

Department of War Detailed Analysis of Options for the Destruction and Disposal of Covered Materials Containing Per- and Polyfluoroalkyl Substances



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I. INTRODUCTION

Per- and polyfluoroalkyl substances (PFAS) are a family of thousands of chemicals that have unique physical and chemical properties that impart oil, water, stain, and soil repellency; chemical and thermal stability; and friction reduction to a range of products. Since the 1950s, many products commonly used by consumers and industry have been manufactured with or from PFAS. These products have application in several industries, including the aerospace, semiconductor, medical, automotive, construction, electronics, firefighting, and aviation industries, as well as in consumer applications such as carpets, clothing, furniture, outdoor equipment, and food packaging¹.

Due to their widespread historical use, PFAS are found worldwide in soil, sediments, surface water, groundwater, rainwater, and air. PFAS are persistent chemicals that break down very slowly over time and may be linked to harmful health effects in humans and animals.² The most studied PFAS chemicals in the environment include perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), both of which are no longer manufactured in the U.S. PFOS production was voluntarily phased out between 2000 and 2002 and PFOA production phase out began in 2006.³

Since the 1970s, the Department of War (DoW) has used Aqueous Film-Forming Foam (AFFF) to rapidly suppress fires that involve jet fuel. AFFF quickly extinguishes petroleum-based fires, thus minimizing loss of life and protecting equipment and facilities. AFFF formulations contained various PFAS over the years, including PFOS and PFOA. Over the past few years, the Department has undertaken a significant initiative to develop and demonstrate PFAS-free alternatives for AFFF, referred to as fluorine-free firefighting agents (F3). The Department published a new Military Performance-based specification (MILSPEC) for fluorine free foam (F3) on January 6, 2023.⁴ Six F3 agents have completed the military specification qualification process and are available for use. Additional F3 products are undergoing qualification testing to meet DoW MILSPEC standards and the Department continues funding for research, demonstration, and validation projects aimed at improving the firefighting performance of F3 agents. The Department continues to transition to the use of these fluorine-free alternative products on its installations. The Military Departments are also evaluating available technologies, in addition to alternative foams, to replace current AFFF systems in facilities.

¹ ITRC. 2023. PFAS Uses and Products. September 2023. Available online: <https://pfas-1.itrcweb.org/2-5-pfas-uses/>. Accessed September 2025.

² EPA. 2021. PFAS Strategic Roadmap: EPA's Commitments to Action 2021-2024. EPA-100-K-21-002. October 2021. Available online: <https://www.epa.gov/system/files/documents/2021-10/pfas-roadmap_final-508.pdf>. Accessed December 16, 2022.

³ US EPA. 2016. Factsheet PFOA & PFOS Drinking Water Health Advisories. EPA 800-F-16-003.

⁴ MIL-PRF-32725 "FIRE EXTINGUISHING AGENT, FLUORINE-FREE FOAM (F3) LIQUID CONCENTRATE, FOR LAND-BASED, FRESH WATER APPLICATIONS", available online: <https://media.defense.gov/2023/Jan/12/2003144157/-1/-1/1/MILITARY-SPECIFICATION-FOR-FIRE-EXTINGUISHING-AGENT-FLUORINE-FREE-FOAM-F3-LIQUID-CONCENTRATE-FOR-LAND-BASED-FRESH-WATER-APPLICATIONS.PDF>.

DoW is required by section 322 of the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2020 to cease the use of AFFF on military installations (i.e., land-based applications) and inherent in this process is the removal of existing AFFF. The total volume of AFFF that requires disposal is estimated to be over two million gallons⁵. In addition, firefighting equipment (e.g., firetrucks) and facilities with AFFF systems (e.g., airplane hangars) will need to be rinsed before the new F3 firefighting agent is installed, and this PFAS-containing rinsate will also require disposal. DoW estimates that there will be an additional 1.5 million gallons of rinsate requiring management. Because Congress has dictated timelines for replacement of AFFF, there is a large volume of AFFF and rinsate across all of DoW that requires management. Per section 322, as of October 2023, DoW has prohibited new procurement of AFFF for use at its installations. Use of existing AFFF at military installations will cease by October 2026.⁶

In addition to DoW's transition from the use of AFFF at its military installations, quantities of PFAS-containing materials are generated from DoW's nationwide cleanup program, emergency use of AFFF, and spills of AFFF. These combined quantities exceed DoW's long-term storage capabilities, so DoW requires a comprehensive destruction and disposal strategy to address covered DoW PFAS-containing materials being sent to an offsite commercial destruction or disposal facility.

II. PRIOR EPA AND DOW PFAS DESTRUCTION AND DISPOSAL INTERIM GUIDANCE DOCUMENTS

In December 2020, the U.S. Environmental Protection Agency (EPA) published its *Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substance and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances*, December 18, 2020. This EPA Interim Guidance evaluated destruction and disposal technologies that were currently available for the management of PFAS, including permitted deep well injection (also known as Class I wells), permitted hazardous waste landfills (also known as Resource Conservation and Recovery Act (RCRA) Subtitle C landfills), solid waste landfills (also known as RCRA Subtitle D landfills), hazardous waste combustors (including incinerators), and other thermal treatment.

The DoW PFAS Task Force considered this EPA Interim Guidance when developing the DoW *Interim Guidance on Destruction or Disposal of Materials Containing PFAS Substances in the U.S.*, July 11, 2023. This July 2023 DoW interim guidance was developed to comply with section 343 of the FY 2022 NDAA and identified the following six commercially available alternatives to destroy or dispose of DoW PFAS-containing materials, in order of consideration:

⁵Assistant Secretary of War for Energy, Installations, & Environment. 2023. *Interim Guidance on Destruction or Disposal of Materials Containing Per- and Polyfluoroalkyl Substances in the United States*. July 11, 2023. *Hereafter referred to as DoW's 2023 interim guidance.*

⁶Section 322 of the NDAA for FY 2020 allows a maximum of two, one-year waivers if certain conditions are met and the Secretary of Defense certifies to Congress that the waiver (i.e., extension) is necessary. On August 2, 2024, the Secretary of Defense provided Congress with the first certification of the waiver. On July 31, 2025, the Secretary of Defense provided Congress with the second certification of the waiver. The prohibition of use of AFFF on military installations is now extended to October 1, 2026.

