DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
1322 PATTERSON AVENUE, SE, SUITE 1000
WASHINGTON NAVY YARD, DC 20374-5065

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Ser EV/006
28 September 2017

From: Commander, Naval Facilities Engineering Command

Subj: INTERIM PER- AND POLYFLUORALKYL SUBSTANCES (PFAS) SITE GUIDANCE FOR NAVFAC REMEDIAL PROJECT MANAGERS (RPMS)/SEPTEMBER 2017 UPDATE

Ref: (a) DASN (E) Perfluorinated Compounds/Perfluoroalkyl Substances (PFC/PFAS) – Identification of Potential Areas of Concern (AOCs) Memorandum, 20 June 2016

Encl: (1) Interim Per- and Polyfluoroalkyl Substances (PFAS) Site Guidance for NAVFAC Remedial Project Managers (RPMs)/September 2017 Update

1. In accordance with reference (a), guidance and procedures for addressing Perfluoroalkyl Substances (PFAS) under the Environmental Restoration, Navy (ER,N) Program and Navy Base Realignment and Closure (BRAC) Program are provided in Enclosure (1). As many Navy installations have been receiving requests to evaluate PFAS at cleanup sites, this PFAS Site Guidance assists with identifying sampling methodologies and promoting a consistent approach for dealing with PFAS at Navy Environmental Restoration (ER) sites.

2. This Guidance supersedes and updates previous PFC Interim Guidance/FAQs issued on 29 January 2015.

3. The main objective of the PFAS Site Guidance is to assist Remedial Project Managers (RPMs) with programmatic and technical issues related to PFAS at Naval ER sites. These issues include: eligibility and funding responsibilities and scenarios, sampling and analysis, investigation, risk assessment methodology, and response and remedial action requirements.

4. The Headquarters point of contact is Ms. Kim P. Brown, who can be reached at kim.brown@navy.mil or (202) 685-0096. Technical questions can also be directed to Mr. Timothy Reisch at timothy.reisch@navy.mil or (757)322-4130 and Ms. Jennifer Corack at jennifer.corack@navy.mil or (757) 322-4335.

Larry E. Douchand

LARRY E. DOUCHAND, PE
Assistant Commander for
Environmental Programs

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Interim Per- and Polyfluoroalkyl Substances (PFAS) Site Guidance for NAVFAC Remedial Project Managers (RPMs)/ September 2017 Update

Objective/Purpose

The objective of this document is to assist Remedial Project Managers (RPMs) with programmatic and technical issues related to a group of chemicals called perfluorinated compounds (PFC)[1] or per- and polyfluoroalkyl substances (PFAS) at Department of Navy (DON) Environmental Restoration (ER) sites. These issues include: funding responsibilities, risk assessment, and regulatory requirements. The "Frequently Asked Questions" are presented to give general guidance. However, RPMs are encouraged to discuss site-specific conditions with their respective ER Manager or Base Closure Manager to determine if circumstances allow for Environmental Restoration, Navy (ER,N) or Base Realignment and Closure (BRAC) eligibility.

Applicability

The guidance and procedures in this document apply to actions taken under the ER,N and BRAC funded Defense Environmental Response Program (DERP).

Background

Certain PFAS have been identified as emerging contaminants (ECs) for the DERP program. PFAS were used in a variety of industrial and military applications, including as a component in aqueous film forming foam (AFFF), routinely used at airfields and firefighting training areas (FTAs). These compounds are environmentally persistent, and have been detected in environmental samples long after a release was reported. This environmental persistence and the tendency to bioaccumulate in living organisms and some demonstrated toxicity in laboratory animals, have increased interest in these ECs.

The U.S. Department of Defense (DoD) works with the U.S. Environmental Protection Agency (EPA) and state agencies to reach consensus on how to address ECs such as PFAS. ECs may have insufficient or limited health and science data. Additionally, sampling and analytical methods may not be available or may not be able to achieve the detection limits needed and contaminant migration pathways may yet to be determined.. Naval Facilities Engineering Command (NAVFAC) has prepared this interim guidance to support RPMs regarding how to handle PFAS at their sites.

PFAS are a class of man-made chemicals that have been used since the mid-20th century to make products that resist heat, stains, grease and water. PFAS have been widely used on products to enhance stain- and water-resistance properties (e.g., cookware, clothing, rugs, fast food wrappers, etc.) Because they help reduce friction, they are also used in a variety of other industries, including aerospace, automotive, building and construction, and electronics. Additionally, PFAS are a component of some firefighting suppressants for fighting petroleum fuel fires.

[1] Previous DoN policy and guidance used the term PFC. PFC are a subset of PFAS; therefore the term PFAS is used in the remainder of this document.

Currently, there are no Safe Drinking Water Act (SDWA) federal regulations or Clean Water Act (CWA) Ambient Water Quality Human Health Criteria for any PFAS. For contaminants not subject to any national primary drinking water regulation, the SDWA authorizes the EPA to publish nonregulatory lifetime health advisories (LHAs) or take other appropriate actions. These LHAs are created to assist state and local officials in evaluating risks from these contaminants in drinking water. In May of 2016, the EPA issued a lifetime health advisory (LHA) for two PFAS, specifically perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). Each LHA was set at 0.07 µg/L, and, in addition included an LHA for the total concentration of PFOA and PFOS combined of 0.07 µg/L when both PFOA and PFOS have been detected. Per these advisories, it is inappropriate to evaluate the sum of PFOA and PFOS detection limits when PFOA and/or PFOS are not detected. Additionally, the EPA LHA only applies to PFOA and PFOS; EPA does not advocate applying these levels to any other PFAS.

For additional information on PFOA and PFOS as ECs, see EPA's web site (https://www.epa.gov/pfas/basic-information-about-and-polyfluoroalkyl-substances-#tab-1).

PFAS Guidance FAQ Highlights

1. Sampling and Analysis

The January 2015 version of this guidance recommended that initially PFAS investigations should focus solely on PFAS for which vetted toxicity values are available which included perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), and perfluorobutanesulfonic acid (PFBS).

