	NOTES
EF 1A, EF 1B	UPPER TUNNEL	UTILITY BLOWER	8,000	5/8"	786	BELT	1.9	2	480/3/60	2.
EF 2A, EF 2B	LOWER TUNNEL	UTILITY BLOWER	31,500	1-1/4"	688	BELT	15.3	20	480/3/60	1.
EF 4A, EF 4B	HARBOR T UNNEL	UTILITY BLOWER	21,500	1-1/4"	527	BELT	7.1	7.5	480/3/60	1.
SF 5A, SF 5B	ADIT 1	UTILITY BLOWER	51,600	3/8"	429	BELT	12.1	15	480/3/60	2.
EF 7 (a-h)	TANKS 1-16 GAUGER	UTILITY BLOWER	2,000	2.5"	1,392	BELT	0.95	2	480/3/60	2.
EF 8	UNDERGROUND PUMPHOUSE	UTILITY BLOWER	7,400	1"	1,425	BELT	3.5	5	480/3/60	2.
PS 1A, PS 1B	TANKS 17-20 UPPER TUNNEL	INLINE VANE AXIAL	4,000	1-1/2"	1,834	BELT	1.86	3	480/3/60	2.
PS 2A, PS 2B	TANKS 17-20 LOWER TUNNEL	INLINE VANE AXIAL	12,500	1-3/4"	1,406	BELT	6.24	7.5	480/3/60	1.
PE 1A, PE 1B	ADIT 6	INLINE VANE AXIAL	16,500	2"	1,282	BELT	8.92	10	480/3/60	2.
PS 4, PS 5	TANKS 17-20 GAUGER	UTILITY BLOWER	2,000	2.5"	1,392	BELT	0.95	2	480/3/60	2.
SF 1A, SF 1B	GAUGER STATION	INLINE VANE AXIAL	5,000	1/2"	1,910	BELT	1.9	2	480/3/60	1.

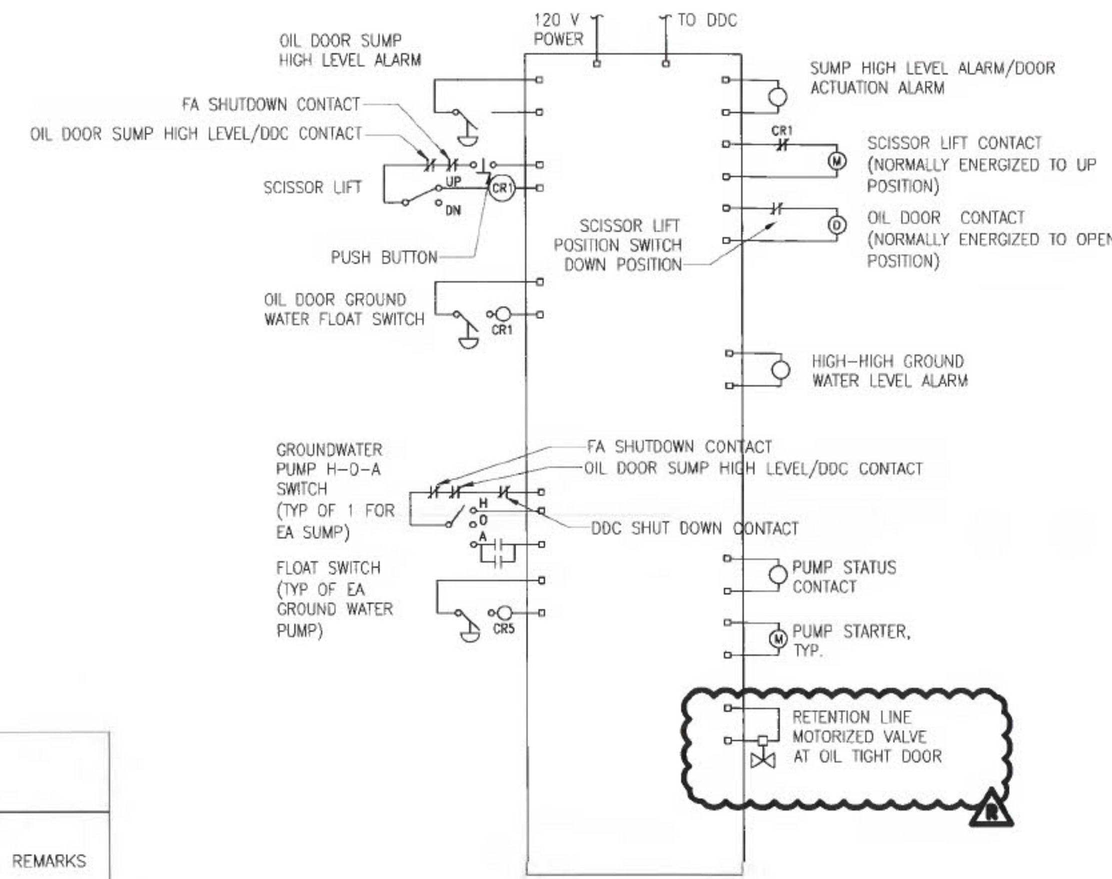
NOTES:

1. REPLACE MOTOR WITH NEW EXPLOSION PROOF MOTOR. EXISTING FANS ARE AMCA TYPE B SPARK RATING. TAB FANS PRIOR TO MOTOR CHANGE. TAB FANS AFTER MOTOR CHANGE TO EQUAL PRIOR TAB RESULTS.
2. NOT IN SCOPE.

PUMP SCHEDULE

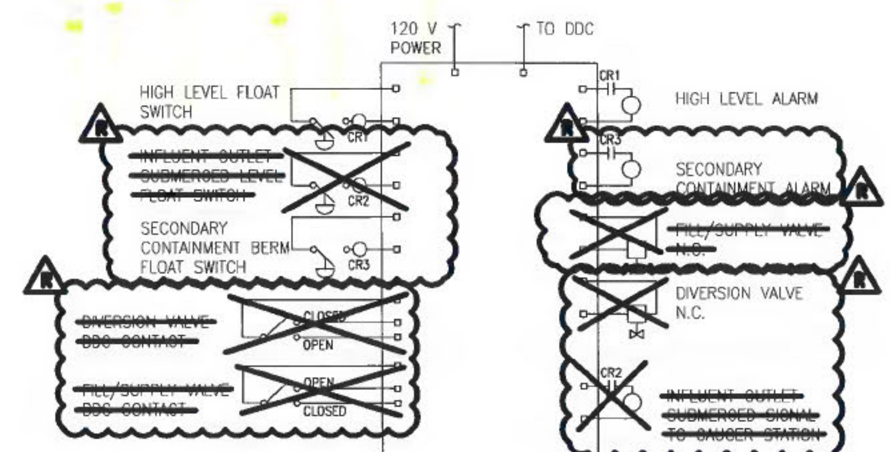
UNIT	TYPE	GPM	TOTAL HEAD [FT]	RPM	BHP	MIN% EFF	ELECTRICAL HP	ELECTRICAL V	ELECTRICAL PH	ELECTRICAL HZ	REMARKS
SP-DOOR-2 1, SP-DOOR-2 2, SP-DOOR-2 3, SP-DOOR-2 4	SUBMERSIBLE	1000	80	1750	34	75	40	480	3	60	1. 2. 3.
SP-DOOR-3 1, SP-DOOR-3 2, SP-DOOR-3 3, SP-DOOR-3 4	SUBMERSIBLE	1000	80	1750	34	75	40	480	3	60	1. 2. 3.
SP-DOOR-4 1, SP-DOOR-4 2, SP-DOOR-4 3, SP-DOOR-4 4	SUBMERSIBLE	1000	80	1750	34	75	40	480	3	60	1. 2. 3.
SP-DOOR-5 1, SP-DOOR-5 2, SP-DOOR-5 3, SP-DOOR-5 4	SUBMERSIBLE	1000	80	1750	34	75	40	480	3	60	1. 2. 3.
SP-DOOR-C 1, SP-DOOR-C 2, SP-DOOR-C 3, SP-DOOR-C 4	SUBMERSIBLE	1000	80	1750	34	75	40	480	3	60	1. 2. 3.
SP-DOOR-2 5, SP-DOOR-3 5, SP-DOOR-4 5, SP-DOOR-5 5, SP-DOOR-C 5, SP-DOOR-OIL 5	SUBMERSIBLE	20	50	1750	3	75	5	480	3	60	1. 2. 3.

1. PUMP SHALL BE SUITABLE FOR JP-5 FUEL, DIESEL FUEL MARINE AND JP-8 FUEL. PROVIDE EITHER STEEL HARDENED 60 HRC OR STAINLESS STEEL 316, SUITABLE FOR CORROSIVE ENVIRONMENT. PROVIDE PREMIUM EFFICIENCY MOTOR, TEFC.
2. PROVIDE PREMIUM EFFICIENCY MOTOR, TEFC.
3. PROVIDE HAND-OFF-AUTO SWITCHES



OIL DOOR CONTROL DIAGRAM

1 MT701 MT701 SCALE: NTS



RETENTION TANK CONTROL DIAGRAM

2 MT701 MT701 SCALE: NTS

AFFF

Mode 8

USN

LICENSED PROFESSIONAL ENGINEER JOEL P. YUEN No. 6805-M HAWAII

I CERTIFY THAT THIS DRAWING WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION.

INSYNERGY ENGINEERING

MECHANICAL, ELECTRICAL & FIRE PROTECTION

DES | DRW | CHK

APPROVED Evan Wine FOR COMMANDER NAVFAC

ACTIVITY

SATISFACTORY TO DATE

DES	DRW	REV
PM/DM		RO
FIRE PROTECTION		JCC
BRANCH MANAGER		SF
CHIEF ENG/ARCH		JCC

DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND NAVFAC HAWAII PEARL HARBOR, HAWAII

JOINT BASE PEARL HARBOR HICKAM (RED HILL) OAHU, HAWAII

FY15 P-1551 (DESC 1551), UPGRADE FIRE SUPPRESSION AND VENTILATION SYSTEMS, RED HILL FUEL STORAGE FACILITY

MECHANICAL SCHEDULES

SCALE:
EPROJECT NO.: 1306143
CONSTR. CONTR. NO. N62742-15-C-1308
NAVFAC DRAWING NO. 19049366
SHEET 305 OF 399

MT701

DRAWFORM REVISION: 18 JULY 2012

THE CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING THE WORK AMONG THE VARIOUS TRADES AS NECESSARY TO AVOID CONFLICTS AND TO [redacted] STALLATION OF ALL WORK WITHIN THE AVAILABLE SPACE.

IF SHEET IS LESS THAN 22" X 34" REDUCED PRINT - USE GRAPHIC SCALES

35

RETENTION TANK SYSTEM - SEQUENCE OF OPERATION:

I MAIN SUMP PUMPS

1. EACH MAIN SUBMERSIBLE SUMP PUMP AFFF GROUNDWATER COLLECTION SHALL BE CONTROLLED BY ITS OWN FLOAT SWITCH. LEAD PUMP SHOULD START AUTOMATICALLY BY FLOAT SWITCH. IF LEAD PUMP FAILS TO START, SECOND LAG PUMP BECOMES THE LEAD PUMP AND STARTS AUTOMATICALLY BY FLOAT SWITCH. UPON FLUID LEVEL AT RETENTION TANK IS HIGHER THAN THE INFLUENT OUTLET LAG SUMP PUMPS START AUTOMATICALLY BY FLOAT SWITCH. SUMP PUMP STOPS AUTOMATICALLY BY FLOAT SWITCH. THE HEIGHT OF THE FLOAT SWITCH SHALL BE AT LEAST 1' ABOVE THE MINIMUM HEIGHT REQUIRED BY THE MANUFACTURER. ACTIVATION OF THE MAIN SUMP PUMP SHALL ANNUNCIATE A ALARM.
2. A FLOAT SWITCH SHALL BE PROVIDED IN EACH SUMP AT APPROXIMATELY 1' BELOW THE TOP OF SUMP. WHEN THIS FLOAT SWITCH IS ACTIVATED AN HIGH HIGH SUMP LEVEL ALARM SHALL BE PROVIDED TO THE MAIN DDC PANEL.
3. INTERLOCK ALL MAIN SUBMERSIBLE PUMPS TO SHUTDOWN UNDER ONE OF THE FOLLOWING CONDITIONS AND PROVIDE SUMP PUMPS LOCK OUT ALARM TO DDC PANEL:
   1) WHEN THE NEW OIL TIGHT DOOR IS CLOSED VIA A DOOR SWITCH
   2) RETENTION TANK IS FILLED. TANK HIGH LEVEL ALARM IS ACTIVATED MOTORIZED VALVE AT OIL TIGHT DOOR IS RECLOSED
4. PROVIDE A HIGH HIGH FLOAT SWITCH ALARM
5. UPON ACTIVATION OF THE MAIN SUMP PUMP:
   1) A SUPERVISORY SIGNAL SHALL BE SENT TO THE FIRE ALARM SYSTEM
   2) THE MOTORIZED VALVE AT THE NEW OIL TIGHT DOOR SHALL OPEN

II RETENTION TANK

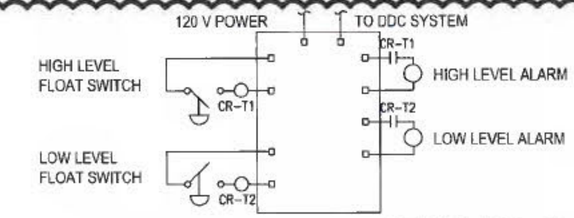
1. A FLOAT SWITCH SHALL BE PROVIDED IN THE RETENTION TANK AT 1' BELOW THE TOP OF THE RETENTION TANK. ~~UPON ACTIVATION AN ALARM SHALL BE PROVIDED TO THE MAIN DDC PANEL AND FIRE ALARM SYSTEM. IN ADDITION, THE DDC PANEL SHALL OPEN THE DIVERTING VALVE AND CLOSE THE SUPPLY VALVE.~~ R
2. A FLOAT SWITCH SHALL BE PROVIDED IN THE RETENTION TANK SECONDARY CONTAINMENT SYSTEM AT 1' BELOW THE TOP. ~~UPON ACTIVATION AN ALARM SHALL BE PROVIDED TO THE MAIN DDC PANEL AND FIRE ALARM SYSTEM.~~ R
3. ~~LOW LEVEL FLOAT SWITCH IN THE RETENTION TANK SHALL ALARM IF THE WATER LEVEL DROPS BELOW 3 FEET FROM THE TANK BOTTOM.~~

III ~~GROUNDWATER COLLECTION PUMPS~~

1. THE GROUNDWATER COLLECTION PUMP SHALL OPERATE TO PUMP ANY GROUNDWATER SEEPAGE INTO THE SUMP TO THE EXST. SUMP. THE PUMP SHALL OPERATE ON ITS OWN FLOAT SWITCH.
2. THE GROUNDWATER PUMP SHALL BE INTERLOCKED TO SHUTDOWN UPON ONE OF THE FOLLOWING CONDITIONS:
   1) ACTIVATION OF THE FIRE ALARM SYSTEM
   2) CLOSING OF THE NEW OIL TIGHT DOOR
3. PROVIDE HIGH GROUND WATER LEVEL ALARM. THE HIGH GROUNDWATER LEVEL FOR THE NEW OIL TIGHT DOOR SHALL ALSO CLOSE THE OIL TIGHT DOOR PER METHOD 1 FOR THE OIL TIGHT DOOR SEQUENCE OF OPERATION

IV WATER TANK

1. A LOW LEVEL AND HIGH LEVEL SENSOR SHALL BE PROVIDED IN THE WATER TANK AND SHALL ALARM BOTH THE DDC PANEL AND FIRE ALARM SYSTEM UPON ACTIVATION.

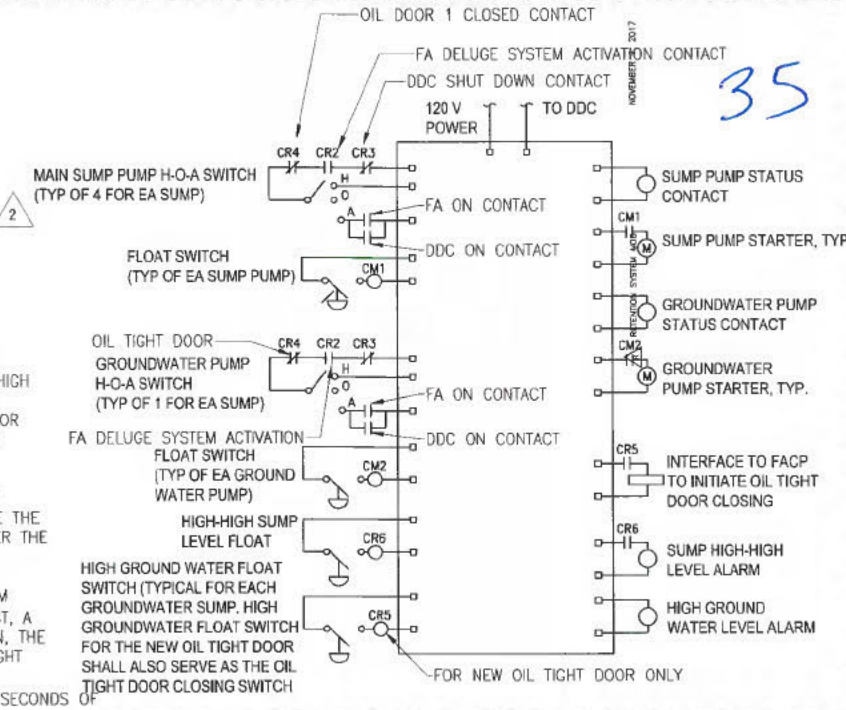


2 MT602 TYP. WATER TANK CONTROL DIAGRAM 2

SCALE: NTS

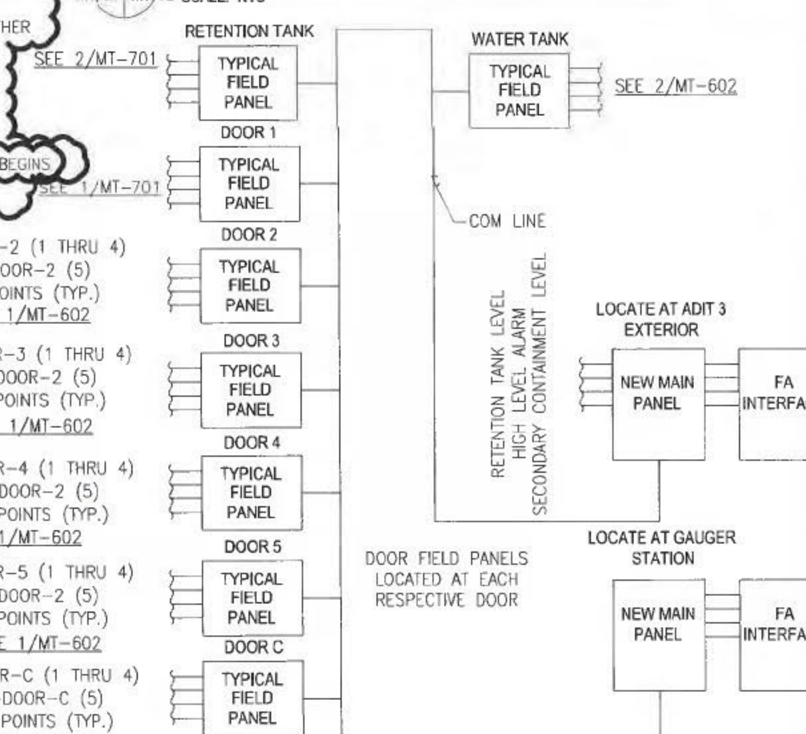
OIL TIGHT DOOR SEQUENCE OF OPERATIONS

1. THE OIL TIGHT DOOR AND SCISSOR LIFT SHALL BE ACTIVATED BY THE FOLLOWING THREE METHODS.
2. METHOD 1: OIL TIGHT DOOR FLOAT ACTIVATION. UPON ACTIVATION OF THE OIL TIGHT DOOR CLOSING/ HIGH GROUNDWATER FLOAT IN THE SUMP, THE FOLLOWING SEQUENCE SHALL TAKE PLACE. FIRST, A VISUAL AND AUDIBLE ALARM SHALL BE SOUNDED ABOVE THE DOOR. FOLLOWING 45 SECONDS OF OPERATION, THE SCISSOR LIFT SHALL BE LOWERED. 45 SECONDS AFTER THE SCISSOR LIFT HAS BEEN LOWERED, THE OIL TIGHT DOOR SHALL CLOSE.
3. METHOD 2: MANUAL PUSH BUTTON ACTIVATION. UPON ACTIVATION OF THE MANUAL PUSH BUTTON, THE FOLLOWING SEQUENCE SHALL TAKE PLACE. FIRST, A VISUAL AND AUDIBLE ALARM SHALL BE SOUNDED ABOVE THE DOOR. FOLLOWING 45 SECONDS OF OPERATION, THE SCISSOR LIFT SHALL BE LOWERED. 45 SECONDS AFTER THE SCISSOR LIFT HAS BEEN LOWERED, THE OIL TIGHT DOOR SHALL CLOSE.
4. METHOD 3: FIRE ALARM SYSTEM ACTIVATION. UPON RECEIVING A SIGNAL FROM THE FIRE ALARM SYSTEM (SEE FIRE ALARM SYSTEM SEQUENCE OF OPERATIONS), THE FOLLOWING SEQUENCE SHALL TAKE PLACE. FIRST, A VISUAL AND AUDIBLE ALARM SHALL BE SOUNDED ABOVE THE DOOR. FOLLOWING 45 SECONDS OF OPERATION, THE SCISSOR LIFT SHALL BE LOWERED. 45 SECONDS AFTER THE SCISSOR LIFT HAS BEEN LOWERED, THE OIL TIGHT DOOR SHALL CLOSE.
5. LOSS OF POWER: IN THE EVENT THAT POWER IS LOST, THE SCISSOR LIFT SHALL BE LOWERED AFTER 45 SECONDS OF VISUAL AND AUDIBLE ALARMS
6. HIGH SUMP WATER LEVEL: IN THE EVENT OF HIGH SUMP WATER LEVEL, THE SCISSOR LIFT SHALL BE LOWERED AFTER 45 SECONDS OF VISUAL AND AUDIBLE ALARMS
6. IN EACH CASE, THE SCISSOR LIFT CAN BE LOWERED AND THE OIL TIGHT DOOR CAN BE RELEASED THRU EITHER MANUAL PUSH BUTTON ACTIVATION OR THRU THE FIRE ALARM SYSTEM REMOTE DEACTIVATION.
7. FOR ALL METHODS, AN ALARM SHALL BE SENT TO THE FIRE ALARM SYSTEM.
8. PROVIDE HIGH GROUND WATER LEVEL ALARM.
9. R THE RETENTION LINE MOTORIZED VALVE AT THE OIL TIGHT DOOR SHALL CLOSE IF DOOR CLOSING SEQUENCE BEGINS. R



1 MT602 TYP. SUMP PUMP CONTROL DIAGRAM 2

SCALE: NTS



NOTES:

1. CONTRACTOR SHALL PROVIDE REQUIRED NO. OF FIELD PANELS INCLUDING ALL CONDUIT AND WIRING TO PERFORM FUNCTIONS AND PROVIDE POINTS INDICATED AND SPECIFIED.
2. CONTRACTOR SHALL PROVIDE POWER TO ALL NEW CONTROL PANELS WHETHER INDICATED OR NOT. ALL POWER REQUIREMENTS AND CONTROL WIRING/CONDUIT REQUIREMENTS SHALL BE COORDINATED WITH THE ELECTRICIAN AND CONTROL WIRING CONTRACTOR.
3. THE DDC SYSTEMS VENDOR SHALL BE COMPLETELY RESPONSIBLE FOR COORDINATING INSTALLATION OF THE RETENTION TANK CONTROL SYSTEM INCLUDING ALL HARDWARE, SOFTWARE, SENSORS, CONDUIT, ALARMS AND WIRING.
4. ALL DDC POINTS SHALL BE RELAYED TO THE MAIN FA SYSTEM PANEL.

2 MT602 RETENTION TANK CONTROL SYSTEM ARCHITECTURE

SCALE: NTS

CATEGORY	POINT NO.	DDC SYSTEM POINTS DESCRIPTION	ANALOG INPUT: TEMPERATURE	WATER LEVEL	RH	GPM	PERCENT	CFM	PPM	ANALOG OUTPUT: SET POINT ADJ.	BINARY INPUT: STATUS ON/OFF	FILTER STATUS (ΔP)	STATUS	ALARM CONTACT STATUS	OPEN/CLOSE	BINARY OUTPUT: OFF-ON	OPEN/CLOSE	SYSTEM FEATURES ALARMS: HIGH ANALOG	LOW ANALOG	HIGH BINARY	LOW BINARY	FLOW FAIL	EQUIP. FAIL/COMM.	DIAGNOSTIC/PANEL ALARM	FIRE ALARM	PROGRAMS: TIME SCHEDULING	DEMAND LIMITING	OPT. START/STOP	RESET	DDC	NOTES
1.		RETENTION SUMPS, TYP.																													
		MAIN SUBMERSIBLE PUMPS									X			X									X		X						
		HIGH LEVEL ALARM									X			X						X			X		X						PROVIDE 1 FOR EACH SUMP
		FLOAT SWITCH									X			X		X							X								PROVIDE 1 FOR EACH PUMP
		GROUNDWATER COLLECTION PUMP									X			X									X								
		GROUNDWATER COLLECTION FLOAT SWITCH									X					X							X								PROVIDE HIGH LEVEL FLOAT SWITCH AND ALARM
2.		RETENTION TANK																													
		TANK HIGH LEVEL ALARM									X									X			X		X						
		~~SECONDARY CONTAINMENT FLOAT SWITCH (2X)~~									X									X			X		X						
		~~INFLUENT OUTLET SUBMERGED FLOAT SWITCH~~																			X										
		~~SUPPLY VALVE N.O. (3X) SEE RETENTION TANK SITE~~									X					X															
		~~DIVERSION VALVE N.C. (3X) SEE RETENTION TANK SITE~~									X					X									X						
3.		OIL TIGHT DOOR																													
		DOOR HOLDER									X			X									X								
		SCISSOR LIFT									X			X									X								
		GROUNDWATER COLLECTION PUMP									X			X									X		X						
		GROUNDWATER COLLECTION FLOAT SWITCH									X			X									X		X						
		~~PUSH BUTTON~~									X			X									X		X						
		RETENTION LINE MOTORIZED VALVE AT OIL TIGHT DOOR									X					X															
4.		~~NEW WATER TANK~~																													
		HIGH LEVEL FLOAT SWITCH									X			X		X							X		X						
		LOW LEVEL FLOAT SWITCH									X			X		X							X		X						

1 MT602 RETENTION TANK CONTROL SYSTEM 2

SCALE: NTS

NOTE: ALSO INCLUDE ADDITIONAL POINTS SHOWN ON SCHEMATICS AND LAYOUTS. PROVIDE 25% ADDITIONAL CAPACITY FOR EXPANSION.

Node 8 AFFF

NOVEMBER 20, 2014	
JUNE 21, 2018	
AMENDMENT 0002	
CHANGE R	
SYM	DESCRIPTION

NAVFAC

(b) (6) [redacted]

I CERTIFY THAT THIS DRAWING WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION. SEAL

INSYNERGY ENGINEERING
MECHANICAL • ELECTRICAL • FIRE PROTECTION
828 Fort Street Mall Suite 500, Honolulu, Hawaii 96813
Phone: (808) 521-3773 Fax: (808) 521-3883
A/E INFO

DES	DRW	CHK

(b) (6) [redacted]

FOR COMMANDER NAVFAC DATE

ACTIVITY

SATISFACTORY TO DATE

DES	DRW	REV
PM/DM		RD
FIRE PROTECTION		JCC
BRANCH MANAGER		SF
CHIEF ENG/ARCH		JCC

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
NAVFAC HAWAII
PEARL HARBOR, HAWAII
JOINT BASE PEARL HARBOR HICKAM (RED HILL) OAHU, HAWAII
FY15 P-1551 (DESC 1551), UPGRADE FIRE SUPPRESSION AND VENTILATION SYSTEMS, RED HILL FUEL STORAGE FACILITY
RETENTION TANK CONTROL SYSTEM

SCALE:
EPROJECT NO.: 1306143
CONSTR. CONTR. NO. N62742-15-C-1308
NAVFAC DRAWING NO. 19049365
SHEET 304 OF 399
MT602

DRAWFORM REVISION: 19 JULY 2012

THE CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING THE WORK [redacted] VARIOUS TRADES AS NECESSARY TO AVOID CONFLICTS AND TO [redacted] INSTALLATION OF ALL WORK WITHIN THE AVAILABLE SPACE.

