October 6th, 2015

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

By email and hand delivered:

CC: Sarah Dunham, Director, Office of Atmospheric Programs
Cindy Newberg, Chief, Alternatives and Emissions Reduction Branch

Dear Administrator McCarthy:

The Environmental Investigation Agency (EIA) congratulates the United States Environmental Protection Agency (EPA) on the two recently finalized rulemakings which alter the alternatives approved by the Significant New Alternatives Policy (SNAP) program: SNAP Rule 19 - EPA–HQ–OAR–2013–0748; FRL–9922–26– OAR] RIN 2060–AS04, Listing of Substitutes for Refrigeration and Air Conditioning and Revision of the Venting Prohibition for Certain Refrigerant Substitutes (Rule 19), and SNAP Rule 20 – EPA–HQ–OAR–2014–0198; FRL-9926-55-OAR] RIN 2060-AS18, Change of Listing Status for Certain Substitutes under the Significant New Alternatives Policy Program (Rule 20).

EPA's SNAP Rules 19 and 20 were a significant first step toward meeting the President's Climate Action Plan (CAP) and eliminating the use of unnecessary high-GWP alternatives, particularly in the retail food refrigeration and motor vehicle air conditioning end-uses, while simultaneously approving many new low-GWP alternatives for use in the U.S. market. This petition is filed pursuant to Section 612(d) of the Clean Air Act (CAA) and 40 CFR 82.184(b)(3). Under section 612 of the Clean Air Act, the EPA has the authority to evaluate alternatives to ozone-depleting substances and publish a list of acceptable and unacceptable substitutes through the SNAP Program. Under its authority, the EPA used notice-and-comment rulemaking both to remove the high-GWP substitutes in SNAP Rule 20 from the list of acceptable substitutes, and to list the low-GWP alternatives of SNAP Rule 19 as acceptable subject to use conditions or narrowed use limits.

I. Background and Summary of Petition

EIA hereby petitions the EPA to issue an additional notice-and-comment rulemaking under the same authority and reasoning exercised in Rule 20 to change the SNAP status of additional high-GWP refrigerants and deem them as unacceptable (or acceptable subject to use restrictions only in specific types of equipment where the EPA determines there are not sufficient proven low-GWP alternatives) across a number of sectors and end-uses. The full list of requests in this Petition is provided in this summary, in a

ENVIRONMENTAL INVESTIGATION AGENCY
P.O. BOX 53343 Washington DC, 20009
TEL +1 202 483 6621 FAX +1 202 986 8626
www.eia-global.org
info@eia-global.org

detailed table summarizing the list of high-GWP refrigerants covered by this Petition is set forth in the Appendix and detailed narratives are set forth in the body of the petition for each end-use.

In the proposal for Rule 20, EPA requested comment on the use and viability of low-GWP refrigerants including R-744, R-717, and hydrocarbons in additional end-uses including refrigerated transport, cold storage warehouses, and industrial process refrigeration with the intent of considering listing additional high-GWP substitutes as unacceptable for these additional end-uses.[1] The overall structure of this Petition is based upon a response to the EPA's request for comment, covering a list of substitutes with GWPs comparable to or higher than those high-GWP HFCs removed under Rule 20, and expanding this approach to additional sectors and end-uses where there are sufficient proven low-GWP alternatives available to warrant the change in status of the listed high-GWP HFCs.

Although EPA's SNAP program does not adopt specific GWP thresholds as the sole criteria for rulemakings, it is consistent with EPA's mandate and authority under the Climate Action Plan and CAA to undertake an additional rulemaking that takes a graduated approach to establishing timeframes for additional changes in listing status for high-GWP HFCs based upon the different ranges of GWP and the availability of low-GWP alternatives. With this in mind, proposed changes in listing status and accompanying timeframes outlined in this Petition are generally structured to achieve a graduated elimination of additional high-GWP HFCs beginning with the highest-GWP substitutes in the most immediate timeframe, progressing in stages to cover additional substitutes with timeframes for effective dates in 2017, 2019 and 2022. This tiered approach is intended to serve as a framework for eliminating the alternatives with the greatest overall impact on human health and the environment in the shortest feasible timeframe, while sending a clear longer term signal to encourage private sector investment in low-emissions technology and the related infrastructure. Setting multiple dates in a single rulemaking for staged changes in listing status will also allow manufacturers and end users reasonable timelines for undertaking a transition in each of their manufacturing lines for equipment using existing refrigerants directly to the *lowest*-GWP alternatives available. In order to ensure that the rulemaking has this policy impact, the EPA must issue a rulemaking that comprehensively addresses all three tiers of high-GWP HFCs in the sectors as set forth herein. Such an approach will allow for the most significant and rapid transitions away from HFCs and ensure maximum gains for the environment, human health and energy efficiency.

