EPA Federal Facilities Superfund Program – RPM Bulletin 2023 - 02
Considerations for PFAS Source Area Investigations

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Purpose:

The purpose of this document is to provide assistance to United States Environmental Protection Agency (EPA) Remedial Project Managers (RPMs) when reviewing per- and polyfluoroalkyl substances (PFAS) Remedial Investigation (RI) Quality Assurance Project Plans (QAPPs) at Federal Facility Superfund sites. The Conceptual Site Model (CSM) needs to account for all sources that are relevant to the site, and not just aqueous film forming foam (AFFF) releases. This document identifies additional source areas to consider during the early stages of a PFAS RI. Even if only AFFF source areas are investigated during the Phase I RI, all source areas should be included in the CSM and subsequent source area investigations need to be completed under subsequent RI phases rather than going back to the Preliminary Assessment/Site Inspection (PA/SI) phase.

Existing Guidance:

EPA.1998. *Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.* EPA/540G-89/004. OSWER Directive 9355.3-01 October. (https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=10001VGY.txt)

EPA, 2018. *Smart Scoping for Environmental Investigations, Technical Guide.* EPA 542-G-18-04. November 2018. (https://semspub.epa.gov/work/HQ/100001799.pdf)

Summary:

1. It is well-documented that both AFFF and non-AFFF sources contribute to PFAS contamination at Federal Facilities. All known and potential PFAS sources should be documented in the CSM.
2. Documenting all known and potential PFAS sources in the CSM does not mean that all sources are high priority and must be investigated now, rather a complete CSM allows for triage and prioritization, and facilitates tracking of work over the course of site activities.
3. The lack of documentation of PFAS use is not sufficient to rule out a site for further investigation. PFAS chemicals are generally not listed on Safety Data Sheets (SDS), or other product inserts but are known to have been used in a variety of products and processes (Gaines, 2022; Gluge et al., 2020; ITRC 2022).
4. The PA/SI framework can be helpful when investigating non-AFFF source areas. However, for a site listed on the National Priorities List (NPL), it is inconsistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulations and Agency RI guidance to go back to the PA/SI stage to investigate additional source areas or new contaminants within the site.
5. Other Federal Agencies (OFAs) have made a variety of public commitments to investigate all sources of PFAS at their facilities. EPA reviewers can use these

commitments, and a variety of other strategies, to hold OFAs accountable for documenting all known and potential PFAS sources in the CSM.

Background:

The science surrounding per- and polyfluoroalkyl substances (PFAS) is still evolving, especially in the fields of health and human toxicity, and environmental effects. PFAS are highly soluble in water, typically present as anions (conjugate base) in solution and have very low volatility due to their ionic nature. Long chain PFAS have low vapor pressure, and aquatic environments are expected to be their primary sink in the environment. They are thermally, chemically, and biologically stable and are resistant to biodegradation, atmospheric photooxidation, direct photolysis, and hydrolysis. The structure of these compounds increases their resistance to degradation: the carbon-fluorine bonds require a lot of energy to break, and the fluorine atoms shield the carbon backbone. Terminal degradation products, such as perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS), do not readily degrade by natural processes.

The complexity and variety of PFAS makes it difficult to evaluate field data and determine the source of the PFAS release. Proprietary mixtures used in manufacturing, fire-fighting, and industrial processes may vary (Gaines, 2022). The "Poly" members of the family transform in the environment (Sepulvedo et al., 2011). For instance, the PFAS in groundwater may be different than the PFAS used in the electroplating bath that caused the release to the groundwater (Sepulvedo et al., 2011). In some cases, it may only be possible to make a rough forensic determination about whether the PFAS in the environment originated from an AFFF-source or a non-AFFF source (Toren et al., 2020; Toren et al., 2021). However, it's also important to note that even that distinction could be complicated. For instance, the compositions of PFAS detected in the environment seldom look like the original formulation released into the environment at a site, and the farther from the source that samples are detected, the more unlike the original formulation they often are observed to be (Toren et al., 2021). As researchers work to enhance our understanding of the chemical properties that may one day enable forensic identification of source areas, we need to encourage Federal Facilities to investigate multiple types of operations that may have caused PFAS releases.