IF SHEET IS LESS THAN 22" X 34" REDUCED PRINT - USE GRAPHIC SCALES

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37 (b)(6)

AFHE SYSTEM INSTALLATION
FISC PEARL HARBOR
TANK LEVEL SETTINGS BASED ON VOLUME

1	2	3	4		5	6				7	8	9	10	11				12	13	14				15				16		17	
		C				H for AST		H for UST		F	T			High Level Switch (HHLA)				T 1		High Level Probe				High Operating Limit				Low Level Alarm		BSW Level Alarm	
#	Tank Location	Tank Rated Capcity, BBLS	Current Overflow Level		Max Allowable Capacity @95% for UST & 98% for AST	98% Overfill Level		95% Overfill Level		Max Flow Rate into Tank, Barrels per hour	Time Delay Relay, Minutes	Skin Valve Closure Time, Min.	Max Allowable fill at HHLA	FOR AST		FOR UST		OPR Time, Minutes	Max Allowable fill at HLA	FOR AST		FOR UST		FOR AST		FOR UST					
			ft.	in.		ft.	in.	ft.	in.					ft.	in.	ft.	in.			ft.	in.	ft.	in.			ft.	in.	ft.	in.	ft.	in.
	UNDERGROUND STORAGE TANKS																														
1	Red Hill Tank 1 POL Storage	285,742	238	1	271,455			213	4 9/16	8,300	5	1	270,625			212	7 3/16	15	268,550			210	8 6/16			210	6 6/16	7			9
2	Red Hill Tank 2 POL Storage	285,387	238	1	271,118			213	4 11/16	8,300	5	1	270,288			212	7 6/16	15	268,213			210	8 10/16			210	6 10/16	7			9
3	Red Hill Tank 3 POL Storage	285,413	238	1	271,142			213	4 12/16	8,300	5	1	270,312			212	7 6/16	15	268,237			210	8 9/16			210	6 9/16	7			9
4	Red Hill Tank 4 POL Storage	285,246	238	1	270,984			213	4 14/16	8,300	5	1	270,154			212	7 8/16	15	268,079			210	8 11/16			210	6 11/16	7			9
5	Red Hill Tank 5 POL Storage	302,333	250	7/8	287,216			224	7 1/16	8,300	5	1	286,386			223	9 14/16	15	284,311			221	11 6/16			221	9 6/16	7			9
6	Red Hill Tank 6 POL Storage	302,286	250	7/8	287,172			224	7 2/16	8,300	5	1	286,342			223	9 14/16	15	284,267			221	11 6/16			221	9 6/16	7			9
7	Red Hill Tank 7 POL Storage	302,460	250	7/8	287,337			224	7	8,300	5	1	286,507			223	9 13/16	15	284,432			221	11 5/16			221	9 5/16	7			9
8	Red Hill Tank 8 POL Storage	301,928	250	7/8	286,832			224	7 5/16	8,300	5	1	286,002			223	10 2/16	15	283,927			221	11 10/16			221	9 10/16	7			9
9	Red Hill Tank 9 POL Storage	302,458	250	7/8	287,335			224	7	8,300	5	1	286,505			223	9 13/16	15	284,430			221	11 5/16			221	9 5/16	7			9
10	Red Hill Tank 10 POL Storage	302,350	250	7/8	287,233			224	7 1/16	8,300	5	1	286,403			223	9 14/16	15	284,328			221	11 6/16			221	9 6/16	7			9
11	Red Hill Tank 11 POL Storage	302,761	250	7/8	287,623			224	6 14/16	8,300	5	1	286,793			223	9 10/16	15	284,718			221	11 2/16			221	9 2/16	7			9
12	Red Hill Tank 12 POL Storage	302,250	250	7/8	287,138			224	7 2/16	8,300	5	1	286,308			223	9 15/16	15	284,233			221	11 7/16			221	9 7/16	7			9
13	Red Hill Tank 13 POL Storage	302,724	250	7/8	287,588			224	6 14/16	12,000	5	1	286,388			223	5 9/16	15	283,388			220	9 8/16			220	7 8/16	7			9
14	Red Hill Tank 14 POL Storage	302,846	250	7/8	287,704			224	6 13/16	12,000	5	1	286,504			223	5 8/16	15	283,504			220	9 7/16			220	7 7/16	7			9
15	Red Hill Tank 15 POL Storage	302,536	250	7/8	287,409			224	7	8,300	5	1	286,579			223	9 12/16	15	284,504			221	11 4/16			221	9 4/16	7			9
16	Red Hill Tank 16 POL Storage	302,450	250	7/8	287,328			224	7 1/16	8,300	5	1	286,498			223	9 13/16	15	284,423			221	11 5/16			221	9 5/16	7			9
17	Red Hill Tank 17 POL Storage	302,676	250	7/8	287,542			224	6 15/16	8,300	5	1	286,712			223	9 11/16	15	284,637			221	11 3/16			221	9 3/16	7			9
18	Red Hill Tank 18 POL Storage	302,682	250	7/8	287,548			224	6 14/16	8,300	5	1	286,718			223	9 11/16	15	284,643			221	11 3/16			221	9 3/16	7			9
19	Red Hill Tank 19 POL Storage	302,560	0	0	0			0	0	8,300	5	1	0			0	0	15	0			0	0			0	0	0			0
20	Red Hill Tank 20 POL Storage	302,498	250	7/8	287,373			224	7	8,300	5	1	286,543			223	9 13/16	15	284,468			221	11 5/16			221	9 5/16	7			9
21	STK 1 JP5 Surge Tank	8,826	17	7	8,385			16	8 7/16	13,000	5	1	7,301			14	6 10/16	5	6,218			12	4 11/16			12	2 11/16	7			9
22	STK 2 DFM Surge Tank	8,836	17	7	8,394			16	8 7/16	13,000	5	1	7,311			14	6 9/16	5	6,228			12	4 11/16			12	2 11/16	7			9
23	STK 3 DFM Surge Tank	8,848	17	7	8,406			16	8 7/16	13,000	5	1	7,322			14	6 9/16	5	6,239			12	4 12/16			12	2 12/16	7			9
24	STK 4 DFM Surge Tank	8,837	17	7	8,395			16	8 7/16	13,000	5	1	7,312			14	6 9/16	5	6,229			12	4 11/16			12	2 11/16	7			9
	ABOVEGROUND STORAGE TANK																														
25	Tank 46 Fuel Storage	139,303	38	6	136,517	37	9 2/16			8,500	5	1	122,675	34	1			15	92,278	27	14/16			26	10 14/16			7			9
26	Tank 47 Fuel Storage	0	0	0	0	0	0			8,500	5	1	0					15	0					0				0			0
27	Tank 48 Fuel Storage	124,012	38	2 7/16	121,532	37	6 10/16			4,000	5	1	115,671	36	2/16			15	100,579	32	8/16			31	10 8/16			7			9
28	Tank 53 Fuel Storage	140,844	38	6	138,027	37	9			500	5	1	137,268	37	9/16			15	131,659	36	10/16			35	10 10/16			7			9
29	Tank 54 Fuel Storage	0	0	0	0	0	0			8,500	5	1	0					15	0					0				0			0
30	Tank 55 Fuel Storage	141,320	40	7 9/16	138,494	39	10			13,000	5	1	121,512	35	7/16			15	86,112	25	6/16			24	10 6/16			7			9
31	TKB1 Ballast Storage	9,438	18	9 12/16	9,249	18	5 4/16			500	5	1	9,041	17	4/16			15	8,916	14	5/16			13	10 5/16			7			9
32	TKB2 Ballast Storage	10,451	21	0	10,242	20	5 2/16			500	5	1	9,538	19	4/16			15	9,413	16	5/16			15	10 5/16			7			9

33 T 301 2 internal Floating Roof

34 TK 311 LSHH has 1, nee for second

Hot sumps

[redacted]

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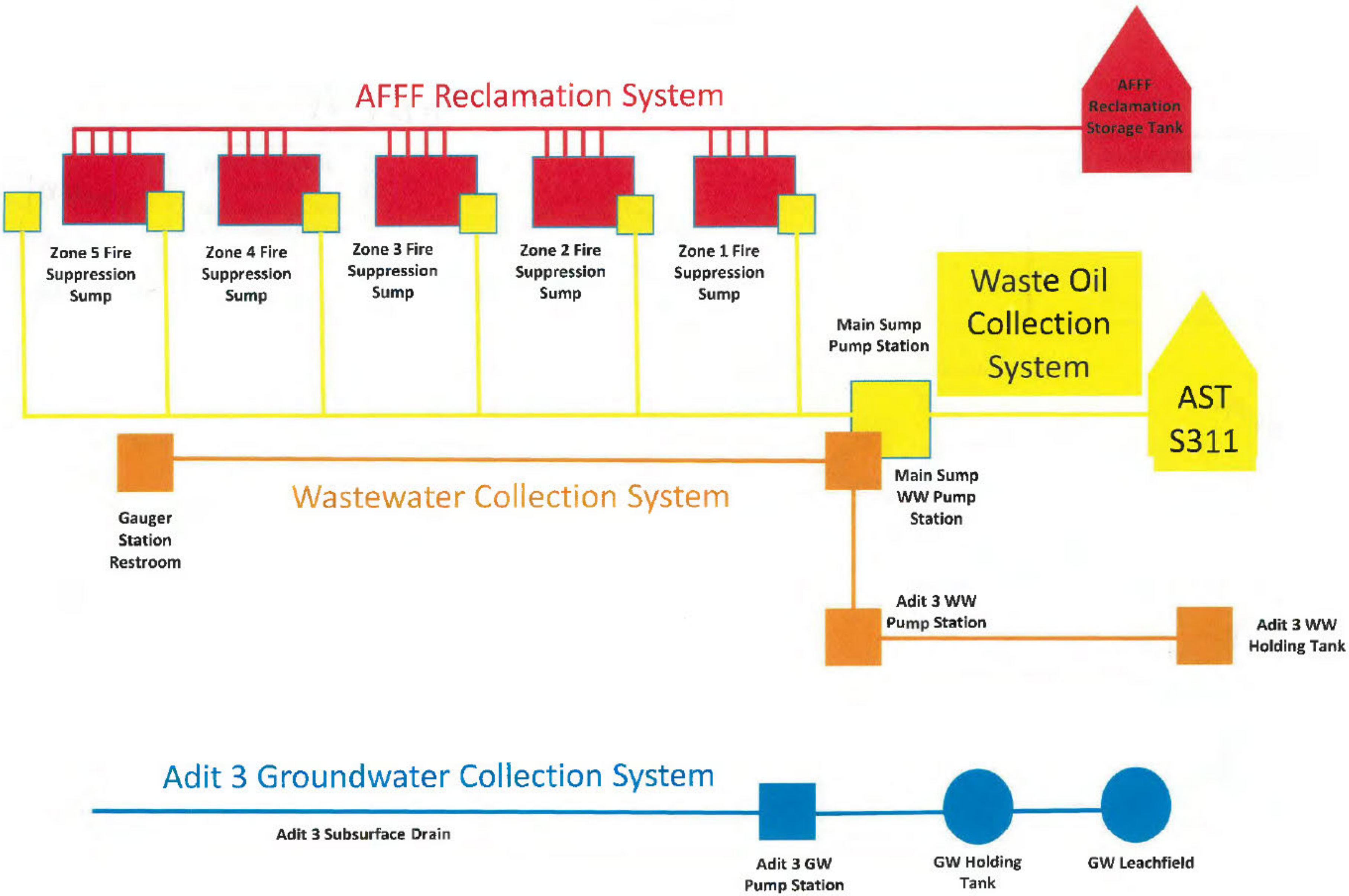

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APPENDIX C
Operational Readiness Assessment

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Report

Joint Base Pearl Harbor-Hickam Operational Readiness Assessment Prepared for Naval Supply Systems Command (NAVSUP) Fleet Logistics Center (FLC), Pearl Harbor, Hawaii

Document Number: 22-SGH-01-2

Issue: 1

Date: April 19, 2022

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ISSUE RECORD

Issue	Date	Revision History	Authored By	Reviewed By	Approved By
1	April 19, 2022	Issued final	(b)(6)	(b)(6)	(b)(6)

DISTRIBUTION

(b)(6)	Simpson, Gumpertz and Heger
File	Risktec Solutions, Inc.

EXECUTIVE SUMMARY

Risktec Solutions (Risktec) appreciates the opportunity to be of service to Simpson, Gumpertz and Heger (SGH) to provide an operational readiness assessment, including a process hazard analysis, of the Joint Base Pearl Harbor-Hickam Defense Fuel Supply Point (DFSP) for the US Navy.

Following a series of events starting May 6, 2021, through November 28, 2021, the State of Hawaii issued an executive order (EO) to, among other things, within thirty days of receipt of this EO:

- Submit work plans and implementation schedules, prepared by a qualified independent third party approved by the department,
    - to assess the Facility operations and system integrity to safely defuel the Bulk Fuel Storage Tanks;
    - to assess operations and system integrity of the Facility to determine design and operational deficiencies that may impact the environment and develop recommendations for corrective action; and
- Upon the Department's approval of the assessments, work plans, and implementation schedules, conduct necessary repairs and make necessary changes in operations to address any deficiencies identified in the assessment and work plan. corrective actions shall be performed as expeditiously as possible.

Risktec reviewed operational practices to assess the state of ongoing operations at Red Hill and Pearl Harbor. Facility systems integrity was evaluated to determine potential impacts to the environment, personnel health and safety, the public, and mission readiness. Assessments were conducted for defueling Red Hill and for ongoing operations at Pearl Harbor and Red Hill.

The assessment was conducted onsite. Methodology included completing the Occupational Health and Safety Administration (OSHA) Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119) Audit Checklist and the Environmental Protection Agency (EPA) Spill Prevention Countermeasures and Controls (SPCC, 40 CFR 112)) Field Inspection and Plan Review Checklist. These checklists are used by OSHA, EPA, and facilities to audit their PSM and SPCC programs against regulations and best practices.

PSM and SPCC are two U.S. regulatory programs that are commonly in place at large marine bulk terminals. Regardless of regulatory applicability, these programs represent good industry practices and are also applied outside the United States through Risk Based Process Safety (RBPS) programs and through strong spill management and containment programs.

A Hazard and Operability Study (HAZOP) was also performed to assess the operational risks associated with both defueling Red Hill and for ongoing operations at Red Hill and Pearl Harbor. The HAZOP is a baseline operational risk assessment for the facility and can be used to manage operational risks within a management system for continual improvement. The results of the HAZOP were reported in a separate report.

In addition to general recommendations made in this report, the HAZOP Team made recommendations in a separate PHA report, which are included here for completeness, for:

- Safely Defueling Red Hill (Section 4.1.1);
- Ongoing Operations at Red Hill (Section 4.1.2); and
- Ongoing Operations (Not Including Red Hill) at Pearl Harbor DFSP (Section 4.1.3).

Additional recommendations for Operational Readiness are shown in Section 4.2.

A proposed high level implementation plan is shown in Section 5.

CONTENTS

TABLES

FIGURES

1 INTRODUCTION

Risktec Solutions (Risktec) was subcontracted by Simpson, Gumpertz and Heger (SGH) to provide an operational readiness assessment, including a process hazard analysis, of the Joint Base Pearl Harbor-Hickam Defense Fuel Supply Point (DFSP) for the US Navy. This report presents the findings from this assessment.

1.1 Background

The Red Hill Bulk Fuel Storage Facility (RHBFSF) site is located approximately 2.5 miles northeast of Pearl Harbor on the island of Oahu in Hawaii. The facility lies along the western edge of the Koolau Range and is situated on a topographic ridge that divides the Halawa Valley and the Moanalua Valley. The site is bordered to the south by the Salt Lake volcanic crater and occupies approximately 144 acres of land. The surface topography varies from approximately 200 feet to 500 feet above mean sea level.

The facility consists of twenty 12.5-million-gallon underground storage tanks (UST) constructed in the early 1940s. Currently, two USTs are permanently out of service (TK 101 and TK 119). The facility currently stores Jet Propulsion Fuel No. 5 (JP-5), Jet Propulsion Fuel No. 8 (JP-8), and marine diesel (F-76). Historic fuel storage has included diesel oil, Navy Special Fuel Oil, Navy distillate, F-76, aviation gas, motor gas, JP-5, and JP-8.

There have been several prior petroleum, oil, and lubrication releases at the site and numerous environmental activities/studies performed for various reasons, including pipe and tank testing, release response, tank monitoring, long-term monitoring, and removal actions.

In January 2014, up to 27,000 gallons of JP-8 was released from tank TK 105, which was being re-filled after having undergone inspections and repair. As a result of the fuel release from tank TK 105 at the RHBFSF in January 2014, the U.S. Environmental Protection Agency (EPA) and the Hawaii Department of Health (DOH) brought an enforcement action against the Navy and the Defense Logistics Agency to address past fuel releases and minimize the likelihood and impact of future releases.

Following a series of events starting May 6, 2021, through November 28, 2021, the State of Hawaii issued an executive order (EO) to:

1. Immediately suspend operations including, but not limited to, fuel transfers at the Bulk Fuel Storage Tanks at the Facility. Respondent shall, however, maintain environmental controls, release detection and release response protocols, and compliance with applicable regulations.
2. Take immediate steps to install a drinking water treatment system or systems at Red Hill Shaft to ensure distribution of drinking water conforms to the standards prescribed by the Safe Drinking Water Act and applicable regulations and minimize movement of the contaminant plume(s). The treatment system(s) shall be reviewed and approved by the Department prior to installation and shall be installed as expeditiously as practicable.
3. Within thirty days of receipt of this EO, submit a work plan and implementation schedule, prepared by a qualified independent third party approved by the department, to assess the Facility operations and system integrity to safely defuel the Bulk Fuel Storage Tanks. Upon the Department's approval of the assessment, work plan, and implementation schedule, conduct necessary repairs and make necessary changes in operations to address any deficiencies identified in the assessment and work plan. Corrective actions shall be performed as expeditiously as possible.
4. Within thirty days of completion of required corrective actions under Item 3, defuel the Bulk Fuel Storage Tanks at the Facility. Any refueling shall be subject to a determination by the Department that it is protective of human health and the environment.
5. Within thirty days of receipt of this EO, submit a work plan and implementation schedule prepared by a qualified independent third party approved by the Department to assess operations and system integrity of the Facility to determine design and operational deficiencies that may impact the environment and develop recommendations for corrective action. Submit the assessment, proposed work, and recommendations for corrective action to the Department with an implementation schedule. Upon the Department's approval, perform work and implement corrective actions. Corrective actions shall be performed as expeditiously as possible.

1.2 Objectives

The objective of the project is to address Actions 3 and 5 from the EO above. Specifically, conduct operational readiness assessment to identify facility systems integrity risks that may impact the environment and to identify corrective actions to address any deficiencies. This includes the following:

- Assess the Facility operations and system integrity to safely defuel the Bulk Fuel Storage Tanks.
- Assess operations and system integrity of the Facility to determine design and operational deficiencies that may impact the environment and develop recommendations for corrective action.

1.3 Scope

In addition to the specific actions required by the EO for RHBFSF, the team reviewed operational practices to assess the state of ongoing operations at Red Hill and Pearl Harbor. Facility systems integrity was evaluated to determine potential impacts to the environment, personnel health and safety, the public, and mission readiness. Assessments were conducted for defueling Red Hill and for ongoing operations at Pearl Harbor and Red Hill.

1.4 Assessment Team

The Risktec Assessment Team consisted of the following individuals:

- [redacted] PE, Principal Consultant II;
- [redacted] Principal Consultant II;
- [redacted] Principal Consultant II;
- [redacted] PE, PHA Facilitator and Technical Director; and
- [redacted] PHA Scribe.

2 METHODOLOGY

The assessment was conducted onsite. Methodology included completing the Occupational Health and Safety Administration (OSHA) Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119) Audit Checklist and the Environmental Protection Agency (EPA) Spill Prevention Countermeasures and Controls (SPCC, 40 CFR 112)) Field Inspection and Plan Review Checklist. These checklists are used by OSHA, EPA, and facilities to audit their PSM and SPCC programs against regulations and best practices.

PSM and SPCC are two U.S. regulatory programs that are commonly in place at large marine bulk terminals. Regardless of regulatory applicability, these programs represent good industry practices and are also applied outside the United States through Risk Based Process Safety (RBPS) programs and through strong spill management and containment programs.

A Hazard and Operability Study (HAZOP) was performed to assess the operational risks associated with both defueling Red Hill and for ongoing operations at Red Hill and Pearl Harbor. The HAZOP is a baseline operational risk assessment for the facility and can be used to manage operational risks within a management system for continual improvement.

The reviews resulted in evaluations of systems integrity and potential impacts to the environment, health and safety, the public, and mission readiness.

A list of acronyms is included in Appendix A and definitions are included in Appendix B.

2.1 Documentation Review

The review of documentation consisted of:

- Organizing all procedures, plans and evidence provided by the client;
- Requesting additional procedures, plans and documents;
- Reviewing each procedure and document and recording concerns; and
- Generating recommendations.

The assessment team reviewed information on each specific process safety element against a regulatory standard protocol. Additionally, Risktec personnel reviewed ergonomic, industrial hygiene, safety culture, personal protective equipment, and other areas during the visit.

2.2 Initial Facility Tours

Facility tours of the Red Hill tank gallery and tunnels, Underground Pump House (UGPH), Upper Tank Farm, Hotel Pier, Mike Dock, Bravo Dock, Sierra Pier, Kilo Pier, and Hickam fueling facility were completed by the Risktec Team.

2.3 Hazard and Operability (HAZOP) Study

A Hazard and Operability (HAZOP) study was conducted the week of February 7-11 and the week of February 21-25. A HAZOP is a qualitative form of Process Hazard Analysis (PHA) that uses a structured approach to systematically address risks for the operations. A cross functional team assembled to complete the HAZOP and the team consisted of representatives from NAVSUP Fuels Operations team and technical support including engineers, instrumentation subject matter experts, and other subject matter experts.

The technical HAZOP report is a standalone report entitled *Pearl Harbor & Red Hill Fuel Supply Point Process Hazard Analysis,* Risktec Document number 22-SGH-01-1, Rev. 3, dated March 31, 2022.

The report shows Recommendations to Complete Prior to Safely Defueling and Recommendations Associated with Critical Risks for Ongoing Operations. These recommendations are also included in this report for completeness.

2.4 Personnel Interviews and Validation Tours

Pearl Harbor DFSP personnel were interviewed to verify the data in the OSHA PSM and EPA SPCC checklists. The individuals interviewed are identified in Appendix C.

2.5 Process Safety and Spill Prevention Checklists

Methodology included completing the Occupational Health and Safety Administration (OSHA) Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119) Audit Checklist and the Environmental Protection Agency (EPA) Spill Prevention Countermeasures and Controls (SPCC, 40 CFR 112)) Field Inspection and Plan Review Checklist. These checklists are used by OSHA, EPA, and facilities to audit their PSM and SPCC programs against regulations and best practices.

PSM and SPCC are two U.S. regulatory programs that are commonly in place at large marine bulk terminals. Regardless of regulatory applicability, these programs represent good industry practices and are also applied outside the United States through Risk Based Process Safety (RBPS) programs and through strong spill management and containment programs.

Table 1 presents the elements reviewed during the risk assessment. Completed copies of the checklists can be found in Appendices E and F.

Table 1: OSHA Process Safety Elements

PSM Elements	
1. Employee Participation	8. Mechanical Integrity
2. Process Safety Information	9. Hot Work Permits (Safe Work Permitting)
3. Process Hazards Analysis	10. Management of Change
4. Operating Procedures	11. Incident Investigation
5. Training	12. Emergency Planning and Response
6. Contractors	13. Compliance Audits
7. Pre-Start-up Safety Review	14. Trade Secrets – not applicable

3 OPERATIONAL READINESS ANALYSIS

3.1 General Overview

In conducting the Operational Readiness Assessment, the Risktec team included information from the HAZOP, the PSM and SPCC checklists, interviews, and field validations, in order to assess the facility's risks and make recommendations for defueling Red Hill and for ongoing operations at Pearl Harbor and Red Hill.

Although Risktec concurs with the facility's determination that the OSHA PSM regulation does not apply to the facility for various reasons (not documented in this report), it is recommended that a "risk-based process safety management system" be implemented to reduce the likelihood of releases, quickly detect those releases, and mitigate the impact of releases. This type of management system has been proven throughout industry to not only reduce releases, but to favorably impact bottom line results. A model management system already exists for Navy facilities and is described in depth in the Navy Safety and Occupational Health Manual, OPNAV M-5100.23. Although this document doesn't specifically address process safety, much can be leveraged to develop a risk-based process safety management system.

A management system framework will allow the NAVSUP Fuels group to effectively manage the operations at Red Hill and Pearl Harbor going forward. In facilities not applicable to OSHA's Process Safety Management Program, the industry best practice is the implementation of a Risk Based Process Safety management system.

A Risk Based Process Safety (RBPS) management system allows the facility to identify risks, implement programs to address the risks, and continuously improve. This approach ensures the facility's programs are suitable for the operational, environmental and safety risks at the Pearl Harbor Defense Fuel Supply Point.

The Risk Based Process Safety approach recognizes that all hazards and risks are not equal; consequently, it advocates that more resources should be focused on more significant hazards and higher risks.

Essential elements of a risk-based management system are shown in Figure 1 below.

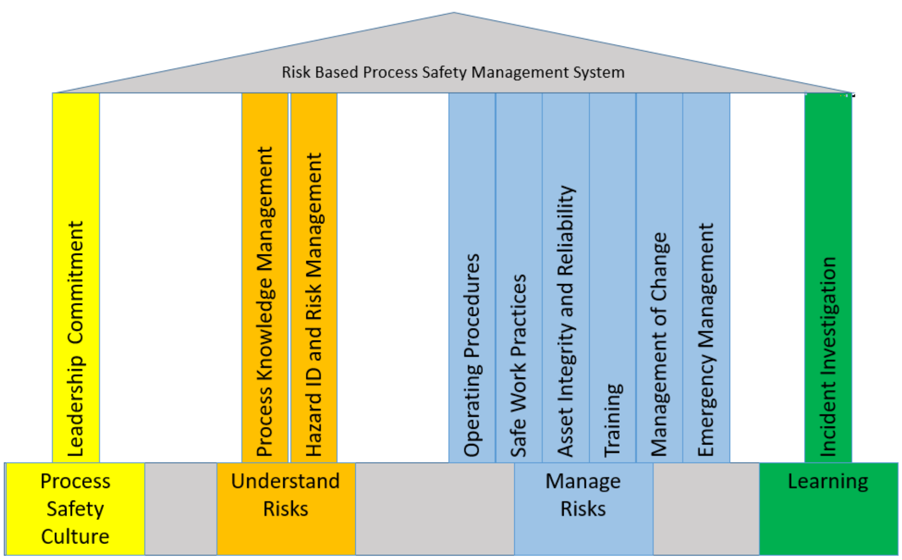


Figure 1: Risk Based Process Safety Management System

(Ref: Risk Based Process Safety Overview, Process Safety Overview for Non PSM Facilities)

A strong RBPS management system, coupled with strong process safety leadership, is the only way to sustainably avoid large and small incidents alike. Loss prevention benefits include:

- Lives saved and injuries prevented
- Reduced property damage loss
- Reduced business interruption loss
- Reduced fines and litigation costs
- Reduced regulatory attention
- Reduced remediation costs

Operating organizations around the world have learned that when they implement robust process safety management systems, their productivity and quality increase while costs decrease. This can lead to improved quality and reduced rework.

3.1.1 *Jurisdictional Overlap*

3.1.1.1 *Organizational Structure*

From the facility's Operation, Maintenance, Environmental and Safety (OMES) Plan, the relationship between the various Government agencies and contractors are as follows (see Figure 2 also):

- The JBPHH owns the fueling infrastructure (e.g., piping, tanks, etc.) and the fuel at the FLC Pearl Harbor.
- NAVSUP Fleet Logistics Center Pearl Harbor (NAVSUP FLCPH) provides logistics, business and support services to fleet, shore and industrial commands of the Navy, Coast Guard and Military Sealift Command and other joint and allied forces.
- The DFSP Pearl Harbor Bulk Terminal is a government-owned/government-operated (GOGO) facility that is operated and maintained by government civilian personnel.
- Joint Base Pearl Harbor Hickam (JBPHH) is the owner of the property. The DFSP Pearl Harbor Bulk Terminal is considered to be a tenant on the JBPHH.
- The Joint Base Security Department provides security and law enforcement to JBPHH.

The United States Environmental Protection Agency and Hawaii Department of Health made the following determination in the 2014 Administrative Order of Consent (AOC):

- Facility Owner: NAVY (Commander Navy Region Hawaii)
- Facility Operators: NAVY (Commander Navy Region Hawaii)

The DLA's current organizational structure and complex accountability/responsibility roles has created an environment where operational readiness is threatened. The facility has not kept up with modern industrial trends for operational philosophy, technology, or safeguards. For example, a standard set of piping and instrumentation drawings showing all installed equipment, including instrumentation, is not available. Also, Control Room Operators (CROs) must rely on a single PIT to monitor the gravity pressure created by 3.5 miles of pipeline and approximately 200 feet of product head from any of the Red Hill tanks.

In general, most federal and state safety and environmental programs are designed assuming that the facility "owner" and facility "operator" are one in the same. In this configuration, there is no confusion as to who is responsible for the safe operation of the facility, and who is authorized to allocate necessary resources to maintain that safety.

Risktec personnel are aware that other DOD Bulk Fuel facilities are managed differently. For example, instead of GOGO, there are government-owned/contractor-operated (GOCO) and contractor-owned/contractor-operated (COCO) arrangements.

Although strategic fuel management is critical to completion of the mission of the Navy, operating fuel terminals is not part of their core competencies. In order to address operational and maintenance issues created by jurisdictional overlap, and to expeditiously restore the mission readiness of the facility, it is recommended to evaluate alternative operational arrangements such as Government Owned Contractor Operated (GOCO) or Contractor Owned Contractor Operated (COCO).

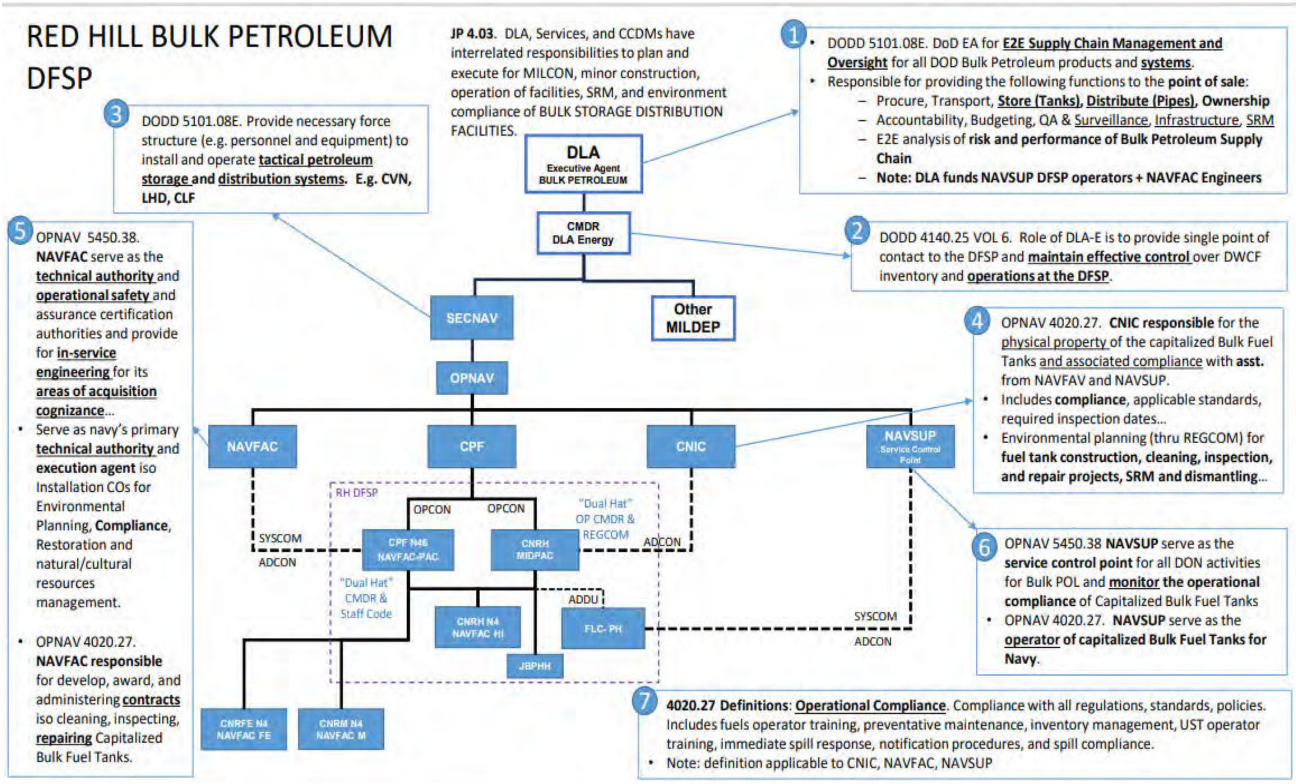


Figure 2: Organizational Overlaps at JBPHH DFSP

3.2 Hazard and Operability Study

A Hazard and Operability Study (HAZOP) was performed to assess the operational risks associated with both defueling Red Hill and for ongoing operations at Red Hill and Pearl Harbor. The HAZOP is a baseline operational risk assessment for the facility and can be used to manage operational risks within a management system for continual improvement.

The HAZOP report documents a Process Hazard Analysis (PHA) for Pearl Harbor and Red Hill Fuel Terminal for NAVSUP FLCPH. The review was conducted using the Hazard and Operability (HAZOP) and What-If methodologies. The methodologies employed in this study meet the requirements of the Occupational Safety and Health Administration (OSHA) rule, Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119) and the Environmental Protection Agency's rule 40 CFR Part 68, Accidental Release Prevention Requirements, Risk Management Program Under the Clean Air Act, Section 112(r)(7).

The PHA was conducted in-person on dates February 7, 2022, through February 11, 2022, and on February 21, 2022, through February 25, 2022. The PHA Team met for a total of ten (10) days. The PHA was facilitated and documented by Risktec with key participation from Navy Supply Fleet Logistics Center Pearl Harbor personnel and support personnel. The multidisciplinary team identified process hazards associated with the Pearl Harbor & Red Hill Fuel Terminal. The team focused on those process hazards that could lead to significant impact on mission readiness, safety or health, public, and/or environment during routine and non-routine operations.

The PHA Team identified one hundred twenty (120) recommendations for reducing the likelihood and/or severity of potential consequences associated with the Pearl Harbor & Red Hill Fuel Terminal. Those recommendations are prioritized and segregated by affected facility in the tables included in Section 4.

3.3 Operational Readiness

3.3.1 *Employee Participation*

Employee Participation is an element of the Occupational Safety and Health Administration's (OSHA) PSM Standard as well as a good industry practice for managing process safety. The regulatory language requires that:

- Employers consult with employees, and their representatives, on the development of process hazards analyses and on the development of the other elements of process safety management.
- Employers provide to employees, and their representatives, access to process hazard analyses and to all other process safety information.

3.3.1.1 *Observations*

Within the Fuels team, Employee participation opportunities include safety meetings, department meetings, and morning operations planning meetings. Interviews with facility personnel indicated that Safety Councils are being formed in 2022.

3.3.1.2 *Opportunities for Improvement*

There were no opportunities identified.

3.3.2 *Process Safety Information/ Process Knowledge Management*

Process Safety Information (PSI) should be compiled before conducting any process hazard analyses. This data enables the owner/operator, employees and contractors involved in operating the process to identify and understand the hazards posed by those processes involving highly hazardous chemicals.

3.3.2.1 *Observations*

The following process information was observed:

- Process Flow Diagrams;
- OMES Manual; and
- Various uncontrolled documents including pump curves, information on the AFFF system, and other uncontrolled engineering documents.

3.3.2.2 *Opportunities for Improvement*

Develop a Process Safety Information (PSI) policy which identifies the necessary PSI, how it will be maintained and where it will be stored and who will be responsible. After implementing a Management of Change Program, ensure that documentation is updated or created as needed, and maintained in a document control system. At a minimum, ensure that information includes:

- Piping and Instrumentation Diagrams (maintained "evergreen");
- Operating Procedures;
- Safe Upper and Lower Operating Limits;
- Materials of Construction;
- Electrical Diagrams;
- Electrical Classifications;
- Relief Systems and Design Basis; and
- Codes and Standards Employed.

