



NACAA
National Association of Clean Air Agencies

Tackling the PFAS Air Emissions Problem: State Perspectives

November 12, 2020



NH'S EVOLUTION OF PFAS KNOWLEDGE

STACK TESTING OF LEGACY AND EMERGING PFAS
INSTALLATION OF AIR POLLUTION CONTROL



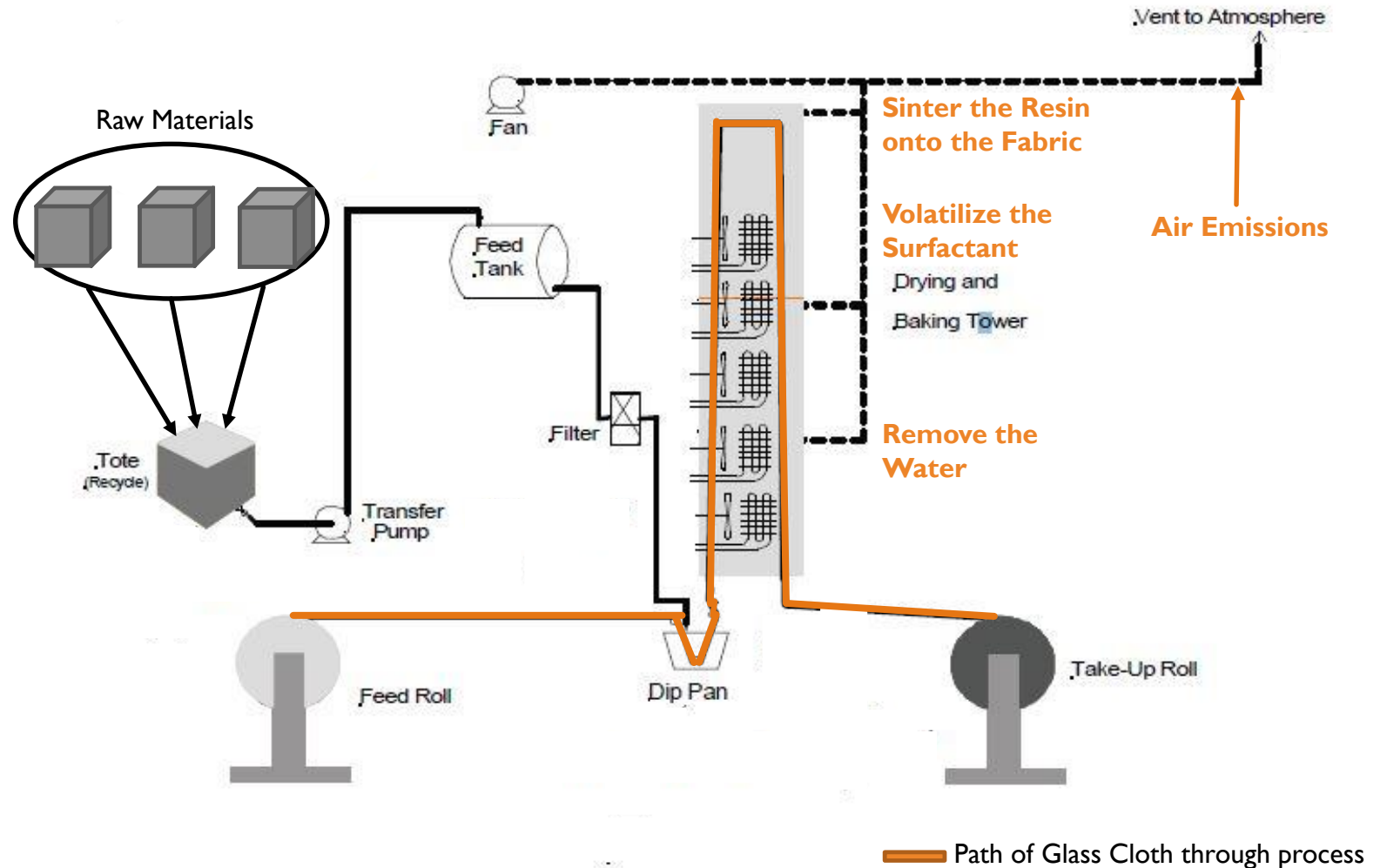
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FACILITY
OVERVIEW

