DoD Occupational Medicine Provider Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) Factsheet: A Guide for Department of Defense Occupational Medicine Providers Evaluating DoD Firefighters

Introduction

Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) refer to a large and complex class of man-made fluorinated chemicals found in many consumer products, as well as in industrial products such as certain firefighting foam called aqueous film forming foam (AFFF). In consumer products, PFAS are used to keep food from sticking to cookware, as a barrier to grease in food packaging, and to make products (such as sofas, carpets, clothes, and mattresses) stain- and water-resistant. PFAS are also used in the aerospace, automotive, construction, and electronics industries to reduce friction and to provide heat and chemical resistant electrical insulation. PFAS are not uniquely attributable to Department of Defense (DoD) activities.

In the 1970s, the DoD began using AFFF fire suppressants containing PFAS. Because PFAS are resistant to degradation by chemical and heat, these AFFF formulations are able to quickly extinguish petroleum-based liquid fuel (i.e., jet fuel) fires, and prevent their re-ignition, saving lives, materials, and vessels. The DoD has sharply curtailed the use of AFFF and currently, only uses AFFF in firefighting emergencies or where AFFF can be completely captured and properly disposed. Additionally, DoD has invested significant resources in research to identify PFAS-free substitutes for AFFF and has started to transition and replace AFFF with PFAS-free alternatives at military installations.

Firefighters may also be exposed to PFAS from sources other than AFFF-containing PFAS. These sources may include protective clothing containing PFAS, such as turnout gear, as well as PFAS released into the air as part of any type or class of fire. The National Fire Protection Association, interagencies (including the DoD), and others are working to find adequate replacements for PFAS in the materials used to make firefighter protective ensembles, including clothing.

People are exposed to PFAS through a variety of exposure routes. Ingestion is the primary exposure route for PFAS, such as through the consumption of foods and/or drinking water that has been impacted with PFAS. While inhalation is not typically an exposure route for the general population, occupational exposures to PFAS can occur from the inhalation of aerosols and particulates containing PFAS. However, more research is needed to understand the magnitude of exposures that occur from inhalation compared to other exposure routes. Absorption through the skin is not thought to be a significant exposure route for humans according to the Centers for Disease Control and Prevention's (CDC) Agency for Toxic Substances and Disease Registry (ATSDR). Additional information about exposures to PFAS can be found on the ATSDR website ("How can I be exposed?") at https://atsdr.cdc.gov/pfas/index.html.

Many PFAS compounds don't break down readily in the environment or in the body because of the unique chemistry of the carbon-fluoride bonds. As a result, PFAS tend to be very persistent in the environment, and have very long half-lives within the human body. In the body, PFAS can act like fatty acids, but unlike fatty acids, they are not readily metabolized. As a consequence of biological mechanisms in the body that reabsorb fatty acids from the gut and urine, PFAS tend to be reabsorbed back into the body, resulting in very slow elimination rates and very long half-lives. Many PFAS preferentially accumulate in blood bound to blood proteins and preferentially blood albumin, which makes blood PFAS analyses a very useful measure of an individual's total body burden that reflects their exposure to PFAS. Blood samples analyzed and collected by the CDC found that nearly every person tested in the United States has certain PFAS in their blood.

The CDC is conducting a large research effort to determine whether there are potential adverse health outcomes associated with blood PFAS levels in people.

Health Effects

Research over the last 30 years has not determined a causal link between PFAS exposure and any clinically relevant adverse health outcome. A large number of studies have examined the possible relationship between blood PFAS levels in people and the incidence and severity of adverse health effects, of which, the majority of these studies were focused on perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), and many involved mixtures of PFAS. Results from some of these studies have suggested an association between high levels of exposure to certain PFAS and the following health outcomes:

- Increased cholesterol levels
- Changes in liver enzymes
- Decreased antibody response to some vaccines
- Increased risk of high blood pressure and/or pre-eclampsia in pregnant women
- Small decreases in infant birth weight
- Increased risk of kidney cancer and testicular cancer

At this time, scientists are studying the relationship between PFAS and certain health effects and health officials have not established health-based screening levels for PFAS in blood. Additional information concerning PFAS health effects can be found on the ATSDR website at: https://atsdr.cdc.gov/pfas/health-effects/index.html

Why are Occupational Medicine providers testing DoD firefighters for PFAS?

