F-GAS REDUCTION INCENTIVE PROGRAM (FRIP):

SOLICITATION FOR THIRD-PARTY SUBCONTRACTOR SERVICES

FOR A RISK ASSESSMENT OF RESIDENTIAL MONOBLOC AIR-TO-WATER HEAT PUMPS USING A3 REFRIGERANTS

Release Date: September 4, 2025

Application Deadline: October 3, 2025

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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 full risk assessment of residential monobloc air-to-water heat pump[1] (ATWHP) configurations using A3[2] refrigerants. This project will include performing a complete flammability risk assessment under different residential installation configurations and lifecycle events for monobloc ATWHPs. This project would be similar to past A2L[2] and A3 refrigerant risk assessments for other residential and commercial heating, ventilation, and air-conditioning (HVAC) system categories. The primary objective of this project is to aid in the development of comprehensive guidelines for stakeholder groups responsible for developing product and application safety standards and building codes (hereafter referred to as "codes and standards") for the safe use of A3 refrigerants, including the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standing Standard Project Committee (SSPC) 15 and Subcommittee 15.2, Underwriters Laboratories (UL) and International Electrotechnical Commission (IEC) 60335-2-40 Standard committees. This research project will provide valuable information for the safe use of flammable refrigerants in the North American market.

PROGRAM OVERVIEW & BACKGROUND

Pursuant to legislative mandates and climate goals, California has undertaken various 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.[3] California SB 1206 builds on SB 1383, directing CARB to assess how to transition California's economy away from HFCs and to ultra-low-global warming potential (GWP) (100-year GWP < 10) or no-GWP alternatives no later than 2035, and then to initiate a rulemaking mandating that transition.[4] California also has aggressive decarbonization goals; Assembly Bill (AB) 1279 set a statewide target to reach carbon

[1] A monobloc air-to-water heat pump (ATWHP) is a relatively new type of indirect HVAC system whereby the refrigerant is fully contained in a single piece of equipment located outside the building. ATWHP systems provide heating and cooling via indirect heat transfer between the outdoor air and a secondary heat transfer fluid (either water or glycol) that is circulated through the building.
[2] ASHRAE Standard 34 assigns safety classifications to refrigerants based on toxicity and flammability. The capital letter indicates the toxicity, with 'A' indicating lower toxicity; the numeral denotes the flammability, with '3' being classified as higher flammability.
[3] Bill Text – SB 1383 Short-Lived Climate Pollutants
[4] Bill Text – SB 1206 Hydrofluorocarbon Gases

neutrality no later than 2045.[5] As a result, California is significantly investing in residential building decarbonization and the transition to heat pumps that rely on climate-friendly refrigerants.

The F-gas Reduction Incentive Program (FRIP)[6] is a CARB funding program established by SB 1013 that seeks to alleviate barriers to adopting climate-friendly refrigerant technologies and to reduce HFC emissions.[7] CARB selected NASRC as the third-party administrator for FRIP Round 2 in Fall 2023 via a competitive solicitation.[8] In close coordination with CARB, NASRC is responsible for administering FRIP. HFCs are potent greenhouse gases (GHG), primarily used as refrigerants and in smaller quantities as foam blowing agents, aerosol propellants, fire suppressants, and solvents. The stationary HVAC sector is currently the largest source of HFC emissions in California, and residential HVAC is the largest subsector of stationary HVAC, contributing over 60% of emissions for the sector.[9] Demand for HVAC equipment is only expected to increase as the climate warms and population grows.

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 hydrofluoroolefins (HFO), hydrochlorofluoroethers (HCFE), and hydrochlorofluoroolefins (HCFO). Ultra-low-GWP refrigerants are currently being deployed in several sectors and applications already, most notably in commercial, industrial and residential refrigeration, and mobile vehicle air conditioning. They are also used in HVAC applications internationally. However, more research is needed before HVAC equipment using ultra-low-GWP refrigerants can be widely deployed in the United States.