1. Carbon reactivation units with environmental permits (for used granular activated carbon (GAC) only)
2. Hazardous waste landfills with environmental permits
3. Solid waste landfills that have composite liners, and gas and leachate collection and treatment systems with environmental permits
4. Underground injection control wells with environmental permits
5. Other PFAS destruction technologies with environmental permits or accepted by environmental regulators
6. Hazardous waste incinerators (HWIs) with environmental permits

On July 14, 2023, DoW issued *Guidance on Incineration of Materials Containing Per- and Polyfluoroalkyl Substances*, prohibiting the use of incineration as a matter of policy until further notice from Office of the Assistant Secretary of War for Energy, Installations and Environment (OASW(EI&E)).

In April 2024, the EPA published *Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substance and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances – Version 2 (2024)*, which is an update to their December 2020 guidance.⁷ The update included new destruction and disposal technology testing results available after the 2020 guidance was published. The 2024 guidance encourages the use of destruction and disposal options that have a lower potential for releasing PFAS into the environment. Technologies EPA evaluated include: permitted class 1 non-hazardous industrial or hazardous waste injection wells; permitted hazardous waste landfills; municipal solid waste landfills with composite liners and leachate and gas collection treatment; GAC reactivation units with thermal oxidizers; and permitted hazardous waste combustors that operate under certain conditions. Additionally, the updated guidance included a technology evaluation framework to help managers of PFAS-containing materials evaluate emerging technologies and inform decisions about destruction and disposal of PFAS-containing materials.

III. UPDATED 2025 DOW PFAS DESTRUCTION AND DISPOSAL GUIDANCE AND ANALYSIS

DoW is now issuing updated interim guidance based upon this analysis to help DoW make informed decisions in the evaluation of existing destruction and disposal options for covered DoW PFAS-containing materials. This 2025 analysis takes into account new PFAS disposal and destruction information, including the EPA’s 2024 updated guidance, and

⁷“Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances—Version 2 (2024).” U.S. Environmental Protection Agency, 8 Apr. 2024. Referred to as “EPA Interim PFAS Disposal Guidance (Apr. 2024)” in later footnotes. Available online: <https://www.epa.gov/system/files/documents/2024-04/2024-interim-guidance-on-pfas-destruction-and-disposal.pdf>

incorporates and updates the July 2023 DoW PFAS destruction and disposal guidance and analysis.

This analysis was used in the development of DoW's 2025 interim guidance and considers options for DoW's PFAS-containing materials being sent to a commercial facility for disposal or destruction, unless the materials are from household or consumer products, or the material qualifies as a hazardous waste.⁸

This document analyzes PFAS-containing waste management options to identify options that minimize PFAS emissions to the environment and potential human health exposures. This analysis identifies the following waste management options in no specific order:

1. Carbon Reactivation Units with environmental permits (for use with GAC only).
2. Hazardous Waste Landfills with environmental permits.
3. Solid Waste Landfills that have composite liners and leachate collection and treatment systems, with environmental permits (not for AFFF concentrate).
4. HWIs with environmental permits that meet specific temperature requirements.
5. Underground injection control wells with environmental permits (for liquids only).
6. Thermal desorption units that use off-gas collection and thermal oxidation with environmental permits (for soils).
7. Other PFAS destruction technologies with Environmental permits or regulator-acceptance.

IV. EVALUATION OF AVAILABLE OFF-SITE COMMERCIAL DESTRUCTION & DISPOSAL OPTIONS

A. Screening Criteria for Options

In choosing among disposal and destruction options, one of the key factors for DoW's analysis is the additional oversight and controls provided via environmental permitting requirements at existing storage, disposal and destruction facilities. DoW recognizes the statutory authority and responsibility of EPA and State environmental regulatory agencies to regulate the disposal and destruction of wastes that may threaten human health or the environment, and to issue environmental permits that protect human health and the environment.

⁸The analysis does not apply to PFAS cleanup destruction technologies as remedial alternatives are evaluated and selected with environmental regulator involvement and in accordance with the federal cleanup law, the Comprehensive Environmental Response, Compensation, and Liability Act. Any waste streams generated from DoW PFAS cleanup actions, however, that are sent to commercial disposal or destruction facilities (e.g., GAC) used to treat drinking water in a cleanup that must now be regenerated or disposed) are covered by this analysis. Additionally, materials classified as hazardous wastes, even if mixed with PFAS, are not covered by this analysis as hazardous waste regulations (e.g., land disposal restrictions) identify the appropriate destruction or disposal options. Per the 2025 DoW guidance, DoW Components shall apply the criteria in this guidance (e.g., minimum temperature required for hazardous waste incinerators) for the specific destruction or disposal option utilized for the hazardous waste, in addition to those required by RCRA regulations.

All options discussed in this section are governed by that environmental oversight provided by EPA and State regulators.⁹

Consistent with EPA's 2020 and 2024 interim guidance, DoW has tried to consider waste management options for AFFF and other PFAS-containing waste to develop alternatives that are as protective as possible of human health and the environment. DoW therefore considered the following criteria:

- Currently available waste management options for the disposal of large quantities of AFFF and PFAS-containing material;
- Identified options in DoW's 2023 interim guidance or EPA's 2024 interim guidance;
- Options with protections in place to minimize emissions or releases;
- Environmentally permitted regulator approved options (where permits are not required); and
- The type and composition of the materials to be destroyed or disposed, including the relative concentrations of PFAS.

While cost was not a screening factor for this analysis, the costs and availability of identified options will need to be evaluated by the DoW Components for disposal or destruction of installation-specific PFAS-containing materials.

The analysis that follows carefully evaluated the most effective means for destroying or disposing of PFAS-containing materials and wastes, and prioritized use of destruction and disposal technologies that have a lower potential for PFAS release to the environment to help support protection of human health and the environment. One important factor DoW considered was the additional oversight and requirements that are associated with a facility obtaining an environmental permit. DoW also had to consider that most of the PFAS-containing materials that DoW generates are from its AFFF transition, AFFF spill responses, or its cleanup program where known PFAS exposures have occurred and are being mitigated and otherwise addressed. Direct human exposures (e.g., PFAS in drinking water that is being addressed under DoW's cleanup program which generates materials for destruction and disposal) had to be balanced against the potential environmental releases from destruction and disposal facilities. Even if releases occur in very small quantities at destruction and disposal facilities, they do not necessarily present any exposure risks to specific populations in the surrounding community.¹⁰

⁹Department of War (DoW). 2025. Updated Interim Guidance on Destruction or Disposal of Materials Containing Per- and Polyfluoroalkyl Substances in the United States. February 20, 2026.

