Administrator Regina McCarthy
Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

By Email

October 6, 2015

Petition for Change of Status of HFCs under Clean Air Act Section 612 (Significant New Alternatives Policy)

Dear Administrator McCarthy:

The Natural Resources Defense Council (NRDC) and the Institute for Governance & Sustainable Development (IGSD) congratulate the United States Environmental Protection Agency (EPA) on its successful adoption of final "change of status" standards adjusting the list of acceptable alternatives maintained under the Significant New Alternatives Policy Program (SNAP) to list as unacceptable certain high global warming potential (GWP) chemicals from a number of applications. These rules are an important first step to ensuring that SNAP continually adjusts to eliminate the most environmentally harmful chemicals from the approved list as additional, environmentally preferable substitutes become available.

After this important step forward, much work remains to be done. As a next step, NRDC and IGSD hereby petition EPA to remove the chemicals listed below from the list of acceptable substitutes for the specified end uses under EPA's SNAP program. In the following petition, NRDC and ISGD request changes of listing status for the high-GWP chemicals we understand to be most used in the US marketplace for each application in which a lower-GWP alternative is available. There may be numerous, infrequently-used high-GWP chemicals similar to those we are petitioning to ban whose status we have not specifically requested be changed. NRDC and IGSD ask EPA to consider changing the listing status of these chemicals alongside those explicitly requested in this petition.

This petition is filed pursuant to Section 612(d) of the Clean Air Act and 40 C.F.R § 82.184(b)(3). Under section 612 of the Clean Air Act, EPA has the responsibility to evaluate alternatives to ozone-depleting substances (ODSs) identified in section 602 and to publish a list of acceptable and unacceptable substitutes through the SNAP program. EPA also has the authority to revise this list on its own, or in response to a petition, to remove a

substitute previously listed as acceptable. As EPA determined in the SNAP delisting rule, a chemical once deemed an acceptable alternative can be made unacceptable by the emergence of newer alternatives with lower overall human health and environmental impacts.

It is imperative that EPA continue the process it began in the SNAP delisting rule. There are many high-GWP refrigerants and substances used for replacement of other ODSs still on the SNAP approved list for which adequate substitutes are available. Furthermore, there are some substances on the SNAP list marketed as refrigerants that are counterproductive to environmental protection because they, if carelessly used, can contaminate recycled refrigerants risking damage to equipment, endangering service technicians, and discouraging recycling. Accordingly, NRDC and IGSD hereby petition EPA to make the following changes to the listing status of approved alternatives under SNAP:

1) Remove R-404A and R-507A from the list of acceptable substitutes in all new and retrofit stationary and transportation applications effective January 1, 2017. Ban the servicing of systems with new R-404A and R-507A refrigerant effective January 1, 2020.

2) Remove HFC-23 from the list of acceptable substitutes for all new and retrofit industrial process refrigeration applications effective January 1, 2017. Apply narrow use restrictions to HFC-23 in very low temperature refrigeration and total flooding fire suppression, allowing only for applications in which all other approved alternatives are physically inadequate effective January 1, 2017.

3) Remove sulfur hexafluoride (SF_6), perfluorinated compounds (PFCs), HCFC-22 blends, HCFC-124, and trifluoroiodomethane (CF3I) from the list of acceptable substitutes in all flooding and streaming fire suppression applications effective January 1, 2019.

4) Remove HFC-134a from the list of acceptable substitutes in all new centrifugal, screw, reciprocating, and scroll chillers effective January 1, 2019.

5) Remove HFC-134a from the list of acceptable substitutes in all new medium- and heavy-duty vehicle air conditioning effective January 1, 2021.

6) Remove HFC-134a from the list of acceptable substitutes in new household refrigerators and freezers effective January 1, 2021.

7) Remove R-410A from the list of acceptable substitutes in all new

a. Portable factory sealed air conditioners and dehumidifiers effective January 1, 2019
b. Air-cooled centrifugal, screw, reciprocating, and scroll chillers effective January 1, 2019
c. Water-cooled centrifugal, screw, reciprocating, and scroll chillers effective January 1, 2023
d. Light commercial air conditioning effective January 1, 2023
e. Household residential split air conditioning effective January 1, 2025 (NRDC and IGSD request that EPA defer consideration of the petition for those end-use sectors (7(d)-7(e)) that currently lack an approved low-GWP alternative until EPA has SNAP-approved a low-GWP alternative.)

8) Remove R-410A, R-407A, R-407C, and R-407F from the list of acceptable substitutes in all new and retrofit cold storage warehouses and industrial process refrigeration effective January 1, 2023.

9) Remove R-410A, R-407C, and R-407F from the list of acceptable substitutes in all new and retrofit industrial process air conditioning effective January 1, 2023.

10) Restrict the sale of small canisters of HFC-134a to certified technicians only, effective January 1, 2017 or earlier.

11) Reference international standards IEC 60335-2-40 and ISO5149 when granting SNAP approval for new alternatives in the end uses covered by those standards.

12) Remove HFC-134a, HFC-245fa, HFC-365mfc and HFC-227ea from the list of acceptable substitutes in rigid polyurethane spray foams effective January 1, 2017.