Recently the Office of the Secretary of Defense directed projects performing PFAS sampling and analysis should not truncate the list of reported analytes. As such, all drinking water sample results should include all 14 PFAS that are listed in the current drinking water analytical method (i.e., EPA Method 537, Rev. 1.1) as method analytes. The 14 method analytes of EPA Method 537, Rev. 1.1 are:

N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)
N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)
Perfluorobutanesulfonic acid (PFBS)
Perfluorodecanoic acid (PFDA)
Perfluorododecanoic acid (PFDoA)
Perfluoroheptanoic acid (PFHpA)
Perfluorohexanesulfonic acid (PFHxS)
Perfluorohexanoic acid (PFHxA)
Perfluorononanoic acid (PFNA)
Perfluorooctanesulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluorotetradecanoic acid (PFTA)
Perfluorotridecanoic acid (PFTrDA)
Perfluoroundecanoic acid (PFUnA)

Since there is no "standard" laboratory method for matrices other than drinking water, laboratories have made modifications to EPA Method 537, Rev. 1.1 to address other media such as sediment, soil, groundwater, and surface water. These modifications are not standardized among laboratories and therefore, neither are the lists of analytes that are detected. Analyses of these media should report results for all PFAS analytes included in the modified method.

The Navy's direction is to apply the LHA to actual drinking water sampling only to determine if there is complete exposure. Other media, such as groundwater and soil, should be addressed on a site-specific basis. However, to avoid delays in receipt of results used to assess current exposure, it is recommended

that only those PFAS with health advisory levels or vetted toxicity values (i.e., currently PFOA, PFOS, and PFBS) be requested for expedited turn-around-time and expedited data validation. Since the other PFAS are not being used to make decisions, receipt of those data do not need to be expedited. Data evaluation and site management decisions should be based on the DQOs for the site which should include only the analytes with toxicity values, and all other PFAS analytes should be placed in an appendix of the report.

For additional information, see FAQs S2, S3, S6, and RR8.

2. Investigation

RPMs should consider investigating ER sites for PFAS when the conceptual site model (CSM) indicates:

a. Historical release or use of aqueous film forming foam (AFFF), or
b. Historical use of an area for other industrial activities (e.g. plating operations) that may have released PFAS.

Based on recent Navy experience, sites at Naval and Marine Corps Air Stations (NAS and MCAS respectively), including outlying or auxiliary landing fields, or other applicable installations with potential repeated (e.g., former firefighting training areas) or significant (e.g., crashes) AFFF releases should be prioritized for investigation.

Note that environmental investigations at potential PFAS sites will generate investigation-derived waste (IDW). Currently no PFAS are classified as listed hazardous wastes, and therefore, solid material may be able to be disposed as non-hazardous solid waste. RPMs should consult the disposal facility to verify their current disposal acceptance criteria. Manifests should document that the solid waste may contain PFAS.

For IDW water, it is recommended that a sample be analyzed by a laboratory prior to disposal. If the combined concentration of PFOA and PFOS is less than 70 parts per trillion (ppt) , the water would not need special handling, treatment or disposal due to PFOA and PFOS (i.e., it can be disposed of if not prohibited by other legally enforceable requirements).

For additional information, see FAQs G2, G3, INV1, INV5, INV6, RR8, and FY1.

3. Human Health Risk Assessment

At this time, the EPA has not officially decided how to incorporate the PFOA and PFOS reference doses (RfDs) and the PFOA cancer slope factor (CSF) derived by the EPA Office of Water into the CERCLA program.

The Navy's current recommendation is that the RfD and CSF values derived by the EPA Office of Water be used to estimate risk-based screening levels that can be referenced during investigations, assist with delineation of releases, and estimate potential human health risks consistent with guidance provided by EPA's Risk Assessment Guidance for Superfund (RAGS) documents and OSWER Directive 9285.7-53 (Human Health Toxicity Values in Superfund Risk Assessment). Data evaluation and site management decisions should be based on the DQOs for the site which should include only the analytes with toxicity values, and all other PFAS analytes should be placed in an appendix of the report.

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For additional information, see FAQs R2, R3, R5, and RR2.

4. Response to PFAS Detections

If sampling indicates the presence of PFAS, then the response should be consistent with DoD Instruction 4715.18 on Emerging Contaminant (EC):

a. At a minimum, the nature and extent of contamination should be delineated .
b. If there is no current or potential future exposure, then further action should be delayed until there is greater certainty regarding toxicity and/or remedial technologies.
c. If further action is delayed, then consideration should be given to include the extent of contamination on the Base Master Plan or other appropriate documents.
d. Interim response actions may be initiated to prevent exposure (e.g., providing alternate drinking water, monitoring, controlling land use, controlling plume migration, etc.).

For additional information, see FAQs INV2 – INV5, RR1, RR4 – RR7, ARAR1, ARAR2, and LUC1.

5. Remedial Actions

At present, information regarding degradation and transformation pathways and effective remedial technologies is limited and still being investigated. As such, it may only be possible to (1) prevent exposure by implementing Land Use Controls (LUCs) or (2) initiate interim remedies (e.g. well head treatment).

For additional information, see FAQs INV3, INV4, RR1, RR8, LUC1, and FY1.

Organization of this Document

The remainder of this document is presented as Frequently Asked Questions (FAQs), as follows.

General/Definitions

G1. What are emerging contaminants (ECs)?
G2. Is it reasonable to assume that PFAS will be present at my site?
G3. What are the similarities and differences between AFFF formulations that I need to know about for my site?

Eligibility and Funding

E1. Are PFAS considered CERCLA contaminants?
E2. Can ER,N or BRAC funding be used to investigate and remediate PFAS?
E3. What if the site has achieved site closure (SC)?

Sampling and Analysis

S1. Are there special sampling techniques for these chemicals?

S2. What analytical method should be used for drinking water samples?
S3. What analytical methods are currently available for other media?
S4. Are there any DoD-ELAP accredited laboratories that can perform PFAS analysis?
S5. Is there a difference between how aqueous samples (not including drinking water samples) are prepared and analyzed when the sample contains a high concentration of PFAS versus low concentrations of PFAS?
S6. Is there a standard target analyte list for PFAS investigations?