The three tiers consist of the following: the first and highest-GWP tier includes SF_6, HFC-23 and HFC-23 blends R-508A and R-508B, which should be listed unacceptable as of January 1, 2017 or one year following the passage of a final rule. SF_6, with GWP of 22,800, HFC-23 with GWP of 14,800 and HFC-23 blends R-508A and R-508B with GWPs above 13,000, are between ten to fifteen times more damaging to the climate than other refrigerants already eliminated under Rule 20, making them by far the highest-GWP substitutes allowed under the SNAP program. SF_6, HFC-23 and HFC-23 blends should be eliminated in all remaining end-uses, which include fire suppression equipment, very low temperature refrigeration, and industrial process refrigeration. In the second tier, EPA should target all chemicals with a GWP greater than 3,000 to be listed as unacceptable for all remaining stationary refrigeration end-uses

[1] http://www.gpo.gov/fdsys/pkg/FR-2014-08-06/pdf/2014-18494.pdf, see p46149.

by January 1, 2019. This class of alternatives includes HFC-236fa, HFC-227ea, HFC-507A, and HFC-404A. For certain end-uses, such as household refrigeration, where low-GWP alternatives are sufficient, it is also feasible to include substitutes with GWPs ranging from 1,430-3,000 in the same timeframe, including HFC-410A, HFC-134a, and HFC-407A/B/C, while for other end-uses with fewer available low-GWP alternatives, these substitutes are included in the third tier to allow additional time for industry to transition. The third tier should cover all remaining substitutes with GWPs higher than 1,000, including HFC-134a, R-410A, with a suggested effective date of January 1, 2022. While these timelines should be feasible for refrigeration end-uses as covered under this Petition, certain other air conditioning end-uses such as split and unitary air conditioning will require additional time and should be considered under a subsequent rulemaking.

Finally, this petition addresses the issue of the recently SNAP listed high-GWP HFC blends: alternatives R-513A, R-450A, R-448A, and R-449 These chemicals, with GWPs of approximately between 600-1400, were recently listed under [EPA–HQ–OAR–2003–0118; FRL–9918–30– OAR] RIN 2060–AG12 Protection of Stratospheric Ozone: Determination 29 for Significant New Alternatives Policy Program (Notice 29) and [EPA–HQ–OAR–2003–0118; FRL–9930–55– OAR] RIN 2060–AG12 Protection of Stratospheric Ozone: Determination 30 for Significant New Alternatives Policy Program (Notice 30)] have been deemed as acceptable for new and retrofit equipment for eleven different end-uses including domestic refrigeration, vending machines, stand-alone refrigeration equipment, and industrial process refrigeration, among many others. These new substitutes have GWPs that are comparable to other high-GWP substitutes removed from the list of approved SNAP alternatives in Rule 20 and their impacts on human health and the environment is a major policy decision. Use of these substances and other similar substances will lead to sustained high-GWP HFC emissions within these end-uses and sub-sectors for decades to come given the long lifetimes of these types of equipment, and the experiences of previous phase-outs of ozone depleting substances. CFCs, for example were phased out in the year 2,000 and yet it was estimated by industry representatives more a decade later that 20-30,000 chillers using CFCs were still in service.[2] Introducing new high-GWP substitutes to the market also undermines the market development for low-GWP alternatives, many of which are already proven and widely commercially available in the U.S. and/or the international market, by dis-incentivizing private sector investment in the low-emission technology and the related infrastructure.

These new high-GWP HFCs have not yet been widely adopted by equipment manufacturers and thus should have their status changed and be removed from the SNAP list of acceptable alternatives effective immediately, except as noted herein, before a market is created for their widespread use. At minimum, these substitutes should not be allowed for use in new equipment, and allowed in used equipment only where they will contribute to substantial emission reductions from existing equipment through retrofits. The use of these chemicals in retrofits should be limited to use in equipment manufactured before January 1, 2019 to ensure that these chemicals remain the transitional alternatives that they are intended to be.

[2] http://www.rses.org/assets/rses_journal/0610_Capitol.pdf

The changes in listing status and effective dates suggested in this Petition will help maintain the role of the United States as a global leader in the transition away from high-GWP refrigerants, by putting the U.S. refrigeration sector on a path similar to that of the European Union, China, Australia, and other countries implementing national policies to move as quickly as feasible to the lowest-GWP alternatives. The EU F-Gas Regulation already prohibits the sale of domestic refrigerators and freezers containing HFCs with GWPs greater than 150, and will prohibit sale of all stationary refrigeration equipment (except those designed to cool products below -50°C) containing HFCs with a GWP greater than 2,500 as of January 1, 2020.[3] It also prohibits hermetically sealed commercial refrigeration equipment, the equivalent to the SNAP end-use for stand-alone equipment, containing HFCs with a GWP greater than 150 as of January 1, 2022.[4] Australia recently announced a commitment to reduce HFC emissions by 80% in 2036.[5] In order to maintain its leadership role, it is imperative that the U.S. follow a similar path and avoid a sustained transition to using new HFC blends with high GWPs.

In summary, and as outlined in more detail within table contained in the Appendix and following section of the Petition for each sector and end-use, EIA petitions EPA to make the following changes in listing status of the following high-GWP HFCs in the listed end-uses:

- Remove SF_6, HFC-23 and R-508A and R-508B (blends containing HFC-23) from the list of acceptable substitutes in all fire suppression and explosion protection applications, all new and retrofit industrial process refrigeration and very low temperature refrigeration applications, effective January 1, 2017.
- Remove HFC-236fa, HFC-125, HFC-227ea and all remaining PFCs from the list of acceptable substitutes in fire protection and explosion protection for both total flooding and streaming applications effective January 1, 2019. Consider narrowed use restrictions for HFC-134a in these applications, with potential exemption of HFC-227ea for specified applications where HFC-134a or low-GWP alternatives are not feasible for technical or safety reasons.
- Remove R-450A, R-513A, R-448A, and R-449A from the list of acceptable substitutes for new equipment in all applications effective immediately. Allow these substitutes in retrofit equipment only for equipment manufactured before January 1, 2019.
- Remove R-507A, R-404A, HFC-236fa, and HFC-227ea from the list of acceptable substitutes for all new and retrofit stationary refrigeration and industrial air conditioning applications effective January 1, 2019. Stationary refrigeration applications include: industrial process refrigeration, cold storage warehouses, very low temperature refrigeration, refrigerated transport, industrial process air conditioning, reciprocating/screw/scroll/centrifugal chillers, household refrigerators and freezers, commercial ice machines, and water coolers.
- Remove R-407A, R-410A, and R-410B from the list of acceptable substitutes for cold storage warehouses effective January 1, 2019. Remove HFC-134s, R-407F, R-407C, R-420A and all

[3] See Annex III, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0517&from=EN
[4] Ibid.
[5] https://www.environment.gov.au/system/files/resources/d8c15c43-2966-43fe-aff2-bfff3f23f600/files/factsheet-actions-australia-taking.pdf

other alternatives with a GWP >1,000 from the approved list of substitutes for cold storage warehouses effective January 1, 2022.

- Remove R-407A, R-410A, R-410, and R-134a from the list of acceptable substitutes for all new and retrofit equipment in industrial process refrigeration, effective January 1, 2022.
- Remove R-422, R-422B, and R-422C from the list of acceptable substitutes for all new and retrofit equipment for very low temperature applications, effective January 1, 2019.
- Remove HFC-134a from the list of acceptable substitutes for all new and retrofit equipment for refrigerated transport, effective January 1, 2022. Remove R-407C/F, R-410A/B, and HFC-134a from the list of acceptable substitutes for all new and retrofit equipment for industrial process air conditioning effective as of January 1, 2022.
- Remove KDD6, R-134a,R-245fa, R-410B, R-421A, R-422D, R-424A, R-434A, R-422B, R-422C, R-427A, R-423A, R-420A, SP34E, R-414B (Hot Shot), Hot Shot 2, FOR12A, and FOR12B from the list of acceptable substitutes in new and retrofit reciprocating, screw and centrifugal chillers in new and retrofit equipment effective as of January 1, 2019.
- Remove R-410A from the list of acceptable substitutes in new and retrofit reciprocating, screw and centrifugal chillers in new and retrofit equipment effective as of January 1, 2022.
- Remove R-428A, R-421B, R-434A, R-401B, R-402A, R-402B , R-409A, R-409B, R-406A, R-407C, R-407F, R-420A, R-422B, R-422C, R-422D, R-427A, R-426A, R-424A, R-426A (RS-24), KDD5/R-438A and KDD6 from the list of acceptable substitutes in all new household refrigerators and freezers effective January 1, 2017.
- Remove HFC-134a from the list of acceptable substitutes in all new household refrigerators and freezers effective January 1, 2019,
- Reference international standards IEC 60335-2-24 and ISO 7371 with respect to acceptable use conditions for hydrocarbons in household refrigerators and freezers and other applicable household and commercial applications where hydrocarbons are listed as acceptable in future. IEC working groups have been formed under IEC TC61C and TC61D with mandates to develop additional requirements for A2 and A3 refrigerants including re-evaluation charge size limits, new technologies and safety mechanisms and additional mitigation measures.
- Remove FOR12A, FOR12B, HFC–134a, KDD6, R– 125/290/134a/600a (55.0/1.0/42.5/1.5), R– 404A, R–407C, R–410A, R–410B, R–417A, R–421A, R–422B, R–422C, R–422D, R–426A, R–437A, R–438A, R–507A, RS-24 (2002 formulation), SP34E from the list of acceptable substitutes in retrofit equipment for vending machine applications, effective January 1, 2022.
- Remove HFC-134a, R-406A, R-407A/B/C, R-411A/B from the list of acceptable substitutes in new and retrofit commercial ice machines with an effective date of January 1, 2022.
- Remove R-407A, R-407C, R-407F, R-427A, R-421A, R-410A, R-410B from the list of acceptable substitutes in new and retrofit supermarket systems and remote condensing units effective as of January 1, 2022.
- Remove R-134a, R-421A/B, R-424A, R-426A, R-438A, R-422A/B/C/D, R-407A/B, R-407F from the list of acceptable equipment in new and retrofit water coolers effective as of January 1, 2022.

II. Analysis of Sectors and End-Uses for Additional Changes in Listing Status

The following sections provide detailed analysis for each end-use and information regarding the availability of low-GWP alternatives to support the suggested changes in listing status and accompanying timelines contained in this Petition.

Fire Suppression and Explosion Protection

The fire suppression and explosion protection sector is divided into two end-uses: total flooding agents and streaming applications. Total flooding agents are classified as when a specific concentration of extinguishing agent is discharged into an enclosed area by an automated system. Streaming applications consist of extinguishing agents when used as directed in a portable fire extinguisher.