Despite the many operations and activities that may have contributed to PFAS contamination at a Facility, some Facilities focus their PFAS investigation on a few, targeted locations, like fire training areas where AFFF may have been released. Potential PFAS sources may not be obvious at a Facility. For example, maintenance shops may be a source area because PFAS is a hydraulic fluids additive in aviation and aerospace, corrosion protection, lubrication, batteries, degreasers, strippers, and other cleaning products (Gaines, 2022; Gluge et al., 2020). In many cases the Federal Facility ruled out, prior to RI Scoping, more obvious source areas based on lack of documentation of PFAS as an ingredient in a formulation. PFAS has been used in many products from the mid-40's to present but may not be listed as an ingredient. For example, EPA has reviewed Department of Defense (DoD) Facility PA/SIs that rule out landfills and metalworking shops because there is no documentation of PFAS use. The lack of documentation of PFAS disposal or use is not sufficient to rule out a site for further investigation because PFAS chemicals are generally not listed on Safety Data Sheets (SDS) or other product inserts. Instead, it is recommended to rely on multiple lines of evidence (e.g., interviews, spill reports, purchase records) and peer-reviewed published data that documents PFAS use in certain processes and products, such as those provided in the References Section at the end of this Bulletin. Some of the references also identify the years when certain PFAS chemicals may have been used for specific processes and activities that took place on Federal Facilities.

Many DoD Facility PFAS RI Work Plans submitted to the EPA continue to focus on AFFF releases and storage areas as the main source of PFAS in the environment. In some instances, early scoping (e.g., Preliminary Assessment/Site Investigation or PA/SI) did not appropriately consider non-AFFF potential sources. EPA maintains that all potential sources of PFAS contamination should be identified and/or addressed during the initial investigation. While AFFF may be a major source at many Federal Facilities, focusing solely on this one source may cause incomplete characterization of the nature and extent of contamination and other inadequacies in RIs, Feasibility Studies and Records of Decision. In general, available PFAS toxicity values may lead to very low screening levels, triggers for action and response goals (e.g., parts per trillion in current and potential future drinking water), therefore, relatively small releases of PFAS can result in actionable concentrations. Documenting all known and potential sources in the CSM does not mean that all sources are high priority and must be fully delineated and assessed for risk now, rather a complete CSM still allows for triage and prioritization and facilitates tracking of conformational sampling work over-time (EPA, 2018).

Within the past few years, and as required by the National Defense Authorization Act (NDAA), DoD has used the PA/SI framework to investigate AFFF releases on their installations. The Air Force recently released a Performance Works Statement to use the PA framework to investigate non-AFFF sources of PFAS at over 100 instillations nationwide. In some instances, Navy Facilities have conducted investigations that included non-AFFF releases. The Department of Energy (DoE) released their PFAS Roadmap in August 2022 (DoE, 2022a) which commits to an initial assessment of PFAS sources at DoE facilities and a guidance on current and historical uses of PFAS. In November 2022, DoE released its initial assessment which included PFAS uses unique to DoE, such as Cold War era liquid waste discharges, Manhattan Project liquid discharges, uranium enrichment activities, and plutonium production activities (DOE, 2022b). Many PFAS sources at DoE facilities are similar to DoD facilities, such as AFFF use, metal plating, wastewater treatment plants, and landfills.

The tables below include a variety of source area types that may be found at a Federal Facility. EPA PFAS specialists prioritized potential Federal Facilities source areas based on volume of release, dispersive uses, concentrated waste disposal, and likelihood to have occurred at Facilities. Other criteria include potential for offsite migration and what human and ecological receptors may be present, especially where Environmental Justice concerns exist. It is important to research the time period when these types of facilities were used, and what the waste disposal practices may have been. Table 1 includes sources of PFAS that EPA would support being investigated at earlier phases of the RI process. Table 2 identifies potential sources of PFAS that should be considered and EPA would support being investigated at later stages of the RI process.