¹⁰See EPA 2024 Guidance at page 1 which states, "While the purpose of an effective destruction and disposal technology is to prevent or minimize environmental releases, it is also important to distinguish between a potential environmental release and a direct human exposure. A PFAS release does not inherently imply direct and immediate human exposure and a release does not necessarily present an unacceptable risk to specific populations."

B. Options Analysis

1. Carbon Reactivation Units with environmental permits (for use with granular activated carbon only)

Because DoW, and others, have widely used GAC to remove PFAS from drinking water and groundwater, DoW evaluated carbon reactivation units. While carbon reactivation units “use high temperatures to thermally desorb contaminants from GAC, which allows for the carbon to be used again,”¹¹ they are not defined as “incinerators” and instead are a form of recycling/preserving virgin materials. While there are about seventeen commercial carbon reactivation units across the country, currently only four “operate under RCRA permits and applicable air permits” which “provide additional regulatory oversight and include operating requirements and emission limitations to safely and effectively treat the hazardous contaminants.”¹² Due to these additional safeguards, RCRA-permitted carbon reactivation units “may operate under conditions more conducive to destroying PFAS and controlling related [products of incomplete combustion].”¹³ Additionally, GAC reactivation is economically favored over replacement with virgin carbon.¹⁴ As identified in DoW’s 2023 guidance and this analysis, carbon reactivation units are currently available, receive environmental permits, are an identified option in DoW’s and EPA’s guidance, and have protections in place to minimize emissions or releases. Therefore, DoW has identified RCRA and CAA-permitted carbon reactivation units as an available destruction option to address PFAS-containing GAC.

2. Hazardous Waste Landfills with environmental permits

In the EPA 2024 Guidance, EPA recognized hazardous waste landfills with an environmental permit as one of three technologies that have a lower potential for environmental release of PFAS compared to other technologies in the same category, and are viewed as one of the more protective technologies.¹⁵ Hazardous waste landfills “have the most stringent environmental controls in place for minimizing environmental releases and migration of some PFAS from disposed waste.”¹⁶ Because they typically do not accept biodegradable wastes and are not biologically active, they do not generally need to be equipped to collect and control landfill gas (unlike solid waste landfills). According to EPA, “permitted hazardous waste landfills have the most protective landfill engineering controls and practices for the containment of PFAS waste and would be more effective at minimizing PFAS release into the environment than other landfill types.”¹⁷ Engineering controls and containment practices for hazardous waste landfills include double liner systems with leachate collection and leak detection and extensive record keeping. As identified in our 2023 guidance and this analysis, hazardous waste landfills

¹¹EPA Interim PFAS Disposal Guidance (Apr. 2024). “Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances,” page 48.

¹²EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 48.

¹³EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 52.

¹⁴EPA Interim PFAS Disposal Guidance (Apr. 2024). Page D-2.

¹⁵EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 2.

¹⁶EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 12.

¹⁷EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 2.

are currently available, receive environmental permits, are an identified option in DoW's and EPA's guidance, and have protections in place to minimize emissions or releases.

The DoW Components will need to consider the type of PFAS-containing materials when considering the use of hazardous waste landfills. For example, liquids must be solidified to remove any free liquids before disposal in a landfill, which may increase the volume significantly (e.g., threefold).¹⁸

3. Solid Waste Landfills that have composite liners and leachate collection and treatment systems, with environmental permits. (Not an option for AFFF concentrate)

The EPA 2020 and 2024 guidances identify a variety of solid waste landfills: municipal solid waste, ash monofill, industrial, and construction and demolition landfills.¹⁹ Because environmental controls can vary at landfills, EPA evaluated the viability of landfilling as a means of containing PFAS. In DoW's 2023 guidance, DoW identified solid waste landfills with composite liners and gas and leachate collection and management in place as available disposal option that maximizes reduction of PFAS releases or emissions to the environment and human health exposures. EPA's 2024 guidance, however, raised additional concerns with potential releases of PFAS from solid waste landfills, even with these controls.²⁰ As an additional precaution, any solid waste landfill DoW uses for PFAS-containing materials must have a composite liner, gas and leachate collection and management systems, and an environmental permit. In addition, based on the type of media, chemical concentrations, and volume of media to be disposed, DoW Components must consider the availability of technologies that may contain PFAS as described in Table 3-4 of the EPA 2024 Guidance.²¹ The DoW Components are directed to use other options for the disposal or destruction of AFFF concentrate (i.e., unmixed liquid concentrate) waste and other liquid PFAS-containing materials.

4. Hazardous waste incinerators with environmental permits that meet specific temperature requirements

DoW also considered thermal treatment technologies, recognizing that these options have data gaps in the understanding of their ability to control the migration of all PFAS compounds into the environment. Thermal treatment technologies include a wide-variety of technologies and controls, including hazardous waste combustors (e.g., incinerators, cement kilns, lightweight aggregate kilns), as well as other thermal treatment (e.g., carbon reactivation units, sewage sludge incinerators, municipal waste combustors, thermal oxidizers).²² In the EPA 2024 Guidance, EPA recognized hazardous waste combustors with an environmental permit as one of three technologies that have a lower potential for environmental release of PFAS compared to other technologies in the same category, and are viewed as one of the more protective

¹⁸Geoengineer. Available online: <https://www.geoengineer.org/education/web-class-projects/cee-549-geoenvironmental-engineering-winter-2013/assignments/stabilization-solidification> Accessed March 16, 2025

¹⁹EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 12 and 13.

²⁰EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 71-76.

²¹EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 77-79.

²²EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 46-51.

technologies.²³ EPA acknowledged that HWIs are designed to optimize temperatures, residence times, turbulence, and other parameters to ensure compliance with organic destruction removal efficiencies.²⁴ EPA, notwithstanding its acknowledgment of uncertainties with PFAS thermal treatment technologies, recognized that the subset of permitted hazardous waste combustors “may operate under conditions more conducive to destroying PFAS and controlling related [products of incomplete combustion] PICs relative to thermal treatment units that do not have both RCRA and [Clean Air Act] CAA permits.”²⁵ Additionally, EPA emphasized that all HWIs, cement kilns, and lightweight aggregate kilns are subject to RCRA and CAA permitting requirements and include operating requirements and emissions limitations to safely and effectively treat regulated hazardous contaminants and may adequately destroy PFAS and minimize PICs (emissions).²⁶ These operating requirements include emission limitations for metals, dioxins/furans, particulate matter, hydrogen chloride and chlorine gas, and carbon monoxide or hydrocarbons, as well as limits on minimum organic destruction and removal efficiency (DRE) (e.g. 99.99 percent for organic chemicals).²⁷ After considering the latest studies and additional information presented in the next section V of this guidance on implementation of section 330 of the FY 2020 NDAA, DoW has identified RCRA and CAA-permitted HWIs with operating temperatures greater than 1100°C in the afterburner/secondary combustion chamber as an available destruction option if the commercial incinerator has conducted a “PFAS Emissions Field Test” following EPA’s 2024 Appendix A recommendations. As identified in DoW’s 2023 guidance and this analysis, HWIs are currently available, receive environmental permits, are an identified option in DoW’s and EPA’s guidance, and have protections in place to minimize emissions or releases.