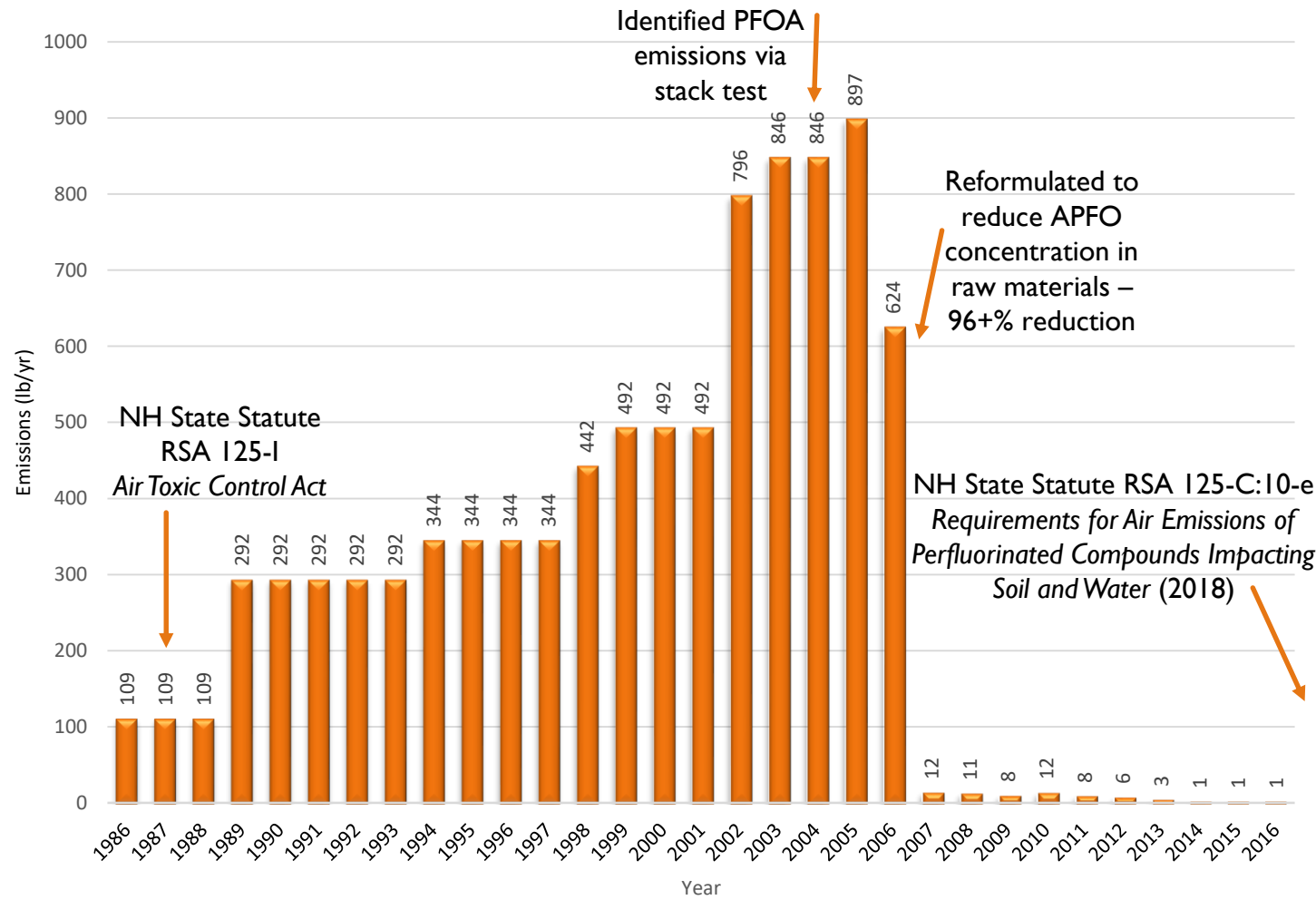
FABRIC COATERS

TYPICAL GLASS CLOTH PROCESS DIAGRAM





ESTIMATED HISTORICAL PFOA AIR EMISSIONS



* Estimated PFOA emissions only (no other PFAS, precursors or PICs) and based on 2004 stack test results

