Environmental Investigation Agency Comments on Proposed Part 495, Sulfur Hexafluoride Standards and Reporting
submitted via email

The Environmental Investigation Agency (EIA) appreciates the opportunity to submit comments on proposed Title 6 NYCRR Part 495 Sulfur Hexafluoride Standards and Reporting. EIA is an independent non-profit campaigning organization dedicated to identifying, investigating, and implementing solutions to the world's most pressing environmental problems. Our climate campaign focuses on reducing the climate impact of fluorinated gases (F-gases), by eliminating reliance on these super polluting gases and exposing related illicit trade. We strongly support New York State's efforts to reduce the harmful impacts of Sulfur Hexafluoride (SF_6) on our climate and support the following elements to improve this proposal's climate and health benefits.

EIA appreciates and approves of New York's effort to phaseout SF_6, however, we strongly urge the department to consider phasing out all F-gases in switchgear due to the negative impacts that these fluorinated substitutes will have on the climate and human health. Several known fluorinated substitutes to SF_6 are per- or polyfluoroalkyl substances (PFAS), or forever chemicals with known toxicity and health impacts, and some of these also have considerable climate impacts albeit significantly less than SF_6

Non-fluorinated, non-PFAS alternatives are available for this sector with no climate impacts or toxicity concerns. The European Union (EU) will prohibit the putting into operation of medium voltage electrical switchgear relying on F-gases from 2026 (up to and including 24kV) and 2030 (from more than 24kV and up to and including 52kV).[1] Putting into operation high voltage switchgear using F-gases with a global warming potential (GWP) of 1 or more is banned from 2028 (from 52kV up to and including 145kV) and 2032 (more than 145kV).[2] As New York seeks to lead on climate mitigation of F-gases, environmental justice must remain front and center in all policy and regulatory actions. Eliminating SF_6 without also prohibiting other fluorinated substitutes could encourage unnecessary industry uptake of PFAS substances for use in electrical switchgear. These fluorinated substances leak during servicing and when equipment is retired, releasing potent greenhouse gases and potentially exposing workers and nearby communities to toxic pollution. Phasing out all F-gases in switchgear is a low-hanging fruit to eliminate non-essential uses of PFAS substances to protect the climate and public health.

EIA strongly supports the SF_6 phaseout and recommends the New York DEC consider the following factors to strengthen the proposed rule:

- Currently, the proposal leaves the door open for fluorinated SF_6 substitutes with high-GWPs that are also PFAS. New York should consider going beyond the EU's model and implementing a complete F-gas phaseout for switchgear; or match the EU's 1 GWP cap on switchgear.
- Allowing fluorinated F-gas substitutes which are PFAS runs counter to New York's recent efforts to counteract and hold companies accountable for PFAS pollution, including its recent legal

[1] Regulation (EU) No 2024/573, Article 13(9a-b).
[2] Regulation (EU) No 2024/573, Article 13(9c-d).

settlement against 3M for the production of these chemicals.[3] There are significant toxicity concerns with fluorinated SF_6 substitutes, including fluoronitrile (C4FN), fluoroketone, and hydrofluoroolefin (HFO)-1234yf, among others.

- Safe and climate-friendly alternatives with GWPs of zero and no toxicity concerns have already been on the market for over 10 years.[4] This includes AIG (air insulated gas) switchgear equipment which relies on natural-origin gases (NOGs) or "dry air," which is made up of an oxygen and nitrogen mix. New York can lead the federal government in this next phaseout, just as California and Washington have shown what is possible for managing HFCs.

The climate damages of fluorinated SF_6 substitutes

The climate impact of SF_6 is significant, known for being the most potent greenhouse gas with a GWP100 of 23,500 and an atmospheric lifetime of 3,200 years.[5] However, potential fluorinated SF_6 substitutes which this proposal would encourage are also of major concern; this includes fluoronitrile with a GWP100 of 2750.[6] Even when mixed with other gases, fluoronitrile still has a GWP100 of up to 700.[7] Increasing electricity demand and the transition to decentralized renewable energy sources drive the need for medium- and high-voltage switchgear. The stock of installed medium-voltage switchgear units is expected to increase between 40 and 90 percent by 2050.[8] To prevent these still high-GWP SF_6 alternatives from being introduced and harming the climate for decades, New York must strongly consider a complete phaseout of F-gas insulated switchgear in this or future rulemakings given the availability of zero-GWP alternatives.