Recognizing the need to transition to ultra-low-GWP refrigerants while decarbonizing the building sector, in 2024, the U.S. Department of Energy (DOE) convened a working group with industry stakeholders to chart a path towards updating codes and standards to allow for ultra-low-GWP refrigerants in HVAC products. The working group consisted of experts and representatives from the fire service, codes and standards bodies, HVAC manufacturers, non-governmental environmental organizations and government agencies. Over the course of several months, the working group developed a comprehensive list of research topics that would inform the development of the codes and standards process to enable the safe use of ultra-

[5] Bill Text – AB 1279 California Climate Crisis Act
[6] https://ww2.arb.ca.gov/our-work/programs/FRIP
[7] Bill Text – SB 1013 Fluorinated Refrigerants
[8] https://ww2.arb.ca.gov/our-work/programs/FRIP/grant-solicitation
[9] CARB's F-gas Inventory. https://ww2.arb.ca.gov/ghg-slcp-inventory

low-GWP refrigerants in product segments with lower barriers to acceptance (e.g., indirect and small charge systems). The working group identified the need to fully understand the risks of A3 refrigerants in residential monobloc ATWHPs as a high priority project.

This project will help support California's climate and decarbonization goals by completing risk assessments for residential installation configurations of ATWHPs using ultra-low-GWP A3 refrigerants, which are currently being deployed in Europe. This project also directly supports the legislative directive in SB 1206 to increase the availability of ultra-low-GWP refrigerant technologies available internationally in California.[10]

BUDGET & TIMELINE

The total proposed cost for this project should not exceed $1.5 million, not including in-kind or match funding. Match or in-kind funding of at least 25 percent must be provided by respondents. The agreement is expected to be executed in October 2025, and the work is expected to be completed by March 2027 (about 18 months).[11] The total FRIP contribution is subject to change based on the outcomes of the project. If additional funding becomes available from other funding sources, such as funding from federal programs, NASRC and CARB may narrow the scope of this project.

APPLICANT ELIGIBILITY

Applicants who submit a proposal in response to this solicitation must be capable of completing the tasks described in the scope of work or identify additional subcontractors in their proposal that are necessary to complete the scope of work. Multiple subcontractors with complementary expertise are encouraged to apply together to ensure successful and timely completion of the project objectives.

SCOPE OF WORK

Project Objectives. NASRC, under a grant from CARB, seeks a subcontractor to perform the tasks described below. Applicants may also propose additional tasks that would contribute to the study's primary objective which is to aid in the development of comprehensive guidelines for stakeholder groups responsible for reviewing and developing codes and standards for A3 refrigerants (e.g., R-290 or propane, R-600a or isobutane, and other hydrocarbons). It may be necessary for the subcontractor to

[10] Bill Text – SB 1206 Hydrofluorocarbon Gases

[11] Applicants may also propose an alternative timeline in their proposal, with a justification.

add additional tasks (identified by codes and standards groups or the Advisory Panel and approved by NASRC and CARB) such that the codes and standards groups can make updates to their standards. Direct input from codes and standards groups should be sought during the implementation of the study to inform such changes.[12]

Task 1. Project Management and Administration. The subcontractor will be responsible for all project management, any additional subcontractor selection if deemed necessary (with NASRC and CARB's approval), review of technical results, and interim and final deliverables. The subcontractor will meet, at minimum, monthly with NASRC and CARB (or more frequently if requested by either party) and provide project status updates throughout the duration of the contract.

Subtask 1.1. Establish Advisory Panel. The subcontractor will establish an advisory panel to solicit technical input from key organizations, including but not limited to HVAC equipment manufacturers, industry trade groups, contractor trade groups, non-government organizations, standard setting organizations, and city, local, and state fire service personnel (recommended one representative from each service), to ensure the project activities align with expectations. The subcontractor will meet with the Advisory Panel periodically (at minimum quarterly and more frequently as needed) to receive guidance, monitor progress, and ensure milestones are achieved effectively.