Investigation

INV1. What should an installation-wide PA/SI include?
INV2. What should be expected regarding fate and transport of PFAS?
INV3. What if PFAS may have reached a drinking water source?
INV4. What if a release is suspected to have migrated offsite?
INV5. Should a PFAS investigation be carried out at a site where foam was used but there are no records supporting that the foam formulation contained PFAS??
INV6. How should investigation-derived waste (IDW) at PFAS sites be disposed?

Risk Assessment

R1. Should PFAS automatically be included in the risk assessment?
R2. What human health risk assessment screening levels are available?
R3. What human health toxicity values are available?
R4. What exposure pathways should be included in a human health risk assessment?
R5. Should we still use the EPA's 2009 Short-term Provisional Health Advisory levels and/or the toxicity values generated in 2009 for PFOA and PFOS?
R6. Do PFAS need to be considered in the ecological risk assessment?
R7. What ecological risk assessment screening levels are available?

Applicable or Relevant and Appropriate Requirements and/or To Be Considered Values

ARAR1. Are there Federal ARARs or TBCs for any PFAS?
ARAR2. Are there State ARARs for any PFAS?

Remedial Response Considerations

RR1. If sampling indicates presence of PFAS, is response warranted?
RR2. How should cleanup levels be established for PFAS?
RR3. How should removal management levels be established for PFAS?
RR4. If PFAS are the only risk driver, does it drive a CERCLA response?
RR5. What if other contaminants are present at levels requiring action and it is unclear if PFAS are present at levels that would warrant action?
RR6. What if other contaminants are present at levels requiring action and it is likely that PFAS are present at levels that would warrant action?

RR7. What treatment technologies are available for PFAS?

Land Use Controls (LUCs)

LUC1. Should land use controls (LUCs) be considered when PFAS are present?

Five-Year Review Issues

FY1. Should PFAS be considered during 5-Year Reviews?

FAQ – General/Definitions

G1. What are emerging contaminants (ECs)?

There is no single, consensus definition of ECs across agencies; different organizations (e.g., DoD, EPA, state agencies) have different definitions of ECs, and thus, possibly different chemicals identified as ECs. For DoD, an EC is defined as a contaminant that:

- Has a reasonably possible pathway to enter the environment;
- Presents a potential unacceptable human health or environmental risk; and
- Does not have regulatory standards based on peer-reviewed science, or the regulatory standards are evolving due to new science, detection capabilities, or pathways.

For reference, EPA's definition is: "An "emerging contaminant" is a chemical or material that is characterized by a perceived, potential or real threat to human health or the environment or by a lack of published health standards" (EPA 2014a).

G2. Is it reasonable to assume that PFAS will be present at my site?

If the CSM suggests that AFFF was released into the environment, it is likely that a variety of PFAS will be present at the site. At DoD facilities, one of the primary sources of environmental PFAS will be areas where AFFF was used for activities related to firefighting (e.g., fire training areas, runways, crash sites, hangars, fuel farms, where fires or accidental releases of AFFF occurred, equipment testing and washout areas, oil-water separators or other piping systems where released AFFF may have flowed). Sludge from oil-water separators at hangars and sludge from sewage treatment at air bases could potentially contain PFAS.

AFFF is the name on the Military Specification (MIL-SPEC) (where the MIL-SPEC is owned by the Navy) for the firefighting foam commonly used for hydrocarbon (e.g., fuel) fires. However, fluorinated foams by any name should be noted in the investigations and their ingredients identified, if known. Sludge from oil-water separators at hangars and sludge from sewage treatment at air bases could potentially contain PFAS. Ship maintenance facilities may have stored AFFF for use in replenishing the foam fire-suppressant systems on the ships.

Additionally, PFAS were sometimes included in mist suppressants which may have been used in plating baths for hard chrome plating. Low concentrations of PFAS have also been identified in effluent from wastewater treatment plants and in landfill leachate. The historical research aspect of the installation-wide investigation should identify any source of PFAS.

G3. What are the similarities and differences between AFFF formulations that I need to know about for my site?

AFFF formulations used at DoD facilities differ in their chemical composition. Each formulation is comprised of various individual PFAS at varying individual concentrations. Formulations used at DoD facilities are listed on the Qualified Products List (QPL). To be listed on the QPL, formulations must meet the requirements of the Navy MIL-SPEC for AFFF. Every formulation listed on the QPL must be compatible with all other formulations that are currently listed on the QPL. This allows for the mixing of different formulations without introducing performance issues. Because of this, vessels such as firefighting vehicles containing a formulation are not typically drained and cleaned prior to introducing a different formulation. In addition, some formulations contain such high concentrations of some PFAS that conventional cleaning

protocols would not eliminate them. As a result, the determination of potential for release of a particular PFAS should be partially based on AFFF usage, not usage of a particular AFFF formulation.

FAQ - Eligibility and Funding

E1. Are PFAS considered CERCLA contaminants?

PFAS, including PFOA and PFOS, are not listed as Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substances and therefore have not historically been included in typical CERCLA/DERP environmental investigations. Though not a CERCLA hazardous substance, PFAS are considered a CERCLA pollutant or contaminant.

PFAS fall within the definition of ECs contained in DOD EC Instruction 4715.18, and can be included in a DERP investigation if a reasonable basis exists to suspect a release may have occurred.

E2. Can ER,N or BRAC funding be used to investigate and remediate PFAS?

If the conceptual site model (CSM) indicates the use or release of AFFF or other industrial activities for which PFAS are associated, then ER,N or BRAC funds can be used to investigate, and if necessary, perform restoration of media impacted by PFAS. However, ER,N or BRAC funds can only be used to address past releases of PFAS (ER,N or BRAC funds cannot be used to investigate/remediate potential ongoing releases at active operations).

As with any ECs, it can be challenging to reach concurrence on the potential risk and/or cleanup levels for contaminants with limited toxicity information, such as PFAS (see Risk Assessment section). Therefore RPMs should check with ER Managers (for ER,N) or Base Closure Managers (for BRAC) before agreeing to cleanup levels to ensure that the state of the science information is being appropriately considered.

E3. What if the site has achieved site closure (SC)?

