UNDER SECRETARY OF DEFENSE
4000 DEFENSE PENTAGON
WASHINGTON, D.C. 20301-4000

PERSONNEL AND READINESS

APR 18 2022

MEMORANDUM FOR DEPARTMENT OF DEFENSE PER- AND POLYFLUOROALKYL SUBSTANCES TASK FORCE

SUBJECT: Assessment of Health Effects of Per- and Polyfluoroalkyl Substances Exposure, National Defense Authorization Act for Fiscal Year 2019

Section 315(c) of the National Defense Authorization Act for Fiscal Year 2019 requires the Secretary of Defense to conduct an assessment of members of the Armed Forces and veterans regarding potential health impacts from per- and polyfluoroalkyl substances (PFAS) through the completion of four tasks:

- Meta-analysis that considers the current scientific evidence base linking the health effects of PFAS on individuals who served as members of the Armed Forces and were exposed to PFAS at military installations;
- Estimate of the number of members of the Armed Forces and veterans who may have been exposed to PFAS while serving in the Armed Forces;
- Development of a process that would facilitate the transfer between DoD and the Department of Veterans Affairs of health information of individuals who served in the Armed Forces and may have been exposed to PFAS during such service; and
- Description of the amount of funding that would be required to administer a potential registry of individuals who may have been exposed to PFAS while serving in the Armed Forces.

While a formal report to Congress is not required, the attached document provides responses to these congressionally-directed tasks and aligns with ongoing PFAS work within DoD and our interagency partners. My point of contact is Dr. Jody Wireman at (571) 342-7960 or jody.r.wireman.civ@mail.mil.

Gilbert R. Cisneros, Jr.

Attachment:
As stated

Assessment of Members of the Armed Forces and Veterans Potential Health Impacts from Per- and Polyfluoroalkyl Substances

Section 315(c) of the National Defense Authorization Act for Fiscal Year 2019

I. Overview

This report provides responses to section 315(c) of the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2019, which requires the Department of Defense (DoD) to conduct an assessment of members of the Armed Forces and veterans regarding potential health impacts from per- and polyfluoroalkyl substances (PFAS) through the completion of four tasks. Section 315(c) states:

> (c) Assessment of Health Effects of PFAS Exposure.--The Secretary of Defense shall conduct an assessment of the human health implications of PFAS exposure. Such assessment shall include--
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> (1) a meta-analysis that considers the current scientific evidence base linking the health effects of PFAS on individuals who served as members of the Armed Forces and were exposed to PFAS at military installations;
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> (2) an estimate of the number of members of the Armed Forces and veterans who may have been exposed to PFAS while serving in the Armed Forces;
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> (3) the development of a process that would facilitate the transfer between the Department of Defense and the Department of Veterans Affairs of health information of individuals who served in the Armed Forces and may have been exposed to PFAS during such service; and
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> (4) a description of the amount of funding that would be required to administer a potential registry of individuals who may have been exposed to PFAS while serving in the Armed Forces.

II. Background

The DoD has and continues to evaluate PFAS levels in drinking water[1] along with investigating potential PFAS releases in other environmental media (e.g., groundwater and soil). In October 2020, the DoD began offering blood testing for all of its DoD firefighters during their annual occupational exam. This testing will provide preliminary data that can be used now and in the future to assist in the evaluation of PFAS exposures to members of the Armed Forces and veterans.

The DoD also collaborates with and supports other Federal agencies that lead efforts associated with environmental and occupational exposure assessments, risk assessments, and health studies. The Department of Health and Human Service (HHS) Agency for Toxic Substances and Disease Registry (ATSDR) developed a PFAS toxicology profile that includes health studies; however, there are not enough and/or appropriate studies available to complete a meta-analysis for any sub-populations to include members of the Armed Forces and veterans.[2] This dearth of information has led to a number of efforts by the Centers for Disease Control and Prevention (CDC) National Center for Environmental Health (NCEH)/ATSDR and others to conduct

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[1] Department of Defense. Office of the Under Secretary of Defense for Acquisition and Sustainment. Perfluorooctane Sulfonate and Perfluorooctanoic Acid on Military Installations. Report to Congress. May 2020.
[2] ATSDR. Toxicological Profile for Perfluoroalkyls, May 2021. Available at: https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf (accessed on 8/11/2021).