Task 2. Develop Interim Report on Installation Configurations for Modeling. This task is focused on the dispersion and risk assessment evaluation of A3 refrigerants, primarily utilizing R-290 (propane) as a representative proxy for ATWHPs. The subcontractor will select a minimum of two representative product and installation configurations (such as ground or roof levels) of residential monobloc ATWHPs of 1-to-5-ton capacities. The installation parameters the subcontractor selects should be guided by a literature review of past risk assessments, literature reviews, and research, including "Leak Hole Sizes from Refrigeration, Air-Conditioning, and Heat Pump Systems"[13] and those conducted by Oak Ridge National Lab for the 2024 DOE working group effort. The subcontractor will review product safety standards and installation/servicing practices in countries where monobloc ATWHPs with A3 refrigerants are commercially available (e.g., manufacturer literature, industry standards, contractor training, and other resources from Europe and Australia). The

[12] Other tasks or modifications to the existing tasks may be considered, at CARB's sole discretion.
[13] D. Colbourne, M. Pitarch Mocholi, P. Munzinger, D. Oppelt, B. Paetzold, I. Vince, "Leak hole sizes from refrigeration, air conditioning and heat pump systems," International Journal of Refrigeration, Volume 131, 2021, Pages 559-567.
https://www.sciencedirect.com/science/article/pii/S0140700721002759

subcontractor will also review the work statement developed by ASHRAE SSPC 15.2 for the Air-Conditioning, Heating, and Refrigeration Technology Institute (AHRTI) research project on low probability monobloc heat pumps, if available.

The subcontractor will complete a report to provide a thorough assessment of the design parameters, operational requirements, and refrigerant management strategies (such as refrigerant handling, installation, leak detection, maintenance, and end-of-life decommissioning) for these systems. Example scenarios:

- ATWHP charge size based upon:
    - current UL and IEC standards,
    - current products available in Europe and Australia, and
    - the charge size needed to replace key product categories in North America with ATWHPs, if different from products in foreign markets
- Presence and shape of walls
- Proximity of installation to doors and windows, other refrigerant-containing units, or potential ignition sources
- Changing ambient conditions such as still air and wind
- Different types of leaks such as slow leak through corrosion, fast leak from failure, forced refrigerant releases during fire suppression
- External fires encroaching on unit

Other scenarios may be considered such as manufacturing configurations of ATWHPs available after the project is launched as well as other scenarios that emerge during discussions and feedback received from the Advisory Panel.

Task 3. CFD Modeling and Field Testing.

Subtask 3.1. Perform CFD Modeling. The subcontractor will develop a comprehensive process to identify and model potential combustion events for various monobloc ATWHP installations. The subcontractor will use CFD (Computational Fluid Dynamics) modeling to model leak dispersion and flammable concentrations of refrigerant. At a minimum, 20 CFD modeling cases should be selected from a combination of refrigerant charge level, leak location, outdoor condition, and installation scenario as identified in Task 2 and approved by NASRC and CARB.

The subcontractor must evaluate how much refrigerant is necessary to cause an ignition event to inform potential mitigation strategies. Modeling results should demonstrate the refrigerant concentration changes over time in the vicinity of the outdoor unit in both 2D and 3D. Other fire risk scenarios may be included and

considered in the CFD modeling that are not included in the validation testing per Subtask 3.2.

Subtask 3.2. Prepare Experimental Facility and Test Equipment. The subcontractor will utilize previous research, testing, and reports which analyzed leaks in HVAC and refrigeration systems, for guidance on specific scenarios for testing. The subcontractor will assess and prepare an experimental facility that can simulate a medium sized residential monobloc ATWHP (around 3 tons cooling/heating). This setup will consider realistic building configurations, including detailed floor plans, typical equipment layouts, and sensor placements for effective monitoring. The facility should be designed to replicate real-world conditions, enabling the evaluation of refrigerant leakage scenarios that are statistically probable, similar to past research.[14] Testing scenarios should also consider refrigerant sensor locations and other safety features (e.g., alarms) to mitigate potential impacts. The subcontractor shall use the testing scenarios to validate the CFD models by conducting up to 10 validation tests. The CFD models will be calibrated by conducting these validation tests using R-290 or carbon dioxide (CO_2) as a surrogate where feasible. The subcontract shall also prepare a testing plan (setup, instrumentation, number of sensors, etc.) to be approved by NASRC and CARB before the testing is completed.

