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April 1, 2020

Ms. Maureen Sullivan
Deputy Assistant Secretary of Defense for Environment

The Coalition for Responsible Waste Incineration (CRWI) is a trade association comprised of 27 members representing companies that own and operate hazardous waste combustors and companies that provide equipment and services to the hazardous waste combustion industry. Our members have extensive expertise in using combustion to destroy hazardous organic wastes. We believe that a modern hazardous waste combustor that is meeting the Clean Air Act and RCRA requirements in their permits also meet the requirements in the National Defense Authorization Act for Fiscal Year 2020 for the incineration of wastes containing per- and polyfluoroalkyl substances. The scientific, engineering, and regulatory basis for that belief are attached.

If you have any questions, please contact me at (703-431-7343 or mel@crwi.org).

Sincerely yours,

Melvin E. Keener, Ph.D.
Executive Director

cc: CRWI members
A. Leeson – SERDP
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Section 330 of the National Defense Authorization Act (NDAA) for Fiscal Year 2020 requires that the Department of Defense "shall ensure that when materials containing per- and polyfluoroalkyl substances (referred to in this section as "PFAS") or aqueous film forming foam (referred to in this section as "AFFF") are disposed—

(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 the requirements of the Clean Air Act (42 USC 7401 et seq.), including controlling hydrogen fluoride;"

The Department of Defense has been sued (*Save Our County, et al. v. U. S. Defense Logistics Agency*, U. S. District Court for the Northern District of California, 3:20-cv-01267) to prevent the continued use incineration to destroy discarded aqueous film forming foam (AFFF) due to concerns that this method is not meeting statutory requirements. However, CRWI contends that incineration of AFFF at permitted hazardous waste incinerators destroys the PFAS wastes and currently meets all of the criteria in the NDAA.

There are four criteria contained in the statute pertaining to the incineration of AFFF are:

- A temperature range adequate to break down PFAS wastes;
- Maximum degree of reduction in emissions of PFAS;
- The incineration is conducted in accordance with the requirements of the Clean Air Act, and
- Hydrogen fluoride is controlled.

How permitted hazardous waste incinerators meet each of these criteria are discussed below.

<u>Temperature range</u>.

It has been well established that there are three key interrelated factors (time, temperature, and mixing) that govern the destruction of organic compounds during combustion (Brunner, C. 1993. Hazardous Waste Incineration. McGraw-Hill). For example, at a fixed temperature and residence time in the combustion chamber, destruction can be increased by better mixing. These concepts have been used since the 1980's in that all hazardous waste incinerators must meet a destruction removal efficiency (DRE) requirement. Hazardous waste incinerators are required to develop a set of site-specific operating parameters during testing to show they meet the destruction removal efficiency requirements in 40 CFR 63.1219(c). These operating parameters include:

- Minimum combustion chamber temperature;
- Maximum flue gas flowrate or production rate;
- Maximum hazardous waste feed rate; and

- Operation of waste firing system (e.g., minimum firing nozzle pressure, maximum viscosity, etc.).

(Technical Support Document for HWC MACT Standards. Volume IV: Compliance with the HWC MACT Standards. EPA. September 2005)

Once this set of conditions is developed for a facility, that facility is not allowed to operate outside of those conditions. Thus, each hazardous waste incinerator already has a complete set of operating conditions including temperature in their permit that satisfies the temperature range requirement in Section 330 of the NDAA. That temperature will differ between facilities but NDAA does not require that each facility meet the same temperature – only that the temperature range is "adequate to break down PFAS chemicals…" When hazardous waste incinerators meet the requirements in 40 CFR 63.1219, they are also meeting the "temperature range" requirement in Section 330 of NDAA.

<u>Maximum degree of reduction</u>.