exposure assessments and health studies. The NCEH/ATSDR are conducting exposure assessments of populations located near eight current or former DoD installations to understand exposures associated with drinking water where perfluorooctanoic acid (PFOA) and/or perfluorooctane sulfonate (PFOS) levels in drinking water were above the 70 parts per trillion (ppt) Environmental Protection Agency (EPA) lifetime Health Advisory (HA). In addition, the NCEH/ATSDR have also planned health studies at the former Pease Air Force Base and a multi-site effort involving 10 locations (4 of which are associated with current DoD installations).[3,4] With a goal of better understanding health outcomes from different levels of PFAS exposures, these NCEH/ATSDR health studies will evaluate the following health outcomes: immune response, lipid metabolism, kidney function, thyroid disease, liver disease, glycemic parameters, diabetes, and, if the study participant size is large enough, cancer. Results from these efforts may provide valuable information about potential exposures and associated health effects.

Likewise, the CDC National Institute for Occupational Safety and Health (NIOSH) is also involved in a number of efforts to evaluate exposures and associated effects – in this case from PFAS-related occupational activities. This work includes efforts to evaluate civilian firefighters and potential exposures from aqueous film forming foam (AFFF), a PFAS-containing firefighting foam. In addition, NIOSH and the National Institute of Standards and Technology are evaluating PFAS in firefighter protective equipment/turnout gear.

The DoD also collaborates with and supports guidance and regulatory advances led by other Federal agencies, academia, and private organizations involved with PFAS human health and epidemiological analyses, fate-and-transport[5], depuration rates (e.g., elimination half-lives[6]), and other research to better understand potential PFAS exposures and human health effects. These agencies include, but are not limited to the EPA, Department of Agriculture, and HHS's Food and Drug Administration and National Institute of Environmental Health Sciences.

As required by the NDAA for FY 2019, this assessment focuses on members of the Armed Forces and veterans potentially exposed to PFAS at military installations while serving in the Armed Services. This report does not include DoD civilians or beneficiaries in the analyses.

III. Meta-Analysis of PFAS Health Effects on Members of the Armed Forces (Task 1)

The first task under section 315(c) is to include "a meta-analysis that considers the current scientific evidence base linking the health effects of PFAS on individuals who served as members of the Armed Forces and were exposed to PFAS at military installations." Meta-analysis is a statistical procedure used by epidemiologists for combining information from

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[3]ATSDR. Pease Study. Available at: https://www.atsdr.cdc.gov/pfas/activities/pease.html?CDC_AA_refVal=https%3A%2F%2Fwww.atsdr.cdc.gov%2Fpfas%2FPease-Study.html (accessed 9/29/2020).

[4] ATSDR. Multi-site Health Study. Available at https://www.atsdr.cdc.gov/pfas/activities/studies/multi-site.html (accessed on 9/29/2020).

[5] Fate and transport is the movement and chemical alteration of contaminants as they move through air, soil or water.

[6] A half-life is amount of time it takes for half of a chemical of interest, like PFAS, to leave the body; in the case of PFAS it can be represented by the time it takes for blood levels of a specific PFAS to be reduced by one half (50 percent).

multiple, independent studies in order to reach conclusions or address questions that are not possible in the individual studies.

A. Literature Review

In order to accomplish this task, the DoD first conducted a literature review of the latest scientific evidence and cross-referenced the latest public draft of the ATSDR "Toxicology Profile for Perfluoroalkyls" to ensure all relevant health studies were included.[7] The literature review focused on both environmental and occupational PFAS exposures and health effects, and evaluated the current scientific evidence associating human health effects to PFAS exposures. For the purpose of this assessment, studies that focused on maternal-fetal health, or child and developmental health effects were excluded. A total of 217 studies were included in the review, of which 151 were human health effect studies, and 66 were exposure studies.[8] The purpose of the assessment was to understand whether and, if so, how a meta-analysis could be accomplished for members of the Armed Force or veterans.