3.3.3 *Process Hazard Analysis/ Hazard Identification and Risk Assessment*

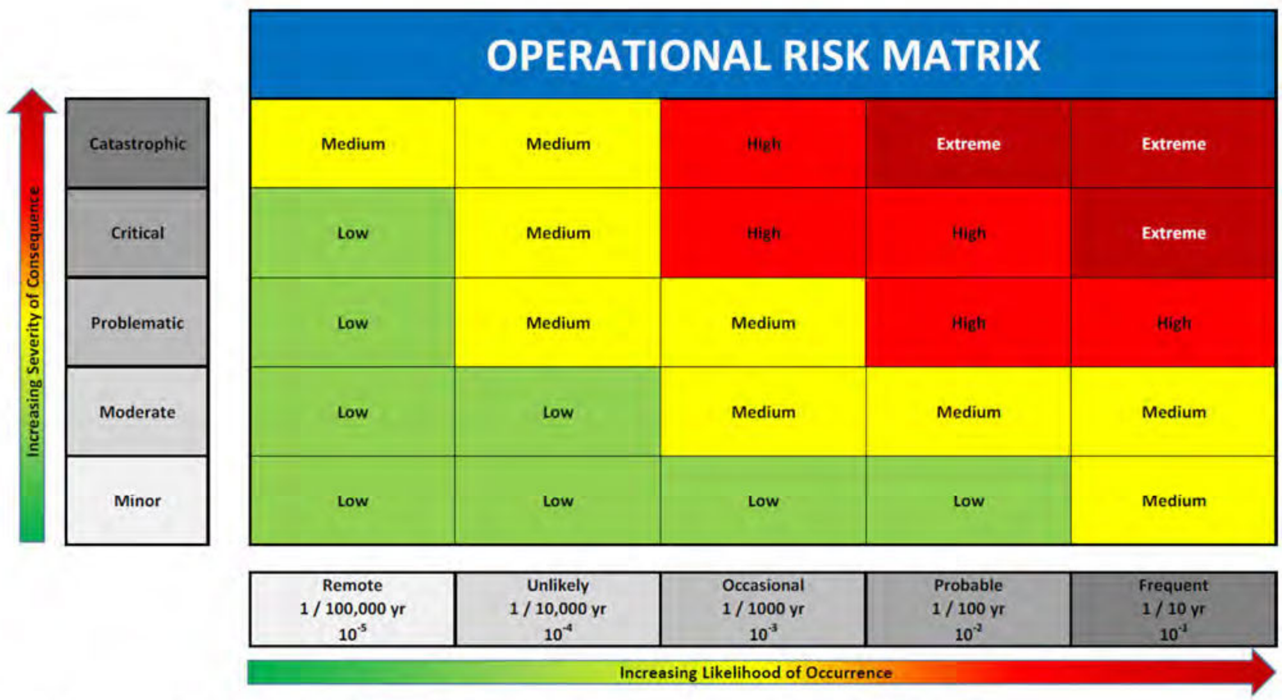
A critical component to process safety and reliability is conducting through detailed hazard analysis and risk assessment. Prior to undertaking this effort, a risk tolerability/acceptance matrix must be developed. The matrix shown below is JBPHH's current risk matrix. It is included in each operating order.

Risk Assessment Matrix		Probability			
		Frequency of Occurrence Over Time			
		A Likely	B Probable	C May	D Unlikely
I	Loss of Mission Capability; Unit Readiness or Asset; Death	1	1	2	3
II	Significantly Degraded Mission Capabilityor Unit Readiness; Severe Injury or Damage	1	2	3	4
III	Degraded Mission Capability or Unit Readiness; Minor Injury or Damage	2	3	4	5
IV	Little or No Impact to Mission Capability or Unit Readiness; Minimal Injury or Damage	3	4	5	5
Risk Assessment Codes 1 - Critical 2 - Serious 3 - Moderate 4 - Minor 5 - Negligible					

Figure 3: JBPHH Risk Matrix

This type of matrix is referred to as a “4 by 4” matrix, in that it includes four rows for consequence and four columns for probability. The matrix is acceptable as is but does not reflect current industry best practice. Primarily, it is lacking consequences for environmental and public impacts and probabilities are qualitative, instead of quantitative. Additionally, there are no definitions for the probability terms – “Likely, Probable, May, and Unlikely”. Also, there are no criteria for Risk Levels – “1-Critical, 2-Serious, 3-Moderate, 4-Minor, or 5-Negligible”. Although, the Navy Safety and Occupational Health Manual included some information for risk assessments, it appeared that this information was not being utilized.

Figures 4 through 7, below, provide a good example of a “5 by 5” matrix with definitions and requirements for all factors.



Reference: "A Practical Approach to Hazard Identification for Operations and Maintenance Workers," Center for Chemical Process Safety (CCPS), Wiley, 2010. Page 239.

Figure 4: Industry Matrix (5 by 5)

OPERATIONAL CONSEQUENCE	CONSEQUENCE LEVEL AND DESCRIPTION				
	Minor	Moderate	Problematic	Critical	Catastrophic
Health and Safety	Low impact to employee / contractor (e.g.: first aid)	Medium impact to employee / contractor (e.g.: medical aid or minor illness)	High impact to employee / contractor (e.g.: lost time or severe illness)	Major impact to employee / contractor (e.g.: fatality, permanent injury) / impact to individual members of the public	Catastrophic impact to employee(s) / contractor(s) (e.g.: multiple fatalities, onset of life threatening health effects) / impact to a community
Financial	Financial loss or OPEX impact < $100,000	Financial loss or OPEX impact $100,001 up to $1,000,000	Financial loss or OPEX impact $1,000,001 up to $10,000,000	Financial loss or OPEX impact $10,000,001 up to $50,000,000	Financial loss or OPEX impact > $50,000,000
Reputation	Individual concern / no media coverage / isolated complaints / no impact to customers	Community interest / short term or local media coverage / short term impact to customers	State or industry interest / active media coverage / local adverse social impact / timing delays for customers	Prolonged media coverage / widespread adverse social impact / extensive impact to customer relationships	National interest / continuing media coverage / cancelled customer contracts
Environmental & Regulatory	Limited impact / limited scale / remediation period in days / no off-site or receptor (sensitive environmental impacts) / No notice of violation	Short term impact / small scale / remediation period of several weeks (< 1 year) / Off-site impacts with no receptor impacts / Notice of violation requiring administrative self disclosure	Medium term impact / medium scale / remediation period of several months (> 1 year) / Off-site impacts with receptor impacts / Notice of violation w/ fine not resulting in enforcement action	Long term impact / large scale / remediation period of multiple years (< 5 years) / Off-site impacts with the ability to remediate receptors within 5 years / Notice of violation w/ fine resulting in enforcement action	Extensive long term impact / large scale / remediation period of several years (> 5 years) / Off-site impacts with an inability to remediate receptors within 5 years / Notice of violation resulting in limitation or temporary loss of license to operate

Figure 5: Industry Matrix: Consequence Table

LIKELIHOOD LEVEL	LIKELIHOOD DESCRIPTION	
	Facility Likelihood	Non-Facility Likelihood
Frequent	At Least Once Within 10 Years This scenario could happen multiple times during the lifetime of a facility.	10% to 90%
Probable	At Least Once Between 10 to 100 Years This scenario could happen once during the lifetime of a facility.	1% to 10%
Occasional	At Least Once Between 100 to 1,000 Years This scenario could happen, but has not historically happened, at a facility.	0.1% to 1%
Unlikely	At Least Once Between 1,000 to 10,000 Years A similar scenario is extremely unlikely to happen anywhere within the industry.	0.01% to 0.1%
Remote	At Least Once > 10,000 Years	Less Than 0.01%

Figure 6: Industry Matrix: Likelihood Table

RISK RATING AND REQUIRED ACTIONS			
RISK RATING	**CONDITIONS**	**RECOMMENDATION CLOSURE**	**REQUIRED ACTIONS**
EXTREME Risk	**Urgent Improvement Opportunity** Extreme Risk remains even **after controls are evaluated (residual risk).** Further controls need to be evaluated considering the velocity of risk (how quickly the impact can be realized), risk resolution options, and cost-benefit analysis.	**Within 1 year from report issuance**	Accountable VP, Director and Leadership need to support the development of further controls or accept the risk exposure.
HIGH Risk	**Serious Improvement Opportunity** High Risk remains even **after controls are evaluated (residual risk).** Further controls need to be evaluated considering the velocity of risk (how quickly the impact can be realized), risk resolution options, and cost-benefit analysis.	**Within 2 years from report issuance**	Accountable Director and Leadership need to support development of further controls or accept the risk exposure.
MEDIUM Risk	**Potential Improvement Opportunity** Medium Risk. Controls are in place, however additional controls may be required.	**Within 3 years from report issuance**	Further controls may be required where existing controls are not in place or have not been verified to be working as intended.
LOW Risk	**Limited Improvement Opportunity** Low Risk. Controls are in place and no further risk reduction is required. Also applies to documentation (i.e. PSI, checklists, non-critical procedures, etc.) that requires updating or revising.	**Within 4 years from report issuance**	No further controls are required.

Figure 7: Industry Matrix: Risk Ratings and Actions

3.3.3.1 *Observations*

JBPHH performed the initial Process Hazard Analysis for the JBPHH DFSP in February 2022, resulting in 120 recommendations. This was the first round of PHA to be performed and should be continued to be updated every five years.

3.3.3.2 *Opportunities for Improvement*

Consider repeating/revalidating the Process Hazard Analysis (PHA) every 5 years to assess the hazards introduced by implementing changes to the process. The next PHA would be due in 2027.

Develop a policy and schedule for PHA completion that includes techniques and methods to be used, personnel to include and information to be reviewed. Include a requirement for all major projects to include a PHA as part of the project design.

Evaluate JBPHH risk matrix to include expanded consequences for Environmental and Public Impact.

3.3.4 ***Operating Procedures***

OSHA PSM requires written operating procedures to provide clear instructions for safely conducting activities involved in operating processes and to develop and implement safe work practices to control hazards during operations of covered processes. Operating procedures are required for all operating phases including:

- Initial startup
- Normal operations
- Temporary operations
- Emergency shutdown
- Emergency operations
- Normal shutdown
- Startup following a turnaround or after an emergency shutdown

3.3.4.1 *Observations*

The OMES Manual contains Operating Procedures which are top-level documents explaining work processes for Red Hill and Pearl Harbor DFSP. Beneath the OMES Procedures there are Operations Orders (Figure 8), second-level documents, which explain detailed step by step instructions for carrying out work. Per the OMES manual, "The Operations Orders are specific written orders to complete a task or operation. These orders include the delivery of fuel, repair and/or installation of equipment, etc. The order describes the "who, what, where, when and why" of a specific operation.

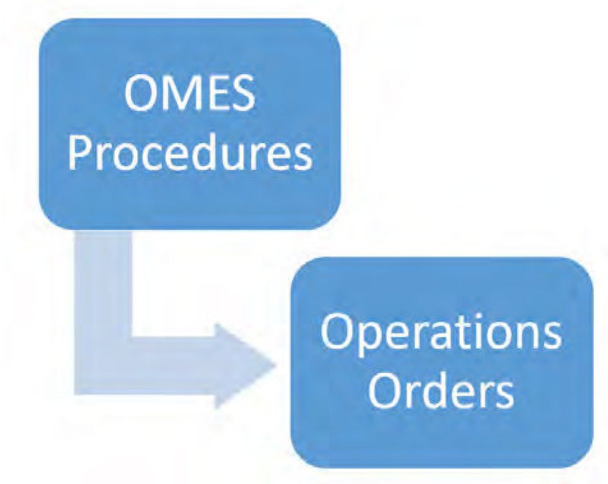


Figure 8: Operations Orders are contained in the OMES

All operations orders are incorporated into the DFSP Pearl Harbor Bulk Terminal Fuels Asset Management and Maintenance System (FAMMS) computer program. The FAMMS program is designed to provide most of the pertinent details needed by the operators.

Two types of Operations Orders are used by the DFSP: Specific Operation Orders and Recurring Operation Orders. Most of the Operations Orders were developed and implemented following the May 6, 2021, incident.

Specific Operation Orders are used for the following operations and functions:

- Receipts and issues to or from ships and other watercraft
- Commercial pipeline operations
- Tank-to-tank transfers
- Issues to tank trucks (occurring at one time)

Recurring Operation Orders are written for infrequent operations, such as:

- Small issues at truck load stands, e.g., for calibrations of meters
- Loading multiple trucks at the truck fill stand
- Isolating tanks (e.g., for preventive maintenance)

Recurring Operations Orders are reviewed each morning and modified to meet the operations for that day's activities. If the operator discovers that there is an inconsistency with the order, the supervisor approves the change and the operator proceeds. All high-risk activities are signed-off by the Deputy Fuels Director.

The template for Operations Orders does not contain detailed step by step instructions and other key information required to comply with OSHA PSM.

Operations orders for the following activities were reviewed:

- F76 Fuel Line Pressure to Hotel pier for PPSI Pressure Testing
- Repack F76 Pipeline from Upper Tank Farm Tank 54 to Hotel Piers 1 – 4
- Loading Commercial JP5 Trucks from UTF TK 55
- Loading FLC F76 Truck from UTF TK 47
- Loading FLC JP5 Trucks from UTF TK 55

Currently, the Fuels department performs simultaneous operations routinely. At the time of the PHA, simultaneous operations must be approved by the Fuels Deputy Director. The limiting factor is the number of available personnel.

There is no training associated with operations orders. However, 'high risk activities' do have a discussion before the order is initiated.

3.3.4.2 *Opportunities for Improvement*

Operating orders (procedures) should be established in writing for each work activity and all operational phases. A new procedure template with all industry best practice sections (like health and safety, consequence of deviation, etc.) included should be developed. NOTE: During the HAZOP, a procedure template was provided to POND personnel. Normal operations and emergency operations should be addressed; emergency operations should address loss of electricity, building ventilation, fire or explosion.

Develop Operations Orders that include the following:

- Ensure that the procedures describe the expected system response, how to determine if a step or task has been done properly, and possible consequences associated with errors or omissions.
- Address safe operating limits and consequences of deviation from safe operating limits.
- Address limiting conditions for operation.
- Provide clear, concise instructions with a place for initialling critical steps.
- Supplement procedures with checklists.
- Make effective use of pictures and diagrams.
- Develop written procedures to control temporary or non-routine operations.
- Interlink related procedures.
- Validate procedures and verify that actual practice conforms to the intended practice.
- Signature block with date and approvals

Ensure Operations Orders are reviewed annually and updated and maintained in a document control system.

Ensure Operators are trained on the Operations Orders initially and with refresher training every three years.

Ensure a section of the new procedure template discusses PPE required, the hazards of the fuels and what to do if you come in contact with the fuels.

All operating orders/procedures should be version controlled within a document control system where changes/revisions to the documents are managed and to allow for yearly document review.

As part of a Life Critical Safety Program, the following should be addressed. Further Life Critical Procedures are addressed in the Hot Work Section 3.3.9.

Develop a formal written procedure implementing a Lock-out/Tag-out (LOTO) process including training on the LOTO work permit.

Develop a formal written procedure implementing a line opening process that address hazards and controls that must be in place.

Implement an access control process that includes electronic badging into and out of the facility. This system should report real-time accounting for all personnel in the facility. In lieu of an electronic system, implement a sign-in/sign-out process which is controlled by the Control Room Operator (CRO).

3.3.5 *Training/Training and Performance Assurance*

OSHA PSM intends for training to impart knowledge of the process and its hazards, teach skills in performing operating procedures including emergency operations and assure that employees understand and adhere to the current operating procedures and safe work practices of the process.

3.3.5.1 *Observations*

The basic training curriculum for Pearl Harbor DFSP is located in the ESAMs, My NAVSUP programs, and OPNAVINST5100. At the time of the review, training records indicate that training is completed on-time. Supervisors and Work Leaders remind employees when training is behind schedule. Due to Covid restrictions, some specialized training is past due, because in-person training was prohibited.

Basic safety training is provided to all employees.

Confined Space training for most operators consists of On-the-Job awareness level training. The Safety Officer and other key individuals responsible for Confined Space Entries receive specialized training.

An Operator Competency-Based Training program is in place. Control Room Operators and Roving Operators in the Fuels department, go through an initial operations-specific training program. New employees shadow an existing operator for approximately 2 months. During this time of On-the-Job (OTJ) training, the experienced operator uses a qualification checklist to mentor the new employee. Upon completion of the checklist, the new employee is interviewed by the Work Leader or the Bulk Fuels Operations Supervisor, who determines if the new employee is qualified to work on his own.

There is no training on routine or non-routine operations orders. The supervisors and operators discuss high risk operations orders before work begins.

A best practice in industry operator training is a competency-based graduated training continuum. Training programs include a combination of simulators, emergency shutdown and response, OTJ training and computer-based modules. Testing includes a passing threshold. Review boards (comprised of multiple people) review the training records and meet to determine qualifications and repeat training requirements.

3.3.5.2 *Opportunities for Improvement*

Implement a formal written program establishing operator initial and refresher training requirements. Job shadowing can be one aspect of this training program, but should not constitute the primary training method. Consider operator pre-qualification requirements prior to employment. Establish a training department/coordinator to be responsible for all training activities and consider using a process simulator for CRO initial and refresher training.

- Ensure training programs include initial and refresher training on Safe Work practices for affected employees.
- Ensure Operators are trained to reliably perform their roles including training on Operations Orders and formal verification of competency.

3.3.6 *Contractors*

Best practice for contract workers in a marine terminal will ensure that contract workers can perform their jobs safely, and that contracted services do not add to or increase facility operational risks. Pearl Harbor DFSP addresses contractor safety expectations in the contract. Project managers oversee contractors and their safety performance. The US Army Corps of Engineers Safety and Health Requirements Manual EM-385-1-1 (November, 2014) is used to manage contractor projects; compliance with this manual is a contract requirement. Under EM-385, contractors must submit an Accident Prevention Plan (APP) or Project Safety and Occupational Health (SOH) Plan for each project. The EM-385-1-1 references 29 Code of Federal Regulation (CFR) 1910, Occupational Safety and Health Standards for General Industry, among other safety and health standards.

3.3.6.1 *Opportunities for Improvement*

No further opportunities were identified.

3.3.7 ***Pre-Startup Safety Review (PSSR)***

A Pre-startup Safety Review is a final check to verify readiness of a process and help to ensure that the process is safe to start (if new or modified) or restart (if returning to service after a shutdown).

A Pre-Startup Safety Review verifies that significant hazards arising from plant or equipment modifications have been eliminated or minimized to an acceptable level and ensures that all elements relevant to safe operation have been addressed prior to the initial startup of new or modified facilities. This includes verification that the construction and equipment are in accordance with the design specifications, the facility is prepared to safely start up, operators have been adequately trained, a process hazard analysis (PHA) has been performed with all pre-startup action items complete, and operating procedures have been updated to ensure continuing safe operation.

A PSSR should be conducted by subject matter experts with representatives from the operations, maintenance and engineering groups. Templates for PSSRs are publicly available. A best practice is to edit the PSSR template prior to use with process-specific questions or process-specific issues to be addressed prior to start-up/restart.

A PSSR should be performed for:

- New facilities,
- Modified facilities when the modification is significant enough to require a change in the process safety information.
- Startup following an extended shutdown.

3.3.7.1 *Opportunities for Improvement*

Develop a formal written procedure implementing a Pre-Startup Safety Review (PSSR) program.

Develop a written plan for conducting Prestart-up Safety Reviews including the use of a PSSR template. The plan should include roles and responsibilities, approvals, conditions that must be met prior to startup, communication requirements to affected people, and update of affected records, like piping and instrumentation diagrams.

The PSSR template will help to identify actions that must be completed before start-up as well as actions that may be completed after start-up within 30/60/90 days. Follow-up actions should be tracked in an action tracking tool.

3.3.8 ***Mechanical Integrity/ Asset Integrity and Reliability***

The asset integrity element is the systematic implementation of activities, such as inspections and tests necessary to ensure that important equipment will be suitable for its intended application throughout its life. Specifically, work activities related to this element focus on: (1) preventing a catastrophic release of a hazardous material or a sudden release of energy and (2) ensuring high availability (or dependability) of critical safety or utility systems that prevent or mitigate the effects of these types of events.

3.3.8.1 *Observations*

Personnel interview indicated Mechanical Integrity (MI) procedures existed for some equipment, but no procedures were provided or reviewed. The Recurring Maintenance Minor Repair program is used to manage maintenance of equipment. Based on personnel interview, training of personnel involved in maintaining the ongoing integrity of process equipment is primarily done as "on-the-job training".

3.3.8.2 *Opportunities for Improvement*

- Develop and implement detailed MI procedures for all equipment subject to test and inspection requirements.
- Develop structured written procedures for training personnel involved in maintaining the ongoing integrity of process equipment.
- Develop a list of critical operating equipment and instrumentation as well as a plan for stocking of this critical equipment.

3.3.9 ***Hot Work Permits/ Safe Work Practices***

Hot work permits are intended to control hot work operations to minimize ignition sources for potential fires and explosions resulting from releases of flammable materials. Hot work operations apply to electric or gas welding, cutting, brazing, and similar flame or spark producing operations such as grinders, welding burning, or brazing.

A program covering Life Critical Safety procedures should focus on the higher risk activities which have been shown to most likely result in fatalities. These procedures contain actions individuals can take to prevent a work-related fatality. While some of these are covered in the OMES and the OPNAVINST 5100, they should be enhanced to contain requirements of OSHA PSM as well as good industry practice.

3.3.9.1 *Observations*

Five sample hot work permits were reviewed, and the Fire Chief was interviewed. The Fire Chief is responsible for issuing hot work permits at Pearl Harbor DFSP. According to the OMES the facility complies with NFPA 51B "Standard for Fire Prevention During Welding, Cutting, and Other Hot Work".

The OMES does not describe the requirements for conducting hot work and the requirements for hot work are not readily available to the operators or other workers at RHL and PRL.

There is not a Safe Work Permitting procedure for work other than hot work.

3.3.9.2 *Opportunities for Improvement*

The following opportunities exist for improving the hot work program at PRL and RHL.

As part of a Life Critical Safety program, the following should be addressed. Further Life Critical procedures are addressed in the Operating Procedures Section 3.3.4.

Develop and implement a hot work program that is owned by the Operations / Fuels group. This program should meet the criteria of OSHA PSM. It should ensure that Operators know what hot work is being performed in their area, and that operators are trained to write hot work permits.

In addition, develop and implement a Safe Work program that includes procedures and controls for confined space entry, energy isolation, elevated work, and other Life Critical procedures.

Consider the Operations Department (Fuels) to be the owner of the Life Critical Standards. The owner will issue the permits for work conducted within their area, be trained to issue hot work permits, and shall be responsible for monitoring hot work being conducted in their area of operation.

3.3.10 ***Management of Change***

The MOC element helps ensure that changes to a process do not inadvertently introduce new hazards or unknowingly increase risk of existing hazards. The MOC element includes a review and authorization process for evaluating proposed adjustments to facility design, operations, organization, or activities prior to implementation to make certain that no unforeseen new hazards are introduced and that the risk of existing hazards to employees, the public, and/or the environment is not unknowingly increased. It also includes steps to help ensure that potentially affected personnel are notified of the change and that pertinent documents, such as procedures, process safety knowledge, and other key information, are kept up to date.

The JBPHH does not currently have a formal Management of Change program. As a result, changes to equipment and procedures do not undergo a systematic hazard review along with documentation of the changes in the process safety information (drawings, procedures, training, set point limits, etc.).

An MOC is used to ensure that the environmental, health, and safety risks are carefully evaluated and controlled prior to implementing significant changes. The MOC process gives employers a chance to identify potential new hazards that could result from these changes.

The MOC process should be conducted in a systemic way. The basic steps to follow include:

1. Recognize the proposed change(s).
2. Evaluate the hazards and risks.
3. For a simple change, a simple MOC checklist can be completed.
4. Determine if the hazards and risks can be reduced, controlled, or eliminated.
5. Assign actions if hazard control measures are required.
6. Determine if the change(s) can or should be made.
7. The person who is authorized to approve a change (for example, Deputy Director of Operations) should be identified who can approve changes to proceed.
8. Implement change(s) if determined safe to do so.
9. Conduct Pre-Startup Safety Review (PSSR).
10. Ensure actions required for Startup are complete. A separate PSSR checklist is provided.
11. Train workers on the implemented changes.
12. Approve change for Startup.

A Management of Change program can be either paper-based or electronic, and a simple way to initiate a new MOC program is to use a paper-based system. A paper-based MOC template is provided in Appendix D, along with a What-If template for evaluating medium complexity changes.

Ideally, a dedicated person should be assigned to be the MOC Coordinator for the facility to ensure that changes are properly evaluated, actions are followed up in an action tracking system, and documentation is complete. Training and implementation will be required to have an effective MOC program.

3.3.10.1 *Observations*

Different organizations at Pearl Harbor DFSP are responsible for implementing projects including the following:

- NAVFAC – owners of facilities, roads, fences. Engineering support for large projects.
- EXWC – Technical experts for construction
- POL (Petroleum, Oil, Lubricants) specialists – Implementation of large projects, pigging, tank inspections.
- Fuels Organization #700 –Maintenance and improvement projects (RMRR)

A Management of Change program is not in place at Pearl Harbor DFSP.

3.3.10.2 *Opportunities for Improvement*

Develop a formal written procedure implementing a Management of Change (MOC) process. The process should be paper-based initially with the goal to move to an electronic system once the program is fully implemented and understood. Implement a Management of Change program that includes:

- Training for all employees.
- Define the scope of the MOC system.
- Manage all sources of change.
- Ensure that MOC reviewers have appropriate expertise and tools.
- Levels of review and authorization/approvals are defined.
- Update records.
- Communicate changes to personnel.

As part of the MOC and PSSR procedures, require operator training before any process change is made.

3.3.11 *Incident Investigation*

Developing, sustaining, and enhancing incident investigation competency allows an organization to learn from experience. Incident investigation is a process for reporting, tracking, and investigating incidents that includes: (1) a formal process for investigating incidents, including staffing, performing, documenting, and tracking investigations of process safety incidents and (2) the trending of incident and incident investigation data to identify recurring incidents. This process also manages the resolution and documentation of recommendations generated by the investigations.

3.3.11.1 *Observations*

Incidents or "Mishaps" at Pearl Harbor DFSP are reported in the Enterprise Safety Applications Management System (ESAMS). ESAMS is an application that houses the safety training modules, records, collects data for "mishaps", fire and emergency services response as well as equipment and vehicle tracking. According to the OMES Manual Section 8.4, training is 'periodically' provided for hazard/mishap incidents.

Incident investigations are completed by the Safety Officer. He does not use any tool or investigative methods. He uses an ESAMS screen (template) to complete the data input and 'lead' him through the investigation. Near misses are generally not reported, investigated, or communicated.

Interviews also concluded that incident investigation results, may be discussed in a Safety Stand-down or Operational Pause. Employees that do not attend this stand-down may not receive this information.

OPNAVINST 5102 Navy and Marine Corps Mishap and Safety Investigation, Reporting and Recordkeeping Manual describes the incident investigation program requirements.

On May 6, 2021, a major incident occurred at the Red Hill facility. The event was investigated by Austin Brockenbrough and Associates (ABA), LLC and an investigation report was issued on September 7, 2021. Personnel interviews indicated that Fuels organization personnel received a debrief on the incident conclusions. However, some operators interviewed did not recall receiving the debrief or indicate an understanding of the root causes.

Although the 07 September, 2021 Red Hill Fuel Facility Pipeline Failure Full System Integrity Report showed a root cause of "incorrect sequencing of valves" and "procedural error", a modern incident investigation technique would look closely at the organizational procedural issues, including why the procedures were deficient and how the management system should be improved to address procedural issues. It was also observed that the investigation report did not utilize an industry accepted incident investigation tool. Focusing on human behavior as a root cause is not part of a modern incident investigation technique.

3.3.11.2 *Opportunities for Improvement*

Consider updating OPNAVINST 5102 to reflect modern incident investigation tools and techniques that are fit for purpose, and scalable for the level of incident (such as Source, Tap Root, Apollo, 5 Whys and Fishbone for simple investigations, and others).

Ensure training is provided in selected incident investigation techniques. Lessons learned should be communicated at all levels for serious incidents.

Develop a systematic and in-depth approach to safety, health, and environmental event/incident investigations and reporting with an emphasis on the following:

- The policy should address roles and responsibilities, communications, and incident documentation. Investigations should follow formal methodologies to identify root causes.
- Verify that all incidents and near misses are reported.
- Ensure the investigations are timely, thorough, effective, and efficient.
- Communication of mishap/incidents should include a discussion of the root cause, contributory causes as well as corrective actions for all employees involved.

Figure 9: Incident Hierarchy

3.3.12 *Emergency Planning and Response/Emergency Management*

The team completed the U.S. Occupational Safety and Health Administration's (OSHA's) Process Safety Management (PSM) of Highly Hazardous Chemicals (29 CFR 1910.119) Field Checklist. This review process included the review of relevant documents and validation with field observations and interviews.

The team reviewed the following Joint Base Pearl Harbor Hickam plans addressing Emergency Planning and Response:

- JBPHH Core Contingency Plan,
- Emergency Response Procedures (Section 7 of the Operations, Maintenance, Environmental and Safety Plan, Defense Fuel Support Point, Pearl Harbor Bulk Terminal, Pearl Harbor, Hawaii), and
- Red Hill Fuel Storage Facility Response Plan.

3.3.12.1 *Observations*

Observations regarding JBPHH practices are shown in the OSHA PSM Field Checklist provided in Appendix E.

The Emergency Planning and Response Program is a robust program with some best practices. Areas of best practices include the following. Also, personnel are trained in their roles.

- Robust spill response equipment is available at storage locations including Ford Island SMT, Fire Department, Fuels Building, and field locations.
- Contracts are held with emergency response contractors and the contractor contact information is contained with the FRP.
- Maintenance is conducted on critical emergency response equipment including alarm system, oil tight door, and fire response equipment.

There is currently no formal access control system to track all workers inside the facilities.

3.3.12.2 *Opportunities for Improvement*

Some opportunities exist for improvement including the following:

Typically, facilities have alarms for local emergencies (leave the work area and muster at a safe distance) and evacuation alarms (evacuate the facility).

- It is recommended to distinguish between local emergencies with muster points, and evacuation emergencies.
- All employees entering the facility should be trained on the types of alarms and muster/evacuation routes
- It is recommended that alarms are tested weekly to ensure alarm operability and to raise awareness of employee understanding of alarm types.

Ensure personnel are trained and there is a system in place to carry out and document head count following a local muster or evacuation.

- Implement an accountability system to track personnel inside the facility.

Ensure an emergency response critique is carried out, documented, and that actions are followed up after each actual emergency response or drill.

3.3.13 ***Compliance Audits***

Compliance Audits are an element of OSHA's Process Safety Management (PSM) Standard and are a good industry practice for managing process safety. The audit element is intended to evaluate whether management systems are performing as intended.

Risktec did not review or conduct any compliance audits during their assessment. Facility personnel interviews indicated that an annual self-assessment if performed for safety programs.

3.4 Preparedness and Prevention (SPCC/FRP)

The Preparedness and Prevention review compliments the PSM Emergency Planning and Response element in Section 3.3.11 above. The JBPHH DFSP relies on several emergency preparedness and response plans to ensure effective actions are taken for any emergency. These plans meet US Coast Guard and US EPA requirements, are thorough and detailed and are listed below:

- Commander Navy Region Hawaii (CNRH) Integrated Contingency Plan (ICP)
- Spill Prevention, Control, and Countermeasure (SPCC) Plan for Commander Navy Region Hawaii (CNRH)
- Red Hill Fuel Storage Facility (RHFSF) Response Plan

Each plan has been reviewed and verified in the field. Personnel interviews were also held to validate roles and responsibilities.

The U.S. Environmental Protection Agency SPCC Field Inspection and Plan Review Checklist for Onshore Facilities has been completed and is attached as Appendix F.

3.4.1.1 *Observations*

See Observations in Section 3.3.11 above.

3.4.1.2 *Opportunities for Improvement*

Like many large complex facilities, understanding roles and performing duties in an emergency situation is critical to minimizing the impact of the emergency, mitigating the consequences and expediting the recovery and return to normal operations. Drills and exercises ensure all organizations and personnel are prepared and understand their assignments.

- Conduct drills and exercises, both table-top and field, periodically to ensure all personnel are prepared and equipped to perform in an emergency.

4 RECOMMENDATIONS

The PHA team issued a separate report for the HAZOP process and 120 recommendations. The recommendations are included here for completeness:

- Safely Defueling Red Hill (Table 2, section 4.1.1)
- Ongoing Operations at Red Hill (Table 3, section 4.1.2)
- Ongoing Operations (Not Including Red Hill) at Pearl Harbor DFSP (Table 4, section 4.1.3)

Recommendations for Operational Readiness are shown in Section 4.2.

A proposed high level implementation plan is included in Section 5.

For some recommendations contained within the tables below, risk ranking is not provided (i.e., the cells are "white"). The PHA Team determined that available information was insufficient to permit an informed evaluation of the risk. Additionally, recommendations 103 through 120 were not risk ranked as part of the supplemental Human Factors and Facility Siting checklists. However, the PHA team and Risktec personnel completed these checklists and associated recommendations to accompany the PHA.