The National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2020 requires DoD to offer and provide blood testing for PFAS to all DoD firefighters beginning October 1, 2020. Currently, blood PFAS testing is offered to DoD firefighters during their annual

occupational medicine examination, to newly hired DoD firefighters in order to establish a baseline blood PFAS level in firefighters, and to other DoD personnel who perform firefighting duties as part of their job assignment (e.g., Navy damage control officers) as required by Section 707 of the NDAA for FY 2020 (Public Law 116-92) (DoDM 6055.05). This testing is not part of the occupational medical qualification or medical surveillance program, rather, it is a congressionally mandated offer to assess the PFAS exposure of DoD firefighters. This is not a mandatory test and will not result in any adverse action if a DoD firefighter chooses not to have their blood tested for PFAS.

The following PFAS compounds are associated with AFFF, specified in DoDM 6055.05, "Occupational Medical Examinations: Medical Surveillance and Medical Qualification," and will be quantitatively assessed in firefighter blood samples using an analytical methodology similar to that used by the CDC:

Target PFAS Analytes:
- perfluorodecanoic acid (PFDA)
- perfluoroundecanoic acid (PFUnDA or PUFA)
- perfluoroheptanesulfonic acid (PFHpS)
- perfluorohexanesulfonic acid (PFHxS)
- perfluorohexanoic acid (PFHxA)
- perfluorononanoic acid (PFNA)
- perfluorooctanoic acid - linear isomer (n-PFOA)
- perfluorooctanoic acid - branched isomers (Sb-PFOA)
- total PFOA (linear and branched PFOA isomers)
- perfluorooctane sulfonate – linear isomer (n-PFOS)
- perfluorooctane sulfonate - branched isomers (Sm-PFOS)
- total PFOS (linear and branched PFOS isomers)
- 2-(N-methylperfluorooctane sulfonamido) acetic acid (MeFOSAA)
- dodecafluoro-3H-4,8-dioxanoate (ADONA)
- perfluorododecanoic acid (PFDoDA)

The current procedures for performing periodic (annual) occupational medical examinations for DoD firefighters (civilian and military) are found in DoD Manual 6055.05, "Occupational Medical Examinations: Medical Surveillance and Medical Qualification."

How do Occupational Medicine providers test for PFAS?
The DoD convened a tri-service group of clinical and environmental chemists for the purpose of determining PFAS testing guidance and standards applicable to testing PFAS levels in DoD firefighter blood and blood serum samples. The Quality Assurance Project Plan (QAPP) for clinical analyses of all target PFAS analytes describes the analytical methodology, performance standards, and quality assurance and control processes that a Clinical Laboratory Improvement Amendments (CLIA) certified laboratory must follow in order to report the level of PFAS in firefighter blood. Currently, all DoD contract lab(s) providing clinical analytical analyses of blood, or blood serum,

must adhere to these standards. The result of these analytical analyses are included in the firefighter's medical records.

The clinical procedure, briefly, is as follows: a 1 mL whole blood sample will be obtained in an ethylenediaminetetraacetic acid (EDTA; lavender-top) tube, which can be refrigerated or kept at room temperature for transportation. The sample will be sent to the nearest CLIA-certified reference lab capable of performing the analytical analysis of the sample for PFAS. Contact the reference lab and installation/Military Treatment Facility resource management office for ordering and billing information.

What does the Occupational Medicine Provider do with the results?
The occupational medicine provider is expected to review and convey the results to the individual employee and answer the employee's questions related to PFAS exposure. The information below will help guide the provider's interaction with the firefighter. More detailed talking points addressing particular situations are under development and will be provided to the OM enterprise for use once completed.

- CDC data indicate that over 98% of all Americans tested have detectable levels of some PFAS in their blood. There is no single or combined level of PFAS in blood at which any health effect is known to occur in humans. An individual's blood PFAS levels cannot be used to identify the date of exposure, magnitude, frequency, or the source of exposures or be used to determine the likelihood of developing any health effect. This is because there are currently no established health-based reference levels for PFAS in whole blood, blood plasma, or blood serum. The test for PFAS in blood simply determines how much of each PFAS compound is in the blood, representing a historical accumulation of PFAS compounds from multiple exposures and multiple sources.

- For individuals with historical or ongoing exposures to PFAS, there is insufficient evidence at this time to deviate from established standards of medical care. For personnel with signs or symptoms of disease, occupational medicine providers should advise these individuals to follow up with their personal healthcare provider who should use the same established standards of medical care they would use for an individual who did not have occupational exposure to PFAS.

