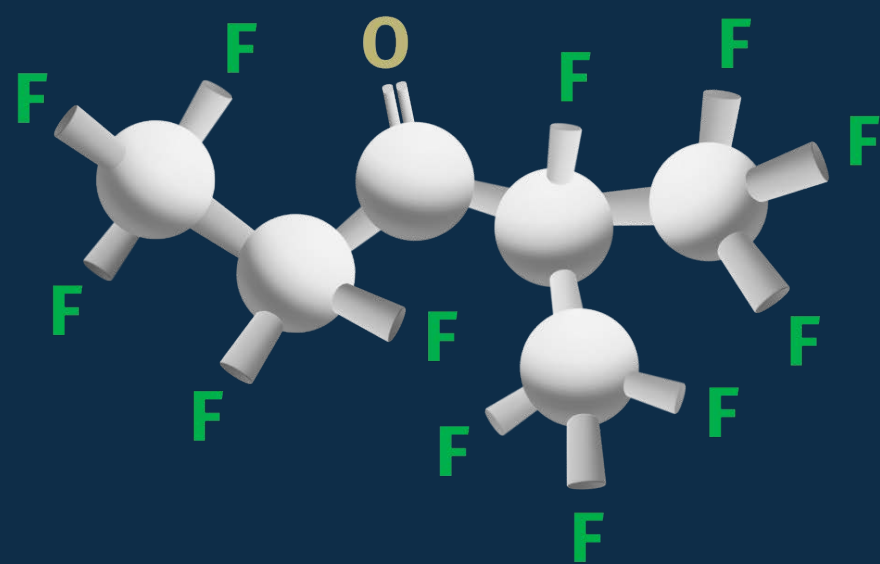


FK-5-1-12

What is FK-5-1-12?

FK-5-1-12 is a NEAT* chemical. It is used as a fire protection *Clean Agent* that does not react with electronics or leave a residue.

* NEAT is a pure substance, a single compound, or a single element, that happens to be in the liquid phase.



PROPERTIES	UNIT	WATER	FK-5-1-12
Boiling Point	°C	100	49
Freezing Point	°C	0	-108
Solubility of FK-5-1-12 into water and vice versa	ppm	~1	20 ppm max
Specific Heat, vapor, Cp @ 25°C	kJ/kg °C	1.87	0.891
Vapor Pressure @ 25°C	kPa	3.17	40.36
Heat of Vaporization @ 25°C	kJ/kg	2442	94.9

FACTS about FK-5-1-12



FK-5-1-12 evaporates **50x** faster than water.



FK-5-1-12 has little to no affinity to water.



FK-5-1-12 will not partition to ground water when used in fire suppression.



FK-5-1-12 will partition to the atmosphere and break down via UV ray absorbance in about 1 week.

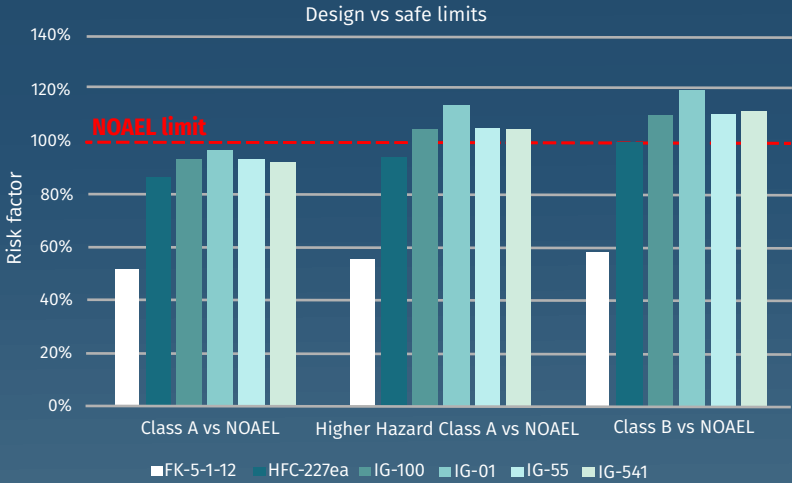


FK-5-1-12 is not on the EPA TRI list (Toxic Release Inventory).



FK-5-1-12 is listed on the EPA SNAP list as safe for use in occupied spaces.