B. Health Study Review for Meta-Analysis

Epidemiologic studies identified through PubMed® searches, last conducted in September 2019, were reviewed. Search terms are included in Table 1. The studies were grouped by type of health effect and resulted in seventeen groups displayed in Table 2. Within each group, studies were classified as occupational, exposure to PFAS in-drinking water supply, or general population studies. The general population studies focused on adverse health effects associated with PFAS levels in blood serum. Only studies of adult populations were considered for this report because this NDAA requirement is for exposure to members of the Armed Forces and veterans (also noted in Table 2).

Table 1. Overview of the number of hits by search terms

Search Term	Number of Hits	Health Effect	Number of Hits
Military	95	Endocrine	408
Firefighting/Firefighter	17	Liver/Hepatic Enzymes	848
Health Effects	1,527	Thyroid	166
Cancer	596	Lipids/Cholesterol	2139
Death	274	Gastrointestinal	34
Cardiovascular	334	Body Weight/Body Mass Index	459
Respiratory	92	Reproductive	981
Dermal	14	Neuro	67
Renal/Urinary	222	Children/Developmental	318
Skeletal/Osteoporosis	55	Ocular/Eye	27

[7] ATSDR's *Toxicological Profile for Perfluoroalkyls* was in draft at the time of this assessment (version June 2018).
[8] ATSDR's *Toxicological Profile for Perfluoroalkyls* is inclusive of adult, maternal-fetal, and children and development health studies.

Table 2. Overview of the number of studies examining PFAS health effects

Health Effect	Number of Studies	Health Effect	Number of Studies
Death	6	Cardiovascular	26
Immunological	7	Cancer	22
Neurological	4	Body Weight/Body Mass Index	6
Musculoskeletal	6	Diabetes	22
Hematological	3	Thyroid	32
Gastrointestinal	4	Renal/Urinary	22
Respiratory	7	Liver/Hepatic enzymes	27
Reproductive/Female	18	Lipids/Cholesterol	30
Reproductive/Male	14	Maternal-Fetal and Children/Developmental*	239

*These categories were excluded from our review as this effort focused on military members and veterans

The types, quality, and number of epidemiologic studies do not support completing a meta-analysis for any of the reported health effects. While the decision not to do a meta-analysis was made on the studies within each health effect group, several concerns were common across the groups.

- Many of the studies identified exposure to only PFOA and/or PFOS, but EPA currently identifies over 600 PFAS compounds in commercial use.[9] Recent studies have addressed more PFAS compounds than PFOA and/or PFOS, but the number of compounds studied is limited, and across studies, there is considerable variation in the number of compounds studied. Thus, a meta-analysis for PFAS, as a class of compounds, cannot be accomplished.

- In addition, a meta-analysis for a single compound could be misleading due to the likely confounding effect by another PFAS.

- Exposure in many of the studies is determined by a one-time serum measurement without information on exposure duration or route. Serum levels cannot determine route, frequency, magnitude, or source of exposure; they provide a snapshot of exposure at the time of sample collection.

- In addition, several of the epidemiologic studies within health effects groups are not independent (i.e., they were conducted on the same population). A meta-analysis requires that studies in the analysis are independent of each other.

- Finally, many of the epidemiologic studies on PFAS are cross-sectional, which cannot, by their nature, demonstrate causal association (i.e., there is no specific information on historical exposures to illustrate cause followed by effect).

[9] EPA. PFAS Master List of PFAS Substances (Version 2). Available at: https://comptox.epa.gov/dashboard/chemical_lists/pfasmaster. (accessed on 9/2/2021)

Future health studies work by the ATSDR should be able to better identify whether environmentally-relevant exposures may result in adverse health effects.[10,11]

C. Health Study Findings

While the epidemiologic studies are not sufficient to support conducting a meta-analysis of PFAS, the data were sufficient to evaluate potential associations between certain PFAS and adverse health outcomes. Many of the epidemiologic studies are cross-sectional and cannot demonstrate causal association. The strength of these associations are based on whether a dose-response relationship is observed in a study and whether this relationship was consistent across studies. There was sufficient data from two general population studies to suggest that some PFAS compounds, including PFOA and PFOS, may decrease antibody response to vaccines. There is also evidence of an association between PFAS and hepatic (liver) enzymes, and some PFAS and increased serum lipid levels, particularly total cholesterol. These associations have been identified by others, included ATSDR.