5. Underground injection control wells with environmental permits (for liquids only)

In the EPA 2024 Guidance, EPA recognized underground injection control, also known as deep well injection, with an environmental permit as one of three technologies that have a lower potential for environmental release of PFAS compared to other technologies in the same category, and are viewed as one of the more protective technologies.²⁸ EPA acknowledged underground injection has the capability to control migration of PFAS to the environment, but “the limited number of these wells currently receiving PFAS and accepting off-site waste, the well location, and waste transportation logistics may significantly limit the type and quantity of PFAS-containing fluids appropriate for underground injection control.”²⁹ Because of the limited availability of underground injection control locations, use for only liquid materials, and the volume of disposal required for DoW PFAS-containing materials, DoW believes this disposal option will rarely be an available option for DoW. DoW, however, has identified underground injection control as a disposal option. As identified in DoW’s 2023 guidance and this analysis,

²³EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 2.

²⁴EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 47.

²⁵EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 46.

²⁶EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 53.

²⁷EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 46.

²⁸EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 2.

²⁹EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 92.

underground injection control wells are currently available, receive environmental permits, are an identified option in DoW's and EPA's guidance, and have protections in place to minimize emissions or releases.

6. Thermal desorption units that use off-gas collection and thermal oxidation with environmental permits (for soils)

DoW mentioned permitted thermal desorption units in its 2023 guidance, as an example of an alternative to HWIs for PFAS-impacted soils. EPA's 2024 Guidance also acknowledges that "though the efficacy of thermal and catalytic oxidizers in destroying PFAS is currently unknown, a properly optimized thermal oxidizer can readily achieve a DRE of 99.99% for volatile organic carbons"³⁰. Thermal treatment technologies that utilize a desorption stage have been demonstrated to remove organic contaminants from soil, sludge, or sediment by heating them to evaporate the contaminants from the solid material and then collect the vapor in a vapor treatment system.³¹ Some thermal desorption units are configured with thermal oxidizers to treat process gases and destroy volatile organic compounds and organic hazardous air pollutants, with some thermal oxidizers being able to also accept liquid feed streams³². In the EPA 2024 Guidance, EPA recognized that "Each thermal oxidizer is designed to optimize temperatures, residence times, and turbulence to address the composition of the particular feed stream at that unit and meet the requirements of a regulation or permit. Depending on the type of thermal oxidizer (direct-fired, regenerative, recuperative, or flameless), the operating temperature ranges from 760°C to 1,200°C (1,400°F to 2,190°F). The residence time of thermal oxidizers ranges from 0.5 to 2 seconds, depending on site-specific criteria."³³ EPA also noted that "...some thermal oxidizers are being used for halogenated wastes, including PFAS precursors. The operating conditions for some thermal oxidizers have the potential to effectively treat PFAS".³⁴ As identified in DoW's 2023 guidance and this analysis, thermal desorption with a thermal oxidizer unit is a currently available technology, receive environmental permits, are an identified option in DoW's and EPA's guidance, and have protections in place to minimize emissions or releases. DoW is therefore identifying thermal desorption units that utilize off-gas collection that is treated by a thermal oxidizer, as a destruction option.

7. Other emerging PFAS destruction technologies with Environmental permits or regulator-acceptance.

DoW's 2023 guidance recognized that other destruction technologies existed or were developing (in addition to HWI and GAC regeneration) and could be considered if the new destruction technologies had an environmental permit or were otherwise approved for PFAS use by the appropriate environmental regulator, and their use is consistent with other criteria in this guidance. EPA's 2024 guidance identifies four emerging technologies (mechanochemical degradation, electrochemical oxidation, gasification and pyrolysis, and supercritical water

³⁰EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 52.

³¹EPA Office of Solid Waste and Emergency Response (Sep 2012). EPA 542-F-12-020. Available online: <https://www.sam.usace.army.mil/Portals/46/docs/library/DDMT/IR%203.23.pdf>

³²EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 51.

³³EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 51.

³⁴EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 51

oxidation (SCWO)) that show promise for PFAS destruction, production of few to no hazardous residuals or byproducts, commercial availability, and cost effectiveness for various impacted matrices.³⁵ To assist PFAS material managers with evaluating whether one of these technologies is suitable, EPA developed the PFAS destruction and disposal technology evaluation framework, which identified priority pieces of information that could provide an evaluation of an emerging technology and its applicability for PFAS disposal or destruction, and focus on innovative technologies that reduce PFAS releases to the environment. EPA has confirmed that users of the framework are not required to fully address each question, rather users should identify the most relevant questions to gain a holistic understanding of the technology's potential for PFAS transformation and/or release to the environment. For example, use of certain air emission methodologies (e.g., USEPA Other Test Method for non-polar volatile PFAS (OTM-50)) may not be relevant for supercritical water oxidation systems because the volume of gaseous effluent emitted is not sufficient to meet the sample collection volumes required by OTM-50. EPA's 2024 guidance acknowledged that they tested the effectiveness of SCWO units from multiple vendors for treating AFFF concentrate. EPA's tests indicated overall destruction efficiencies of greater than 99 percent, although they were not able to monitor all air emissions due to method limitations.³⁶ Over the last eight years, DoW's Environmental Security Technology Certification Program (ESTCP)³⁷ has been conducting rigorous demonstration and validation of multiple PFAS destruction technologies (e.g., SCWO, mechanochemical degradation, hydrothermal alkaline treatment). ESTCP projects collect data comparable to EPA's technology evaluation framework and this data could be useful for DoW decision makers when considering the use of emerging PFAS technologies.

Consistent with EPA's 2024 guidance, DoW's preference is to utilize environmentally permitted technologies which provide additional oversight and emission limitations to safely and effectively destroy or dispose of PFAS-containing materials. Currently, DoW is aware of only a few non-incineration destruction technologies that have environmental permits or regulatory approval to operate at commercial locations (e.g., SCWO units). In addition to SCWO, other technologies are being demonstrated to address PFAS. Therefore, the DoW Components may consider other existing and developing PFAS treatment or destruction technologies that are accepted/permitted by the appropriate State or Federal regulator, on a site-specific basis. When considering other technologies, the DoW Components must follow chain of command procedures to pre-notify OASW(EI&E) of the selected technology on a site-specific basis.