In this sector, in addition to HFCs, the petition also focuses on the need to remove perfluorochemicals (PFCs) from the list of acceptable alternatives. PFCs are a group of chemicals which do not break down in the environment and have been found to affect growth, development, reproduction, and liver function in laboratory animals.[6] While the effects of PFCs on human health is still uncertain, restricting their use due to their direct impacts on human health is also advisable under the precautionary principle, by which EPA is charged to act. PFCs used in fire extinguishing have GWPs above 8,000, and therefore, their impact on climate, and related effects on the environment and human health provide an immediate justification for completely eliminating them as SNAP approved alternatives. As reasoned below, there are sufficient alternatives to high-GWP HFCs and PFCs in both total flooding and streaming fire suppression and explosion protection applications to remove these substances from the SNAP list of alternatives. Removal of PFCs from the SNAP list of approved alternatives is consistent with the EPA's Significant New Use Rule (SNUR) under the Toxic Substances Control Act and its 2009 Long-Chain Perfluorinated Chemicals Action Plan to work toward eliminating products containing PFCs by 2015.[7]

Total Flooding

In total flooding applications, EPA should list SF_6 with a GWP of 22,800, HFC-23 with a GWP of 14,800, and HFC-23 blends R-508A and R-508B with GWPs above 13,000, as unacceptable as of January 1, 2017 or one year following the final passage of a rule. Fire protection equipment containing HFC-23 has been prohibited from placement on the market under the European Union's F-Gas Regulation beginning January 1, 2016 which demonstrates sufficient alternatives are available for its elimination as an alternative. [8] Additionally, EPA should list HFC-236fa, PFC-218 and PFC-410 with GWPs between 8,800 and 9,810[9] as unacceptable by January 1, 2019. Finally, EPA should list all other substitutes with 100-year GWPs above 3,000 as unacceptable, or unacceptable subject to narrowed use restrictions, as

[6] http://www.cdc.gov/biomonitoring/PFCs_FactSheet.html

[7] http://www.epa.gov/oppt/existingchemicals/pubs/actionplans/pfcs.html See also http://www.epa.gov/oppt/existingchemicals/pubs/pfcs_action_plan1230_09.pdf

[8] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0517&from=EN See Annex III.

[9] AR4 values, http://www.ghgprotocol.org/files/ghgp/tools/Global-Warming-Potential-Values.pdf

follows: HFC-125, HFC-227ea by 2022. Finally, EPA should restrict the acceptable use of R-134a with a GWP of 1,430 in fire suppression and explosion protection applications by 2022 to only those applications where the EPA establishes that low-GWP substitutes are not yet sufficiently available.

SF_6, HFC-23, R-508A and R-508B (HFC-23 blends), HFC-125 and HFC-227ea are all currently listed as acceptable substitutes for Halon 1301 in total flooding systems. PFC-218 and PFC-410 are listed as acceptable substitutes for Halon 1301 subject to narrowed use limits in non-residential uses where other alternatives are not technically feasible. HFC-236fa is currently listed as acceptable subject to narrowed use limits where other non-PFC agents are not technically feasible due to safety or performance. The EPA should remove these six substitutes from all subsectors where HFC-134a or low-GWP substitutes including carbon dioxide, water, and Foam A are available as alternatives. In cases where EPA determines that sufficient proven lower-GWP alternatives do not exist at present, HFC-125 and HFC-227ea, may remain listed acceptable subject to narrowed use limits and revisited in a subsequent rulemaking.

Streaming (portable fire extinguishers)

In streaming applications, EPA should follow a similar approach listing HFC-227ea and HFC-236fa, with GWPs of 3,350 and 8,060 respectively as unacceptable as of January 1, 2019. In addition, EPA should also change the listing status to unacceptable for PFC-614 with a GWP of 9,300.[10] These substitutes are currently listed as acceptable subject to use limits in non-residential uses. EIA has determined through investigation and interviews that high-GWP HFCs can be eliminated from all commercial and residential end uses of portable fire extinguishers by the dates set forth in this Petition. Low-GWP substitutes that are acceptable for this end use and widely used in portable fire extinguishers include carbon dioxide, water, dry chemical, foam, and Firebane 1170 & 1115. Carbon dioxide fire extinguishers are widely available and used for Class B and C liquid and electrical fires.[11] Water fire extinguishers using air-pressurized water are widely used for Class A fires that involve flammable solids, such as paper or wood.[12] Dry chemical extinguishers come in a variety of types and are suitable for a combination of class A, B, and C fires and are filled with foam or powder and pressurized with nitrogen.[13] Carbon dioxide, nitrogen and argon systems such as those sold by Kidde[14] and Fike[15] are proven and available alternatives that are sufficient for almost all applications where a 'clean agent' that is both non-conductive and non-corrosive to electronics is required. These alternatives have the advantage of not leaving a corrosive residue on electronic equipment, and thus good substitutes for HFC-227ea and HFC-236fa, which are touted for their non-corrosive property in specialty uses involving sensitive electronics. Systems using inert gases are available for a wide range of applications including data centers, computer control rooms, engine rooms, power generation, and commercial buildings.[16] Therefore, the use of HFCs

[10] AR4 value, http://www.ghgprotocol.org/files/ghgp/tools/Global-Warming-Potential-Values.pdf
[11] https://fireextinguisherdepot.com/fire-extinguishers-1/carbon-dioxide-fire-extinguishers-1.html
[12] http://www.mfs-fire-extinguishers.co.uk/types.htm
[13] http://www.fire-extinguisher101.com/
[14] http://kevtafiresystems.com/wp-content/uploads/2012/01/Doc_Kidde-CO2-DIOM.pdf
[15] http://www.fike.com/products/co2-fire-suppression-system/
[16] http://www.fike.com/products/proinert2-inert-gas-fire-protection-system/

should be restricted to essential applications where the above listed alternatives are not technically suitable, for example, in some commercial and military aviation uses where a clean agent fire suppressant is needed for an occupied space. For many applications, risks from CO_2 to humans occupying a space can be mitigated by safety mechanisms such as alarm controls that warn any occupants to evacuate before a system is activated.