I. Background

HFCs were originally added to the SNAP list because they were deemed an improvement on the ODSs they replaced – chlorofluorocarbons (CFCs) and hydrofluorocarbons (HCFCs) that deplete the ozone layer and also have high global warming potentials (GWPs). While HFCs are not ODSs, some HFCs are extremely potent greenhouse gases (GHGs), with GWPs thousands of times greater than that of carbon dioxide (CO_2).

Currently, HFCs make up 1.5 percent of the United States' greenhouse gas emissions, but in the U.S. alone, emissions of HFCs are expected to triple by 2030.[i] Atmospheric concentrations of HFCs are increasing as well, with HFC -134a increasing by an average of 10% per year from 2006 to 2012.[ii] Even though HFCs may currently make

up a small piece of global climate emissions, their projected rapid growth underscores the urgent need to replace these chemicals with lower-GWP alternatives. Further, without stringent rules in place, HFC emissions increases could counteract the progress EPA is striving to make in other sectors to reduce carbon pollution.

HFCs are relatively short-lived GHGs that preventing thermal radiation from escaping earth's atmosphere by strongly absorbing wavelengths emitted by the sun. Commonly used HFCs persist in the atmosphere for 5-50 years and therefore cause more immediate damage to climate than their 100-year GWPs would indicate. Inaction on HFC consumption threatens to exacerbate climate change feedback loops like increased atmospheric water vapor, decreases in arctic albedo and increased methane releases, carbon cycle disruptions, and other drastic short term accelerators to climate change.

The relatively short-lived nature of these pollutants offers a unique opportunity to reverse and avoid some of the effects of climate change. EPA has the opportunity, through its SNAP program, to rapidly protect the global climate by removing the most harmful and unnecessary chemicals from the list of approved alternatives.

The SNAP program implements Section 612 of the Clean Air Act. The SNAP program was created to assure the health and environmental safety of alternatives for ozone-depleting substances. The purpose of the SNAP program is "to allow a safe, smooth transition away from ozone-depleting compounds by identifying substitutes that offer lower overall risks to human health and the environment."[iii] Section 602 of the Clean Air Act contains a list of Class I and Class II ozone-depleting substances that have been or are being phased out. Under the SNAP program EPA evaluates proposed substitutes and classifies the substitutes as acceptable, acceptable subject to use limits or conditions, or unacceptable.[iv]

EPA's acceptability determinations are comparative evaluations, where EPA looks not only at the proposed substitute in comparison to the relevant Class I or Class II substance listed in Section 602, but also in comparison to "other substitutes for the same end-use." In comparing these substitutes directly with each other, EPA then may "prohibit the use of those substitutes found, based on the same comparisons, to increase overall risks."[v] This progressive comparative analysis allows the SNAP program to continually promote new and less environmentally harmful substitutes as they are developed and listed.

The comparative analysis requires EPA to analyze, among other things, "atmospheric effects and related health and environmental impacts... [and] general population risks from ambient exposure to compounds with direct toxicity and to increased ground-level ozone."[vi] Further, the "overall risk characterization will consider such factors as: Toxicity and exposure -- both human health and ecological; chlorine loadings; ozone-depletion potential; global-warming potential; and flammability."[vii]

EPA's recent SNAP delisting rule was an important step forward in employing this comparative analysis to revise and update the SNAP list, and it is imperative that the Agency continue this successful approach with respect to more end-uses and chemicals.

NRDC and IGSD petition to remove the particular chemicals listed above because all of them meet two requirements. First, each chemical has an unacceptably high GWP in comparison with one or more lower-GWP alternatives that possess similar thermodynamic characteristics.[viii] Second, unless otherwise noted, the available alternatives to the chemicals proposed for SNAP unacceptability listing can achieve equal or greater energy efficiency in hardware design specifically for these new alternatives and taking on board the latest technical advances.

NRDC and IGSD submit that all of the chemicals described below are good candidates for delisting with respect to their particular end-use(s), and EPA should act to delist them as quickly as possible.

II. Analysis of Chemicals for which Change of Status is Requested

1. ***Remove R-404A and R-507A from the list of acceptable substitutes in all new and retrofit stationary and transportation applications effective January 1, 2017. Ban the servicing of systems with new R-404A and R-507A refrigerant effective January 1, 2020.***

NRDC and IGSD petition to remove R-404A and R-507A from the list of acceptable substitutes for all class I and class II ODSs in all new and retrofit applications effective January 1, 2017.

R-404A is a nearly azeotropic blend of HFC-143a, HFC-125, and HFC-134a used primarily in commercial refrigeration, industrial refrigeration, and refrigerated transportation. R-404A's high GWP of 3902 makes it unsuitable for use now that lower-GWP alternatives have been developed and are commercially available. R-507A consists of equal parts HFC-125 and HFC-143a, making it close to R-404A in performance but with an even higher GWP of 3985. Its status as an acceptable alternative to class I and II ODSs should therefore be removed along with R-404A.

In its July final rule, EPA disallowed the use of R-404A and R-507A in commercial refrigeration in stand-alone, condensing unit, and direct and indirect supermarket retail food refrigeration and vending machines.[ix] NRDC and IGSD reiterate their support for this important action and view it as an important first step in updating the SNAP list to eliminate obsolete high-GWP HFCs.