Table 1: Priority PFAS Source Areas at Federal Facilities

PFAS Source Areas	Function of PFAS	Types of PFAS	Reference
Areas where AFFF was used, stored, spilled, or disposed, including but not limited to: buildings, hangars, pipelines and gas station fire suppression systems; hose and nozzle rinse and drying areas; crash sites; miscellaneous fire sites (e.g., vehicle, building, dumpsters); runways; fire response vehicle and tank refilling locations; drum washing locations [e.g., Defense Reutilization and Marketing Office (DRMO) sites]; vehicle washing locations, burn pits; and intersections near fire stations	AFFF is used to extinguish hydrocarbon fires by lowering the surface tension of water AFFF was used to wash cars and trucks at car washes and automobile hobby shops at military installations	PFOA, PFOS, PFHxS, fluorotelomers (6:2 FTSA), TFA, PFPrA, TFMS, PFEtS, PFPrS other PFAS	Bjornsdottor, et al., 2019; DoE 2022b; EPA, 2021; Gaines, 2022; Gluge et al., 2020; NAVFAC, 2020; Putman, 2018
Maintenance Shops: Chrome, nickel, copper, tin, and zinc/zinc alloy metal plating, anodizing, and finishing, metal/glass etching and electroless plating	Used in fume suppressants, surfactants, wetting agents	PFSA, PFOS, fluorotelomers, chlorinated PFESAs, other PFAS	DoE, 2022b; EPA, 2021; Gaines, 2022; Gluge et al, 2020
Munitions areas • Target Areas & Skeet Ranges • Munitions test areas • Munitions fill/maintenance shops • OB/OD sites	▪ Historical DoD lubricant for use with ammunition contained a 20 percent(%) fluorocarbon telomer dispersion in 1,1,2-trichloro-1,2,2-trifluoroethane. ▪ Fillers and binders in flares and/or illumination rounds, explosives, propellants, munitions, and munitions components (including hexahydro-1,3,5-trinitro-1,3,5-triazine or RDX) ▪ Enabled long-term storage	PTFE, fluoropolymers, Viton, PFCAs, PCTFE other PFAS	DoE 2022a; DoE 2022b; Office of the Undersecretary of Defense for Acquisition and Sustainment, 2022

Table 1: Priority PFAS Source Areas at Federal Facilities

PFAS Source Areas	Function of PFAS	Types of PFAS	Reference
Landfills and dump sites, construction and demolition and industrial landfills, munitions and medical dump sites	Landfills and historic dump sites may contain a wide range of PFAS-containing materials (e.g., disposed AFFF, concrete, roofing materials, medical supplies, sewage/industrial sludge, treated paper, inks, plastics, rubber, resins, various filters, solvents and lubricants). Over time, the PFAS from the disposed items may leach to the landfill's underlying soil and groundwater	PFOS, PFOA, PTFE, PFCAs, TFA, TFMS, PFPrA, other PFAS	Bjornsdotter et al., 2019; Doe, 2022b; Gaines, 2022; Gluge et al., 2020
Domestic and industrial wastewater treatment plants, sludge drying beds, waste stabilization ponds, and associated sumps and drainage ditches	Facility may have multiple standalone units along with the primary plant that received industrial wastewater which contained PFAS	Precursors, PFCAs, and short-chain PFAS, especially PFBA, PFPeA, and PFHxA. Other PFAS possible, depending upon the source of the wastewater and age of the release.	DoD, 2022b; EPA, 2021; Mendez et al., 2022; Weber et al., 2017
Biosolids disposal and land application sites	Activated sludge may accumulate PFAS from wastewater, may later be land disposed (onsite and/or off-site locations) and leach PFAS or be taken up by agricultural products	PFOS, MeFOSAA, EtFOSAA, PFOA, and other PFAS	Sepulvado et al, 2011

PFAS Acronyms:

EtFOSAA 2-(N-ethylperfluorooctane sulfonamido) acetic acid (EtFOSAA)

