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California Air Resources Board
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Subject: NRDC Comments on ARB Strategy for Reduction in Hydrofluorocarbons

The Natural Resources Defense Council (NRDC) appreciates the opportunity to comment on the California Environmental Protection Agency Air Resources Board's (CARB's) "Short-Lived Climate Pollutant Reduction Strategy Concept Paper," published on May 7, 2015. As Governor Brown and the California Air Resources Board understand, climate change is already causing harm to people in California and beyond. This past year, 2014, was our planet's warmest year on record, and California is in the grip of a devastating drought. Swift and dramatic action to reduce emissions of all greenhouse gases is critical. We thus applaud CARB for undertaking this initiative aimed at three classes of short-lived but extremely potent greenhouse gases. As CARB notes, California must achieve deep reductions in these short-lived climate pollutants (SLCPs) in order to reach its future climate goals.

We urge CARB to follow through on the Concept Paper by enacting the regulations needed to action to ensure rapid reduction in all three classes of pollutants. In this comment, we address in detail the strategy for reducing hydrofluorocarbons (HFCs). NRDC will, in a separate comment, address the strategy for reducing methane and black carbon.

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Hydrofluorocarbons (HFCs)

HFCs are a class of chemicals used as replacements for two classes of chemicals, chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), which were phased out because of their ozone depleting potential. In addition to harming the ozone layer, CFCs and HCFCs have high global warming potentials (GWPs). HFCs represent an improvement over these chemicals because they do not harm the ozone layer, but HFCs are themselves highly potent agents of climate change, with GWPs thousands of times greater than that of carbon dioxide. For example, HFC-134a, the most abundant HFC, has a global warming potential of 1,430. This means that, over a 100-year timeframe, each ton of HFC-134a emitted to the atmosphere results in 1,430 times more warming than a ton of carbon dioxide.

CARB notes that "F-gases, specifically HFCs, are the fastest growing source of [greenhouse gas] emissions in California."[1] Nationally, HFCs make up 1.5 percent of the United States' greenhouse gas emissions, and domestic emissions of HFCs are expected to triple by 2030.[2] Atmospheric concentrations of HFCs are increasing as well: HFC-134a increased by an average of ten percent per year from 2006 to 2012.[3] HFC's projected rapid growth underscores the urgent need to replace these chemicals with lower-GWP alternatives. Without strong standards limiting their use, HFC emission increases would counteract the carbon pollution reductions CARB is striving to make in other sectors.

Strong action by CARB to reduce HFCs will be important in California and beyond. Currently the United States and other nations are working toward an agreement to reduce rapidly-growing global HFC use under the Montreal Protocol. CARB's actions can provide a significant boost to these international negotiations. By showing that it is feasible to replace high-GWP HFCs with low-GWP alternatives and by creating the market for the development of additional substitutes, California will give other nations the confidence needed to move forward with an amendment to the Montreal Protocol. Similarly, California's actions can facilitate further steps by EPA to set standards for high-GWP HFCs.

1 California Air Resources Board, *Short Lived Climate Pollutant Reduction Strategy*, Concept Paper, May 2015 *available at* http://www.arb.ca.gov/cc/shortlived/concept_paper.pdf [*hereinafter* "Concept Paper"].
2 The President's Climate Action Plan, Executive Office of the President, pg. 10 (June 2013) *available at* http://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf (last accessed Oct. 1, 2014).
3 U.S. EPA, *Climate Benefits of the SNAP Program Status Change Rule*, pg. 1 (June, 2014)) *available at* Memorandum to Docket: References and Associated Documents, Docket No. EPA-HQ-OAR-2014-0198-0003.

NRDC believes that the Concept Paper has identified many of the right targets for CARB to pursue. In particular, addressing a) the usage of high-GWP HFCs in new products, b) high-GWP HFC leakage from distributed refrigeration systems, and c) end-of-life HFC venting from existing products will be critical to achieving an 80% reduction in HFC use by 2030. Proposals to limit HFC use alongside increases in energy efficiency should be explored whenever possible, as the carbon dioxide emissions from the electricity used to run these systems contributes significantly to life cycle greenhouse gas emissions. NRDC proposes several areas around which an HFC reduction strategy may be built, and looks forward to collaborating with stakeholders as CARB moves forward in developing its HFC reduction strategy.

