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# Aqueous Film Forming Foam Investigation Report

Red Hill Bulk Fuel Storage Facility

October 2023

U.S. ENVIRONMENTAL PROTECTION AGENCY  
REGION 9  
75 Hawthorne Street  
San Francisco, CA 94105



## US EPA REGION 9 AFFF INVESTIGATION REPORT

<b>Investigation Date:</b>	August 2023	<b>Inspection Announced:</b> N/A	
<b>Time:</b>	<b>Entry:</b> N/A	<b>Exit:</b> N/A	
<b>Regulatory Program(s)</b>	RCRA Subtitle C: Hazardous Waste Management		
<b>Company Name:</b>	Department of the Navy		
<b>Facility or Site Name:</b>	Red Hill Bulk Fuel Storage Facility		
<b>Facility Location:</b>	Red Hill Fuel Tank Farms		
<b>(city, state, zip code)</b>	Honolulu Hawaii, HI 96819		
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<b>(city, state, zip code)</b>	Joint Base Pearl Harbor-Hickam, HI 96860		
<b>County:</b>	Honolulu		
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<b>Facility/Site Identifier:</b>	HDOH Site ID: 9-102771, EPA ID: HIR000050401		
<b>NAICS:</b>	92811 – National Security		
<b>SIC:</b>	9711 – National Security		
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### Attachment A – List of References Cited

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## 1. INTRODUCTION

On November 29, 2022, a release of approximately 1,300 gallons of aqueous film forming foam (AFFF) liquid concentrate<sup>1</sup> (“AFFF release”) occurred at the Red Hill Bulk Fuel Storage Facility (“Red Hill Facility” or “the facility”) in Honolulu County, Hawai‘i. The release occurred during maintenance activities conducted by the maintenance contractor for the AFFF fire suppression system at the Red Hill Facility.<sup>2</sup> An investigation convened by Joint Task Force – Red Hill (JTF-RH) and the United States Navy (Navy) and performed by the United States Army Corps of Engineers (ACE) (“ACE Investigation”), concluded that the AFFF release was the result of 1) the improper installation of an air vacuum valve during modification of the Red Hill Facility fire suppression system performed in between December 2021 and April 2022,<sup>3</sup> coupled with 2) a failure to disable AFFF concentrate pumps during testing of the Red Hill Facility fire suppression system on November 29, 2022.

The United States Environmental Protection Agency (EPA) Region 9, has prepared this AFFF Investigation Report under the authority of the Resource Conservation and Recovery Act (RCRA) Section 3007(a), as amended, 42 U.S.C. § 6927(a) to document:

- the events related to the AFFF release;
- the cause of the AFFF release; and
- the Navy’s actions towards protecting human health and the environment from potential impacts of the AFFF release.

The findings of this AFFF Investigation Report are based on EPA documentation, documentation and data made available to EPA Region 9 by the Navy, information obtained by EPA Region 9 during RCRA inspection activities conducted at Red Hill in February and March 2022, and other publicly available information.<sup>4</sup>

## 2. BACKGROUND

This section provides background information about the Red Hill Facility, including its general operations, fuel storage, environmental setting and its now-deactivated AFFF fire suppression system, documents EPA Region 9’s efforts to obtain information about the AFFF release via information requests, and briefly describes AFFF and its use for fire suppression.

### 2.1. Red Hill Facility

#### 2.1.1. Facility Location and Operations

The Red Hill Facility spans approximately 144 acres in south-central O‘ahu approximately two to three miles east of Pearl Harbor.<sup>5</sup> The majority of the facility ground surface is situated between approximately 200 and

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<sup>1</sup> Joint Task Force-Red Hill (JTF-RH) Public Affairs Office, 2023. Joint Task Force – Red Hill Announces AFFF Investigation Findings and Publishes Video Footage. May 5, at 1. (PDF p. 1 of JTF-RH, 2023)

<sup>2</sup> United States Army Corps of Engineers (ACE) Investigation Report, at 1. (PDF p. 5 of JTF-RH, 2023).

<sup>3</sup> ACE Investigation Report, Enclosure 11 at 1. (PDF p. 271 of JTF-RH, 2023).

<sup>4</sup> Sources of information relied upon for this AFFF investigation report are cited in the footnotes herein and listed in Attachment A. Note that the reference JTF-RH (2023), as listed in Attachment A, contains multiple sources cited in footnotes herein - the corresponding page number in JTF-RH (2023) is indicated in each applicable footnote. The internet addresses for the references cited are provided in Attachment A where applicable. References for which a publicly accessible internet address is not available are included in Attachment A.

<sup>5</sup> Naval Facilities Engineering Systems Command (NAVFAC), 2022. Quarterly Release Response Report, May 6 and November 20, 2021 Releases, Red Hill Bulk Fuel Storage Facility, JBPBH O‘ahu, Hawai‘i (Quarterly Release Report). October 3, at 5.



500 feet above mean sea level<sup>6</sup> within the Red Hill Ridge on the southwest flank of the Ko'olau Mountain Range.<sup>7</sup> The facility is bordered by residential neighborhoods and the United States Coast Guard reservation to the southwest and southeast, preservation land to the northeast and a correctional facility and industrial park to the north.<sup>8</sup> An open-pit quarry is located just north of the correctional facility.

The Red Hill facility was constructed by the U.S. Government in the early 1940s<sup>9</sup> for the underground storage of fuel and to supply fuel to the Navy. The Naval Supply Systems Command Fleet Logistics Center Pearl Harbor operates The Red Hill Facility (EPA ID HIR000050401) as a fuel tank farm that supplies fuel for military operations in Hawai'i and throughout the Pacific.<sup>10,11</sup> It is classified as conducting national security under the North American Industry Classification System (NAICS Code 92811). The Red Hill Facility contains multiple underground storage tanks (USTs) as described in Section 2.1.3. The facility is a Large Quantity Generator (LQG) of hazardous waste under RCRA.<sup>12</sup>

### 2.1.2. Environmental Setting

The area surrounding the Red Hill Facility experiences average temperatures ranging from the low 60s to high 80s (degrees Fahrenheit) and receives approximately 40 inches of annual rainfall, the majority of which falls between November and April.<sup>13</sup> The facility is located within volcanic rocks of the Ko'olau formation, which is made up of basaltic lava flows, including pāhoehoe and a'ā flows, that erupted from a northwest-trending rift zone. The valleys flanking the Red Hill ridge were eroded through water flow and are filled with sedimentary deposits atop weathered basalt.<sup>14</sup>

A groundwater aquifer exists beneath the facility with a water table approximately 15 to 20 feet above mean sea level.<sup>15</sup> This aquifer serves as a major drinking water source for the surrounding military and municipal community.<sup>16</sup> The regional groundwater flow direction is west towards Pearl Harbor with potential localized variability.<sup>17</sup> The bottoms of the Red Hill Facility USTs are situated approximately 100 to 130 feet above the groundwater aquifer.<sup>18</sup> The Red Hill Shaft is the closest drinking water supply well to the facility and is located within the Red Hill Facility's lower access tunnel, approximately [REDACTED] feet topographically downgradient (i.e., below) the nearest UST.<sup>19</sup> This well was contaminated as a result of the 2021 fuel releases described below in

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<sup>6</sup> Commander, Navy Region Hawai'i, 2021. Tank 5 Quarterly Release Response Report, Red Hill Bulk Fuel Storage Facility, JBPHH, Oahu, Hawai'i. March, at 3.

<sup>7</sup> Quarterly Release Report, at 5.

<sup>8</sup> Quarterly Release Report, at 3.

<sup>9</sup> Quarterly Release Report, at 3.

<sup>10</sup> Office of the Secretary of the Navy, 2022. Red Hill Bulk Fuel Storage Facility Tank Closure Plan. November 1 (Closure Plan), at 12.

<sup>11</sup> Quarterly Release Report, at 5.

<sup>12</sup> Under the RCRA statute, the EPA maintains the authority to regulate the management and disposal of a waste if it is found to present an imminent or substantial endangerment to human health or the environment (42 USC 6973)

<sup>13</sup> Quarterly Release Report, at 6.

<sup>14</sup> Quarterly Release Report, at 6.

<sup>15</sup> Quarterly Release Report, at 7.

<sup>16</sup> Quarterly Release Report, at 5.

<sup>17</sup> Quarterly Release Report, at 7.

<sup>18</sup> The Red Hill Facility is located at the administrative boundary between the Waimalu Aquifer System of the Pearl Harbor Aquifer Sector and the Moanalua Aquifer System of the Honolulu Aquifer Sector (see Quarterly Release Report, at 7).

<sup>19</sup> Quarterly Release Report, at 8.

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Section 2.1.3.<sup>20</sup> The Red Hill Shaft formerly provided potable water to the Joint Base Pearl Harbor-Hickam (JBPHH) Water Distribution System.<sup>21</sup>

Several streams flow in the vicinity of the Red Hill Facility, including the South Halawa Stream approximately 600 to 800 feet north of the Red Hill fuel tanks. These surface water features are not in contact with the basal groundwater aquifer beneath the facility.<sup>22</sup>

### 2.1.3. Fuel storage

The Red Hill Facility has 24 USTs (twenty 12.5-million-gallon bulk fuel storage tanks and four 400,000-gallon fuel surge tanks), numerous aboveground storage tanks (ASTs), and associated piping and equipment. The 20 bulk fuel storage tanks are positioned at the highest elevation within the Red Hill Facility, located within the volcanic rocks of the Ko'olau Mountain Range. The 4 fuel surge tanks are adjacent to the pumphouse located downhill from the 20 bulk fuel storage tanks. The bulk fuel storage tanks are comprised of concrete lined with steel with no secondary containment. These tanks are used to store petroleum products until they are ready for distribution.<sup>23</sup>

The tank support facilities include a lower access tunnel, an upper access tunnel, and a tunnel that connects the Red Hill Facility to a pumphouse on JBPHH.<sup>24</sup> The tunnels are accessed through openings or access doors into the tunnels known as “adits.”<sup>25</sup> Redacted CUI / DCRIT<sup>26</sup>

In 2021, a series of fuel spills at the Red Hill Facility resulted in the release of jet fuel from the piping below the USTs to the ground beneath the Red Hill Facility. This release contaminated the underlying drinking water aquifer impacting Navy and Army drinking water systems.<sup>27</sup> Following the 2021 fuel releases and resulting impacts to drinking water, the Hawai'i Department of Health (DOH) issued two Emergency Orders with the second one requiring the Navy to defuel and close the Red Hill Facility.<sup>28</sup> The Department of Defense (DoD) established the Joint Task Force-Red Hill (JTF-RH) to be the single accountable DoD entity for safe and expeditious defueling of the Red Hill Facility.

### 2.1.4. Fire Suppression System

The Red Hill Facility was equipped with an AFFF fire suppression system, which was designed in 2013 and installed between 2015 and 2018<sup>29,30,31</sup> as part of a fire suppression system upgrade under the Fiscal Year 2015

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<sup>20</sup> EPA, 2023. Investigation and Remediation of 2021 Fuel Releases at the Red Hill Bulk Fuel Storage Facility, May 5. <https://www.epa.gov/red-hill/investigation-and-remediation-2021-fuel-releases-red-hill-bulk-fuel-storage-facility#drinking%20water%20system%20recovery>, last accessed June 29, 2023.

<sup>21</sup> The potable water formerly sourced from the Red Hill Shaft is currently sourced from the Waiawa Shaft, which is located to the west of the Red Hill Facility (see Quarterly Release Report, at 8)

<sup>22</sup> Quarterly Release Report, at 7.

<sup>23</sup> EPA, 2022. Underground Storage Tank System Inspection Report, Bulk Fuel Storage Systems Including Red Hill and the Airport Hydrant System Serving Joint Base Pearl Harbor-Hickam, August 17 (Redacted), at 5.

<sup>24</sup> Closure Plan, at 15.

<sup>25</sup> Closure Plan, at 15.

<sup>26</sup> Closure Plan, at 16.

<sup>27</sup> EPA, 2023. About Red Hill Fuel Releases. <https://www.epa.gov/red-hill/about-red-hill-fuel-releases#2021-11>, last accessed June 29, 2023.

<sup>28</sup> State of Hawai'i, 2022. Emergency Order, Docket No. 22-UST-EA-01 Re: Emergency Change-In-Service, Defueling, and Closure of 20 Underground Storage Tanks, Surge Tanks, and Associated Piping, Red Hill Bulk Fuel Storage Facility, May 6.

<sup>29</sup> The Red Hill Facility AFFF fire suppression system remains in place but has been off-line since the AFFF release on November 29, 2022.

<sup>30</sup> ACE Investigation Report, Enclosure 14, at 2. (PDF p. 286 of JTF-RH, 2023)

<sup>31</sup> Closure Plan, at 10.

National Defense Authorization Act (NDAA).<sup>32</sup> The AFFF system provided fire protection for the lower tunnel of the Red Hill Facility.<sup>33</sup> The AFFF system included construction of Building 313 to house a tank to hold the AFFF concentrate and the pumps and controllers for the AFFF, as well as the water used to mix with AFFF to fight fires. The fire suppression system was designed to be triggered by flame detectors equipped with infrared (IR) sensors that can sense the heat of a fire.<sup>34</sup> The flame detectors are positioned throughout the length of the lower tunnel – a simultaneous alarm from any two detectors would trigger activation of the AFFF system in the zone where the fire was detected.<sup>35</sup> When triggered, AFFF foam, created by mixing the AFFF concentrate with water, would be released from sprinklers. In this event, water would be fed from two **Redacted CUI / DCRIT** [REDACTED] From Building 313 water and AFFF concentrate would be pumped separately through underground piping into Adit 6 and then to five mixing/release stations that serve the lower access tunnel piping and a series of sprinklers beneath the fuel tanks.<sup>36,37</sup> The AFFF conveyance piping runs primarily underground from Building 313 to Adit 6 and consists of 4-inch stainless steel carrier pipe surrounded by 6-inch polyvinyl chloride (PVC) secondary containment pipe to capture any AFFF concentration leakage from the piping.<sup>38</sup>

## 2.2. AFFF

AFFF is a type of Class B fire-fighting foam designed to combat flammable liquid fuel fires.<sup>39</sup> It is a surfactant that is manufactured and stored in its concentrate form, with a consistency similar to dish washing detergent. When AFFF is mixed with water at designated ratios, the resulting solution foams and produces an aqueous (i.e., water-based) film that spreads across the surface of a hydrocarbon fuel to extinguish the fire and creates a vapor barrier that prevents reignition by cutting off the fuel from atmospheric oxygen.<sup>40</sup> The fire extinguishing properties of AFFF derive from a mixture of fluorinated and non-fluorinated (hydrocarbon) surfactants that together lower the surface tension of water allowing the AFFF/water mixture to form the film over the liquid hydrocarbon.<sup>41</sup> AFFF also contains other ingredients such as water and organic solvents.<sup>42</sup> AFFF was first developed in the 1960s for Naval firefighting activities.<sup>43</sup>

The fluorinated surfactants in AFFF come from a class of chemicals known as per- and polyfluoroalkyl substances (PFAS). Broadly speaking, PFAS are characterized as having carbon atoms linked to each other and bonded to fluorine atoms.<sup>44</sup> PFAS typically consist of a water-soluble “head” connected to a fluorinated alkyl<sup>45</sup> “tail.”. Historically, AFFF was manufactured with so-called “long chain” PFAS,<sup>46</sup> with perfluorooctane sulfonic acid (PFOS) and/or long-chain polyfluoroalkyl fluorotelomer compounds as the primary PFAS active

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<sup>32</sup> RADM James P. Waters III, USN, 2022. Supplement to Command Investigation into the 6 May 2021 and 20 November 2021 Incidents at Red Hill Bulk Fuel Storage Facility. April 15, at 55. (PDF p. 79 of JTF-RH, 2023)

<sup>33</sup> ACE Investigation Report, Enclosure 11, at 1. (PDF p. 270 of JTF-RH, 2023)

<sup>34</sup> ACE Investigation Report, Enclosure 11, at 1 (PDF p. 270 of JTF-RH, 2023).

<sup>35</sup> ACE Investigation Report, at 3 (PDF p. 7 of JTF-RH, 2023).

<sup>36</sup> ACE Investigation Report, Enclosure 14, at 2 (PDF p. 286 of JTF-RH, 2023).

<sup>37</sup> RADM James P. Waters III, USN, 2022. Supplement to Command Investigation into the 6 May 2021 and 20 November 2021 Incidents at Red Hill Bulk Fuel Storage Facility. April 15, at 55-56 (PDF p. 79-80 of JTF-RH, 2023).

<sup>38</sup> ACE Investigation Report, Enclosure 14, at 2 (PDF p. 286 of JTF-RH, 2023).

<sup>39</sup> Interstate Technology and Regulatory Council (ITRC), 2022. Aqueous Film-Forming Foam (AFFF). Fact Sheet. July, (ITRC Fact Sheet) at 1.