C. On-site hazardous waste storage with environmental permits

EPA's 2020 and 2024 guidance documents recognize that interim storage is not a destruction or disposal method, but asserts that interim storage "may be a short-term option" if the destruction or disposal of PFAS and PFAS-containing materials is "not imperative, on-site storage capacity is readily available, and interim storage has proper controls in place to reduce releases into the environment."³⁸ EPA defines "interim storage" as storage "estimated to be

³⁵EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 119.

³⁶EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 120.

³⁷DoW's Environmental Security Technology Certification Program (ESTCP) funds demonstration and validation of innovative cost-effective environmental technologies and promotes technology implementation by direct insertion and partnering with end users and regulators. <https://serdp-estcp.mil/>

³⁸EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 11.

anywhere from 2 to 5 years.”³⁹ EPA also identifies that interim storage may be less appropriate for high-volumes.⁴⁰ DoW finds that multi-year storage of large quantities of PFAS-containing materials is not a viable option, from either a safety, environmental, logistical, or economic perspective.⁴¹ Thus, in general, DoW assesses that, due to the volume of PFAS-containing waste materials at issue from both its AFFF change out activities and generated from DoW’s nationwide cleanup program, DoW will need to implement actual destruction or disposal solutions for those materials.

DoW is currently conducting cleanup investigations and response actions at over 700 military installations and State Guard facilities.⁴² These investigations and response actions generate PFAS-containing materials (e.g., GAC, soils). While this guidance generally only applies to DoW materials sent off-base to commercial destruction and disposal facilities, if DoW had to plan for, locate, and secure storage of all PFAS-containing materials at applicable DoW Guard facilities, these storage requirements would affect the pace of this necessary cleanup. In addition, the storage would generate its own risks of release to the environment.

DoW is also transitioning to a new firefighting agent for land-based applications and will need to remove existing AFFF. The volume of AFFF that requires disposal is estimated to be over 2 million gallons. DoW does not have the warehouse capacity to properly and safely store this AFFF and associated rinsate at individual bases. DoW is concerned with the risks of release to the environment from storage and believes that secondary containment would be needed to contain releases of PFAS. Storage areas at individual military installations or Guard facilities, where these PFAS-containing materials could potentially be stored if space was available, are not likely to have secondary containment. Building additional storage capacity, to include the necessary contracting actions, would negatively affect the pace of these required cleanup and AFFF replacement activities. DoW believes it does not have the capacity to properly store all PFAS-containing materials at its facilities, and thus disposal or destruction of those materials is imperative.

DoW Components that are storing PFAS-containing materials for over 90 days before the materials are transported to a destruction or disposal facility, shall use onsite hazardous waste storage where available.

V. DOW IMPLEMENTATION OF SECTION 330 OF THE FY 2020 NDAA

The Department is also required to meet Section 330 of the FY 2020 NDAA which requires DoW to ensure that when PFAS-containing materials, including AFFF, are sent to a HWI:

³⁹EPA Interim PFAS Disposal Guidance (Dec 2020). Page 5.

⁴⁰EPA Interim PFAS Disposal Guidance (Apr. 2024). Page 11.

⁴¹EPA. 2024. Final PFAS National Primary Drinking Water Regulation. April 26, 2024. Available online: <<https://www.govinfo.gov/content/pkg/FR-2024-04-26/pdf/2024-07773.pdf>>. Accessed May 3, 2024.

⁴²DoW 2025. PFAS data-cleanup of PFAS. <https://www.acq.osd.mil/eie/eer/ecc/pfas/data/cleanup-pfas.html>

- “(1) all incineration is conducted at a temperature range adequate to break down PFAS chemicals while also ensuring the maximum degree of reduction in emission of PFAS, including elimination of such emissions where achievable;
- (2) all incineration is conducted in accordance with Clean Air Act (42 USC 7401 et seq.), including controlling hydrogen fluoride;
- (3) any materials containing PFAS that are designated for disposal are stored in accordance with the requirement under part 264 of title 40, Code of Federal Regulations; and
- (4) all incineration is conducted at a facility that has been permitted to receive waste regulated under [the Resource Conservation and Recovery Act]⁴³ (42 USC 6921 et seq.)”

Because the first criterion requires a lengthy discussion, this analysis starts by addressing the second, third, and fourth criteria.

The second criterion in section 330 requires that all incineration of PFAS-containing materials is conducted in accordance with CAA requirements. The third criterion in section 330 requires that PFAS-containing materials stored at hazardous waste facilities prior to incineration be stored in accordance with RCRA requirements. The fourth criterion in section 330 requires that incineration is conducted at a RCRA-permitted hazardous waste facility. Based upon the review of these three criteria, if a DoW Component chooses to incinerate PFAS-containing materials in its custody, the DoW Component must send those PFAS-containing materials, including AFFF, only to RCRA- and CAA-permitted HWIs. RCRA-permitted HWIs with CAA Title V permits operate under conditions that represent the maximum commercially available destruction efficiencies for PFAS, including the control of hydrogen fluoride and other PICs. Additionally, RCRA- and CAA-permitted HWI have experience in the proper storage of regulated hazardous wastes and must comply with part 264 of title 40, Code of Federal Regulations, concerning storage of material at their facilities. Therefore, the DoW Components are required to ensure that HWIs utilized for the incineration of PFAS-containing materials, including AFFF, have valid RCRA and CAA operating permits.

The first criterion in section 330 requires that if DoW sends PFAS-containing materials to incinerators, the incinerators utilize a temperature range adequate to break down PFAS while also minimizing emissions of PFAS (i.e., “maximum degree of reduction in emission of PFAS...”). Because the second, third, and fourth criterion in section 330 require incineration at permitted HWIs and because these permitted facilities are required to maintain minimum temperature thresholds, DoW used those minimum thresholds in determining whether it can reasonably conclude that HWIs will achieve the requirements of the first criterion in section 330.

⁴³The Solid Waste Disposal Act of 1965 is commonly referred to as the Resource Conservation and Recovery Act (RCRA), which significantly amended the Solid Waste Disposal Act, in 1976.