GWP Limits by End-Use

Limiting the GWP of a refrigerant used in a particular end-use application (e.g. refrigerated transport, retail food refrigeration) is an effective way to prevent the use of high-GWP refrigerants while maintaining chemical and manufacturer neutrality. In addition, specifying end-use GWP limits and distinguishing between new and retrofit systems allows for tailoring of standards to specific applications and consideration of the efficiency implications for a given refrigerant switch. NRDC recommends two tiers of GWP limitation—the first regarding applications with non-flammable medium-GWP refrigerant alternatives that may be instituted immediately and the second regarding a later transition towards low-GWP refrigerants for which ASHRAE fire safety standards and building codes are currently under development.

For the first tier, NRDC recommends:

1. Setting a GWP_{100} limit of 2500 for all new HVAC and refrigeration equipment, and for service and maintenance of all applications, effective January 1, 2018.

   Reclaimed and recycled gas could be used until January 1, 2028, at which point all equipment should either be retrofitted with compliant alternatives or replaced by new equipment. This regulation would put California ahead of European Union Regulation No 517/2014 Article 13, which bans refrigerants above a GWP_{100} of 2500 in 2020 but allows continued use in applications of less than 40-ton CO_2-equivalent refrigerant charges.

   In particular this measure would eliminate use of R-404A and R-507A, two similar refrigerants with GWP_{100} = 3950 and GWP_{100} = 3900, respectively. R-404A and R-507A are used in commercial, industrial, and transportation refrigeration, including medium- and low-temperature refrigeration applications, including retail food display

cases, walk-in refrigerators, retail freezers, cold storage warehouses, supermarket condensing systems, refrigerated transport, and industrial process applications. Many of these systems represent the leakiest refrigerant applications currently in use, with annual leak rates of up to 30%.[4] EPA has proposed to remove approval for commercial use in its "Protection of Stratospheric Ozone: Change of Listing Status for Certain Substitutes Under the Significant New Alternatives Policy Program," published in the Federal Register on August 6, 2014, at 79 Fed. Reg. 46,126 ("un-SNAP Proposal"). Nonetheless, ARB can and should place further limits on this group of HFCs.

Commercial, industrial, and transportation alternatives below GWP_{100} = 2500 have been developed in R-449A and R-452A—blend refrigerants with GWPs 65% and 45% lower than R-404A, respectively, and ASHRAE class A1 non-flammability and non-toxicity. Importantly, these substitutes are expected to achieve better efficiency with only minor adjustments to expansion devices. Alternatively, although they have higher GWPs, the R-407 variants are suitable in applications for which R-449A and R-452A are unavailable. Other refrigerants removed by this suggested GWP limitation are R-422 class, R-428A, R-434A, R-508B, and MO-89, most of which have been targeted in commercial refrigeration by EPA's un-SNAP Proposal. It is possible that exceptions for certain end-uses or situations could be appropriate, including military uses, extreme low temperatures, or applications for which there are no available alternatives.

2. Setting a GWP_{100} limit of 750 effective January 1, 2018, for:
    a. all new medium-pressure water chillers with large screw or centrifugal compressors;
    b. service, maintenance, and all new refrigeration equipment for stationary commercial applications;
    c. service, maintenance, and all new refrigeration equipment for industrial applications with under 200 lb of refrigerant charge.

This standard would curtail the use of R-134a, a compound used at medium pressure when serving medium- and high-temperature cooling requirements. In general, R-134a is found in residential refrigerators, commercial and industrial cooling systems, and water chillers for HVAC and refrigeration. Although residential refrigerators in the EU and elsewhere now use propane and isobutane, we do not recommend including residential refrigeration at this point because building codes in the U.S. do not permit this switch. In the other HVAC and refrigeration applications listed above, the proposed standard would achieve a fifty percent reduction in the GWP of the refrigerant.