If a site has already been investigated and achieved SC, then any additional investigation should only be initiated after careful consideration, with adequate justification, and with concurrence from the respective ER Manager (for ER,N) or Base Closure Manager (for BRAC). To consider sampling a site for PFAS, the conceptual site model (CSM) must be well understood and strongly suggest that there is reason to believe these chemicals have impacted environmental media in areas where exposure can occur.

FAQ – Sampling and Analysis

S1. Are there special sampling techniques for these chemicals?

Yes, special sampling techniques should be used. PFAS are a class of manufactured compounds that are extensively used in a variety of industrial and commercial products to make items more resistant to stains, grease, and water. Some of these products could be present and/or used during

a routine sampling event, such as plastic bags and bottles, waterproof clothing, detergents, and waterproof pens and paper. As such the use of these products could possibly contaminate the samples during sample collection. This includes what is used to prepare the sampling site, what is used to collect the sample, what is used to clean the sampling equipment, what the sample is collected in, and how the sample is shipped.

Several precautions that should be taken during sample collection to avoid inadvertent sample contamination:

- Post-it Notes should not be used at any time during sample handling, or mobilization/demobilization.
- Personnel involved with sample collection and handling should avoid wearing new clothing (e.g., at least 6 washings since purchase).
- Personnel involved with sample collection and handling should not wear water resistant clothing immediately prior to or during sample collection.
- Personnel involved with sample collection and handling should not wear Tyvek® suits.
- Personnel involved with sample collection and handling should wear nitrile gloves at all times while collecting and handling samples.

Many food and snack products are packaged in wrappers treated with PFAS. Therefore, hands will be thoroughly washed after handling fast food, carryout food, or snacks.

- Pre-wrapped food or snacks (like candy bars, microwave popcorn, etc.) must not be in the possession of the sampling personnel during sampling.
- Blue Ice® must not be used to cool samples or used in sample coolers.
  Products containing Teflon®-containing materials, when possible, should be avoided (e.g., tubing, bailers, tape, and plumbing paste). In cases where Teflon®-containing materials are unavoidable, ensure adequate purging is performed prior to sampling (e.g., in-well pumps) and/or rinse blanks are collected prior to sampling.

Sample bottles should be obtained from the laboratory performing the analysis. DoD Environmental Laboratory Accreditation Program (ELAP) accredited laboratories are required to ensure the sample bottles provided to clients have been verified as clean (meet the acceptance criteria for blanks for analysis). Drinking water samples must be collected in accordance with EPA Method 537. EPA Method 537 requires drinking water samples to be collected in polypropylene bottles with a polypropylene screw cap. All other samples must be collected in a high density polyethylene (HDPE) container with an unlined plastic screw cap.

More information on sampling can be found in the EDQW PFAS Sampling Fact Sheet, Rev. 1.2, November 2016 on the DENIX website: http://www.denix.osd.mil/edqw/home/.

S2. What analytical method should be used for drinking water samples?

Drinking water samples must be analyzed by EPA Method 537, which currently lists 14 perfluoroalkyl acids, including PFOS and PFOA.

S3. What analytical methods are currently available for other media?

There currently are no published EPA methods for media other than drinking water. DoD ELAP laboratories have modified EPA Method 537 for the other media (i.e., groundwater, surface water, sediment, soil) and expanded the analyte list to include other PFAS. These modified methods are the methods that are currently recommended for all matrices other than drinking water. DoD ELAP requirements for these modified methods can be found in the DoD Quality Systems Manual (QSM), Version 5.1, Appendix B, Table B-15.

A copy of the DoD QSM, Version 5.1 can be found under the heading "What's New" on the Environmental Data Quality Workgroup (EDQW) page on the DENIX website: http://www.denix.osd.mil/edqw/home/

S4. Are there any DoD-ELAP accredited laboratories that can perform PFAS analysis?

Yes, there are DoD-ELAP accredited laboratories that can provide EPA Method 537 and modified EPA Method 537. A list of DoD ELAP accredited laboratories can be found on DENIX at: http://www.denix.osd.mil/edqw/accreditation/home/. A list of DoD ELAP laboratories that are currently accredited to perform analysis of drinking water samples by EPA Method 537 can be generated by performing a method search for "EPA 537". A list of DoD ELAP laboratories that are currently accredited to perform analysis of other media in accordance with the requirements of DoD QSM Version 5.1 can be generated by performing a method search for "PFAS by LCMSMS Compliant with QSM 5.1 Table B-15".

The DENIX database should be used as a starting point when selecting a laboratory for a project. It does not provide all information needed (e.g., analyte lists for methods). To ensure the laboratory you select is accredited for your project analytes, the project manager/chemist must review the laboratory's scope of accreditation, which is found on their accreditation body's website.

The DoD ELAP accredited laboratory database can be found by following the link under the heading "Search Accredited Labs" on the Environmental Data Quality Workgroup (EDQW) page on the DENIX website: http://www.denix.osd.mil/edqw/home/

S5. Is there a difference between how aqueous samples (not including drinking water samples) are prepared and analyzed when the sample contains a high concentration of PFAS versus low concentrations of PFAS?

Yes, samples containing a high concentration of PFAS, such as AFFF formulations, must be prepared by serial dilution using an aliquot of the sample received and analyzed by direct injection of the serial dilution. Each sample is required to be prepared and analyzed in this manner in duplicate, therefore, two analytical results are reported for each sample.

Preparation of samples not containing high concentrations of PFAS utilizes the entire sample that was collected in the field. The entire sample is extracted using a solid phase extraction process and an aliquot of the extract is analyzed. No duplicate is performed in the laboratory analysis on these samples.

In order to determine which category a sample falls into, laboratories screen each sample. In order to not affect the final result of low concentration samples, it is recommended that a smaller bottle (e.g., 75-125 mL versus 250 mL) be collected for screening purposes alongside the routine sample volumes in the field. If samples are collected that are known to contain high concentrations of PFAS, this should be clearly noted on the chain of custody (CoC) that is sent with the samples to the laboratory.

Requirements for both processes are included in the DoD QSM, Version 5.1, Appendix B, Table B-15.