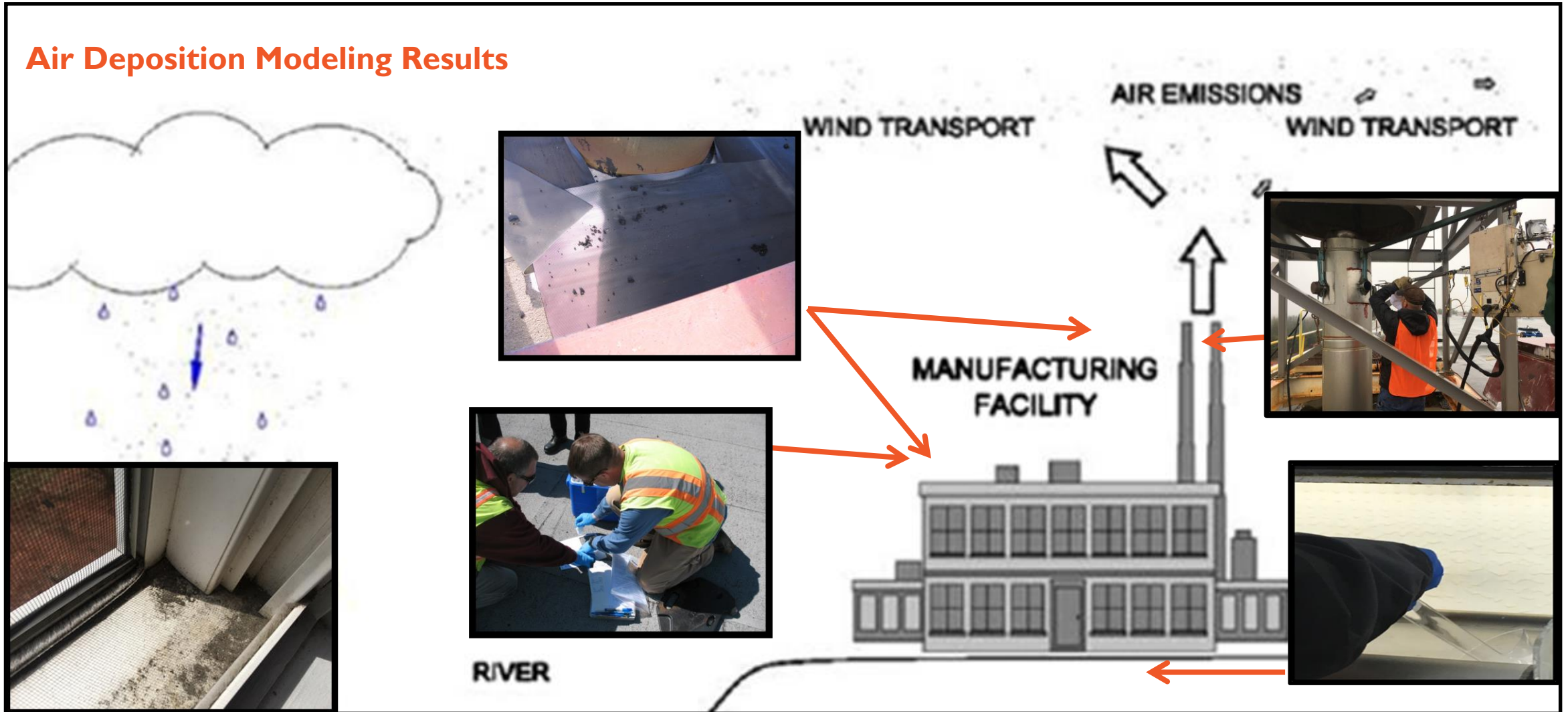
Air Deposition Modeling of Historical PFOA Emissions

- To identify where additional private well sampling should be done
- To determine the size/shape of deposition area
- Identification places to further evaluate during the site investigation (e.g. soil or groundwater testing)



Was PFAS still being released? Where might it have gone?