Moving forward from EPA's delisting of R-404A and R-507A from commercial applications, the next large end-use that requires action is industrial refrigeration. R-404A and R-507A are used over a wide range of applications for both low-temperature and medium-temperature refrigeration. These systems cool with direct-expansion coils and typically have site-installed refrigerant pipework that leak between 5-10% per year[x].

There are several suitable lower-GWP alternatives for industrial applications, including the well-established R-407 series (in particular, R-407A and R-407F) and the recently developed R-448A, R-449A and R-452A blends. The R-448A and R-449A refrigerants, while not yet extensively deployed, offer GWP reductions of about 65% below R-404A, maintain A1 non-flammability, and can be retrofitted into existing systems without an oil change or used in new equipment. R-452A benefits are talked about below. Thermodynamic efficiency often surpasses R-404A and R-507A levels with modest adjustments to the thermal expansion device.

The next major end-use that for which R-404A and R-507A should be delisted is the refrigerated transportation sector. Refrigerated trucks often travel through a wide range of climatic conditions and therefore require refrigerants with low compressor discharge temperatures to avoid system damage in high ambient temperature conditions. R-452A offers a non-flammable, low discharge temperature alternative with a 45% reduction in GWP from R404A. R-452A's application is being considered under SNAP and Chemours has committed to making R-452A generally available 12 months after approval. R-452A can be used to retrofit existing equipment or incorporated into new system designs and has demonstrated thermodynamic efficiency and capacity comparable to that of R-404A in most configurations. The R-407 series of refrigerants may also be used in the transportation sector as long as appropriate measures (e.g. liquid injection) are taken to mitigate high compressor discharge temperature.

While R-452A and the R-407 series offer non-flammability and significant reductions in GWP below R-404A, this sector will eventually need to move towards long-term near-zero-GWP solutions. EPA should not, however, hesitate to grant SNAP approval to interim refrigerants like R-452A while industry and others research future solutions.

Thermo King and Carrier, the two major manufacturers of refrigerated transportation equipment, have both indicated the near-immediate availability of R-452A systems. Thermo King has committed to making R-452A equipment available as soon as SNAP approves it, while Carrier has been selling R-452A systems in Europe for a considerable period. Further delaying the change of listing status for R-404A in transportation refrigeration only serves to impede industry's efforts to transition this end-use.

In addition to the proposed SNAP unacceptability listing on new and retrofit use of R-404A and R-507A, NRDC and IGSD propose a service ban on new R-404A and R-507A refrigerant effective January 1, 2020. Intended to avoid a long service tail, the ban would require owners of R-404A and R-507A systems to retrofit before 2020 so that servicing could be done with available R-448A, R-449A, R-452A or R-407-class refrigerants.

With alternatives available in all applications, further SNAP action on R-404A and R-507A will result in significant greenhouse gas emissions savings from multiple sectors.

2. ***Remove HFC-23 from the list of acceptable substitutes for all new and retrofit industrial process refrigeration applications effective January 1, 2017. Apply narrow use restrictions to HFC-23 in very low temperature refrigeration and total flooding fire suppression, allowing only for applications in which all other approved alternatives are physically inadequate effective January 1, 2017.***

HFC-23, with its very high GWP of 14,800, has become obsolete in the applications for which it is currently SNAP approved except for a very narrow range of special uses. NRDC and IGSD petition EPA to list HFC-23 as unacceptable in industrial process refrigeration and to place narrow use restrictions on very low temperature refrigeration and total flooding fire suppression to permit only those applications for which all other alternatives are physically inadequate.

HFC-23, famous for being a mostly unwanted high-GWP byproduct of the HCFC-22 manufacturing process, has a very low boiling point of -116°F and is therefore suited to certain refrigeration and fire suppression applications. In particular, HFC-23 is important in very low temperature refrigeration applications like medical storage and other high-value low-temperature refrigeration applications. In total flooding fire suppression, HFC-23 is used in applications that demand high vapor pressure at very low space temperature and under special circumstances in which very high quantities of fire extinguishing agent must be discharged in occupied spaces. HFC-23's no-observed-adverse-effect-level (NOAEL) is a factor of three higher than the next highest fire extinguishing agent and it is therefore uniquely able to safely extinguish or prevent fires in occupied spaces. Moreover, both of the applications listed above are generally non-emissive and the climate impact of use in these cases is negligible.

That being said, HFC-23's GWP makes its use in nonessential applications unacceptable—even within the SNAP categories mentioned above. NRDC and IGSD believe that as long as HFC-23 is confined to its current applications, its use in the U.S. does not represent a major climate risk. As such, rather than list HFC-23 as unacceptable, EPA should issue use restrictions on HFC-23 in both very low temperature refrigeration and total flooding fire suppression to ensure that its use does not expand as other HFCs are removed from the list of approved alternatives.

In addition, HFC-23 should be delisted from industrial process refrigeration given the availability of R-717 (ammonia) systems for large industrial applications and the availability of R-407A/F, R-448A, and R-449A for small and medium industrial distributed systems. Note that R-448A and R-449A are not yet SNAP approved for industrial applications, but they show increased performance in all applications currently served by R-404A. Additional SNAP approval action will ensure a full suite of suitable alternatives to HFC-23 in industrial refrigeration applications.