FK-5-1-12 has the greatest safety factor of all gaseous fire extinguishing agents



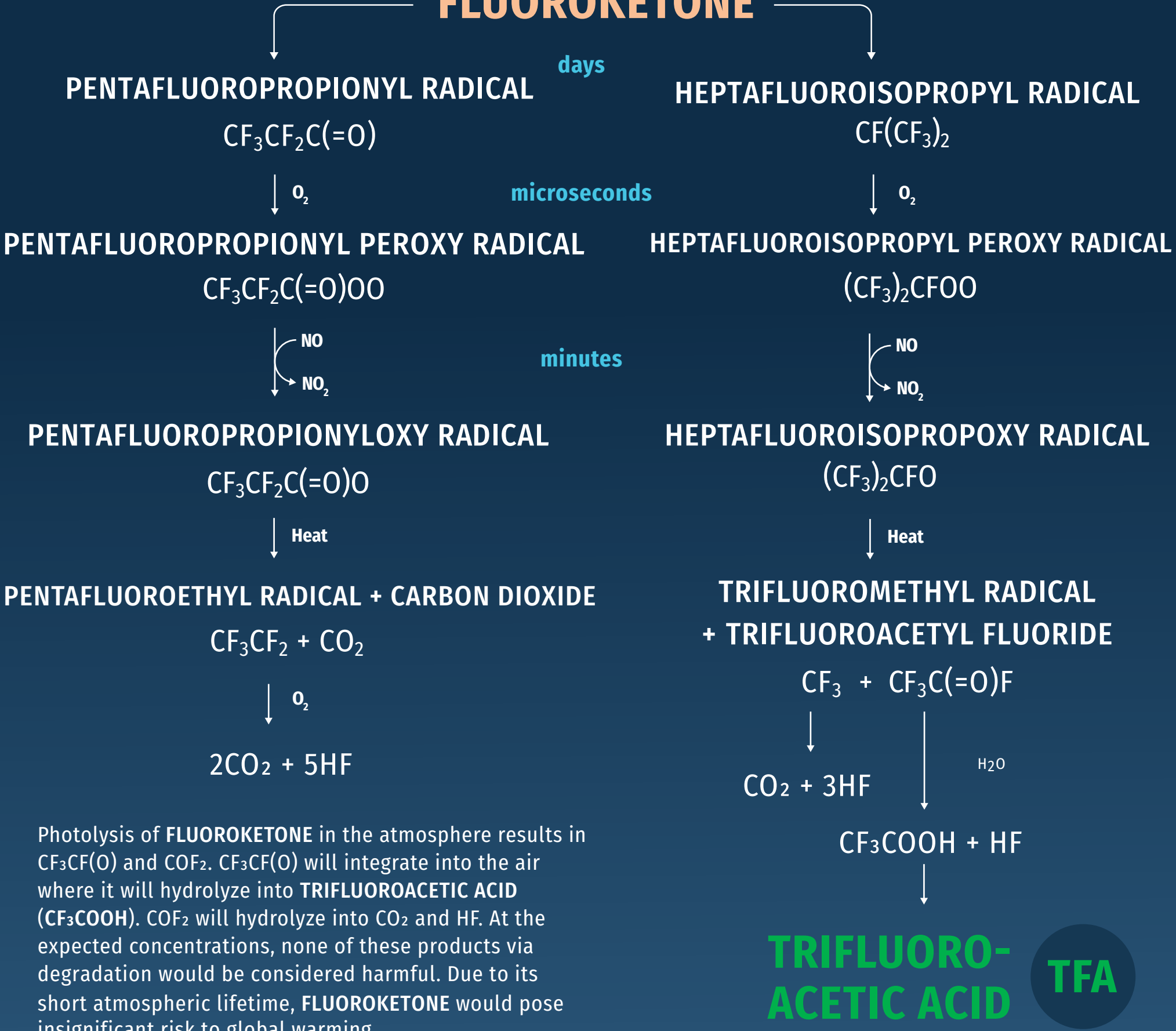
Degradation Mechanism¹²



Atmospheric
degradation
of FK-5-1-12

FK-5-1-12

FLUOROKETONE



Photolysis of **FLUOROKETONE** in the atmosphere results in $\text{CF}_3\text{CF(O)}$ and COF_2 . $\text{CF}_3\text{CF(O)}$ will integrate into the air where it will hydrolyze into **TRIFLUOROACETIC ACID** (CF_3COOH). COF_2 will hydrolyze into CO_2 and HF . At the expected concentrations, none of these products via degradation would be considered harmful. Due to its short atmospheric lifetime, **FLUOROKETONE** would pose insignificant risk to global warming.

