# Memorandum

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From: [redacted]

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Project: 221162 – Red Hill Defueling Support, Joint Base Pearl Harbor-Hickam, Honolulu, HI

Subject: AFFF Retention System Bypass Line to F-76 Pipeline and Repair Methods

This memorandum presents our thoughts on the development and evaluation of conceptual bypass line configurations for the existing aqueous film-forming foam (AFFF) retention and F-76 pipelines in the lower access and harbor tunnels. We also provide preliminary guidance on design requirements for these cross-pipe-connection options.

We recognize that the U.S. Navy (Navy) is implementing operational and structural changes in the Red Hill fuel system such that there will be a low probability of a spill during defueling. Nevertheless, the Navy is planning to have a contingency containment system in place whereby if a fuel spill occurs in the lower access tunnel during the defueling of the Red Hill tanks, the AFFF retention system can be used to collect the fuel and then transfer it to the F-76 pipeline.

## 1. CONTAINMENT SYSTEM CONCEPT

In the current piping configuration, the contents of a spill in the tank gallery would initially be collected in one of the five existing AFFF sumps (Figure 1). Pumps in these sumps would then activate and lift the spilled contents into the elevated AFFF retention pipeline. After the May 2021 fuel spill, the AFFF retention pipeline held fuel for approximately six months, which potentially compromised some joint seals along the PVC sections of the pipeline. To avoid potential leakage at damaged joints should a future spill occur, the Navy requested SGH investigate bypass line concepts to transfer a postulated spill from the AFFF retention pipeline to the steel F-76 pipeline. This would then allow the AFFF retention pipeline to transfer its

contents and not be utilized (again) for short-term storage. There are multiple advantages to diverting the contents of the AFFF retention pipeline into the F-76 pipeline. This concept can:

1. Reduce the number of joints requiring repair along the AFFF retention pipeline between ADIT 3 and the tank gallery.

2. Increase the holding volume for any spilled contents.

3. Allow any spilled contents to be partitioned using the multiple sets of available sectional valves.

4. Assure that spilled fuel will not stay in the AFFF retention pipeline for an extended period and further degrade seals, potentially leading to secondary leaks.

5. Push any spilled contents to the pumphouse instead of an above-ground storage tank at ADIT 3. The pumphouse is connected to the fuel oil reclamation facility (FORFAC) and, therefore, could keep the spilled fuel in a closed system versus requiring vacuum truck transport at ADIT 3.

## 2. RECONNAISSANCE

While on site in April 2023, SGH observed several locations where a potential bypass between the AFFF retention pipeline and the F-76 pipeline could be installed. We considered the following:

1. The presence of a shutoff valve in the AFFF retention pipeline downstream of a bypass connection point.

2. Clear height and interferences along the bypass line.

3. The presence of monitoring wells in the tunnel floor.

4. Constructability and presence of existing flanges in the AFFF retention and F-76 pipelines.

5. Degree of congestion and means of supporting a new bypass line, including use of existing pipe supports.

Within the tank gallery, the AFFF retention and F-76 pipelines are generally at the same elevation until [redacted], where the F-76 pipeline changes elevation and continues downstream supported on concrete pads instead of being supported on elevated steel pipe supports (Figure 2). It could be advantageous to utilize gravity to feed the contents of the AFFF retention pipeline into the F-76 pipeline using a bypass line somewhere downstream of [redacted], to limit the need for additional pumps or modify where the AFFF pumps send the contents of each sump (five total), recognizing that there is no F-76 pipeline in the immediate vicinity of Sump 1.

## 3. POTENTIAL BYPASS LOCATIONS

We identified three potential locations where the AFFF retention and F-76 pipelines could be connected at [redacted]. This section presents potential layout, support, and connection concepts for the bypass line.