A. Relevant RCRA and CAA Permitting Requirements

The regulatory requirements for RCRA- and CAA-permitted HWIs are summarized as follows:

- RCRA-permitted HWIs must follow stringent regulatory requirements and are required by EPA to conduct testing to determine a DRE. The key factors in achieving a high DRE are time in the incinerator (residence time), high temperature, and turbulence (i.e., mixing). The purpose of DRE testing is to demonstrate that virtually all the molecules of a surrogate compound are destroyed in the incinerator. For HWIs, EPA requires a minimum DRE of 99.99 percent. During DRE testing, a surrogate compound is fed into the incinerator that represents classes of compounds that are extremely difficult to destroy. EPA has developed a system of ranking these surrogate compounds, based on their difficulty to destroy.
- After a 99.99 percent DRE is achieved, EPA or the delegated State, issues a CAA Title V permit that includes requirements for operation. This includes a high temperature range and other parameters that are continuously monitored, and if not complied with, the incinerator will stop the flow of materials to the combustion unit automatically and immediately.

While there are several operating conditions specified in a HWI permit, the first criterion in section 330 focuses on a temperature range adequate to break down PFAS. DoW reviewed minimum temperatures specified in nine existing HWI permits to achieve their DRE and found their permits require a minimum temperature in the kiln that range from 1200° Fahrenheit (F) to 1824°F (648°Celsius (C) to 995°C). At these facilities, the kiln is followed by an afterburner/secondary combustion chamber to maximize organic destruction and their permits require a minimum temperature in the afterburner/secondary combustion chamber that ranges from 1488°F to 2026°F (809°C to 1107°C). Based on the studies and information described below, HWIs that operate at temperatures greater than 1100 °C in the afterburner/secondary combustion chamber are adequate to break down detectable PFAS chemicals and significantly minimize PFAS emissions.

B. Existing Data on Destruction Capabilities of Incinerators

EPA's 2024 guidance contains the following findings on the destruction capabilities of HWIs:

- HWIs are designed to optimize temperatures, residence times, turbulence, and other parameters to ensure compliance with organic DRE requirements. Most commercial HWIs use rotary kilns as a primary combustion chamber to facilitate the thermal treatment of containerized wastes (e.g., in drums) and solid wastes such as contaminated soils. The kiln maintains a continuous standing flame fueled by high-heating-value wastes and auxiliary fuels that maintain high temperatures. Typically, solids retention time in the kiln is 0.5 to 1.5 hours, while gas residence time through the kiln is usually around 2 seconds. Kiln flame/solids temperatures range from 650°C to 1,650°C (1,200°F to 3,000°F). The rotary kiln is followed by an afterburner where additional high-heating-

value gaseous and liquid wastes, and auxiliary fuels are added. The afterburner is typically operated at about 1,100°C to 1,370°C (2,000°F to 2,500°F) with a gas residence time from 1 to 3 seconds to maximize organic destruction and minimize the formation of PICs.⁴⁴

Studies and information on PFAS destruction indicate that the temperature ranges used in these types of HWIs are effective in destroying the approximately 50 PFAS that can currently be detected in air emissions through an EPA methodology (e.g., OTM-50):

- In 2021, EPA began conducting pilot-scale PFAS incineration studies using its “Rainbow” furnace, which allows EPA to conduct incineration experiments under controlled conditions.⁴⁵ This research identified fluorocarbon tracer gases (surrogates) that could potentially be used to monitor destruction efficiencies during incineration, and then began experiments. The first publication from these experiments suggests that PFAS can be destroyed when subjected to aggressive thermal environments above 1100°C.
- In 2021, the New York State Department of Environmental Conservation (NYSDEC) announced that it had completed a study to determine if the thermal treatment of PFAS-containing materials at the Norlite facility in Cohoes, New York, resulted in soil and surface water contamination. The Norlite facility is a RCRA- and CAA-permitted hazardous waste combustor that had treated AFFF over a number of years. This NYSDEC study found no clearly discernible pattern of aerial deposition of PFAS that could be traced to Norlite’s operations. Sampling identified low-level detections of PFAS compounds in all soil samples collected at upwind, downwind, and at background locations, consistent with emerging research on the prevalence of PFAS in urban, suburban, and rural environments. Concentrations of PFAS found in soils in the vicinity of the facility were below guidance values NYSDEC developed, indicating that the facility successfully destroyed the PFAS material and did not emit traceable amounts of PFAS during combustion.⁴⁶
- In 2021 and 2022, a commercial RCRA and CAA permitted HWI (Clean Harbors Environmental Services’ in Aragonite, Utah) conducted PFAS-specific studies with the objective to “demonstrate the ability of the high-temperature incineration system at Aragonite to effectively destroy PFAS in the waste feed during normal process operating conditions with a secondary objective of conducting a mass balance of PFAS in process streams and demonstrating high hydrogen fluoride removal”.⁴⁷ In the 2021 study, AFFF was added in high concentrations to a waste feed and sampled at various times throughout the incineration process. A 99.9999

⁴⁴EPA Interim PFAS Disposal Guidance (Apr 2024), page 47.

⁴⁵“Combustion of C₁ and C₂ PFAS: Kinetic Modeling and Experiments,” Krug et al., *Journal of the Air & Waste Management Association*. 2022, 72:3, 256-270. Published Feb. 11, 2022.

⁴⁶*Norlite Environmental Sampling Report*, pp 25-26. New York State Department of Environmental Conservation, March 2021, https://www.dec.ny.gov/docs/materials_minerals_pdf/norlitesamplingfull0321.pdf.

⁴⁷EPA Interim PFAS Disposal Guidance (Apr. 2024) Appendix B, page B-1.

percent DRE was obtained for PFOS, PFOA, Perfluorohexane Sulfonic Acid (PFHxS), and hexafluoropropylene oxide dimer acid (otherwise known as Gen-X) at a temperature range between 1,893°F and 2,008°F (1,034 °C to 1,098 °C) in the kiln, and a range of 2,052F to 2,110 °F (1122 °C to 1154 °C) in the afterburner.⁴⁸ In the 2022 study, a 99.9999 percent DRE was obtained for PFOS, PFOA, Perfluorohexane Sulfonic Acid (PFHxS), perfluorobutanesulfonate (PFBS), and hexafluoropropylene oxide dimer acid at a temperature range between 1,949°F and 2,219°F (1,065 °C to 1,215 °C) in the kiln, and a range of 2,048°F to 2,075 °F (1,120 °C to 1,135 °C) in the afterburner.⁴⁹ To measure PFAS air emissions, the studies utilized the EPA test method for stack gas sampling of PFAS available at that time (e.g. OTM-45). The studies demonstrate the ability of the high-temperature incineration system to effectively destroy PFAS in the waste feed during normal process operating conditions for the five selected PFAS.⁵⁰ However, the studies did not fully evaluate the formation of PICs due to methodology limitations at the time, i.e., EPA’s OTM-50 methodology was not made available until January 2024.⁵¹ Overall, both tests showed that DREs of 99.999 percent for the five target PFAS were achieved. Of the 49 compounds detected by OTM-45, 34 were non-detect in the stack gas and only 15 were detectable at extremely low concentrations (e.g. insignificant generation of PICs).