MeFOSAA 2-(N-methylperfluorooctane sulfonamido) acetic acid

PCTFE Polychlorotrifluoroethylene

PFAS per- and polyfluoroalkyl substances

PFBS per- and polyfluoroalkyl substances

PFCA perfluorocarboxylic acid

PFESA perfluoroalkyl ether sulfonic acid

PFEtS perfluoroethane sulfonic acid

PFHxS perfluorohexanesulfonic acid

PFOA perfluorooctanoic acid

PFOS perfluorooctane sulfonic acid

PFPrA Perfluoropropanoic acid

PFPrS perfluoroethane sulfonic acid

PFSA perfluoroalkane sulfonic acid

PTFE Polytetrafluoroethylene

TFA Trifluoroacetic acid

TFMS trifluoromethane sulfonic acid

Table 2: Other Likely PFAS Source Areas at Federal Facilities

PFAS Source Areas	Function of PFAS	Types of PFAS	Reference
Textile coatings applied at the instillation	Finishing agents for textiles, including use in firefighting protective clothing and waterproofing tents/fabrics	Fluorotelomers, fluoropolymers	EPA, 2021; Gluge et al., 2020
Maintenance Shops and Hangars	Hydraulic fluids additive in aviation and aerospace. Corrosion protection, lubrication	Anionic PFAS with a sulfonic group	Gluge et al., 2020
Maintenance Shops: Auto, aviation, and battery shops	Films and electrolytes in batteries and fuel cells. Lubricants. Solvents. Degreasers, strippers, and other cleaning products	PFSA, PTFE, hydrofluoroethers, other PFAS	Gaines, 2022
Maintenance Shops: Electronics manufacture, testing, or repair; welding operations	Heat transfer fluids/cooling agents, cleaning solutions, lubricants. Cured epoxy resins are removed from integrated circuit modules by solutions containing PFAS. PFAS are used in low-foaming noncorrosive wetting agents for soldering electrical parts, cleaning components and repelling of moisture and oils	PFOA, PFSA, other PFAS	Gaines, 2022; Gluge et al., 2020
Areas where paint was applied or rinsed such as paint shops or paint booths, or where paint was disposed	PFAS was used in paints as an emulsifier, dispersant, and finishing agent to enhance protective properties of anticorrosive paints, improve surface appearance, antifouling, and create and oil-water repellency	fluoropolymers	Gluge et al., 2020
Car and vehicle wash facilities	Tanks may have held cleaning products with surfactants containing PFAS. PFAS also used in a variety of cleaning products to enhance wettability. Various functions within car parts, fluids, waxes and polishes	Multiple types of PFAS	Gaines, 2022; Gluge et al., 2020; Putnam, 2018
Pesticide storage, mixing, disposal, and/or spill areas	Active PFAS ingredients were added to kill the intended pest. Inactive PFAS ingredients helped the active ingredient get to or stay on the surface being protected. PFAS may have been used as inert surfactants in pesticide products.	Multiple types of PFAS, including PFPAs, PFAS polymers, and fluorotelomers	Gaines, 2022
Dry Cleaning Facilities	Replacement for tetrachloroethene-based systems	hydrofluoroethers, other PFAS mixes	Gaines, 2022

Table 2: Other Likely PFAS Source Areas at Federal Facilities

PFAS Source Areas	Function of PFAS	Types of PFAS	Reference
Facility-wide: Transformers, equipment rooms with large electronic equipment, server rooms	PFAS containing products can be used on numerous types of electronic equipment found within a Facility. U.S. Department of Energy reported the use of PFAS as a dielectric fluid (heat-transfer) in high power transformers and capacitors	Multiple types of PFAS	Gaines, 2022
DoE Sites: Uranium enrichment, plutonium production, gaseous diffusion plant construction/process equipment/lubricants, and Manhattan Project and Cold-War era operations	PFAS were first produced on an industrial scale for use in uranium separation activities during the Manhattan Project	PFDeA, PFUA, PFBS, PFHpA, PFHxS, PFHxA, PFNA, PFOS, PFOA	DoE, 2022b; Gaines, 2022
Research and development laboratories	DoE has detected PFAS at their labs around the country. General laboratory work at any federal facility may have used products containing PFAS	Multiple types of PFAS	DoE, 2022b; Gaines, 2022

PFAS Acronyms:

EtFOSAA 2-(N-ethylperfluorooctane sulfonamido) acetic acid (EtFOSAA)