IV. Estimated Number of Military Members and Veterans Potentially Exposed to PFAS (Task 2)

The second task under section 315(c) is to include "an estimate of the number of members of the Armed Forces and veterans who may have been exposed to PFAS while serving in the Armed Forces."

Exposure to PFAS is a national issue with a large percentage of the U.S. population being exposed to PFAS through a variety of means.[12] Exposure for members of the Armed Forces and veterans is likely to have occurred from several pathways, many of which are not associated with military-unique activities (e.g., food packaging, stain-resistant coatings on fabrics and carpets). Therefore, this assessment is based on an approach focused on likely routes of exposure related to service in the Armed Forces and associated military activities, and beyond exposures common to the general population. The analysis considered two exposure scenarios to estimate the number of current members and veterans of the Armed Services potentially exposed to PFAS while serving in the military. The analysis includes A) exposures to PFAS-impacted drinking water associated with military-related environmental releases and B) the occupational scenario most associated with potential PFAS exposures (use of AFFF by firefighters and related disciplines).

A. Environmental Exposure Pathway (Drinking Water)

As of December 31, 2019, 24 locations were identified where DoD was the drinking water purveyor,[13] and PFOS and/or PFOA water concentrations were above the EPA lifetime HA

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[10] ATSDR. Pease Study. Available at: https://www.atsdr.cdc.gov/pfas/activities/pease.html?CDC_AA_refVal=https%3A%2F%2Fwww.atsdr.cdc.gov%2Fpfas%2FPease-Study.html (accessed on 9/29/2020).

[11] ATSDR. Multi-site Health Study. Available at: https://www.atsdr.cdc.gov/pfas/activities/studies/multi-site.html (accessed on 9/20/2020).

[12] ATSDR. 2017. Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) in the US Population. August 21, 2017. https://www.atsdr.cdc.gov/pfas/docs/PFAS_in_People.pdf.

[13] Water Purveyor – responsible to supply drinking water to their customers

levels of 70 ppt.[14] To estimate the number of members of the Armed Forces potentially exposed to PFOS and/or PFOA-impacted water at these locations, information on the total population (e.g., military personnel, DoD civilian employees, contractor personnel, beneficiaries) served by these water distribution system(s) were evaluated. Each Military Service determines the population served by each of their drinking water distribution systems in the United States and in other countries. This information is maintained by the Services for all systems and included in the EPA's Safe Drinking Water Information System for U.S. locations.[15] Results from the evaluation indicate that these DoD drinking water distribution systems were able to serve approximately 175,000 people at the time when PFOS and/or PFOA levels exceeded the EPA lifetime HA. Therefore, the number of members of the Armed Forces who potentially consumed PFOS- and/or PFOA-impacted water would be a smaller subset of this population in any 1-year period.

B. Occupational Exposure Pathway (Firefighter and Related Disciplines)

Military occupational specialty (MOS) codes in the Army and Marine Corps, Air Force specialty codes, and ratings in the Navy and Coast Guard were used to estimate the number of firefighters and associated occupations that may have worked with AFFF and been exposed to PFAS. Two databases were used -- one included active duty members only and another included active duty, National Guard, and Reserve members. The average annual number of Active Duty members of the Armed Forces firefighters has been 14,400, since 1970 (ranging from 23,000 in 1971-1989 to less than 7,100 since 2006).[16]

There were approximately 74,000 Armed Forces firefighters and associated occupations from 1990 to 2019, including active duty, National Guard, and Reserve members.[17] Using this number, it is estimated that there were approximately 150,000 firefighters from 1971-1989 (including active duty, National Guard, and Reserves).[18] Therefore, we estimate that approximately 225,000 military firefighters and related disciplines have served in the Armed Forces since 1971 (150,000 from 1971-1989 plus 74,000 from 1990-2019), and potentially worked with AFFF. The actual percentage of these firefighters and related disciplines who worked with AFFF and exposure parameters (e.g., duration, frequency, and use-cases) are not known.

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[14] Two of these locations are in addition to those reported in the Office of the Under Secretary of Defense for Acquisition and Sustainment. Perfluorooctane Sulfonate and Perfluorooctanoic Acid on Military Installations. Report to Congress. May 2020. These include Chièvres Air Base / Caserne Daumerie (closed/vacated) and Naval Air Station Lakehurst (Joint Base McGuire-Dix-Lakehurst).