<sup>40</sup> ITRC Fact Sheet, at 2.

<sup>41</sup> ITRC Fact Sheet, at 2.

<sup>42</sup> ITRC, 2022. Per- and Polyfluoroalkyl Substances Technical and Regulatory Guidance, June, at 58-59.

<sup>43</sup> ITRC, 2022. Per- and Polyfluoroalkyl Substances Technical and Regulatory Guidance, June, at 58.

<sup>44</sup> ITRC, 2022, Per- and Polyfluoroalkyl Substances Technical and Regulatory Guidance, June, at 11.

<sup>45</sup> Alkyl refers to carbon atoms connected to other carbon atoms by a single bond.

<sup>46</sup> Long-chain PFAS are those with at six to eight carbons (depending on the specific type of PFAS). PFOS and PFOA are both long chain PFAS.

ingredients. The PFAS in modern<sup>47</sup> AFFF are typically “short-chain” polyfluoroalkyl fluorotelomer compounds<sup>48</sup> with no more than six carbon atoms in the alkyl tail.<sup>49</sup> Nevertheless, modern AFFF may still contain traces of perfluoroalkyl substances, including those with greater than 6 carbons such as perfluorooctanoic acid (PFOA).<sup>50</sup>

Since 1969, AFFF has been the designated fire-fighting agent for fuel fires at military facilities under the current Military Specification (MILSPEC).<sup>51</sup> The AFFF used in the Red Hill Facility fire suppression system met the requirements of the revised 2017 AFFF MILSPEC,<sup>52</sup> which placed limits in the amount of PFOS and PFOA that can be present in AFFF used at military installations.<sup>53</sup> The Department of Defense (DoD) is in the process of transitioning to the use of fluorine-free firefighting agents that achieve the firefighting performance of AFFF. The 2020 National Defense Authorization Act (NDAA) Sections 322-324, contain provisions for this transition.<sup>54</sup> According to the Tank Closure Plan for the Red Hill Facility, the Navy plans to remove the Red Hill fire suppression system in accordance with the 2020 NDAA requirements for DoD facilities.<sup>55</sup> Under the 2022 NDAA, a new MILSPEC for PFAS-free foams was issued by Naval Sea Systems Command (NAVSEA) in January 2023.<sup>56</sup>

Neither AFFF nor PFAS (either as individual chemicals or as collective class of chemicals) are currently listed hazardous wastes or considered Hazardous Constituents under RCRA. Therefore, wastes containing AFFF or PFAS are not currently regulated under RCRA regulations found at the Code of Federal Regulations, Chapter 40, Section 261. However, in October 2021, EPA announced initiation of two rulemaking efforts towards the regulation of PFAS-impacted wastes.<sup>57</sup> One rulemaking effort will provide regulatory clarification that under RCRA EPA can require investigation and cleanup of wastes that meet the statutory definition of hazardous waste.<sup>58</sup> This modification would clarify that, at present, PFAS and other emerging contaminants can be cleaned up through the RCRA corrective action program. The other rulemaking effort would add four PFAS<sup>59</sup> as Hazardous Constituents in Appendix VIII of the RCRA regulations. The addition of these PFAS as RCRA Hazardous Constituents serves as a building block towards future efforts to regulate PFAS as a listed hazardous

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<sup>47</sup> “Modern” AFFF typically refers to AFFF developed in response to the U.S. EPA voluntary PFOA Stewardship Program which promoted the phase out of long chain PFAS. See ITRC, 2022. Per- and Polyfluoroalkyl Substances Technical and Regulatory Guidance, June, at 58.

<sup>48</sup> In polyfluoroalkyl substances not every carbon in the alkyl tail is bonded to the maximum possible number of fluorine atoms whereas in perfluoroalkyl substances, every carbon in the alkyl tail bonded to the maximum possible number of fluorine atoms (i.e., “fully fluorinated”).

<sup>49</sup> ITRC Fact Sheet, at 2. Note that this type of AFFF is sometimes referred to as “C6” due to the PFAS surfactants containing six or fewer carbons (i.e., short-chain PFAS).

<sup>50</sup> ITRC, 2022. Per- and Polyfluoroalkyl Substances Technical and Regulatory Guidance, June, at 58.

<sup>51</sup> ITRC, 2022. Per- and Polyfluoroalkyl Substances Technical and Regulatory Guidance, June, at 58.

<sup>52</sup> RADM James P. Waters III, USN, 2022. Supplement to Command Investigation into the 6 May 2021 and 20 November 2021 Incidents at Red Hill Bulk Fuel Storage Facility. April 15, at 56. (PDF p. 80 of JTF-RH, 2023).

<sup>53</sup> Naval Sea Systems Command (NAVSEA), 2017. Performance Specification, Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF) Liquid Concentrate, For Fresh and Sea Water. MIL-PRF-24385F(SH) w/Amendment 2, September 7.

<sup>54</sup> National Defense Authorization Act for Fiscal Year 2020, Public Law 116-92, December 20, 2019.

<sup>55</sup> Office of the Secretary of the Navy, 2022. Red Hill Bulk Fuel Storage Facility Tank Closure Plan. November 1, at 10.

<sup>56</sup> NAVSEA, 2023. Performance Specification MIL-PRF-32725, Fire Extinguishing Agent, Fluorine-Free Foam (F3) Liquid Concentrate, for Land-Based, Fresh Water Applications, January 6.

<sup>57</sup> EPA, 2021. EPA Response to New Mexico Governor and Acts to Address PFAS Under Hazardous Waste Law, October 26. <https://www.epa.gov/newsreleases/epa-responds-new-mexico-governor-and-acts-address-pfas-under-hazardous-waste-law>, last accessed June 29, 2023.

<sup>58</sup> As defined in RCRA Section 1004(5).

<sup>59</sup> The four PFAS proposed for addition as RCRA Hazardous Constituents are PFOA, PFOS, PFBS and Gen-X chemicals.

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waste.<sup>60</sup> As of July 2023, RCRA rulemaking associated with PFAS has not yet been proposed for public comment.

### 2.3. Information Requests to the Navy

Using its information gathering authority under Section 3007(a) of RCRA, EPA Region 9 submitted an Information Request Letter to the Navy on January 6, 2023, seeking information about the clean-up, monitoring and remediation of the November 29, 2022 AFFF release and other AFFF releases at the Red Hill Facility.<sup>61</sup> The types of information requested included laboratory reports of all groundwater and surface water PFAS sampling results, descriptions of the Navy's cleanup efforts following the AFFF release, including the storage, treatment and disposal of all recovered AFFF or PFAS-impacted environmental material, and the Navy's plan to address any detections of PFAS in the sole source drinking water aquifer that underlies the Red Hill Facility. EPA Region 9 set a submission deadline for this information of February 6, 2023. On February 3, 2023, the Navy requested an extension to the February 6, 2023, deadline.<sup>62</sup> On February 14, 2023, EPA Region 9 agreed to extend the deadline to February 20, 2023 for certain pieces of information and to March 15, 2023 for the remaining pieces of information, while also noting that delays in responding to the information request letter impedes EPA's investigation into the AFFF release.<sup>63</sup> By March 15, 2023, the Navy had submitted a partial response to the EPA's information request, including submitting some requested information on February 20, 2023. The Navy provided additional information on May 5, 2023, when JTF-RH released the ACE's Investigation report.

On January 31, 2023, EPA Region 9 issued another request for information under the Clean Water Act requiring the Navy to conduct PFAS sampling and analysis of treated groundwater being discharged to Halawa Stream.<sup>64</sup> Also on January 31, 2023, EPA Region 9 and Hawai'i DOH (collectively, "the Regulatory Agencies") requested that the Navy sample and analyze all active and inactive sources for the JBPHH drinking water system for PFAS.<sup>65</sup> The Navy conducted the required sampling of the treated groundwater being discharged to Halawa Stream on March 15, 2023. The Navy also conducted PFAS sampling of Waiawa and Navy Aiea-Halawa sources on April 18, 2023 and asked to delay sampling of the Red Hill source. The treated groundwater discharging to Halawa Stream contained PFAS at concentrations lower than the applicable Hawai'i EALs,<sup>66</sup> based on analysis by EPA Method 1633. Similarly, PFAS were not detected in the drinking water sample analyzed by EPA Methods 537.1/533 for the Waiawa source. PFOS was detected and reported with a J data qualifier in the drinking water sample analyzed by EPA Methods 537.1/533 for the Navy Aiea-Halawa source. There were no other detections of PFAS in the Navy Aiea-Halawa source.

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<sup>60</sup> EPA, 2021. EPA Response to New Mexico Governor and Acts to Address PFAS Under Hazardous Waste Law, October 26. <https://www.epa.gov/newsreleases/epa-responds-new-mexico-governor-and-acts-address-pfas-under-hazardous-waste-law>, last accessed June 29, 2023.

<sup>61</sup> EPA Region 9, 2023. Request for Information Pursuant to Section 3007(a) of the Resource Conservation and Recovery Act for the Releases of Aqueous Film Forming Foam at Red Hill Bulk Fuel Storage Facility, January 6.

<sup>62</sup> Department of the Navy, 2023. U.S. Department of the Navy Extension Request in Response to the U.S. Environmental Protection Agency Letter to the Release of Aqueous Film Forming Foam at the Red Hill Bulk Fuel Storage Facility, February 3.

<sup>63</sup> EPA Region 9, 2023. Request for Extension of Time to Provide Information Pursuant to Request for Information under Section 3007(a) of the Resource Conservation and Recovery Act for the Releases of Aqueous Film Forming Foam at Red Hill Bulk Fuel Storage Facility, February 14.

<sup>64</sup> EPA Region 9, 2023. Request for Information Pursuant to Section 308 of the Clean Water Act Docket No. CWA-308-9-23-002, January 31.

<sup>65</sup> EPA Region 9, 2023. Per- and Polyfluoroalkyl Substances Sampling of Joint Base Pearl Harbor-Hickam Water System Sources, January 31.

<sup>66</sup> Hawai'i DOH, 2022. Interim Soil and Water Environmental Action Levels (EALs) for Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS), Table D-4a, Summary of Aquatic Habitat Goals, December 29.

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### 3. AFFF RELEASE AND SUBSEQUENT DOD INVESTIGATION AND RESPONSE

JTF-RH convened the ACE Investigation on December 2, 2022 to determine the cause of the discharge of AFFF on November 29, 2022. The investigation was tasked with determining and documenting the immediate events of the AFFF release, the Navy's initial response to the AFFF release, and its cause. The results of the ACE Investigation are summarized below. The information presented in this section was obtained from documents that the Navy has made publicly available, including an Investigation Report released on May 5, 2023, and Situation Reports (SITREPs) submitted by the Navy to the Hawai'i Department of Health (DOH). As described in Section 6, EPA Region 9 has requested additional information from the Navy regarding its environmental investigation and cleanup activities in response to the AFFF release.

#### 3.1. Events of November 29, 2022

According to information provided by the maintenance contractor for the Red Hill AFFF fire suppression system, Media Plumbing & Heating, Inc., DBA Kinetix<sup>67</sup> (Kinetix), and compiled as part of the ACE Investigation, at approximately 9:00 a.m. on November 29, 2022, four Kinetix personnel reported to the Red Hill Facility outside of Building 313 to perform annual maintenance activities on the AFFF system. The scheduled activities consisted of the annual upper tunnel flow test and the annual Adit 6 fire alarm test. The Kinetix team performed these activities concurrently between approximately 9:00 a.m. and 10:45 a.m.<sup>68</sup> Although not apparently scheduled to do so on November 29, 2022, at approximately 11:00 a.m., three members of the Kinetix team began conducting a semi-annual signal verification test, which tests the signal from the IR sensors in the lower tunnel to the fire alarm panel.<sup>69</sup> Based on the timeline constructed by the ACE Investigation, the AFFF release occurred during the signal verification test between approximately 12:11 p.m. and 12:21 p.m.<sup>70</sup> A Fleet Logistic Center (FLC) rover notified the Kinetix team of the AFFF release.<sup>71</sup> It appeared that AFFF concentrate had been pumped to Adit 6 from the AFFF tank in Building 313 and discharged onto the floor of Adit 6.<sup>72</sup>

The AFFF concentrate pooled on the floor inside Adit 6 and then proceeded to seep under a door from Adit 6 to the outside onto a paved access road and some surrounding soil along the edge of the access road.<sup>73</sup> Seepage under the door to the outside occurred at approximately 12:20 p.m., as captured by a video camera aimed toward the entrance to Adit 6.<sup>74</sup> At approximately 12:40 p.m., the video camera captured on-site personnel notifying each other of the release.<sup>75</sup> At approximately 1:30 p.m., the AFFF concentrate flowed over a manhole cover above utility vaults containing pipeline for the fire suppression system's water supply.<sup>76</sup> According to one

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<sup>67</sup> ACE Investigation Report, at 3 (PDF p. 7 of JTF-RH, 2023).

<sup>68</sup> ACE Investigation Report, Enclosure 12, at 1. (PDF p. 272 of JTF-RH, 2023)

<sup>69</sup> Based on the findings of the ACE Investigation, Kinetix was scheduled to conduct IR detector signal verification test the following day, on November 30, 2022. According to the Navy, Kinetix personnel states that Kinetix "has to constantly evolve their maintenance scheduling due to many reasons. Kinetix personal also indicated that the on-site technician on November 29, 2022, took advantage of the available access to the IR sensors to complete the signal verification test without coordinating through the Kinetix Quality Control (QC) manager, thereby violating Kinetix's SOP. *See:* Enclosures 10 and 12 of Deputy Commanding General, U.S. Army Corps of Engineers, 2023. Command Investigation into the Facts and Circumstances Surrounding the Discharge of Aqueous Film Forming Foam that Occurred at Red Hill Bulk Fuel Storage Facility on 29 November 2022. April 6. (PDF p. 266 and 275 of JTF-RH, 2023)

<sup>70</sup> AFFF Video Event Timeline, at 1. (PDF p. 305 of JTF-RH, 2023)

<sup>71</sup> ACE Investigation Report, Enclosure 12, at 1. (PDF p. 272 of JTF-RH, 2023)

<sup>72</sup> ACE Investigation Report, Enclosure 14, at 2. (PDF p. 286 of JTF-RH, 2023)

<sup>73</sup> JTF-RH Public Affairs Office, 2023. Press Release: Join Task Force – Red Hill Announces AFFF Investigation Findings and Publishes Video Footage, May 5, at 1. (PDF p. 1 of JTF-RH, 2023)

<sup>74</sup> AFFF Video Event Timeline, at 1. (PDF p. 305 of JTF-RH, 2023)

<sup>75</sup> AFFF Video Event Timeline, at 1. (PDF p. 305 of JTF-RH, 2023)

<sup>76</sup> According to the Navy, these pipelines operate in a closed-loop system that does not connect to the storm or wastewater sewer system. *See:* AFFF Video Event Timeline, at 2. (PDF p. 306 of JTF-RH, 2023)

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of the Navy's SITREPs, the AFFF released in Adit 6 appears to have impacted the Adit 6 tunnel, the asphalt outside of Adit 6, the soil adjacent to the impacted asphalt, a concrete drainage, and potentially a culvert, inlet and drainage pipe.<sup>77</sup> The impacted concrete drainage runs southwest along the access road from the asphalt apron at the entrance to Adit 6 to a culvert that directs stormwater under the access road to a stormwater outfall on the north side of the access road.<sup>78</sup>

### **3.2. Navy's Initial Response to the AFFF Release**

In the minutes and hours that immediately followed the AFFF release, emergency responders, including Navy and civilian personnel, mustered outside Adit 6 to conduct an initial evaluation of the release and perform containment measurements such as laying down absorbent padding. Some of these activities were captured by the camera outside of Adit 6 between approximately 1:17 p.m. and 4:25 p.m.

In the days following the AFFF release the Navy targeted approximately 3,000 cubic feet of soil for removal. The excavation of this soil began on November 29, 2022,<sup>79</sup> and was completed in December 2022.<sup>80</sup> Additional excavation areas from outside of Adit 6 included: the asphalt apron at the entrance of Adit 6, the concrete drainage ditch to the southwest along the access road, the culvert running under the access road from the drainage ditch, and the stormwater outfall beyond the culvert.<sup>81</sup> The Navy took measures to prevent any AFFF-contaminated materials from entering a storm drain, including installing an expandable bellow plug in front of the storm drain.<sup>82</sup>

Navy SITREP 6, dated February 7, 2023, indicates that a total of approximately 151 cubic yards of soil, asphalt and concrete were removed as part of this effort.<sup>83</sup> The Navy transported excavated concrete and asphalt to an interim location on JBPHH in dump trucks and placed excavated soil into 55-gallon drums for disposal.<sup>84</sup> Water associated with the Navy's AFFF release response was placed in two 10,000-gallon frac tanks and 55-gallon drums. The Navy also placed personal protective equipment (PPE), debris and absorbent pads into 55-gallon drums. Neither the SITREPs nor the Navy's Waste Management Plan for AFFF Response indicate the disposal facility or facilities the Navy has selected to receive AFFF-impacted waste.