Since it is impractical to test for every organic HAP listed in section 112(b) of the Clean Air Act, hazardous waste combustion facilities are instead required to select one or more compounds that is more difficult to destroy than the compounds that they would normally combust and show at least 99.99% destruction removal efficiency (DRE) for those compounds. This concept was developed early in the regulation of hazardous waste incinerators under Subpart O of the RCRA regulations. In the guidance document for hazardous waste incinerators ("Guidance on Setting Permit Conditions and reporting Trial Burn Results. Volume II of the Hazardous Waste Incineration Guidance Series," January 1989, EPA/625/6-89/019), EPA discusses the concepts for demonstrating DRE for organic hazardous waste. In the opening paragraphs of this guidance document, EPA explains this concept.

> "The Subpart O regulations require that POHC's (Principal Organic Hazardous Constituents) be designated for each waste feed. The required DRE must then be demonstrated for the POHC's during the trial burn. Since the POHC's must be representative of the waste feed, they are chosen on factors such as difficulty to incinerate and concentration in the waste feed. The operator is then limited in the permit to burning only waste containing hazardous constituents no more difficult to incinerate than the POHC's for which compliance was demonstrated during the trial burn. The heat of combustion of the hazardous constituents has been used to rank the incinerability of compounds on the premise that compounds with a lower heat of combustion are more difficult to burn."

The guidance gives detailed instructions on selecting POHCs and the entire process of demonstrating DRE. Hazardous waste facilities have used this guidance since 1989 to demonstrate the ability to meet these criteria. Appendix VIII of the guidance contains a list of organic compounds ranked on how difficult they are to destroy (incinerability index). This idea was initially suggested by the researchers at the University of Dayton

(Dellinger, B. and D. L. Hall. 1986. The Viability of Using Surrogate Compounds for Monitoring the Effectiveness of Incineration Systems. Journal of the Air Pollution Control Association, 36:179-183). Class 1 chemicals on this list are the most difficult to destroy. For example, chlorobenzene is a Class 1 chemical. When a facility demonstrates a minimum DRE of 99.99% for chlorobenzene, it can be inferred that the facility can destroy a similar or greater percentage of any organic chemical ranked lower in Class 1 or any chemical in Classes 2, 3, or 4.

Researchers continued to update this index until 2001. While there are no longer-chain PFAS compounds in the index, there are eight organic compounds containing fluorine in the 2001 index. They are shown below.

Compound	Class	Rank	Footnote
Chlorotrifluoromethane (F-13)	1	20	4
Fluoroacetic acid	2	46-48	
Fluoroacetimide	2	60	
Trichlorotrifluoroethane (F-113)	3	82-85	1
Dichlorodifluoromethane (F-12)	3	86-90	1
Trichlorofluoromethane (F-11)	3	86-90	1
Chlorodifluoromethane (F-22)	4	156-158	1
Dichlorofluoromethane (F-21)	4	159-164	1

Footnote 1. Boldface print indicates compound thermal stability is fully evaluated; ranking based on UDRI experimental mixture data coupled with reaction kinetic theory.

Footnote 4. Italicized print indicates compound thermal stability is fully evaluated based on UDRI or literature data coupled with reaction kinetic theory.

There have been a limited number of studies that would allow determination of where certain PFAS wastes fit within the incinerability index. In 2001, 3M commissioned a series of tests on the thermal degradation of perfluorooctanesulfonic acid (PFOS) and two C8 perfluorosulfonamides (FC-1395 and FC-807A). The report was issued in 2003 and submitted to EPA's docket (EPA-HQ-OPPT-2003-0012-01511). In the report, University of Dayton researchers showed approximately 99.95% destruction of PFOS and the two C8's at 900 C with a 2 second residence time. Two studies were commissioned by DuPont. In the first, DuPont wanted to know if paper and textiles treated with fluorotelemer-based acrylic polymers would release perfluorooctanoic acid (PFOA) when combusted under conditions found in a typical municipal incinerator. In this study, University of Dayton researchers determined that the temperature at which 99.9% of the polymers by themselves were destroyed was 1000 C (with a 2 second residence time). For the paper and fabric coated with the polymers, 99.9% of the PFAS compounds were destroyed at 750 C (with a 2 second residence time). This study was published in 2005 (Yamada, T., P. Taylor, R. Buck, M. Kaiser, and R. Giraud. 2005. Thermal degradation of fluorotelemer treated articles and related materials.