S6. Is there a standard target analyte list for PFAS investigations?

For drinking water analysis, yes. Method 537, Rev 1.1 currently includes the following 14 compounds:

N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)
N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)
Perfluorobutanesulfonic acid (PFBS)
Perfluorodecanoic acid (PFDA)
Perfluorododecanoic acid (PFDoA)
Perfluoroheptanoic acid (PFHpA)
Perfluorohexanesulfonic acid (PFHxS)
Perfluorohexanoic acid (PFHxA)
Perfluorononanoic acid (PFNA)
Perfluorooctanesulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluorotetradecanoic acid (PFTA)
Perfluorotridecanoic acid (PFTrDA)
Perfluoroundecanoic acid (PFUnA)

When drinking water is analyzed, results for these compounds should be reported by the laboratory.

For media other than drinking water, no, there is no standard analyte list.

Since currently there is no "standard" laboratory method for matrices other than drinking water, laboratories have made modifications to Method 537, Rev. 1.1 to address other media such as soil, groundwater, and sediment. These modifications are not standardized among laboratories and therefore, neither are the lists of analytes that are detected. Aqueous media (e.g., groundwater and surface water) analyzed by a modified method should report the 14 analytes included in Method 537, Rev. 1.1.

For solid media, all PFAS should be reported that can be detected and that are included in Method 537, Rev. 1.1, without additional lab fees[2] or special/additional processing, provided that it includes the PFAS which have health advisory levels or toxicity values developed or vetted by EPA (currently this includes PFOA, PFOS, and PFBS). In order to address potential bias and consistency issues, all analyses for non-drinking water samples (e.g., groundwater, surface water, soil, sediment) must meet DoD QSM, Version 5.1, Appendix B, Table B-15 requirements.

The DON's direction is to apply the LHA to actual drinking water sampling only to determine if there is a complete exposure pathway. Other media, such as groundwater and soil, should be addressed on a site-specific basis. However, to avoid delays in receipt of results used to assess current exposure, it is recommended that only those PFAS with vetted toxicity values (i.e., currently PFOA, PFOS, and PFBS) be requested for expedited turn-around-time and expedited data validation. Since the other compounds are not being used to make decisions, receipt of those data do not need to be expedited. Data evaluation, validation, and site management decisions should be based on the DQOs for the site which should include only the analytes with toxicity values. All other PFAS analytes should be placed in an appendix of the report.

FAQ – Investigation

INV1. What should an installation-wide PA/SI include?

An installation-wide PA/SI should identify all areas on the installations where AFFF is or was stored, used, released, disposed, etc. Unfortunately, historical documentation of AFFF use and releases is often incomplete because records were not required. Therefore, in addition to document reviews, interviews will be crucial to understanding past practices and identifying the potential for environmental releases. The base Fire Department should be contacted to determine if the base currently or historically used AFFF, and locations where it has been used (e.g., training, crashes, etc.). Coordination with the Water Program Media Managers, Spill Program Managers, the regional Navy On Scene Coordinators (NOSC) will also provide information on AFFF releases/spills. AFFF that was stored or released at installations may have migrated to the subsurface, therefore potential PFAS-impacted soil or sediment may be an on-going source for PFAS impacts to groundwater and/or surface water.

Although AFFF is considered the primary source of PFAS at DON installations, PFAS are also found in a variety of other materials/processes including sources such as chromium plating bath mist suppressant, wastewater treatment plant biosolids/effluent, and landfill leachate.

Identification of sites will be based on the review of existing information about use and disposal practices at the installation and may include limited field data to determine the nature of any

[2] Note: If a laboratory lowered the price in its bid to only report PFOA, PFOS, and PFBS, it is not necessary to change the analyte list just to meet this recommendation.

releases and potential threat to receptors. Consideration should be given to: (1) areas where firefighting exercises were conducted; (2) areas where fire suppression infrastructure exists or existed (e.g., fire stations, AFFF equipment storage areas, and former pump houses); (3) unplanned release areas such as crash sites, equipment cleaning discharge locations, and fire suppression systems located at fuel storage areas; (4) areas where chromium electroplating operations were performed; (5) landfill and waste disposal areas receiving waste streams containing PFAS; and (6) areas where waste material and sludge from wastewater treatment plants was disposed.

To evaluate the threat to human receptors, the PA/SI should include information on groundwater gradients, topographic maps, locations of drinking water wells, and maps illustrating the relative positions of potential sites to drinking water wells.

INV2. What should be expected regarding fate and transport of PFAS?

Current sampling results indicate that the highest groundwater concentrations will likely be found near the source area and diminish with distance. Preliminary research data suggest that individual PFAS may differ in their affinity for each matrix as well as their rates of migration from a source. Although PFAS are very water soluble, some PFAS have been found in soils at FTAs that have been closed for years.

Due to the emerging status and complex chemistries, a clear picture of environmental fate and transport is not available at this time. In an effort to begin answering some of these questions, the DoD has funded several Strategic Environmental Research and Development (SERDP) projects related to this topic.

INV3. What if PFAS may have reached a drinking water source?

If anytime during an investigation, a potential for drinking water exposure to any on-base or off-base human receptor is identified, the FEC should immediately (1) notify NAVFAC HQ, (2) gain approval to initiate a communications plan and (3) implement drinking water sampling of affected properties. NAVFAC Atlantic is a resource and has communication plans, fact sheets, etc. from multiple investigations, which can be provided to expedite the initial actions.

If PFOA and/or PFOS are confirmed in drinking water above the EPA LHAs, then immediate actions must be taken to notify affected individuals and reduce/eliminate the exposure. For immediate response, this typically involves providing alternate (e.g., bottled) water for drinking, cooking, and any consumption until a long term solution is implemented.

If drinking water wells have been impacted, but do not have levels of PFOA and/or PFOS above the EPA LHAs, then a site-specific decision needs to be made regarding continued monitoring until a long-term solution is implemented.

INV4. What if a release is suspected to have migrated offsite?