By capping F-gas switchgear at a GWP of 1, the EU has laid a path upon which New York can build. If necessary to ease concerns about the speed of the transition, DEC can implement exceptions similar to the EU, allowing for F-gases under 1,000 GWP in switchgear equipment only when a two-year procurement process has resulted in no bids for the required equipment. It should also be noted the EU has prohibited the use of virgin SF_6 for maintenance and servicing starting in 2035.[9] Furthermore, leakage checks, emission containment, and labeling requirements have been extended to cover SF_6 in electrical switchgear.

The climate-friendly & non-toxic alternatives are available

Fortunately, these climate super polluting and PFAS-containing fluorinated SF_6 substitutes are not the only viable solutions for GIE (gas insulated equipment). Safe and climate-friendly alternatives have already been on the market for over 10 years. This includes AIG switchgear equipment which relies on NOGs or "dry air," which is made up of an oxygen and nitrogen mix. In addition to having a GWP of 0

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[3] New York State Attorney General. Attorney General James Secures Critical Improvements to Proposed Multibillion Dollar Settlement with 3M for Contaminating Drinking Water with Toxic PFAS. (August 2023).
[4] Switching Gears for Net Zero Alliance.Why we need action today. (2024) https://www.switchinggearsfornetzero.com/#positions
[5] EPA. Sulfur Hexafluoride (SF_6) Basics. (April 2023). https://www.epa.gov/eps-partnership/sulfur-hexafluoride-sf6-basics
[6] IPCC. The Earth's Energy Budget, Climate Feedbacks and Climate Sensitivity Supplementary Material. https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter07_SM.pdf
[7] GE Solutions. Handbook C4-FN Mixtures For High-Voltage Equipment. (May 2023). https://www.gegridsolutions.com/products/reference/handbook-c4-fn-mixtures-for-high-voltage-equipment-v1.1.pdf
[8] IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press.
[9] Regulation (EU) No 2024/573, Article 13(7).

and no toxicity concerns, these gases are not able to be patented, meaning they will continue to be readily and cheaply available. This is in contrast to the current supplier of a PFAS used in switchgear, 3M, who has announced they will stop their production of these substances by the end of 2025.[10] The industry is ready to move away from this detrimental technology. Additionally, AIG technology has U.S.-based production streams compared to potential supply chain vulnerabilities linked to PFAS-insulating gases which will primarily be produced in Asian markets.

The health risks of fluorinated SF_6 substitutes as PFAS

In addition to the climate damage fluorinated SF_6 substitutes for switchgear represent, many of them are also PFAS which can cause significant health risks for the technicians servicing equipment, communities living near switchgear equipment, and for the general public. SF_6 substitutes, such as fluoronitrile and fluoroketone fall into this category. The Organisation for Economic Co-operation and Development (OECD) defines PFAS as "fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it), i.e. with a few noted exceptions, any chemical with at least a perfluorinated methyl group (–CF3) or a perfluorinated methylene group (–CF2–) is a PFAS."[11]

Fluoronitrile has also been found to be toxic, with highly concentrated exposure found to trigger neurological issues like memory alterations and brain toxicity in mice, weeks after exposure.[12] Studies have also concluded the acute toxicity of both fluoronitrile and fluoroketone is higher than SF_6, so more precautions must be taken to ensure the safety of people in case of gas leakage.[13] Long-term testing with gas-insulated high-voltage (HV) switchgear resulted in decomposition products, formed by fluoronitrile in combination with gas moisture, which are classified as hazardous and toxic.[14] Even SF_6 alternatives with low-GWPs (under 20) are still classified by the EPA CompTox database as having PFAS structures,[15] including Fluoroketone, HFO-1336mzzE, HFO-1234yf, HFO-1234zeE, and HFO-1233zd. Fluoronitrile and fluoroketone are also on the Contaminant Candidate List (CCL) 5 PFAS subset, which are not currently subject to proposed or promulgated national drinking water regulation, but are known or