Geotextile fabric and plastic sheet were laid at the limit of the excavated area at the entrance of Adit 6.<sup>85</sup> A new culvert was not installed; the inlet was concreted to immobilize potential contaminants.<sup>86</sup> Excavated areas were

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<sup>77</sup> Commander Navy Region Hawai'i, 2023. Red Hill – Adit 6 AFFF release Emergency Response, SITREP 6, Incident Case No.: 20221129-1438, February 27 (SITREP 6) at 2.

<sup>78</sup> SITREP 6, at 4.

<sup>79</sup> SITREP 6, at 4.

<sup>80</sup> SITREP 6, at 3.

<sup>73</sup> SITREP 6, at 4.

<sup>82</sup> JTF-RH Hill, 2022. Navy Region Hawai'i, Joint Task Force-Red Hill Provide Updates on Response Efforts to AFFF release at Red Hill Bulk Fuel Storage Facility, Dec 1. <https://www.pacom.mil/JTF-Red-Hill/Press-Room/Press-Releases/Article/3236855/navy-region-hawai'i-joint-task-force-red-hill-provide-updates-on-response-effort/> last accessed June 26, 2023.

<sup>83</sup> SITREP 6, at 5.

<sup>84</sup> JTF-RH, 2022. Navy Region Hawai'i, Joint Task Force-Red Hill Provide Updates on Response Efforts to AFFF release at Red Hill Bulk Fuel Storage Facility, Dec 1. <https://www.pacom.mil/JTF-Red-Hill/Press-Room/Press-Releases/Article/3236855/navy-region-hawai'i-joint-task-force-red-hill-provide-updates-on-response-effort/> last accessed June 26, 2023.

<sup>85</sup> SITREP 6, at 3.

<sup>86</sup> SITREP 6, at 9.



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backfilled with clean fill consisting of soil or gravel and covered with a temporary asphalt cap to minimize rain infiltration.<sup>87,88</sup>

Prior to backfilling excavated areas, the Navy conducted soil sampling, including confirmation sampling at excavation limits, based on a Sampling and Analysis Plan (SAP) prepared by the Navy, reviewed by EPA Region 9, and approved by Hawai'i DOH on December 1, 2022.<sup>89</sup> Soil samples were collected from the excavation areas outside of Adit 6 between December 2 and December 15, 2022. The soil samples were analyzed for PFAS by EPA Method 1633 and for 2-(2-butoxyethoxy)ethanol by EPA Method 8015.<sup>90</sup> PFAS results were compared to applicable EPA residential scenario regional screening levels (RSLs)<sup>91</sup> and Hawai'i DOH interim soil environmental action limits (EALs).<sup>92</sup> Several PFAS, including 6:2 fluorotelomer sulfonate, perfluoroheptanoic acid (PFHpA), perfluorohexanoic acid (PFHxA) and PFOA, were detected in soil above their respective EALs. No PFAS were detected above their respective RSLs.<sup>93</sup>

Inside Adit 6, the Navy placed absorbant padding to remove as much AFFF as possible. Adit 6 cleaning was conducted between January 3 and January 9, 2023. The Navy sealed the interior walls and concrete floor with epoxy to lock any residual contamination in place and prevent contamination from migrating to subsurface soils. The Navy conducted a permeability test on the Adit 6 floor on January 26, 2023, and granted resumed access to Adit 6 on January 30, 2023.<sup>94</sup>

In addition to these cleanup activities, the Navy disabled the Red Hill Facility AFFF fire suppression system following the AFFF release.<sup>95</sup>

### **3.3. Findings of Investigation into Cause of the AFFF release**

On December 2, 2022, JTF-RH convened an investigation to determine the cause of the November 29, 2022 discharge of AFFF. As part of the investigation, subject matter experts from the ACE conducted interviews, visited the Red Hill Facility, reviewed applicable documents, and prepared expert statements, upon which much of the ACE's investigation findings are based. The ACE's investigation found that the AFFF release directly stemmed from the coupling of two human errors: 1) the improper installation of an air vacuum valve to the AFFF system inside Adit 6 as part of AFFF fire suppression system modifications performed between December 2021 and April 2022 with 2) the failure to disable or lock-out the AFFF concentrate pumps in Building 313 from automatically starting prior to the IR detector signal test on November 29, 2022. Together, these actions resulted in the discharge of approximately 1,300 gallons of AFFF.<sup>96</sup> The series of events that culminated in the AFFF release on November 29, 2022, as identified by the ACE Investigation, are further described below.

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<sup>87</sup> SITREP 6, at 6.

<sup>88</sup> JTF-RH Public Affairs Office, 2023. Press Release: Join Task Force – Red Hill Announces AFFF Investigation Findings and Publishes Video Footage, May 5, at 2. (PDF p. 2 of JTF-RH, 2023)

<sup>89</sup> SITREP 6, at 3, 7.

<sup>90</sup> NAVFAC, 2022. PFAS-Specific Sampling and Analysis Plan, Red Hill Bulk Fuel Storage Facility, Adit 6, December 7, 2022, at 11. Based on the safety data sheet, 2-(2-Butoxyethoxy)ethanol is a solvent and a primary non-fluorinated ingredient of the AFFF concentrate released (Ansulite AFC-3MS 3% AFFF).

<sup>91</sup> EPA, 2023. Regional Screening Level (RSL) Summary Table (TR = 1E-06, HQ=0.1) May.

<sup>92</sup> Hawai'i DOH, 2022. Interim Soil and Water Environmental Action Levels (EALs) for Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS), Table A-2, Soil Action Levels, December 29.

<sup>93</sup> Summary of Chemistry Results, Adit 6 – AFFF release Response PFAS Sampling, Red Hill, JBPHH, December 2022.

<sup>94</sup> SITREP 6, at 10.

<sup>95</sup> Command Investigation into the Facts and Circumstances Surrounding the Discharge of Aqueous Film Forming Foam that Occurred at Red Hill Bulk Fuel Storage Facility on 29 November 2022. April 6, at 10. (PDF p. 286 of JTF-RH, 2023)

<sup>96</sup> Initial reports indicated that approximately 1,100 gallons of AFFF concentrate were released, this figure was later assessed at approximately 1,300 gallons. See: ACE Investigation Report, Enclosure 14, at 1. (PDF p. 285 of JTF-RH, 2023)

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### 3.3.1. Improper Installation of an Air Vacuum Valve

As described above in Section 2.1.4., the AFFF fire suppression system for the Red Hill Facility was installed between 2015 and 2018 with, among other components, piping to convey AFFF concentrate from the tank in Building 313 to Adit 6. The conveyance piping consisted of a stainless-steel inner pipe surrounded with PVC secondary containment piping. During maintenance of the system in August 2021, AFFF concentrate was observed in the PVC secondary containment piping.<sup>97</sup> The piping was pressure tested and determined not to be leaking.<sup>98</sup> However, AFFF was again observed in the secondary containment piping three weeks after the fire suppression system was put back into service. This observation prompted the Navy to develop a contractor scope of work to modify the AFFF fire suppression system.<sup>99</sup>

The modifications to the AFFF fire suppression system were performed by Kinetix between December 2021 and April 2022.<sup>100</sup> The modifications included the installation of multiple valves along the AFFF conveyance piping between Building 313 and Adit 6 in order to maintain separate “wet” (i.e., filled with AFFF concentrate) and “dry” (i.e., empty) sections of the underground AFFF concentrate piping. The purpose of keeping a dry section of pipe was to prevent AFFF leakage into secondary containment piping. These modifications were considered a temporary solution until the leaking AFFF concentrate piping could be replaced. With the modifications, the dry section of pipe was designed to remain empty until filled with AFFF when triggered by a fire event.<sup>101</sup>

One of the valves installed to maintain this separation was a Pratt WAV10-300-FS air vacuum valve.<sup>102</sup> Under its designed configuration, this valve would permit air to be purged from the dry section of pipe allowing it, and the valve, to then be filled with AFFF in the event of a fire that triggered the AFFF fire suppression system. Operating as intended, the air vacuum valve would discharge primarily air from the AFFF concentrate piping, although it was foreseen that a small amount of AFFF concentrate might escape through the closing valve as it as it filled with AFFF concentrate.<sup>103</sup> Therefore, the air vacuum valve was designed with an AFFF capture line connected to a relief drain containment vessel, which consisted of a 8-foot tall, 8-inch diameter standpipe<sup>104</sup> located in Adit 6. The purpose of the drain containment vessel was to capture any small amount of AFFF that might escape the valve when the pipe was purged of air and filled with AFFF.<sup>105</sup>

Under the design the of the AFFF system modification, the AFFF capture line was intended to be connected to the air vent, a central opening on the air vacuum valve that allows air to escape and then becomes blocked during valve closure.<sup>106</sup> In other words, as designed, once air had been purged from the dry section of pipe through the air vent, it would close as the valve filled with AFFF concentrate, preventing all but a small amount of AFFF from escaping the valve and entering the AFFF capture line. However, upon inspection in the weeks following the AFFF release, ACE investigators determined that the AFFF capture line had instead been connected to the valve flush connection, a second opening, adjacent to and slightly offset from the air vent.<sup>107</sup>

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<sup>97</sup> ACE Investigation Report, Enclosure 14, at 2. (PDF p. 286 of JTF-RH, 2023)

<sup>98</sup> ACE Investigation Report, Enclosure 14, at 2. (PDF p. 286 of JTF-RH, 2023)

<sup>99</sup> ACE Investigation Report, at 4. (PDF p. 8 of JTF-RH, 2023)

<sup>100</sup> ACE Investigation Report, at 4.

<sup>101</sup> ACE Investigation Report, at 4.

<sup>102</sup> The scope of work called for the installation of a Pratt WAV05-300-FS air vacuum valve; however, installation of the slightly different valve was not likely a contributor to the AFFF release. See: ACE Investigation Report, at 2. (PDF p. 6 of JTF-RH, 2023)

<sup>103</sup> The air vacuum valve was designed with a float that rises as liquid enters the valve chamber, closing the valve by shutting the outlet of the air vent. See: ACE Investigation Report, Enclosure 14, at 4. (PDF p. 288 of JTF-RH, 2023)

<sup>104</sup> Joint Task Force Red Hill 29 November. . . Inadvertent Discharge (PDF p. 301 of JTF-RH, 2023)

<sup>105</sup> ACE Investigation Report, Enclosure 13, at 8. (PDF p. 283 of JTF-RH, 2023)

<sup>106</sup> ACE Investigation Report, Enclosure 14, at 4. (PDF p. 288 of JTF-RH, 2023)

<sup>107</sup> ACE Investigation Report, Enclosure 14, at 4. (PDF p. 288 of JTF-RH, 2023)

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The valve manufacturer's design intends for the valve flush connection to be plugged,<sup>108</sup> as it is open to the inside of the valve and is not designed to be blocked when the valve is closed and filled with AFFF concentrate.<sup>109</sup> Therefore, the connection of the AFFF capture line to the valve flush connection opening inadvertently created a bypass around the valve closure mechanism such that AFFF concentrate entering the valve under pressure (as would be the case when sensors detected a fire and triggered AFFF concentrate to be pumped from the tank in Adit 6 into the dry portion of the AFFF conveyance pipe) would exit the valve through the valve flush connection opening into the drain line and fill the containment vessel in Adit 6 to the point of overflowing,<sup>110</sup> as occurred on November 29, 2022.

The scope of work for the AFFF system modification called for leak testing and removal of AFFF concentrate from the pipe following leak testing. One of the ACE investigators concluded that either the leak testing was not performed, or the air vacuum valve was isolated when it was performed. Had the leak testing been performed as specified, AFFF concentrate would have discharged into the containment vessel via the drain piping and the incorrect valve installation thereby identified.<sup>111</sup>

### 3.3.2. Failure to Disable AFFF Concentrate Pumps During Testing Activities

The ACE Investigation concluded that the improper installation of the air vacuum valve described above would have prevented the AFFF system from functioning as intended during an emergency fire event that triggered AFFF concentrate to be pumped into the conveyance piping.<sup>112</sup> Any AFFF that reached the air vacuum valve would be discharged through the drain line into the containment vessel. This fact was not realized during a semi-annual signal verification test performed in May 2022 because during that testing Kinetix disabled (i.e., locked out) the AFFF concentrate pumps by placing them in manual mode. With the pumps disabled, no AFFF was pumped into the dry portion of AFFF conveyance piping and therefore no AFFF was discharged through the air vacuum valve.

Through interviews with Kinetix personnel in the days following the AFFF release, ACE investigators determined that during the semi-annual signal verification test conducted on November 29, 2022, the AFFF concentrate pumps were not disabled to manual mode but instead left in automatic mode. As a result, the signal verification test, which effectively simulated the detection of a fire by activating IR sensors in the lower tunnel, triggered the AFFF concentrate pumps to automatically pump AFFF concentrate to the AFFF conveyance piping. Once the AFFF concentrate reached the improperly installed air vacuum valve it bypassed the closed air vent and discharged through the valve flush connection to the containment vessel, ultimately overflowing the vessel onto the floor.

### 3.3.3. JTF-RH Recommendations and Actions Stemming from the ACE Investigation

The ACE Investigation highlighted issues with the original AFFF fire suppression system that together with a series of human errors culminated in the AFFF release on November 29, 2022. Based on the ACE Investigation, JTF-RH put forth the following recommendations:<sup>113</sup>

- The Government should perform more effective oversight of AFFF-related activities at the Red Hill Facility, similar to Navy oversight of aviation, submarine and nuclear activities;
- The Red Hill AFFF fire suppression system should be decommissioned and all AFFF concentrate should be removed from the Red Hill Facility; and

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<sup>108</sup> ACE Investigation Report, Enclosure 14, at 4. (PDF p. 288 of JTF-RH, 2023)

<sup>109</sup> ACE Investigation Report, Enclosure 13, at 6. (PDF p. 281 of JTF-RH, 2023)

<sup>110</sup> ACE Investigation Report, Enclosure 13, at 8. (PDF p. 283 of JTF-RH, 2023)

<sup>111</sup> ACE Investigation Report, Enclosure 13, at 7-8. (PDF p. 283-284 of JTF-RH, 2023)

<sup>112</sup> ACE Investigation Report, at 6. (PDF p. 10 of JTF-RH, 2023)

<sup>113</sup> ACE Investigation Report, at 6. (PDF p. 10 of JTF-RH, 2023)

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- If the use of AFFF is deemed necessary at the Red Hill Facility, the Navy should fully and thoroughly inspect and test all aspects of the AFFF system to ensure it functions as designed.

Per these recommendations, the Navy has directed the review of the quality assurance processes in place for oversight of contractor maintenance and repair work on systems containing hazardous materials. The AFFF fire suppression system at the Red Hill Facility remains inactive. JTF-RH is currently working with the Navy and with the Federal Fire Department (FedFire) to develop a fire response plan that appropriately balances the priorities of fire suppression, personnel safety, and environmental concerns. The Navy is seeking a viable alternative to AFFF for fire suppression at underground storage tanks.<sup>114</sup>

#### **4. EPA RESPONSE TO PUBLIC COMMENT REGARDING THE AFFF RELEASE**

EPA Region 9 has been coordinating closely with JTF-RH as part of the defueling of the Red Hill Facility. At the time of the AFFF release, EPA Region 9 was drafting an Administrative Consent Order (Consent Order) with the Navy and the Defense Logistics Agency (DLA) that requires these agencies to safely defuel and close the Red Hill Facility. EPA Region 9 released the proposed Consent Order in December 2022 and opened a public comment period. During this period EPA Region 9 conducted virtual meetings with stakeholder community representatives, hosted a public Town Hall and Open House with representatives from the Navy and DLA, among other agencies, and solicited public input on the proposed Consent Order. EPA Region 9 received and reviewed over 1,700 public comments prior to negotiating and finalizing the Consent Order in June 2023 (2023 Consent Order).<sup>115</sup> Many of these comments raised concerns regarding the AFFF release and the use of AFFF at the Red Hill Facility. EPA Region 9 addressed these concerns in Section 8 of its Response to Comments document for the proposed Consent Order.<sup>116</sup>

In its Response to Comments, EPA Region 9 stated that the Navy would conduct its ongoing PFAS investigation and any cleanup, as appropriate, under 1) a separate Administrative Order on Consent (AOC) with the Navy from 2015 related to the Red Hill Facility<sup>117</sup> and 2) a 1994 Comprehensive Environmental Response Compensation and Liability Act (CERCLA) Federal Facility Agreement (FFA) with the Regulatory Agencies for the Pearl Harbor National Priorities List.<sup>118</sup> Both the 2015 AOC and the 1994 CERCLA FFA include stipulated penalties for noncompliance. Under this approach, the Regulatory Agencies have authority to oversee the Navy's PFAS investigation.<sup>119</sup>

#### **5. NAVY'S ONGOING ENVIRONMENTAL INVESTIGATION**

The Regulatory Agencies have required the Navy to conduct ongoing environmental investigation, characterization, and remediation work targeting the AFFF release.<sup>120</sup> The Navy performs this work at the Red

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<sup>114</sup> Command Investigation into the Facts and Circumstances Surrounding the Discharge of Aqueous Film Forming Foam that Occurred at Red Hill Bulk Fuel Storage Facility on 29 November 2022. April 6, at 10. (PDF p. 14 of JTF-RH, 2023)

<sup>115</sup> EPA Region 9, 2023. Red Hill: 2023 Consent Order. <https://www.epa.gov/red-hill/red-hill-2023-consent-order>, last accessed June 29, 2023.