3. ***Remove sulfur hexafluoride (SF_6), perfluorinated compounds (PFCs), HCFC-22 blends, HCFC-124, and trifluoroiodomethane (CF3I) from the list of acceptable substitutes in all flooding and streaming fire suppression applications effective January 1, 2019.***

NRDC and IGSD petition EPA to list SF_6, PFCs, HCFC-22 blends, HCFC-124, and CF3I as unacceptable under SNAP on account of the environmental hazards they pose and in light of the many fire suppression alternatives available. It is our understanding that none of these agents are currently used in fire suppression and therefore removal from the list of alternatives is preemptive of unnecessary future use.

SF_6 is an inorganic fire suppression agent currently SNAP-approved in military and civilian aviation applications despite its extremely high GWP of 23,900. Historically, SF_6 has been used as a simulant gas used by the US Air Force to test the flow properties of halon fire protection systems.

PFCs are persistent and environmentally harmful chemicals also currently SNAP-approved in fire suppression end uses where safer alternatives are listed. PFCs reached the marketplace in the 1990s to considerable acclaim, but failed to gain large market share and are no longer believed to be manufactured or installed.

HCFC-22 blends, HCFC-124, and CF3I are ozone depleting substances for which suitable HFC and non-HFC alternatives exist. They should summarily be removed from the list of approved alternatives in all flooding and streaming fire suppression applications.

4. ***Remove HFC-134a from the list of acceptable substitutes in all new centrifugal, screw, reciprocating, and scroll chillers effective January 1, 2019.***

<u>Centrifugal Chillers</u>

Large centrifugal chillers are used to efficiently cool large commercial buildings. These chillers have traditionally used CFC-11, CFC-12, and HCFC-123. CFC-11 and HCFC-123 are low pressure refrigerants, meaning their circuits operate below atmospheric pressure and benefit from lower refrigerant leakage rates than more-common positive

pressure circuits. In low-pressure designs, outside air tends to leak into the refrigerant circuit rather than refrigerant leaking out of the circuit, as with medium and high pressure refrigerants.

The use of HFC-134a in these end uses raises different concerns. HFC-134a is a medium pressure refrigerant that suffers from both a high GWP and the propensity to leak into the atmosphere. Manufacturers who have shifted out of low pressure CFC-11 or HCFC-123 chillers to HFC-134a have incurred a penalty on refrigerant leakage in both cases and, in the case of HCFC-123, a GWP increase of more than a factor of eighteen. In addition, HFC-134a's theoretical coefficient of performance (COP) is 6% lower than CFC-11's and approximately 5% lower than HCFC-123's[xi]. To avoid the transition penalties of lower energy efficiency and higher refrigerant leak rates, at least one manufacturer is selling low-pressure centrifugal chillers using HCFC-123.

The remaining manufacturers started using medium-pressure HFC-134a in centrifugal chillers, and now lower-GWP alternatives are available that are dramatically better with respect to human health, environment, and technical performance.

The modern low-pressure alternative, HFO-1233zd, has excellent properties including a GWP of 7, A1 non-flammability and nontoxicity, and a theoretical energy efficiency about 3% higher than HFC-134a. HFO-1233zd will require equipment redesign irrespective of what refrigerant is being used now, as its pressure is different than that of HFC-134a and HCFC-123. Nonetheless, the three-pronged benefit of low GWP, low leakage, and high energy efficiency make the redesign effort worthwhile: HFO-1233zd should satisfy the market for large centrifugal chillers far into the future.

Medium pressure alternatives to HFC 134a are also available. SNAP-approved HFO-1234ze provides an alternative with similar theoretical efficiency to HFC-134a and a GWP of <1. HFO-1234ze is classified as having 2L flammability, meaning that certain standards updates will be necessary for HFO-1234ze chillers to be widely commercially available. In particular, the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Standard 15 and Underwriters Laboratories (UL) Standard 60335-2-40 need to be updated to include 2Ls, followed by the International Mechanical Codes and Uniform Mechanical Codes (UMC and IMC) adopting references to these updated standards. The necessary updates for HFO-1234ze sales in air cooled chillers are expected in 2016, while standards for water-cooled chillers in mechanical rooms will be available in either 2018 or 2021, depending on the success of several code integration strategies.

Additional medium pressure alternatives exist; Honeywell's R-450A and Chemours's R-513A offer design-compatible HFC-134a alternatives that can be rapidly adopted—with only changes to controls—while HFO-1234ze redesigns are completed and

building codes become fully compatible with 2L refrigerants. These transitional refrigerants offer roughly a 50% GWP reduction from HFC-134a and are nonflammable. In the case of R-513A, energy efficiency is nearly thermodynamically equal to that of the HFC134a being replaced. R-450A suffers a more significant efficiency penalty and may not be ideal from a total climate impact standpoint.

Medium-pressure chiller manufacturers can employ R-450A or R-513A as a simple, interim solution if a full conversion to HFO-1234ze or HFO-1233zd is for some reason not feasible by 2019. R-513A and R-450A are not suitable long-term solutions, however, because they do not reduce the GWP to acceptable long term levels. These refrigerants may be the choice only in HFC-134a applications where it is not yet feasible to mitigate flammability of currently available lower-GWP refrigerants.