4.1 HAZOP Recommendations

4.1.1 *To Safely Defuel Red Hill (To Be Implemented prior to Defueling)*

Table 2: PHA Recommendations to be Addressed Prior to Defueling

Recommendations to be Addressed Prior to Defueling	Risk Ranking
1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	1
6. Install additional PITs in piping in Red Hill Tank Gallery (at a minimum, on each side of sectional valves) and Harbor Tunnel to better detect potential vacuum conditions and/or loss of product. Ensure new and existing PITs are in scheduled PM program for improved reliability of critical instrumentation. (High Priority)	1
25. Include verification step in Operations Order that piping is restrained before starting any evolution involving transferring liquid from any tank in Red Hill Tank Gallery. (High Priority)	1
27. If possible, add a equalization line across the outboard main tank valve prior to defueling to reduce the likelihood of sudden opening of large valve and resultant surge. Add equalization lines across both main fuel valves after defueling prior to reuse. Consider tank to tank sluicing when sizing equalization line. (High Priority)	1
28. Ensure Oil Tight Door 1) will remain functional during loss of power and 2) is part of a PM program to improve reliability of closure on demand. (High Priority)	1
31. Evaluate underlying cause(s) of line sag creating vacuum and modify as warranted. (High Priority)	1

Recommendations to be Addressed Prior to Defueling	Risk Ranking
32. Evaluate the need for Dresser Couplings in the [redacted] and [redacted] main distribution piping in Red Hill Tank Gallery between TK 114 JP-5 Tank (Red Hill) and TK 116 F-76 Tank (Red Hill), shown on Drawing [redacted] If they can be removed safely, remove the Dresser Couplings. JP-5 Emergent Pipeline Repairs were underway at the time of the PHA and will include eliminating old Dresser Coupling on [redacted] JP-5 piping. This recommendation should be completed prior to returning JP-5 piping to service. (High Priority)	1
8. Consult manufacturer on reverse pressure capability (vacuum) of Dresser Couplings installed around pumps installed in UGPH and Red Hill Tank Gallery. Consider modifying design if manufacturer has alternate sealing system and Dresser Couplings remain part of design. (High Priority)	2
9. Consider adding observer and/or remote camera observation at Dresser Couplings during initial pressurization prior to defueling. (High Priority)	2
38. Develop a car-seal or lock administrative control system and identify safety-critical manual valves which should be controlled to reduce the likelihood of human error. Valves to consider include but are not limited to 24" butterfly tank vent valves at RHL, manual block valves on the inlet or discharge of relief devices, manual block valves on bleed of body cavity of twin-seal DBB device, key firewater supply and distribution valves. (High Priority)	3
14. Evaluate the current ratings of all piping and hoses between RHL and piers and docks to identify areas of concern due to deadhead pumps and static pressure when transferring or defueling RHL. (High Priority)	
99. The Navy policy is to use the Incident Command System (ICS)/Unified Command (UC) for structuring Navy spill response management organizations. The NAVSUP FLCPH fuel personnel manages the initial response. If additional resources are needed, the Federal Fire Department Incident Commander will establish an emergency command post and assume responsibility for the response. The Emergency Spill Coordinator or the Commanding Officer can contact the Region Navy On-Scene Coordinator to activate the Region Spill Management Team (SMT). The Region SMT will then establish other ICS functions. Port Operations is the coordinator for the Facility Response Team (FRT), an on-water contractor resource based on Ford Island. The roles, staffing and resources for each organization needs to be clearly defined, drilled and aligned prior to defueling operations. (High Priority)	
107. Consider additional operators and technical support for defueling operations. (High Priority)	

4.1.2 *If Red Hill Operations Resume*

Table 3: Recommendations for Ongoing Operations at Red Hill

Recommendations for Ongoing Operations at Red Hill	Risk Ranking
5. Consider equipping UGPH, (b)(6) [redacted] Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers (b)(6) [redacted] with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	1
15. Install ESD functionality to both suction and discharge MOVs to (b)(3)(A) [redacted] to close when pump status is not running, to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	1
16. Evaluate alternate design to eliminate use of Dresser Couplings throughout PRL and RHL. (High Priority)	1
17. Equip UGPH Sump, all five AFFF Sumps, and all other sumps currently without level indication, with level alarm high and pump run status instrumentation and ensure instrumentation is in a scheduled PM system using certified and calibrated test equipment. Consider modeling automated action of high level alarm to be similar to Red Hill Main Sump. (High Priority)	1
18. Evaluate the need for emergency electrical supply to ESD MOVs and OCVs (if not fail-safe) at PRL to reduce the likelihood of significant release of flammable liquid on loss of containment at Dresser Coupling(s) adjacent to pump. (High Priority)	1
19. Ensure OCVs on the discharge of each (b)(3)(A) (b)(3)(A) (b)(3)(A) [redacted] are pressure or leak tested per schedule and records retained for auditing. (Medium Priority)	1
24. Modify CIR contracts to include restraining pipe between blanked sections when taking tank out of service for maintenance or inspection. (High Priority)	1
26. Consider utilization of Product Interface Detector to supplement detection of the presence of vacuum/lack of fluid in pipeline. (Medium Priority)	1
29. Consider installing a filtration system on the S-315 air intake to the ventilation system to reduce dust accumulation in Upper and Lower Tunnels that may reduce reliability of safety systems such as Oil Tight Door closure. (Medium Priority)	1
30. Evaluate the location of electrical room which contains transformer, primary disconnects, and MCC switch gear (b)(3)(A) [redacted] and consider relocation to an area external to tunnel system, similar to (b)(3)(A) [redacted] Electrical Room Relocation Project MILCON P-8006. (High Priority)	1
45. Ensure run status indication on all pumps inside all AFFF Sumps (20 pumps) is integrated with the AFHE SCADA to alert Control Room Operator (CRO) to potential release of fuel and/or AFFF. (High Priority)	1
46. Equip all non-fuel sumps (including five AFFF Sumps, Adit 3 Groundwater Sump, Adit 3 Septic Sump, Harbor Tunnel Sump, and Adit 1 Sump) a with fuel or oil detection instrumentation and alert Control Room Operator (CRO) to potential release of fuel. (Medium Priority)	1

Recommendations for Ongoing Operations at Red Hill	Risk Ranking
47. Evaluate the design of the 14" AFFF discharge line piping on the discharge of 20 AFFF Sumps pumps as part of the current project to upgrade PVC to CS. The PHA Team is concerned about 1) the volume flow and separately, 2) line slope or configuration to trap liquid in retention line, and 3) lack of damage control isolation in long-run of piping. (High Priority)	1
48. Evaluate the maintainability of the AFFF System to ensure adequacy for reliability needed. (High Priority)	1
49. Train all affected personnel on the design, intent, and operation of the AFFF System, including refresher training. (High Priority)	1
50. Consider equipping AFFF Retention Tank with reliable level indication and level alarm to alert Control Room Operator (CRO) to presence of level in AFFF Retention Tank. (Medium Priority)	1
51. Consider designing a system to separate oil and water to reduce the likelihood of discharging flammable liquid to environment from Adit 3 Groundwater Sump. (Medium Priority)	1
53. Evaluate an emergency breathing air supply for Harbor Tunnel due to its long length, limited egress, and reduced ventilation. (Medium Priority)	1
66. Design and install interlock and permissive systems for all fuel movements to/from RHL and UGPH, to reduce the likelihood of human error of sequencing valves during lineup. Design should consider use of the manual clutch to bypass MOV operation. (HighPriority). Some action is already underway as the result of AB&A Root Cause Analysis into the May 6, 2021 Mishap.	1
7. Perform a Pipe Collapse Pressure Study to determine the pressure required to collapse the existing pipe and identify and install safeguard(s) as warranted. Consider integrating this recommendation with upcoming API 570 Assessment. (High Priority)	2
76. Develop full documentation package with P&IDs for the fire suppression system for RHL. (High Priority)	2
77. Ensure firewater and AFFF main and jockey pumps are on a PM schedule and automatic transfer switch to emergency diesel-driven generators are tested periodically at load to meet requirements of NFPA. (Medium Priority)	2
79. Evaluate the available inventory of AFFF on site and determine if additional quantities are desired. NFPA 30 Chapter 16 requires 15 minutes of foam concentrate inventory based on design flow rate. (Low Priority)	2
80. Evaluate combining the SCADA systems for AFHE and fire suppression for ease of CRO monitoring or consider a Smart Grid system solution. (Low Priority)	2
82. Identify an alternative to AFFF that does not contain PFAS or PFOA to eliminate exposure potential to humans or environment. (High Priority)	2
11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	3

Recommendations for Ongoing Operations at Red Hill	Risk Ranking
22. Ensure new replacement pumps for [redacted] (b)(3)(A) are equipped with 1) appropriate seal materials for the resulting temperatures of periods of lower than normal flow operation and 2) minimum flow recirculation protection to reduce the likelihood of increased temperature during periods of lower than normal flow operation. (High Priority)	3
33. Evaluate lighting at the discharge location of the 24" horizontal vent pipe to increase the likelihood of detection by camera in area, and improve lighting if warranted. (Medium Priority)	3
34. Consider equipping 24" horizontal vent pipe discharge with fuel or oil detection and alarm instrumentation to detect the presence of liquid fuel. (Medium Priority)	3
36. Consider implementing four-gas personnel monitor PPE requirement for personnel working in any tunnels. (Medium Priority)	3
37. Evaluate use of panic button and man-down feature of intersite radio system. (Medium Priority)	3
39. Evaluate the reliability of the heat activated water deluge in Upper Access Tunnel in Red Hill Tank Gallery in conjunction with the evaluation of AFFF in Lower Access Tunnel (LAT). Develop recommendations for improved reliability. (High Priority)	3
40. Improve the reliability of draining condensed/accumulated liquid in Red Hill Tank Gallery manifolded vent piping. Options to consider include 1) manually checking and draining low point per scheduled interval, and 2) adding a level detection and alarm instrumentation to alert operations to abnormal accumulation of hydrocarbon and/or water. Include all instrumentation in PM program with calibrated testing equipment. (Medium Priority)	3
42. Consider adding cameras to the following locations: 1) AFFF Retention Tank area to increase the likelihood of observing an overfill at AFFF Retention Tank, 2) between upper portion of Harbor Tunnel and lower portion of Harbor Tunnel to increase the likelihood of observing an overfill of Harbor Tunnel, and 3) near Adit 3 to increase the likelihood of observing an overfill at TK 311 Slop Tank. (Medium Priority)	3
43. Install a second and independent high level indication and alarm on TK 311 Slop Tank to reduce the likelihood of overfilling TK 311 unknowingly. (Medium Priority)	3
44. Review current practices and operability of TK 311 Slop Tank with groundwater treatment equipment and personnel adjacent to TK 311 to evaluate the interaction of the two operations and modify practices if warranted. (Low Priority)	3
65. Develop a SOP for dewatering Tank 47/48/54 F-76 Tank (Upper Tank Farm), Tank 46/53 F-24 Tank (Upper Tank Farm) and Tank 55 JP-5 Tank (Upper Tank Farm) to increase the likelihood of complete dewatering not partial dewatering. (High Priority)	3
67. Investigate anchor chair requirements for all tanks in the UTF and FORFAC, and Tank 311 at RHL. (Medium Priority) This recommendation may be similar to a recommendation from SGH.	3
93. Consider incorporating visual strobe light with the alarm system to further increase awareness of fire suppression activation. (Medium Priority)	3

Recommendations for Ongoing Operations at Red Hill	Risk Ranking
35. Evaluate the vent piping between "P traps" in grouped tanks to determine if low point piping could accumulate trapped liquid over time due to condensing and/or undetected overfill; and if credible identify method to remove accumulated liquid if warranted. (Medium Priority)	4
57. Consider installing small platform in lieu of portable ladders for safer access to HPB for each of the three products OR relocate HPB to ground level. Hard pipe the discharge of the HPB to Main Sump. Ensure the end of the discharge piping is visible to person(s) performing task. (Low Priority)	4
61. Consider using nitrogen to relieve vacuum inside piping instead of air to reduce the likelihood of producing a flammable mixture. (Medium Priority)	4
63. Ensure Operations Order for line pack include specific step to close high point bleed valve (HPB) before completely opening ball valve. (Low Priority)	4
89. Develop unique work orders for vessel to vessel fuel transfers. (High Priority)	5
23. Perform a hydraulic surge analysis. Consider integrating this recommendation with upcoming API 570 Assessment. (High Priority)	
54. If defueling to PAR is pursued, coordination with PAR to develop an Operations Plan which reviews safeguards at PAR for 1) maximum pressure of ~130 psig, 2) maximum flowrate, 3) overfill protection, and 4) transient surge when isolated at PAR is required. (High Priority)	
81. Understand the multiple roles of nitrogen in the AFFF fire suppression system and evaluate safeguards and add additional safeguards if warranted. Consider the impact of nitrogen leak and potential asphyxiation. (High Priority)	
84. Collaborate with vendor of AFFF system to determine all purposes of nitrogen system, capability of nitrogen system (pressure), and safeguards in the current design. Identify and install additional safeguards if warranted. (High Priority)	
85. Ensure the AFFF 175 psig components (if there are any) are adequately designed and documented for maximum pressure of ~220 psig fire water. If they are not, add additional safeguards as warranted. (High Priority)	
86. Ensure re-design of fire suppression system addresses deadlegs which prevent complete transfer of foam/water mixture after activation of fire suppression system and allow potential future fuel and foam releases upon loss of containment. (High Priority)	
87. Implement a Mechanical Integrity Inspection Program for all identified dead-legs in fuel handling and fire suppression systems. (Medium Priority)	
88. Equip AFFF sump pumps with remote start from the fire suppression SCADA system to allow for operation in case AFFF pumps cannot be operated locally due to lack of access (OPD or fire rated door closed). (High Priority)	
105. Ensure the closing of the oil tight doors displays on the control room display. (High Priority)	
115. Consider reinforcing the window/wall facing the UGPH. (High Priority)	

4.1.3 *To Safely Continue Ongoing Operations at Pearl Harbor DFSP*

Table 4: Recommendations for Ongoing Operations (Not Including Red Hill) at Pearl Harbor DFSP

Recommendations for Ongoing Operations at Pearl Harbor DFSP	Risk Ranking
1. To increase the reliability of operator response to normal, return to service, and emergency operations, develop written procedures detailing operator actions including which steps should be field verified by two individuals, in order to reduce the likelihood of loss of containment. Training and refresher training should address both what and why. Ensure operating procedures, training materials, and training records are part of document control system. (High Priority) This recommendation aligns with 2018 Phase 1 QRVA of the Administrative Order of Consent (Recommendations 7, 8, 9, and 11).	1
2. Ensure the PITs located [redacted] (b)(3)(A) are in a scheduled PM system using certified and calibrated test equipment. The calibration should meet the requirements of OPNAV Instruction 3960.16B. (High Priority)	1
3. Consider installing local ESD on refueling piers and docks at PRL Ensure ESD actions are consistent with Coast Guard requirements and do not create additional hazards. (Medium Priority)	1
4. If additional safeguards are warranted, design and install automation to safely shutdown refueling piers and docks at PRL in event of emergency or loss of containment, including isolation of sectional valves to minimize quantity of loss of containment. (High Priority)	1
5. Consider equipping UGPH, [redacted] (b)(6) Pumphouse, Lower Yard Tunnel (LYT), Harbor Tunnel, Surge Tank Tunnel, Upper Access Tunnel, Lower Access Tunnel, and enclosed valve stations/chambers [redacted] (b)(6) with LEL or fuel or oil detection and alarm instrumentation and evaluate automated ESD and/or initiation of Aqueous Film Forming Foam (AFFF) Fire Suppression System. (Medium Priority)	1
10. Ensure the PSLs, PSHs, PITs, VSs, TTs, CTs and FSs on [redacted] (b)(3)(A) are in a scheduled PM system using certified and calibrated test equipment. (High Priority)	1
21. Consider equipping all french drains at PRL and RHL with check valve/non-return valve to reduce the likelihood of backflow of flammable liquid as a result of loss of containment. (Medium Priority)	1
41. Add testing for sulfur compounds (or other credible toxic compounds) as part of pre-offloading analysis for fuel receipts at PRL. (Medium Priority)	1
52. Provide means to remove contamination from water supply. (High Priority)	1
74. Remove electrical connections and sockets from the inside of FORFAC containment area to reduce the likelihood of electrocution during periods of heavy rain or spill in secondary containment. If not feasible, install protective safeguards to reduce the risk of electrocution. (High Priority)	1

Recommendations for Ongoing Operations at Pearl Harbor DFSP	Risk Ranking
75. As an interim recommendation, 1) replace sockets with GFCI sockets inside the FORFAC secondary containment, 2) develop an SOP to engage NAVFAC prior to predicted heavy rainfall and include emergency phone numbers for power company contact, 3) provide access to breaker box near Tank 1301 Reclaim (B1) Tank, and 4) install signage that specifies "do not enter during periods of heavy rain or standing water" and includes a phone number contact to de-energize the area. (High Priority)	1
13. Change the test pressure used for testing all hoses from 150 psig to 330 psig to comply with 33 CFR Part 154 Coast Guard and worst credible case scenario deadhead pressure of 219 psig. Due to the significant change in test pressure, the test procedure and equipment must be reviewed and revised as warranted for adequacy prior to use. If hoses with a allowable operating pressure of 330 psig are not commercially available, the deadhead pressure must be limited on sources above 300 psig. (High Priority)	2
20. Repair and seal containment around Tank 1301 Reclaim (B1) Tank and Tank 1302 Reclaim (B2) Tank to reduce the likelihood of soil contamination resulting from an overfill in Tank 1301/1302. (Medium Priority)	2
78. Establish a stand-alone maintenance contract apart from other base facilities with documented maintenance standards. (High Priority)	2
83. Consider a SOP for all individuals in tunnels to have a 15 minute escape air bottle system for emergency egress during activation of fire suppression system, which shuts down ventilation. (Medium Priority)	2
11. Evaluate the duration of the time delay on all tanks equipped with overfill protection and reduce where appropriate to reduce the quantity of liquid that may be released on overfill. (High Priority)	3
64. Consider testing for fluorides and chlorides in all liquids either before defueling if possible or after receipt and consider alternatives to receiving defuels from Navy vessels if data warrants. (Medium Priority)	3
67. Investigate anchor chair requirements for all tanks in the UTF and FORFAC, and Tank 311 at RHL. (Medium Priority) This recommendation may be similar to a recommendation from SGH.	3
69. Install PITs on the suction and discharge of (b)(3)(A) Pump to allow CRO to monitor (b)(3)(A) performance. (Medium Priority)	3
71. Consider installing a second dissimilar check valve adjacent to 6" check valve on the discharge of (b)(3)(A) Pump to reduce the likelihood and quantity of reverse flow. (Low Priority)	3
72. Use the existing level switch to activate a new, local audible and visual alarm with LSH-1328. (Medium Priority)	3
92. Consider treating the engine compartment as a confined space which would include controlled access, deactivation of fire suppression system while inside, and reactivation of system when entry is complete. (High Priority)	3
58. Perform Job Safety Analysis (JSA) on high-risk tasks to address human factors and PPE requirements. (Medium Priority)	4
59. Ensure seals and enclosures necessary to maintain electrical area classification Class 1 Div I are included in PM program. (Medium Priority)	4

Recommendations for Ongoing Operations at Pearl Harbor DFSP	Risk Ranking
60. Ensure transformers, switch gear, automatic transfer switch (ATS), and other equipment in Switch Gear Room meets requirements of Class 1 Div I. (High Priority)	4
68. Install a differential pressure transmitter/switch and alarm across Duplex strainer on the suction of (b)(3)(A) Pump to decrease the likelihood of cavitation of (b)(3)(A) (Medium Priority)	4
70. Include all PRL cameras in scheduled PM program. (Medium Priority)	4
73. Install a pressure relief device on the discharge of (b)(3)(A) Pump, sized and documented for blocked outlet and discharges to a safe location. (Medium Priority)	4
56. Implement a document control system to generate unique, trackable operations orders and log revisions.	5
90. Ensure scupper plugs in secondary containment coamings are verified in place prior to transfer as part of work order for both vessel to vessel and barge/YON to shore transfers. (High Priority)	5
91. Develop a procedure for verifying the presence of water in all cargo tanks, and if water is present, a procedure for removing water contaminated fuel with vacuum truck. (High Priority)	5
12. Due to variability of ships that can come to PRL to unload, the Pre-Plan Meeting must include gathering information about the deadhead pressure (not safeguarded pressure) of the offloading pumps to ensure marine transfer hose is adequate for 1.5 x ship pump deadhead pressure. (High Priority)	
55. Determine the maximum pressure that can be provided by PAR if the pressure control valve malfunctions open and ensure piping at PRL and RHL is adequate for resultant pressure, and if not implement safeguards to reduce the likelihood of overpressuring PRL and RHL piping. (High Priority)	
62. Ensure Area Classification boundaries are clearly denoted in written PSI and understood by impacted personnel. (High Priority)	
94. Develop a procedure that outlines the specific manpower requirements for multiple, simultaneous operations as the number of operations increased and that requires written approval for SIMOPS by appropriate level of management. (High Priority)	
95. Consider adding additional AFHE workstations and larger monitors to accomplish need for visibility of more quadrants simultaneously. (Medium Priority)	
96. Evaluate the size and location of current backup control room to better accommodate additional CROs and reduce access and distractions. (High Priority)	
97. Provide government smart phones to all Rovers for improved communications due to current radio reliability and that some communications are lengthy and better suited for cell phone instead of radio. (High Priority)	
98. Create a fatigue policy for all Fuels Distributions System workers, operators, and maintainers that limits hours worked in a day and days worked consecutively. (High Priority)	

Recommendations for Ongoing Operations at Pearl Harbor DFSP	Risk Ranking
100. Review current sampling schedule and identify opportunities for optimization and eliminating non-required sampling and analysis. (Medium Priority)	
101. Improve communications between fuel laboratory and CROs after analysis is complete for increased efficiency during multiple simultaneous operations. (Medium Priority)	
102. Ensure safeguards are adequate for [redacted] (b)(3)(A) [redacted] cavitation or deadheading due to closed valve during loading process. If not, add additional safeguards as warranted. (Medium Priority)	
103. Consider requirement for flame retardant clothing while working in hydrocarbon environment. (High Priority)	
104. Consider installing emergency PPE throughout the facility. (High Priority)	
106. Consider inventorying spare parts/replacements for critical instrumentation to reduce the wait time for repairs. (Medium Priority)	
108. Implement Management of Change Program. (High Priority)	
109. Develop Incident Investigation Program that includes Incident Investigation techniques and near miss reporting and investigation, and sharing of lessons. (High Priority)	
110. Implement a tunnel sign-in/sign-out process to be able to account for all personnel within the tunnel at any time. (Medium Priority)	
111. Require guides and all groups to have at least one form of emergency communication – likely a radio. (Medium Priority)	
112. Post signs periodically indicating the distance to the nearest emergency phone and instructions to dial "99" then "911". (Medium Priority)	
113. Locating and tracking people is crucial for underground working conditions. Traditional technologies such as GPS and WiFi tracking do not work underground. Consider implementation of a system designed to locate and track personnel while in the tunnel. (Low Priority)	
114. Consider requiring SCBA, emergency air packs, installing SCBA station(s) or breathing airline throughout tunnel. (Medium Priority)	
116. Consider providing appropriate PPE, for example bunker gear, and safeguards to allow CROs ample time to escape the area during an emergency. (High Priority)	
117. Consider relocation of the control room from the UGPH to the back control room located in the Fuels Distribution Building. (Low Priority)	
118. Review the need for emergency stations (safety shower and eye wash) and first aid stations throughout the facility in proximity to fuel piping. (Low Priority)	
119. Due to the geographical vastness of this facility, review the need for installing alarms on safety showers and eyewash stations. (Low Priority)	
120. Implement a formal safe work system, which includes coordination and control of all "intervention" work on the process and references all Life Critical standards, such as hot work, confined space, lock-out/tag-out, etc. (High Priority)	

4.2 To Improve Operational Readiness

Table 5 below contains the 23 recommendations that were generated specifically from the completion of the OSHA PSM Field Checklist and the EPA SPCC Field Checklist. The four recommendations below that are denoted with an "asterisk" are also made in the HAZOP recommendations.

Table 5: Operational Readiness Recommendations

Operational Readiness Recommendations
Develop a Process Safety Information (PSI) policy which identifies the necessary PSI, how it will be maintained and where it will be stored and who will be responsible.
Consider repeating/revalidating the Process Hazard Analysis (PHA) every 5 years to assess the hazards introduced by implementing changes to the process. The next PHA would be due in 2027.
Develop a policy and schedule for PHA completion that includes techniques and methods to be used, personnel to include and information to be reviewed. Include a requirement for all major projects to include a PHA as part of the project design.
Operating orders (procedures) should be established in writing for each work activity and all operational phases. A new procedure template with all industry best practice sections (like health and safety, consequence of deviation, etc.) included should be developed. NOTE: During the HAZOP, a procedure template was provided to POND personnel.*
Ensure a section of the new procedure template discusses PPE required, the hazards of the fuels and what to do if you come in contact with the fuels.
All operating orders/procedures should be version controlled within a document control system where changes/revisions to the documents are managed and to allow for yearly document review.*
Develop a formal written procedure implementing a Lock-out/Tag-out (LOTO) process including training on the LOTO work permit.
All areas should be evaluated as to whether or not they are confined spaces and signage should be provided. Develop a formal written procedure implementing a confined space permitting system and training for all employees.
Develop a formal written procedure implementing a line opening process that address hazards and controls that must be in place.
Implement an access control process that includes electronic badging into and out of the facility. This system should report real-time accounting for all personnel in the facility. In lieu of an electronic system, implement a sign-in/sign-out process which is controlled by the Control Room Operator (CRO).
Emergency response sections on the current operating orders address spills and leaks. They do not have any operation orders or emergency actions that address loss of electricity, building ventilation, fire or explosion.
Implement a formal written program establishing operator initial and refresher training requirements. Job shadowing can be one aspect of this training program but should not constitute the primary training method. Consider operator pre-qualification requirements prior to employment. Establish a training department/coordinator to be responsible for all training activities and consider using a process simulator for CRO initial and refresher training.
Develop a formal written procedure implementing a Pre-Start-up Safety Review (PSSR) program.
Develop a formal written procedure implementing a Management of Change (MOC) process. The process should be paper based initially with the goal to move to an electronic system once the program is fully implemented and understood.*

Operational Readiness Recommendations
As part of the MOC and PSSR procedures, require operator training before any process change is made.
Develop and implement detailed Mechanical Integrity procedures for all equipment subject to test and inspection requirements.*
Develop structured written procedures for training personnel involved in maintaining the ongoing integrity of process equipment.
Develop and implement a hot work program that is owned by the Operations / Fuels group. This program should meet the criteria of OSHA PSM. It should ensure that Operators know what hot work is being performed in their area, and that operators are trained to write hot work permits. In addition, develop and implement a Safe Work program that includes procedures and controls for confined space entry, energy isolation, elevated work, and other Life Critical procedures.
Develop and implement a written process for incident investigation including reporting requirements, data tracking, training, and thorough incident investigation tools, etc. The level of incident investigation may be fit for purpose for the incident severity. Incident investigations should be completed in a timely manner and communicated across the affected organizations to share learnings.
Obtain training for specific employees on the use of incident investigative tools (like TapRoot, Apollo, etc.).
Ensure personnel are trained and there is a system in place to carry out and document head count following a local muster or evacuation.
Typically, facilities have alarms for local emergencies (leave the work area and muster at a safe distance) and evacuation alarms (evacuate the facility). It is recommended to distinguish between local emergencies with muster points, and evacuation emergencies. All employees entering the facility should be trained on the types of alarms and muster/evacuation routes via an initial orientation. It is recommended that alarms are tested weekly to ensure alarm operability and to raise awareness of employee understanding of alarm types.
Ensure an emergency response critique is carried out, documented, and that actions are followed up after each actual emergency response or drill.

5 PROPOSED IMPLEMENTATION PLAN

It is not expected that all recommendations made as a result of this assessment be implemented. Priority should be established by Navy leadership taking into consideration, among other things, the following:

- the assigned risk ranking associated with the recommendation (i.e., 1 – 5, red to green, critical to negligible)
- anticipated schedule for defueling Red Hill
- expected future use of the facility (will fuel storage at Red Hill resume)
- technical feasibility of the recommendation
- financial impact of the recommendation
- other efforts underway or planned to address the risk.

Typically, a workshop would be held to engage all stakeholders in the review and selection of recommendations to be actioned. At this workshop, engineering solutions would not be discussed, but appropriate responsibility and schedule would be determined.

Risktec has attempted in this section to develop a preliminary implementation plan (Table 6) for those recommendations considered critical. This implementation plan does not consider other efforts that may be underway or planned but can be used as a go-by for the stakeholder workshop.