<sup>116</sup> EPA Region 9, 2023. 2023 Administrative Consent Order for Defueling, Closure, and Drinking Water Protection for the Red Hill Bulk Fuel Storage Facility and Joint Base Pearl Harbor-Hickam Water System, Response to Comments. June.

<sup>117</sup> EPA, Region 9, 2015. Administrative Order on Consent, EPA DKT No. RCRA 7003-R9-2015-01, May 27.

<sup>118</sup> Department of the Navy, 2023. Clarification of Scope Required by 2015 Red Hill Administrative Order on Consent and Schedule for Consolidated Environmental Scope of Work for Red Hill Bulk Fuel Storage Facility, May 15.

<sup>119</sup> EPA Region 9, 2023. 2023 Administrative Consent Order for Defueling, Closure, and Drinking Water Protection for the Red Hill Bulk Fuel Storage Facility and Joint Base Pearl Harbor-Hickam Water System, Response to Comments. June, at 17.

<sup>120</sup> EPA Region 9 and Hawaii DOH (the "Regulatory Agencies"), 2023. Clarification of Scope Required by 2015 Red Hill Administrative Order on Consent and Schedule for Consolidated Environmental Scope of Work, Red Hill Bulk Fuel Storage Facility, February 17.

Hill Facility under multiple regulatory requirements, including those pursuant to the 2015 AOC.<sup>121</sup> In addition to the remediation activities described in Section 3.2, the Navy is conducting weekly groundwater sampling for PFAS at 10 monitoring wells and the Red Hill Shaft.<sup>122</sup> The groundwater sampling locations are positioned between 240 feet and 4,290 feet from Adit 6.<sup>123</sup> Two monitoring wells appear to be positioned upgradient from Adit 6 and the remaining eight appear to be positioned cross- or downgradient from Adit 6 with respect to the generally westward regional groundwater flow direction (see Section 2.1.2). The groundwater monitoring wells are designed for sampling the groundwater aquifer described in Section 2.1.2. In addition to these monitoring wells, two piezometers are located generally cross- or downgradient from Adit 6 and access a shallower perched aquifer.<sup>124</sup> The groundwater samples collected from the groundwater monitoring wells and piezometers are analyzed for 40 PFAS by EPA Method 1633. Validated Navy groundwater monitoring sample results presented to date show no exceedances of PFAS based on Hawai‘i DOH EALs and EPA RSLs. The Navy’s SAP established an initial monitoring period of six months,<sup>125</sup> as communicated to EPA Region 9 by the Navy in an email in March 2023. According to the JBPHH Safe Waters website, weekly groundwater monitoring is still ongoing.<sup>126</sup>

The Regulatory Agencies have requested that the Navy expand the scope of groundwater sampling for PFAS to include all wells in the Red Hill groundwater monitoring network. In a letter sent to the Navy on February 17, 2023, the Regulatory Agencies clarified that the scope of the Navy’s ongoing Red Hill environmental investigation includes groundwater sampling for PFAS.<sup>127</sup> The Navy sent a letter to the Regulatory Agencies on May 15, 2023, noting that, under the 1994 FFA, the Navy had initiated the CERCLA investigation process to identify the nature and extent of PFAS releases from Navy activities at JBPHH and the Red Hill Facility. This letter indicated that the PFAS releases from Navy activities will be addressed under both the 1994 FFA and the 2015 AOC. On May 18, 2023, the Navy submitted a consolidated groundwater sampling program for the Red Hill Facility to the Regulatory Agencies.<sup>128</sup> According to the Navy, the purpose of this consolidated plan is to coordinate all of the Red Hill groundwater sampling programs into a single program to facilitate better regulatory oversight and sampling event execution.<sup>129</sup> The consolidated sampling plan proposes monthly groundwater sampling for PFAS, with analysis by EPA Method 1633, at the same subset of groundwater monitoring locations sampled as part of the weekly monitoring conducted under the SAP described above.<sup>130</sup> On May 31, 2023, having reviewed the consolidated groundwater sampling program, EPA Region 9 emailed

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<sup>121</sup> The Regulatory Agencies, 2023. Clarification of Scope Required by 2015 Red Hill Administrative Order on Consent and Schedule for Consolidated Environmental Scope of Work, Red Hill Bulk Fuel Storage Facility, February 17.

<sup>122</sup> The May 5, 2023 JTF-RH Press Release regarding the AFFF release indicates that, as of May 5, 2023, groundwater monitoring was ongoing at nine groundwater monitoring wells and the Red Hill Shaft.

<sup>123</sup> NAVFAC, 2023. Distance Between AFFF Release and Existing Sampling Locations, Red Hill Bulk Fuel Storage Facility, JBPHH, Oah‘u, Hawai‘i, January 26, 2023.

<sup>124</sup> NAVFAC, 2022. PFAS-Specific Sampling and Analysis Plan, Red Hill Bulk Fuel Storage Facility, Adit 6, Joint Base Pearl Harbor-Hickam, O‘ahu, Hawai‘i, December 7, at 12, Figure 2.

<sup>125</sup> NAVFAC, 2022. PFAS-Specific Sampling and Analysis Plan, Red Hill Bulk Fuel Storage Facility, Adit 6, Joint Base Pearl Harbor-Hickam, O‘ahu, Hawai‘i, December 7, at 11.

<sup>126</sup> Safe Waters Joint Base Pearl Harbor-Hickam. PFAS Sampling. [https://jbphh-safewaters.org/public/framework/bannerhtml.aspx?idhtml=10773&banner=jbphh\\_environmental.png&title=PFAS%20Sampling&Domain=env.jbphh-safewaters.org&idMenu=92559&ddIDSN=SYSTEM&DSN=SYSTEM](https://jbphh-safewaters.org/public/framework/bannerhtml.aspx?idhtml=10773&banner=jbphh_environmental.png&title=PFAS%20Sampling&Domain=env.jbphh-safewaters.org&idMenu=92559&ddIDSN=SYSTEM&DSN=SYSTEM), last accessed July 28, 2023.

<sup>127</sup> The Regulatory Agencies, 2023. Clarification of Scope Required by 2015 Red Hill Administrative Order on Consent and Schedule for Consolidated Environmental Scope of Work, Red Hill Bulk Fuel Storage Facility, February 17, at 3.

<sup>128</sup> Department of the Navy, 2023. Consolidated Groundwater Sampling Program at Red Hill Bulk Fuel Storage Facility. May 18.

<sup>129</sup> NAVSEA, 2023. Consolidation and Optimization of Groundwater Sampling Program Red Hill Bulk Fuel Storage Facility, Joint Base Pearl Harbor-Hickam, Oahu, Hawaii, May, at 1.

<sup>130</sup> NAVSEA, 2023. Consolidation and Optimization of Groundwater Sampling Program Red Hill Bulk Fuel Storage Facility, Joint Base Pearl Harbor-Hickam, Oahu, Hawaii, May, at 5-6.

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the Navy requesting that the Navy commit to sample all Red Hill monitoring wells for PFAS, not only those proposed in the consolidated plan. This and subsequent related requests are further discussed in Section 6.

## 6. FINDINGS AND RECOMMENDATIONS

Based on EPA Region 9's review of the ACE Investigation and information regarding the Navy's environmental response to AFFF release, EPA Region 9 has the following findings and associated recommendations for the Navy/DoD:

1. **The Navy/DoD should provide EPA Region 9 with a report documenting in detail the environmental sampling, remediation, and waste management activities stemming from the AFFF release.**

In addition to the information requests described in Section 2.3, EPA Region 9 corresponded with the Navy in March 2023 and again in May 2023, requesting information about the status of the Navy's environmental sampling and cleanup efforts in response to the AFFF release, including associated reporting. The Navy has made public individual laboratory analytical reports containing results of soil and groundwater sampling, standalone summary tables of soil and groundwater data, and other items as required by Hawai'i DOH including SITREPs. However, the Navy has not submitted a report, such as a removal action completion report, that would provide context for these items and document environmental sampling results, remediation efforts, data gaps, waste management activities, and the extent of remaining PFAS impacts to the environment, if any, stemming from the AFFF release.

EPA Region 9 recommends that the Navy compile this information into a report to be submitted to the Regulatory Agencies. This report will facilitate EPA Region 9's evaluation of potential impacts, if any, to human health and the environment stemming from the AFFF release. It will also provide basis for the design of the Navy's ongoing environmental sampling program. The report should include the following elements:

- Steps taken to clean up the original release (e.g., excavation, use of spill kits/absorbents, etc.);
- Maps depicting the extent of release, the extent of cleanup efforts, locations of confirmation samples, and areas where PFAS concentrations exceed screening criteria after the removal actions;
- Sampling methods and results;
- Tables summarizing sampling results from all environmental media (e.g., soil, groundwater) sampled with comparisons of those results to applicable environmental regulatory levels (e.g., Hawai'i DOH EALs);
- Data gaps;
- Methods of waste sampling, management, and disposal; and
- Recommended next steps.

The report should include detailed information such as the depths of excavations, volumes of soil removed, methods of sample collection and handling, and the basis for conclusions/recommendations.

2. **The Navy/DoD should expand its groundwater sampling for PFAS to include all groundwater monitoring wells in the Red Hill well network.**

As discussed in Section 5, upon review of the Navy's May 2023 consolidated groundwater sampling program, EPA Region 9 requested that the Navy expand PFAS groundwater sampling to include all wells in the Red Hill well network. This request was reiterated in an email to the Navy on July 21,

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2023, in which EPA Region 9 asked that the Navy commit to sampling all of the Red Hill groundwater monitoring wells for PFAS at least once.

EPA Region 9 recommends that the Navy expand the proposed PFAS monitoring program to include all Red Hill monitoring wells in order to delineate the extent of PFAS at the Red Hill site. Results from an initial sampling of all Red Hill wells for PFAS are needed to serve as the basis for selecting specific wells for further sampling. The expanded PFAS groundwater sampling (at all wells) should be conducted at the next groundwater sampling event and the results should be incorporated into, and help inform of the scope of, any future PFAS Remedial Investigation for the Red Hill facility pursuant to the 1994 FFA and/or the 2015 AOC.



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DEPARTMENT OF THE NAVY  
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5090  
Ser N04/032  
February 3, 2023

Ms. Amy Miller-Bowen,  
Enforcement Director  
U.S. Environmental Protection Agency Region IX  
75 Hawthorne Street  
San Francisco, CA 94105

Dear Ms. Miller-Bowen:

SUBJECT: U.S. DEPARTMENT OF THE NAVY EXTENSION REQUEST IN  
RESPONSE TO THE U.S. ENVIRONMENTAL PROTECTION AGENCY  
LETTER TO THE RELEASE OF AQUEOUS FILM FORMING FOAM AT  
THE RED HILL BULK FUEL STORAGE FACILITY

The U.S. Navy is respectfully requesting a deadline extension in response to the U.S. Environmental Protection Agency's (EPA) January 6, 2023 letter on information about the clean-up, monitoring, and remediation of the November 29, 2022 and other releases of Aqueous Film Forming Foam (AFFF) concentrate at the Red Hill Bulk Fuel Storage Facility (RHBFSF) and in the surrounding environment under Section 3007(a) of the Resource Conservation and Recovery Act (RCRA).

As an initial matter, the Navy will voluntarily provide the requested information, but notes that Section 3007(a) of RCRA may not be the appropriate authority for your request. As you know, that section allows EPA to request information or gain access to records from any person "who generates, stores, treats, transports, disposes of, or otherwise handles or has handled hazardous wastes." However, the information or records must be "related to" the hazardous wastes handled. As neither AFFF nor its typical components are listed or characteristic hazardous waste pursuant to RCRA regulations, your request is beyond the scope of Section 3007(a). Nevertheless, the Navy will provide the information you requested, voluntarily, in the interest of transparency.

Commander, Navy Installations Command (CNIC), headquartered in Washington, D.C. has assembled a team of AFFF subject matter experts to conduct a thorough assessment of all historical AFFF releases at Joint Base Pearl Harbor-Hickam (JBPHH), which includes the RHBFSF. The team does not anticipate completing their assessment and producing a finalized report prior to EPA's initial deadline request for information of Monday, February 6, 2023.

As a result, the Navy is respectfully requesting an extension of that deadline to Wednesday, March 15, 2023 for Appendix A, questions 1, 2, 3, 6, and 7.

5090  
Ser N4/032  
February 3, 2023

With respect to the EPA's request for information in Appendix A – Items 4 and 5, all PFAS laboratory reports/electronic data deliverables are readily available on the Navy's Electronic Data Management System (EDMS) which was developed in collaboration with EPA and DOH. Laboratories directly upload analytical results – allowing our regulatory partners the ability to access the data as soon as it is available; concurrent with the Navy. If additional EPA individuals require access, please let the Navy know and we will be glad to set up additional accounts for EPA.

The Navy is in the process of uploading laboratory reports of samples collected from Red Hill prior to the implementation of the EDMS system. Previous PFAS laboratory reports for the drinking water wells will be uploaded into EDMS by mid-February.

The Navy will continue to work diligently to ensure that EPA is provided all information pertaining to the November 29, 2022 AFFF release, as well as all historical data related to past AFFF releases that have occurred at JBPHH.

If there are any questions regarding this matter, please feel free to contact me at 808-473-4148 or by email at donald.c.panthen.civ@us.navy.mil.

Sincerely,



D. C. PANTHEN  
Director, Red Hill Program Management Office  
By direction

Copy to: Jamie Marincola, Enforcement and Compliance Assurance Division  
Kathleen Ho, Deputy Director, Hawaii Department of Health  
CAPT Cameron Geertsema, NAVFAC Hawaii, Commanding Officer  
Sherri Eng, Navy Region Hawaii, Environmental Director





## DEPARTMENT OF THE NAVY

COMMANDER  
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5090  
Ser N4/143  
May 18, 2023

Grant Scavello  
U.S. Environmental Protection Agency, Region 9  
Red Hill Project Coordinator  
75 Hawthorne Street  
San Francisco, CA 94105

Kelly Ann Lee  
State of Hawai'i, Department of Health  
Red Hill Project Coordinator  
P.O. Box 3378  
Honolulu, HI 96801

Dear Mr. Scavello and Ms. Lee:

**SUBJECT: CONSOLIDATED GROUNDWATER SAMPLING PROGRAM AT RED HILL BULK FUEL STORAGE FACILITY**

The purpose of this letter is to provide the United States Environmental Protection Agency (EPA) and the Hawaii Department of Health (DOH), collectively the "Regulatory Agencies," with the Navy's consolidated groundwater sampling program. This plan consolidates all monitoring requirements associated with the 2021 fuel releases, the 29 November 2022 aqueous film forming foam (AFFF) release, and the original quarterly monitoring performed under the 2015 Administrative Order on Consent (AOC).

This consolidated plan, provided as enclosure (1), was developed based on discussions held and feedback received between the Navy and the Regulatory Agencies during numerous meetings in March and April 2023. On March 08, 2023, during a meeting focused specifically on the Notice of Interest (NOI) sampling frequency, methods, and locations, the Navy presented information to support a consolidated sampling program. The discussion focused on continuing to perform groundwater sampling in a manner that satisfactorily addressed the Regulatory Agencies' requirements in response to the 2021 fuel releases, while also reducing the laboratories' turn-around times to quickly inform groundwater assessments for the Regulatory Agencies and the Navy.

In senior-level discussions between the Regulatory Agencies and the Navy on April 11, 2023 during a 2015 AOC clarification meeting, the April 13, 2023 Red Hill Remediation Roundtable meeting, and e-mail correspondence between the Regulatory Agencies and the Navy on April 26, 2023, the Regulatory Agencies re-enforced the desire for a consolidated site-wide monitoring program. This request expanded the scope of the March 8, 2023 discussion to include the November 2022 AFFF release, as well as the original quarterly sampling performed under the 2015 AOC.

The Navy agrees that a consolidated, optimized plan that addresses the multiple groundwater sampling requirements in a single document is beneficial to all parties, and has updated the enclosed plan to incorporate the Regulatory Agencies' expanded requests.