Screw, Reciprocating, and Scroll Chillers

HFC-134a is also currently used in screw chillers and to a much lesser extent reciprocating and scroll chillers, as an alternative to class I and II ODSs. Screw chiller compressors require medium- or high-pressure working fluids; as such, HFO-1234ze, R-450A, and R-513A are all suitable alternatives in this product class. Similar to the discussion of centrifugal chillers above, R-450A and R-513A may be used as interim solutions based on existing designs, or manufacturers may move straight to HFO-1234ze redesigns in screw chiller offerings. HFO-1234ze's efficiency and low GWP make it the ideal long-term market-driven solution for this smaller class of chillers, while R-450A and R-513A constitute possible interim step solutions. These non-flammable solutions may need to be maintained for special public safety situations in the future, but not for stationary chillers.

5. ***Remove HFC-134a from the list of acceptable substitutes in all new medium- and heavy-duty vehicles effective January 1, 2021.***

The technology developed to replace HFC-134a in motor vehicle air conditioning (MAC) passenger vehicles and light-duty trucks is equally applicable to heavy-duty trucks and most off-road vehicles.[xii] As such, we incorporate by reference our October 2014 comments on that transition (*See* SNAP Delisting Rule, Docket No. EPA-HQ-OAR-2014-0198-0136). HFO-1234yf, HFC-152a, and CO_2 are SNAP listed as alternatives to HFC-134a for the MAC sector and, so far, all companies that are phasing down HFC-134a have selected HFO-1234yf. HFO-1234yf is not currently SNAP approved for medium- and heavy-duty vehicles, but SNAP has indicated that it will begin approvals starting with the medium- and heavy-duty vehicles that most directly resemble light-duty vehicles.

NRDC and IGSD therefore petition to list HFC-134a unacceptable for medium- and heavy-duty vehicles MACs after MY 2021 with some exceptions.

Heavy-duty on-road and off-road vehicles use components and systems from the same suppliers as those for light-duty vehicles and will therefore benefit from the current phase out of HFC-134a. In addition, heavy-duty vehicles have the advantage of more available space in engine compartments, which makes redesign and implementation of low-GWP refrigerants simpler than for light-duty vehicles where it is sometimes necessary to wait for a major model upgrade in order to fit the system.

The larger available space in the engine compartment of large trucks compared to passenger vehicles also makes it easier to implement secondary-loop MACs (SL-MACs). SL-MACs reduce the refrigerant charge and leakage by up to 50% in systems with single cooling points and to reduce the refrigerant charge and leakage by up to 75% or more in systems with two cooling points as a result of shorter refrigerant hoses and fewer refrigerated component connections. Trucks with sleeper cabs typically have one cooling point in the driver's compartment and one cooling point in the sleeper cab. Trucks with electrically-powered MACs to allow comfort while parked without the engine running can implement hermetically sealed low-GWP systems with near-zero life-cycle refrigerant emissions.

Suppliers of HFO-1234yf have confirmed ample supplies of HFO-1234yf from production facilities in China and Japan and additional production facilities are under construction at two locations in the United States and elsewhere. CO_2 is available in vast quantities, while HFC-152a production be expanded or diverted from aerosol product uses where it is no longer environmentally acceptable. A contested application patent protects HFO-1234yf, but the patents for CO_2 and HFC-152a have expired.

NRDC and IGSD also suggest that EPA collaborate with other federal and state authorities to incentivize truck manufactures to incorporate reliability and fuel efficiency measures in addition to reducing refrigerant emissions. Design changes for increased fuel efficiency include fluid valves (rather than air dampers) to prevent hot antifreeze from entering the cab during air conditioning, controls that dehumidify and demist at evaporator temperatures optimized for technical and fuel performance (rather than over-cooling and reheating air), and integration with engine controls to cool during deceleration and low power loads in order to minimize incremental fuel consumption (during deceleration cooling, the air conditioner fan speed can be controlled to maintain comfort). Design changes for minimizing refrigerant leaks include fewer and better leak-tight fittings, less-permeable hoses, mounting to reduce harmonic vibration, and leak checking after charging using more sensitive detectors.

Removing SNAP approval for HFC-134a from medium and heavy trucks on the same schedule as passenger vehicles and light trucks will help the alternatives achieve full economy of scale. A SNAP listing of unacceptable after model year 2021 will also help consumers save money on infrastructure changes because a national HFC-134a phase down

schedule will be in place. Specifically, synchronized bans will shut down refrigerant supply streams and will induce the HFC-134a service tail to follow a similar trajectory for both light-duty and heavy-duty vehicles. The necessary supply and maintenance infrastructure will therefore be phased down simultaneously. NRDC and IGSD urge EPA not to allow additional time to pass between the ban of HFC-134a in light-duty and heavy-duty vehicles.

For situations where public safety cannot be guaranteed or where technology cannot be implemented effectively by 2021, non-flammable options like R-450A and R-513A may be used for specific applications.

6. ***Remove HFC-134a from the list of acceptable substitutes in new household refrigerators and freezers effective January 1, 2021.***

Across the United States, at least 150 million domestic refrigerators, freezers, and combination units preserve food using HFC-134a. During their lifetimes, these units do not typically leak much HFC-134a, but improper disposal frequently results in the entire refrigerant charge being vented to the atmosphere. Because improper disposal is prevalent and hard to control, domestic refrigerators and freezers have a significant impact on US greenhouse gas emissions.