Table 6: Proposed Implementation Plan

Timing	Recommendation
Immediate	Review third-party assessment
	Hold stakeholder meeting to review defueling recommendations and assign accountability for those to be actioned
	Develop POAM for Red Hill defueling considering recommendations selected from Table 2 in Section 4.1.1. and Table 5 in Section 4.2.
0-12 months	Implement POAM to defuel Red Hill tanks (including administrative and engineering changes)
	Revise facility risk matrix
	Train all employees on risk awareness
	Develop/revise operating orders for defueling activities
	Develop/update "life-critical" safety standards (selected for defueling operations) and other selected programs: • hot work and safe work permitting • lock-out/tag-out (energy isolation) • opening process piping and equipment • personal protective equipment • plant access and security • management of change • pre-start-up safety reviews • emergency response • incident investigation
	Implement selected life-critical safety standards and other selected programs prior to defueling

Timing	Recommendation
	Train all affected employees on life-critical safety standards, defueling operating orders and other selected programs
1-2 years	Safely defuel Red Hill tanks
	Provide oversight, coaching and mentoring for defueling activities as required
	Hold stakeholder meeting to review all other recommendations and assign accountability for those to be actioned
2-4 years	Implement selected recommendations for operational improvements to Pearl Harbor DFSP (including administrative and engineering changes)
	Develop/update EHS standards, for example: • safe work authorization/permitting • confined space entry • process safety information • process hazard analyses • corrective action tracking • etc.
	Implement EHS standards, new and existing
	Train all affected employees on EHS standards
Every 5 years	Conduct Process Hazard Analysis to review cumulative effect of all changes on process integrity
On-going and periodically as required	Audit process safety management system to identify continuous improvements
	Leverage operational success at PRL DFSP enterprise-wide

6 REFERENCES

Ref	Title
1.	40 CFR 68, *Chemical Accident Prevention Provisions (Risk Management Plan Rule)*, promulgated in 1994.
2.	29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals,* promulgated in 1992.
3.	Center for Chemical Process Safety, *Guidelines for Auditing Process Safety Management Systems, Second Edition.*
4.	American Institute of Chemical Engineers, *Guidelines for Risk Based Process Safety*, John Wiley and Sons Inc., Hoboken, New Jersey, 2007.
5.	International Association of Oil and Gas Producers (2018), *IOGP Life Saving Rules.* IOGP, London, United Kingdom.
6.	OPNAV M-5100.23 (2020), *Navy Safety and Occupational Health Manual*.
7.	ONAVINST 5102.1D (2005), *Navy & Marine Corps Mishap and Safety Investigation, Reporting, and Record Keeping Manual*.
8.	*Operation, Maintenance, Environmental, And Safety Plan* (OMES), Defense Fuel Support Point, Pearl Harbor Bulk Terminal, Pearl Harbor, Hawaii, August, 2018
9.	*Commander, Navy Region Hawaii (CNRH) Fleet Logistics Center Pearl Harbor (FLCPH) Spill Prevention, Control, and Countermeasure Plan* (SPCC), 2019
10.	*Commander, Navy Region Hawaii (CNRH) Red Hill Fuel Storage Facility (RHFSF) Response Plan,* August 2020
11.	*Red Hill Fuel Facility Pipeline Failure Full System Integrity Report*, September, 2021

APPENDIX A ACRONYMS AND ABBREVIATIONS

AFCEC	Air Force Civil Engineer Center
AFFF	Aqueous-film forming foam
AFHE	Automated Fuel Handling Equipment
AGA	American Gas Association
ANSI	American National Standards Institute
AOE	Auxiliary, Oiler, Explosives
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
AST	Aboveground storage tank
ASTM	American Society for Testing and Materials (formerly)
ATG	Automatic tank gauge
BMP	Best Management Practice
BOWTS	Bilge Oily Wastewater Treatment System
BS&W	Basic Sediment and Water
CCTV	Closed circuit television
CFR	Code of Federal Regulations
CNIC	Commander, Naval Installations Command
CNRH	Commander Navy Region Hawaii
COMNAVBASEPEARLINST	Commander Naval Base Pearl Harbor Instruction
COMNAVREG	Commander, Navy Region
COMPACFLT	Commander, Pacific Fleet
CMP	Centrally Managed Program
COR	Contracting Officer Representative
COTP	Captain of the Port
CPR	Cardiopulmonary resuscitation
DD	Department of Defense (form)
DESC	Defense Energy Support Center (now DLA Energy)
DFSP	Defense Fuel Support Point
DLA	Defense Logistics Agency
DLAD	DLA Directive
DLAI	DLA Instruction
DLAR	DLA Regulation
DoD	Department of Defense

DOT	Department of Transportation
DRP	Disaster Response Plan
DS-FE	DLA Installation Support for Energy
DS-FEE	DLA Installation Support for Energy – Environmental Division
DWCF	Defense Working Capital Fund
EEBD	Emergency escape breathing device
EMA	Emergency Management Agency
EPA	Environmental Protection Agency
ESAMS	Enterprise Safety Applications Management System
e-stop	Emergency stop (button)
ETGI	Electronic Telemetered Gauging Instrument
EXWC	Engineering and Expeditionary Warfare Center
FAME	Fatty acid methyl ester
FAMMS	Fuels Asset Management Maintenance System
FDSO	Fuel Distribution System Operator
FDSW	Fuel Distribution System Worker
F&ES	Fire and Emergency Services
FISC	Fleet Industrial Supply Center
FLC	Fleet Logistics Center
FLCPH	Fleet Logistics Center Pearl Harbor
FOD	Foreign object debris
FOILS	Fuel Operations Isolation Lock System
FOR	Fuel Oil Reclaimed
FORFAC	Fuel Oil Reclaimed Facility
FSII	Fuel system icing inhibitor
GOGO	Government-owned government-operated
HAZCOM	Hazard communication
HDPE	High density polyethylene
HFRR	High Frequency Reciprocating Rig
IAW	In accordance with
ICRMP	Integrated Cultural Resources Management Plan
ICP	Integrated Contingency Plan
IDLH	Immediately Dangerous to Life and Health
IWDC	Industrial Wastewater Discharge Certificate

ISGOTT	International Safety Guide for Oil Tankers and Terminals
JBPHH	Joint Base Pearl Harbor Hickam
JHA	Job hazard analysis
LED	Light-emitting diode
MAOP	Maximum Allowable Operating Pressure
MARPOL	International Convention for the Prevention of Pollution from Ships
MAWP	Maximum Allowable Working Pressure
MILCON	Military Construction
MIL-STD	Military Standard
MOA	Memorandum of Agreement
MOP	Maximum Operating Pressure
MOV	Motor operated valve
MTR	Marine transportation-related
N/A	Not applicable
NATOPS	Naval Air Training and Operating Procedures Standardization
NAVFAC	Naval Facilities Engineering Command
NAVFACHI	Naval Facilities Engineering Command Hawaii
NAVSUP	Naval Supply Systems Command
NEPA	National Environmental Policy Act
NFIRS	National Fire Incident Reporting System
NFPA	National Fire Protection Association
NOAA	National Oceanic and Atmospheric Administration
NOP	Normal Operating Pressure
NPDES	National Pollutant Discharge Elimination System
NPMS	National Pipeline Mapping System
NRC	National Response Center
NSN	National Stock Number
NWGLDE	National Work Group on Leak Detection Evaluations
NWS	National Weather Service
OCIMF	Oil Companies International Marine Forum
OJT	On-the-job training
OMES	Operations, Maintenance, Environmental, and Safety (Plan)
OMSI	Operation and Maintenance System Instructions
OOS	Out of service

OPA 90	Oil Pollution Act of 1990
OPNAVINST	Chief of Naval Operations Instruction
OSHA	Occupational Safety and Health Administration
ORM	Other Regulated Material
OWRO	oily water/recovered oil
OWS	Oil/water separator
PHMSA	Pipeline and Hazardous Materials Safety Administration
PIC	Person-in-Charge
PFD	Personal flotation device
PLC	Programmable Logic Controller
PMP	Preventative Maintenance Plan
POL	Petroleum, oil, and lubricants
PPE	Personal protective equipment
PSV	Pressure safety valve
PTO	Power take-off
QA	Quality Assurance
QAR	Quality Assurance Representative
QI	Qualified Individual
RO	Responsible Officer
RP	Recommended Practice
RSTRENG	Remaining strength
RVP	Reid Vapor Pressure
SCADA	Supervisory Control and Data Acquisition
SDS	Safety Data Sheet
SIOATH	Source Identification and Ordering Authorization
SISA	Supply Information Systems Analyst
SITREP	Situation Report
SOP	Standard Operating Procedure
SPCC	Spill, Prevention, Control, and Countermeasures (Plan)
SRM	Sustainment, Restoration, and Modernization
STI	Steel Tank Institute
SWMP	Storm Water Management Plan
TBD	To be determined
TCCOR	Tropical Cyclone Conditions of Readiness] Checklists

UFGS	Unified Facilities Guide Specifications
UFC	Unified Facilities Criteria
UFM	Unscheduled Fuel Movement
UGPH	Underground Pump House
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
UST	Underground storage tank
VC	Valve Chamber
VS	Valve Station
WFM	Water Fuels Maintenance
YON	Yard Oiler Non-self-powered

APPENDIX B DEFINITIONS

HAZOP - A hazard and operability study (HAZOP) is a structured and systematic examination of a complex planned or operation in order to identify and evaluate problems that may represent risks to personnel or equipment. A HAZOP is one form of PHA.

Life Critical Procedures – Rules to provide workers in the oil and gas industry with the actions they can take to protect themselves and their colleagues from fatalities.

PHA - A process hazard analysis (PHA) is a set of organized and systematic assessments of the potential hazards associated with an industrial process. PHAs may include HAZOP, What-If Analysis and other methodologies.

PSM - To help ensure safe and healthful workplaces, OSHA has issued the Process Safety Management of Highly Hazardous Chemicals standard (29 CFR 1910.119), which contains requirements for the management of hazards associated with processes using highly hazardous chemicals.

Risk Based Process Safety – a process safety management framework to help drive operational excellence and reduce major accidents.

SPCC – The purpose of the Spill Prevention, Control, and Countermeasure (SPCC) rule is to help facilities prevent a discharge of oil into navigable waters or adjoining shorelines. This rule is part of the U.S. Environmental Protection Agency's oil spill prevention program and was published under the Clean Water Act.

What-If Analysis - A What-if Analysis consists of structured brainstorming to determine what can go wrong in a given scenario.

APPENDIX C INTERVIEWEE LIST

Name	Title
(b)(6) [redacted]	Occupational Safety and Health Specialist
	Fuel Distribution Systems Worker
	Deputy Director Fuels
	Maintenance Manager
	Environmental Protection Specialist
	Operator
	Operator
	Operations Supervisor
	Regional Fire Chief of the Federal Fire Dept. Navy Region Hawaii
	General Engineer
	Project Mgr.-Mechanical Integrity Pond & Company
	Bulk Operations Supervisor
	Supervisor General Engineer

APPENDIX D PROCESS SAFETY MANAGEMENT TEMPLATES

(b) (4)

[redacted]

(b) (4)

[redacted]

(b) (4)

[redacted]

(b) (4)

[redacted]

(b) (4)

[redacted]

APPENDIX E OSHA PSM FIELD CHECKLIST

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
1	Employee Participation	119(c)(1) 68.83(a) **R**	1.1 Does a written program exist addressing employee participation in PSM/RMP?	The Site is not covered under the OSHA Process Safety Management regulation and therefore, a written employee participation program is not required. However, as a best practice, employee participate in the process safety of the facility should be incorporated in the other programs.	
1	Employee Participation	119(c)(2) 68.83 (b) **R, I**	1.2 Does the written plan address consultation with employees and their representatives on the conduct and development of PHAs?		
1	Employee Participation	119(c)(2) 68.83(b) **R,I**	1.3 Does the written plan include consultation with employees and their representatives on the development and implementation of other elements of the PSM/RMP standard?		
1	Employee Participation	119(c)(3) 68.83(c) **R, I**	1.4 Does the written plan provide for access to PHA and other PSM/RMP information by employees, contractor employees and their representatives?		
1	Employee Participation	GMP R, I	GMP1 Is there a confidential process for informing management of violations of the PSM/RMP program?		
1	Employee Participation	GMP R, I	GMP2 Is there a mechanism to continuously involve employees in the PSM/RMP process?		
1	Employee Participation	GMP I	GMP3 Based on a representative number of interviews, is there sufficient involvement of employees and contractors in the PSM/RMP program(s)?		
2	Process Safety Information (PSI)	119(d) 68.65(a) **R, I**	2.1 Has the owner or operator compiled written PSI before conducting any PHAs required by PSM/RMP, which includes information pertaining to the:	The initial PHA, although not required by regulation, was conducted in February 2022. Recommendations to improve the Process Safety Information were made by the PHA Team.	
2	Process Safety Information (PSI)		a) Hazards of the regulated substances used or produced by the process?	Yes, Safety Data Sheets were available for all products.	
2	Process Safety Information (PSI)		b) Technology of the process?	Only flow diagrams were available.	
2	Process Safety Information (PSI)		c) Equipment in the process?	Major equipment was listed in the flow diagrams, but equipment specific data was difficult to find since the equipment is very old.	
2	Process Safety Information (PSI)	119(d)(1) 68.65(b) Note – MSDS meeting 1910.1200 may be used if they include this information **R, O**	2.2 Based on review of a representative sample of PSI, does the PSI include information pertaining to the hazards of highly hazardous chemicals used or produced by the process, including:		

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
2	Process Safety Information (PSI)		a) Toxicity information?	Yes in the Safety Data Sheet	
2	Process Safety Information (PSI)		b) Permissible Exposure Limits?	Yes in the Safety Data Sheet	
2	Process Safety Information (PSI)		c) Physical Data?	Yes in the Safety Data Sheet	
2	Process Safety Information (PSI)		d) Reactivity Data?	Yes in the Safety Data Sheet	
2	Process Safety Information (PSI)		e) Corrosively Data?	Yes in the Safety Data Sheet	
2	Process Safety Information (PSI)		f) Thermal & Chemical Stability Data?	Yes in the Safety Data Sheet	
2	Process Safety Information (PSI)		g) Hazardous effects of inadvertent mixing of different materials that could foreseeably occur?	No concerns since there are only three fuel products. Mixing will only cause off-spec product which would be used as marine fuel.	
2	Process Safety Information (PSI)	119(d)(2) 68.65(c)(1) R	2.3 Based on review of a representative sample of PSI, does the PSI include information pertaining to the technology of the process, including:		
2	Process Safety Information (PSI)		a) Block Flow Diagrams or simplified PFD	Yes, flow diagram available, however it would be beneficial to have the AFFF system on the same drawing.	
2	Process Safety Information (PSI)		b) Process Chemistry	Yes	
2	Process Safety Information (PSI)		c) Maximum Intended Inventory	Yes,	
2	Process Safety Information (PSI)		d) Safe Upper and Lower Limits for items such as temperatures, pressures, flows, or compositions	No. Pressures, temperatures, limits not available	
2	Process Safety Information (PSI)		e) Evaluation of the Consequences of Deviations?	Yes, developed in the HAZOP Feb 2022	
2	Process Safety Information (PSI)	119(d)(3)(i) 68.65(d)(1) **R**	2.4 Based on review of a representative sample of PSI, does the PSI include information pertaining to the equipment in the process, including:		
2	Process Safety Information (PSI)		a) Materials of construction?	Yes	
2	Process Safety Information (PSI)		b) P&IDs?	No	

Element #	Element Name	Reference[1]	Question	Evidence of Compliance/Findings	Recommendation
2	Process Safety Information (PSI)		c) Electrical classification?	Yes a map is available	
2	Process Safety Information (PSI)		d) relief system design and design basis?	No	
2	Process Safety Information (PSI)		e) ventilation system design?	No	
2	Process Safety Information (PSI)		f) design codes and standards employed?	Design codes for the old equipment is not available. For newer equipment it is available	
2	Process Safety Information (PSI)		g) material and energy balances for processes built after 5/26/92 for PSM, 6/21/99 for RMP?	N/A	
2	Process Safety Information (PSI)		h) safety systems (e.g. interlocks, detection or suppression systems)?	Information is available for the AFFF system	
2	Process Safety Information (PSI)	119(d)(3)(ii) 68.65(d)(2) **R, O, I**	2.5 Based on review of a representative sample of PSI, has the employer documented that equipment complies with recognized and generally accepted good engineering practice, codes and standards?	Original equipment from the 1940's is not required to comply with today's codes. However, newer equipment is in compliance.	
2	Process Safety Information (PSI)	119(d)(3)(iii) 68.65(d)(3) **R, O**	2.6 Based on review of a representative sample of PSI, has the employer determined and documented that where equipment is designed, and constructed in accordance with codes, standards, and practices that are no longer in general use, the equipment is designed, maintained, inspected tested, and operated in a safe manner?	No, the HAZOP identified several instances where preventative maintenance is not completed.	
2	Process Safety Information (PSI)	GMP R	GMP1 Are there written procedures in place to:		
2	Process Safety Information (PSI)		a) Manage PSI as below; and	No, there is no written policy for how to manage PSI data.	Develop a Process Safety Information (PSI) policy which identifies the necessary PSI, how it will be maintained and where it will be stored and who will be responsible.
2	Process Safety Information (PSI)		b) Maintain PSI on file for the life of the process?	NAVSUP documents are stored in the library. However, critical PSI data is most likely be stored on servers and personal computers as well.	
2	Process Safety Information (PSI)	GMP R	GMP2 Are other occupational hazards (besides toxicity) included in process safety information (e.g. radiation, noise, etc.)?	Noise areas are also included.	
2	Process Safety Information (PSI)	GMP R	GMP3 Is process safety information available electronically, such that it is available at all times; versus hard copies stored in one or more locations?	PSI data is available in both hard copies and electronic in some cases.	
2	Process Safety Information (PSI)	GMP R	GMP4 Are there written process descriptions available for each facility process?	Yes, written descriptions are available.	

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
2	Process Safety Information (PSI)	GMP R	GMP5 Do procedures exist that identify the safety-related design basis for equipment and if so, are these procedures documented for the equipment "owners" so design intent may be preserved as modifications are suggested?	There was no information available for design intent. The majority of the equipment is from the 1940s.	
2	Process Safety Information (PSI)	GMP R	GMP6 Does instrumentation documentation include items such as:		
2	Process Safety Information (PSI)		a) Instrument alarms – including their set points?	Not easily available. NIWC, a contractor, has this information.	
2	Process Safety Information (PSI)		b) Interlocks – including their set points and actions?	N/A	
2	Process Safety Information (PSI)		c) Control valves – including type, size and action (e.g. air to open, air to close, etc.)?	No.	
2	Process Safety Information (PSI)		d) Transmitters – including range and equipment location?	No.	
2	Process Safety Information (PSI)	GMP I	GMP7 Based on interviews of a representative number of employees, are personnel aware of the location and content of Material Safety Data Sheets (MSDSs)?	Yes, every person interviewed was able to tell us where the safety data sheets were located.	
3	Process Hazard Analysis (PHA)	119(e)(1) 68.67(a) **R**	3.1 Has a priority order been established for conducting process hazard analyses on the processes covered by the PSM/RMP program?		
3	Process Hazard Analysis (PHA)		a) Initial PHAs	The initial PHA was held in Feb 2022.	
3	Process Hazard Analysis (PHA)		b) Revalidated PHAs	N/A	Consider repeating/revalidating the Process Hazard Analysis (PHA) every 5 years to assess the hazards introduced by implementing changes to the process. The next PHA would be due in 2027.
3	Process Hazard Analysis (PHA)	119(e)(l) 68.67(a) R,I	3.2 Based on a review of documentation, was the priority order based on a rationale that considered relevant issues including:	No plans have been made for the revalidation of the PHA.	
3	Process Hazard Analysis (PHA)		a) Extent of process hazards	N/A	
3	Process Hazard Analysis (PHA)		b) Number of potentially affected employees	N/A	
3	Process Hazard Analysis (PHA)		c) Age of the process	N/A	
3	Process Hazard Analysis (PHA)		d) Operating history of the process	N/A	
3	Process Hazard Analysis (PHA)	119(e)(1)(i)-(v) R	3.3 Is there a written schedule for completion of process hazard analyses which meets the schedule established for:	N/A	Develop a policy and schedule for PHA completion that includes techniques and methods to be used, personnel to include and information to be reviewed. Include a requirement for all major projects to include a PHA as part of the project design.
3	Process Hazard Analysis (PHA)	119(e)(l) **R**	3.4 Are PHAs being conducted as soon as possible?	N/A	

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
3	Process Hazard Analysis (PHA)	119(e)(2) 68.67(b) **R**	3.5. Is an acceptable methodology being used for PHAs?	The initial PHA was conducted using HAZOP for normal operations and What If? for defueling operations.	
3	Process Hazard Analysis (PHA)	119(e)(2) R,I	3.6 Based on review of a representative number of completed PHAs, were the methodologies appropriate to the complexity (to determine and evaluate the hazards) of the process?	Yes	
3	Process Hazard Analysis (PHA)	119(e)(3) 68.67(c) R, O, I	3.7 Based on review of a representative number of completed initial and revalidated PHAs, do the PHAs address:		
3	Process Hazard Analysis (PHA)		a) The hazards of the process?	Yes	
3	Process Hazard Analysis (PHA)		b) The identification of any previous incidents which had likely potential for catastrophic consequences (i.e. including "near-misses")?	Yes, the May 6, 2021, Sept 29, 2021, Nov. 20, 2021 incidents were considered.	
3	Process Hazard Analysis (PHA)		c) Engineering and Administrative Controls applicable to the hazards?	Yes	
3	Process Hazard Analysis (PHA)		d) Consequences of Failure of Engineering and Administrative Controls?	Yes	
3	Process Hazard Analysis (PHA)		e) Facility/Source Siting?	Completed	
3	Process Hazard Analysis (PHA)		f) Human Factors?	Completed	
3	Process Hazard Analysis (PHA)		g) Qualitative evaluation of a range of possible safety and health effects of failure of controls on employees in the workplace?	Yes	
3	Process Hazard Analysis (PHA)	119(e)(4) 68.67(d) **R,I**	3.8 Based on review of a representative number of completed PHAs, did the PHA team have expertise in engineering and process operations?	Yes, participants are listed in the PHA report.	
3	Process Hazard Analysis (PHA)	119(e)(4) 68.67(d) **R, I**	3.9 Based on review of a representative number of completed PHAs, did at least one team member have experience and knowledge specific to the process being evaluated?	Yes, Deputy Director of Fuels, fuels engineer, and two operators participated.	
3	Process Hazard Analysis (PHA)	119(e)(4) 68.67(d) **R**	3.10 Based on review of a representative number of completed PHAs, was at least one team member knowledgeable in the specific PHA methodology being used?	Yes, Risktec provided the facilitation and scribe.	
3	Process Hazard Analysis (PHA)	40.68.50 R	3.11 Based on review of a representative sampling of completed PHAs, in addition to OSHA documentation requirements, is there a written report prepared for each PHA?	Yes, Risktec prepared a report for this initial PHA	
3	Process Hazard Analysis (PHA)	119(e)(5) 68.67(e) **R,I**	3.12 Based on review of a representative number of completed PHAs, is a system in place to promptly address the team's findings and recommendations?	Prioritized findings and recommendations will be included in the report. The Navy will be responsible for implementation.	
3	Process Hazard Analysis (PHA)	119(e)(5) 68.67(e) **R, O**	3.13 Based on a review of a representative number of completed PHAs, are recommendations resolved in a timely manner?	Data unavailable. This is the initial PHA.	
3	Process Hazard Analysis (PHA)	119(e)(5) 68.67(e) **R**	3.14 Based on review of a representative number of completed PHAs, are resolutions and their rationale documented?	Data unavailable. This is the initial PHA.	
3	Process Hazard Analysis (PHA)	119(e)(5) 68.67(e) **R**	3.15 Based on review of a representative number of completed PHAs, are the actions to be taken documented?	Data unavailable. This is the initial PHA.	

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
3	Process Hazard Analysis (PHA)	119(e)(5) 68.67(e) **R**	3.16 Based on review of a representative number of completed PHAs, do actions appear to be completed as soon as possible?	Data unavailable. This is the initial PHA.	
3	Process Hazard Analysis (PHA)	119(e)(5) 68.67(e) **R**	3.17 Is a system in place (including a schedule) to track the status, resolution and implementation of PHA recommendations and action items?	Data unavailable. This is the initial PHA.	
3	Process Hazard Analysis (PHA)	119(e)(6) 68.67(f) **R**	3.18 Is there a written procedure in place to update and revalidate PHAs within 5 years of the initial PHA?	There is no policy is in place to require a 5 year review or PHAs for projects.	
3	Process Hazard Analysis (PHA)	119(e)(7) 68.67(g) **R**	3.19 Based on a review of a representative number of completed PHAs, are initial PHAs, updates and revalidations of PHAs, and documented resolutions of recommendations kept for the life of the process?	Data unavailable. This is the initial PHA.	
3	Process Hazard Analysis (PHA)	119(e)(5) 40.68.67 (e) R,I	3.20 Based on records review and interviews with a representative number of employees, are PHA recommendations and actions communicated to employees whose work assignments are in the process and who may be affected by them?	Data unavailable. This is the initial PHA.	
3	Process Hazard Analysis (PHA)	GMP **R**	GMP1 Is there a written PHA policy and procedure?	No	
3	Process Hazard Analysis (PHA)	GMP **R**	GMP2 Is there a written procedure in place addressing the requirements for conducting PHAs and how they will be performed?	No	
3	Process Hazard Analysis (PHA)	GMP **R**	GMP3 Have PHAs been completed in accordance with the schedule?	Data unavailable. This is the initial PHA.	
3	Process Hazard Analysis (PHA)	GMP **R**	GMP4 Is there a tracking system in place to track progress on completing PHAs?	Data unavailable. This is the initial PHA.	
3	Process Hazard Analysis (PHA)	GMP **R**	GMP5 Are the qualifications of team leaders documented?	Yes, Risktec provided the facilitation and scribe.	
3	Process Hazard Analysis (PHA)	GMP **R**	GMP6 Based on review of a representative number of completed initial and revalidated PHAs do the PHAs:		
3	Process Hazard Analysis (PHA)		a) Describe the PHA techniques used?	Yes, HAZOP and What If?	
3	Process Hazard Analysis (PHA)		b) Identify the team members and their areas of technical expertise?	Included in the PHA report.	
3	Process Hazard Analysis (PHA)		c) Categorize and prioritize the PHA recommendations?	Included in the PHA report.	
3	Process Hazard Analysis (PHA)	GMP **R**	GMP7 Is there a system for management review of the PHA findings and recommendations?	Data unavailable. This is the initial PHA.	
4	Operating Procedures	119(f)(1-2) 68.69(a-b) **R, O, I**	4.1 Based on a representative sample of covered process(es):		
4	Operating Procedures		a) are there written operating procedures for the processes and do they provide clear instruction for conducting activities safely?	There are operating orders for many routine activities involving the fuel system. The orders are updated each morning for the day's activities. Existing orders are "red lined" if there is a change. The operators call their supervisor for approval to proceed. Each step in the process is not included in the order. There are no consequences of deviation. There are no orders for sampling tanks, relieving line pressure, etc.	Operating orders (procedures) should be established in writing for each work activity and all operational phases. A new procedure template with all industry best practice sections (like health and safety, consequence of deviation, etc.) included should be developed. NOTE: During the HAZOP, a procedure template was provided to POND personnel.

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
4	Operating Procedures		b) are these procedures accessible to employees who work in or maintain the process?	No. All orders are generated and sent each morning to the control room operator.	
4	Operating Procedures		c) are these procedures followed?	Yes, the CR operators have copies of the orders and they initial the steps.	
4	Operating Procedures	119(c)(2) 68.83(b) **R, I**	4.2 Were employees involved in the preparation of the written operating procedures?	The operators are not involved in writing the orders. The supervisors review the orders. The orders are written by the operations engineer.	
4	Operating Procedures	119(f)(1)(I 68.69(a)(1)) **R, I**	4.3 Based on a representative sample of written operating procedures for the covered processes, do they address the following operating phases:		
4	Operating Procedures		a) Initial start-up?	No.	
4	Operating Procedures		b) Normal operations?	Yes, for all valve and fueling activities.	
4	Operating Procedures		c) Temporary operations?	No.	
4	Operating Procedures		d) Emergency shutdown including the conditions under which emergency shutdown is required, and the assignment of shutdown responsibility to qualified operators to ensure that emergency shutdown is executed in a safe and timely manner?	No. There is an emergency response plan section on the operating orders. But the section does not define in detail what must be done.	
4	Operating Procedures		e) Emergency operations?	No	
4	Operating Procedures		f) Normal shutdown?	Yes, but the orders need more information	
4	Operating Procedures		g) Start-up following a turnaround or after an emergency shutdown?	No.	
4	Operating Procedures	119(f)(1)(ii) 68.69(a)(2) **R, I**	4.4 Based on a representative sample of operating procedures for the covered processes, do they address the following information about operating limits:		
4	Operating Procedures		a) Consequence of Deviations?	No	
4	Operating Procedures		b) Steps required to correct or avoid a deviation?	No	
4	Operating Procedures	119(f)(1)(iii) 68.69(a)(3) **R, I**	4.5 Based on a review of a representative sample of operating procedures for the covered process, do they address the following safety & health considerations:		
4	Operating Procedures		a) Properties of, and hazards presented by the chemicals used the process?	No, The hazards of the chemicals (fuels) are not mentioned on any of the operating orders. There is a tools and materials section, but no mention of PPE or what to do if you are exposed to fuel.	Ensure a section of the new procedure template discusses PPE required, the hazards of the fuels and what to do if you come in contact with the fuels.
4	Operating Procedures		b) Precautions necessary to prevent exposure, including engineering controls, administrative controls and personal protective equipment?	PPE is missing. The orders mention "point and call" as an administrative procedure as well as dual operators. There are very few engineering controls on the system.	
4	Operating Procedures		c) Controls measures to be taken if physical contact or airborne exposure occurs?	None mentioned.	
4	Operating Procedures		d) Quality control for raw materials and control of hazardous chemical inventories?	Yes, quality control is specifically addressed in the orders for loading and unloading the ships.	
4	Operating Procedures		e) Any special or unique hazards?	Nothing mentioned.	

Element #	Element Name	Reference[1]	Question	Evidence of Compliance/Findings	Recommendation
4	Operating Procedures	119(f)(1)(iv) 68.69(a)(4) **R**	4.6 Based on a review of a representative sample of operating procedures for the covered processes, do they address safety systems (e.g. but not limited to, deluge systems, PRVs, combustible sensors, fire monitor systems, etc.) and their functions?	No. There is an AFFF system. This system is not mentioned in the procedures.	
4	Operating Procedures	119(f)(3) 68.69(c) **R, O, I**	4.7 Based on a review of a representative sample of operating procedures, are the operating procedures:		
4	Operating Procedures		a) Annually certified that they are current and accurate?	They have not had operating orders in place for a year yet. They started writing them after the May 6, 2021 incident.	
4	Operating Procedures		b) Reviewed as often as necessary to assure that they reflect current operating practice (See 10.9)?	The orders are in the process of being written. If the order identifies that a change needs to be made, he contacts his supervisor before proceeding.	All operating orders/procedures should be version controlled within a document control system where changes/revisions to the documents are managed and to allow for yearly document review.
4	Operating Procedures	119(f)(4) 68.69(d) **R, O,** I	4.8 Are written safe work practices developed, implemented and followed, including:		
4	Operating Procedures		a) Lockout/tagout?	OMES section 4.7 discusses LOTO. There is no specific LOTO procedure.	Develop a formal written procedure implementing a Lock-out/Tag-out (LOTO) process including training on the LOTO work permit.
4	Operating Procedures		b) Confined space entry?	OMES section 4.3.3 defines entrances into confined spaces. There is no specific confined space procedure.	All areas should be evaluated as to whether or not they are confined spaces and signage should be provided. Develop a formal written procedure implementing a confined space permitting system and training for all employees.
4	Operating Procedures	119(f)(4) 68.69(d) **R, O,** I	c) Opening process equipment or piping?	No order written specific to opening process equipment.	Develop a formal written procedure implementing a line opening process that address hazards and controls that must be in place.
4	Operating Procedures		d) Control over entry into a process by maintenance, contractor, laboratory or other support personnel?	No process to control entry. There appears to be an out of date badge scanning system but it is not in service. The operators have camera systems that could be used to identify visitors to the area.	Implement an access control process that includes electronic badging into and out of the facility. This system should report real-time accounting for all personnel in the facility. In lieu of an electronic system, implement a sign-in/sign-out process which is controlled by the Control Room Operator (CRO).
4	Operating Procedures	GMP **R**	GMP1 Is there a written program in place to develop and implement written operating procedures?	No. The OMES manual talks about the existence of operating orders but does not provide any guidance to the content of the orders, the templates or the requirements.	
4	Operating Procedures	GMP **R**	GMP2 Do operating procedures include emergency actions required for events such as:		Emergency response sections on the current operating orders address spills and leaks. They do not have any operation orders or emergency actions that address loss of electricity, building ventilation, fire or explosion.
4	Operating Procedures		a) Loss of steam or other heating system	N/A	

Element #	Element Name	Reference[1]	Question	Evidence of Compliance/Findings	Recommendation
4	Operating Procedures		b) Loss of electricity	No	
4	Operating Procedures		c) Loss of cooling water, process water, or refrigerant	N/A	
4	Operating Procedures		d) Loss of plant or breathing air	N/A	
4	Operating Procedures		e) Loss of instrument air	N/A	
4	Operating Procedures		f) Loss of building or spot ventilation	No	
4	Operating Procedures		g) Loss of nitrogen or other inerting system	N/A	
4	Operating Procedures		h) Loss of chemical injection system	N/A	
4	Operating Procedures		i) Uncontrolled reaction	N/A	
4	Operating Procedures		j) Fire or explosion?	No	
4	Operating Procedures	GMP **R**	GMP3 Do operating procedures include, or at least point to, comprehensive spill control measures for each chemical handled?	Yes, in the Emergency Response Section they state, "Notify the chain of command of the emergency and respond to the emergency with clean-up material and containers and drip pans as required by the emergency."	
5	Training	119(g)(1)(i) 68.71(a)(1) **R**	5.1 Based on a review of a representative sample of training records, have employees involved in operating the process received initial training?	Training requirements are outlined in the OMES manual section 8.3. All new employees are paired with an experienced operator for shadowing. Once the employee training checklist is complete, the work leader reviews the checklist and interviews the new employee and determines if the new employee is approved to work on his own.	Implement a formal written program establishing operator initial and refresher training requirements. Job shadowing can be one aspect of this training program, but should not constitute the primary training method. Consider operator pre-qualification requirements prior to employment. Establish a training department/coordinator to be responsible for all training activities and consider using a process simulator for CRO initial and refresher training.
5	Training	119(g)(1) 119(n) 1910.38(a) 68.71(a)(1) (RMP allows owner to certify knowledge, skills and abilities for those employed before 6/21/99) **R, I**	5.2 Based on a review of a representative sample of training records and interviews with a representative number of operation employees, does training cover:		
5	Training		a) An overview of the process?	Yes as part of shadowing. No 'formal' training.	
5	Training		b) Operating procedures? (see 4.4, 4.6 & 4.8)	Yes as part of shadowing. No 'formal' training on operations orders.	
5	Training		c) Emphasis on the specific safety and health hazards?	OMES section 8.4, Yes as part of shadowing	
5	Training		d) Emergency operations including shutdown?	Yes as part of shadowing	
5	Training		e) Safe work practices applicable to the employee's job tasks?	Yes as part of shadowing	
5	Training		f) Emergency evacuation and response?	Yes as part of shadowing	

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
5	Training	119(g)(2) 68.71(b) **R, I**	5.3 Based on a review of a representative number of training records, is refresher training provided within three years of the date of last training or more often if determined to have been necessary?	Some refresher training is offered. Due to covid, all training and refresher is overdue.	
5	Training	**R, I**	5.4 Based on interviews with operation employees, were they consulted regarding the frequency of refresher training?	No	
5	Training	119(g)(2-3) 68.71(c) **R,I**	5.5 Based on a review of a representative number of training records and interviews with a representative number or operation employees, did the employer ascertain that each employee involved in operating a process received and understood the training?	Yes, the work leader reviews the checklist and interviews the new employee to confirm understanding before approving him to work alone.	
5	Training	119(g)(1) 68.71(c) **R**	5.6 Based on a representative sample of training records, do the records document:		
5	Training		a) Identity of employee(s) receiving training?	Yes, records have been provided.	
5	Training		b) Date of the training?	Yes, records have been provided.	
5	Training		c) Description of training?	Yes, records have been provided.	
5	Training		d) Means used to ascertain that employees understood the training?	Very few training classes are provided in person. Most are passive, that is, read on your own and sign. I was told that some training requires a 70%+ to pass the test although no one could give me an example.	
5	Training		e) Name of persons conducting training?	Yes, records have been provided.	
5	Training	GMP **R**	GMP1 Is there a written program addressing the training of employees involved in operating processes?	Training requirements are outlined in the OMES manual section 8.3. This is minimal training. Confined space training for the workers is only awareness only.	
6	Contractors	119(h)(1) **R**	<u>Employer Responsibilities</u> 6.1 Does the employer have a written plan describing their program for contractors performing maintenance or repair, turnaround, major renovation, or special work on or adjacent to a covered process?		
6	Contractors	119(h)(1) **R, I**	6.2 Based on a review of a representative sample of contractor records, has the employer applied its contractor program to contractors performing work on or adjacent to a covered process?		
6	Contractors	119(h)(2)(i) 68.87(b)(1) **R, I**	6.3 Based on the written program and a review of employer's documentation, is information obtained and evaluated when selecting a contractor regarding the contract employer's:		
6	Contractors		a) Safety program and	Although contractors are heavily utilized, they were not made available for interviews due to contractual complexities.	
6	Contractors		b) Performance/ injury and illness rates and experience?	Although contractors are heavily utilized, they were not made available for interviews due to contractual complexities.	