5090  
Ser N4/143  
May 18, 2023

The changes to the proposed consolidated groundwater sampling plan include the following:

- The consolidation of sampling locations from the May and November 2021 Notice of Interest sampling program and 2015 AOC quarterly groundwater long-term monitoring program to a single listing of wells. This single listing allows for better alignment at all sampling locations and eliminates the potential for discrepancies in understanding specific sampling requirements created by technical nuances of NOI sampling locations, plume delineation wells, and sentinel wells. The consolidated plan also identifies the locations sampled for per- and polyfluoroalkyl substances (PFAS), in response to the November 2022 AFFF release.
- An optimization of the sampling frequency of data collection to reduce sampling backlogs and laboratory turn-around times. This optimization increases the likelihood of receiving validated data more timely to assess the groundwater conditions near the Red Hill Bulk Fuel Storage Facility.
- The use of low-flow sampling methods, as recommended in the DOH Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan, at all locations. The low-flow purging and sampling approach improves the representativeness of the sample data.
- An optimization of the analyte list, focusing on fuel-related and PFAS contamination.

The Navy intends to begin implementation of this consolidated sampling plan starting June 05, 2023. The Navy requests any formal, written feedback by the Regulatory Agencies no later than May 24, 2023 to allow adequate time to review and incorporate recommendations into the consolidated groundwater sampling plan, as necessary.

Please do not hesitate to contact me directly for matters related to this consolidated sampling plan. I am available by email at [Cameron.J.Geertsema.mil@us.navy.mil](mailto:Cameron.J.Geertsema.mil@us.navy.mil), or by phone at (808) 471-3926.

Sincerely,



C. J. GEERTSEMA, P.E.  
Regional Engineer  
By Direction of the  
Commander

Enclosure: 1. Consolidation and Optimization of the Groundwater Sampling Programs, May 2023

**Consolidation and Optimization of the Groundwater Sampling Programs**  
**Red Hill Bulk Fuel Storage Facility**  
**Joint Base Pearl Harbor-Hickam, O‘ahu, Hawai‘i**  
*Naval Facilities Engineering Systems Command, Hawaii, JBP HH HI*  
*May 2023*

## **1. Executive Summary**

The Navy is consolidating Notice of Interest (NOI), Groundwater Long-Term Monitoring (GW LTM), delineation and sentinel wells, and per- and polyfluoroalkyl substances (PFAS) groundwater sampling programs into one comprehensive, optimized groundwater sampling program. The new program is based on the following:

- Hawai‘i Department of Health (DOH) guidance;
- The Red Hill Administrative Order on Consent (AOC);
- DOH Notice of Interest (NOI) requirements that have expired on November 13, 2022;
- The March 8, 2023 meeting with the U.S. Environmental Protection Agency (EPA) and DOH regarding future sampling requirements;
- The April 13, 2023 Red Hill Remediation Roundtable meeting, and
- Reviews of NOI data collected and analyzed at least weekly since May 2021

The consolidated sampling approach includes the following changes:

- Integrating and coordinating all of the Red Hill groundwater sampling programs into a single program to facilitate better regulatory oversight, and sampling event execution throughout and in the vicinity of the Red Hill Bulk Fuel Storage Facility;
- Revising the NOI analyte list, with a focus on fuel-related analytes;
- Optimizing the NOI sampling frequency from weekly to monthly;
- Incorporation of Data Quality Objectives;
- Optimizing NOI monitoring locations to provide comprehensive assessment of the general area; and
- Standardizing the NOI sample collection method to use low-flow purging and sampling methodology, as recommended in the DOH Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan (TGM) (DOH 2021)

## **2. Groundwater Sampling Program Improvements**

### **2.1 SAMPLING PROGRAM INTEGRATION**

To optimize the sampling programs for targeted sampling for faster lab turnaround times and more efficient data analyses, the various programs have been integrated into a single, comprehensive groundwater sampling program. The consolidated groundwater monitoring program requirements include the analytical suite, analytical methods, laboratory turnaround times, sampling locations, sample collection methods, and sampling frequency.

In accordance with the *Sampling and Analysis Plan, Investigation and Remediation of Releases and Groundwater Protection and Evaluation, Revision 01* (DON 2017b), the U.S. Navy Environmental Restoration Program, NAVFAC Pacific, Navy Project Procedures Manual (DON 2015), and the TGM, the consolidated groundwater sampling program includes NOI and GW LTM sampling of inside- and outside-tunnel sampling locations using low-flow sampling techniques. Groundwater sampling also includes measuring depth to groundwater and depth to well bottom from the top of casing and assessing the presence or absence of an immiscible phase. A photoionization detector is used to evaluate whether well volatile organic compound levels are above ambient conditions, prior to deploying an oil/water interface probe.

Headspace monitoring is performed at all locations, and fuel product thickness gauging is conducted at wells with screens that bracket the water table. Bailers are used to assess and photo document the presence or absence of floating product on the groundwater surface in wells installed in unconfined conditions.

Field parameters collected during purging include water level measurements, observations (i.e., water clarity and condition, evidence of free product), dissolved oxygen measurements, and groundwater sampling parameters (turbidity, specific conductance, oxidation reduction potential, pH).

During the April 13, 2023 Red Hill Remediation Roundtable meeting, the Regulatory Agencies requested that the Navy include PFAS-specific sampling in the consolidated groundwater sampling program. Consistent with the *PFAS-Specific Sampling and Analysis Plan* (DON 2022), PFAS is sampled from 10 monitoring wells to determine whether the aqueous film-forming foam (AFFF) release near the ground surface impacted the groundwater using low-flow (pump) purging. Two additional samples are collected at piezometers RHMW17S and RHMW17D (shallow and intermediate), which are installed in perched groundwater above the basal aquifer. Samples are analyzed for all PFAS components that are included in the EPA Draft Method 1633 list.

## 2.2 REVISED ANALYTE LIST

NOI, GW LTM, delineation well, and sentinel well sampling has generated a substantial dataset characterizing the nature and extent of the fuel releases. The NOI sampling included analyses of chemicals of potential concern (COPCs) and additional analytes including chemicals that are not associated with fuels. Therefore, this document presents the notification of changes to the ongoing NOI sampling program and integration of the various groundwater monitoring programs into one overall program informed by the substantial body of laboratory results, DOH guidance, and the composition of the fuels. This process mimics the process employed under the AOC. Table 1 and Table 2 provide a summary of the analytical list for the consolidated groundwater monitoring program, which includes monthly analytes, analytical methods, and screening criteria.

The following ten primary COPCs were established in February 2016 (EPA Region 9 and DOH 2016) for the AOC investigations and the GW LTM program and shall remain the same for the consolidated sampling program:

- Total petroleum hydrocarbons (TPH)-gasoline range organics (TPH-g), TPH-diesel range organics (TPH-d), and TPH-oil range organics (TPH-o)
- Naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene
- Benzene, toluene, ethylbenzene, and total xylenes (BTEX)

During the March 8, 2023 Navy, EPA, and DOH collaboration meeting, the Navy presented a list of reduced analytes for NOI sampling. Inclusion of the non-fuel related, full suite analytes increased processing time for commercial laboratories, data validators, and sampling and shipping, without adding valuable information to identify and characterize potential fuel release impacts. This contributed to delays in validation, reporting, and timely analyses of results, and impeded rapid assessment of impacts to groundwater and the ability to quickly respond to changes in groundwater conditions.

Although it was valuable during emergency response activities in late 2021 and early 2022, continued inclusion of additional analytes runs counter to TGM guidance of “Do not simply list chemicals associated with specific laboratory methods that will be utilized to test samples collected at the site”<sup>1</sup> and will no longer be implemented. Based on the laboratory results from all groundwater monitoring events, the infrequent detection of low concentrations of analytes that are not associated with fuel confirms that the analytes used as the AOC and GW LTM COPCs are appropriate. Out of an abundance of caution, additional Polycyclic Aromatic Hydrocarbons (PAHs) analyzed for NOI sampling will also continue as part of the consolidated sampling program, because some

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<sup>1</sup> <https://health.hawaii.gov/heer/tgm/section-06/>, last accessed March 15, 2023.

PAHs are potentially associated with jet fuels at low concentrations. The Navy also agreed to add non-volatile dissolved organic carbon and it has been added to the natural attenuation parameter (NAP) list for monthly sampling.

Table 1. Consolidated Groundwater Monitoring Program (Fuel).

Parameter	Analytical Method	Analyte(s)	GW Screening Criterion (DOH EALs) (µg/L)	Quarterly LTM	Monthly NOI
TPH	EPA 8260	TPH-g	300	x	x
	EPA 8015	TPH-d	400	x	x
		TPH-o	500	x	x
Total TPH	—	Reported as a non-overlapping sum of TPH-g/d/o with BTEXMN subtracted	—		x
TPH with SGC	EPA 3630/8015	TPH-d	—	x	x
		TPH-o	—	x	x
VOCs	EPA 8260	Benzene	5	x	x
		Ethyl Benzene	30	x	x
		Toluene	40	x	x
		Total Xylenes	20	x	x
AOC / LTM PAHs	EPA 8270 SIM	1-Methylnaphthalene	10	x	x
		2-Methylnaphthalene	10	x	x
		Naphthalene	17	x	x
PAHs	EPA 8270 SIM	Acenaphthene	20	x	x
		Acenaphthylene	240	x	x
		Anthracene	0.18	x	x
		Benzo(a)anthracene	0.029	x	x
		Benzo(a)pyrene	0.2	x	x
		Benzo(b)fluoranthene	0.22	x	x
		Benzo(g,h,i)perylene	0.13	x	x
		Benzo(k)fluoranthene	0.4	x	x
		Chrysene	1	x	x
		Dibenzo(a,h)anthracene	0.022	x	x
		Fluoranthene	13	x	x
		Fluorene	240	x	x
		Indeno(1,2,3-cd)pyrene	0.095	x	x
		Phenanthrene	210	x	x
		Pyrene	68	x	x
Fuel Additives	EPA 8270	Phenol	300	x	x
	EPA 8270	2-(2-Methoxyethoxy) Ethanol	800	x	
Lead Scavengers <sup>a</sup>	EPA 8011	1,2-Dibromoethane	0.04	x	x
	EPA 8260	1,2-Dichloroethane	5	x	x
NAPs	SM 3500-Fe	Ferrous Iron	—	x	
	RSK 175M	Methane	—	x	x
	EPA 300.0	Nitrate, Sulfate, Chloride	—	x	
	EPA 353.2	Nitrate-Nitrite as Nitrogen	—	x	
	EPA 2320	Carbonate, Bicarbonate, and Total Alkalinity	—	x	
	EPA 9060A	TOC	—	x	x
	EPA 9060A	Dissolved Organic Carbon <sup>a</sup>	—	x	
General Chemistry <sup>b</sup>	EPA 9060A	NVDOC	—		x
	EPA 300.0	Bromide, Chloride, Fluoride, Nitrate, Sulfate	—	x	
	EPA 6010C	Calcium, Iron, Dissolved Lead, Total Lead, Magnesium, Manganese, Potassium, Sodium	—	x	
	SMWW4500-Si-D / SiO2-C	Dissolved Silica, Total Silica	—	x	

## Notes:

x	Compound is included in the respective groundwater sampling program	MN	1- and 2-methylnaphthalenes
—	not applicable	NAP	natural attenuation parameters
a	Discontinued if one year's worth of sampling show levels are below DOH EALs	PAH	polycyclic aromatic hydrocarbons
b	Monitored on the first GW LTM event of a new well	SGC	silica gel clean-up
ug/L	microgram per liter	TPH-g	total petroleum hydrocarbons - gasoline range organics
BTEX	benzene, toluene, ethylbenzene, xylene	TPH-d	total petroleum hydrocarbons - diesel range organics
DOH EAL	Hawaii Department of Health Environmental Action Level	TPH-o	total petroleum hydrocarbons - residual range organics
GW	groundwater	VOC	volatile organic compounds



Table 2. Consolidated Groundwater Monitoring (PFAS).

Parameter	Analytical Method	Analyte(s)	GW Screening Criterion (DOH EALs) (µg/L)	Monthly PFAS
PFAS	EPA 8015	2(2-Butoxyethoxy) ethanol	—	x
	EPA Draft Method 1633	Perfluorobutanoic acid	15	x
		Perfluoropentanoic acid	1.5	x
		Perfluorohexanoic acid	1.9	x
		Perfluoroheptanoic acid	0.077	x
		Perfluorooctanoic acid	0.012	x
		Perfluorononanoic acid	0.012	x
		Perfluorodecanoic acid	0.0077	x
		Perfluoroundecanoic acid	0.019	x
		Perfluorododecanoic acid	0.026	x
		Perfluorotridecanoic acid	0.026	x
		Perfluorotetradecanoic acid	0.26	x
		Perfluorobutanesulfonic acid	1.7	x
		Perfluoropentanesulfonic acid	—	x
		Perfluorohexanesulfonic acid	0.077	x
		Perfluoroheptanesulfonic acid	0.038	x
		Perfluorooctanesulfonic acid	0.0077	x
		Perfluorononanesulfonic acid	—	x
		Perfluorodecanesulfonic acid	0.038	x
		Perfluorododecanesulfonic acid	—	x
		1H,1H, 2H, 2H-Perfluorohexane sulfonic acid	—	x
		1H,1H, 2H, 2H-Perfluorooctane sulfonic acid	1.5	x
		1H,1H, 2H, 2H-Perfluorodecane sulfonic acid	—	x
		N-methyl perfluorooctanesulfonamide	—	x
		N-ethyl perfluorooctanesulfonamide	—	x
		Perfluorooctanesulfonamide	0.046	x
		N-methyl perfluorooctanesulfonamidoacetic acid	—	x
		N-ethyl perfluorooctanesulfonamidoacetic acid	—	x
		N-methyl perfluorooctanesulfonamidoethanol	—	x
		N-ethyl perfluorooctanesulfonamidoethanol	—	x
		Hexafluoropropylene oxide dimer acid	0.012	x
		4,8-Dioxa-3H-perfluorononanoic acid	1.2	x
		9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	—	x
		11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	—	x
		3-Perfluoropropyl propanoic acid	—	x
		2H,2H,3H,3H-Perfluorooctanoic acid	—	x
		3-Perfluoroheptyl propanoic acid	—	x
		Perfluoro(2-ethoxyethane) sulfonic acid	—	x
		Perfluoro-4-methoxybutanoic acid	—	x
		Perfluoro-3-methoxypropanoic acid	—	x
		Nonafluoro-3,6-dioxaheptanoic acid	—	x

## Notes:

x	Compound is included in the respective groundwater sampling program
—	not applicable
µg/L	microgram per liter
DOH EAL	Hawaii Department of Health Environmental Action Level
GW	groundwater
PFAS	per- and polyfluorinated substances

### 2.3 OPTIMIZE SAMPLING FREQUENCY

As discussed during the March 8, 2023 collaboration meeting, weekly NOI sampling conducted after the 2021 release events effectively captured the increase and subsequent decrease of COPC concentrations in the monitoring wells following the releases, which provided an understanding of the impacts of those releases. The data showed that concentrations have significantly decreased and stabilized, in most cases, returning to non-detectable or within historical ranges. As a result, the current weekly sampling frequency no longer provides added information that is not captured by monthly (or quarterly) sampling. Reducing the sampling frequency to monthly allows for groundwater characterization and trend analyses without sacrificing accuracy, and reduces processing time for the commercial laboratories, the data validators, and sampling and shipping. The monthly sampling frequency is in accordance with the DOH TGM, which states: "Long-term monitoring of groundwater should be carried out at a frequency adequate to assess trends in potential environmental concerns and guide and monitor the effectiveness of remedial actions" (DOH TGM Section 6.6.8.5<sup>2</sup>).

Tables 3 and 4, below, summarize the frequency for each sampling location monitored monthly and quarterly under the consolidated sampling program.

**Table 3. Sampling Matrix (Fuel).**

Sampling Matrix (Fuel)	HDWW2253-03	RHWW2254-01	RHP01	RHP02	RHP03	RHP04A	RHP04B	RHP04C	RHP05	RHP06	RHP07	RHP08	RHWW01R	RHWW02	RHWW03	RHWW04	RHWW05	RHWW06	RHWW08	RHWW09	RHWW10	RHWW11	RHWW12A	RHWW13	RHWW14	RHWW15	RHWW16	RHWW17	RHWW18 (JJ)	RHWW19	RHWW20 (BB)	RHWW21 (II)	RHWW22 (MM)	NHWW23 (KA)	NHWW24 (ZZ)	NHWW25 (TT)	NHWW26 (KK)	NHWW27 (QQ)	NHWW28 (PP)	NHWW29 (WW1)	NHWW30 (WW3)
2015 AOC LTM	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
2021 NOI Sampling (Fuel)	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M

**Notes**

Q - Quarterly

M - Monthly

Gray shading are monitoring wells planned for installation.

**Table 4. Sampling Matrix (PFAS).**

Sampling Matrix (PFAS)	HDWW2253-03	RHWW2254-01	RHWW02	RHWW03	RHWW04	RHWW06	RHWW10	RHWW12A	RHWW16	RHWW17
2022 NOI Sampling (PFAS)	M	M	M	M	M	M	M	M	M	M

**Notes**

M - Monthly

PFAS - Per and Polyfluorinated Substances

<sup>2</sup> <https://health.hawaii.gov/heer/tgm/section-06/>, last accessed March 15, 2023.



