FRIP | F-gas Reduction Incentive Program

F-GAS REDUCTION INCENTIVE PROGRAM (FRIP):

SOLICITATION FOR THIRD-PARTY SUBCONTRACTOR SERVICES

FOR SYNTHETIC REFRIGERANT DEGRADATION PRODUCTS LITERATURE REVIEW AND WHITE PAPER

Release Date: June 5, 2025

Application Deadline: July 3, 2025

California Climate Investments — Cap and Trade Dollars at Work

California Air Resources Board

North American Sustainable Refrigeration Council

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SOLICITATION PURPOSE

The North American Sustainable Refrigeration Council (NASRC), under a grant from the California Air Resources Board (CARB), is soliciting proposals from qualified third-party subcontractors to conduct a comprehensive literature review and develop a white paper on the environmental and health impacts of synthetic hydrofluorocarbon (HFC) and HFC-alternative refrigerants, foam blowing agents and aerosol propellants and their degradation products. A literature review should focus on key areas like persistence, bioaccumulation, biodegradation, toxicity, and global warming potential (GWP). The selected subcontractor will execute activities outlined in the scope of work below.

PROGRAM OVERVIEW

Pursuant to legislative mandates and climate goals, California has undertaken a number of measures that focus on reducing hydrofluorocarbon (HFC) emissions and transitioning to climate-friendly alternatives. California Senate Bill (SB) 1383 sets a statewide target to reduce HFC emissions by 40% below 2013 levels by 2030. SB 1206 builds on SB 1383, directing the California Air Resources Board (CARB) to assess how to transition California's economy away from HFCs and to ultra-low-GWP (100-year GWP < 10) or no-GWP alternatives no later than 2035 and then to initiate a rulemaking mandating this transition.

HFCs are primarily used as refrigerants and in smaller quantities as foam blowing agents, aerosol propellants, fire suppressants and solvents. Ultra-low-GWP alternatives to HFC refrigerants include both natural refrigerants, such as ammonia, carbon dioxide, and hydrocarbons (e.g., isobutane and propane), as well as synthetic refrigerants such as hydrochlorofluoroethers (HCFE), hydrochlorofluoroolefins (HCFO), and hydrofluoroolefins (HFO). In some sectors and applications, synthetic refrigerants are the ultra-low-GWP alternative of choice. For example, HFO-1234yf has been widely used in mobile vehicle air conditioning since the U.S. EPA updated the Clean Car Rule for model year 2017 and later.[1] Almost all new cars produced today use HFO-1234yf.[2] Similarly, aerosol propellants and foam blowing agents employ both some of the same natural and synthetic compounds. However, when emitted, HFC and HFC-alternative synthetic compounds used in HFC industries (refrigeration and HVAC, foam blowing and aerosol propellants) react with other molecules in the atmosphere and yield persistent and potentially harmful degradation products, such as trifluoroacetic acid (TFA) and other high-GWP greenhouse gases such as HFC-23. In order to make informed policy and regulatory decisions about supporting a transition away from HFCs and to low- and ultra-low-GWP alternatives while

[1] 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 40 C.F.R. Parts 85, 86, and 600 (2012). https://www.govinfo.gov/content/pkg/FR-2012-10-15/pdf/2012-21972.pdf

[2] The 2024 EPA Automotive Trends Report: Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975 (EPA-420-R-24-022, November 2024)

minimizing unintentional negative impacts, CARB requires a more comprehensive understanding of the latest scientific research on the environmental and health impacts associated with the past and future emissions of synthetic refrigerants and other HFC industries identified above, including their atmospheric degradation products.

Up to $25,000 of funding is available for this scope of work. This work requires a fast turnaround. The agreement is expected to be executed in July 2025 and the work is expected to be completed by November 2025.

Funding for this scope of work comes from CARB's F-gas Reduction Incentive Program (FRIP).[3] CARB selected NASRC as the third-party administrator for FRIP Round 2 in Fall 2023 via a competitive solicitation.[4] In close coordination with CARB, NASRC is responsible for administering FRIP.

SCOPE OF WORK

NASRC, under a grant from CARB, seeks a subcontractor to deliver the following services:

Task 1. Administration. Engage in periodic (at least monthly and potentially more frequently at the discretion of NASRC or CARB) consultation calls with grant staff. Submit invoices to NASRC (strong preference for a single invoice upon completion of the project but multiple milestone-based invoices may be possible, if necessary, at NASRC's or CARB's discretion).