For Class B fires where PFC foam suppression has been employed, alternative dry chemical fire suppressants are widely proven, used, and available. These chemicals include sodium bicarbonate, potassium bicarbonate, monoammonium phosphate, and widely used in products such as Purple K, which are the most commonly used fire suppressant in residential and commercial applications.[17] Systems such as those sold by Ansul[18] are suitable for liquid fires involving petroleum in applications such as refineries.

SF_6, HFC-23, HFC-23 blends R-508A and R-508B, should be deemed as unacceptable under the SNAP program for use in both total flooding and streaming fire suppression and explosion protection applications as of January 1, 2017 or one year following the final passage of a rule. HFC-236fa, HFC-227ea, PFC-218 and PFC-410 should be deemed as unacceptable under the SNAP program for use in both total flooding and streaming fire suppression and explosion protection applications by January 1, 2019. HFC-125, HFC-227ea should be deemed as unacceptable under the SNAP program for use in both total flooding and streaming fire suppression and explosion protection applications by January 1, 2022. By 2022, restrictions for the acceptable use of R-134a in key fire suppression and explosion protection end uses should be imposed to limit the use of HFC-134a in fire suppression end uses to only those where low-GWP substitutes are not yet commercialized.

Very Low Temperature Refrigeration

Very low temperature refrigeration includes systems that maintain temperatures of -80 degrees Fahrenheit (-62 degrees Celsius) or lower, such as some medical freezers and freeze dryers, and some industrial refrigeration applications. EPA should list HFC-23 with a GWP of 14,800 and blends containing HFC-23, R-508A and R-508B, both with GWPs above 13,000 as unacceptable in new and retrofit equipment as of January 1, 2017 or one year following the passage of a final rule. Other substitutes with GWPs ranging from approximately 3,000 to 3,985 that should be listed as unacceptable in new equipment as of January 1, 2019 are as follows: R-507A, R-404A, R-422, R-422B, and R-422C.

The above changes of listing status will leave low-GWP substitutes including R-170 (ethane), R-290, R-744, and air with GWPs from 0 to 6. The remaining portion of the market will also still be able to use R-407C, which has a GWP below 2,000 and should be listed unacceptable at a later date once it is determined that the entire market can be supplied by R-744, ethane, or other low-GWP substitutes.

[17] http://www.bfpe.com/Dry-Chemical/
[18] https://www.ansul.com/en/us/Pages/ProductDetail.aspx?ProductDetail=Twin-Agent+Units

Thermo Fisher Scientific recently introduced an ultra-low temperature (ULT) cascade refrigeration system for a medical freezer application operating with a combination of ethane (R-170) and R-290.[19] The use of a variable speed compressor in this system is cited as achieving up to a 50% reduction in energy consumption. Panasonic offers a similar product – a large capacity ULT Freezer achieving temperatures of -86 degrees Fahrenheit using R-290/R-170 and claiming up to 40% energy efficiency gains.[20]

Mayekawa's Pascal Air refrigeration system for low temperature warehouses uses air as the working refrigerant fluid and can achieve temperatures as low as -120°C.[21] Mayekawa has installed at least 54 units of the Pascal Air in a number of applications, including ultra-low temperature warehouses, rapid food freezing systems, and in the chemical process cooling industry.[22]

HFC-23 and blends containing HFC-23, R-508A and R-508B should all be deemed unacceptable for use in very low temperature refrigeration in new and retrofit equipment as of January 1, 2017 or one year following the passage of a final rule. R-507A, R-404A, R-422, R-422B, and R-422C should be similarly be removed from the list of acceptable substitutes in very low temperature refrigeration as of January 1, 2019.

Cold Storage Warehouses

The EPA should list the following substitutes with GWPs ranging from around 2000 to 3,990 as unacceptable in new and retrofit equipment for cold storage warehouses effective January 1, 2019: R-404A, R-507A, R-508A, R-508B, NARM 502, HFC-227ea, R-407A, R-410A and R-410B. Additionally, EPA should list R-134a, R-407C, R-407F and R-420A with GWPs ranging from 1,430 to 2,000 as unacceptable for new and retrofit equipment as of January 1, 2022. Finally, EPA should list R-513A and R-450A as unacceptable for new equipment with immediate effect and for use in retrofits for any equipment manufactured after January 1, 2019 where their use results in a substantial reduction in the GWP over the current refrigerant.

Ammonia (R-717), with a GWP of 0, is the single most commonly used refrigerant for industrial refrigeration, which includes both cold storage and process cooling.[23] Low-GWP equipment using ammonia and other low-emission technology is more than sufficiently available for a range of equipment types used for cold storage warehouses including packaged systems, chillers, and remote condensing units. The other low-GWP substitutes include R-744, evaporative cooling, and desiccant cooling, all currently available with GWPs of zero or one.