## 2.4 OPTIMIZE MONITORING LOCATIONS

Sampling locations in each program were evaluated and locations were retained or excluded in an effort to optimize future sampling. Locations were removed based on their representativeness of groundwater conditions, duplication of (e.g., close proximity to) other sampling locations, anomalous water levels (elevated) and response to pumping conditions or other factors that differ from surrounding wells, or inclusion in another groundwater sampling program. Figure 1 shows the groundwater monitoring well sampling locations. Appendix A provides the justification for each well that was retained or excluded from the consolidated groundwater sampling program.

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## 2.5 STANDARDIZE SAMPLE COLLECTION METHOD

NOI sampling was conducted using both unpurged bailer and low-flow (pump) purging. No fuel product has been observed at monitoring locations to date with the exception of Red Hill Shaft shortly after the November 2021 release event. The use of different sampling methods have resulted in notable differences in analyte concentrations between the NOI and GW LTM programs. The low-flow sampling method is widely accepted to produce results that are more representative of surrounding aquifer conditions, as indicated in the DOH TGM, and as discussed in the following<sup>3</sup>. The inconsistency in sampling methods can impede long-term trend analysis of aquifer conditions.

The DOH TGM cautions against sampling with bailers, because “Bailers [are] prone to agitate the water column and result in loss of VOCs or inclusion of suspended sediment in sample if not used properly.” In addition, the TGM states that “Caution should also be taken in the use of a bailer to collect samples that are to be tested for highly sorptive, semi-volatile and non-volatile organic compounds and metals due to the possible suspension of sediment in the bottom of the well and bias of data intended to be compared to action levels for dissolved-phase contaminants” (DOH TGM Section 6.6.7.4<sup>4</sup>). For these and other reasons, according to the TGM:

“The HEER Office recommends that low-flow purging and sampling approaches be utilized whenever feasible in order to improve the representativeness of the sample data.” (DOH TGM Section 6.6.5.3<sup>5</sup>)

Therefore, the Navy will return to collecting samples via DOH and EPA’s recommended low-flow methodology, which is used during the GW LTM, to ensure sample integrity, representativeness of aquifer conditions, and compatibility with environmental action levels.

The use of bailers will continue for field observations in wells installed in unconfined aquifer conditions, including photo-documentation, which consists of collecting bailer samples at the water surface in wells installed in unconfined conditions prior to purging or sampling and taking pictures of a clear bailer held against a white background to make observations of whether there are any signs of product or sheen.

## 3. Summary of Changes

Overall, the extensive groundwater data sets provided useful data confirming that the COPC list (EPA Region 9 and DOH 2016) remains appropriate for groundwater monitoring at the Red Hill Bulk Fuel Storage Facility and should continue to be used in the consolidated groundwater sampling program, with additional fuel-related analytes.

The Navy has revised and consolidated the current groundwater sampling program to the following:

- (1) **Wells**. Figure 1 summarizes the monitoring locations included in the consolidated groundwater sampling program. Appendix A explains the rationale for the well locations included in the consolidated program.
- (2) **Analytes**. Table 1 and Table 2 summarize the parameters that will be analyzed in the consolidated groundwater sampling program.

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<sup>3</sup> EPA also cautions against collecting unpurged bailer samples because “Stagnant water is subject to physiochemical changes and may contain foreign material, which can be introduced from the surface or during well construction, resulting in non-representative sample data. To safeguard against collecting a sample biased by stagnant water, specific well-purging guidelines and techniques should be followed.” One of the appropriate sampling methods discussed in this EPA guidance is sampling via a low-flow sampling pump. *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers*, <https://health.hawaii.gov/heer/files/2021/07/USEPA2002b.pdf>

<sup>4</sup> <https://health.hawaii.gov/heer/tgm/section-06/>, last accessed March 15, 2023.

<sup>5</sup> <https://health.hawaii.gov/heer/tgm/section-06/>, last accessed March 15, 2023.

- (3) **Frequency.** Table 3 and Table 4 summarize the revised sampling frequencies for the groundwater monitoring programs.
- (4) **Sampling Methods.** Sampling of the monitoring wells and Red Hill Shaft will use the low-flow sampling methods recommended in the DOH TGM, consistent with the quarterly GW LTM program. Bailers will continue to be used prior to purging and sampling to conduct field observations (including photo-documentation) in monitoring wells installed in unconfined conditions.

No other changes are being made to the sampling program at this time. Based on data obtained and additional work to identify the nature and extent of the fuel releases in the environment, the scope and frequency of data collection may change. When conditions allow, the Navy expects to eventually transition the consolidated sampling program to normal quarterly sampling, consistent with the GW LTM program.

#### 4. References

- California Water Quality Control Board (CWQCB). 2015. *Leaking Underground Fuel Tank Guidance Manual*. September 2012, Revised December 2015.
- Department of Health, State of Hawaii (DOH). 2021. *Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan*. Interim Final. Honolulu, HI: Hazard Evaluation and Emergency Response Office. November 12, 2008. Latest Update: July 2021.
- . 2022. *Recommended Risk-Based Drinking Water Action Levels for Total Petroleum Hydrocarbons (TPH) Associated with Releases of JP-5 Jet Fuel (Revised February 12, 2022)*. 22-005 RH, April 20.
- Department of the Navy (DON). 2015. *Final Project Procedures Manual, U.S. Navy Environmental Restoration Program, NAVFAC Pacific*. JBPHH HI: Naval Facilities Engineering Command, Pacific. May.
- . 2016. *COPC Recommendations, Long Term Groundwater Monitoring, Red Hill Bulk Fuel Storage Fuel Facility*. January 12.
- . 2017. *Sampling and Analysis Plan, Investigation and Remediation of Releases and Groundwater Protection and Evaluation, Red Hill Bulk Fuel Storage Facility, Joint Base Pearl Harbor-Hickam, O'ahu, Hawai'i; April 20, 2017, Revision 01*. Prepared by AECOM Technical Services, Inc., Honolulu, HI. Prepared for Defense Logistics Agency Energy, Fort Belvoir, VA, under Naval Facilities Engineering Command, Hawaii, JBPHH HI.
- . 2022. *PFAS-Specific Sampling and Analysis Plan, Red Hill Bulk Fuel Storage Facility, Adit 6, Joint Base Pearl Harbor-Hickam, Hawaii*. Revision 1. Prepared for: Red Hill OIC. December 7. JBPHH HI: Naval Facilities Engineering Systems Command Pacific. December.
- Environmental Protection Agency, United States, Region 9; and Department of Health, State of Hawaii (EPA Region 9 and DOH). 2016. *Final Scoping for AOC SOW Sections 6 and 7, and Navy's Proposed Chemical of Potential Concern (COPC) Recommendations*. Letter from: Bob Pallarino, EPA Red Hill Project Coordinator, and Steven Chang, Hawaii DOH Red Hill Project Coordinator, to: James A. K. Miyamoto, Naval Facilities Engineering Command, Hawaii, Joint Base Pearl Harbor-Hickam. February 4.
- Interstate Technology & Regulatory Council (ITRC). 2018. *TPH Risk Evaluation at Petroleum-Contaminated Sites*. TPHRisk-1. Washington, DC: ITRC, TPH Risk Evaluation Team. <https://tphrisk-1.itrcweb.org>.





## Appendix A

### Justification for Monitoring Location Changes

Locations	Description of Change	Reason For Change
<b>Adit 3 Sump</b>	Removal of monitoring location from NOI program	<p>Not a basal groundwater location.</p> <p>Location was appropriate initially during the emergency response phase of the NOI for source investigation, but not appropriate for assessing risk since the NOI has transitioned to groundwater monitoring. The sump water is sourced by drainage from the tunnel and vadose zone and water samples from the sump are not representative of groundwater. Contribution to detects at Adit 3 Sump are not necessarily attributed to fuel and instead are from external sources un-related to the fuel stored at the Facility. Sump sampling may occur intermittently during site characterization and remediation activities, as necessary.</p>
<b>RHMW01</b>	Removal of monitoring well from GW LTM program; replaced with RHMW01R	<p>Duplicate well with better alternative available.</p> <p>RHMW01 is submerged while 01R is screened across water table. RHMW01R was installed to replace RHMW01 and provide a well that can also be utilized to measure for the presence/absence of light non-aqueous phase liquid.</p>
<b>RHMW07</b>	Removal of monitoring well from GW LTM program; replaced with RHMW16	<p>Not representative; better alternative at RHMW16.</p> <p>Well is screened in a zone lacking strong hydraulic connection with surrounding basal aquifer, as evidenced by elevated water levels and muted response to pumping and barometric pressure changes. RHMW16, located very close to RHMW07, will be included in the sampling program and is installed in a deeper zone with a strong connection to the basal aquifer.</p>
<b>RHMW10</b>	Add monitoring well in NOI program	RHMW10 fills in a potential gap to the southeast from the center of the tank farm; GW LTM and PFAS programs already sample this well.
<b>RHMW16A</b>	Removal of monitoring well from GW LTM program	Duplicate well - RHMW16 is screened in a deeper zone with a strong hydraulic connection to the basal aquifer while 16A is above water table.
<b>Halawa Deep HDMW 2253-03</b>	Add monitoring well to NOI program	There is interest in sampling wells in the vicinity of the quarry to assess whether there is any potential COPC migration to the northwest towards Halawa Shaft; GW LTM and PFAS programs already sample at this well.
<b>Oily Waste Disposal Facility Wells</b>	Removal of monitoring wells; replaced with RHP wells	Prior to Plume Delineation well installations, OWDF wells were sampled because they were the only wells in that area. There are currently eight P-wells installed, and two more that will be completed, that are better suited for condition assessments from the release due to their proximity to the Red Hill Shaft and the 2021 fuel release.
<b>RHP Wells</b>	Add RHP wells in NOI and GW LTM program	Red Hill Plume Delineation wells have been installed both on and off the Red Hill facility to expand the groundwater monitoring network and evaluate the horizontal extent of fuel impacts that were observed following the November 2021 release.
<b>Sentinel Wells</b>	Add Sentinel Wells in NOI and GW LTM program	Similar to RHP wells, Sentinel wells have been installed on and off the Red Hill facility to characterize potential contaminant migration following the November 2021 release, and understand the surrounding geology.

INCH-POUND

MIL-PRF-24385F(SH)  
w/AMENDMENT 2

7 September 2017

SUPERSEDING

MIL-F-24385F(SH)  
w/AMENDMENT 1

5 August 1994

MIL-F-24385F(SH)

7 January 1992

## PERFORMANCE SPECIFICATION

### FIRE EXTINGUISHING AGENT, AQUEOUS FILM-FORMING FOAM (AFFF) LIQUID CONCENTRATE, FOR FRESH AND SEA WATER

This specification is approved for use by the Naval Sea Systems Command and is available for use by all Departments and Agencies of the Department of Defense.

#### 1. SCOPE

1.1 Scope. This specification covers the requirements for aqueous film-forming foam (AFFF) liquid concentrate fire extinguishing agents consisting of fluorocarbon surfactants and other compounds, as required, to conform to this specification. At the time of use they shall be diluted with fresh or sea water to form a fire-extinguishing solution. Certain proportioning equipment may produce AFFF solutions of extreme concentrations; requirements for such concentrations are specified herein.

1.2 Classification. Concentrates shall be of the following types, as specified (see 6.2):

Type 3 - To be used as three parts concentrate to ninety-seven parts water by volume solution.

Type 6 - To be used as six parts concentrate to ninety-four parts water by volume solution.

#### 2. APPLICABLE DOCUMENTS

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

#### SPECIFICATIONS

##### FEDERAL

NN-P-71 - Pallets, Material Handling, Wood, Stringer Construction, 2-Way and 4-Way (Partial)

O-D-1407 - Dry Chemical, Fire Extinguishing, Potassium Bicarbonate

DELETED

DELETED

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to [CommandStandards@navy.mil](mailto:CommandStandards@navy.mil), with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.dla.mil>.

AMSC N/A

FSC 4210

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MILITARY

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MIL-D-43703 - Drum, Shipping and Storage, Molded Polyethylene

STANDARDS

FEDERAL

DELETED

MILITARY

MIL-STD-129 - Military Marking for Shipment and Storage

MIL-STD-130 - Identification Marking of U.S. Military Property

MIL-STD-147 - Palletized Unit Loads

DELETED

(Copies of these documents are available online at <http://quicksearch.dla.mil>.)

2.1.2 Other Government publications. The following other Government publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

PUBLICATIONS

DEPARTMENT OF DEFENSE

DoD QSM 5.1 - Department of Defense (DoD) Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.1

(Copies of this document are available online at <http://www.denix.osd.mil/edqw/documents/documents>.)

DEPARTMENT OF TRANSPORTATION

Code of Federal Regulations, Title 49

(Application for copies should be addressed to the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

MILITARY

DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER (DTNSRDC)

Standard Marine Bioassay Procedure for Shipboard Chemicals

(Application for copies should be addressed to Commander, David W. Taylor Naval Ship Research and Development Center, (Code 2865), Annapolis, MD 21402.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

A342/A342M - Standard Test Methods for Permeability of Weakly Magnetic Materials

DELETED

DELETED

MIL-PRF-24385F(SH)  
w/AMENDMENT 2

- D445 - Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity) (DoD adopted)
- D1141 - Standard Specification for Substitute Ocean Water
- D1331 - Standard Test Methods for Surface and Interfacial Tension of Solutions of Surface-Active Agents
- D1796 - Standard Test Method for Water and Sediment in Fuel Oils by the Centrifuge Method (Laboratory Procedure)
- DELETED
- D3953 - Standard Specification for Strapping, Flat Steel and Seals.
- D4814 - Standard Specification for Automotive Spark-Ignition Engine Fuel
- D6199 - Standard Practice for Quality of Wood Members of Containers and Pallets
- E11 - Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves
- E527 - Standard Practice for Numbering Metals and Alloys (UNS)
- E729 - Standard Practice for Conducting Acute Toxicity Tests with Fish, Macroinvertebrates and Amphibians

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

AMERICAN PUBLIC HEALTH ASSOCIATION

Standard Methods for the Examination of Water and Waste Water

(Application for copies should be addressed to the American Public Health Association, 1015 15<sup>th</sup> Street NW, Suite 300, Washington, DC 20005.)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- NFPA No. 412 - Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles

(Application for copies should be addressed to the National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269.)

SAE INTERNATIONAL

- SAE-AMS-STD-595 - Colors Used in Government Procurement

(Copies of this document are available online at [www.sae.org](http://www.sae.org).)

UNIFORM CLASSIFICATION COMMITTEE, AGENT

Uniform Freight Classification Ratings, Rules, and Regulations

(Application for copies should be addressed to the Uniform Classification Committee Agent, Tariff Publication Officer, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606.)

**2.3 Order of precedence.** Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.



### 3. REQUIREMENTS

3.1 Qualification. Liquid concentrate fire extinguishing agents furnished under this specification shall be products which are qualified for listing on the applicable Qualified Products List at the time set for opening of bids (see 4.3 and 6.4).

3.2 Materials. Concentrates shall consist of fluorocarbon surfactants plus other compounds as required to conform to the requirements specified hereinafter. The material shall have no adverse effect on the health of personnel when used for its intended purpose.

3.3 Concentrate characteristics. Concentrates shall conform to the chemical and physical requirements shown in [table I](#).

3.3.1 Film formation and sealability. The foam produced film shall spread over the fuel surface and seal off vapor production to prevent sustained ignition (see 4.7.6).

3.3.2 Stability. The concentrate (Type 3 or Type 6) and a 3 percent premix solution of Type 3 or a 6 percent premix solution of Type 6 as applicable shall conform to the following requirements after 10 days storage at 65 Celsius (°C)  $\pm 2.0$  °C (see 4.7.11):

- a. Spreading coefficient: (See [table I](#))
- b. Foamability: (See [table I](#))
- c. Film formation and sealability: As specified in 3.3.1
- d. Fire performance, 28 square feet (ft<sup>2</sup>) fire, 1.5 and 3 percent of Type 3 and 3 and 6 percent of Type 6 fresh and sea water solutions: As specified in 3.4
- e. Stratification: No visible evidence following test (see 4.7.15)
- f. Precipitation: 0.05 percent by volume (see 4.7.16).

3.3.3 Compatibility. The concentrates of one manufacturer shall be compatible in all proportions with concentrate furnished by other manufacturers listed on the qualified products list. The material shall also be compatible with materials in inventory which were acquired under previous issues of this specification and known to be still in use in significant quantities. Information regarding these materials may be obtained from NAVSEA. The concentrate shall conform to the following requirements after 10 days storage at 65 °C  $\pm 2.0$  °C (see 4.7.12):

- a. Foamability: (See [table I](#))
- b. Film formation and sealability: As specified in 3.3.1
- c. Fire performance 28 ft<sup>2</sup>, 3 percent of Type 3 and 6 percent of Type 6 fresh and sea water solution: As specified in 3.4
- d. Stratification: No visible evidence following test (see 4.7.15)
- e. Precipitation: 0.05 percent by volume (see 4.7.16).