Task 2. Research. Review relevant literature on the environmental and health impacts of synthetic HFC and HFC-alternative refrigerants' and other HFC industries' degradation products with increased use. Prioritize critical reviews of recent scientific data, government reports and databases, peer-reviewed publications, and other reports from reputable sources.

- Data Quality: Assess the quality and reliability of the research, with an emphasis on peer-reviewed publications.
- Methodology: Evaluate the methods used in studies, including experimental design, statistical analysis, and data interpretation.
- Study Design: Consider the study design.
- Bias: Identify potential biases in research and findings.
- Consistency: Look for consistency in results across multiple studies. Identify any gaps or unsubstantiated conclusions in the studies referenced.

[3] https://ww2.arb.ca.gov/our-work/programs/FRIP
[4] https://ww2.arb.ca.gov/our-work/programs/FRIP/grant-solicitation

Where possible, identify the funding source for each study referenced. Potential references include but are not limited to the following.

Academic papers such as:

- Behringer, D., Heydel, F., Gschrey, B., Osterheld, S., Schwarz, W., Warncke, K., Henne, S., Reimann Empa, S., Blepp, M., Jörß, W., Liu, R., Ludig, S., & Gartiser, S. (2021). *Final report Persistent degradation products of halogenated refrigerants and blowing agents in the environment: type, environmental concentrations, and fate with particular regard to new halogenated substitutes with low global warming potential*. https://www.umweltbundesamt.de/sites/default/files/medien/5750/publikationen/2021-05-06_texte_73-2021_persistent_degradation_products.pdf
- Bhagyashree Bharal, Ruchitha, C., Kumar, P., Pandey, R., Mahesh Rachamalla, Som Niyogi, Naidu, R., & Kaundal, R. K. (2024). Neurotoxicity of per- and polyfluoroalkyl substances: Evidence and future directions. *The Science of the Total Environment*, 176941–176941. https://doi.org/10.1016/j.scitotenv.2024.176941
- Cousins, I. T., Johansson, J. H., Salter, M. E., Sha, B., & Scheringer, M. (2022). Outside the Safe Operating Space of a New Planetary Boundary for Per- and Polyfluoroalkyl Substances (PFAS). *Environmental Science & Technology*, *56*(16). https://doi.org/10.1021/acs.est.2c02765
- Dekant, W., & Dekant, R. (2023). Mammalian toxicity of trifluoroacetate and assessment of human health risks due to environmental exposures. *Archives of Toxicology*, *97*(4), 1069–1077. https://doi.org/10.1007/s00204-023-03454-y
- Duan, Y., Sun, H., Yao, Y., Meng, Y., & Li, Y. (2020). 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*, *134*, 105295. https://doi.org/10.1016/j.envint.2019.105295
- Fenton, S. E., Ducatman, A., Boobis, A., DeWitt, J. C., Lau, C., Ng, C., Smith, J. S., & Roberts, S. M. (2020). Per- and polyfluoroalkyl substance toxicity and human health review: Current state of knowledge and strategies for informing future research. *Environmental Toxicology and Chemistry*, *40*(3), 606–630. https://doi.org/10.1002/etc.4890
- Fleet, D., Hanlon, J., Osborne, K., La Vedrine, M., Ashford, P. (2017). *Study on environmental and health effects of HFO refrigerants (Publication number: M-917|2017)*. https://varmtochkallt.se/wp-content/uploads/2021/04/M917.pdf
- Glüge, J., Breuer, K., Hafner, A., Vering, C., Müller, D., Cousins, I. T., Lohmann, R., Goldenman, G., & Scheringer, M. (2024). Finding non-fluorinated alternatives to fluorinated gases used as refrigerants. *Environmental Science: Processes & Impacts*, *26*(11), 1955–1974. https://doi.org/10.1039/d4em00444b.
- Goodrum, P. E., Anderson, J. K., Luz, A. L., & Ansell, G. K. (2020). Application of a Framework for Grouping and Mixtures Toxicity Assessment of PFAS: A Closer Examination of Dose-Additivity Approaches. *Toxicological Sciences*, *179*(2), 262–278. https://doi.org/10.1093/toxsci/kfaa123