4 UNEP Ozone Secretariat. *Fact Sheet 4: Commercial Refrigeration*, Pg. 2. April 2015 *available at* http://conf.montreal-protocol.org/meeting/workshops/hfc_management-02/presession/English/FS%204%20Commercial%20Refrigeration%20final.pdf (last accessed June 11, 2015).

R-513A, which is expected to be a SNAP-approved soon, is non-flammable, non-toxic, has GWP_{100} = 631, and may be used in most new and retrofitted R-134a systems without efficiency or capacity loss. Trane expects to launch the Sintesis® line of R-513A chillers in the U.S. in June 2015, while R-513A will be available from DuPont. Honeywell has developed a competing refrigerant, R-450A, with similar properties and GWP_{100} = 601. Either of these products may be used to comply with the impending limitation, and offer meaningful GWP benefit.

The refrigerants used in higher pressure R-410A chillers and low-pressure R-123 or industrial chillers would not be affected by this proposed standard.

For the second tier, NRDC recommends:

1. Setting a GWP_{100} limit of 200 for new chillers effective January 1, 2025.

   This limitation will require the implementation of A2L-class refrigerants, which ASHRAE characterizes as having mild flammability. Chillers employing these refrigerants are already permitted under building codes as long as NFPA 70's requirements for motors are followed. Because water-cooled chillers are located in mechanical rooms and transfer heat from water to water and air-cooled chillers are outdoors and transfer heat from process water to outdoor air, it is generally expected that use of A2L refrigerants will be permitted. Specifically, U.S. building codes are widely expected to be modified to allow A2L refrigerants in mechanical rooms with reasonable safeguards by 2021, at which point their use will be cost competitive with standard non-flammable refrigerants.[5]

2. Setting strong GWP limits for:

   a. Self-contained HVAC units (e.g. rooftop units, room air conditioners, and other R-410A applications)
   b. Residential ducted and ductless split systems
   c. Transportation refrigeration
   d. Mass transportation air conditioning

We do not provide a specific GWP limit for these products given the ongoing safety research and international code development. We expect that a number of refrigerants, some mildly flammable and some more flammable (A2L-A3), will be approved for each of these end-uses. In India, R-290 (propane) has been demonstrated at commercial scale in both room air conditioners and mini-split residential HVAC systems. China is also commercializing both R-290 and R-32 room air conditioners with success. EPA has recently added both substances to

5 See http://www.achrnews.com/articles/129241-carefully-embracing-flammable-refrigerants; http://tc31.ashraetcs.org/pdf/Standard%2015%20Proposed%20Changes%20for%202L%20Refrigerants.pdf

the SNAP list of approved alternatives, subject to use restrictions. Pending thorough safety assessments, we believe that the lowest-possible GWP limits should be set in a timely manner.

CARB may wish to consider the possibility of establishing limitations to go into effect several years from now that would be contingent on the revision of building codes and the EPA SNAP process. We anticipate that an across-the-board GWP_{100} limit of 750 would be a conservative estimate of a reasonable limit. But developments in the use of propane in unitary equipment or the lack of safety assurance for A2L refrigerants in refrigerated transport applications, for example, could require that the standard be higher or lower for each application. NRDC will continue to assess the outlook of GWP limitations for these end uses, and will provide CARB with additional suggestions.

Mitigation Fees

CARB should consider implementing a mitigation fee on the sale of high-GWP refrigerants that scales with GWP and increases over time, applicable to commercial and industrial distributed refrigerant systems. These systems are also the target of CARB's Refrigerant Management Program (RMP), which regulates stationary distributed refrigeration systems with over 50lb of refrigerant charge. In particular, the RMP requires leak testing, prompt leak repair, service records, and licensed refrigerant handling for large systems. Rigorous refrigerant management to prevent leaks and properly recover high-GWP refrigerants is vital and we applaud CARB's efforts on this front. A mitigation fee would complement this structure by providing a direct incentive for equipment owners to retrofit with a low-GWP alternative. Mitigation fees would of course also ensure that CARB has the resources necessary to implement the management program. The use of a GWP-weighted mitigation fee is also consistent with AB32's use of market based structures to require that those emitting greenhouse gases internalize the costs of those emissions and could provide a model as others consider ways to address HFC use.