In order to reduce these emissions, NRDC and IGSD petition EPA to remove HFC-134a from the list of acceptable class I and II ODS substitutes effective January 1, 2021. Updated Department of Energy (DOE) energy efficiency standards are also expected to go into effect for domestic refrigeration equipment in that year, so we suggest a coordinated approach that allows for a single redesign to incorporate both refrigerant and efficiency upgrades.

Several alternatives to HFC-134a are being explored, including HFO-1234yf, HFO-1234ze, propane (R-290), isobutane (R-600a), R-513A, and R-450A. HFO-1234yf has the benefit of being nearly design compatible with HFC-134a, although adjustments to desiccants, expansion valves, and heat exchangers may be necessary to match HFC-134a efficiency. HFO-1234ze offers a more efficient, lower-capacity version of its cousin that will require more redesign but offers greater life cycle benefit.

Propane and isobutane, two hydrocarbons widely used abroad, provide an excellent potential option. Today, these options are restricted by UL's and EPA's charge limit of 57g in domestic refrigeration applications—a charge limit too small to build a typical refrigerator/freezer with just one refrigerant circuit. Given the widespread and apparently safe use of units with more than 57 grams abroad (nearly half a billion units are in use[xiii]), we believe that UL and EPA should approve use conditioned on appropriate safety mitigation. If UL or EPA did so, the US market could follow the major shift to

hydrocarbon refrigerators that has already occurred abroad. Hydrocarbons offer potential efficiency gains over HFC-134a, low GWP, and are inexpensive and plentiful.

R-513A and R-450A are HFC-134a replacements offered by Chemours and Honeywell, respectively, and could be used as medium-GWP interim steps towards the much lower GWP solutions provided by HFO-1234yf, HFO-1234ze, and the hydrocarbons. However, in this application we believe it makes much more sense for manufacturers to skip the interim transition to R-513A and R-450A given the safe demonstration of hydrocarbons across the globe.

Energy efficiency is important when selecting domestic refrigerator and freezer refrigerants, as over 98% of the life cycle carbon-equivalent emissions are from the fossil fuel and biomass used to generate electricity to power the appliance. Hydrocarbons and HFO-1234ze offer the clearest path to more efficient, low-GWP refrigerators, and a well-timed EPA HFC-134a delisting, alongside revisited charge limitations and safety mitigation, could facilitate this transition rapidly and at low cost to manufacturers.

7. ***Remove R-410A from the list of acceptable substitutes in all new:***

a. Portable factory sealed air conditioners and dehumidifiers effective January 1, 2019

b. Air-cooled centrifugal, screw, reciprocating, and scroll chillers effective January 1, 2019

c. Water-cooled centrifugal, screw, reciprocating, and scroll chillers effective January 1, 2023

d. Light commercial air conditioning effective January 1, 2023

e. Household residential split air conditioning effective January 1, 2025

NRDC and IGSD request that EPA defer consideration of the petition for those end-use sectors (7(d)-7(e)) that currently lack an approved low-GWP alternative until EPA has SNAP-approved a low-GWP alternative.

NRDC and IGSD petition EPA to establish a comprehensive timeline for the phase down of R-410A. NRDC and IGSD request that EPA defer consideration of items 7(d) and 7(e) until the first lower-GWP alternative is SNAP-approved in those end-uses.

R-410A has replaced R-22 in almost all residential and medium-scale commercial comfort cooling applications in the US, bringing with it safety and stratospheric protection but also a dangerously-high GWP of 2088 and middling energy efficiency. Any international agreement to phase down HFCs will require strict controls on R-410A and EPA could demonstrate no greater leadership to the international community than by proposing such an R-410A ban. Furthermore, an EPA ruling on R-410A will address

industry's request for a firm timeline for phasing down those refrigerants, and is an absolute requirement for a second round of SNAP status changes.

Portable Factory-Sealed Products

The UL484 safety standard was recently updated to include Class 2 and Class 3 refrigerants for use in factory-sealed portable appliances like small air conditioners, dehumidifiers and other similar devices. EPA's Rule 19 provides additional options for refrigerants in this area. EPA has listed certain climate-friendly hydrocarbons (ethane, isobutane, and propane) and a hydrocarbon blend (R-441A) as acceptable in stand-alone commercial and household refrigerators and freezers, very low temperature refrigeration, non-mechanical heat transfer, vending machines, and room air conditioning units. EPA has also listed HFC-32 as acceptable in room air conditioning units—a two-thirds reduction in GWP from R-410A. EPA has also exempted ethane, isobutane, propane, and R-441A from the §608 venting prohibition for the specific applications listed above.

Chillers

Some chillers equipped with screw and scroll compressors use high-pressure refrigerant circuits that offer high cooling capacity. Generally smaller than medium- and low-pressure equipment, these units use R-410A with a GWP of 2088. The high GWP and prevalence of these chillers in US commercial buildings make R-410A a priority for removal from the list of acceptable substitutes. As such, NRDC and IGSD petition for the earliest-possible removal of these systems in commercial chiller applications.