Overall Reaction

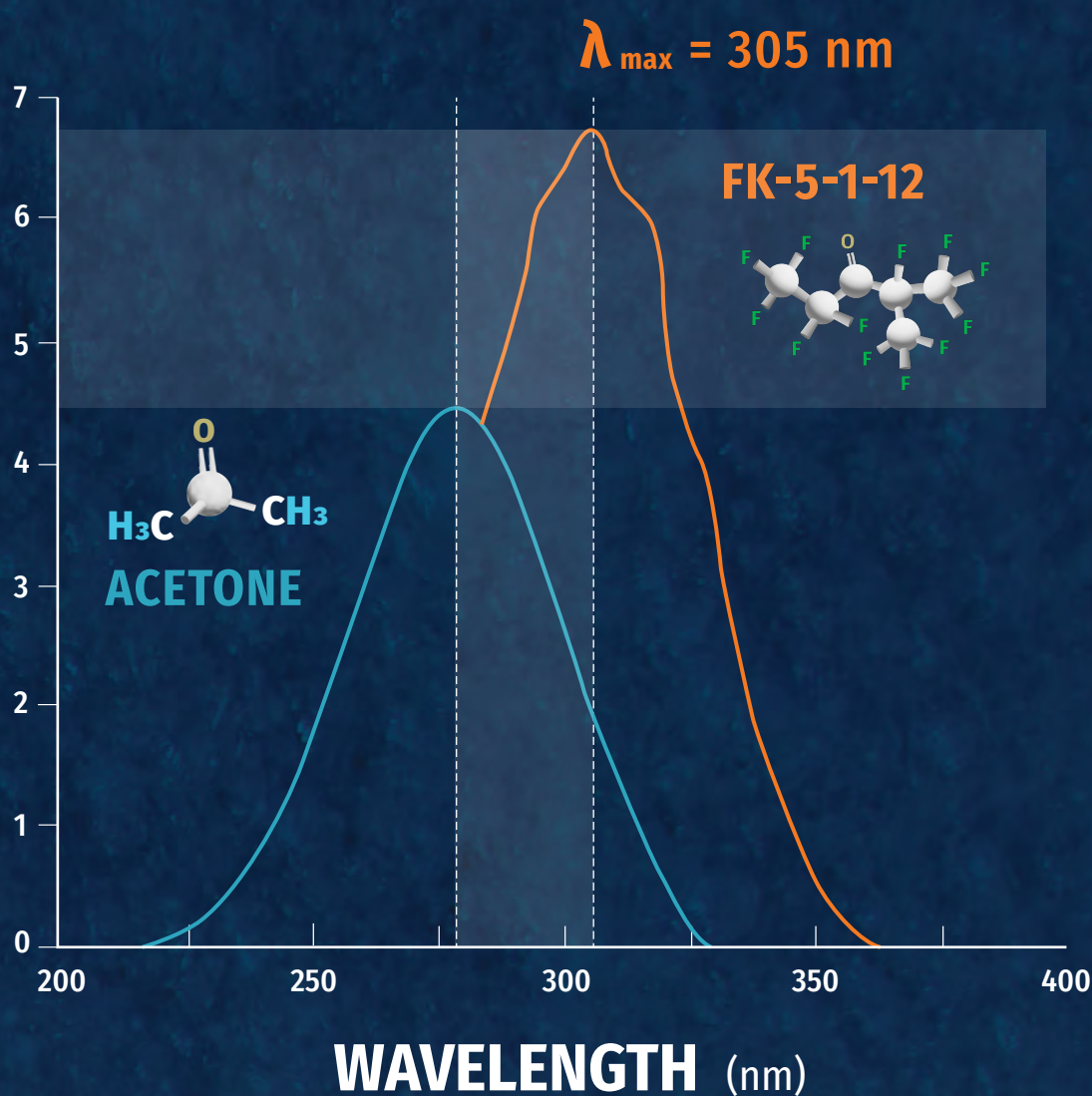


Into what resultant products does
FK-5-1-12 break down?