TABLE I. Chemical and physical requirements for concentrates or solutions.

Requirement	Values		Applicable publication	Test paragraph
	Type 3	Type 6		
Refractive index, minimum	1.3630	1.3580	-	4.7.1
Viscosity, centistokes:			ASTM D445	4.7.2
Maximum at 5 °C	20	10		
Minimum at 25 °C	2	2		
Hydrogen ion concentration (pH)	7.0 to 8.5	7.0 to 8.5	-	4.7.5
Spreading coefficient, minimum	3	3	-	4.7.4
Foamability:				
Foam expansion, minimum	5.0	5.0	NFPA STD 412	4.7.5
Foam 25% drainage time, minutes, minimum	2.5	2.5	NFPA STD 412	4.7.5
Corrosion rate:				
General				
Cold rolled, low carbon steel (UNS G10100), milli in/yr, maximum	1.5	1.5	ASTM E527	4.7.7
Copper-nickel (90-10) (UNS C70600), milli in/yr, maximum	1.0	1.0	ASTM E527	4.7.7
Nickel-copper (70-30) (UNS N04400), milli in/yr, maximum	1.0	1.0	ASTM E527	4.7.7
Bronze (UNS C90500), milligrams, maximum	100	100	ASTM E527	4.7.7
Localized, corrosion-resistant (CRES) steel, (UNS S30400)	No pits	No pits	-	4.7.7
Perfluorooctanoic acid (PFOA) content, ppb, maximum	800 <sup>1/</sup>	800 <sup>1/</sup>	DoD QSM 5.1	4.7.8
Perfluorooctane Sulfonate (PFOS) content, ppb, maximum	800 <sup>1/</sup>	800 <sup>1/</sup>	DoD QSM 5.1	4.7.8
DELETED				
Dry chemical compatibility, burn-back, resistance time, seconds, minimum	360	360	-	4.7.10
Environmental impact:				
Toxicity, LC <sub>50</sub> , mg/L, minimum	500	1000	-	4.7.13.1
COD, mg/L, maximum	1000K	500K	-	4.7.13.2
$\frac{BOD}{COD} \times 20$ , minimum	0.65	0.65	-	4.7.13.3
NOTE:				
<sup>1/</sup> Current limit of quantitation.				

3.3.4 Total fluorine content. The total fluorine content of the AFFF shall be determined and shall not deviate more than 15 percent of the value determined and reported at time of qualification report (see 4.7.17.1).

3.4 Fire performance. The foam shall conform to the fire performance requirements shown in [table II](#).

TABLE II. Fire performance.

	AFFF solutions, percent		
	1.5% of Type 3 3.0% of Type 6	3% of Type 3 6% of Type 6	15% of Type 3 30% of Type 6
	(Fresh and sea)	(Fresh and sea)	(Sea)
28-ft <sup>2</sup> fire (see 4.7.14.1):			
Foam application time to extinguish, seconds, maximum	45	30	55
Burnback time of resulting foam cover, seconds, minimum	300	360	200
50-ft <sup>2</sup> fire (see 4.7.14.2):			
Foam application time to extinguish, seconds, maximum		50 (Sea only)	
Burnback time of resulting foam cover, seconds, minimum		360	
40-second summation, minimum		320	

### 3.5 Marking.

3.5.1 Identification marking shall be in accordance with MIL-STD-130. In addition, the marking on the containers (see 5.3) shall be in white characters against a green background for Type 3, a blue background for Type 6.

3.5.2 Two identical markings conforming to [figures 1](#) and [2](#) shall be applied to containers so that the markings are located diametrically opposite. The markings shall be applied on the containers in such a manner that water immersion contact with the contents of the containers, or normal handling will not impair the legibility of the marking. Paper labels shall not be used.

## 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.3).
- b. Quality conformance inspection (see 4.4).
  - (1) Examination of filled containers
  - (2) Quality conformance inspection.

4.3 Qualification inspection. Qualification inspection shall be conducted at a laboratory satisfactory to the Naval Sea Systems Command. Qualification inspection shall consist of the inspections and tests shown in [table III](#).

TABLE III. Qualification and quality conformance inspections.

Examination or test	Reference paragraph		Qualification	Quality conformance
	Requirement	Test		
Refractive index	3.3	4.7.1	X	X
Viscosity	3.3	4.7.2	X	X
pH value	3.3	4.7.3	X	X
Spreading coefficient	3.3	4.7.4	X	X
Foamability	3.3	4.7.5	X	X
Film formation and sealability	3.3.1	4.7.6	X	X
General corrosion	3.3	4.7.7	X	
Localized corrosion	3.3	4.7.7	X	
PFOA content	3.3	4.7.8	X	
PFOS content	3.3	4.7.8	X	
DELETED				
Fluorine content	3.3.4	4.7.17	X	X
Dry chemical compatibility	3.3	4.7.10	X	
Stability	3.3.2	4.7.11	X	
Compatibility	3.3.3	4.7.12	X	
Environmental impact	3.3	4.7.13	X	
28-ft <sup>2</sup> fire test	3.4	4.7.14	X	
50-ft <sup>2</sup> fire test	3.4	4.7.14	X	X
Examination of filled containers		4.6		X
Torque to remove cap <sup>1/</sup>	5.1.1.1.1f	4.7.18.2	X	X
NOTE: <sup>1/</sup> Torque test to be performed a minimum of 48 hours after initial closure.				

4.3.1 Samples for qualification inspection. One hundred gallons of Type 3 and 200 gallons of Type 6 are required for the qualification inspection.

#### 4.4 Sampling for quality conformance inspection.

4.4.1 Inspection lot. A lot shall consist of all foam manufactured as one unchanged process batch and transferred from one mixing tank to the shipping container.

4.4.2 Sampling for examination of filled containers. As a minimum, the contractor shall randomly select a sample quantity from each lot of filled containers in accordance with [table IV](#) and examine them in accordance with 4.6, 5.1.1.1, and 5.1.1.2. The sample size depends on lot size. If one or more defects are found in any sample, the entire lot shall be rejected. The contractor has the option of screening 100 percent of the rejected lot for the defective characteristics, or providing a new lot, which shall be examined in accordance with the sampling plan contained herein. The contractor shall maintain for a period of three years after contract completion, records of inspections, tests, and any resulting rejections.



TABLE IV. Sample size for examination of filled containers.

Lot size	Sample size
2-5	All
6-50	5
51-90	7
91-150	11
151-280	13
281-500	16
501-1200	19
1201-3200	23

4.4.3 Sampling for quality conformance inspection. Three filled 5-gallon containers shall be selected at random from each lot and used as one composite sample for the tests specified in 4.6, or three 5-gallon containers of the product shall be withdrawn from an agitated mixing tank prior to packaging. The results of the tests required by 4.5 shall be submitted to NAVSEA or the designated laboratory.

4.5 Quality conformance inspection. The samples selected in accordance with 4.4.3 shall be subjected to the quality conformance inspection of [table III](#). If the sample tested is found to be not in conformance with any of the quality conformance tests, the lot represented by the sample shall be rejected (see 6.3).

4.6 Examination of filled containers. Each sample filled container shall be examined for defects of construction of the container and the closure, for evidence of leakage, and for unsatisfactory markings. Each filled container shall also be weighed to determine the amount of contents.

4.7 Test procedure.<sup>1</sup> Test procedures shall be as follows:

4.7.1 Refractive index. The refractive index shall be determined at 25 °C ±0.1 °C, using sodium vapor source lamp illumination.

4.7.2 Viscosity. The viscosity shall be determined at temperatures of 5 °C ±0.1 °C and 25 °C ±0.1 °C in accordance with ASTM D445, using capillary viscosimeters in the appropriate size.

4.7.3 pH value. The pH value shall be determined potentiometrically, using a pH meter with a glass electrode and a reference electrode, at 25 °C ±1.0 °C.

4.7.4 Spreading coefficient. The spreading coefficient shall be determined with reference to cyclohexane in accordance with the following relationship:

$$\text{Where: } S_{a/b} = \gamma_b - \gamma_a - \gamma_i$$

$$S_{a/b} = \text{Spreading coefficient}$$

$$\gamma_b = \text{Surface tension of cyclohexane as determined in 4.7.4.1}$$

$$\gamma_a = \text{Surface tension of AFFF solution as determined in 4.7.4.1}$$

$$\gamma_i = \text{Interfacial tension between liquids as determined in 4.7.4.2}$$

<sup>1</sup> Where sea water is required for tests, synthetic sea water in accordance with ASTM D1141 shall be used. A sea salt mixture conforming to this standard may be purchased from Lake Products Company, Inc., P.O. Box 2248, St. Louis, Missouri 63043.



4.7.4.1 Surface tension. The surface tension of  $3\pm0.05$  percent of Type 3 or  $6\pm0.1$  percent of Type 6 by volume in distilled water, as appropriate, and of reagent grade cyclohexane shall be determined with a DuNoy tensiometer, or equal, at  $23\text{ }^{\circ}\text{C}\pm2.0\text{ }^{\circ}\text{C}$  in accordance with ASTM D1331.

4.7.4.2 Interfacial tension. The interfacial tension between  $3\pm0.05$  percent of Type 3 or  $6\pm0.1$  percent of Type 6 by volume in distilled water, as appropriate, and reagent grade cyclohexane shall be determined with a DuNoy tensiometer, or equal, at  $23\text{ }^{\circ}\text{C}\pm2.0\text{ }^{\circ}\text{C}$  until the readings come to equilibrium and in accordance with ASTM D1331.

4.7.5 Foamability. The foam shall be generated by means of a special 2-gallons-per-minute (gal/min) test nozzle. The basic nozzle, as made by National Foam System, Inc., Lionville, Pennsylvania, or equal, shall be modified by shortening the length of the foam barrel from  $2\frac{1}{2}$  to  $1\frac{1}{4}$  inches, and by adding a "wing-tip" spreader on the outlet. The spreader shall have a  $\frac{1}{8}$ -inch wide, circular orifice,  $1\frac{1}{8}$  inches long. (It may be made by slightly compressing a Bernz-o-matic TX-1527, or equal, flame spreader.) A print of the nozzle construction is available from the Naval Research Laboratory, Code 6180, Washington, DC 20375. During foam sample collection, the nozzle inlet pressure shall be maintained at a gauge pressure of 100 pounds per square inch (lb/in<sup>2</sup>), and the solution temperature at  $23\text{ }^{\circ}\text{C}\pm5.0\text{ }^{\circ}\text{C}$ . The nozzle shall be held at hip height and directed onto the backboard from a distance of 4 to 6 feet. The method and procedure shall be in accordance with NFPA 412. Foamability shall be run on 6 percent fresh and sea water solutions of the Type 6 concentrate and 3 percent fresh and sea water solutions of the Type 3 concentrate.

4.7.6 Film formation and sealability.

4.7.6.1 Test equipment. A CRES graduated measure of 1,000-milliliter (mL) capacity ( $4\frac{1}{2}$  inches in diameter, 5 inches deep; Cole-Parmer Co., Chicago, Illinois, or equal) shall be fitted with two retaining clips at the top edge. The clips serve to restrain a cone 5 inches in height and  $4\frac{3}{4}$  inches in diameter, made of 80-mesh perforated CRES, in an inverted position inside the measure. The 2-gal/min nozzle specified in 4.7.5 shall be used for foam production.

4.7.6.2 Test procedure. After placing 400 mL of water and 200 mL of 98-percent cyclohexane in the measure, 200 mL of freshly-made foam shall be poured onto the fuel. The inverted cone shall be pushed down into the measure, thereby pushing most of the foam aside but allowing the film-producing liquid to creep in through the mesh openings. A foam-free surface shall be created by manually scooping out most of the residual foam from the center of the cone. After a 1-minute waiting period, a pilot flame shall be passed over the fuel surface at a height of about  $\frac{1}{2}$  inch. A small flash is permitted, but no sustained ignition shall result, if an effective vapor seal is present. A 1-inch long pilot flame shall be provided with a hand-held propane cylinder fitted with a capillary tubing outlet.

4.7.7 Corrosion. The liquid for immersion of the metal specimens for general corrosion and localized corrosion tests shall consist of the concentrate diluted by 10 percent by volume with sea water.

4.7.7.1 General corrosion.

4.7.7.1.1 Test specimens. The test specimens shall consist of the following metals, in accordance with UNS designations (see ASTM E527): G10100 steel, C70600 copper-nickel alloy, N04400 nickel-copper, and C90500 bronze. All specimens, except the bronze, shall be milled to finished dimensions of approximately  $\frac{1}{16}$  inch thick,  $\frac{1}{2}$  inch wide, and 3 inches long. The bronze shall have sand cast faces and be approximately  $\frac{3}{16}$  inch thick,  $\frac{1}{2}$  inch wide, and 3 inches long. All specimens shall be degreased in acetone, rinsed with distilled water, and air dried before exposure. (Prepared metal specimens may be obtained from the Metaspec Company, Box 27707, San Antonio, Texas 78227-0707.)

4.7.7.1.2 Test procedures. Five weighted specimens of each metal shall be fully immersed in the test medium in a separate 600-mL beaker and held at room temperature for a period of 60 days. A watch-glass cover shall be used to retard evaporation. At the end of the exposure period, the weight-loss shall be determined and the corrosion rate calculated as required.



#### 4.7.7.2 Localized corrosion.

4.7.7.2.1 Test specimens. The test specimens shall consist of UNS S30400 CRES milled to finished dimensions of approximately  $\frac{1}{16}$  inch thick,  $\frac{1}{2}$  inch wide, and 3 inches long. After degreasing with acetone, rinsing with distilled water, and air drying before exposure, the specimens shall be pretreated by immersion in a 1:9 concentrated nitric acid-water solution for the period of 5 minutes.

4.7.7.2.2 Procedure. Ten specimens shall be girdled lengthwise with a clean  $\frac{1}{16}$  to  $\frac{1}{8}$ -inch wide band of a good grade of gum rubber of a size such that the band is taut during the test. Because of the poor quality of most commercial rubber bands, it is recommended that the bands for this test be cut from  $1\frac{3}{4}$  inch flat width pure gum amber tubing (Preiser Scientific Rubber tubing, Pure Gum, Gooch type,  $\frac{1}{32}$ -inch thin wall, pure gum amber tubing, very elastic, especially made for Gooch crucibles, or equal). This tubing is most easily cut into uniform strips with a blade-type papercutter, but can also be cut with sharp shears. The specimens girdled with the rubber bands shall be placed in a 600-mL beaker so that no contact is made between individual specimens. A  $\frac{1}{4}$ -inch layer of glass beads shall be introduced into the beaker to aid in stabilizing specimen position. Enough liquid shall be added to completely immerse the specimens, and a watch-glass shall be placed over the beaker to retard evaporation (but allow air access) and act as a dust cover, and the assemblies allowed to stand at room temperature for 60 days.

4.7.7.2.3 Results. The specimens shall be monitored daily over the 60-day period to ascertain the presence or absence of pitting. These daily examinations shall be made without disturbing the test (other than removing the cover). Corrosion is customarily signaled by the appearance of a dark spot which, if removed after sufficient exposure, discloses a corrosion pit. If the suspected area cannot be positively identified by the naked eye, it can be at a magnification of 10X. At the end of the test, each specimen shall be inspected carefully with particular attention being given to the edges of the specimens and those areas of the specimens under or adjacent to the rubber bands. 10X magnification shall be used, if necessary.

4.7.8 PFOA and PFOS content. The tests for PFOA and PFOS content shall be conducted by a laboratory that is accredited by the DoD Environmental Laboratory Accreditation Program (ELAP) and tests in compliance with the "Per- and Polyfluoroalkyl Substances (PFAS) Using Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS) with Isotope Dilution or Internal Standard Quantification in Matrices Other Than Drinking Water" table of DoD QSM Version 5.1. (A list of ELAP accredited laboratories can be found online at <http://www.denix.osd.mil/edgw/accreditation/accreditedlabs>. Under the "Method" drop-down list, select "PFAS by LCMSMS Compliant with QSM 5.1 Table B-15".) Test results shall be recorded from the lowest dilution possible while still meeting all of the requirements in the DoD QSM table. This may require results to be recorded from two different dilutions; one for PFOA and one for PFOS.

4.7.8.1 PFOA content. PFOA content shall be determined in accordance with 4.7.8. Results shall be expressed in parts per billion (ppb).

4.7.8.2 PFOS content. PFOS content shall be determined in accordance with 4.7.8. Results shall be expressed in ppb.

#### 4.7.9 Total halides. DELETED

4.7.10 Dry chemical compatibility. The foam's compatibility with potassium bicarbonate dry chemical extinguishing agent shall be determined by measuring the burnback time in the presence of dry chemical.