[15] EPA Safe Drinking Water Information System, https://www.epa.gov/enviro/sdwis-overview.

[16] Source: Defense Manpower Data Center (Number of Active Duty Armed Service members from 1971-2019).

[17] Source: Defense Medical Surveillance System (individual counts of firefighters and related disciplines).

[18] Estimate of Firefighters and Related Disciplines from 1971 to 1989.

- Step 1. 23,000 (avg. # firefighters 1971-1989) ÷ 7100 (avg. # firefighters 1990-2019) ≈ 3.2 x more firefighters per yr in 1971-1989 than 1990-2019.
- Step 2. **74,000 (# firefighters from 1990-2019)** / 30 yr ≈ 2470 avg. # new firefighters per yr from 1990-2019.
- Step 3. 3.2 (from Step 1) x 2470 avg # new firefighters per yr (Step 2) = 7900 (estimated avg annual change of new firefighters per yr for 1971-1989).
- Step 4. 7900 new firefighters/yr * 19 yr (1971-1989) ≈ **150,000 total firefighters from 1971-1989**.

The CDC's NIOSH is evaluating non-DoD civilian firefighters PFAS exposures from AFFF and potentially other sources (e.g., equipment). In addition, NIOSH and others are conducting literature searches and evaluating whether other occupational PFAS exposures should be further evaluated. This information, along with the current DoD firefighter PFAS blood testing effort under section 707 of the NDAA for FY 2020, may be useful in determining whether DoD firefighters have measureable occupational exposure to PFAS.

V. DoD and Department of Veterans Affairs PFAS Health-Related Information Sharing (Task 3)

The third task under section 315(c) is: "the development of a process that would facilitate the transfer between the DoD and the Department of Veterans Affairs (VA) of health information of individuals who served in the Armed Forces and may have been exposed to PFAS during such service."

Possible health effects related to PFAS exposure may not surface for many years due both to: 1) disease etiology and progression; and 2) levels of exposure from various PFAS sources over time (drinking water, food packaging, work-related, carpets, etc.). As a result, sharing exposure and health data captured during a Service member's career with the VA for future utilization is extremely important. Table 3 lists potential data elements that can be shared between DoD and VA to analyze PFAS exposure among Armed Forces members and veterans, and the data systems where the information is currently stored or may be stored in the future.

Table 3. Data elements possibly required for assessing PFAS exposure and health effects and their associated data systems

Data Element	Data System
Drinking water data (PFAS sampling results by installation/drinking water system location)	Defense Occupational and Environmental Health Readiness System - Industrial Hygiene (DOEHRS-IH) Environmental Health Module
Firefighter blood testing laboratory results (as required by NDAA for FY 2020)	Current: Armed Forces Health Longitudinal Technology Application (AHLTA), Future: Military Health System (MHS-GENESIS)
Relevant patient encounter data (e.g., occupational health exams, visits related to concerns of exposures and/or possibly related health effects) from Armed Forces and Veterans	Current: AHLTA/Composite Health Care System /Essentris®/(Veterans Information Systems and Technology Architecture) VistA, Future: DoD's MHS-GENESIS and VA's Electronic Health Record Modernization Program
Service Treatment Record (STR) data (separation history and physical examination, clinical evaluation, treatment)	Health Artifact and Image Management Solution
Occupational data (job title, MOS code)	Defense Manpower Data Center (DMDC)
Individual location	DMDC
Demographics	DMDC
Periodic Health Assessments and Pre- and Post-Deployment Health Assessments	Defense Medical Surveillance System (DMSS)
Blood serum specimens (1990 to present)	Department of Defense Serum Repository

Although data interoperability is a challenge for the DoD and VA because of the numerous disparate data systems (and paper records) that store exposure and health data, there are multiple existing processes and future initiatives that address this issue. The VA-DoD FY 2019-2021 Joint Strategic Plan[19] lists interoperability (seamless integration of VA and DoD data) and health care as two of our strategic goals. Within these strategic goals are objectives to enhance health data interoperability via electronic health record (EHR) modernization, provide individual exposure-related data and medical information, and enhance the exchange of personnel data between the VA and DoD to deliver comprehensive benefits and services. In order to achieve these objectives, initiatives including MHS-GENESIS (new EHR for MHS) and the Individual Longitudinal Exposure Record (ILER) are being developed, deployed, and utilized.