Task 4. Develop Final Report on Parametric Study, Risk Analysis, and Mitigation Strategies. The subcontractor will develop a report that will analyze the impact of various design and installation parameters on safety. The subcontractor should also include a comprehensive fault tree risk analysis, identifying potential hazards associated with A3 refrigerants. The subcontractor will consider frequency of system leaks, leak size, likelihood of ignition source, and other factors to understand the probabilistic risk of ignition at different lifecycle stages (i.e., manufacture, transport storage, installation, operation, servicing, and decommissioning). Based on the analysis, the subcontractor will assess the likely effectiveness of potential mitigation strategies under different charge size and leak rate combinations and propose a set of actionable mitigation strategies to ensure the safe deployment of A3 refrigerants in residential monobloc ATWHPs. Potential mitigation strategies could include charge size limits, enhanced system tightness, releasable charge and shut-off valves, leak detection, ventilation strategies, and placement restrictions. The report should also identify codes and standards, policy, and other barriers and propose solutions for the

[14] D. Colbourne, M. Pitarch Mocholi, P. Munzinger, D. Oppelt, B. Paetzold, I. Vince, "Leak hole sizes from refrigeration, air conditioning and heat pump systems," International Journal of Refrigeration, Volume 131, 2021, Pages 559-567, https://www.sciencedirect.com/science/article/pii/S0140700721002759

Northern American market to adopt ATWHPs using A3 refrigerants. The subcontractor will share the final report with specific guidelines for standards bodies to summarize the findings from the studies conducted on A3 refrigerant systems and will then work iteratively with the standards bodies to finalize changes to the codes.

STUDY DELIVERABLES

The subcontractor will be expected to provide:

1. Quarterly progress reports submitted to NASRC and CARB throughout the duration of the contract.
2. Interim report per Task 2 for the installation configurations and scenarios to be considered for modeling, which must be submitted to NASRC, CARB, and the Advisory Panel for feedback.
3. Testing plan including setup, instrumentation, number of sensors, etc. must be submitted to NASRC, CARB, and the Advisory Panel for feedback per Subtask 3.2 before validation testing begins.
4. Draft final report including modeling and field test results as well as recommendations for codes and standards organizations, and recommendations for any additional research necessary per Task 4. The draft report must be submitted to NASRC, CARB, and the Advisory Panel for feedback before final publication and circulation.
5. Final, Americans with Disabilities Act (ADA)-compliant, report of work completed, risk assessments, analysis, and recommendations, incorporating any feedback from NASRC, CARB, and the Advisory Panel. Final report to be shared with codes and standards committees.

PROPOSAL REQUIREMENTS

Qualified applicant(s) 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 research reports and peer-reviewed publications, and ability to provide a neutral, science-based perspective.
- **Proposed Approach:** Methodology for delivering the scope of work, including timelines and estimated resource allocation for each task and deliverable.
- **Budget:** Itemized cost estimates aligned with the tasks and deliverables outlined in this solicitation, including a 25 percent in-kind or match funding from the applicant(s). 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.
- **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 refrigerant compounds, refrigerant-containing equipment, analytical chemistry, refrigerant safety testing, risk assessments (including CFD analysis and fault tree analysis). (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 the work proposed and deliverables expected, including a minimum 25 percent in-kind or match funding from the applicant(s). (20 points)

SUBMISSION INSTRUCTIONS

Proposals must be submitted electronically by 5:00 PM Pacific Time on October 3, 2025, to info@fripfunding.com. Late submissions will not be considered. For questions or clarifications regarding this solicitation, please contact info@fripfunding.com no later than September 19, 2025. Responses to questions will be publicly posted by September 25, 2025.

TIMELINE OVERVIEW

Timelines are subject to change at NASRC and CARB's sole discretion.

Milestone	**Date**
Solicitation Issuance	September 4, 2025
Deadline for Questions	September 19, 2025
Responses to Questions	September 25, 2025
Proposal Submission Due	October 3, 2025
Contract Award Notification	October 10, 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.

CARB reserves the right to negotiate with applicants to modify the project scope, the level of funding, or both. If CARB is unable to successfully negotiate and execute a funding agreement with an applicant, CARB, at its sole discretion, reserves the right to withdraw the pending award and fund the next highest ranked eligible project. This does not limit CARB's ability to withdraw a proposed award for other reasons, including for no cause.