KETONE	MW	COMPOSITION	TOTAL	% PRODUCT	Δ MASS
C ₆ F ₁₂ O	316	1	316	----	316
PRODUCTS					
CF ₃ COOH	114	1	114	24.3%	114
HF	20	9	180	38.3%	180
CO ₂	44	4	176	37.4%	176
			470	100%	470

UV Absorption of Ketones

CROSS-SECTION
($10^{-20} \text{ cm}^2 \text{ molecule}^{-1}$)



FK-5-1-12 undergoes a degradation in the atmosphere when compared to **Acetone**, a structurally similar chemical.

Photolysis of **FK-5-1-12**

Taniguchi, N., Wallington, T. J., Hurley, M. D., Guschin, A. G., Molina, L. T., & Molina, M. J. (2003). Atmospheric Chemistry of $\text{C}_2\text{F}_5\text{C}(\text{O})\text{CF}(\text{CF}_3)_2$: Photolysis and Reaction with Cl Atoms, OH Radicals, and Ozone. *Journal of Physical Chemistry A*, 107(15), 2674-2679. <https://doi.org/10.1021/jp0220332>

MESOSPHERE

100's of years into Mesosphere

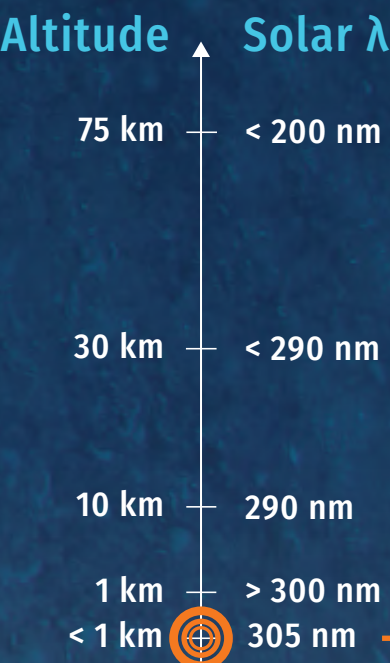
STRATOSPHERE

1 to 3 years into Stratosphere

TROPOSPHERE

Days to weeks to reach Troposphere

Hours to reach planetary boundary layer



The photolysis rate of **FK-5-1-12** leads to an atmospheric lifetime of 4.5 to 15 days.

Break Point -
Photolysis of **FK-5-1-12**

TFA the NATURAL PFAS

PFAS⁸

Per- and polyfluoroalkyl substances

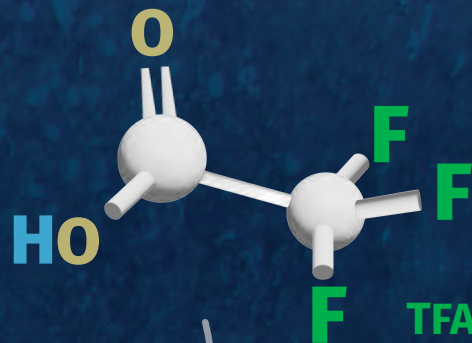
Mostly man-made chemicals, widely used for their durability and stability. Used in consumer and industrial applications, such as — stain resistant fabric, nonstick cookware, semiconductor manufacturing, food packaging, pharmaceuticals and medical devices.¹⁰

Long Chain = PFOA
≥ 7 carbons

Small Chain = TFA
≤ 6 carbons

Some PFAS exhibit high persistence in both the environment and the human body, meaning they do not degrade and have the ability to accumulate over a period of time. Studies suggest that long-term exposure to certain PFAS may be linked to health effects.⁶