MeFOSAA 2-(N-methylperfluorooctane sulfonamido) acetic acid

PCTFE Polychlorotrifluoroethylene

PFPA perfluoroalkyl phosphonic acids

PFAS per- and polyfluoroalkyl substances

PFBS per- and polyfluoroalkyl substances

PFCA perfluorocarboxylic acid

PFDeA perfluorodecanoic acid

PFESA perfluoroalkyl ether sulfonic acid

PFEtS perfluoroethane sulfonic acid

PFHpA Perfluoroheptanoic acid

PFHxS perfluorohexanesulfonic acid

PFNA Perfluorononanoic acid

PFOA perfluorooctanoic acid

PFOS perfluorooctane sulfonic acid

PFPrA Perfluoropropanoic acid

PFPrS perfluoroethane sulfonic acid

PFSA perfluoroalkane sulfonic acid

PTFE Polytetrafluoroethylene

PFUA Perfluoroundecanoic acid

TFA Trifluoroacetic acid

TFMS trifluoromethane sulfonic acid

Expectations for PFAS Investigations:

EPA comments provided to the other federal agency (OFA) on the scope of a PFAS investigation workplan or PFAS investigation report should address the need for the OFA to follow the CERCLA process. The OFAs as the lead agency are required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP 300.430(d)), EPA Guidance (EPA, 1998), and the Federal Facilities Agreements to carry out a RI that adequately characterizes the site for the purpose of developing and evaluating effective remedial alternatives, including no further action. Emphasize the need to work with EPA and state regulators to prioritize sources and plan to address lower priority sources.

EPA can also remind the OFA of the commitments made by their agencies. The OFA likely has issued policies regarding PFAS investigations. RPMs can request or seek out these statements to reinforce expectations. Because the majority of NPL sites are under either DoD or DoE, those statements are discussed in greater detail below.

The Office of Secretary of Defense (OSD) has issued a variety of policies regarding PFAS investigations and response actions at DoD facilities. OSD policies as well as those of each Department can be found at the DoD Environment, Safety and Occupational Health Network and Information Exchange website (DoD, 2024).

A recent DoD report from their Office of the Inspector General supports the recommendation to focus more broadly on all PFAS sources, noting that due to the exclusive focus on AFFF, "…a major source of potential PFAS exposure, and not on all sources of potential PFAS exposure... people and the environment may continue to be exposed to preventable risks" and recommends that DoD address potential exposures to PFAS from sources other than AFFF (DoD, OIG, 2021) During a December 2021 hearing, Deputy Assistant Secretary of Defense, Richard Kidd, testified to Congress that, "While the IG [Inspector General] Report encourages DoD to look at sources more broadly than AFFF, we already address all DoD sources of PFAS releases to groundwater under our cleanup program." (Kidd, 2021). DoD's PFAS 101 website commits to investigating non-AFFF source areas and following the CERCLA process during PFAS investigations, (DoD, 2022a) including at Base Realignment and Closure (BRAC) sites (Gluge et al., 2020).

In August 2022, DoE released their PFAS Strategic Roadmap which outlines their approach, goals, objectives, and planned actions from 2022 to 2025 (DoE, 2022a). On November 22, 2022, DoE released their Initial Assessment of PFAS at DoE sites (DoE, 2022b). The Roadmap commits to publishing a report of all known historic and current uses of PFAS at DoE facilities by December 30, 2022 with a guidance for further investigation by September 30, 2023.

Actions and Options for EPA Reviewers:

1. One approach is to request that the QAPP clearly documents what sources are included in the scope of the RI, and what are not (and why). EPA reviewers should document for the record the known or potential sources that have been excluded in the QAPP and request prioritization of source areas.