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
6	Contractors	119(h)(2)(ii) 68.87(b)(2) **R, I**	6.4 Are contractor employees informed, prior to the initiation of the contractor's work at the site, of the known potential fire, explosion, or toxic release hazards related to the contractor's work and the process?		
6	Contractors	119(h)(2)(iii) 68.87(b)(3) **R, I**	6.5 Are the applicable provisions of the emergency action plan explained to contractor employers prior to the initiation of the contractors' work at the site?		
6	Contractors	119(h)(2)(iv) 68.87(b)(4) **R, O, I**	6.6 Are there written safe work practices a)developed and b) implemented that control the access of contract employers and employees to covered process units? (See 4.11d)		
6	Contractors	119(h)(2)(v) 68.67(b)(5) **R, I**	6.7 Is there a written program in effect by the employer to periodically evaluate the contract employers' responsibilities under the PSM/RMP standards? (see below)		
6	Contractors	119(h)(2)(v) **R, I**	6.8 Has the employer ensured, through periodic evaluations, that the training provided to contractor employees by the contractor is equivalent to the training required for direct hire employees?		
6	Contractors	119(h)(2)(v) **R,I**	6.9 If the evaluation determines that the contractor is not meeting their responsibilities under this section, is responsive action taken?		
6	Contractors	119(h)(2)(vi) **R**	6.10 Does the facility maintain a contract employee injury and illness log?		
6	Contractors	119(h)(3)(i) 68.67(c)(1) **R, I**	**Contract Employer Responsibilities** 6.11 Does the contract employer have a written program describing the training required to perform work practices necessary to safely perform the job?		
6	Contractors	119(h)(3)(i) 68.67(c)(2) **R, I**	6.12 Based on a representative sample of contract_employee records and interviews, does the contract employer assure that each contract employee is instructed in the known potential fire, explosion, or toxic release hazards related to his/her job and the covered process, and in the applicable provisions of the emergency action plan?		
6	Contractors	119(h)(3)(iii) 68.67(c)(3) **R, I**	6.13 Based on review of a representative number of contract employee records, does the contract employer document the:		
6	Contractors		a) Identity of the contract employee	Although contractors are heavily utilized, they were not made available for interviews due to contractual complexities.	
6	Contractors		b) Date of training	Although contractors are heavily utilized, they were not made available for interviews due to contractual complexities.	
6	Contractors		c) Means to verify that the contract employees have received and understood the training required by this paragraph?	Although contractors are heavily utilized, they were not made available for interviews due to contractual complexities.	

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
6	Contractors	119(h)(3)(iv) 68.67(c)(4) **R,O, I**	6.14 Is there evidence that contractors ensure their employees follow facility safety rules and work practices required by the PSM/RMP standards including:		
6	Contractors		a) Lockout/tagout?	Although contractors are heavily utilized, they were not made available for interviews due to contractual complexities.	
6	Contractors		b) Confined space entry?	Although contractors are heavily utilized, they were not made available for interviews due to contractual complexities.	
6	Contractors		c) Opening process equipment or piping?	Although contractors are heavily utilized, they were not made available for interviews due to contractual complexities.	
6	Contractors		d) Control over access to process areas?	Although contractors are heavily utilized, they were not made available for interviews due to contractual complexities.	
6	Contractors	119(h)(3)(v) 68.67(c)(5) **R,O, I**	6.15 Does the contractor advise the facility employer of unique hazards presented by or found during the contractor's work?		
6	Contractors	GMP **R**	GMP1 Based on a review of the employer's records, are contractor work methods and/or experience evaluated?	Although contractors are heavily utilized, they were not made available for interviews due to contractual complexities.	
6	Contractors	GMP **R, I**	GMP2 Is process safety information available to contract employees?		
7	Pre-Startup Safety Review (PSSR)	119(l)(1) 68.77(a) **R**	7.1 Is a written procedure in place that addresses a) documentation and b) implementation of PSSR for new facilities and for modified facilities when the modification is significant enough to require a change in the process safety information?	There is no evidence of a pre-startup program in place.	Develop a formal written procedure implementing a Pre-Startup Safety Review (PSSR) program.
7	Pre-Startup Safety Review (PSSR)	119(i)(2)(i) 68.77(b)(1) R, O, I	7.2 Based on a review of a representative sample of PSSR documentation, does the review confirm that construction and equipment is in accordance with design specifications?	The AFFF project was originally designed with a steel pipeline. Due to cost cutting, the system was installed with a partial PVC line. It does not meet the original design specifications but was allowed to start-up. Because of recent events, the PVC line will need to be removed and replaced.	
7	Pre-Startup Safety Review (PSSR)	119(i)(2)(ii) 68.77(b)(2) **R, O, I**	7.3 Based on a review of a representative sample of PSSR documentation, does the review confirm that safety, operating, maintenance and emergency procedures are in place and are adequate?	It is apparent that projects have been completed without consideration of safety, operating and environmental concerns. An example would be installing ground water monitoring wells under a pipeline in the tunnel.	
7	Pre-Startup Safety Review (PSSR)	119(i)(2)(iii) 68.77(b)(3) **R,I**	7.4 Based on a review of a representative sample of PSSR documentation for new facilities, does the review confirm that PHAs have been performed and recommendations have been resolved or implemented before startup?	There have been no PHAs performed on any project.	
7	Pre-Startup Safety Review (PSSR)	119(i)(2)(iii) 68.77(b)(3) **R, I**	7.5 Based on a review of a representative sample of PSSR documentation, for modified facilities, does the review confirm that the process meets the requirements contained in the management of change program?	There is no management of change process.	Develop a formal written procedure implementing a Management of Change (MOC) process. The process should be paper-based initially with the goal to move to an electronic system once the program is fully implemented and understood.

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
7	Pre-Startup Safety Review (PSSR)	119(i)(2)(iv) 68.77(b)(3) **R, I**	7.6 Based on a review of a representative sample of PSSR documentation, does the review confirm that operator training has been completed?	Operator training on projects and changes is not evident.	As part of the MOC and PSSR procedures, require operator training before any process change is made.
7	Pre-Startup Safety Review (PSSR)	119(i)(2) 68.77(b) **I**	7.7 Based on a representative number of interviews, are PSSRs conducted prior to the introduction of highly hazardous chemicals to the process?	No PSSRs are completed.	
7	Pre-Startup Safety Review (PSSR)	GMP **R**	GMP1 Do the PSSRs include general safety issues such as:	Although contractors are heavily utilized, they were not made available for interviews due to contractual complexities.	
7	Pre-Startup Safety Review (PSSR)		a) Fire protection facilities	No PSSRs are completed.	
7	Pre-Startup Safety Review (PSSR)		b) Means of egress	No PSSRs are completed.	
7	Pre-Startup Safety Review (PSSR)		c) Availability and location of safety equipment	No PSSRs are completed.	
7	Pre-Startup Safety Review (PSSR)		d) Equipment guards	No PSSRs are completed.	
7	Pre-Startup Safety Review (PSSR)		e) Electrical classification	No PSSRs are completed.	
7	Pre-Startup Safety Review (PSSR)		f) Ventilation	No PSSRs are completed.	
7	Pre-Startup Safety Review (PSSR)		g) Tripping hazards	No PSSRs are completed.	
7	Pre-Startup Safety Review (PSSR)		h) Proper drainage to avoid icing conditions in winter?	No PSSRs are completed.	
7	Pre-Startup Safety Review (PSSR)	GMP **R**	GMP2 Does the PSSR process allow the review team to judge whether or not the facility is ready for startup?	No PSSRs are completed.	
8	Mechanical Integrity	119(j)(1)(i) 68.73(a) **R, I**	8.1 Based on a review of the mechanical integrity procedures, do the procedures include the following process equipment:	Interview indicated MI procedures existed for some equipment, but no procedures were provided or reviewed.	Develop and implement detailed MI procedures for all equipment subject to test and inspection requirements.
8	Mechanical Integrity		a) Vessels and storage tanks (pressurized or not)		
8	Mechanical Integrity		b) Piping systems including valves and other piping components		
8	Mechanical Integrity		c) Relief and vent systems and devices		
8	Mechanical Integrity		d) Emergency shutdown systems		
8	Mechanical Integrity		e) Controls (including monitoring devices and sensors, alarms, and interlocks)		
8	Mechanical Integrity		f) Pumps		

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
8	Mechanical Integrity	119(j)(2) 68.73(b) **R, I**	8.2 Are there written procedures established and implemented to maintain the on-going integrity, i.e. preventive and turnaround maintenance, of covered process equipment which includes:	Interview indicated MI procedures existed for some equipment, but no procedures were provided or reviewed.	
8	Mechanical Integrity		a) Fixed equipment		
8	Mechanical Integrity		b) Rotating equipment; and		
8	Mechanical Integrity		c) I&E equipment.		
8	Mechanical Integrity	119(j)(3) 68.73(c) **R, I**	8.3 Based on a records review and interviews with employees and contract employees, are written procedures established and implemented to train personnel involved in maintaining the ongoing integrity, i.e. preventive and turnaround maintenance, of process equipment as follows:	Based on personnel interview, training of personnel involved in maintaining the ongoing integrity of process equipment is primarily done as "on-the-job training".	Develop structured written procedures for training personnel involved in maintaining the ongoing integrity of process equipment.
8	Mechanical Integrity		a) Overview of the process and hazards?		
8	Mechanical Integrity		b) Procedures applicable to job tasks for:		
8	Mechanical Integrity		i) Fixed equipment;		
8	Mechanical Integrity		ii) Rotating equipment;		
8	Mechanical Integrity		iii) I&E equipment		
8	Mechanical Integrity		c) Maintenance procedures?		
8	Mechanical Integrity		d) Safe work practices?		
8	Mechanical Integrity	119(j)(4)(I) 68.73(d)(1) **R**	8.4 Are there written procedures for performance of tests and inspections (for preventive and turnaround maintenance) on process equipment which includes:	Interview indicated MI procedures existed for some equipment, but no procedures were provided or reviewed.	
8	Mechanical Integrity		a) Fixed equipment;		
8	Mechanical Integrity		b) Rotating equipment;		
8	Mechanical Integrity		c) I&E equipment.		
8	Mechanical Integrity	119(j)(4)(ii) 68.73(d)(2) **R, I**	8.5 Based on review of a representative sample of test and inspection documentation, are tests and inspections (for preventive and turnaround maintenance) performed in accordance with recognized and generally accepted good engineering practices for:	Based on a record review from FAMMS and personnel interview, tests and inspections are performed in accordance with RAGAGEP.	
8	Mechanical Integrity		a) Fixed equipment;		
8	Mechanical Integrity		b) Rotating equipment;		
8	Mechanical Integrity		c) I&E equipment.		

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
8	Mechanical Integrity	119(j)(4)(iii) 68.73(d)(3) **R, I**	8.6 Based on a review of a representative sample of test and inspection documentation (for preventive and turnaround maintenance) are the frequencies consistent with applicable manufacturers' recommendations and good engineering practices, and more frequent if determined to be necessary by prior operating experience for:	Based on a record review from FAMMS and personnel interview, tests and inspections frequencies are consistent with applicable manufacturers' recommendations and good engineering practices.	
8	Mechanical Integrity		a) Fixed equipment;		
8	Mechanical Integrity		b) Rotating equipment;		
8	Mechanical Integrity		c) I&E equipment.		
8	Mechanical Integrity	119(j)(4)(iv) 68.73(d)(4) **R**	8.7 Based on a review of a representative sample of mechanical integrity records, are the results documented for:	Based on a record review from FAMMS and personnel interview, tests and inspections results are documented.	
8	Mechanical Integrity		a) Preventative maintenance:		
8	Mechanical Integrity		i) Fixed equipment;		
8	Mechanical Integrity		ii) Rotating equipment;		
8	Mechanical Integrity		iii) I&E equipment.		
8	Mechanical Integrity		b) Turnaround maintenance:		
8	Mechanical Integrity		i) Fixed equipment;		
8	Mechanical Integrity		ii) Rotating equipment;		
8	Mechanical Integrity		iii) I&E equipment.		
8	Mechanical Integrity	119(i)(4)(iv) 68.73(d)(4) **R**	8.8 Does the documentation include:	Based on a record review from FAMMS and personnel interview, tests and inspections results are documented with the required information.	
8	Mechanical Integrity		a) Date or inspection or test?		
8	Mechanical Integrity		b) Name of person performing the test or inspection?		
8	Mechanical Integrity		c) Serial number or other identifier of the equipment?		
8	Mechanical Integrity		d) Description of the test and inspection?		
8	Mechanical Integrity		e) Results of the test and inspection?		
8	Mechanical Integrity	119(j)(5) 68.73 (e) R, O, I	8.9 Based on a review of a representative sample of mechanical integrity records and interviews with employees and contract employees, for the following, are equipment deficiencies that are outside acceptable limits (e.g. as defined by PSI) corrected before further use or in a timely manner to assure safe operation?	Based on personnel interview, equipment deficiencies and the results of tests and inspections are not always captured.	

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
8	Mechanical Integrity		a) Preventive maintenance:		
8	Mechanical Integrity		i) Fixed equipment;		
8	Mechanical Integrity		ii) Rotating equipment;		
8	Mechanical Integrity		iii) I&E equipment.		
8	Mechanical Integrity		b) Turnaround maintenance:		
8	Mechanical Integrity		i) Fixed equipment;		
8	Mechanical Integrity		ii) Rotating equipment;		
8	Mechanical Integrity		iii) I&E equipment.		
8	Mechanical Integrity	119(j)(6) 68.73(f) **R, O, I**	8.10 Based on a review of a representative sample of written procedures and interviews with employees and contract employees, is there a quality assurance program which assures:	No quality assurance program exist to ensure equipment is suitable, installed properly and consistent with design specifications or manufacturer's instructions, or maintenance materials and spare parts are available.	
8	Mechanical Integrity		a) that new equipment as it is fabricated is suitable for the intended process application for new plants and equipment?		
8	Mechanical Integrity		i) Fixed equipment;		
8	Mechanical Integrity		ii) Rotating equipment;		
8	Mechanical Integrity		iii) I&E equipment.		
8	Mechanical Integrity		b) appropriate checks and inspections are performed to assure that the equipment is installed properly and consistent with design specifications and the manufacturer's instructions?		
8	Mechanical Integrity		i) Fixed equipment;		
8	Mechanical Integrity		ii) Rotating equipment;		
8	Mechanical Integrity		iii) I&E equipment.		
8	Mechanical Integrity		c) maintenance materials, spare parts and equipment are suitable for the process application for which they will be used?		
8	Mechanical Integrity		i) Fixed equipment;		
8	Mechanical Integrity		ii) Rotating equipment;		
8	Mechanical Integrity		iii) I&E equipment.		
8	Mechanical Integrity	GMP **R**	GMP1 Are there written procedures for fixed process equipment to:		

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
8	Mechanical Integrity		a) Determine coverage; and		
8	Mechanical Integrity		b) Is there a listing of equipment to be included in the program to maintain the on-going integrity?		
8	Mechanical Integrity	GMP **R**	GMP2 Are there written procedures for rotating process equipment to:		
8	Mechanical Integrity		a) Determine coverage; and		
8	Mechanical Integrity		b) Is there a listing of equipment to be included in the program to maintain the on-going integrity?		
8	Mechanical Integrity	GMP **R**	GMP3 Are there written procedures for I&E process equipment to:		
8	Mechanical Integrity		a) Determine coverage; and,		
8	Mechanical Integrity		b) Is there a listing of equipment to be included in the program to maintain the on-going integrity?		
8	Mechanical Integrity	GMP **R**	GMP4 Does the company obtain and keep on file equipment vendor technical manuals and other documents that show any vendor's recommendations for preventive and turnaround maintenance including test and inspection frequencies for:		
8	Mechanical Integrity		a) Fixed equipment;		
8	Mechanical Integrity		b) Rotating equipment;		
8	Mechanical Integrity		c) I&E equipment.		
8	Mechanical Integrity	GMP **R**	GMP5 Does the employer certify annually, or at some other frequency, that the mechanical integrity procedures (8.5 & 8.7) are current and accurate for:		
8	Mechanical Integrity		a) Fixed equipment;		
8	Mechanical Integrity		b) Rotating equipment;		
8	Mechanical Integrity		c) I&E equipment.		
8	Mechanical Integrity	GMP **R**	GMP6 Are mechanical integrity procedures (8.5 & 8.7) readily accessible to employees as appropriate for:		
8	Mechanical Integrity		a) Fixed equipment;		
8	Mechanical Integrity		b) Rotating equipment;		
8	Mechanical Integrity		c) I&E equipment.		
8	Mechanical Integrity	GMP **R, I**	GMP7 Has a predictive/preventive maintenance program been established for the site?		

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
9	Hot Work Permits	68.85(a) **R**	9.1 Is there a written program in place that requires a hot work permit for hot work operations conducted on or near a PSM/RMP covered process?	Section 4.5.4 OMES refers to NFPA 51B. OMES 5.2.4 says hot work must be conducted through the Fire Chief and Safety offices. OMES Section 5.2.7 addresses fire watches. Five sample hot work permits were reviewed.	Develop and implement a hot work program that is owned by the Operations / Fuels group. This program should meet the criteria of OSHA PSM. It should ensure that Operators know what hot work is being performed in their area, and that operators are trained to write hot work permits. In addition, develop and implement a Safe Work program that includes procedures and controls for confined space entry, energy isolation, elevated work, and other Life Critical procedures.
9	Hot Work Permits	119(k)(1) 68.85(a) **R, I**	9.2 Based on a review of a representative sample of hot work documentation, other documentation identifying tasks required to be performed, and interviews with a representative number of employees involved in hot work operations, are hot work permits issued for all hot work operations conducted on or near PSM/RMP covered processes?	Contractors are responsible for requesting their own hot work permits so it is possible that hot work could be performed without a permit.	
9	Hot Work Permits	119(k)(2) 68.85(b) **R**	9.3 Based on a review of a representative sample of hot work permits, do the permits indicate the date(s) authorized for the hot work?	How work permits indicate the date of the permit.	
9	Hot Work Permits	119(k)(2) 68.85(b) **R**	9.4 Based on a review of a representative sample of hot work permits, do the hot work permits describe the object on which the hot work is to be performed?	Four out of five hot work permits reviewed described the object on which the hot work is being performed. One permit number 468708 only stated the description of FORFAC with no additional description of the welded object.	
9	Hot Work Permits	119(k)(2) 68.85(b) **R, I**	9.5 Based on a review of the written hot work procedure, a representative sample of hot work permits and interviews with a representative number of employees involved in hot work operations, are hot work permits kept on file until the hot work operations are completed?	According to the fire chief hot work permits are kept for three years. Also they are entered into the E SAMS system. (Enterprise Safety Application Management System)	
9	Hot Work Permits	1910.252(a) (2)(i) 68.85(b) **R,I**	9.6 Based on a review of a representative sample of hot work permits, do the permits identify openings, cracks and holes where sparks may drop to combustible materials below?	Checklist questions 7 and 8 address this.	
9	Hot Work Permits	1910.252(a) (2)(ii) 68.85(b) **R**	9.7 Based on a review of a representative sample of hot work permits, do the permits describe the fire prevention and or protection measures required to handle any emergencies?	Fire prevention and protection measures are addressed.	
9	Hot Work Permits	1910.252(a) (2)(iii) 68.85(b) **R,I**	9.8 Based on a review of a representative sample of hot work permits and interviews with a representative number of employees involved in hot work operations, do the permits assign firewatchers whenever welding is performed in locations where other than a minor fire might develop?	Fire watches are assigned but may have other responsibilities.	It is recommended that the fire watch is dedicated and cannot perform duties other then being the fire watch.

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
9	Hot Work Permits	1910.252(a) (2)(iv) 68.85(b) **R, I**	9.9 Based on a review of a representative sample of hot work permits and interviews with a representative number of employees involved in hot work operations, are the permits authorized, preferably in writing, by an "individual" responsible for welding and cutting operations, and is authorization preceded by site inspection and designation of appropriate precautions?	The checklist states that the PAI must verify that the questions are as stated before issuing the checklist.	
9	Hot Work Permits	1910.252(a) (2)(v & ix) 68.85(b) **R, I**	9.10 Based on a review of a representative sample of hot work permits, do the permits address precautions associated with combustible materials on floors or floors, walls, partitions, ceilings or roofs of combustible construction?	This is addressed in the checklist.	
9	Hot Work Permits	1910.252(a) (2)(vii) 68.85(b) **R, I**	9.11 Based on a review of a representative sample of hot work permits, do the hot work permits require relocation of combustibles where practicable and covering with flame proofed covers where not practicable?	This is addressed in the checklist question number 10.	
9	Hot Work Permits	1910.252(a) (2)(viii) 68.85(b) **R, I**	9.12 Based on a review of a representative sample of hot work permits, do the permits identify for shutdown any ducts or conveyor systems that may convey sparks to distant combustibles?	This is addressed in the checklist.	
9	Hot Work Permits	1910.252(a) (2)(x & xii) 68.85(b) **R, I**	9.13 Based on a review of a representative sample of hot work permits, do the permits require precautions whenever welding on components (e.g., steel members, pipes, etc.,) that could transmit heat by radiation or conduction to unobserved combustibles?	This is addressed in the checklist.	
9	Hot Work Permits	1910.252(a) (2)(xi) 68.85(b) **R, I**	9.14 Based on a review of a representative sample of hot work permits, do the permits identify hazards associated with welding on walls, partitions, ceilings or roofs with combustible coverings or welding on walls or panels of sandwich-type construction?	This is addressed in the checklist question number 13.	
9	Hot Work Permits	1910.252(a) (2)(xiii) 68.85(b) **R, I**	9.15 Based on a review of the hot work procedure, related documentation and interviews with a representative number of employees involved in hot work operations, have areas and procedures for safe welding and cutting based on fire potential been established?	According to the fire chief NAVFAC can authorize low risk hot work without the Fire Department. This can include hot work in staging areas or in the open. NAVFAC then submits these hot work permits to the fire department.	
9	Hot Work Permits	1910.252(a) (2)(xiii)(B) 68.85(b) **R, I**	9.16 Based on a review of the hot work procedure and related documentation, has an "individual" responsible for authorizing cutting and welding operations in process areas been designated?	The fire chief is responsible for authorizing hot work.	
9	Hot Work Permits	1910.252(a) (2)(xiii) 68.85(b) **R, I**	9.17 Based on a review of relevant documents and interviews with a representative number of employees involved in hot work operations, have welders, cutters and their supervisors been appropriately trained in the safe operation of their equipment?	Contractors are responsible for being trained on the safe operation of their equipment.	

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
9	Hot Work Permits	1910.252(a)(2)(xiii)(D) 68.85(b) **R, I**	9.18 Based on a review of relevant hot work and contractor related documentation, are outside contractors informed of hot work permit requirements?	Contractors performing hot work notify the fire department that they are going to conduct hot work. The fire department reviews a hot work checklist with the contractor performing the hot work.	
10	Management of Change	119(l)(1) 68.75(a) **R, O, I**	10.1 Has a written procedure been established and implemented to manage changes to process chemicals, technology, equipment, procedures, or process conditions and changes to facilities that affect a covered process?	No, written policy or practice. It became apparent that employees in various departments were not aware of changes made to the process or projects in various stages of implementation.	
10	Management of Change	119(l)(2)(i-v) 68.75(b)(1-5) **R**	10.2 Does the MOC procedure address the following prior to any change:	N/A	
10	Management of Change		a) Technical basis for proposed change?	There is no management of change process.	
10	Management of Change		b) Impact of change on safety and health?	There is no management of change process.	
10	Management of Change		c) Modifications to operating procedures?	There is no management of change process.	
10	Management of Change		d) Necessary time period for the change?	There is no management of change process.	
10	Management of Change		e) Authorization requirements for the proposed change?	There is no management of change process.	
10	Management of Change		f) Provide for the tracking of changes.	There is no management of change process.	
10	Management of Change	119(l)(3) 68.75(c) **R, I**	10.3 Based on a review of representative records and interviews with a representative number of employees, do procedures exist to a) inform and b) train employees whose job function will be affected by the change prior to the start-up of the process and is this being done for:	N/A	
10	Management of Change		a) Operating employees?	There is no management of change process.	
10	Management of Change		b) Maintenance employees?	There is no management of change process.	
10	Management of Change		c) Contract employees?	There is no management of change process.	
10	Management of Change	119(l)(4) 68.75(d) **R**	10.4 Does the MOC procedure require update of the process safety information affected by the change?	N/A	
10	Management of Change	119(l)(5) 68.75(e) **R**	10.5 Does the MOC procedures require updates to the operating procedures if they are affected by the change (i.e. process chemicals, technology, equipment, facilities, etc.)?	N/A	
10	Management of Change	GMP **R**	GMP1 Does the written MOC procedure address both temporary and permanent changes?	There is no management of change process.	
10	Management of Change	GMP **R**	GMP2 Do the procedures address:	There is no management of change process.	
10	Management of Change		a) What constitutes a temporary or permanent change?	There is no management of change process.	
10	Management of Change	GMP **R**	b) Time limits for temporary changes?	There is no management of change process.	
10	Management of Change	GMP **R**	c) Requirement for extensions of the time period for temporary changes?	There is no management of change process.	

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
10	Management of Change	GMP **R**	d) Restoration of equipment and procedures to their original or designed conditions at the end of the change?	There is no management of change process.	
10	Management of Change	GMP **R**	GMP3 Are provisions made in the MOC variances procedure for various situations that may be encountered, for example, changes during emergency situations?	There is no management of change process.	
10	Management of Change	GMP **R**	GMP4 Based on a review of a representative sample of completed MOC documentation, are the a) documentation and b) implementation requirements of the MOC procedure being met?	There is no management of change process.	
10	Management of Change	GMP **R**	GMP5 Does the MOC procedure address when a PHA is required for a "change"?	There is no management of change process.	
10	Management of Change	GMP **R**	GMP6 Are changes in personnel, staffing levels, etc. included in the MOC procedure?	There is no management of change process.	
11	Incident Investigation	119(m)(1) 68.81(a) **R, I**	11.1 Is there a written procedure addressing the requirements for investigating each incident which:	The OMES manual section 7.13.2 Pipeline Accident Investigation and Reporting requires investigation and reporting of pipeline incidents using PHMSA Form 11, Pipeline Failure Investigation Report (available at http://www.phmsa.dot.gov/) to investigate the accident;	
11	Incident Investigation		a) Resulted in;	There is no written policy or procedure for incident implementation. Incident reporting is required in the Facility Response Plan B.2.3, Table C.1, as well as PHMSA pipeline spill reporting.	
11	Incident Investigation		b) Or could reasonably have resulted in ("near miss"), a catastrophic release of a highly hazardous chemical; and based on interviews with a representative number of employees, is this being done?	There is no written policy or procedure for incident investigation. Investigations are done by the Fuels Safety Officer. He does not use any tools and uses a template in ESAMS to document. ESAMS then is used for the OSHA 300 log.	Develop and implement a written process for incident investigation including reporting requirements, data tracking, training, and thorough incident investigation tools, etc. The level of incident investigation may be fit for purpose for the incident severity. Incident investigations should be completed in a timely manner and communicated across the affected organizations to share learnings.
11	Incident Investigation	119(m)(2) 68.81(b) **R,**	11.2 Does the procedure require that incident investigations be initiated as soon as possible, but no later than 48 hours following the incident?	There is no written policy or procedure for incident investigation	
11	Incident Investigation	119(m)(3) 68.81(c) **R, I**	11.3 Does the procedure require establishment of a team consisting of at least one person knowledgeable in the process involved, a contract employee if the incident involved work of the contractor, and other persons with appropriate knowledge and experience to thoroughly investigate and analyze the incident?	There is no written policy or procedure for incident investigation	
11	Incident Investigation	119(m)(4) 68.81(d) **R**	11.4 Based on a representative sample of incident investigation reports, do they document that a report is prepared which includes at least the following:	The only documented RCI that was provided was for May 6, 2021	
11	Incident Investigation		a) Date of incident?	6-May-21	
11	Incident Investigation		b) Date investigation began?	Per the final RCI report, June and July 2021 personnel were on-site for the investigation	

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
11	Incident Investigation		c) Description of the incident?	The following is what appears to have happened on May 6th. Towards the end of Evolution 3, the valve lineup below Tank 20 was set as described above for a period of over five minutes creating a vacuum with a volume of 23 bbl. Operations then moved to Evolution 4. As Tank 12 was being prepared for use in Evolution 4, the valve lineup was again set to allow for another five minutes of sag creating an additional 16 bbl. of vacuum. When Tank 12's skin valve was opened, the inrush from the head in Tank 12 collapsed the 39 bbl. of vacuum. This created a calculated transient surge pressure of approximately 350 psig in only milliseconds, or almost instantaneously, near Tanks 18 and 20. This energy displaced the (b)(3)(A) JP-5 mainline piping near Tank 20 at least 16 inches laterally and separated the Dresser couplings at Tanks 18 and 20	
11	Incident Investigation		d) Factors that contributed to the incident?	Human error as they did not follow the instructions per the evolution, leaking butterfly valves, dresser couplings, etc.	
11	Incident Investigation		e) Any recommendations resulting from the investigation?	Development of operations orders, better training, piping restraint	
11	Incident Investigation	119(m)(5) 68.81(e) **R, O**	11.5 Is there a written procedure in place to promptly address and resolve incident report findings and recommendations?	There is no written policy or procedure for incident investigation.	
11	Incident Investigation	119(m)(5) 68.81(e) **R**	11.6 Based on a representative sample of incident reports, are resolutions and corrective actions determined and documented?	We were provided only one RCI. It is not apparent how many incidents are actually investigated nor are documented. There is no database which tracks corrective actions.	
11	Incident Investigation	119(m)(6) 68.81(f) **R, I**	11.7 Based on a representative review of applicable records and interviews with a representative number of employees, are incident reports, findings, and recommendations shared with personnel whose job tasks are relevant to incident findings, including contract employees?	Interviews with employees identified a lack of timely communication. The results of the May 6th incident were not communicated until after the Sept 29th incident. Even in the Feb 2022 PHA, the operators present were unaware of the root cause of the incident.	
11	Incident Investigation	119(m)(7) 68.60(f) **R,**	11.8 Are incident investigation reports retained for five years?	There are some incidents on a server, but there is no policy to maintain the reports.	
11	Incident Investigation	GMP **R**	GMP1 Does the procedure require employees to report all such incidents?	No policy/procedure has been identified.	
11	Incident Investigation	GMP **R, I**	GMP2 Are employees in process areas where the incident occurred consulted, interviewed, or included on the investigation team?	The operator and the rover write in their respective log book after the incident that they are aware of the incident.	
11	Incident Investigation	GMP **R**	GMP3 Does the report identify the team members and their background/expertise?	No policy/procedure has been identified.	
11	Incident Investigation	GMP **R**	GMP4 Is there a management review of the incident?	Yes, management reviews reported incidents.	
11	Incident Investigation	GMP **R**	GMP5 Does the accident investigation provide for an objective determination of root cause?	No. They do not use any tools to identify root cause.	Obtain training for specific employees on the use of incident investigative tools (like TapRoot, Apollo, etc.).
12	Emergency Planning & Response	119(n) 68.95(a) **R**	12.1 Has a written emergency action plan been established and implemented for the entire plant per 1910.38?		