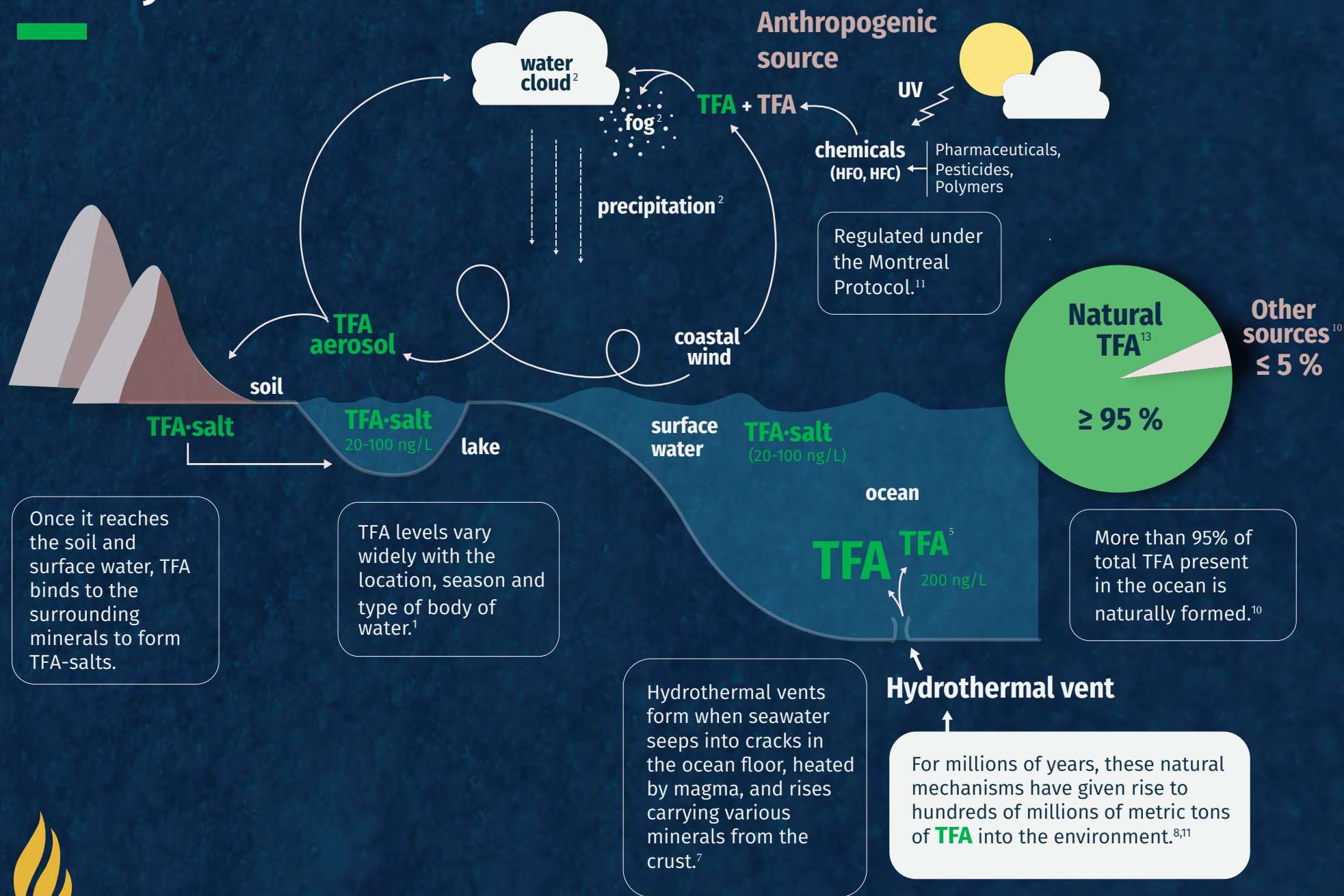
TFA has existed in the environment, well before the industrial era. According to EPA, the current and projected concentrations are highly unlikely to have detrimental effects on humans and ecosystems from a toxicological standpoint.



TFA molecule

Trifluoroacetic acid, also called TFA, is a liquid miscible with water that rapidly converts to salts (sodium, potassium and carbonate) when released in the environment.

Its Cycle Through the Ecosystem.



How much TFA?