Where can I find reference blood PFAS levels to compare with firefighter results?
The CDC has been measuring certain PFAS in the general population for nearly 25 years. Their results are reported in the National Health and Nutrition Examination Survey (NHANES). These blood PFAS levels are reflective of nearly 2000 individuals sampled annually who are between 12 and 65 years of age. The CDC monitors 12 or more PFAS compounds in the blood of survey participants, publishing the results annually. CDC scientists found four PFAS (PFOS, PFOA, PFHxS, and PFNA) in the blood of nearly all of the people tested, indicating widespread accumulation of these PFAS in the U.S. population (ATSDR PFAS Information for Clinicians: Factsheet). Data tables showing blood PFAS results in the general population, since 1999, can be viewed at: https://www.cdc.gov/exposurereport/.

What do the results of the blood test mean regarding PFAS exposure?

An individual's exposure to PFAS from all sources is best determined by analysis of a blood sample. There are currently no established health-based reference levels for PFAS in whole blood, blood plasma, or blood serum. The test for PFAS in blood simply determines how much of each PFAS compound is in the blood and represents a historical accumulation of PFAS compounds from multiple exposures and multiple sources.

Additional information about exposures to PFAS can be found on ATSDR's website ("How can I be exposed?") at https://atsdr.cdc.gov/pfas/health-effects/exposure.html.

What does it mean if PFAS is detected in a blood test?
It means a person has been exposed to PFAS in the past. Even if the source of exposure is removed, it can take years for the human body to fully eliminate PFAS. Scientists are studying the relationship between PFAS and certain health effects and health officials have not established health-based screening levels for PFAS in blood.

Currently, there is no clinically proven means of reducing an individual's detected blood PFAS levels. People who experience any signs or symptoms of any disease or illness should follow up with their healthcare providers for a medical evaluation. The healthcare provider should treat the individual using established standards of medical care regardless of whether that individual has elevated blood PFAS levels.

How can an individual reduce future exposure to PFAS?
PFAS are present at low levels in some food products and in the environment, so one probably cannot prevent all PFAS exposure. Strategies for reducing individual exposures to PFAS are described on the ATSDR website at: https://www.atsdr.cdc.gov/pfas/pfas-exposure.html.

Individuals in occupational settings with potential PFAS exposure should follow their industrial hygienist's guidance to reduce or eliminate potential exposure. For firefighters, the proper use of protective ensembles (e.g., protective clothing, gloves, boots, self-contained breathing apparatus) will reduce their exposure to PFAS.

The DoD has taken several actions to minimize the potential for occupational exposure to PFAS in AFFF by limiting AFFF use outside of emergency firefighting and replacing AFFF with PFAS-free alternatives at military installations. The National Fire Protection Association, interagencies (including the DoD), and others are working to find adequate replacements for PFAS in the materials used to make firefighter protective ensembles, including clothing.

References and Additional Resources

Agency for Toxic Substances and Disease Registry. *An Overview of the Science and Guidance for Clinicians PFAS on Per- and Polyfluoroalkyl Substances (PFAS)*. US Department of Health and Human Services. Available at: https://www.atsdr.cdc.gov/pfas/index.html

Agency for Toxic Substances and Disease Registry. *PFAS Information for Clinicians*. January 18, 2024. Available at: https://www.atsdr.cdc.gov/pfas/docs/PFAS-info-for-clinicians-508.pdf

Agency for Toxic Substances and Disease Registry. *ToxFAQs™ for Perfluoroalkyls*. U.S. Department of Health and Human Services. Available at: https://www.atsdr.cdc.gov/toxfaqs/TF.asp?id=1116&tid=237#bookmark09

Defense Health Agency PFAS Website: https://www.health.mil/Military-Health-Topics/Health-Readiness/Public-Health/PFAS

Department of Defense Manual 6055.05, *Occupational Medical Examinations: Medical Surveillance and Medical Qualification*. April 5, 2024. Available at: https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodm/605505m.PDF?ver=ag9MtySOX5CzK9HYHfkh3g%3D%3D.

Department of Defense PFAS Website: https://www.acq.osd.mil/eie/eer/ecc/pfas/index.html

Environmental Protection Agency. *Per- and Polyfluorinated Substances (PFAS).* Available at: https://www.epa.gov/pfas

Food and Drug Administration Per and Polyfluoroalkyl Substances (PFAS) Website, U.S. Department of Health and Human Services. Available at: https://www.fda.gov/food/chemicals/and-polyfluoroalkyl-substances-pfas

National Defense Authorization Act for Fiscal Year 2020. Conference Report. Available at: https://docs.house.gov/billsthisweek/20191209/CRPT-116hrpt333.pdf

National Center for Health Statistics. *National Health and Nutrition Examination Survey, 2017-2020. Perfluoroalkyl and Polyfluoroalkyl (PFAS_I).* Centers for Disease Control and Prevention. Published May 2024. Available at: https://wwwn.cdc.gov/Nchs/Nhanes/2017-2018/P_PFAS.htm