If the CSM indicates that a historical release may have migrated offsite, then sampling may need to be initiated offsite to identify nature and extent and potential complete exposures. The most significant concern is the potential impact that offsite migration would have on drinking water wells in the vicinity. In this instance, ER Managers (for ER,N) or Base Closure Managers (for

BRAC) and NAVFAC HQ should be notified. The sampling should be expedited if potentially complete exposures are expected. Coordination with legal, real estate, and possibly the regulators will be needed to gain right of entry access agreements to private properties.

INV5. Should a PFAS investigation be carried out at a site where foam was used but there are no records supporting that the foam formulation contained PFAS??

Yes, for the following reasons: 1) Current understanding is that any AFFF formulations on the QPL may include perfluoroalkyl substances like PFOA, 2) Any AFFF formulations likely also contain polyfluoroalkyl substances, some of which have the potential to degrade into the perfluoroalkyl substances, including PFOA, 3) the polyfluoroalkyl substances may possess toxicity and 4) the equipment used to deliver AFFF may still contain small amounts of older product from previous refills. Reported uses of "protein foam" were typically "fluoroprotein foam" which contained other fluorinated surfactants, including PFOS. Given the different formulations used, it is recommended that PFAS investigations should also include sites that only report uses of "protein foam" or "fluoroprotein foam."

INV6. How should investigation-derived waste (IDW) at PFAS sites be disposed?

Environmental investigations at potential PFAS sites will generate investigation-derived waste (IDW). Currently no PFAS are classified as listed hazardous wastes, and therefore, solid material may be able to be disposed as non-hazardous solid waste. RPMs should consult with the disposal facility to verify their current disposal acceptance criteria. Manifests should document that the solid waste may contain PFAS.

For IDW water, it is recommended that a sample be analyzed by a laboratory prior to disposal. If the combined concentration of PFOA and PFOS is less than 70 parts per trillion (ppt)[3], the water can be disposed of if not prohibited by other legally enforceable requirements.

For IDW water with a combined concentration of PFOA and PFOS greater than 70 ppt, the water should be treated so the combined PFOA and PFOS concentration is less than 70 ppt, and then can be disposed of within any legally enforceable requirement (i.e., would not require special handling, treatment, or disposal due to PFOA and PFOS).

If it is expected that the concentrations of PFOA and PFOS will be much higher than 70 ppt (e.g., captured residual from an accidental release in a hangar), special actions may be needed to dispose of the waste-stream. These instances should be brought to the attention of NAVFAC HQ for coordination with the appropriate program (e.g., compliance). The most current technical considerations, limitations, and options will be provided for consideration.

[3] Although the lifetime health advisory is for drinking water and not specifically for IDW, until additional guidance is provided by EPA it is assumed that if water could be used as drinking water based on PFAS levels, that disposal of the water is unlikely to have additional restrictions.

FAQ - Risk Assessment

R1. Should PFAS automatically be included in the risk assessment?

PFAS should only be sampled for if the CSM suggests the potential for a historical release of these chemicals. If the CSM supports environmental sampling for PFAS, then these sampling results should be considered to make remedial decisions. For the majority of sites, this will include a quantitative risk assessment. However, it should be noted in the uncertainty section that Tier 2 and/or 3 toxicity values would be used for these ECs.

R2. What human health risk assessment screening levels are available?

As always, screening levels may be developed through partnering relationships between the RPM and regulatory agencies. Ordinarily, the EPA Regional Screening Level (RSL) tables would be a good place to start. However, the most recent version of the RSL table (June 2017) does not include PFOA and PFOS (although the EPA Office of Water estimated chronic toxicity values for them in May 2016). The toxicity values developed by the EPA Office of Water are included in the on-line RSL calculator. As such it is currently unclear what EPA's recommendation is regarding these toxicity values.

On November 15, 2016, EPA Office of Water released a memorandum that clarified that the Health Advisories developed by the EPA Office of Water in May 2016 were only to be applied to drinking water. The Health Advisories are based on toxicity values derived in documents that specifically target exposure via drinking water; not dermal contact or inhalation. EPA also stated that the Health Advisories are not applicable in identifying risk levels for ingestion of food. The EPA memo did not specifically address ingestion of non-food solids such as soil or if this restriction extends to the toxicity values upon which the LHAs are based.
Until EPA guidance is provided, cleanup teams should discuss the level of confidence they would assign to screening levels based on the EPA Office of Water's toxicity values. When those RfDs are used with the current (June 2017) RSL calculations and default assumptions, the possible screening levels are provided on the table below. Note that since these toxicity values are not listed in the current (June 2017) RSL table, they are not be considered vetted Tier 3 toxicity values as described in EPA directive (2003).

Screening Level Scenario	Groundwater (µg/L)			Soil (mg/kg)		
	PFOA[1]	**PFOS[1]**	**PFBS[2]**	**PFOA[1]**	**PFOS[1]**	**PFBS[2]**
Residential exposure	0.4	**0.4**	380	1.3	**1.3**	1,600
Industrial worker exposure	**NA**	**NA**	**NA**	16	**16**	23,000

1. Values calculated for PFOA and PFOS using the EPA's on-line RSL calculator in June 2017 and are based on a target hazard quotient of 1.
2. Values are from the EPA Regional Screening Level table, June 2017.
NA means that currently these values are not applicable.

R3. What human health toxicity values are available?

Currently there are no toxicity values for any PFAS available from a Tier 1 (i.e., EPA's Integrated Risk Information System [IRIS]) source.

Non-cancer toxicity values are currently available for PFOA and PFOS for the ingestion route of exposure (i.e., reference doses [RfDs]) (EPA 2016a; 2016b). Note that as of June 2017 EPA has not confirmed that these are Tier 3 values. Although Tier 3 toxicity values are appropriate for use in CERCLA HHRAs per (EPA 2003), there is always increased uncertainty associated with the use of Tier 3 toxicity values since their level of peer review and acceptance in the scientific community are not as rigorous as for Tier 1 and Tier 2 toxicity values. As such, if CERCLA cleanup levels are being derived, RPMs should discuss this with their respective ER Manager. The chronic noncancer RfDs for both PFOA and PFOS is 2E-05 mg/kg-day. For both chemicals, this value is based on developmental effects. The EPA Office of Water also estimated a cancer slope factor (CSF) for oral exposure to PFOA of 0.07 $(mg/kg\text{-}day)^{-1}$.