2. Emphasize the need for a comprehensive risk assessment during the PFAS RI. EPA cannot consider the PFAS RI complete until all sources of PFAS and co-contaminants are identified across exposure scenarios.
3. Where an OFA is currently conducting a non-PFAS investigation or action(s) in parts of the site that could potentially contain a PFAS Source Area, it may be necessary to evaluate PFAS before considering CERCLA decision points final. If the site is close to determining UU/UE or Construction Complete, PFAS Source Areas need to be evaluated in that media and location prior to decision making.
    a. At sites with ongoing response actions that are well established, in an operation and maintenance phase, any impacts to the fate and transport of PFAS or risks from PFAS exposures needs to be evaluated in conjunction with any co-contaminants that may be present. In this instance, PFAS can be placed in a separate operable unit to keep ongoing actions moving forward.
    b. At sites where the remedial investigation, feasibility study, record of decision, etc. have not been put in place, risks from PFAS exposures needs to be evaluated in conjunction with any co-contaminants that may be present before finalizing any CERCLA decision.
4. EPA reviewers should request that the CSM include all potential source areas and co-occurring contaminants (PFAS and non-PFAS). Strategies for identifying source areas at a Federal Facility include:
    a. Conduct soil sampling at known source areas to determine if current Regional Screening Levels (RSLs) have been exceeded.
    b. Request that the OFA sample all existing monitoring wells on an installation for PFAS. Conduct extensive groundwater sampling of all monitoring wells at all depths to help strategize how to investigate nature and extent in another source area.
    c. If sampling all monitoring wells is not feasible, focus on a geographic area, general industrial area, or Operable Unit with PFAS source areas listed above.
    d. Utilize PFAS forensics to identify releases associated with AFFF and those from another source.
5. When EPA's expectations about a comprehensive CSM have not been met, below is a variety of potential language for RPMs to use in letters and comment documents provided to the OFA.

Example of general CERCLA process language that can be used in a cover letter for comments on a Uniform Federal Policy (UFP)-QAPP or investigation report:

> The OFA is required by the NCP (NCP 300.430(d)), EPA Guidance (OSWER Directive 9355.3-01), and the Federal Facilities Agreement (Cite the FFA) to carry out a remedial investigation that adequately characterizes the site for the purpose of developing and evaluating effective remedial alternatives, including no further action. Under CERCLA the purpose of the remedial investigation is to define source areas of contamination, the potential pathways of migration, and the potential receptors and associated exposure pathways. To do this, all potential

sources should be identified at the outset of the investigation. For PFAS, this is particularly important since the available toxicity values result in screening levels in the low parts per trillion, meaning that even small releases could result in the identification of PFAS as a chemical(s) of potential concern in the risk assessment. The OFA (use appropriate Department/agency to cite their policies) have committed to following the CERCLA process and have committed to Congress to characterize PFAS source areas beyond AFFF.

EPA expects a PFAS CSM to present known and potential PFAS source areas, transport mechanisms, pathways, exposure routes and human and ecological receptors, including agricultural uses via irrigation, water intake of livestock, plant uptake, and subsequent introduction into the food chain. EPA considers a comprehensive CSM essential to response action development and prioritization. EPA understands that investigating certain source areas may need to be prioritized and this prioritization process should be well documented and agreed upon by the project team.

Additional suggestions for specific situations that may be helpful:

Situation: OFA proceeds without EPA concurrence/review

The OFA has requested to move forward with the PFAS Investigation without resolution or concurrence with EPA and/or state partners. EPA does not agree with this approach and any conclusion drawn from this effort should not be considered as a final PFAS PA/SI or RI. If the OFA chooses to move forward, it is at their own risk, and EPA may require additional work in accordance with Section XXXX of the FFA/consent order to adequately evaluate areas of potential concern.

Situation: There are too few PFAS source areas identified in the PFAS investigation

EPA was not involved in the scoping and review of the PFAS UFP-QAPP or investigation, and therefore cannot concur that all potential PFAS areas of concern were identified. EPA does not agree that the PFAS Investigation adequately identified all potential PFAS areas of concern. [EPA requests a scoping meeting to evaluate additional PFAS areas of potential concern in collaboration with federal and state partners. (if applicable)] If the OFA proceeds with the PFAS Investigation prior to EPA and state partner concurrence, EPA may require additional work in accordance with Section XXXX of the (FFA/consent order) to ensure that all potential PFAS areas of concern were adequately assessed.

Situation: EPA disagrees with the prioritizing of source areas that will be included in the next phase of the PFAS Investigation.

EPA concurs that the XX sites are the highest priority, and the OFA should proceed with proposed work described in XX document. However, EPA does not agree with the OFA's determination that XX site(s) do not warrant further assessment. EPA provided comments to include additional sampling locations/media/other to meet the UFP-QAPP objective of determining the presence/absence of PFAS at areas of potential concern. EPA may require additional work in accordance with Section XXXX of the (FFA/consent order) to meet the PFAS Investigation's overall objective of identifying all potential PFAS release areas. [EPA requests a meeting in collaboration with federal and state partners to discuss our concerns. (if applicable)]

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