While equipment using ammonia (R-717) is already widely available and in use, systems also utilizing R-744 as a secondary refrigerant with ammonia are becoming more common in order to reduce

[19] http://news.gnom.es/pr/embraco-presents-innovative-solution-for-the-medical-scientific-area-in-atmosphere-america-2015
[20] http://www.panasonic-healthcare.com/global/biomedical/ultra-low-freezers/mdf-du700vh
[21] http://www.r744.com/articles/6121/pascal_air_environmentally_friendly_ultra_low_temperature_storage
[22] Ibid.
[23] http://www.scribd.com/doc/122993371/Industrial-Refrigeration-Best-Practices-Guide#scribd

ammonia charge sizes and associated toxicity risks. For example, US Cold Storage, the third largest refrigerated warehouse provider in the country has installed 11 systems since 2011 using a combination of R-717 and R-744 in either a cascade system or in critical brine systems using R-744 as a secondary coolant.[24] The use of R-744 to lower the charge size of R-717 systems makes these systems safer from the perspective of both human health and environmental risk perspectives, with the added bonus of remaining cost-competitive with pure ammonia systems at less than a 5% margin.[25] The use of evaporative cooling in evaporative condensers or in closed circuit towers using water or a solution of either ethylene or propylene glycol is another low-GWP alternative available.[26]

Ammonia, ammonia cascade systems, evaporative cooling, and desiccant cooling are all available for use in cold storage warehouses. There is no cold storage end use where HFCs or the new high-GWP blends are needed. R-404A, R-507A, R-508A, R-508B, NARM 502, HFC-227ea, R-407A, R-410A and R-410B should be deemed as unacceptable alternatives as of January 1, 2019. R-134a, R-407C, R-407F and R-420A with GWPs ranging from 1,430 to 2,000 should be deemed as unacceptable for new and retrofit equipment as of January 1, 2022. Finally, since R-513A and R-450A have just come onto the SNAP list on July 2, 2015, and there is no significant uptake of these chemicals to date, they should be deemed as unacceptable for use in new equipment immediately following the passage of the final rule requested herein and in retrofit equipment manufactured after January 1, 2019 where their use results in a substantial reduction in the GWP over the current refrigerant.

Industrial Process Refrigeration

The EPA should list HFC-23 with a GWP of 14,800, and HFC-23 blends R-508A and R-508B as unacceptable in new and retrofit industrial process equipment as of January 1, 2017 or one year following the passage of a final rule. In addition, EPA should list the following substitutes with GWPs ranging from around 3,350 to 8,060 as unacceptable in new and retrofit industrial process refrigeration: HFC-236fa, R-404A, R-507A, R-508A, R-508B, NARM 502, HFC-227ea. In the same rulemaking, EPA should also list R-407A, R-410A, and R-410B, and R-134a with GWPs between 1,430 to almost 3,000 as unacceptable as of January 1, 2022. Finally, EPA should list R-513A and R-450A, both with GWPs around 600, as unacceptable in new equipment with immediate effect, in order to prevent the creation of a market for new equipment using these new high-GWP substitutes. These chemicals should be allowed for use as retrofits for existing equipment manufactured prior to January 1, 2019 in end uses where there are not sufficient commercialized low-GWP retrofits on the market. The EPA should impose policies in the proposed rule to ensure that these new high-GWP chemicals do not create emissions for decades, but instead ensure that these chemicals are the transitional chemicals they are intended to be, replaced by low-GWP alternatives as soon as practicable.

Proven and available low-GWP alternatives are available for a range of equipment types used for industrial process refrigeration uses including cooling towers, rack systems, scroll compressors and

[24] http://www.uscold.com/wp-content/uploads/2015/06/Publication_Accelerate-America_Mike_Lynch_sm.pdf
[25] Ibid.
[26] http://www.baltimoreaircoil.com/english/about-us/who-we-serve

condensers, and heat pumps. Manufacturers of equipment that utilize R-717 and R-744, substitutes with GWPs from zero to one include: Cimco[27], Evapco[28], Star Refrigeration[29], Mayekawa[30], Baltimore Aircoil Company[31], Johnson Controls[32] and some of the other companies listed separately in the following section on chillers, which are frequently used for process refrigeration and industrial air conditioning uses. In order to reduce the potential for workers to be exposed to R-717, R-717/R-744 cascade systems have also become much more common in order to reduce the charge size of ammonia. Johnson Controls is one example of a major manufacturer already producing R-717/R-744 cascade systems.[33]

HFC-23 and HFC-23 blends R-508A and R-508B should be deemed as unacceptable in new and retrofit industrial process equipment as of January 1, 2017 or one year following the passage of a final rule. R-513A and R-450A as unacceptable in new equipment with immediate effect, and should be allowed for use as retrofits for existing equipment manufactured prior to January 1, 2019.