There are several ways that a mitigation fee will encourage equipment owners to reduce emissions of HFCs. Equipment owners who successfully prevent leaks use less refrigerant in their systems and thus will pay lower fees. An escalating mitigation fee will also encourage equipment owners to retrofit their systems with lower GWP refrigerants or to replace old equipment with equipment designed for low-GWP refrigerants. Funds collected from this fee could be used to provide grants for retrofits or the purchase of new high-efficiency, low-GWP equipment and innovative systems (such as cascade systems in supermarkets). We look forward to working with CARB to further discuss the policy and legal questions concerning a mitigation fee system.

Refrigerant Buyback Program

NRDC also suggests that CARB consider implementing a refrigerant buy-back requirement for the manufacturers of high-GWP (e.g. above GWP_{100} = 1000) packaged and mini-split residential HVAC and refrigeration equipment (e.g. domestic refrigerators, room air conditioners, central air conditioners) sold in California. While the mitigation fee described above would apply primarily to systems with the highest risk of leakage, this program targets equipment that is hermetically sealed and mostly likely to leak at end-of-life when lines are cut or other improper disposal takes place. Although venting of refrigerants to the atmosphere is illegal, enforcement is difficult and technicians can save time and money by venting rather than properly evacuating and disposing of refrigerant. By creating a buy-back program, CARB could create the incentives needed to ensure proper disposal, avoiding significant end-of-life emissions.

There are various ways that CARB might structure a buy-back program. One way would be to require that manufacturers purchase back the refrigerant from their unit sales in California. Such a buy-back would provide a market for recovered gases, and an incentive for end users, municipal recycling facilities, and residential HVAC technicians to properly handle HFCs in old equipment. Manufacturers might participate in the program either by paying for the proper disposal of refrigerants or by buying back the refrigerant following processing and repackaging (with appropriate certification) at a U.S. reclaiming facility. A retroactive cut-in date for program eligibility would likely be necessary to make this program practical (e.g. equipment manufactured after January 1, 2005).

Recycled Refrigerant Standard

CARB should consider setting a standard requiring that a minimum portion of high-GWP refrigerants sold by manufacturers or refrigerant distributors in California be recycled refrigerant. At present, estimates suggest that less than ten percent of refrigerants are recycled and reused.[6] As noted, refrigerants that are not recycled most often end up being vented to the atmosphere. By setting a minimum recycled product standard, CARB could significantly increase the rates of refrigerant recycling and improve refrigerant management in California and beyond. CARB could set the required percentages of recycled refrigerant based on the current availability of recycled refrigerant and the GWP of the refrigerant, with higher rates of recycled refrigerant required for the highest GWP refrigerants. Thus, the standard could require a higher level of recycled product for higher GWP products or might apply only to refrigerants above a certain GWP level. In this way, the standard would, either in combination with or in lieu of the mitigation fee requirement, provide an additional incentive for users to switch to low GWP alternatives.

6 See http://eosclimate.com/wp-content/uploads/2015/04/EOS-Climate-White-Paper.pdf

Light-Duty Vehicle Standards

NRDC suggests that CARB consider limiting refrigerants in new light-duty motor vehicle air conditioning (MVAC) systems sold in California to GWP_{100} = 150, effective January 1, 2019. Although CARB considered similar measures as a part of the LEV III amendment to the Low-Emission Vehicle Program, ARB settled on incentives for vehicles sold after 2017.[7] EPA's proposed outright ban on R-134a in new vehicles for model year (MY) 2021, part of the un-SNAP Proposal, has put the United States four years behind the European Directive 2006/40/EC's (the MAC Directive's) limit of GWP_{100} = 150 in MY 2017. EPA's schedule corresponds very closely to business-as-usual, especially considering CARB's incentives and the credits for low-GWP refrigerants in CAFE legislation. NRDC believes that California could continue to lead the nation in this area by instituting the GWP_{100} = 150 limit in 2019. A high threshold of fleet compliance, e.g. 80-90%, could be set for MY 2019 to ease compliance for vehicles that will soon be taken out of an original equipment manufacturer's (OEM's) fleet. Alternatively, ARB could require that any vehicle with an R-1234yf variant sold abroad be sold in that configuration in California.