Air Deposition Modeling Results



Davis et al., 2007, *Chemosphere*

See September 26, 2018 Letter from NHDES to SGPP *Determination of BACT Applicability Pursuant to RSA 125-C:10-e, II* for in depth listing of analytical results.



NH AIR EMISSION STACK TESTING

Observations from 2016 stack tests:

- PFOA, PFHxA and PFPeA emissions at low levels.
- Emissions occurred even when product was not being run.
- Cleaning the ovens and replacing duct work, stack and dilution fan reduced PFOA emissions by 67%.

Observations from 2018 stack tests:

- At least one fraction of the sample train had detections of:

PFBA	PFPeA	PFHxA	PFHpA	PFOA
PFNA	PFBS	PFHxS	PFOS	HPFO-DA
- Pilot-scale pollution control device was not effective for all PFAS.
- EPA ORD detected 190 different PFAS and tentatively identified 89 compounds in some of the fractions of the stack test samples and 12 PFAS in the SUMMA canisters
- PFAS emissions were still high enough to trigger NH BACT Law



NH STATE STATUTE RSA 125-C:10-e *Requirements for Air Emissions of Perfluorinated Compounds Impacting Soil and Water*

BACT Requirement

- A device that emits to the air any PFCs or precursors that have caused or contributed to an exceedance of an AGQS or SWQS as a result of the deposition of any such PFCs or precursors from the air, shall be subject to the determination and application of BACT.
- The construction, installation, or modification of any device that has the potential, based on an applicability threshold adopted by the department, to cause or contribute to an exceedance of an AGQS or SWQS as a result of the deposition of any PFCs or precursors from the air, shall be prohibited without first applying for and obtaining a permit from the department that establishes emission limitations for such device based on BACT.

Cause/Contribute Requirement

- The application of BACT cannot cause or contribute to or have the potential to cause or contribute to an exceedance of an AGQS or SWQS, as a result of the deposition from the air.

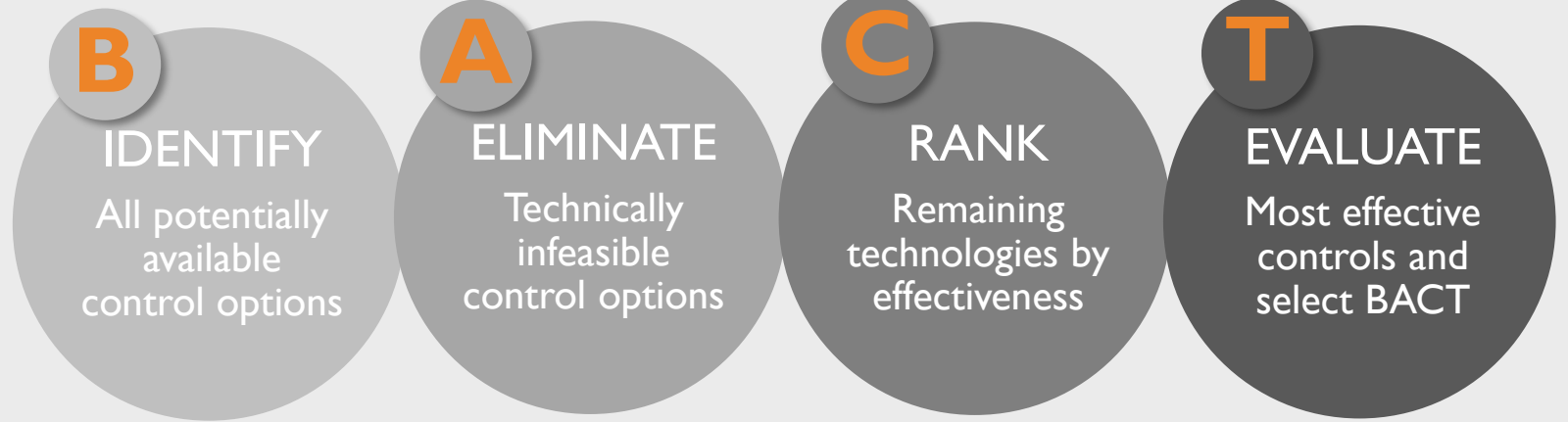




PFAS REGULATION AND CONTROL EQUIPMENT

BACT LAW

NH State Statute RSA 125-C:10-e,
*Requirements for Air Emissions of Perfluorinated
Compounds Impacting Soil and Water*



BEST AVAILABLE CONTROL TECHNOLOGY

...an **emission limitation** based on the **maximum degree of reduction for each air contaminant** that would be emitted from any device that the department, on a case-by-case basis, taking into account **energy, environmental, public health, and economic impacts** and other costs, determines is **achievable** for such device through application of production processes or **available equipment**, methods, systems, and techniques...