- Persson, L., Carney Almroth, B. M., Collins, C. D., Cornell, S., de Wit, C. A., Diamond, M. L., Fantke, P., Hassellöv, M., MacLeod, M., Ryberg, M. W., Søgaard Jørgensen, P., Villarrubia-Gómez, P., Wang, Z., & Hauschild, M. Z. (2022). Outside the Safe Operating Space of the Planetary Boundary for Novel Entities. *Environmental Science & Technology*, *56*(3). https://doi.org/10.1021/acs.est.1c04158
- Peter, H., Gredelj, A., Glüge, J., Scheringer, M., & Cousins, I. T. (2024). The Global Threat from the Irreversible Accumulation of Trifluoroacetic Acid (TFA). *Environmental Science & Technology*. https://doi.org/10.1021/acs.est.4c06189
- Peter, H., Gredelj, A., Glüge, J., Scheringer, M., & Cousins, I. T. (2024). The Global Threat from the Irreversible Accumulation of Trifluoroacetic Acid (TFA). *Environmental Science & Technology*. https://doi.org/10.1021/acs.est.4c06189
- Thomson, J. D., Campbell, J. S., Edwards, E. B., Medcraft, C., Nauta, K., Pérez-Peña, M. P., Fisher, J. A., Osborn, D. L., Kable, S. H., & Hansen, C. S. (2024). Fluoroform (CHF_3) Production from CF_3CHO Photolysis and Implications for the Decomposition of Hydrofluoroolefins and Hydrochlorofluoroolefins in the Atmosphere. *Journal of the American Chemical Society*. https://doi.org/10.1021/jacs.4c11776
- Zheng, G., Eick, S. M., & Salamova, A. (2023). Elevated Levels of Ultrashort- and Short-Chain Perfluoroalkyl Acids in US Homes and People. *Environmental Science & Technology*, *57*(42), 15782–15793. https://doi.org/10.1021/acs.est.2c06715

Government documents (including international materials) such as:

- European Chemicals Agency, "Annex B to the Annex XV Restriction Report: Proposal for a Restriction on Per- and Polyfluoroalkyl Substances (PFASs)," March 22, 2023. https://echa.europa.eu/documents/10162/6f4a2076-7221-67a3-64f7-c67cc307f59c
- Newton, D. (2024). *State Water Resources Control Board Executive Summary*. https://www.waterboards.ca.gov/pfas/docs/broad-spectrum-pfas-method-comparison-study-summary-combined.pdf
- *Registration Dossier - ECHA*. (2023). Europa.eu. https://echa.europa.eu/registration-dossier/-/registered-dossier/5203/7/6/2
- Umwelt Bundesamt, "Derivation of a Health Guideline Value for Trifluoroacetic Acid (TFA)" https://www.umweltbundesamt.de/sites/default/files/medien/421/dokumente/ableitung_eines_gesundheitlichen_leitwertes_fuer_trifluoressigsaeure_fuer_uba-homepage.pdf
- Umwelt Bundesamt, "Reducing the Input of Chemicals into Waters: Trifluoroacetate (TFA) as a Persistent and Mobile Substance with Many Sources," November 2021, https://www.umweltbundesamt.de/sites/default/files/medien/11850/publikationen/hgp_reducing_the_input_of_chemicals_into_waters_v2.pdf

Task 3. Draft and finalize literature review report. Synthesize literature findings in a narrative discussion. Topics highlighted should include:

- A list of synthetic refrigerants and non-refrigerant HFC and HFC alternatives and their degradation processes and products based on environmental fate and transport. The list of synthetic compounds should include but is not limited to primary HFCs (e.g., HFC-134a, HFC-125, HFC-23), primary HFOs (e.g., HFO-1234yf, HFO-1233zd(E), HFO-1234ze(E), HFO-1336mzz(Z), HFO-1336mzz(E)), and commonly used HFC and HFC-HFO refrigerant blends (e.g., R-404A, R-410A, R-448A, R-454B).
- Persistence and concentration of degradation products of HFCs and HFC alternatives, such as TFA, in water bodies, including groundwater and surface waters, in crops for human consumption, and in other relevant media.
- Associated research on the environmental detection, fate, and occurrence as well as the health impacts of short-chain per- and polyfluoroalkyl substances (PFAS) with similar characteristics to TFA.
- Toxicity of degradation products to various life forms, including but not limited to aquatic organisms, soil microorganisms, and birds.
- Toxicity of degradation products to human health.
- Contribution of synthetic refrigerants to TFA accumulation in the environment relative to other TFA sources. If not de minimis, the contribution of TFA from non-refrigerant HFC and HFC alternatives must be considered in the analysis.
- Projections on the environmental and health impacts of an increase in synthetic refrigerant usage globally, in concert with impacts of other degradation product sources, through 2100. If not de minimis, the contribution of TFA from non-refrigerant HFC and HFC alternatives must be considered in the analysis.
- Projections on California-specific impacts of degradation products, where applicable.
- Estimated thresholds at which irreversible effects on the environment or health will occur due to the impacts of synthetic refrigerants' and non-refrigerant HFC and HFC alternatives degradation products, on local and global scales.
- Recommendations based on existing data on how to minimize risks associated with using synthetic refrigerants and non-refrigerant HFC and HFC alternatives given the State's goals to reduce HFC emissions and transition to ultra-low-GWP or no-GWP alternatives.
- Future research needs.