High-pressure alternatives HFC-32, R-454B, R-446A, R-447A, and "DR-55" have all been developed as medium-GWP replacements for R-410A. Daikin Industries and other Japanese manufacturers have championed HFC-32, a pure hydrofluorocarbon, for use in direct and indirect cooling applications. It offers a GWP of 675, 2L flammability, and high energy efficiency when optimized to the system design, but has higher discharge temperatures. Chemours's R-454B, GWP 490, has been shown to have modest flammability and high energy efficiency, while their soon-to-be-numbered "DR-55" promises near-design-compatibility with R-410A, very low burning velocity, a GWP of 675, and good energy efficiency. Honeywell has developed R-446A, GWP 490, and R-447A, GWP 580, with emphasis on the same climate-friendly attributes and is currently implementing those refrigerants in Asia.

SNAP has already included a 2L refrigerant in its list of acceptable alternatives for chillers, HFO-1234ze, which operates at medium pressure. As discussed in the previous section on chillers, the necessary standards updates for 2L-class air-cooled chillers are expected in 2016, while standards for 2L-class water-cooled chillers in mechanical rooms will be available in either 2018 or 2021. As such, NRDC and IGSD believe that the

conversion away from R-410A is feasible for air-cooled chillers by 2019 and for water-cooled chillers placed in mechanical rooms by 2023. Moreover, the proposal of this impending change of status will encourage ongoing efforts to clear regulatory hurdles regarding the adoption of 2L-class alternatives.

The expected climate benefits of transitioning away from R-410A in chillers are two-pronged and very large. The reduction of GWP by at least a factor of three means significant direct emissions saving; moreover, 2L alternatives are typically more efficient than R-410A in native designs and have the potential to reduce use-phase electricity consumption. This life cycle benefit provides all the more reason to add R-410A alternatives to the SNAP list promptly and change the listing status of R-410A so that code organizations and industry know they can expect rapid, comprehensive transition of chiller refrigerants.

Light Commercial and Residential A/C

Light commercial and residential air conditioning constitute a major subset of the heating, ventilating, and air conditioning (HVAC) sector and have also been dominated by R-410A since R-22's phase out. These systems differ from chillers in that they directly condition air intended for space cooling, whereas chillers are indirect systems that cool water that will eventually be circulated through coils in the space.

Commercial products included in this sector include rooftop air conditioning units and air handlers, while residential products include split systems, packaged central air conditioners, ductless mini-splits, heat pumps, and packaged-terminal air conditioners. There is also overlap between these two categories, as certain classes of residential products may also be used in small businesses or other light commercial applications.

The alternatives being developed for these applications are the same as for chillers, and also offer the dual benefit of much-lower GWP and greater energy efficiency. NRDC and IGSD urge EPA to move forward expeditiously with the consideration of SNAP applications for the alternatives listed in the chillers section so manufacturers may begin preparing the transition. Such action, along with the changes of status proposed, will set the US on a path towards major HFC emissions reductions.

ASHRAE 15 has established a subcommittee—ASHRAE 15.2—to determine safety standards for flammable refrigerants in residential applications. ASHRAE 15.2 expects to complete its work by December 31, 2017, in order to be included in the 2021 International Residential Code published by the International Code Council for state and local government adoption. According to that schedule, residential standards will be finished well in advance of 2025, ensuring the widespread availability of systems using low-GWP alternatives before R-410A's proposed change of status.

For light commercial systems, the language developed by ASHRAE 15.2 for residential products will likely be published into an updated ASHRAE 15, which has jurisdiction over all commercial refrigeration systems. While this process will likely follow the same 2021 code cycle timeline as residential applications, NRDC and IGSD believe that less time between code adoption and change of listing status is required for commercial applications. A change of status in 2023 reflects the U.S. Department of Energy's estimate for refrigerant changeover used in setting efficiency standards for commercial unitary air conditioners (rooftop units).

8. ***Remove R-410A, R-407A, R-407C, and R-407F from the list of acceptable substitutes in all new and retrofit cold storage warehouses and industrial process refrigeration effective January 1, 2023. Remove R-410A, R-407C, and R-407F from the list of acceptable substitutes in all new and retrofit industrial process air conditioning effective January 1, 2023.***

As discussed in the previous section, the R-410 and R-407 refrigerants will be supplanted by available alternatives starting widely in 2021. NRDC and IGSD petition that they be removed categorically from industrial and cold storage applications in 2023 in light of the availability of suitable alternatives. In addition, currently-existing alternatives like R-717 and R-744 allow this transition to begin even sooner if site-specific design concerns allow.

9. ***Restrict the sale of small canisters of HFC-134a to certified technicians only, effective January 1, 2017.***

Small can sales of HFC-134a to uncertified do-it-yourself users have been a major source of emissions as long as HFC-134a has been used in MAC systems. As noted in previous petitions, half of HFC-134a sold for MAC professional service maintains 90% of vehicles requiring service. The other half is sold to do-it-yourself users who account for 10% of all MAC systems.

While closing this gap would constitute a major emissions savings on its own, an even greater environmental risk has emerged. As industry shifts to HFO-1234yf MAC systems to comply with EPA's delisting of HFC-134a in new vehicles starting model year 2021, the opportunity will arise to user-recharge an HFO-1234yf MAC system with HFC-134a. Small cans of HFC-134a are expected to be ten times less expensive than the cost of an HFO-1234yf recharge, an incentive more than sufficient to make this loophole a major climate concern. For example, a small can of HFC-134a with a retail price of $20 contains about $4 of refrigerant, but would have a retail price of at least $60 with HFO-1234yf costing $54 for the same amount. As such, restricting the sales of HFC-134a small cans has significant climate benefit and will ensure that EPA realizes the emissions savings estimated in the light-duty vehicle HFC-134a delisting.