- RSA 125-C:10-b, I(a)



Pilot Scale
Fiberbed Mist
Collection
System



PFAS REGULATION AND CONTROL EQUIPMENT

BACT LAW

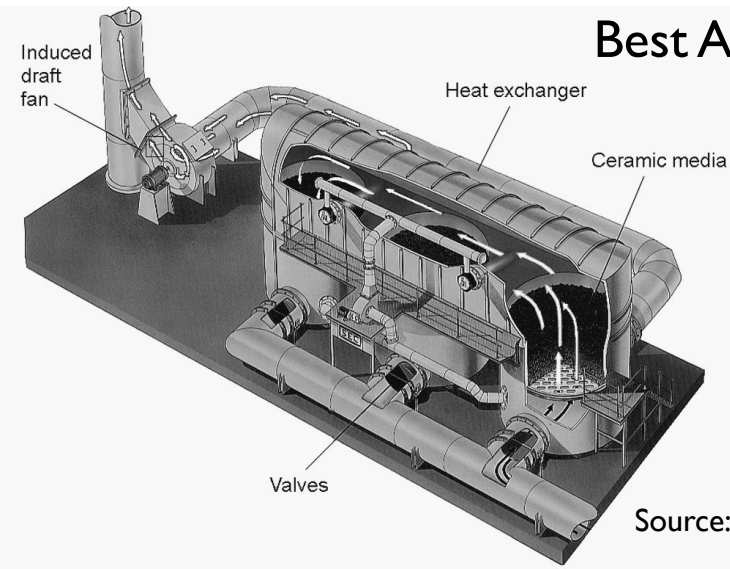
NH State Statute RSA 125-C:10-e,
*Requirements for Air Emissions of Perfluorinated
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CONTROL TECHNOLOGY OPTIONS

Regenerative Thermal Oxidizer (RTO)	Recuperative Thermal Oxidizer	Catalytic Oxidation	Filtration Systems (Fiberbed Mist Collection System)	Absorption (Scrubber)
Highest control effectiveness	Similar control effectiveness of RTO	Lower control effectiveness than oxidizers	Limited efficiency when used in	Low control effectiveness
Best thermal efficiency	Lower thermal efficiency than RTO	Susceptible to catalysts poisoning, blinding and fouling	Questionable effectiveness for all	Transfer PFAS from gas to water stream; water treatment and disposal issues
Ability to reduce all PFAS regardless of carbon chain length	Increased fuel usage and increased emissions	Not suitable for particulate and moisture	High electrical and energy demand; water treatment and disposal issues	



INCREASING CONTROL EFFECTIVENESS



Best Available Control Technology: 3-chamber RTO

Source: [US EPA APTI 415: Control of Gaseous Emission](#)



Per- and Polyfluoroalkyl Substances (PFAS): Incineration to Manage PFAS Waste Streams

Background

Per- and polyfluoroalkyl substances (PFAS) are a very large class of man-made chemicals that include PFOA, PFOS and GenX chemicals. Since the 1940s, PFAS have been manufactured and used in a variety of industries in the United States and around the globe. PFAS are found in everyday items such as food packaging, non-stick stain repellent, and waterproof products, including clothes and other products used by outdoor enthusiasts. PFAS are also widely used in industrial applications and for firefighting. PFAS can enter the environment through production or waste streams and can be very persistent in the environment and the human body. PFAS have many and varied pathways into waste streams, presenting challenges for ultimate disposal. Determining the appropriate method for ultimate disposal of PFAS wastes is a complex issue due to their volatility, solubility, and environmental mobility and persistence. EPA is currently considering multiple disposal techniques, including incineration, to effectively treat and dispose of PFAS waste.