Centrifugal, Reciprocating, Screw and Scroll Chillers

The EPA should list the following high-GWP HFC and HCFC substitutes with GWPs ranging from approximately 1,4300 to 8,060 as unacceptable in new and retrofit industrial centrifugal, reciprocating, screw, and scroll chillers as of January 1, 2019: HFC-236fa, ISCEON 59, R-404A, R-507, R-507A, HFC-227ea, KDD6, HFC--134a, HFC-245fa R-410B, R-421A, R-422D, R-424A, R-434A, R-422B, R-422C, R-427A, R-423A, R-420A, SP34E, R-414A (GHG-X4), GHG-X5, R-414B (Hot Shot), Hot Shot 2, HFC-245fa, FOR12A, FOR12B. Additionally, the EPA should list R-450A and R-513A, both with GWPs of around 600, as unacceptable in new chillers with an immediate effective date, while continuing to allow their use for retrofit equipment manufactured before January 1, 2019, in end-uses where sufficient low-GWP alternatives do not exist and where their use results in a substantial reduction in the GWP over the current refrigerant. Finally, the EPA should remove R-410A from the list of acceptable substitutes in all chiller applications, effective as of January 1, 2022.

It will be particularly important to send the long term market signal that will incentivize development of standards needed to allow for the broader safe use of low-GWP substitutes in these types of equipment. While R-717 has already achieved widespread market use, standards for the safe use of other low-GWP alternatives that carry flammability risks that must be mitigated are being developed under Underwriters Laboratories (UL) and can expect to be completed by 2018.

The low-GWP substitutes available on the U.S. market include R-717, water, water/lithium bromide absorption, evaporative/desiccant cooling, HFO-1233zd, and HFO-1234ze. Manufacturers of

[27] http://www.cimcorefrigeration.com/pdf/ECO%20CHILL.PDF
[28] http://www.evapco.com/sites/evapco.com/files/hvac_features_bulletin_701b__0.pdf
[29] http://www.star-ref.co.uk/star/innovation.html
[30] http://www.mayekawa.eu/en/products/special-products/high-pressure-screw-compressor-unit/gh-series
[31] http://www.baltimoreaircoil.com/english/about-us/who-we-serve
[32] http://www.johnsoncontrols.com/content/us/en/products/building_efficiency/products-and-systems/industrial_refrigeration/york_process_systems/industrial_cooling/screw-compressors.html
[33] http://www.johnsoncontrols.co.uk/content/gb/en/products/building_efficiency/refrigeration/industrial/applications-solutions/cold_store_solutions.html

chillers using R-717, water and other natural low-GWP substitutes, including for uses in light and large industrial refrigeration and air conditioning applications, include Star Refrigeration[34], Power Partners[35], Mayekawa[36], GEA Refrigeration,[37] Refteco[38], and Beijer Ref[39].

The already deep market penetration of R-717 in chillers, including industrial refrigeration and air conditioning end uses should be considered, particularly in light of ongoing technological capacities to improve A2 safety through lower charge sizes, automated control systems, and R-717/R-744 brine systems.[40] In IPCC Assessment Report 3, it was stated that R-717 systems were estimated to have a 90% market share in systems of 100kW cooling capacity and above in the USA.[41] 90% of chillers produced for the European market use R-717.[42]

The uptake of HFO-1234ze (GWP=1), another low-GWP alternative, in both air and water centrifugal and screw chillers has also been coming online rapidly over the past year. Trane[43], Carrier[44], Geoclima[45], and Airedale[46] have all introduced HFO-1234ze chiller equipment to the commercial market. HFO-1233zd (GWP <7) is also available as an alternative in centrifugal chillers and requires no standards changes to be adopted. Trane has already transitioned an entire line of centrifugal chillers for the European market to HFO-1233zd with capacities ranging from 20kW to 14,000kW.[47]

Finally, the EPA has yet to consider listing R-290 or R-744 as acceptable, or acceptable subject to use conditions, as low-GWP substitutes for chillers under SNAP, yet they have been widely proven by multiple manufacturers outside of the U.S. Market. Geoclima, for instance has introduced models using R-290 in their Greenmiser line of reciprocating chillers.[48] Similarly Johnson Controls has a line of air-cooled R-290 screw chillers with capacities ranging from 95 to 400 kW.[49] Another possibility is double combination R-290/R-744 chillers, which Geoclima piloted successfully in 2013.[50] R-290 chillers manufactured by FT Refrigeration used in an industrial refrigeration setting offered a 24% reduction in

[34] http://www.azane-inc.com/products/Azanechiller.aspx
[35] http://www.ppiway.com/brands-solutions/eco-max
[36] http://www.mayekawa.eu/en/media/brochure-downloads/download/23
[37] http://www.gea.com/global/en/productgroups/chillers_heat-pumps/chillers/index.jsp
[38] http://www.refteco.com/chillers/ammonia-chiller-cha/
[39] http://www.beijerref.ro/en/produse/nh3-brine-chillers-swa/107/
[40] http://www.shecco.com/files/news/guide_nh3-final.pdf
http://www.ammonia21.com/articles/6433/guide_china_nh_sub_3_sub_technology_has_significant_growth_potential_in_industrial_refrigeration
[41] http://www.ipcc.ch/ipccreports/tar/wg3/index.php?idp=148
[42] http://ec.europa.eu/clima/events/docs/0007/johnson_controls_ammonia_slides_en.pdf
[43] http://www.coolingpost.com/world-news/trane-first-with-1233zd-chiller/
[44] http://www.coolingpost.com/world-news/carrier-latest-to-install-r1234ze-chiller/
[45] http://www.welcomegroup.com.hk/products_subcat.php?id=23
[46] http://www.achrnews.com/articles/126828-airedale-chiller-with-low-gwp-hfo-refrigerant-to-cool-new-john-lewis-store
[47] http://www.racplus.com/news/trane-launches-european-focused-chiller-range-including-a-centrifugal-version-using-hfo-refrigerant/8664781.article
[48] http://www.geoclima.com/v-range/
[49] http://www.johnsoncontrols.nl/content/dam/WWW/jci/be/eu_library/refrigeration/netherlands/SABlight_SB3306_Feb_2013Prt.pdf
[50] http://www.geoclima.com/double-combination-cycle-r290-co2/