Chemosphere. 61:974-984). In the second DuPont study, University of Dayton researchers confirmed and extended the findings of the 2005 study (Taylor, P., T. Yamada, R. Striebich, J. Graham, and R. Giraud. 2014. Investigation of waste incineration of fluorotelomer-based polymers as a potential source of PFOA in the environment. Chemosphere 110:17-22).

The temperature data from the studies mentioned above can be used to estimate where the compounds evaluated in each of these studies fit into the index. CRWI's best estimate from the available data place the longer-chain PFAS compounds in the middle of Class 2. Thus, if a facility shows a 99.99% DRE for a Class 1 compound, it would also be able to destroy at least 99.99% of these PFAS compounds. Hazardous waste incinerators meeting the DRE requirements in 40 CFR 63.1219(c) and having demonstrated 99.99% DRE for a Class 1 compound would also meet the "maximum degree of reduction" requirement in Section 330 of the NDAA.

Incineration is conducted in accordance with the requirements of the Clean Air Act.

Before a hazardous waste incinerator can operate, it must conduct a comprehensive performance test to show that it meets the requirements in 40 CFR 63.1219. Once the test is completed, the facility must submit a notice of compliance (40 CFR 63.1210(d)). The operating parameter limits established in the comprehensive performance test are then incorporated into that facility's Title V permit. A facility is required to comply with those requirements at all times (40 CFR 63.1206(b)). In addition, a hazardous waste incinerator is required under 40 CFR 1206(c)(3) to install and operate a system that will automatically cut off hazardous waste feed when any operating parameter is exceeded. The facility is not allowed to resume waste feed until all operating parameters return to the levels allowed in their permit. A hazardous waste incinerator operating within its Title V limits is in compliance with the requirements of the Clean Air Act.

Control of hydrogen fluoride.

The effectiveness of a wet scrubbing control method to remove acid gases from a combustion gas air stream is dictated by the solubility in water of each acid gas. The CRC Handbook, 56th Edition lists the solubility of hydrogen chloride as 82.3 g/100 cc in cold water and as 56.1 g/100 cc in hot water and hydrogen fluoride is listed as infinitely soluble in cold water and very soluble in hot water. Hydrogen fluoride is therefore more soluble in water than is hydrogen chloride. Thus, a facility that has been designed to use wet scrubbing to control hydrogen chloride will also effectively control hydrogen fluoride. The operating limits established during a comprehensive performance test for control of hydrogen chloride will also effectively control hydrogen fluoride emissions. EPA recognized this in the 2010 proposed boiler rule (75 FR 32,006, June 4) where in Footnote 16 the Agency stated "HCl can serve as a surrogate for the other acid gases in a technology-based MACT standard, because the control technology that would be used to control HCl would also reduce the other acid gases." In response to comments that HCl was not a good surrogate, EPA responded as follows.

> “The acid-gas HAP (HCl, HF, HCN and Cl2) are expected to be removed using technologies that take advantage of their solubility or their acidity (or both). This will likely be done using technologies that are often used for control of SO2 or SO3 (also acidic gases). Because it is highly likely that facilities will choose to control these acid gases by applying the same technology and the means of removal for each are similar, it is logical to select one (HCl) as a surrogate to represent the control of the others.”

EPA Docket ID No. EPA-HQ-OAR-0059-3289, page 114 of 1762.

The Portland Cement MACT rule (75 FR 59,970, September 9, 2010) also used similar language.

Thus, a hazardous waste incinerator that has a wet scrubber and is meeting its hydrogen chloride limits will also be effectively controlling hydrogen fluoride emissions.