### 3.1 Pipe Support [redacted]

There is a shutoff valve in the AFFF retention pipeline by [redacted], nearly opposite the high point vent in the F-76 pipeline (Figure 3). At this location, the AFFF retention and F-76 pipelines are approximately 10 ft apart. A fitting (tee or bend) installed in the AFFF retention pipeline would facilitate the connection of a new pipe segment that could be supported by the [redacted] steel beam and directed into a new fitting (tee or wye of sufficient diameter and angle) in the F-76 pipeline. The bypass line could be engineered as a regular or flexible flow line. It is likely that no additional pipe supports would be needed from the floor of the tank gallery due to the presence of the [redacted] steel beam.

[redacted]

### 3.2 Between Pipe Supports [redacted] and [redacted]

Between [redacted], there is another shutoff valve in the AFFF retention pipeline, which is downstream of an existing manifold that connects to the AFFF retention pipeline (Figure 4). This section of the AFFF retention pipeline is steel versus PVC, as observed at other locations. This manifold comprises four valves that could be used to transfer the AFFF retention pipeline contents into the F-76 pipeline using multiple flow lines. Alternatively, a single larger flow line can replace the manifold with its four smaller flow lines. In either case, some modifications may be required to the existing AFFF retention pipeline. A regular pipe or a flexible flow line could be engineered to connect this existing manifold to the F-76 pipeline. A new fitting would need to be engineered in the F-76 pipeline to facilitate the connection. Given the proximity of the manifold to the F-76 pipeline and given the manifold's current hanger-type support system, additional pipe supports may be required compared to that for the previous location [redacted]. A hydraulic analysis may also be required to appropriately design the connections, supports, and bypass line between the manifold and the F-76 pipeline, considering the flow restrictions of using smaller piping.

### 3.3 Pipe Support [redacted]

There is a concrete anchor immediately downstream of [redacted]. At this location, the tunnel narrows from the oil-tight door to the concrete anchor. A bypass line, instead of maintaining constant clear height throughout the width of the tunnel, could angle down across the tunnel and tie into the F-76 pipeline (Figure 5), as suggested by NAVFAC. Installing the bypass line connection into the F-76 pipeline at a location between the concrete anchor and [redacted] could provide sufficient clear height below the new bypass line while avoiding the congestion of the system just upstream of the oil-tight door and while limiting the length of PVC AFFF retention pipeline used during a fuel spill.

Two options (A and B) are presented. Both options involve removing a small section of pipe along the AFFF retention pipeline. Option A, as shown in Figure 6, also requires a small section of pipe to be removed from the F-76 pipeline to facilitate the installation of the bypass line, whereas Option B (Figure 7) directly ties the bypass line to the F-76 using a new fitting. A new bend fitting at the AFFF retention pipeline would re-direct the flow rather than abruptly diverting the flow, thus limiting loads to be resisted by new pipe support on the AFFF pipeline due to a sudden change of flow direction.

In Option A, the bypass line to the F-76 pipeline connection could be a flange at the end of the F-76 pipeline with an orifice to create a closed system (Figure 6). However, this option may also require additional support for the cantilever sections of the F-76 pipeline. In Option B, the bypass line could alternately connect to a new wye fitting to be installed in the F-76 pipeline (Figure 7), in which case the F-76 pipeline would remain a single pipe segment. In both scenarios, a high-point vent in the F-76 pipeline at or near the bypass line would need to be installed.

[redacted]

[redacted]

If the F-76 pipeline is modified in such a way that results in the permanent discontinuity between the upstream and downstream pipe sections (relative to the bypass line), a pressure-rated blind flange should be installed in the upstream section of the F-76 pipeline as a precaution against inadvertent fuel release into this pipeline within the tank gallery.

Depending on which location is most feasible, closing the respective AFFF retention pipeline shutoff valve would prevent any spill contents from flowing downstream along the AFFF retention pipeline and thus would negate any required joint repairs in the AFFF retention pipeline downstream of this valve. This would also reduce the overall risk of the release of spilled fuel from the AFFF retention pipeline in the sensitive area near the wells in the vicinity of the ADIT 3 wye and the Red Hill water shaft. The AFFF retention pipeline shutoff valve or new fitting should be designed for loads due to the flow of contents in the AFFF retention pipeline.