- In 2022, a literature review covering 163 published works on thermal treatment of PFAS was published.⁵² This paper suggests that “complete combustion of PFAS will likely be most successful in incinerators that employ a two-stage process. In these, the waste is first fed into the primary combustion chamber where PFAS desorb and partially degrade. The gaseous byproducts are sent to a secondary chamber (the afterburner) that operates in excess air (stoichiometric excess of oxygen) at high temperature (>950°C) and short residence times (1-3 seconds).”⁵³ DoW notes that HWIs employ this two-stage process. This paper also stated that the “general consensus across these lab-scale studies is that even the most stable PFAS (e.g., long-chain sulfonates) desorb at temperatures less than 1000°C, and they are destroyed in the gas phase at temperatures greater than 1000°C.”⁵⁴
- A 2022 performance test report on Chemours Company Fayetteville Works thermal oxidizer summarizes the ability of the thermal oxidizer and 4-stage scrubber system to achieve emission reduction [of 99.99 percent] based on testing

⁴⁸EPA Interim PFAS Disposal Guidance (Apr. 2024) Appendix B, page B-2.

⁴⁹EPA Interim PFAS Disposal Guidance (Apr. 2024) Appendix B, page B-2.

⁵⁰EPA Interim PFAS Disposal Guidance (Apr. 2024) Appendix B, page B-1.

⁵¹EPA Interim PFAS Disposal Guidance (Apr. 2024) page 45.

⁵²“Critical Review of Thermal Decomposition of Per- and Polyfluoroalkyl Substances: Mechanisms and Implications for Thermal Treatment Processes,” Wang et al., *Environ. Sci. Technol.* 2022, 56, 5355-5370. Published April 21, 2022.

⁵³*Id.* at page 5363.

⁵⁴*Id.* at page 5363.

conducted in March 2020 and 2022.⁵⁵ EPA’s 2024 guidance provides a high-level review of the report. The test used multiple EPA methods to sample PFAS compounds from polymer and monomer PFAS production process waste gases fed into the thermal oxidizer. The results of the tests showed that the mandated 99.99 percent destruction of targeted PFAS compounds had been achieved. In both testing years the average PFAS DRE was above 99.999 percent with no result being lower than 99.999 percent for the PFAS compounds tested.

- A 2023 publication, described additional work conducted by EPA that built on EPA’s 2021 “rainbow furnace” studies and found that for AFFF incineration, PFAS reached non-detect levels (near the detection limit) for PICs as the peak temperature approached 1100°C, and that PFAS destruction efficiencies are high.⁵⁶ This study calculated destruction efficiencies instead of Destruction and Removal Efficiencies because samples were collected before any pollution control devices. OTM-50 was used to quantify 30 PFAS PICs, and results indicated that greater than 99.99 percent destruction efficiencies were achieved with peak temperatures above 1090°C.⁵⁷
- In 2023, research conducted by the University of Notre Dame, investigated ways to improve understanding of PFAS thermal destruction technologies at the laboratory scale in a tube furnace simulating a kiln with use of common alkali and alkaline-earth metal additives to enhance the mineralization of PFOS adsorbed onto GAC. The study found that at 1000°C, PFAS containing solids completely mineralized to hydrofluoric acid (HF) with a minor amount of off gas without the addition of any additives. In the presence of Ca(OH)₂ (hydrated lime) as an additive, mineralization temperatures can be reduced to 800°C with the majority of fluorine being found in the remaining ash, and little production of HF.⁵⁸
- In 2024, researchers from Colorado State University,⁵⁹ published results of their work on quantum machine learning to predict the thermal destruction of PFAS during incineration. The study concluded that PFAS mineralization during hazardous waste incineration requires greater than 950°C and 2 seconds gas residence time for complete mineralization and suggested that thermal destruction of longer carbon chain PFAS found in AFFF may be viable at common afterburner temperatures of ≥1000°C and 2 seconds gas residence time, given other process variables such as mixing, fuel:oxygen:PFAS

⁵⁵EPA Interim PFAS Disposal Guidance (Apr. 2024) Appendix C.

⁵⁶Shields E., et al (2023). “*Pilot Scale Thermal Destruction of Per- and Polyfluoroalkyl Substances in a Legacy Aqueous Film Forming Foam*”. ACS ES&T Engineering, volume 3, issue 9, pages 1308-1317.

⁵⁷EPA Interim PFAS Disposal Guidance (Apr. 2024) page 45.

⁵⁸Abou-Khalil et al. (2024), “*Enhancing the Thermal Mineralization of Perfluorooctanesulfonates on Granular Activated Carbon Using Alkali and Alkaline-Earth Metal Additives*”. Environ. Sci. Technol., 58, pp. 11162-11174.

⁵⁹Anthony Rappe, Department of Chemistry, Colorado State University. Work conducted in support of SERDP project “ER21-1019: *A Quantum Chemical Machine Learning Approach to Prediction of Thermal PFAS Destruction*.”

ratio, and concentrations of hydrogen donors and fluorine scavenger(s) such as lime are optimized.⁶⁰