New data analysis is not expected under this scope. If the listed topics cannot be addressed sufficiently through existing literature, they should be added to the list of future research needs.

A draft white paper must be provided to NASRC, for delivery to CARB, one month before the end of the contract period. The final white paper should incorporate edits as requested by CARB and NASRC after reviewing the draft.

Task 4. Seminar and Fact Sheet. Conduct a virtual or in-person seminar with CARB staff, NASRC, and other stakeholders (if applicable, at the discretion of NASRC or CARB). Produce a plain-language fact sheet with accessible information about the findings of the literature review (if applicable, at the discretion of NASRC or CARB).

DELIVERABLES

The subcontractor will be expected to provide:

1. Draft literature review, per Task 3.
2. Final, Americans with Disabilities Act (ADA)-compliant literature review, per Task 3.
3. Virtual or in-person seminar presentation on literature review for CARB staff, per Task 4.
4. ADA-compliant plain language fact sheet, per Task 4.

PROPOSAL REQUIREMENTS

Qualified applicants must submit a proposal that includes the following information:

- **Organization Overview:** Description of the organization, relevant experience including examples of similar work products such as but not limited to peer-reviewed publications, and ability to provide a neutral, science-based perspective.
- **Proposed Approach:** Detailed methodology for delivering the scope of work, including timelines and estimated resource allocation for each initiative.
- **Budget:** Itemized cost estimates aligned with the deliverables outlined in this solicitation. NASRC and CARB reserve the right to negotiate the indirect cost rate or any other aspect of the budget prior to agreement execution.
- **Staffing Plan:** Description of key personnel who will deliver on the scope of work and their qualifications.
- **References:** Contact information of three clients or partners who can attest to the organization's ability to deliver similar projects successfully.
- **Declarations and Attestations:** Completed and signed CARB Research Program Conflict of Interest Verification and completed and signed CARB FRIP Declarations and Attestations. Both documents are included as attachments to this solicitation.

EVALUATION CRITERIA

Proposals will be evaluated based on the following criteria:

- Demonstrated understanding of synthetic HFC and HFO compounds, analytical chemistry, environmental fate and transport of chemicals, and toxicology (25 points)
- Relevant experience and qualifications of the team (25 points)

- Ability to provide a neutral, science-based perspective (10 points)
- Responsiveness of the proposal to the goals and objectives outlined in the solicitation (10 points)
- Capacity to deliver high-quality work within the timeframe specified in this solicitation (10 points)
- Cost effectiveness of requested funds as they relate to work proposed and deliverables expected (20 points)

SCORING CRITERIA SCORING GUIDANCE

Point Range	Description
91-100	Exceptionally strong. The submission is technically strong, meets stated research objectives, is cost-effective, and has a high potential to be successfully completed.
81-90	Strong. The submission is technically sound.
71-80	Mixed. The submission has either strong technical merit or strong policy significance, but not both.
61-70	Weak. The submission is not sufficiently linked to the needs of CARB and offers limited technical merit.
60 or below	Unacceptable. The submission is not linked to the interests or needs of CARB and lacks technical merit.

SUBMISSION INSTRUCTIONS

Proposals must be submitted electronically by 5:00 PM Pacific Time on July 3, 2025 to info@fripfunding.com with the subject line "Synthetic Ref Research_[Name of Applicant]". Late submissions will not be considered. For questions or clarifications regarding this solicitation, please contact info@fripfunding.com no later than June 20, 2025. Responses will be publicly posted online by June 25, 2025.

TIMELINE OVERVIEW

Milestone	Date
Solicitation Issuance	June 5, 2025
Deadline for Questions	June 20, 2025
Proposal Submission Due	July 3, 2025
Award Notification	July 18, 2025

TERMS & CONDITIONS

NASRC and CARB reserve the right to reject any or all proposals or cancel this solicitation at any time without obligation or liability to any party. If, in the sole and absolute discretion of NASRC and CARB, no responsive or responsible proposals are

submitted for all or part of the scope, NASRC will not make an award for the relevant scope and will consider other options.