A Tier 2 (i.e., EPA's Provisional Peer-Reviewed Toxicity Value [PPRTV]) oral reference dose is available for PFBS (EPA 2014). The chronic Tier 2 noncancer RfD for PFBS is 0.02 mg/kg-day. This is based on kidney effects in a subchronic rat study. EPA also established a Tier 2 subchronic RfD of 0.2 mg/kg-day based on kidney effects in a rat study.

R4. What exposure pathways should be included in a human health risk assessment?

For PFOA, PFOS, and PFBS the only toxicity values available are for ingestion. As such, if the CSM supports it, the ingestion exposure route can be estimated for human health. On November 15, 2016, the U.S. EPA Office of Water issued a memorandum that clarified the Lifetime Health Advisory in drinking water cannot be used to identify risk levels for ingestion of food sources (EPA 2016d). The, U.S. EPA did not clarify if the toxicity values used to develop the Lifetime Health Advisory can be applied to incidental ingestion of soil, such as is reflected in the EPA

RSL for both residential and industrial contact with soil. However, the toxicity values developed by the EPA Office of Water are included in the on-line RSL calculator. This inconsistency has not been explained by EPA so an explanation is not available for this document. As such, at this time there is uncertainty regarding the appropriateness of using those Tier 3 RfDs for incidental ingestion of soil.

For many chemicals, it is possible to estimate the potential toxic effects from dermal exposure by adjusting the oral toxicity value. EPA's current recommendations about when to make this adjustment (√) and when it's not appropriate (x) are summarized in the table below.

As of June 2017 there are no vetted toxicity values for inhalation of PFAS; therefore the inhalation route cannot be quantified.

Substance	**Ingestion**		**Dermal Contact**		**Inhalation**
	Soil	**Water**	**Soil**	**Water**	**Air**
PFOA	TBD by EPA	√	TBD by EPA	x	x
PFOS	TBD by EPA	√	TBD by EPA	x	x
PFBS	√	√	x	√	x

R5. Should we still use the EPA's 2009 Short-term Provisional Health Advisory levels and/or the toxicity values generated in 2009 for PFOA and PFOS?

No. When EPA finalized the health advisory documents for both PFOA (EPA 2016a) and PFOS (EPA 2016b), the EPA considered these values to supersede the previous short-term provisional health advisory levels of 2009. Since the 2016 lifetime health advisory levels are based in part on developmental effects, EPA considers the lifetime health advisory levels to also be protective for short-term exposure. If the 2009 values were used previously to establish remedial goals, the goals may need to be reevaluated to ensure "overall protection of human health," which is a threshold criteria for evaluating remedial alternatives under the NCP.

R6. Do PFAS need to be considered in the ecological risk assessment?

Yes, if the CSM includes complete exposure pathways for ecological receptors and there are accepted screening values provided in accordance with Question R6.

R7. What ecological risk assessment screening levels are available?

Many scientific papers have been published that begin establishing potential values for ecotoxicity of some PFAS. If regulators provide or recommend ecological screening levels for any PFAS, it is recommended to check with a DON ecological risk assessor to vet those values.

FAQ – Applicable or Relevant and Appropriate Requirements and/or To Be Considered Values

ARAR1. Are there Federal ARARs or TBCs for any PFAS?

At this time, no federal ARARs have been identified for PFAS. The EPA's LHAs for PFOA and PFOS are not ARARs, because the LHAs are not promulgated enforceable laws. The LHAs can be used either as TBCs, or as measures of protectiveness. If the LHAs are identified as TBCs, they will have the effect of an ARAR when finalized in a decision document. However, if the LHAs are cited in establishing a risk-based level for the protection of human health, they do not have the effect of an ARAR. Consequently, risk-based protective levels are more flexible than ARARs or TBCs.

ARAR2. Are there State ARARs for any PFAS?

ARARs are identified on a site-specific basis. Several states have promulgated drinking water standards which will likely be considered ARARs. It is important to note that several states also have general risk-based screening values for several PFAS. These are generally not ARARs. If a state identifies a potential ARAR in a timely manner, RPMs should consult with environmental legal counsel to conduct an ARAR analysis.

FAQ – Remedial Response Considerations

RR1. If sampling indicates presence of PFAS, is response warranted?

A decision regarding whether a response is warranted is based on a risk determination (See, for example, OSWER Directive 9355.0-30.) and should be consistent with DoD EC Instruction 4715.18. If a risk assessments determines there is unacceptable risk, potential chemical-specific applicable or relevant and appropriate requirements (ARARs) should be evaluated. Note that the EPA drinking water lifetime health advisories (LHAs) for PFOA and PFOS are not promulgated and do not qualify as potential federal ARARs. However, if a site includes a current drinking water source, the LHAs may be used to evaluate protectiveness of the drinking water and may provide the basis for determining if a site warrants a response action. If a state identifies a potential state requirement, it is important that you contact your environmental counsel for a legal interpretation to determine if the requirement is promulgated, accepted as a potential ARAR, to be considered (TBC), or a risk-based value for evaluating protectiveness.

RR2. How should cleanup levels be established for PFAS?

If it is determined that a site warrants remediation, cleanup levels should be established in the same manner as other contaminants. Cleanup levels must meet the two threshold NCP criteria, which are: (1) overall protection of human health and the environment, and (2) compliance with ARARs. The protectiveness of a cleanup level addresses the human and ecological risks identified in the RI as warranting a response action (i.e., cancer, non-cancer, or ecological risks, and risk-based chemical standards). Compliance with ARARs may introduce additional requirements that were not considered during risk characterization.

If potentially unacceptable risks are identified in the baseline HHRA, toxicity values can be used to develop site-specific risk-based cleanup goals following standard risk procedures, i.e., cleanup goals should be within the cancer risk range (10^{-6} to 10^{-4}) and have a noncancer hazard index of 1 or less. However, RPMs should be cognizant of the potentially significant uncertainty inherent in cleanup goals based on tier 2 or tier 3 toxicity criteria.

RR3. How should removal management levels be established for PFAS?