VI. Estimated Costs to Administer a Registry for PFAS Exposures (Task 4)

The fourth task under section 315(c) is to provide: "a description of the amount of funding that would be required to administer a potential registry of individuals who may have been exposed to PFAS while serving in the Armed Forces."

In order to estimate the funding required to administer a registry of individuals who may have been exposed to PFAS while serving in the Armed Forces, the most recent and relevant DoD and VA registries and other exposure notification programs were examined. These examples include the Airborne Hazard and Open Burn Pit Registry (AHOBPR), Operation Tomodachi Registry, Camp Lejeune Historic Drinking Water Notification Database, and the Chemical Warfare Agent in the Operation Iraqi Freedom Investigation. Lessons from these assessments indicate that registries need to integrate with the VA and DoD EHRs and DoD's DOEHRS-IH, DMSS/STR, DMDC, and ILER. Therefore, costs to develop a registry are contingent on these systems being maintained, enhanced, and linked.

The most recent VA environmental health registry—the AHOBPR—costs $1–2 million annually ($7.3 million for the first 5 years, 2014-2019) for implementation and maintenance (excluding costs for six to eight in-house staff working for 1 year), with approximately 60 percent of the costs coming from information technology (IT) development. The Camp Lejeune Notification Database currently has an annual contract for approximately $1 million (excluding costs for in-house IT support) and would have to be scaled up, since it supports only one installation. Other environmental health exposure registries developed by the CDC have cost between $3 million and $24 million for implementation and maintenance. Actual registry costs vary significantly based on the purpose of the registry and complexity of exposures.

Based on the cost of other environmental health exposure registries developed by the DoD and VA, a PFAS registry may cost approximately $1–2 million per year, with more substantial costs upfront.

Prior to determining whether a registry should be established and identifying associated costs, consideration should be given to the registry's purpose, intent, and whether it is achievable. Additionally, use of existing DoD data systems (Table 3) should be explored prior to building a new registry. Whether a registry is developed for PFAS or not, the DoD (and VA) should continue to support the sustainment and advancement of the systems outlined in Table 3. These

[19] VA-DoD, 2019. Department of Veterans Affairs and Department of Defense Joint Executive Committee Joint Strategic Plan, Fiscal Years 2019-2021.

systems will have a role in exposure assessments and may, someday, obviate the need for separate registries.

VII. Conclusion

DoD is committed to the health and safety of its Service members, their families, and civilian personnel, and to proactively taking action to reduce the potential risks of PFAS from DoD activities. Beginning in October 2020, blood testing for PFAS is offered to all DoD firefighters as part of their annual occupational exam. PFAS drinking water sampling results from DoD installations are included into DOEHRS-IH for current and future access. DoD is actively researching PFAS-free alternatives to AFFF, and limiting AFFF usage to emergencies or land-based training if completely contained and properly disposed. DoD will work with and incorporate information from our federal partners and others to anticipate and evaluate exposures and potential health effects associated with PFAS.

VIII. List of Acronyms

Acronym	Definition
AFFF	Aqueous Film Forming Foam
AHOBPR	Airborne Hazards and Open Burn Pit Registry
ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Centers for Disease Control and Prevention
DMDC	Defense Manpower Data Center
DMSS	Defense Medical Surveillance System
DoD	Department of Defense
DOEHRS-IH	Defense Occupational and Environmental Health Readiness System – Industrial Hygiene
EHR	Electronic Health Record
EPA	Environmental Protection Agency
FY	Fiscal Year
HA	Health Advisory
HHS	Department of Health and Human Services
ILER	Individual Longitudinal Exposure Record
IT	information technology
MHS	Military Health System
MOS	Military Occupational Specialty
NCEH	National Center for Environmental Health
NDAA	National Defense Authorization Act
NIOSH	National Institute for Occupational Safety & Health
PFAS	Poly- and Perfluoroalkyl Substances
PFOA	Polyfluorooctanoic Acid
PFOS	Polyfluorooctane Sulfonate
ppt	parts per trillion
STR	Service Treatment Record
VA	Department of Veterans Affairs