Measures should also be taken to ensure that R-1234yf systems are not user-recharged with considerably-cheaper R-134a. In 2009, CARB decided against banning small cans of R-134a in favor of instituting restrictions on the use of small cans, including a deposit recycling system, labeling, self-sealing valves, and educational programs. We strongly support CARB's existing small can program but believe CARB should reconsider banning small cans of R-134a in light of the coming change in vehicle refrigerant. At a minimum, the small can program should be amended to restrict the use of R-134a in alternative refrigerant systems. CARB should also require different fittings for R-1234yf and R-134a cans and proper labeling to preventing illegal R-134a use. But such steps would still not be as effective as instituting a small-can R-134a ban as of January 1, 2019. We believe that the risk of confusion and misuse of R-134a in R-1234yf systems, as well as the risk of venting from small cans of R-134a during and following use, provides ample justification for banning small cans of R-134a.

Future Research & Further Commitments

In addition to the specific recommendations above, NRDC recommends that CARB coordinate research on several other areas relevant to reducing emissions of HFCs in California.

7 California Air Resources Board. *LEV III Greenhouse Gas Non-test Cycle Provision: Technical Support Document*. January 2012. a*vailable at* http://www.arb.ca.gov/regact/2012/leviiighg2012/levappr.pdf (last accessed June 11, 2015).

1. Building Codes

Many local, state, and national building codes do not currently allow use of any flammable refrigerants. Efforts are underway to approve appropriate standards and to update building codes to reflect safe levels and use conditions for flammable refrigerants, but the process can be long and complex. This effort is important because updating building codes to reflect safe use conditions for flammable refrigerants will be key to achieving CARB's goal of an 80% HFC reduction by 2030. While fire safety is outside CARB's core scope, NRDC believes that there are two ways that CARB can support the efforts toward adoption of standards for safe use of flammable refrigerants:

a. CARB should consider providing grants to academic institutions to study flammable refrigerant safety in residential and commercial applications. In particular, NRDC believes that it would be valuable for CARB to support further research on the relationship between refrigerant auto-ignition temperature and the field conditions necessary to cause actual ignition. In addition, research on optimal refrigerant sensor location and maximum charge amounts should be conducted in a peer-reviewed context.

b. CARB should work to obtain a commitment for swift review and, if acceptable, adoption of proposed codes for safe use of flammable refrigerants into the state mechanical code or CA Title 24. ASHRAE is slated to begin evaluating residential and commercial refrigerant safety this year, and is expected to set standards for safe use of low-flammability refrigerants in certain residential applications fairly soon. California should consider directly adopting these standards as soon as they become available.

By facilitating the process of adopting new standards for the safe use of alternative refrigerants, California could pave the way towards low-GWP HVAC and refrigeration systems across the country.

2. Heavy Duty Vehicle Refrigerants

CARB should consider facilitating grants to academic institutions in order to investigate the feasibility of low-GWP refrigerants in heavy duty vehicles, and to establish a timeline for such a transition. There are unique technical challenges for heavy duty vehicles that do not exist in light duty applications and additional research in this area would be valuable. In particular, it is important to evaluate the use of larger charge sizes of R-1234yf and the efficiency of R-744.

NRDC looks forward to working with other stakeholders and with CARB as it moves forward in developing its HFC reduction goals. The SLCP concept paper highlights that California is well-positioned to lead the nation in transitioning away from high-GWP chemicals. This leadership will allow California to both meet the state goal of an 80% reduction by 2030 and provide a valuable example to the rest of the nation and the international community that decisive action must be taken to eliminate these harmful chemicals.

Sincerely,

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