10. ***Reference international standards IEC 60335-2-40 and ISO5149 when granting SNAP approval for new alternatives in the end uses covered by those standards.***

NRDC and IGSD petition EPA to reference international design standard IEC 60335-2-40 and international use standard ISO 5149 when adding lower-GWP alternatives to the SNAP list. IEC 60335-2-40 and ISO 5149 are international standards developed with US participation and reflect an international perspective on design and use standards for HVAC equipment and refrigerants under consideration by SNAP.

Referencing these standards will allow EPA to consider new SNAP applications for low-GWP, 2L-class alternatives without waiting for the ASHRAE standards development process to finish, which may take until 2018. EPA can use these international standards as a baseline for the use conditions placed on alternative refrigerants and then focus their independent risk analysis efforts on areas relevant specifically to US applications.

11. ***Remove HFC-134a, HFC-245fa, HFC-365mfc and HFC-227ea from the list of acceptable substitutes in rigid polyurethane spray foams effective January 1, 2017.***

NRDC and IGSD commend SNAP on their comprehensive action on high-GWP foams in the first change of status rule. One additional end-use—rigid polyurethane spray foams—should see additional changes of status for HFC-134a, HFC-245fa, HFC-365mfc, and HFC-227ea. Rigid polyurethane spray foams are used as insulation for homes and buildings and can be made with alternatives HFO-1233zd and HFO-1336mzz. Both alternatives offer very low GWP and practically equal insulation properties to those being replaced.

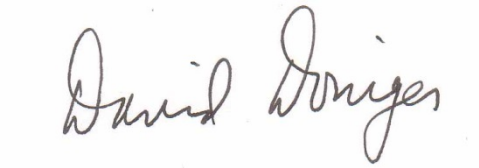
Industry has indicated that they can commercialize low-GWP alternatives within six months once SNAP regulations require it. In addition, Honeywell is expanding its current plant and bringing another plant online in 2018, while Chemours is also pursuing increased production capacity. Spray foam customers and suppliers need a strong signal to begin the transition and SNAP should provide it on a similar timeline to the changes of status finalized for the rest of the foams sector.

* * *

NRDC and IGSD believe that action on the petition items above will put the United States in a strong position regarding both domestic and international efforts to phase down HFCs. In order to maintain each step of the HFC phase-down timeline put forth by the North American proposal to amend the Montreal Protocol, additional SNAP changes of status will be required. By 2019—the first proposed year of control—additional bans will be required to achieve the US's targeted consumption reductions. NRDC and IGSD view the above bans on HFC-134a, R-404A, and R-507A as a significant step towards hitting the

US's first control year goal and believe they will send a strong international message of leadership. Further delisting of R-410A will show that the United States is capable of deep HFC consumption reductions in the near future and is committed to leading the way towards an HFC agreement under the Montreal Protocol.

Sincerely,



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[i] U.S. EPA, Stratospheric Protection Division, Office of Atmospheric Programs, *Benefits of Addressing HFCs under the Montreal Protocol*, pg. 2 (June 2013) *available at* Memorandum to Docket: References and Associated Documents, Docket No. EPA-HQ-OAR-2014-0198-0003. [hereinafter "Benefits of Addressing HFCs"].
[ii] *Id.* at 11.
[iii] Environmental Protection Agency, Significant New Alternatives Policy (SNAP) Program, http://www.epa.gov/ozone/snap/index.html (last visited Sept. 18, 2015)
[iv] *Id.*
[v] Significant New Alternatives Policy Program, Purpose and Scope, 40 C.F.R. § 82.170 (2015).
[vi] Significant New Alternatives Policy Program, Agency Review of SNAP Submissions, 40 C.F.R. § 82.180(a)(7)(i)-(ii) (2015).
[vii] Protection of Stratospheric Ozone; Request for Data and Advanced Notice of Proposed Rulemaking, 57 Fed. Reg. 1984, 1985 (Jan. 16, 1992).
[viii] Some bans are proposed under the assumption that soon-to-be-available refrigerants will be SNAP-approved in that application.
[ix] U.S. EPA, Protection of Stratospheric Ozone: Change of Listing Status for Certain Substitutes under the Significant New Alternatives Policy Program, 80 Fed. Reg. 42,870 (July 20, 2015) (Docket ID No. EPA-HQ-OAR-2014-0198-0238)
[x] http://conf.montreal-protocol.org/meeting/workshops/hfc_management-02/presession/PreSession%20Documents/FS%205%20Industrial%20Refrigeration%20final.pdf
[xi] Low-GWP Chillers Development Update. Dr. Nacer Achaichia, Honeywell. 2014.
[xii] There may be limited exceptions for unique situations such as military vehicles where even mildly flammable refrigerants may not be acceptable
[xiii] *Fact Sheet 3: Domestic Refrigeration.* UNEP Ozone Secretariat. 21 April, 2015.