If we assume that the entire amount of **TFA** produced between 1990 and 2100 is transferred to the oceans as a final destination and evenly distributed, the resulting concentration in the ocean would be 18.6 ppt (or 18.6 ng/L).¹²



This is the equivalent of
1 Grain of salt
inside **2 Olympic pools**

Assuming 1 olympic pool contains 2.5 millions liters of water & 1 grain of salt is 93 mg.

or

It will take
24 million Grains of salt in each pool to reach the NOAEL.
(TFA-sodium salt equivalent)

NOAEL = No Observed Adverse Effect Level



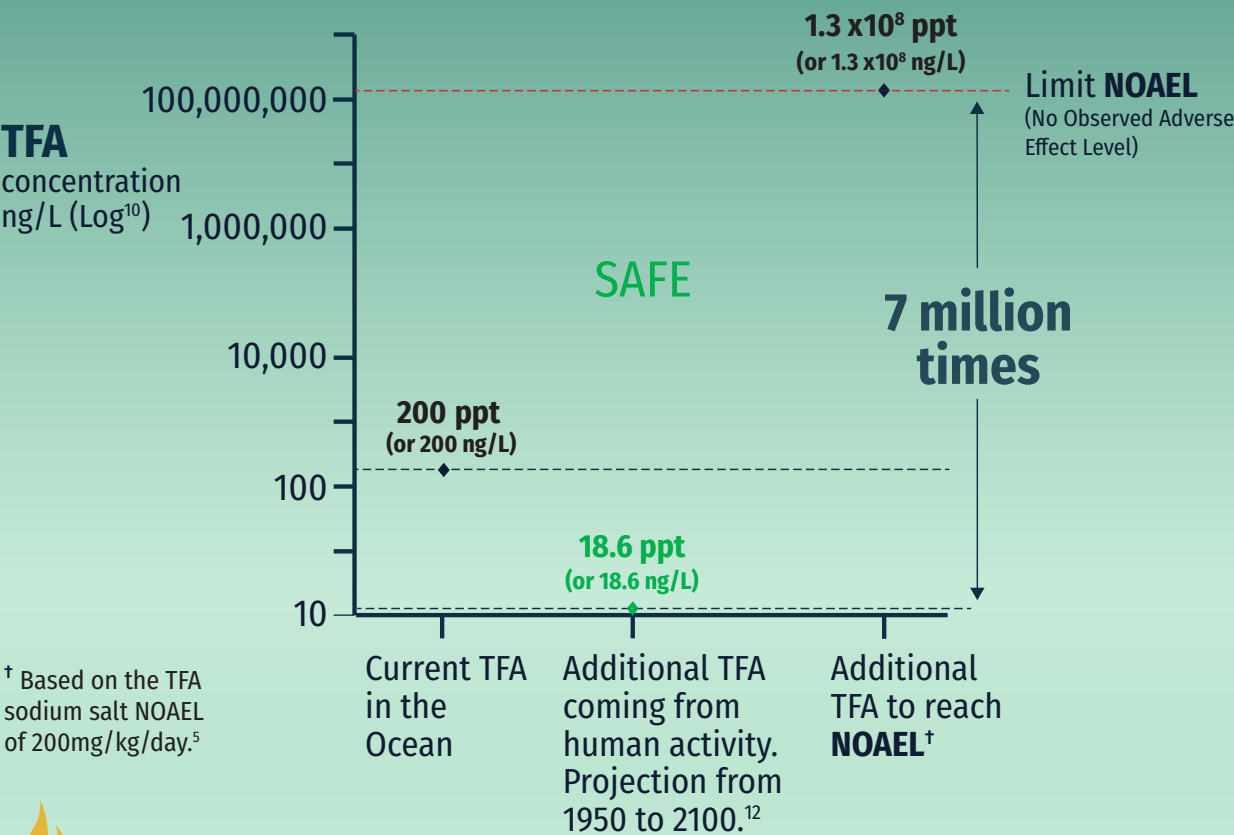
The fate of TFA was investigated in animal subjects, and as anticipated due to its ability to dissolve in water, it is quickly removed from the body through the kidneys and excreted in urine. In humans, it has a half-life of 25-32 hours in the blood.



« TFA continues to be found in the environment, including in remote regions, although concentrations are currently very unlikely to have adverse toxicological consequences for humans and ecosystems. »
EEAP & UNEP Organizations, update 2020.⁹

SAFETY

TFA safety from water intake^{4,12}



Based on this projection, it will take a production increase of **7 million times more TFA** to reach the lowest toxicity level of TFA in drinking water, by 2100.



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TFA

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