[10] 3M News Center. 3M to Exit PFAS Manufacturing by the End of 2025. (Dec 2022). https://news.3m.com/2022-12-20-3M-to-Exit-PFAS-Manufacturing-by-the-End-of-2025

[11] OECD. Environment Directorate Chemicals And Biotechnology Committee. Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance. (July 2021). https://one.oecd.org/document/ENV/CBC/MONO(2021)25/En/pdf

[12] A. CARLES et. al., "Heptafluoroisobutyronitrile (C4F7N), a gas used for insulating and arc quenching in electrical switchgear, is neurotoxic in the mouse brain", Toxicology, (Sept. 2022)

[13] Hazard study of medium-voltage switchgear with SF 6 alternative gas in electrical room. Christophe Preve, Ge´ et al.. ISSN 2515-0855 doi: 10.1049/oap-cired.2017.0385 (June 2017). https://ineris.hal.science/ineris-01863162/document

[14] Investigations on the long-term performance of Fluoronitrile-containing gas mixtures in gas-insulated systems, K. Juhre et al. , CIGRE ID1114, (Aug 2022).

[15] EPA CompTox Chemicals Dashboard, PFAS structures list consists of all records with a structure assigned, and using a combination of a set of substructural filters and percent of fluorine in the molecular formula ignoring all hydrogen atoms. For example, for a compound with the molecular formula C6HF9O6, the percent of fluorine excluding hydrogen contained in the formula would be 9F/(6C + 9F + 6O) = 42%. A threshold of 30% fluorine without hydrogen allows for inclusion of some of the complex highly fluorinated structures. The combination of the set of substructural filters are designed to be simple, reproducible and transparent, yet general enough to encompass the largest set of structures having sufficient levels of fluorination to potentially impart PFAS-type properties. The combination of substructural filters and threshold of percentage of fluorination were identified in the development of the manuscript "A Proposed approach to defining per- and polyfluoroalkyl substances (PFAS) based on molecular structure and formula" by Gaines et al. https://comptox.epa.gov/dashboard/chemical-lists/PFASSTRUCTV5

anticipated to occur in public water systems and may require future regulation under the Safe Drinking Water Act.[16]

New York lawsuit due to PFAS water pollution

The risks presented by these substances have led to more than half of U.S. state attorney generals, including New York, suing the producers of PFAS chemicals for various uses due to their harm to public health.[17] The State's subsequent $10.5 to $12.5 billion settlement with 3M for its role in contaminating millions of Americans' drinking water with PFAS underscores the need to keep these substances from spreading into GIE such as switchgear. New York's ambitious Climate Action Plan aims to achieve 70 percent renewable energy by 2030; 100 percent zero-emission electricity by 2040; a 40-percent reduction in statewide greenhouse gas emissions from 1990 levels by 2030, an 85-percent reduction from 1990 levels by 2050; and net-zero emissions statewide by 2050. However, allowing for the introduction of fluorinated SF_6 substitutes into switchgear stands contrary to these goals. Given this equipment will be in use for decades to come, it is important to consider longer-term health and environmental risks.

SF_6 F-gas substitutes link to Trifluoroacetic Acid (TFA)

The fluorinated SF_6 substitute HFO-1234yf produces 92-100 percent yield of trifluoroacetate as it breaks down. As PFAS precursor compounds, hydrofluorocarbons (HFCs) and HFOs undergo oxidation in the atmosphere to become perfluorocarboxylic acids (PFCA), which are TFA and PFPrA. These are then transported through the ocean or on marine aerosols. Research on TFA presence in the Arctic indicates that increased use of HFOs will lead to greater burdens of TFA even in remote regions.[18]

There is cause for concern with the rising levels of TFA and other short-chain perfluoroalkyl acids, in Arctic ice cores since 1990, which researchers link to the transition away from chlorofluorocarbons (CFCs) to hydrochlorofluorocarbon (HCFCs) and HFCs, major precursor sources for TFA & PFPrA.[19] Recent studies of regional TFA distribution in both major metropolitan areas of Northern California and remote areas in Alaska show a 6-fold increase in TFA concentrations over the past 23 years. Researchers found highest concentrations in streams immediately downwind of the San Francisco Bay Area.[20]