### 3.4 Summary

The above options all appear feasible. However, Option B at [redacted] may be easiest to implement and has other advantages.

## 4. LEAKAGE REMEDIATION OPTIONS FOR PVC AFFF RETENTION PIPELINE

An analysis should be performed to determine whether the AFFF retention pipeline could be pressurized due to the action of the four 1,000-gpm pumps and the postulated 20,000-gal spill volume.

If the pipeline cannot be significantly pressurized, then any weeping through the existing joints of the AFFF retention pipeline in the tank gallery is of minor concern relative to the postulated 20,000-gal spill. However, if the pipeline can be significantly pressurized, then the PVC joint seals may have insufficient capacity to maintain tightness, given their exposure to fuel after the May 2021 event. If the pipeline is significantly pressurized, a concern is that the potentially compromised PVC joints may fail, resulting in simultaneous spills within the tank gallery and no immediate means to remove the spilled fuel. In this case, if the leakage rates through the existing joints are deemed critical, the following options can be considered for leakage remediation of the PVC AFFF retention pipeline joints:

1. Perform a Hydraulic Leakage Test (Not a Hydrostatic Test): The AFFF retention pipeline in the tank gallery could be water tested under similar conditions as a spill containment event to locate leaky joints. Repairs in the tank gallery could then be reduced to a list comprising only high-risk joints. This test could be performed prior to installing a bypass so as to keep any test water separate from any future fuel. There is a shutoff valve at [redacted] at a steel section of the AFFF retention pipeline. At this

location, there is also a manifold with four outlet pipes which can facilitate controlled drainage of any test water.

2. Cured-in-Place-Piping (CIPP): This internal pipe repair method involves inserting an appropriately sized liner into the pipe section and applying internal pressure to expand the liner against the pipe internal surface. This may require intermediate insertion points for long runs, at branch connections, or at fittings. A competent installer would be required for this method to be effective. This repair could be implemented at high-risk joints only if a hydraulic test is performed.

3. Fold-and-Form Lining: This internal pipe repair method involves inserting an appropriately sized liner into the pipe section and applying internal pressure to expand the liner against the pipe internal surface. This may require intermediate insertion points for long runs, at branch connections, or at fittings. A competent installer would be required for this method to be effective. This repair could be implemented at high-risk joints only if a hydraulic test is performed.

4. External Composite Overwrap: This external pipe repair method involves having access to all sides of the pipe joint and appropriately preparing the pipe surface. Each wrap location may require 2 – 4 man hrs. The PVC pipeline would be laterally and vertically displaced to some degree which could introduce undesirable joint movement affecting adjacent joints. A competent installer would be required for this method to be effective. This repair could be implemented at high-risk joints only if a hydraulic test is performed.

5. Install Catchments at High-Risk Joints: This is an external containment method that involves fuel catchment tarps draining into fuel barrels or external lightweight troughs either hanging or placed under the pipeline to collect leaks from the PVC joints. Alternatively, flange guards (spray shields) can be used to collect small amounts of leakage. This method would collect some leakage but not contain leakage in a closed system. The capacity of each catchment is limited with this method, and it can only be used for limited leakage scenarios.

6. Real-Time Inspection During Defueling: During the defueling operation, the Navy could station dedicated rovers at potentially high-risk joints so operations could be immediately alerted about joint leakage. This method could be coupled with the catchment installation to limit overflow from barrels or troughs.

7. Replace High-Risk PVC Joints: Full pipe repair requiring cutting, removal, and replacement of existing joints with new joints unexposed to fuel from the May 2021 JP-5 spill. This repair could be implemented at high-risk joints only if a hydraulic test is performed.

Caulking of the AFFF retention pipeline PVC joints may not be an effective method of repairing high-risk joints. This is because the direction of the fuel pressure on the caulk may be against the caulk's weakest plane and, therefore, may only provide limited assurance of preventing leakage at potentially compromised joints.

[redacted]