- In November 2024, EPA conducted its most comprehensive commercial incinerator PFAS testing at the Clean Harbors Environmental Services (CHES) Aragonite, UT RCRA-permitted hazardous waste incinerator.⁶¹ This testing was a follow-on from two previous comprehensive test programs conducted in 2021 and 2022 at the Aragonite facility (see summary of 2021 and 2022 CHES studies on previous page). The November 2024 testing incorporated most components of the 2021 and 2022 test campaigns, including sampling of liquid waste feed streams (e.g., AFFF concentrate), input chemicals and utilities, process residuals, and exhaust emissions for PFAS target analytes, to support an overall PFAS mass balance. This test program included feeding AFFF concentrate and dynamic spiking of nine PFAS compounds for DRE determination. Tests were conducted under normal operating conditions with mixed solid and liquid waste feeds used to maintain a temperature in the rotary kiln between 950°C and 1196 °C, and over 1100 °C in the afterburner. As during the two previous test programs, EPA’s Other Test Method-45 (OTM-45) was used. Additionally, OTM-50, released by EPA in January 2024, was used in this test for sampling exhaust emissions for 30 volatile fluorinated compounds (VFCs), which could include potential PFAS products of incomplete destruction such as tetrafluoromethane (CF₄) and hexafluoroethane (C₂F₆). The results of the November 2024 PFAS destruction testing demonstrated for the third time the Aragonite RCRA-permitted hazardous waste incineration facility can produce DREs as high as 99.9999 percent for a variety of PFAS. The testing also demonstrated that incineration of PFAS-containing wastes can achieve low to non-detectable concentration of VFCs. DRE values from 99.99 to 99.9999 percent were demonstrated for C₂F₆, supporting the potential use of C₂F₆ as an indicator for PFAS destruction.⁶²
- In 2025, Veolia North America completed a study at its Port Arthur, Texas incinerator. Testing was conducted in July and October of 2024, by a third-party provider. The facility was chosen based on its track record of managing PFAS-containing material, and its ability to maintain an average kiln exit temperature of ~1,660° F (905°C) and reach an average secondary combustion chamber temperature of 2,049 °F (1120 °C) and a residence time of 2.3 seconds. These conditions are conducive to thermal destruction of PFAS compounds with near detection limit concentration for PICs based on previously published pilot and full-scale studies. The testing used the OTM-45 and OTM-50 methods to evaluate PICs in stack air emissions. Although the high detection limit for OTM-50 precluded the quantification of a few thermally stable PICs in the exhaust, nonetheless, Veolia’s results “demonstrated high temperature incineration to be an

⁶⁰Blotevogel, J. et al. 2024. “Thermal Destruction Pathways and Kinetics for *NTf2* and Longer-Chain Bis(perfluoroalkanesulfonyl)imides (Bis-FASIs)”. *Environ.Sci.Technol.Lett.* 11, 1254–1259.

⁶¹EPA 2025. PFAS Destruction by a Hazardous Waste Incinerator: Testing Results. EPA600/R-25/172. September. https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=552166&Lab=CEMM

⁶²EPA 2025. PFAS Destruction by a Hazardous Waste Incinerator: Testing Results. EPA600/R-25/172. September. https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=552166&Lab=CEMM

efficient disposal solution for high concentrations of targeted PFAS, destroying greater than 99% of targeted substances, including up to 99.9999% of PFOS and PFHxS...with few to no PICs detected”⁶³ when temperatures, residence times, and turbulence are optimized. CF₄ was the only PIC detected at the OTM-50 limit of quantitation.

Notwithstanding EPA’s 2024 Guidance general finding that there are uncertainties with PFAS thermal treatment technologies and additional testing was needed with OTM-50 methods, EPA recognized that there is less uncertainty for the permitted facilities that DoW will use for incineration. According to EPA, a subset of permitted HWIs “may operate under conditions more conducive to destroying PFAS and controlling related PICs” relative to thermal treatment units that do not have both RCRA and CAA permits.”⁶⁴ EPA also recognized that permitted HWIs “are designed to optimize temperatures, residence times, turbulence, and other parameters” to “maximize organic destruction and minimize the formation of PICs.”⁶⁵ These controls include pollution control devices which can remove products of combustion.⁶⁶

Updates in research activities have addressed several significant data gaps. Much of this new work has been possible given the 2024 establishment of new air emission sampling and analysis methods for PFAS (i.e., OTM-50) by EPA.⁶⁷ While there are still some uncertainties, controlled pilot-scale studies have empirically demonstrated near-complete mineralization of all PFAS with negligible PIC formation at temperatures ≥ 1000 °C with ≥ 2 seconds residence times.⁶⁸ Additionally, recent testing conducted at the Clean Harbors and Veolia commercial HWI demonstrated that PFAS can be destroyed at high temperatures showing evidence of adequate break down of PFAS and significantly minimized PFAS emissions. Based on the totality of knowledge to date, including that most HWI operate at temperatures greater than minimums set in their operating permits and utilize a two-stage operating process,⁶⁹ the DoW has identified incineration of PFAS-containing materials as a destruction option if the HWI operates at temperatures greater than 1100 °C in the afterburner (secondary combustion chamber)in addition to having RCRA and CAA permits.

⁶³Veolia. 2025. “PFAS Destruction Testing at Veolia’s Port Arthur Incinerator” June. Available online: <https://www.veolianorthamerica.com/media/press-releases/veolia-completes-most-comprehensive-industry-testing-pfas-waste>.

⁶⁴EPA Interim PFAS Disposal Guidance (Apr. 2024), page 2 and 46.

⁶⁵EPA Interim PFAS Disposal Guidance (Apr. 2024), page 47.

⁶⁶EPA Interim PFAS Disposal Guidance (Apr. 2024), pages46-48.

⁶⁷EPA Interim PFAS Disposal Guidance (Apr.. 2024), page 2.

⁶⁸Shields, E. P., Krug, J. D., Roberson, W. R., Jackson, S. R., Smeltz, M. G., Allen, M. R., ... & Linak, W. P. (2023). Pilot-scale thermal destruction of per-and polyfluoroalkyl substances in a legacy aqueous film forming foam. *ACS ES&T Engineering*, 3(9), 1308-1317. Gehrman, H. J., Taylor, P., Aleksandrov, K., Bergdolt, P., Bologna, A., Blye, D., ... & Stapf, D. (2024). Mineralization of fluoropolymers from combustion in a pilot plant under representative european municipal and hazardous waste combustor conditions. *Chemosphere*, 365, 143403.

⁶⁹“Critical Review of Thermal Decomposition of Per- and Polyfluoroalkyl Substances: Mechanisms and Implications for Thermal Treatment Processes,” Wang et al., *Environ. Sci. Technol.* 2022, 56, 5355-5370. Published April 21, 2022

C. DoW's Finding for Section 330

Based on a review of the studies identified above, DoW concludes that RCRA- and CAA-permitted HWIs with a secondary combustion chamber operating temperature above 1100 °C will be adequate to break down detectable PFAS chemicals while also ensuring the significant minimization of PIC formation. Based on the above studies and information that show HWIs utilize this temperature range and other operating parameters to achieve a 99.99 percent DRE, and HWIs are required to have air emission control devices, RCRA and CAA permitted HWIs meet section 330's requirements for an adequate temperature range to break down PFAS that currently can be detected in air emissions and meet emission reduction requirements. Additional research is underway, and DoW will update this guidance as needed to reflect changes as technologies mature, EPA updates its guidance, and additional data, including additional air emission detection methods, becomes available.