Research on the breadth of TFA's harmful impacts on humans and ecosystems continues to evolve, although there is existing evidence of its toxicity and persistence in the environment, underscoring the need to restrict its sources. TFA is toxic to plants,[21] and the accumulation of short-chain PFCAs has been

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[16] EPA, Contaminant Candidate List 5 - CCL 5, https://www.epa.gov/ccl/contaminant-candidate-list-5-ccl-5

[17] Safer States & Toxic Free Future. PFAS Action:vGovernments, Retailers, andvBrands are Stepping Up https://www.saferstates.org/wp-content/uploads/PFAS-Momentum-Factsheet-1.24.2024.pdf
New York State Attorney General. Attorney General James Secures Critical Improvements to Proposed Multibillion Dollar Settlement with 3M for Contaminating Drinking Water with Toxic PFAS. (August 2023). https://ag.ny.gov/press-release/2023/attorney-general-james-secures-critical-improvements-proposed-multibillion

[18] Pickard, H. M. et al., Ice Core Record of Persistent Short-Chain Fluorinated Alkyl Acids: Evidence of the Impact From Global Environmental Regulations, Geophysical Research Letters, (2020), available here.

[19] Pickard, H. M. et al., Ice Core Record of Persistent Short-Chain Fluorinated Alkyl Acids: Evidence of the Impact From Global Environmental Regulations, Geophysical Research Letters, (2020), available here.

[20] Cahill, T. M., Increases in Trifluoroacetate Concentrations in Surface Waters over Two Decades, ACS Publications, (2022), available here.

[21] Solomon, K. R. et al., Sources, fates, toxicity, and risks of trifluoroacetic acid and its salts: Relevance to substances regulated under the Montreal and Kyoto Protocols, Journal of Toxicology and Environmental Health, Part B, (2016), available here.

demonstrated in plants, including crops for human consumption.[22] Recent studies measuring human serum showed TFA concentrations higher than all other PFAS except for perfluorooctanoic acid and perfluorooctane sulfonic acid.[23] A 2023 study found positive correlations between TFA, perfluorobutanoic acid (PFBA, C4), and perfluoroheptanoic acid (PFHpA, C7) concentrations in dust or water and human serum, suggesting dust ingestion and/or drinking water consumption are exposure pathways and that these compounds are now abundant in the indoor environment.[24] TFA is harmful to aquatic organisms, and short-chain PFAS are more widely detected, more persistent, and more mobile in aquatic systems, posing potential risk for human and ecosystem health.[25] TFA has been shown to have negative impacts on the liver function of rats at high enough concentrations.[26]

Given the established risks associated with HFO-1234yf, we believe it is appropriate to limit their abundance, particularly given the market availability of non-fluorinated alternatives that do not pose similar threats.

EIA appreciates New York DEC's recognition of the urgent need to phaseout SF_6. However, we remain concerned that this proposal could encourage an unintended transition to fluorinated SF_6 substitutes in switchgear. The climate damage of F-gases is well known and the established health risks are mounting. Given the availability of zero-GWP, non-toxic, unpatented, comparable technology, New York should at least follow the EU's lead and proceed with a GWP limit of 1 for switchgear, if not a complete phaseout of F-gases for this end-use.

Thank you for considering our comments on the proposed amendments to Part 495. We are available for further discussion and to answer any questions on the above recommendations.

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[22] Liu, Z. et al., Multiple crop bioaccumulation and human exposure of perfluoroalkyl substances around a mega fluorochemical industrial park, China: Implication for planting optimization and food safety, Environment International, Volume 127, (2019), available here.
[23] Duan, Y., et al., Distribution of novel and legacy per−/polyfluoroalkyl substances in serum and its associations with two glycemic biomarkers among Chinese adult men and women with normal blood glucose levels, Environment International, (2020), available here.
[24] Zheng, G., Eick, S. M. & Salamova, A., Elevated Levels of Ultrashort- and Short-Chain Perfluoroalkyl Acids in US Homes and People, ACS Publications, (2023), available here.
[25] Li, F. et al., Short-chain per- and polyfluoroalkyl substances in aquatic systems: Occurrence, impacts and treatment, Chemical Engineering Journal, Volume 380, (2020), available here.
[26] Refolution Industriekälte GmbH, Report and statement of the downsides of HFO refrigerant usage (2021), available here.