The concentration in drinking water at which the DON provides an interim alternate supply of water is a risk management level. The DON has made a policy decision to use the LHAs for PFOA and PFOS as the risk management levels for these PFAS. RPMs should check with their chain of command to determine if there should be risk management levels for additional PFAS at the site, e.g., PFAS identified with potential ARARs or vetted toxicity criteria. RPMs should consult with risk assessors before basing a risk management level on toxicity criteria.

RR4. If PFAS are the only risk driver, does it drive a CERCLA response? What if the team does not agree about PFAS being a risk driver?

Yes. In accordance with DoD EC Instruction 4715.18, if the concentrations of PFAS are sufficiently elevated such that all parties agree that action is necessary for ECs, the team should evaluate remedial alternatives for PFAS. If the team agrees on the cleanup level(s) then a remedy can be implemented.

However, if the team disagrees on the PFAS exposure being a risk, or on cleanup level(s), then one or more interim response actions may be appropriate until consensus risk-based values are identified by the team (e.g., plume migration control, provision of drinking water, monitoring, land use controls).

If the team agrees that there is no actual or potential future exposure, it may be possible to delay further action until there is a greater certainty over the risk (e.g., more complete toxicity information). Alternately, the team may wish to make a risk management decision.

At a minimum, the team should seek to delineate and/or monitor the extent of contamination until there is greater certainty regarding the potential risk and/or remedial technologies. If the team agrees to delay further action until risk-based values are identified, the DON will want to note the area of contamination in the appropriate base facilities planning documents.

RR5. What if other contaminants are present at levels requiring action and it is unclear if PFAS are present at levels that would warrant action?

In accordance with DoD EC Instruction 4715.18, if PFAS are detected but regulators and DON cannot agree that they pose an unacceptable risk, then the team should consider if there are remedial alternatives for the other contaminants which may also address PFAS. If so, and agreement can be reached on the PFAS cleanup level by the team, a remedy should be implemented.

If the team disagrees on the ultimate cleanup level for PFAS, one or more interim response actions may be appropriate until risk-based values are identified (e.g., monitoring, land use controls, plume migration control, provision of drinking water).

If the remedial alternatives for other contaminants do not address PFAS and the team agrees that there is no actual or potential future exposure (for example, there is no current pathway and human receptor), it may be possible to delay further action until there is a greater certainty over the risk (e.g., more complete toxicity information). When selecting a remedy for other contaminants, the team should consider if the remedy has the potential to adversely impact the PFAS. Alternately, the team may wish to make a risk management decision.

At a minimum, the team should seek to delineate and/or monitor the extent of contamination until there is greater certainty regarding the potential risk and/or remedial technologies. If the team agrees to delay further action until risk-based values are identified, the DON will want to note the area of contamination in the appropriate base facilities planning documents.

RR6. What if other contaminants are present at levels requiring action and it is likely that PFAS are present at levels that would warrant action?

In accordance with DoD EC Instruction 4715.18, when the concentrations of PFAS are sufficiently elevated such that all parties agree that action is necessary, then it is possible that the remedial alternatives for other contaminants may address PFAS. However when remedial alternatives for other contaminants do not address PFAS, then an alternate remedy will need to be evaluated. When selecting a remedy for other contaminants, the team should consider if the remedy has the potential to adversely impact the PFAS.

If there is agreement on the PFAS cleanup level by the parties, then there does not need to be a delay in implementing a remedy. However if the team disagrees on the cleanup level for PFAS, one or more interim response actions may be appropriate until consensus risk-based values are identified. If the team agrees that there is no actual or potential future exposure (for example, there is no current pathway and human receptor), it may be possible to delay further action until there is a greater certainty over the risk (e.g., more complete toxicity information). Alternately, the team may wish to make a risk management decision in consultation with regulatory agencies.

At a minimum, the team should seek to delineate and/or monitor the extent of contamination until there is greater certainty regarding the potential risk and/or remedial technologies. If the team agrees to delay further action until risk-based values are identified, the DON will want to note the area of contamination in the appropriate base facilities planning documents.

RR7. What treatment technologies are available for PFAS?

Before implementing any active remedy for these emerging contaminants the RPM should contact NAVFAC Headquarters. Currently, the leading technologies are activated carbon, reverse osmosis and nano-filtration. Ion exchange also shows promise as an adsorbent requiring little development, with the potential advantage of on-site regeneration. However, these treatment processes are further impaired by other groundwater contaminants in addition to the high costs of operation. Ex-situ filtration is optimized for specific chemicals, which can result in non-targeted chemicals passing through. Thus, if there are additional unidentified PFAS in the plume, ex-situ filtration with release to the surface, may unintentionally result in the release and spread of other

PFAS to surface water bodies. Because the toxicity of these other PFAS is not well defined at this time, the potential impact of their release to surface water is unknown.

Research is beginning to provide the potential for alternative strategies. There have been some promising bench scale studies that suggest oxidation-based technologies may have the capacity to break down these recalcitrant chemicals. The research is in the early stages of development but there is hope that alternative technologies are possible. However, in-situ treatment is expected to increase the amount of smaller-chained PFAS in the plume, as a byproduct of the oxidation. Because the relative toxicity of smaller chained PFAS has not been defined, this alternative runs the risk of potentially increasing the toxicity of the plume. Thus, treatment which breaks down the longer-chained PFAS into smaller chained PFAS should be avoided until such time that there is a better understanding of the relative toxicity of these chemicals.

FAQ – Land Use Controls (LUCs)

LUC1. Should land use controls (LUCs) be considered when PFAS are present?

Yes, LUCs can be a helpful risk management tool for ECs such as PFAS, which is consistent with DoD EC Instruction 4715.18. LUCs can be considered for sources of drinking water (i.e., a complete exposure pathway) that contain PFAS above risk-based concentrations.

FAQ - Five-Year Review Issues

FY1. Should PFAS be considered during 5-Year Reviews?

PFAS should be considered during 5-year reviews if (1) it was a contaminant of concern in accordance with the DON 5-year Review Policy (DON 2011), or (2) it was not previously considered but the conceptual site model (CSM) indicates releases potentially have occurred.

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