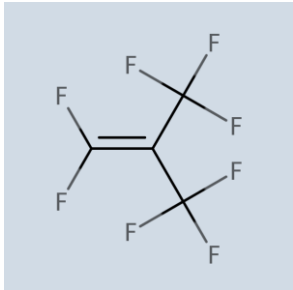
Incineration of halogenated organic compounds occurs via unimolecular decomposition and radical reaction. For unimolecular decomposition, fluorinated organic compounds require temperatures above 1,000°C to achieve 99.99% destruction in 1 second residence time. Unimolecular decomposition of highly fluorinated organics most likely occurs through breakage of C-C or C-F bonds (Tsang et al., 1998). The most difficult fluorinated organic compound to decompose is CF₄, requiring temperatures over 1,400°C, but is easily monitored, making it a potential candidate for destructibility trials.

Options and Considerations for the Disposal of PFAS Waste via Incineration

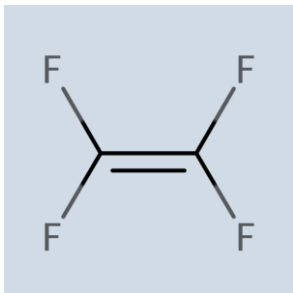
One potential disposal method for PFAS waste is through high temperature chemical breakdown, or incineration. Incineration has been used as a method of destroying related halogenated organic chemicals such as polychlorinated biphenyls (PCBs) and ozone-depleting substances (ODSs), where sufficiently high temperatures and long residence times break the carbon-halogen bond, after which the halogen can be scrubbed from the flue gas, typically as an alkali-halogen. PFAS compounds are difficult to break down due to fluorine's electronegativity and the chemical stability of fluorinated compounds. Incomplete destruction of PFAS compounds can result in the formation of smaller PFAS products, or products of incomplete combustion (PICs), which may not have been researched and thus could be a potential chemical of concern.

Fluorinated organic compounds can also be degraded via incineration by free radical initiation, propagation, and branching mechanisms. Although hydroxyl radical reaction with hydrocarbons is a common combustion flame-propagating mechanism, the strength of the C-F bond makes this pathway unlikely and would instead leave atomic hydrogen, formed at high temperatures, as the likely radical reacting with the carbon-bonded fluorine.

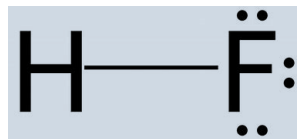
Temperature	Minimum temperature of 1832°F (1000°C)
Time and Turbulence	Minimum gas residence time of 1 second Inlet flow rate not to exceed 70,000 scfm
Oxidizes PFAS	Oxidizes PFAS regardless of regulatory limits Concern about PICs and HF formation



PFIB



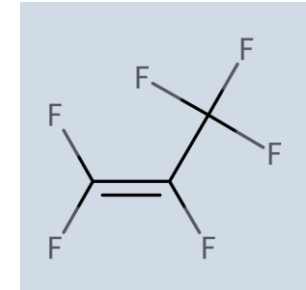
TFE



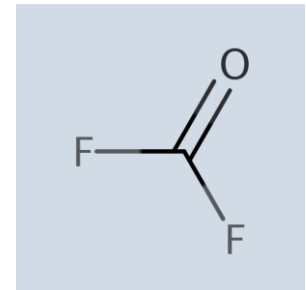
Hydrogen Fluoride

WHERE DO WE GO FROM HERE?

- Installation, operation and testing of RTO.
- Further evaluation of NH Air Toxics Rule applicability using RTO stack test results.
- Further investigation of other industrial facilities including stack testing, evaluation of stack test results, reviewing national data
- Conduct a rainwater study of PFAS background levels – NADP sites
- Continue work with EPA ORD on methods development and validation including OTM-45 which is a quantitative method for polar PFAS compounds and fluorotelomer alcohols and another destruction efficiency test method using CF_4 or C_2F_6 as surrogates
- Review TRI data next year and determine other potential sites.



HFP



Carbonyl Fluoride