4.7.10.1 Test materials. The fuel shall be unleaded gasoline conforming to ASTM D4814. The dry chemical agent shall conform to O-D-1407. The sieve shall be an 8-inch diameter, 40-mesh sieve conforming to ASTM E11.

4.7.10.2 Test procedure. A 28-square-foot fire test shall be conducted in accordance with 4.7.14.1 using Type 3 or 6 AFFF sea water solution, as required. Before placing the burning pan, 1 pound of dry chemical agent shall be evenly distributed over the foam blanket with the aid of a sieve on a long handle. This shall be accomplished within a 30-second period so that the total time from end of foam application to placement of the burning pan will not be longer than 90 seconds. The burnback time shall be determined as in 4.7.14.1.4.

#### 4.7.11 Stability.

4.7.11.1 Sample preparation. Samples of concentrate, and Type 3 and Type 6 AFFF fresh water and sea water solution, as appropriate, shall be prepared in sufficient quantity to perform the required tests. One liter (L) of each shall be placed in lightly stoppered glass cylinders. All samples shall then be stored at 65 °C ±2.0 °C for a period of 10 days. The samples shall then be subjected to the following tests:

- |                                   |          |
|-----------------------------------|----------|
| a. Spreading coefficient          | 4.7.4    |
| b. Foamability                    | 4.7.5    |
| c. Film formation and sealability | 4.7.6    |
| d. Fire performance (28 ft²)      | 4.7.14.1 |
| e. Stratification                 | 4.7.15   |
| f. Precipitation                  | 4.7.16   |

NOTE: In the preparation of the samples to be used for the precipitation test, the synthetic sea water shall be filtered prior to use.

#### 4.7.12 Compatibility.

4.7.12.1 Sample preparation. The Government will provide samples of appropriate qualified product(s) to manufacturers officially authorized to submit candidate material for qualification (see 3.3.3). Mixtures of the Type 3 and Type 6 concentrates to be tested shall be prepared in sufficient quantities to perform the required tests. (For qualification testing, the testing activity will determine the number of product mixtures to be evaluated and the ratio of product comprising these mixtures.) Additionally, 3 percent of Type 3 or 6 percent of Type 6 AFFF fresh water and sea water solutions shall be prepared from each concentrate mixture. One L of each shall be placed in lightly stoppered glass cylinders. The samples shall be stored at 65 °C ±2.0 °C for a period of 10 days. The samples shall then be subjected to the following tests:

- |                                   |          |
|-----------------------------------|----------|
| a. Foamability                    | 4.7.5    |
| b. Film formation and sealability | 4.7.6    |
| c. Fire performance (28 ft²)      | 4.7.14.1 |
| d. Stratification                 | 4.7.15   |
| e. Precipitation                  | 4.7.16   |

#### 4.7.13 Environmental impact.

4.7.13.1 Toxicity. Toxicity test shall be performed on the Killiefish (*Fundulus heteroclitus*) in accordance with ASTM E729, using dynamic procedures. The minimum acceptable dissolved oxygen content of water used in this procedure shall be 5 p/m.

4.7.13.2 Chemical oxygen demand (COD). COD shall be determined in accordance with procedures in Standard Method for the Examination of Water and Waste Water (latest applicable edition).

4.7.13.3 Biodegradability. Biodegradability shall be determined by dividing the value expressed in mg/L for the 20-day biological oxygen demand (BOD20) determined from 5-day BOD test in accordance with the procedure specified in Standard Methods for the Examination of Water and Waste Water (latest applicable edition) by the value expressed in mg/L for COD determined as specified in 4.7.13.2.

4.7.14 Fire test. No fire test shall be conducted when the wind speed is above 10 miles per hour (mi/hr). These tests are normally conducted indoors to avoid adverse weather conditions.

#### 4.7.14.1 Twenty-eight-square-foot fire test.

4.7.14.1.1 Test equipment. The fire test shall be conducted in a level, circular pan 6 feet in diameter, fabricated from ¼-inch thick steel with a 4-inch high side. A shallow water layer shall be used to protect the pan bottom and to ensure complete coverage of the area with fuel. The nozzle used for foam application shall be the 2 gal/min device specified in 4.7.5.



4.7.14.1.2 Test materials. Foam shall be generated at  $23\text{ }^{\circ}\text{C} \pm 5.0\text{ }^{\circ}\text{C}$  from AFFF solutions made with fresh or sea water, as required, at concentration values shown in [table V](#). The fuel shall be 10 gallons of unleaded gasoline conforming to ASTM D4814.

TABLE V. AFFF test concentration values.

Solutions	Type 3	Type 6
Lean <sup>1/</sup>	1.5±0.03	3±0.1
Normal strength	3±0.05	6±0.1
Rich <sup>2/</sup>	15±0.2	30±0.2
<sup>1/</sup> One test with fresh water and one with sea water.		
<sup>2/</sup> One test with sea water.		

4.7.14.1.3 Test procedure. The fuel shall be dumped within a 30-second period. The fuel shall be ignited within 30 seconds of fueling and allowed to burn freely for 10 seconds. After the preburn period, the fire shall be attacked and extinguished as expeditiously as possible and the fire extinguishing time shall be recorded at the exact cessation of all flame, but foam application shall continue for a total of 90 seconds.

4.7.14.1.4 Burnback procedure. Within 60 seconds of the completion of foam application, a burning pan (1-foot diameter with 2-inch side) containing one gallon of unleaded gasoline shall be placed in the center of the 28-square-foot pan and a timer started. When it appears that the fire has spread outside the pan so that the burning will continue after pan removal, the pan shall be removed. The burnback time is that at which it is estimated that 7 square feet (25 percent) of the total area is involved in flames.

NOTE: Intermittent “flash-overs” may occur. They are characterized by creeping faint blue or invisible flames over the foam surface which usually self-extinguish. They are not considered a part of the burnback area unless sustained burning occurs. All isolated, sustained burning areas shall be included in arriving at the 7-square-foot total area.

#### 4.7.14.2 Fifty-square-foot fire test.

4.7.14.2.1 Test site. The fire test shall be conducted on a level, circular area 8 feet in diameter. The base and surrounding wall shall be suitable for containment of the fuel on a substrate of water. The water depth shall be the minimum required to ensure complete coverage area with the fuel.

4.7.14.2.2 Test equipment. The nozzle used for foam application shall be the 2 gal/min device specified in 4.7.5, operated at a gauge pressure of 100 lb/in<sup>2</sup>.

4.7.14.2.3 Test materials. The foam shall be generated at  $23\text{ }^{\circ}\text{C} \pm 5.0\text{ }^{\circ}\text{C}$  from 3±0.05 percent of Type 3 or 6±0.1 percent of Type 6 AFFF solutions made with sea water. The fuel shall be 15 gallons of unleaded gasoline conforming to ASTM D4814.

4.7.14.2.4 Test procedure. The fuel shall be dumped into the area in less than 60 seconds and ignited in less than 30 seconds after fuel dumping is completed. After allowing a preburn period of 10 seconds, the fire shall be attacked and extinguished in an expeditious manner. At 10-second intervals after the start of foam application, observers shall estimate the percentage of fire area extinguished. The percentages at 10, 20, 30, and 40 seconds shall be totaled to give the “40-second summation” value. The exact extinguishing time shall also be recorded at the cessation of all flame, but foam application shall continue for a total of 90 seconds.

4.7.14.2.5 Burnback procedure. Within 60 seconds of the completion of foam application, a burnback test shall be conducted as specified in 4.7.14.1.4, except that the burnback area shall be 12.5 square feet (25 percent).

4.7.15 Stratification. The presence of stratification shall be determined by visual examination of the samples contained in the glass cylinders.

4.7.16 Precipitation. The amount of precipitation shall be determined in accordance with the procedures of ASTM D1796.

4.7.17 Fluorine content.

4.7.17.1 Qualification. The total fluorine content shall be determined. The total fluorine content and the test procedure used to determine the content shall be furnished as part of the qualification inspection report.

4.7.17.2 Quality conformance inspection. The total fluorine content shall be determined in accordance with the test procedure furnished with the qualification inspection report (see 4.7.17.1). The total fluorine content shall be included in the quality conformance inspection report.

4.7.18 Packaging inspection. Sample packages and packs and the inspection of preservation, packaging, packing, and marking for shipment and storage shall be in accordance with the requirements of 4.6, section 5, and the documents specified therein. The magnetic permeability test (for metal handles of 5-gallon containers) of 4.7.17.1 and the torque test (for the pour cap of 5-gallon containers) of 4.7.18.2 shall be included.

4.7.18.1 Magnetic permeability (metal handles of 5-gallon containers). The metal handles of the 5-gallon containers shall be checked to determine conformance with the magnetic requirements of 5.1.1.1.1d using a permeability indicator, low-mu (GO-NO-GO) in accordance with ASTM A342/A342M.

4.7.18.2 Torque test (pour cap of 5-gallon container). The pour cap of the 5-gallon container shall be subjected to a torque test to determine conformance with 5.1.1.1.1f.

## 5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisitions. For the extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.5.)

5.1 Preservation-packaging. Preservation-packaging for Level A shall be as specified hereinafter.

5.1.1 The AFFF liquid concentrate shall be furnished in a 5-gallon or in a 55-gallon plastic container as specified (see 6.2d).

5.1.1.1 Five-gallon plastic container. The container shall be molded polyethylene as specified herein. The container shall be as follows:

- |                               |                   |
|-------------------------------|-------------------|
| a. Capacity                   | 5 gallon (min.)   |
| b. Height, body (overall)     | 15 inches (max.)  |
| c. Diameter, body (overall)   | 11¾ inches (max.) |
| d. Pour opening (inside dia.) | 1½ inches (min.)  |

5.1.1.1.1 The container shall meet the requirements of Department of Transportation Specification Number 34 as specified in the Code of Federal Regulations, Title 49, Part 178.19, and as follows:

- Shall be stackable and self-supporting.
- Shall be provided with a threaded-type plastic cap fitted with a gasket for the pour opening.
- May be provided with a vent opening having an easily punctured membrane. When furnished, vent opening shall be provided with a threaded type plastic cap.
- Shall be provided with an integrally molded or recessible plastic or metal handle. Metal handles shall not exceed a magnetic permeability of 2.0.
- Shall have colors conforming to 5.1.1.3, Type 3 green, Type 6 blue.
- The torque required to remove the pour opening cap shall not exceed 50 inch-pounds.

5.1.1.2 Fifty-five gallon container. The 55-gallon container shall be molded polyethylene, Size 4, conforming to MIL-D-43703.



5.1.1.3 Exterior color and coating. The green color (see 3.5) shall be an approximate match to color number 14187 of SAE-AMS-STD-595. The blue color (see 3.5) shall be an approximate match to color number 15123 of SAE-AMS-STD-595.

5.2 Packing. For Level A no further packing is required.

5.2.1 Method of shipment shall comply with Uniform Freight Classification Ratings, Rules, and Regulations or other carrier rules as applicable to the mode of transportation.

5.2.2 Palletization.

a. Thirty-six 5-gallon plastic containers shall be palletized in accordance with the requirements of MIL-STD-147, Load Type XVII. Pallets conforming to NN-P-71, Type V, Class 1, wood group optional, Size 2, are acceptable. Containers shall be properly and firmly nested and arranged to ensure a snug, non-shifting load. Pallet dimensions may be adjusted to ensure a snug, non-shifting load, but shall not exceed 43 by 52 inches.

b. Inverted caps. The inverted cap shall be the open sheathing type, wood group optional.

c. Top wood cap. The top wood cap shall be the closed sheathing (plywood) wood cap, wood group optional for slats. In addition, each corner of the plywood cap shall be secured to the end and side slats with strapping. Strapping shall be ¾ inch by 0.035 inch and shall extend a minimum of 3 inches into the plywood top and slats. Nails used to secure the strapping shall be clinched.

d. Strapping. All primary, secondary, auxiliary, and horizontal strapping shall not be less than 1¼ inches by 0.035 inch. Strapping shall conform to ASTM D3953, Type I, Finish B. Cross ties shall be applied in accordance with MIL-STD-147.

e. Side frames. Minimum size of side frame members shall be a nominal 1 by 6 inches conforming to Group I, II, III, or IV of ASTM D6199. Nails used to secure flat surfaces of side frames shall be clinched not less than ¼ inch.

5.3 Marking. In addition to the marking specified in 3.5 and any special marking required (see 6.2), containers and palletized unit loads shall be marked in accordance with MIL-STD-129.

## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The concentrate is intended for use in mechanical foam generating equipment such as fire-fighting trucks or foam sprinkler systems for extinguishing fires in flammable liquids such as gasoline or fuel oils. Type 6 is intended for use in proportioners designed to dispense only the 6-percent solution (usually shipboard fire protection systems). Type 3 may be used in any equipment capable of proportioning at variable rates or at fixed 3-percent solution.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- Title, number, and date of this specification.
- The specific issue of individual documents referenced (see 2.1.1 and 2.2).
- Type of concentrate required (see 1.2).
- Size of container required (see 5.1.1).
- Special marking, if required (see 5.3).

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied in a contract. The applicable Data Item Description (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DOD FAR Supplement 27.475-1 exempts the requirements for a DD Form 1423.

Reference paragraph	DID number	DID title	Suggested tailoring
4.5	DI-T-2072	Test report	-

The above DID was cleared as of the date of this specification. The current issue of DOD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

6.4 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL No. 24385 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to [CommandStandards@navy.mil](mailto:CommandStandards@navy.mil). An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at <https://assist.dla.mil>.

6.4.1 Provisions governing qualification. Copies of SD-6 "Provisions Governing Qualification" are available online at <http://quicksearch.dla.mil/> or <https://assist.dla.mil>.

6.5 Sub-contracted material and parts. The packaging requirements of referenced documents listed in section 2 do not apply when material is acquired by the contractor for incorporation into the concentrate and lose separate identity when the concentrate is shipped.

6.6 PFOA and PFOS content. The DoD's goal is to acquire and use a non-fluorinated AFFF formulation or equivalent firefighting agent to meet the performance requirements for DoD critical firefighting needs. The DoD is funding research to this end, but a viable solution may not be found for several years. In the short term, the DoD intends to acquire and use AFFF with the lowest demonstrable concentrations of two particular per- and PFAS; specifically PFOS and PFOA. The DoD intends to be open and transparent with Congress, the Environmental Protection Agency (EPA), state regulators, and the public at large regarding DoD efforts to address these matters. AFFF manufacturers and vendors are encouraged to determine the levels of PFOS, PFOA, and other PFAS in their products and work to drive these levels toward zero while still meeting all other military specification requirements.

6.7 Amendment notations. The margins of this specification are marked with vertical lines to indicate modifications generated by this amendment. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations.

MIL-PRF-24385F(SH)  
w/AMENDMENT 2

THIS END UP

U.S.

AQUEOUS FILM FORMING FOAM (AFFF) LIQUID CONCENTRATE

In accordance with

DEPARTMENT OF DEFENSE SPECIFICATION MIL-PRF-24385

TYPE 3 (3%)

This fire extinguishing concentrate is for use by dilution with water in fixed or mobile systems. It may be used alone or in combination with "twinned" dry chemical equipment. The concentrate may be diluted for use in flow proportioning equipment with sea water or fresh water at volume proportions of three gallons concentrate to 97 gallons water. It may also be diluted for ready-use storage at a three percent premix solution with fresh water. For ready use do not store below 32 °F. Avoid prolonged storage above 120 °F. Do not mix with other than liquid concentrate in accordance with MIL-PRF-24385F(SH) with Amendment 2 and water.

MANUFACTURER'S NAME

ADDRESS

BATCH NO.

DATE OF MANUFACTURE

FIGURE 1. Type 3 container markings.

MIL-PRF-24385F(SH)  
w/AMENDMENT 2

THIS END UP

U.S.

AQUEOUS FILM FORMING FOAM (AFFF) LIQUID CONCENTRATE

In accordance with

DEPARTMENT OF DEFENSE SPECIFICATION MIL-PRF-24385

TYPE 6 (6%)

This fire extinguishing concentrate is for use by dilution with water in fixed or mobile systems. It may be used alone or in combination with “twinned” dry chemical equipment. The concentrate may be diluted for use in flow proportioning equipment with sea water or fresh water at volume proportions of six gallons concentrate to 94 gallons water. It may also be diluted for ready-use storage at six-percent premix solution with fresh water. For ready use do not store below 32 °F. Avoid prolonged storage above 120 °F. Do not mix with other than liquid concentrate in accordance with MIL-PRF-24385F(SH) with Amendment 2 and water.

MANUFACTURER’S NAME

ADDRESS

BATCH NO.

DATE OF MANUFACTURE

FIGURE 2. Type 6 container markings.

CONCLUDING MATERIAL

Custodian:  
Navy – SH

Preparing activity:  
Navy – SH  
(Project 4210-2017-007)

Review activity:  
DLA – IS

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <https://assist.dla.mil>.