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
12	Emergency Planning & Response	119(n) **R**	12.2 Does the emergency action plan include procedures for handling small releases and spills?		
12	Emergency Planning & Response	1910.38(a)(1) **R**	12.3 Does the action plan cover those designated actions employers and employees must take to ensure employee safety from fire and other emergencies?		
12	Emergency Planning & Response	38(a)(2)(I-vi) **R, O, I**	12.4 Does the emergency action plan include the following elements:		
12	Emergency Planning & Response	119(n) 68.95(a) **R**	12.1 Has a written emergency action plan been established and implemented for the entire plant per 1910.38?	ICP Core Plan for Spills OMES Section 4 (Fire), 7 (Emergency Response Procedure)	
12	Emergency Planning & Response	119(n) **R**	12.2 Does the emergency action plan include procedures for handling small releases and spills?	Small/Medium/Worst Case identified in ICP Appendix D RFP Tab A-1	
12	Emergency Planning & Response	1910.38(a)(1) **R**	12.3 Does the action plan cover those designated actions employers and employees must take to ensure employee safety from fire and other emergencies?	Actions for Response in Section 7 OMES	
12	Emergency Planning & Response	38(a)(2)(i-vi) **R, O, I**	12.4 Does the emergency action plan include the following elements:		
12	Emergency Planning & Response		a) Emergency escape procedures and emergency escape route assignments?	ERP 7.2 says on-scene commander can evacuate the facility. Assembly locations in Appendix L of ICP Facility Response Plan describes 6 emergency evacuation zones within the Red Hill Storage Facility, each with a primary and alternate escape route.	
12	Emergency Planning & Response		b) Procedures to be followed by employees who remain to operate critical plant operations before they evacuate?	OMES Section 7 FRP Tab 2.0 shows Immediate Response Actions, as does FRP RP.1	
12	Emergency Planning & Response		c) Procedures to account for all employees after emergency evacuation have been completed?	FRP Section 12.3 states, "Supervisor must conduct a Head Count and report to the CRO when his/her employees have cleared the facility and if anyone is missing."	Ensure personnel are trained and there is a system in place to carry out and document head count following a local muster or evacuation.
12	Emergency Planning & Response		d) Rescue and medical duties for those employees who are to perform them?	FRP Site Safety Plan requirements in Section 9.7 include rescue and medical facilities.	
12	Emergency Planning & Response		e) The preferred means of reporting fires and other emergencies?	OMES Section 7 FRP Section 2.0 and Appendix A Notifications	
12	Emergency Planning & Response		f) Names or regular job titles of persons or departments who can be contacted for further information or explanation of duties under the plan?	Contact information in Section 10.3.1 of FRP	

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
12	Emergency Planning & Response		g) Employee alarm systems?	Fire alarm, Voice FRP Section 4.2 describes Class A detection and Mass Notification system controlled from UGH and Lower Tank Gallery Gauger Station.	Typically facilities have alarms for local emergencies (leave the work area and muster at a safe distance) and evacuation alarms (evacuate the facility). It is recommended to distinguish between local emergencies with muster points, and evacuation emergencies. All employees entering the facility should be trained on the types of alarms and muster/evacuation routes via a initial orientation. It is recommended that alarms are tested weekly to ensure alarm operability and to raise awareness of employee understanding of alarm types.
12	Emergency Planning & Response	1910.165 **R, O, I**	12.5 Is an alarm system established and implemented which complies with 1910.165? Are the alarms:	Fire alarm signals referenced in ERP Table 7.1 and FRP Section 4.2	
12	Emergency Planning & Response		a) Distinctive for each purpose or the alarm?	Notification devices, manual page and pre-recorded message all available in the fire alarm system	
12	Emergency Planning & Response		b) Capable of being perceived above ambient noise and light levels by all employees in the affected portions of the workplace?		
12	Emergency Planning & Response		c) Distinctive and recognizable as a signal to evacuate the work area or perform actions designated under the plan?		
12	Emergency Planning & Response		d) Maintained in operating condition?		
12	Emergency Planning & Response		e) Tested appropriately (non-supervised every 2 months; supervised annually) and restored to normal operating condition as soon as possible after testing?		
12	Emergency Planning & Response		f) Serviced, maintained, and tested by appropriately trained persons?		
12	Emergency Planning & Response		g) Unobstructed, conspicuous and readily accessible, if they are manual alarm systems?	There are pull to activate alarms in the tunnels (visual verification).	
12	Emergency Planning & Response	38(a)(5)(i) **R**	12.6 Has the employer, before implementing the emergency action plan, designated and trained a sufficient number of persons to assist in the safe and orderly emergency evacuation of employees?	Roles and numbers on Spill Management Team are shown in Table 10.9 of FRP.	
12	Emergency Planning & Response	38(a)(5)(ii) **R, I**	12.7 Is the emergency action plan reviewed with each employee covered by the plan:	Plan is reviewed for new employees in Fuels Department as per OMES Section 7.	
12	Emergency Planning & Response		a) Initially when the plan is developed?		
12	Emergency Planning & Response		b) Whenever the employee's responsibilities or designated actions under the emergency action plan change?		

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
12	Emergency Planning & Response		c) Whenever the emergency action plan, itself, is changed?		
12	Emergency Planning & Response	38(a)(5)(iii) **R, I**	12.8 Does the employer review with each employee upon initial assignment those parts of the plan which the employee must know to protect themselves in the event of an emergency?	Operations and Maintenance and Fuels employees receive training, OMES Section 8. New employees in Fuels receive training.	
12	Emergency Planning & Response	1910.120(q) (1) 1910.38(a)(5)(iii) **R,I**	12.9 Has a written emergency response plan been developed and implemented to handle anticipated emergencies and is it available for inspection and copying by employees, their representatives, and OSHA personnel?		
12	Emergency Planning & Response	120(q)(2) (i-xi) 120(p)(8)(iv) (A)(1-2) **R, I**	12.10 Does the emergency response plan address, as a minimum, the following:		
12	Emergency Planning & Response		a) Pre-emergency planning and coordination with outside parties?	Spill Response Contractors listed in Table RP.3 of FRP	
12	Emergency Planning & Response		b) Personnel roles, lines of authority, training, and communication?	FRP Section 10.2.2 Spill Management Team - Navy uses Incident Command System for spill response organizations Appendix B of ICP	
12	Emergency Planning & Response		c) Emergency recognition and prevention?		
12	Emergency Planning & Response		d) Safe distances and places of refuge?	Facility evacuation escape routes and locations in ICP.	
12	Emergency Planning & Response		e) Site security and control?	Not addressed in ERP	
12	Emergency Planning & Response		f) Evacuation routes and procedures?	ICP Appendix L FRP describes 6 evacuation zones and procedures	
12	Emergency Planning & Response		g) Decontamination?	Site Safety Plan requirement to have decontamination methods, requirement of FRP Section 9.7	
12	Emergency Planning & Response		h) Emergency medical treatment and first aid?	Addressed in FRP Section 9.2 and FRP Section 9.7 Site Safety Plan	
12	Emergency Planning & Response		i) Emergency alerting and response procedures?	Fire alarms, notification to IC and outside agencies addressed Section 7.3 of ERP FRP RP.1 - Anyone observing a spill or release notifies the CRO; the CRO notifies all workers and notifies the NAVSUP FLCPH Oil Spill Response Team	
12	Emergency Planning & Response		j) Critique of response and follow-up?	No	Ensure an emergency response critique is carried out, documented, and that actions are followed up after each actual emergency response or drill.

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
12	Emergency Planning & Response		k) PPE and emergency equipment?	PPE in FRP Section 9.8 and 9.7 Site Safety Plan Oil spill equipment is shown in ICP As per the FRP - Oil Proof Door holds the full contents of one of the RH Tanks in the LAT Frame Foot mark spreadsheet shows equipment at each frame in the tunnel Maintenance of OPD, ATG, Tank Tightness Testing described	
12	Emergency Planning & Response		l) Site topography, layout and prevailing weather conditions?	FRP Section 2.0 Facility Information	
12	Emergency Planning & Response		m) Procedures for reporting incidents to local, State and Federal governmental agencies?	Notifications in ICP and ERP FRP Table A.1 Spiller Notification Check-Off list lists each Agency, phone number, and person/date notified Internal notifications are also listed	
12	Emergency Planning & Response	1910.12 **R**	12.11 If applicable, has the employer addressed the requirements of 1910.120(p) for RCRA Treatment, Storage, and Disposal (TSD) Facilities?	ICP Appendix K - Waste Management and Disposal FRP Section 11	
12	Emergency Planning & Response	1910.120(q) **R, I**	12.12 Has training been provided to employees who are likely to discover releases or respond to them, based on the duties they are expected to perform?	RP Section Scenario Tab 2.0 describes the Immediate Response Actions.	
12	Emergency Planning & Response	1910.120(q) **R, I**	12.13 Can employees who have received training in HAZWOPER in first responder awareness level or operations level, or as a HAZMAT technician demonstrate the competencies necessary for these designations?	FRP Section 10.2.1 Table 10.9 lists HAZWOPER training requirements for Response Team members.	
12	Emergency Planning & Response	GMP **R**	GMP1 Are procedures for containing and clean up of minor releases developed in advance?		
12	Emergency Planning & Response	GMP **R, I**	GMP2 Is appropriate equipment provided for the control and clean up of minor releases?		
12	Emergency Planning & Response	GMP **R, I**	GMP3 Are employees who will respond to minor releases appropriately trained?		
12	Emergency Planning & Response	GMP **R**	GMP4 Are emergency drills or simulated exercises conducted on a periodic basis?		
12	Emergency Planning & Response	GMP **R**	GMP5 Are analyses conducted of drills or exercises, the results documented, and actions taken, if needed, to improve the response plan based on the results?		
12	Emergency Planning & Response	GMP **R**	GMP6 Are local community emergency response planners and responder organizations included?		
12	Emergency Planning & Response	GMP **R**	GMP7 Are stationary and rolling stock emergency response equipment routinely checked and demonstrated when possible?		

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
12	Emergency Planning & Response	GMP **R**	GMP8 Are contract employees included in emergency drills?		
12	Emergency Planning & Response	68.95	**Does the emergency response plan contain the following elements?**		
12	Emergency Planning & Response	68.95(a)(1) (i) **R**	12.23 Procedures for informing the public and local emergency response agencies about accidental releases?		
12	Emergency Planning & Response	68.95(a)(1) (ii) **R**	12.24 Documentation of proper first aid and emergency medical treatment necessary to treat accidental human exposure?		
12	Emergency Planning & Response	68.95(a)(1) (iii) **R**	12.25 Procedures and measures for emergency response after an accidental release of a regulated substance?		
12	Emergency Planning & Response	68.95(b) **R**	12.26 Was a written plan used that complies with other Federal contingency plan regulations or is consistent with the approach in the National Response Team's Integrated Contingency Plan Guidance ("One Plan")? If so, does the plan include the elements provided in paragraph (a) of 68.95, and also complies with paragraph (c) of 68.95?		
12	Emergency Planning & Response	68.95 (c) **R**	12.27 Has the emergency response plan been coordinated with the community emergency response plan developed under EPCRA?		
12	Emergency Planning & Response	68.95(d) **R**	12.28 Have local emergency response officials been provided information necessary for developing and implementing the community emergency response plan requested by the LEPC or emergency response officials?		
12	Emergency Planning & Response	GMP **R**	GMP1 Are procedures for containing and clean up of minor releases developed in advance?		
12	Emergency Planning & Response	GMP **R, I**	GMP2 Is appropriate equipment provided for the control and clean up of minor releases?		
12	Emergency Planning & Response	GMP **R, I**	GMP3 Are employees who will respond to minor releases appropriately trained?		
12	Emergency Planning & Response	GMP **R**	GMP4 Are emergency drills or simulated exercises conducted on a periodic basis?		
12	Emergency Planning & Response	GMP **R**	GMP5 Are analyses conducted of drills or exercises, the results documented, and actions taken, if needed, to improve the response plan based on the results?		
12	Emergency Planning & Response	GMP **R**	GMP6 Are local community emergency response planners and responder organizations included?		
12	Emergency Planning & Response	GMP **R**	GMP7 Are stationary and rolling stock emergency response equipment routinely checked and demonstrated when possible?		

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
12	Emergency Planning & Response	GMP **R**	GMP8 Are contract employees included in emergency drills?		
13	Compliance Audits	119(o)(1) 40.68.79(a) **R**	13.1 Based on a representative sample of previous PSM/RMP audits, have audits been conducted at least every three years?	Compliance audits are not part of this scope.	
13	Compliance Audits	119(o) **R**	13.2 Based on a representative sample of previous PSM/RMP audits, do the audits include the certification required?		
13	Compliance Audits	119(o)(2) 68.79(b) **R,I**	13.3 Based on a representative sample of previous PSM/RMP audits, did the PSM/RMP audit team include:		
13	Compliance Audits		a) a person knowledgeable in the process being audited?		
13	Compliance Audits		b) personnel with appropriate knowledge of auditing techniques and PSM/RMP?		
13	Compliance Audits	119(o)(3) 68.79(c) **R**	13.4 Was a report containing the findings of the audit developed?		
13	Compliance Audits	119(o)(4) 40.68.79(d) **R**	13.5 Based on a review of a representative sample of completed PSM/RMP audits, was an appropriate response to each of the findings of the audit promptly determined and documented?		
13	Compliance Audits	119(o)(4) 40.68.79(d) **R**	13.6 Based on a review of a representative sample of completed audits, are the actions that were taken to address "deficiencies" documented?		
13	Compliance Audits	119(o)(5) 40.68.79(d) **R**	13.7 Based on a review of a representative sample of completed PSM/RMP audits, were the two most recent PSM/RMP audits retained?		
13	Compliance Audits	GMP **R**	GMP1 Is there a written procedure in place to address PSM/RMP compliance audits?		
13	Compliance Audits	GMP **R**	GMP2 Based on a representative sample of previous PSM/RMP audits, were a sufficient number of processes selected for auditing to adequately assess the overall level of compliance with the standard?		
13	Compliance Audits	GMP **R**	GMP3 Does the report identify the team members and their background/ expertise?		
13	Compliance Audits	GMP **R**	GMP4 Was the audit report issued promptly on completion of the audit?		
13	Compliance Audits	GMP **R**	GMP5 Did the audit findings identify areas that require responsive action as well as areas where the PSM/RMP system is well implemented?		
13	Compliance Audits	GMP **R**	GMP6 Based on a review of the written audit procedure and previous completed audits, is there a system in place to promptly address the teams findings and recommendations?		
13	Compliance Audits	GMP **R**	GMP7 Is there a management review of the audit findings?		

Element #	Element Name	Reference[1]	Question	Evidence of Compliance / Findings	Recommendation
13	Compliance Audits	GMP I	GMP8 Based on interviews with a representative number of employees, were the results of audits communicated to affected employees?		

[1] GMP = Good Management Practice, R = Records Review, O = On-Site Conditions, I = Interviews
[2] R = Regulatory, P = Policy, O = Observation
[3] 1 = Immediate Action Required, 2 = Priority Action Required, 3 = Action Required

APPENDIX F EPA SPCC CHECKLIST

U.S. ENVIRONMENTAL PROTECTION AGENCY
SPCC FIELD INSPECTION AND PLAN REVIEW CHECKLIST

ONSHORE FACILITIES (EXCLUDING OIL DRILLING, PRODUCTION AND WORKOVER)

Overview of the Checklist

This checklist is designed to assist EPA inspectors in conducting a thorough and nationally consistent inspection of a facility's compliance with the Spill Prevention, Control, and Countermeasure (SPCC) rule at 40 CFR part 112. It is a required tool to help federal inspectors (or their contractors) record observations for the site inspection and review of the SPCC Plan. While the checklist is meant to be comprehensive, the inspector should always refer to the SPCC rule in its entirety, the SPCC Regional Inspector Guidance Document, and other relevant guidance for evaluating compliance. This checklist must be completed in order for an inspection to count toward an agency measure (i.e., OEM inspection measures or GPRA). The completed checklist and supporting documentation (i.e. photo logs or additional notes) serve as the inspection report.

This checklist addresses requirements for onshore facilities including Tier II Qualified Facilities (excluding facilities involved in oil drilling, production and workover activities) that meet the eligibility criteria set forth in §112.3(g)(2).

Separate standalone checklists address requirements for:
Onshore oil drilling, production, and workover facilities including Tier II Qualified Facilities as defined in §112.3(g)(2);
Offshore drilling, production and workover facilities; and
Tier I Qualified Facilities (for facilities that meet the eligibility criteria defined in §112.3(g)(1))

Qualified facilities must meet the rule requirements in §112.6 and other applicable sections specified in §112.6, except for deviations that provide environmental equivalence and secondary containment impracticability determinations as allowed under §112.6.

The checklist is organized according to the SPCC rule. Each item in the checklist identifies the relevant section and paragraph in 40 CFR part 112 where that requirement is stated.

- Sections 112.1 through 112.5 specify the applicability of the rule and requirements for the preparation, implementation, and amendment of SPCC Plans. For these sections, the checklist includes data fields to be completed, as well as several questions with "yes," "no" or "NA" answers.
- Section 112.6 includes requirements for qualified facilities. These provisions are addressed in Attachment D.
- Section 112.7 includes general requirements that apply to all facilities (unless otherwise excluded).
- Sections 112.8 and 112.12 specify requirements for spill prevention, control, and countermeasures for onshore facilities (excluding production facilities).

The inspector needs to evaluate whether the requirement is addressed adequately or inadequately in the SPCC Plan and whether it is implemented adequately in the field (either by field observation or record review). For the SPCC Plan and implementation in the field, if a requirement is addressed adequately, mark the "Yes" box in the appropriate column. If a requirement is not addressed adequately, mark the "No" box. If a requirement does not apply to the particular facility or the question asked is not appropriate for the facility, mark as "NA". Discrepancies or descriptions of inspector interpretation of "No" vs. "NA" may be documented in the comments box subsequent to each section. If a provision of the rule applies only to the SPCC Plan, the "Field" column is shaded.

Space is provided throughout the checklist to record comments. Additional space is available as Attachment E at the end of the checklist. Comments should remain factual and support the evaluation of compliance.

<u>Attachments</u>

- Attachment A is for recording information about containers and other locations at the facility that require secondary containment.
- Attachment B is a checklist for documentation of the tests and inspections the facility operator is required to keep with the SPCC Plan.
- Attachment C is a checklist for oil spill contingency plans following 40 CFR 109. Unless a facility has submitted a Facility Response Plan (FRP) under 40 CFR 112.20, a contingency plan following 40 CFR 109 is required if a facility determines that secondary containment is impracticable as provided in 40 CFR 112.7(d). The same requirement for an oil spill contingency plan applies to the owner or operator of a facility with qualified oil-filled operational equipment that chooses to implement alternative requirements instead of general secondary containment requirements as provided in 40 CFR 112.7(k).
- Attachment D is a checklist for Tier II Qualified Facilities.
- Attachment E is for recording additional comments or notes.
- Attachment F is for recording information about photos.

FACILITY INFORMATION			
FACILITY NAME: Joint Base Pearl Harbor-Hickam (JBPHH)			
LATITUDE: 21 degrees 21' 30"	LONGITUDE: 157 degrees 56' 54"	GPS DATUM: NA	
Section/Township/Range: NA	FRS#/OIL DATABASE ID: NA	ICIS#: NA	
ADDRESS: 850 Ticonderoga Street, Suite 110			
CITY: JBPHH	STATE: Hawaii	ZIP: 96808-5101	COUNTY: Honolulu
MAILING ADDRESS (IF DIFFERENT FROM FACILITY ADDRESS – IF NOT, PRINT "SAME"): SAME			
CITY:	STATE:	ZIP:	COUNTY:
TELEPHONE:	FACILITY CONTACT NAME/TITLE:		
OWNER NAME: Commander, Navy Region Hawaii			
OWNER ADDRESS: 850 Ticonderoga Street, Suite 110			
CITY: JB Pearl Harbor-Hickam	STATE: Hawaii	ZIP: 96860-5101	COUNTY: Honolulu
TELEPHONE: (808) 471-3926	FAX:	EMAIL:	
FACILITY OPERATOR NAME (F DIFFERENT FROM OWNER – IF NOT, PRINT "SAME"): SAME			
OPERATOR ADDRESS:			
CITY:	STATE:	ZIP:	COUNTY:
TELEPHONE:	OPERATOR CONTACT NAME/TITLE:		
FACILITY TYPE: Department of Defense joint military base	NAICS CODE: 928110		
HOURS PER DAY FACILITY ATTENDED: 24	TOTAL FACILITY CAPACITY: 48,244,112 gallons (AST)		
TYPE(S) OF OIL STORED: Hydrocarbon fuels - F24 (JP5), F27 (Jet A), F76 (Marine Diesel) and Lube Oils			
LOCATED IN INDIAN COUNTRY? ☐ YES ☑ NO RESERVATION NAME:			
INSPECTION/PLAN REVIEW INFORMATION			
PLAN REVIEW DATE: 2/14/22-2/18/22	REVIEWER NAME [redacted] (b)(6)		
INSPECTION DATE: 2/14/22-2/18/22	TIME: 0800-1600	ACTIVITY ID NO: NA	
LEAD INSPECTOR: [redacted] (b)(6)			
OTHER INSPECTOR			
INSPECTION ACKNOWLEDGMENT			
I performed an SPCC inspection at the facility specified above.			
INSPECTOR SIGNATURE:	DATE: 2/18/2022		
SUPERVISOR REVIEW/SIGNATURE:	DATE: 2/18/2022		

SPCC GENERAL APPLICABILITY—40 CFR 112.1

IS THE FACILITY REGULATED UNDER 40 CFR part 112?

The completely buried oil storage capacity is over 42,000 U.S. gallons, **OR** the aggregate aboveground oil storage capacity is over 1,320 U.S. gallons **AND** — ☑ Yes ☐ No

The facility is a non-transportation-related facility engaged in drilling, producing, gathering, storing, processing, refining, transferring, distributing, using, or consuming oil and oil products, which due to its location could reasonably be expected to discharge oil into or upon the navigable waters of the United States — ☑ Yes ☐ No

AFFECTED WATERWAY(S): Halawa and Moanalua Streams, Pearl Harbor | DISTANCE: Less than 1/4 mile

FLOW PATH TO WATERWAY:

Facility has multiple flow paths to either Halawa Stream or directly to Pearl Harbor. The most likely spill scenario would be a tank overfill at the Upper Tank Farm (UTF) into the containment area and then from the containment area (via discharge pipe or overfill) to Pearl Harbor or from the truck loading rack or pier/dock directly into Pearl Harbor.

Note: The following storage capacity is not considered in determining applicability of SPCC requirements:

- *Equipment subject to the authority of the U.S. Department of Transportation, U.S. Department of the Interior, or Minerals Management Service, as defined in Memoranda of Understanding dated November 24, 1971, and November 8, 1993; Tank trucks that return to an otherwise regulated facility that contain only residual amounts of oil (EPA Policy letter)*
- *Completely buried tanks subject to all the technical requirements of 40 CFR part 280 or a state program approved under 40 CFR part 281;*
- *Underground oil storage tanks deferred under 40 CFR part 280 that supply emergency diesel generators at a nuclear power generation facility licensed by the Nuclear Regulatory Commission (NRC) and subject to any NRC provision regarding design and quality criteria, including but not limited to CFR part 50;*
- *Any facility or part thereof used exclusively for wastewater treatment (production, recovery or recycling of oil is not considered wastewater treatment); (This does not include other oil containers located at a wastewater treatment facility, such as generator tanks or transformers)*
- *Containers smaller than 55 U.S. gallons;*
- *Permanently closed containers (as defined in §112.2);*
- *Motive power containers(as defined in §112.2);*
- *Hot-mix asphalt or any hot-mix asphalt containers;*
- *Heating oil containers used solely at a single-family residence;*
- *Pesticide application equipment and related mix containers;*
- *Any milk and milk product container and associated piping and appurtenances; and*
- *Intra-facility gathering lines subject to the regulatory requirements of 49 CFR part 192 or 195.*

Does the facility have an SPCC Plan? — ☑ Yes ☐ No

FACILITY RESPONSE PLAN (FRP) APPLICABILITY—40 CFR 112.20(f)

A non-transportation related onshore facility is required to prepare and implement an FRP as outlined in 40 CFR 112.20 if:

☑ The facility transfers oil over water to or from vessels and has a total oil storage capacity greater than or equal to 42,000 U.S. gallons, **OR**

☑ The facility has a total oil storage capacity of at least 1 million U.S. gallons, **AND** at least one of the following is true:

- ☐ The facility does not have secondary containment sufficiently large to contain the capacity of the largest aboveground tank plus sufficient freeboard for precipitation.
- ☑ The facility is located at a distance such that a discharge could cause injury to fish and wildlife and sensitive environments.
- ☐ The facility is located such that a discharge would shut down a public drinking water intake.
- ☐ The facility has had a reportable discharge greater than or equal to 10,000 U.S. gallons in the past 5 years.

Facility has FRP: ☑ Yes ☐ No ☐ NA | FRP Number: NA

Facility has a completed and signed copy of Appendix C, Attachment C-II, "Certification of the Applicability of the Substantial Harm Criteria." — ☑ Yes ☐ No

Comments:

Certification of the Applicability of the Substantial Harm Criteria is included in the Facility's ICP.

SPCC TIER II QUALIFIED FACILITY APPLICABILITY—40 CFR 112.3(g)(2)	
The aggregate aboveground oil storage capacity is 10,000 U.S. gallons or less **AND**	☐ Yes ☑ No
In the three years prior to the SPCC Plan self-certification date, or since becoming subject to the rule (if the facility has been in operation for less than three years), the facility has **NOT** had:	
• A single discharge as described in §112.1(b) exceeding 1,000 U.S. gallons, **OR**	☐ Yes ☐ No
• Two discharges as described in §112.1(b) each exceeding 42 U.S. gallons within any twelve-month period[1]	☐ Yes ☐ No

IF ***YES*** TO ALL OF THE ABOVE, THEN THE FACILITY IS A TIER II QUALIFIED FACILITY[2]
SEE ATTACHMENT D FOR TIER II QUALIFIED FACILITY CHECKLIST

REQUIREMENTS FOR PREPARATION AND IMPLEMENTATION OF A SPCC PLAN—40 CFR 112.3

Date facility began operations: 1925 (approximately)

Date of initial SPCC Plan preparation: NA | Current Plan version (date/number): December 2019

112.3(a)	**For facilities (except farms), including mobile or portable facilities:**	
	• In operation on or prior to November 10, 2011: Plan prepared and/or amended and fully implemented by **November 10, 2011**	☑ Yes ☐ No ☐ NA
	• Beginning operations after November 10, 2011, Plan prepared and fully implemented before beginning operations	☐ Yes ☐ No ☑ NA
	For farms (as defined in §112.2):	
	• In operation on or prior to August 16, 2002: Plan maintained, amended and implemented by **May 10, 2013**	☐ Yes ☐ No ☑ NA
	• Beginning operations after August 16, 2002 through May 10, 2013: Plan prepared and fully implemented by **May 10, 2013**	☐ Yes ☐ No ☑ NA
	• Beginning operations after May 10, 2013: Plan prepared and fully implemented before beginning operations	☐ Yes ☐ No ☑ NA
112.3(d)	Plan is certified by a registered Professional Engineer (PE) and includes statements that the PE attests:	☑ Yes ☐ No ☐ NA
	• PE is familiar with the requirements of 40 CFR part 112	☑ Yes ☐ No ☐ NA
	• PE or agent has visited and examined the facility	☑ Yes ☐ No ☐ NA
	• Plan is prepared in accordance with good engineering practice including consideration of applicable industry standards and the requirements of 40 CFR part 112	☑ Yes ☐ No ☐ NA
	• Procedures for required inspections and testing have been established	☑ Yes ☐ No ☐ NA
	• Plan is adequate for the facility	☑ Yes ☐ No ☐ NA
[redacted] (b)(6)		
112.3(e)(1)	Plan is available onsite if attended at least 4 hours per day. If facility is unattended, Plan is available at the nearest field office. *(Please note nearest field office contact information in comments section below.)*	☑ Yes ☐ No ☐ NA

Comments:

[1] Oil discharges that result from natural disasters, acts of war, or terrorism are not included in this determination. The gallon amount(s) specified (either 1,000 or 42) refers to the amount of oil that actually reaches navigable waters or adjoining shorelines not the total amount of oil spilled. The entire volume of the discharge is oil for this determination.

[2] An owner/operator who self-certifies a Tier II SPCC Plan may include environmentally equivalent alternatives and/or secondary containment impracticability determinations when reviewed and certified by a PE.

AMENDMENT OF SPCC PLAN BY REGIONAL ADMINISTRATOR (RA)—40 CFR 112.4		
112.4(a),(c)	Has the facility discharged more than 1,000 U.S. gallons of oil in a single reportable discharge or more than 42 U.S. gallons in each of two reportable discharges in any 12-month period?[3]	☑ Yes ☐ No
If **YES**	• Was information submitted to the RA as required in §112.4(a)?[4]	☑ Yes ☐ No ☐ NA
	• Was information submitted to the appropriate agency or agencies in charge of oil pollution control activities in the State in which the facility is located§112.4(c)	☑ Yes ☐ No ☐ NA
	• Date(s) and volume(s) of reportable discharges(s) under this section: July 25, 2019, 50 gallons; Octeber 28, 2019, 1,000 gallons	
	• Were the discharges reported to the NRC[5]?	☑ Yes ☐ No
112.4(d),(e)	Have changes required by the RA been implemented in the Plan and/or facility?	☐ Yes ☐ No ☑ NA
Comments:		

AMENDMENT OF SPCC PLAN BY THE OWNER OR OPERATOR—40 CFR 112.5		
112.5(a)	Has there been a change at the facility that materially affects the potential for a discharge described in §112.1(b)?	☐ Yes ☑ No
If **YES**	• Was the Plan amended within six months of the change?	☐ Yes ☐ No
	• Were amendments implemented within six months of any Plan amendment?	☐ Yes ☐ No
112.5(b)	Review and evaluation of the Plan completed at least once every 5 years?	☑ Yes ☐ No ☐ NA
	Following Plan review, was Plan amended within six months to include more effective prevention and control technology that has been field-proven to significantly reduce the likelihood of a discharge described in §112.1(b)?	☐ Yes ☐ No ☑ NA
	Amendments implemented within six months of any Plan amendment?	☐ Yes ☐ No ☑ NA
	Five year Plan review and evaluation documented?	☑ Yes ☐ No ☐ NA
112.5(c)	Professional Engineer certification of any technical Plan amendments in accordance with all applicable requirements of §112.3(d) *[Except for self-certified Plans]*	☐ Yes ☐ No ☑ NA

Name:	License No.:	State:	Date of certification:

Reason for amendment:

Comments:

[3] A reportable discharge is a discharge as described in §112.1(b)(see 40 CFR part 110). The gallon amount(s) specified (either 1,000 or 42) refers to the amount of oil that actually reaches navigable waters or adjoining shorelines not the total amount of oil spilled. The entire volume of the discharge is oil for this determination.

[4] Triggering this threshold may disqualify the facility from meeting the Qualified Facility criteria if it occurred in the three years prior to self certification

[5] Inspector Note-Confirm any spills identified above were reported to NRC

GENERAL SPCC REQUIREMENTS—40 CFR 112.7		**PLAN**	**FIELD**
Management approval at a level of authority to commit the necessary resources to fully implement the Plan[6]		☑ Yes ☐ No	
Plan follows sequence of the rule or is an equivalent Plan meeting all applicable rule requirements and includes a cross-reference of provisions		☑ Yes ☐ No ☐ NA	
If Plan calls for facilities, procedures, methods, or equipment not yet fully operational, details of their installation and start-up are discussed *(Note: Relevant for inspection evaluation and testing baselines.)*		☐ Yes ☐ No ☑ NA	
112.7(a)(2)	The Plan includes deviations from the requirements of §§112.7(g), (h)(2) and (3), and (i) and applicable subparts B and C of the rule, except the secondary containment requirements in §§112.7(c) and (h)(1), 112.8(c)(2),112.8(c)(11), 112.12(c)(2), and 112.12(c)(11)	☐ Yes ☐ No ☑ NA	
If **YES**	• The Plan states reasons for nonconformance	☐ Yes ☐ No ☐ NA	
	• Alternative measures described in detail and provide equivalent environmental protection *(Note: Inspector should document if the environmental equivalence is implemented in the field, in accordance with the Plan's description)*	☐ Yes ☐ No ☐ NA	☐ Yes ☐ No ☐ NA
Describe each deviation and reasons for nonconformance:			

[6] May be part of the Plan or demonstrated elsewhere.

		PLAN	FIELD
112.7(a)(3)	Plan describes physical layout of facility and includes a diagram[7] that identifies: • Location and contents of all regulated fixed oil storage containers • Storage areas where mobile or portable containers are located • Completely buried tanks otherwise exempt from the SPCC requirements (marked as "exempt") • Transfer stations • Connecting pipes, including intra-facility gathering lines that are otherwise exempt from the requirements of this part under §112.1(d)(11)	☑ Yes ☐ No	☑ Yes ☐ No
	Plan addresses each of the following:		
(i)	For each fixed container, type of oil and storage capacity (see Attachment A of this checklist). For mobile or portable containers, type of oil and storage capacity for each container or an estimate of the potential number of mobile or portable containers, the types of oil, and anticipated storage capacities	☑ Yes ☐ No	☑ Yes ☐ No
(ii)	Discharge prevention measures, including procedures for routine handling of products (loading, unloading, and facility transfers, etc.)	☑ Yes ☐ No	☑ Yes ☐ No
(iii)	Discharge or drainage controls, such as secondary containment around containers, and other structures, equipment, and procedures for the control of a discharge	☑ Yes ☐ No	☑ Yes ☐ No
(iv)	Countermeasures for discharge discovery, response, and cleanup (both facility's and contractor's resources)	☑ Yes ☐ No	☑ Yes ☐ No
(v)	Methods of disposal of recovered materials in accordance with applicable legal requirements	☑ Yes ☐ No	
(vi)	Contact list and phone numbers for the facility response coordinator, National Response Center, cleanup contractors with an agreement for response, and all Federal, State, and local agencies who must be contacted in the case of a discharge as described in §112.1(b)	☑ Yes ☐ No	
112.7(a)(4)	***Does not apply if the facility has submitted an FRP under §112.20:*** Plan includes information and procedures that enable a person reporting an oil discharge as described in §112.1(b) to relate information on the: • Exact address or location and phone number of the facility; • Date and time of the discharge; • Type of material discharged; • Estimates of the total quantity discharged; • Estimates of the quantity discharged as described in §112.1(b); • Source of the discharge; • Description of all affected media; • Cause of the discharge; • Damages or injuries caused by the discharge; • Actions being used to stop, remove, and mitigate the effects of the discharge; • Whether an evacuation may be needed; and • Names of individuals and/or organizations who have also been contacted.	☐ Yes ☐ No ☑ NA	
112.7(a)(5)	***Does not apply if the facility has submitted a FRP under §112.20:*** Plan organized so that portions describing procedures to be used when a discharge occurs will be readily usable in an emergency	☐ Yes ☐ No ☑ NA	
112.7(b)	Plan includes a prediction of the direction, rate of flow, and total quantity of oil that could be discharged for each type of major equipment failure where experience indicates a reasonable potential for equipment failure	☑ Yes ☐ No ☐ NA	

Comments:

[7] Note in comments any discrepancies between the facility diagram, the description of the physical layout of facility, and what is observed in the field

		PLAN	FIELD
112.7(c)	Appropriate containment and/or diversionary structures or equipment are provided to prevent a discharge as described in §112.1(b), **except as provided in §112.7(k) of this section for certain qualified operational equipment**. The entire containment system, including walls and floors, are capable of containing oil and are constructed to prevent escape of a discharge from the containment system before cleanup occurs. The method, design, and capacity for secondary containment address the typical failure mode and the most likely quantity of oil that would be discharged. See Attachment A of this checklist. **For onshore facilities**, one of the following or its equivalent: • Dikes, berms, or retaining walls sufficiently impervious to contain oil; • Curbing or drip pans; • Sumps and collection systems; • Culverting, gutters or other drainage systems; • Weirs, booms or other barriers; • Spill diversion pond; • Retention ponds; or • Sorbent materials.		
	Identify which of the following are present at the facility and if appropriate containment and/or diversionary structures or equipment are provided as described above:		
	☑ Bulk storage containers	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	☑ Mobile/portable containers	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	☑ Oil-filled operational equipment (as defined in 112.2)	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	☐ Other oil-filled equipment (i.e., manufacturing equipment)	☐ Yes ☐ No ☑ NA	☐ Yes ☐ No ☑ NA
	☑ Piping and related appurtenances	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	☑ Mobile refuelers or non-transportation-related tank cars	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	☑ Transfer areas, equipment and activities	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	☐ Identify any other equipment or activities that are not listed above:	☐ Yes ☐ No ☐ NA	☐ Yes ☐ No ☐ NA
112.7(d)	Secondary containment for one (or more) of the following provisions is determined to be impracticable: ☐ General secondary containment §112.7(c) ☐ Bu k storage containers §§112.8(c)(2)/112.12(c)(2) ☐ Loading/unloading rack §112.7(h)(1) ☐ Mobile/portable containers§§112.8(c)(11)/ 112.12(c)(11)	☐ Yes ☑ No	
If **YES**	• The impracticability of secondary containment is clearly demonstrated and described in the Plan	☐ Yes ☐ No ☐ NA	☐ Yes ☐ No ☐ NA
	• For bulk storage containers,[8] periodic integrity testing of containers and integrity and leak testing of the associated valves and piping is conducted	☐ Yes ☐ No ☐ NA	☐ Yes ☐ No ☐ NA
	(Does not apply if the facility has submitted a FRP under §112.20): • Contingency Plan following the provisions of 40 CFR part 109 is provided (see Attachment C of this checklist) **AND**	☐ Yes ☐ No ☐ NA	
	• Written commitment of manpower, equipment, and materials required to expeditiously control and remove any quantity of oil discharged that may be harmful	☐ Yes ☐ No ☐ NA	☐ Yes ☐ No ☐ NA

Comments:

[8] These additional requirements apply only to bulk storage containers, when an impracticability determination has been made by the PE

		PLAN	FIELD
112.7(e)	Inspections and tests conducted in accordance with written procedures	☑ Yes ☐ No	☑ Yes ☐ No
	Record of inspections or tests signed by supervisor or inspector	☑ Yes ☐ No	☑ Yes ☐ No
	Kept with Plan for at least 3 years (see Attachment B of this checklist)[9]	☑ Yes ☐ No	☑ Yes ☐ No
112.7(f)	Personnel, training, and oil discharge prevention procedures		
(1)	Training of oil-handling personnel in operation and maintenance of equipment to prevent discharges; discharge procedure protocols; applicable pollution control laws, rules, and regulations; general facility operations; and contents of SPCC Plan	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
(2)	Person designated as accountable for discharge prevention at the facility and reports to facility management	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
(3)	Discharge prevention briefings conducted at least once a year for oil handling personnel to assure adequate understanding of the Plan. Briefings highlight and describe known discharges as described in §112.1(b) or failures, malfunctioning components, and any recently developed precautionary measures	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
112.7(g)	Plan describes how to: • Secure and control access to the oil handling, processing and storage areas; • Secure master flow and drain valves; • Prevent unauthorized access to starter controls on oil pumps; • Secure out-of-service and loading/unloading connections of oil pipelines; and • Address the appropriateness of security lighting to both prevent acts of vandalism and assist in the discovery of oil discharges.	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
112.7(h)	Tank car and tank truck loading/unloading rack[10] is present at the facility		☑ Yes ☐ No
	Loading/unloading rack means a fixed structure (such as a platform, gangway) necessary for loading or unloading a tank truck or tank car, which is located at a facility subject to the requirements of this part. A loading/unloading rack includes a loading or unloading arm, and may include any combination of the following: piping assemblages, valves, pumps, shut-off devices, overfill sensors, or personnel safety devices.		
If **YES** (1)	Does loading/unloading rack drainage flow to catchment basin or treatment facility designed to handle discharges or use a quick drainage system?	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	Containment system holds at least the maximum capacity of the largest single compartment of a tank car/truck loaded/unloaded at the facility	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
(2)	An interlocked warning light or physical barriers, warning signs, wheel chocks, or vehicle brake interlock system in the area adjacent to the **loading or unloading rack** to prevent vehicles from departing before complete disconnection of flexible or fixed oil transfer lines	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
(3)	Lower-most drains and all outlets on tank cars/trucks inspected prior to filling/departure, and, if necessary ensure that they are tightened, adjusted, or replaced to prevent liquid discharge while in transit	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA

Comments:

[9] Records of inspections and tests kept under usual and customary business practices will suffice
[10] Note that a tank car/truck loading/unloading rack must be present for §112.7(h) to apply

		PLAN	FIELD
112.7(i)	Brittle fracture evaluation of field-constructed aboveground containers is conducted after tank repair, alteration, reconstruction, or change in service that might affect the risk of a discharge or after a discharge/failure due to brittle fracture or other catastrophe, and appropriate action taken as necessary (applies to only field-constructed aboveground containers)	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
112.7(j)	Discussion of conformance with applicable more stringent State rules, regulations, and guidelines and other effective discharge prevention and containment procedures listed in 40 CFR part 112	☑ Yes ☐ No ☐ NA	
112.7(k)	Qualified oil-filled operational equipment is present at the facility[11]		☑ Yes ☐ No
	Oil-filled operational equipment means equipment that includes an oil storage container (or multiple containers) in which the oil is present solely to support the function of the apparatus or the device. Oil-filled operational equipment is not considered a bu k storage container, and does not include oil-filled manufacturing equipment (flow-through process). Examples of oil-filled operational equipment include, but are not limited to, hydraulic systems, lubricating systems (e.g. , those for pumps, compressors and other rotating equipment, including pumpjack lubrication systems), gear boxes, machining coolant systems, heat transfer systems, transformers, circuit breakers, electrical switches, and other systems containing oil solely to enable the operation of the device.		
If **YES**	Check which apply:		
	Secondary Containment provided in accordance with 112.7(c)	☑	
	Alternative measure described below (confirm eligibility)	☑	
112.7(k)	Qualified Oil-Filled Operational Equipment		
	• Has a single reportable discharge as described in §112.1(b) from any oil-filled operational equipment exceeding 1,000 U.S. gallons occurred within the three years prior to Plan certification date?		☐ Yes ☑ No ☐ NA
	• Have two reportable discharges as described in §112.1(b) from any oil-filled operational equipment each exceeding 42 U.S. gallons occurred within any 12-month period within the three years prior to Plan certification date?[12]		☐ Yes ☑ No ☐ NA
	*If **YES** for either, secondary containment in accordance with §112.7(c) is required*		
	• Facility procedure for inspections or monitoring program to detect equipment failure and/or a discharge is established and documented	☐ Yes ☐ No ☐ NA	☐ Yes ☐ No ☐ NA
	Does not apply if the facility has submitted a FRP under §112.20:		
	• Contingency plan following 40 CFR part 109 (see Attachment C of this checklist) is provided in Plan **AND**	☐ Yes ☐ No ☐ NA	
	• Written commitment of manpower, equipment, and materials required to expeditiously control and remove any quantity of oil discharged that may be harmful is provided in Plan	☐ Yes ☐ No ☐ NA	

Comments:

Double walled tanks are used for some Qualified Oil-Filled Operational Equipment.

[11] This provision does not apply to oil-filled manufacturing equipment (flow-through process)

[12] Oil discharges that result from natural disasters, acts of war, or terrorism are not included in this determination. The gallon amount(s) specified (either 1,000 or 42) refers to the amount of oil that actually reaches navigable waters or adjoining shorelines not the total amount of oil spilled. The entire volume of the discharge is oil for this determination.

ONSHORE FACILITIES (EXCLUDING PRODUCTION) 40 CFR 112.8/112.12		PLAN	FIELD
112.8(b)/ 112.12(b) Facility Drainage			
Diked Areas (1)	Drainage from diked storage areas is: • Restrained by valves, except where facility systems are designed to control such discharge, **OR** • Manually activated pumps or ejectors are used and the condition of the accumulation is inspected prior to draining dike to ensure no oil will be discharged	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
(2)	Diked storage area drain valves are manual, open-and-closed design (not flapper-type drain valves)	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	If drainage is released directly to a watercourse and not into an onsite wastewater treatment plant, retained storm water is inspected and discharged per §§112.8(c)(3)(ii), (iii), and (iv) or §§112.12(c)(3)(ii), (iii), and (iv).	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
Undiked Areas (3)	Drainage from undiked areas with a potential for discharge designed to flow into ponds, lagoons, or catchment basins to retain oil or return it to facility. Catchment basin located away from flood areas.[13]	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
(4)	If facility drainage not engineered as in (b)(3) (i.e., drainage flows into ponds, lagoons, or catchment basins) then the facility is equipped with a diversion system to retain oil in the facility in the event of an uncontrolled discharge.[14]	☐ Yes ☐ No ☑ NA	☐ Yes ☐ No ☑ NA
(5)	Are facility drainage waters continuously treated in more than one treatment unit and pump transfer is needed?	☐ Yes ☑ No ☐ NA	☐ Yes ☑ No ☐ NA
If ***YES***	• Two "lift" pumps available and at least one permanently installed	☐ Yes ☐ No ☐ NA	☐ Yes ☐ No ☐ NA
	• Facility drainage systems engineered to prevent a discharge as described in §112.1(b) in the case of equipment failure or human error	☐ Yes ☐ No ☐ NA	☐ Yes ☐ No ☐ NA
Comments:			
112.8(c)/112.12(c) Bulk Storage Containers ☐ NA *Bulk storage container* means any container used to store oil. These containers are used for purposes including, but not limited to, the storage of oil prior to use, while being used, or prior to further distribution in commerce. Oil-filled electrical, operating, or manufacturing equipment is not a bu k storage container. *If bulk storage containers are not present, mark this section Not Applicable (NA). If present, complete this section and Attachment A of this checklist.*			
(1)	Containers materials and construction are compatible with material stored and conditions of storage such as pressure and temperature	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
(2)	Except for mobile refuelers and other non-transportation-related tank trucks, construct all bulk storage tank installations with secondary containment to hold capacity of largest container and sufficient freeboard for precipitation	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	Diked areas sufficiently impervious to contain discharged oil **OR**	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	Alternatively, any discharge to a drainage trench system will be safely confined in a facility catchment basin or holding pond	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA

[13] Oil discharges that result from natural disasters, acts of war, or terrorism are not included in this determination. The gallon amount(s) specified (either 1,000 or 42) refers to the amount of oil that actually reaches navigable waters or adjoining shorelines not the total amount of oil spilled. The entire volume of the discharge is oil for this determination.

[14] These provisions apply only when a facility drainage system is used for containment; otherwise mark NA

		PLAN	FIELD
(3)	Is there drainage of uncontaminated rainwater from diked areas into a storm drain or open watercourse?	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
If **YES**	• Bypass valve normally sealed closed	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	• Retained rainwater is inspected to ensure that its presence will not cause a discharge as described in §112.1(b)	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	• Bypass valve opened and resealed under responsible supervision	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	• Adequate records of drainage are kept; for example, records required under permits issued in accordance with 40 CFR §§122.41(j)(2) and (m)(3)	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
(4)	For completely buried metallic tanks installed on or after January 10, 1974 (if not exempt from SPCC regulation because subject to all of the technical requirements of 40 CFR part 280 or 281):		
	• Provide corrosion protection with coatings or cathodic protection compatible with local soil conditions	☐ Yes ☐ No ☑ NA	☐ Yes ☐ No ☑ NA
	• Regular leak testing conducted	☐ Yes ☐ No ☑ NA	☐ Yes ☐ No ☑ NA
(5)	The buried section of partially buried or bunkered metallic tanks protected from corrosion with coatings or cathodic protection compatible with local soil conditions	☐ Yes ☐ No ☑ NA	☐ Yes ☐ No ☑ NA
(6)	• Test or inspect each aboveground container for integrity on a regular schedule and whenever you make material repairs. Techniques include, but are not limited to: visual inspection, hydrostatic testing, radiographic testing, ultrasonic testing, acoustic emissions testing, or other system of non-destructive testing	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	• Appropriate qualifications for personnel performing tests and inspections are identified in the Plan and have been assessed in accordance with industry standards	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	• The frequency and type of testing and inspections are documented, are in accordance with industry standards and take into account the container size, configuration and design	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	• Comparison records of aboveground container integrity testing are maintained	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	• Container supports and foundations regularly inspected	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	• Outside of containers frequently inspected for signs of deterioration, discharges, or accumulation of oil inside diked areas	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
	• Records of all inspections and tests maintained[15]	☑ Yes ☐ No ☐ NA	☑ Yes ☐ No ☐ NA
Integrity Testing Standard identified in the Plan:			
112.12 (c)(6)(ii) *(Applies to AFVO Facilities only)*	Conduct formal visual inspection on a regular schedule for bulk storage containers that meet all of the following conditions: • Subject to 21 CFR part 110; • Elevated; • Constructed of austenitic stainless steel; • Have no external insulation; and • Shop-fabricated.	☐ Yes ☐ No ☑ NA	☐ Yes ☐ No ☑ NA
	In addition, you must frequently inspect the outside of the container for signs of deterioration, discharges, or accumulation of oil inside diked areas.	☐ Yes ☐ No ☑ NA	☐ Yes ☐ No ☑ NA
	You must determine and document in the Plan the appropriate qualifications for personnel performing tests and inspections.[16]	☐ Yes ☐ No ☑ NA	☐ Yes ☐ No ☑ NA

[15] Records of inspections and tests kept under usual and customary business practices will suffice

		PLAN	FIELD
(7)	Leakage through defective internal heating coils controlled:		
	• Steam returns and exhaust lines from internal heating coils that discharge into an open watercourse are monitored for contamination, **OR**	☐Yes ☐No ☑NA	☐Yes ☐No ☑NA
	• Steam returns and exhaust lines pass through a settling tank, skimmer, or other separation or retention system	☐Yes ☐No ☑NA	☐Yes ☐No ☑NA
(8)	Each container is equipped with at least one of the following for liquid level sensing: • High liquid level alarms with an audible or visual signal at a constantly attended operation or surveillance station, or audible air vent in smaller facilities; • High liquid level pump cutoff devices set to stop flow at a predetermined container content level; • Direct audible or code signal communication between container gauger and pumping station; • Fast response system for determining liquid level (such as digital computers, telepulse, or direct vision gauges) and a person present to monitor gauges and overall filling of bulk containers; or • Regularly test liquid level sensing devices to ensure proper operation.	☑Yes ☐No ☐NA	☑Yes ☐No ☐NA
(9)	Effluent treatment facilities observed frequently enough to detect possible system upsets that could cause a discharge as described in §112.1(b)	☑Yes ☐No ☐NA	☑Yes ☐No ☐NA
(10)	Visible discharges which result in a loss of oil from the container, including but not limited to seams, gaskets, piping, pumps, valves, rivets, and bolts are promptly corrected and oil in diked areas is promptly removed	☑Yes ☐No ☐NA	☑Yes ☐No ☐NA
(11)	Mobile or portable containers positioned to prevent a discharge as described in §112.1(b).	☑Yes ☐No ☐NA	☑Yes ☐No ☐NA
	Mobile or portable containers (excluding mobile refuelers and other non-transportation-related tank trucks) have secondary containment with sufficient capacity to contain the largest single compartment or container and sufficient freeboard to contain precipitation	☑Yes ☐No ☐NA	☑Yes ☐No ☐NA
112.8(d)/112.12(d)Facility transfer operations, pumping, and facility process			
(1)	Buried piping installed or replaced on or after August 16, 2002 has protective wrapping or coating	☑Yes ☐No ☐NA	☑Yes ☐No ☐NA
	Buried piping installed or replaced on or after August 16, 2002 is also cathodically protected or otherwise satisfies corrosion protection standards for piping in 40 CFR part 280 or 281	☑Yes ☐No ☐NA	☑Yes ☐No ☐NA
	Buried piping exposed for any reason is inspected for deterioration; corrosion damage is examined; and corrective action is taken	☑Yes ☐No ☐NA	☑Yes ☐No ☐NA
(2)	Piping terminal connection at the transfer point is marked as to origin and capped or blank-flanged when not in service or in standby service for an extended time	☑Yes ☐No ☐NA	☑Yes ☐No ☐NA
(3)	Pipe supports are properly designed to minimize abrasion and corrosion and allow for expansion and contraction	☑Yes ☐No ☐NA	☑Yes ☐No ☐NA
(4)	Aboveground valves, piping, and appurtenances such as flange joints, expansion joints, valve glands and bodies, catch pans, pipeline supports, locking of valves, and metal surfaces are inspected regularly to assess their general condition	☑Yes ☐No ☐NA	☑Yes ☐No ☐NA
	Integrity and leak testing conducted on buried piping at time of installation, modification, construction, relocation, or replacement	☑Yes ☐No ☐NA	☑Yes ☐No ☐NA
(5)	Vehicles warned so that no vehicle endangers aboveground piping and other oil transfer operations	☑Yes ☐No ☐NA	☑Yes ☐No ☐NA

Comments:

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ATTACHMENT A: SPCC FIELD INSPECTION AND PLAN REVIEW TABLE

Documentation of Field Observations for Containers and Associated Requirements

Inspectors should use this table to document observations of containers as needed.

Containers and Piping

Check containers for leaks, specifically looking for: drip marks, discoloration of tanks, puddles containing spilled or leaked material, corrosion, cracks, and localized dead vegetation, and standards/specifications of construction.

Check aboveground container foundation for: cracks, discoloration, and puddles containing spilled or leaked material, settling, gaps between container and foundation, and damage caused by vegetation roots.

Check all piping for: droplets of stored material, discoloration, corrosion, bowing of pipe between supports, evidence of stored material seepage from valves or seals, evidence of leaks, and localized dead vegetation. For all aboveground piping, include the general condition of flange joints, valve glands and bodies, drip pans, pipe supports, bleeder and gauge valves, and other such items (Document in comments section of §112.8(d) or 112.12(d).)

Secondary Containment (Active and Passive)

Check secondary containment for: containment system (including walls and floor) ability to contain oil such that oil will not escape the containment system before cleanup occurs, proper sizing, cracks, discoloration, presence of spilled or leaked material (standing liquid), erosion, corrosion, penetrations in the containment system, and valve conditions.

Check dike or berm systems for: level of precipitation in dike/available capacity, operational status of drainage valves (closed), dike or berm impermeability, debris, erosion, impermeability of the earthen floor/walls of diked area, and location/status of pipes, inlets, drainage around and beneath containers, presence of oil discharges within diked areas.

Check drainage systems for: an accumulation of oil that may have resulted from any small discharge, including field drainage systems (such as drainage ditches or road ditches), and oil traps, sumps, or skimmers. Ensure any accumulations of oil have been promptly removed.

Check retention and drainage ponds for: erosion, available capacity, presence of spilled or leaked material, debris, and stressed vegetation.

Check active measures (countermeasures) for: amount indicated in plan is available and appropriate; deployment procedures are realistic; material is located so that they are readily available; efficacy of discharge detection; availability of personnel and training, appropriateness of measures to prevent a discharge as described in §112.1(b).

Container ID/ General Condition[16] Aboveground or Buried Tank	Storage Capacity and Type of Oil	Type of Containment/ Drainage Control	Overfill Protection and Testing & Inspections
Upper Tank Farm aboveground storage tanks	6,000,000 gallons each	Lined dike with valved discharge line	Level indication with alarm in Control Room
FORFAC aboveground storage tanks (Tanks B1 and B2)	Approximately 1,000 bbls	Concrete dike with valved discharge line	Level indication with alarm in Control Room

[16] Identify each tank with either an A to indicate aboveground or B for completely buried

ATTACHMENT A: SPCC FIELD INSPECTION AND PLAN REVIEW TABLE (CONT.)

Documentation of Field Observations for Containers and Associated Requirements

Container ID/ General Condition[17] Aboveground or Buried Tank	Storage Capacity and Type of Oil	Type of Containment/ Drainage Control	Overfill Protection and Testing & Inspections

[17] Identify each tank with either an A to indicate aboveground or B for completely buried

ATTACHMENT B: SPCC INSPECTION AND TESTING CHECKLIST

Required Documentation of Tests and Inspections

Records of inspections and tests required by 40 CFR part 112 signed by the appropriate supervisor or inspector must be kept by all facilities with the SPCC Plan for a period of three years. Records of inspections and tests conducted under usual and customary business practices will suffice. Documentation of the following inspections and tests should be kept with the SPCC Plan.

Inspection or Test		Documentation		Not Applicable
		Present	Not Present	
112.7–General SPCC Requirements				
(d)	Integrity testing for bulk storage containers with no secondary containment system and for which an impracticability determination has been made	☑	☐	☐
(d)	Integrity and leak testing of valves and piping associated with bulk storage containers with no secondary containment system and for which an impracticability determination has been made	☑	☐	☐
(h)(3)	Inspection of lowermost drain and all outlets of tank car or tank truck prior to filling and departure from loading/unloading rack	☑	☐	☐
(i)	Evaluation of field-constructed aboveground containers for potential for brittle fracture or other catastrophic failure when the container undergoes a repair, alteration, reconstruction or change in service or has discharged oil or failed due to brittle fracture failure or other catastrophe	☑	☐	☐
k(2)(i)	Inspection or monitoring of qualified oil-filled operational equipment when the equipment meets the qualification criteria in §112.7(k)(1) and facility owner/operator chooses to implement the alternative requirements in §112.7(k)(2) that include an inspection or monitoring program to detect oil-filled operational equipment failure and discharges	☑	☐	☐
112.8/112.12–Onshore Facilities (excluding oil production facilities)				
(b)(1), (b)(2)	Inspection of storm water released from diked areas into facility drainage directly to a watercourse	☑	☐	☐
(c)(3)	Inspection of rainwater released directly from diked containment areas to a storm drain or open watercourse before release, open and release bypass valve under supervision, and records of drainage events	☑	☐	☐
(c)(4)	Regular leak testing of completely buried metallic storage tanks installed on or after January 10, 1974 and regulated under 40 CFR 112	☐	☐	☑
(c)(6)	Regular integrity testing of aboveground containers and integrity testing after material repairs, including comparison records	☑	☐	☐
(c)(6), (c)(10)	Regular visual inspections of the outsides of aboveground containers, supports and foundations	☑	☐	☐
(c)(6)	Frequent inspections of diked areas for accumulations of oil	☑	☐	☐
(c)(8)(v)	Regular testing of liquid level sensing devices to ensure proper operation	☑	☐	☐
(c)(9)	Frequent observations of effluent treatment facilities to detect possible system upsets that could cause a discharge as described in §112.1(b)	☑	☐	☐
(d)(1)	Inspection of buried piping for damage when piping is exposed and additional examination of corrosion damage and corrective action, if present	☑	☐	☐
(d)(4)	Regular inspections of aboveground valves, piping and appurtenances and assessments of the general condition of flange joints, expansion joints, valve glands and bodies, catch pans, pipeline supports, locking of valves, and metal surfaces	☑	☐	☐
(d)(4)	Integrity and leak testing of buried piping at time of installation, modification, construction, relocation or replacement	☑	☐	☐

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ATTACHMENT C: SPCC CONTINGENCY PLAN REVIEW CHECKLIST ☑ NA

40 CFR Part 109–Criteria for State, Local and Regional Oil Removal Contingency Plans

If SPCC Plan includes an impracticability determination for secondary containment in accordance with §112.7(d), the facility owner/operator is required to provide an oil spill contingency plan following 40 CFR part 109, unless he or she has submitted a FRP under §112.20. An oil spill contingency plan may also be developed, unless the facility owner/operator has submitted a FRP under §112.20 as one of the required alternatives to general secondary containment for qualified oil filled operational equipment in accordance with §112.7(k).

109.5–Development and implementation criteria for State, local and regional oil removal contingency plans[18]		**Yes**	**No**
(a)	Definition of the authorities, responsibilities and duties of all persons, organizations or agencies which are to be involved in planning or directing oil removal operations.	☐	☐
(b)	Establishment of notification procedures for the purpose of early detection and timely notification of an oil discharge including:	☐	☐
(1)	The identification of critical water use areas to facilitate the reporting of and response to oil discharges.	☐	☐
(2)	A current list of names, telephone numbers and addresses of the responsible persons (with alternates) and organizations to be notified when an oil discharge is discovered.	☐	☐
(3)	Provisions for access to a reliable communications system for timely notification of an oil discharge, and the capability of interconnection with the communications systems established under related oil removal contingency plans, particularly State and National plans (e.g., National Contingency Plan (NCP)).	☐	☐
(4)	An established, prearranged procedure for requesting assistance during a major disaster or when the situation exceeds the response capability of the State, local or regional authority.	☐	☐
(c)	Provisions to assure that full resource capability is known and can be committed during an oil discharge situation including:	☐	☐
(1)	The identification and inventory of applicable equipment, materials and supplies which are available locally and regionally.	☐	☐
(2)	An estimate of the equipment, materials and supplies that would be required to remove the maximum oil discharge to be anticipated.	☐	☐
(3)	Development of agreements and arrangements in advance of an oil discharge for the acquisition of equipment, materials and supplies to be used in responding to such a discharge.	☐	☐
(d)	Provisions for well-defined and specific actions to be taken after discovery and notification of an oil discharge including:	☐	☐
(1)	Specification of an oil discharge response operating team consisting of trained, prepared and available operating personnel.	☐	☐
(2)	Pre-designation of a properly qualified oil discharge response coordinator who is charged with the responsibility and delegated commensurate authority for directing and coordinating response operations and who knows how to request assistance from Federal authorities operating under existing national and regional contingency plans.	☐	☐
(3)	A preplanned location for an oil discharge response operations center and a reliable communications system for directing the coordinated overall response operations.	☐	☐
(4)	Provisions for varying degrees of response effort depending on the severity of the oil discharge.	☐	☐
(5)	Specification of the order of priority in which the various water uses are to be protected where more than one water use may be adversely affected as a result of an oil discharge and where response operations may not be adequate to protect all uses.	☐	☐
(e)	Specific and well defined procedures to facilitate recovery of damages and enforcement measures as provided for by State and local statutes and ordinances.	☐	☐

[18] The contingency plan should be consistent with all applicable state and local plans, Area Contingency Plans, and the NCP.

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ATTACHMENT D: TIER II QUALIFIED FACILITY CHECKLIST

☑ NA

TIER II QUALIFIED FACILITY PLAN REQUIREMENTS —40 CFR 112.6(b)		
112.6(b)(1)	**Plan Certification:** Owner/operator certified in the Plan that:	☐ Yes ☐ No
(i)	He or she is familiar with the requirements of 40 CFR part 112	☐ Yes ☐ No ☐ NA
(ii)	He or she has visited and examined the facility[19]	☐ Yes ☐ No ☐ NA
(iii)	The Plan has been prepared in accordance with accepted and sound industry practices and standards and with the requirements of this part	☐ Yes ☐ No ☐ NA
(iv)	Procedures for required inspections and testing have been established	☐ Yes ☐ No ☐ NA
(v)	He or she will fully implement the Plan	☐ Yes ☐ No ☐ NA
(vi)	The facility meets the qualification criteria set forth under §112.3(g)(2)	☐ Yes ☐ No ☐ NA
(vii)	The Plan does not deviate from any requirements as allowed by §§112.7(a)(2) and 112.7(d), except as described under §112.6(b)(3)(i) or (ii)	☐ Yes ☐ No ☐ NA
(viii)	The Plan and individual(s) responsible for implementing the Plan have the full approval of management and the facility owner or operator has committed the necessary resources to fully implement the Plan.	☐ Yes ☐ No ☐ NA
112.6(b)(2)	**Technical Amendments:** The owner/operator self-certified the Plan's technical amendments for a change in facility design, construction, operation, or maintenance that affected potential for a §112.1(b) discharge	☐ Yes ☐ No ☐ NA
If **YES**	• Certification of technical amendments is in accordance with the self-certification provisions of §112.6(b)(1).	☐ Yes ☐ No ☐ NA
(i)	A PE certified a portion of the Plan (i.e., Plan is informally referred to as a hybrid Plan)	☐ Yes ☐ No ☐ NA
If **YES**	• The PE also certified technical amendments that affect the PE certified portion of the Plan as required under §112.6(b)(4)(ii)	☐ Yes ☐ No ☐ NA
(ii)	The aggregate aboveground oil storage capacity increased to more than 10,000 U.S. gallons as a result of the change	☐ Yes ☐ No ☐ NA
If **YES**	*The facility no longer meets the Tier II qualifying criteria in §112.3(g)(2) because it exceeds 10,000 U.S. gallons in aggregate aboveground storage capacity.*	
	The owner/operator prepared and implemented a Plan within 6 months following the change and had it certified by a PE under §112.3(d)	☐ Yes ☐ No ☐ NA
112.6(b)(3)	**Plan Deviations:** Does the Plan include environmentally equivalent alternative methods or impracticability determinations for secondary containment?	☐ Yes ☐ No ☐ NA
If **YES**	Identify the alternatives in the hybrid Plan:	
	• Environmental equivalent alternative method(s) allowed under §112.7(a)(2);	☐ Yes ☐ No ☐ NA
	• Impracticability determination under §112.7(d)	☐ Yes ☐ No ☐ NA
112.6(b)(4)	• For each environmentally equivalent measure, the Plan is accompanied by a written statement by the PE that describes: the reason for nonconformance, the alternative measure, and how it offers equivalent environmental protection in accordance with §112.7(a)(2);	☐ Yes ☐ No ☐ NA
	• For each secondary containment impracticability determination, the Plan explains the reason for the impracticability determination and provides the alternative measures to secondary containment required in §112.7(d)	☐ Yes ☐ No ☐ NA
	AND	
(i)	PE certifies in the Plan that:	
(A)	He/she is familiar with the requirements of 40 CFR Part 112	☐ Yes ☐ No ☐ NA
(B)	He/she or a representative agent has visited and examined the facility	☐ Yes ☐ No ☐ NA
(C)	The alternative method of environmental equivalence in accordance with §112.7(a)(2) or the determination of impracticability and alternative measures in accordance with §112.7(d) is consistent with good engineering practice, including consideration of applicable industry standards, and with the requirements of 40 CFR Part 112.	☐ Yes ☐ No ☐ NA
Comments:		

[19] Note that only the person certifying the Plan can make the site visit

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ATTACHMENT E: ADDITIONAL COMMENTS

ATTACHMENT E: ADDITIONAL COMMENTS (CONT.)

ATTACHMENT F: PHOTO DOCUMENTATION NOTES

Photo#	Photographer Name	Time of Photo Taken	Compass Direction	Description

ATTACHMENT F: PHOTO DOCUMENTATION NOTES (CONT.)

Photo#	Photographer Name	Time of Photo Taken	Compass Direction	Description

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