energy consumption compared to an aging ammonia system it replaced.[51] Other companies offering commercially available chillers using R-290 include Mayekawa screw compressor J series[52], HeronHill[53], Hitema/StastveldBV[54], and Bundgaard Koleteknik A/S.[55] Mayekawa's AdRef-Noa adsorption chiller using water as a refrigerant is ideal for industrial uses with an available heat recovery source.[56]

Industrial Process Air Conditioning

The EPA should list the following refrigerants, with GWPs ranging from 3,900 to 3,985 as unacceptable in new and retrofit industrial process air conditioning systems effective January 1, 2019: R-404A, R-507, R-507A. Additionally, the EPA should list the following refrigerants as unacceptable in new and retrofit industrial process air conditioning systems effective January 1, 2022, with GWPs ranging from 1,430 to 2,930: ISCEON 59, KDD6, R-410A, R-410B, R-421A, R-422D, R-424A, R-426A, R-434A, R-422B, R-422C, R-427A, R-423A, R-407F, HFC-245fa, FOR12A, FOR12B, and HFC-134a. In addition, EPA should list R-450A and R-513A, both with GWPs of around 600, as unacceptable in new systems, but allow their limited use in retrofit systems where sufficient low-GWP alternatives have not been proven in order to allow for a smooth transition away from high-GWP alternatives in existing equipment manufactured prior to 2019 where their use results in a substantial reduction in the GWP over the current refrigerant.

As detailed in the above sections on cold storage warehouses and industrial refrigeration, ammonia (R-717) is a widely used solution for these types of equipment. If EPA finds that there are certain uses for which R-717 or R-717 cascade systems are not proven alternatives or under which toxicity risks cannot be reasonable mitigated with the use of safety mechanisms or placement of systems on rooftops or in closed, unoccupied spaces, then EPA may consider allowing R-450A and R-513A subject to restrictions for those narrow and specific end uses, based on size or capacity of the system or another criteria.

R-404A, R-507, R-507A should be deemed as unacceptable in new and retrofit industrial process air conditioning systems effective January 1, 2019. ISCEON 59, KDD6, R-410A, R-410B, R-421A, R-422D, R-424A, R-426A, R-434A, R-422B, R-422C, R-427A, R-423A, R-407F, HFC-245fa, FOR12A, FOR12B, and HFC-134a should be deemed as unacceptable in new and retrofit industrial process air conditioning systems effective January 1, 2022. R-450A and R-513A should be deemed as unacceptable in new systems with an immediate effective date, these chemicals could be used in limited instances in retrofit systems in order to allow for a smooth transition away from high-GWP alternatives in existing equipment manufactured prior to January 1, 2019 where their use results in a substantial reduction in the GWP over the current refrigerant.

[51] http://www.hydrocarbons21.com/articles/5287/span_style_color_rgb_255_0_0_update_span_r290_water-cooled_chillers_replace_existing_dairy_refrigeration_plant
[52] http://www.mayekawa.ca/brochures/pdf/J_series_propane_brochure.pdf
[53] http://www.heronhill.co.uk/products/331/eko-air-cooled-chiller
[54] http://www.hitema.it/marketing/realizations
[55] http://www.hitechcr.com.au/wp-content/uploads/2013/07/OzChillNewsletter-June-2013-Web.pdf
[56] http://www.mayekawa.com.au/wordpress/wp-content/uploads/2013/07/AdRef-Noa-Brochure-170713.pdf

Refrigerated Transport

The EPA should list the following substitutes with GWPs ranging from approximately 1,500 to 3,985 as unacceptable for new and retrofit equipment as of January 1, 2019: R-507A, R-404A, R-406A, R407A/B/C/D, R-422C/D, R-421A/B, R-424A, and R-426A. Additionally, EPA should list R-448A, R-449A, R-513A, R-450A with GWPs ranging from 600 to 1,400 as unacceptable with immediate effect.

In Rule 20, EPA acknowledged that lower GWP substitutes for refrigerated transport include liquid CO_2, direct nitrogen expansion, and Stirling cycle, with GWPs in the range of zero to one. A number of companies are supplying low-GWP transport refrigeration systems for the U.S. market including Carrier[57], Johnson Controls[58], Ingersoll Rand[59], Naturefridge[60], and Linde[61], with both medium and low temperature applications covering marine refrigeration, refrigerated trailers for cargo trucks, and refrigerated cargo ships.

The California Air Resources Board (CARB) also recently released a report on the alternatives available for refrigerated transport.[62] In the report, CARB found in its conclusions and summary of the most promising technologies that cryogenic transport refrigeration systems are the most promising technology in the next five to ten years:

> "Staff believes cryogenic TRs are promising because WTW GHG and TTW CP emission reductions are significant at 59 and 100 percent, respectively. Cryogenic TRs provide much faster initial chill-down and temperature recovery after a delivery door opening. Also, initial capital equipment costs for a cryogenic TR are close to the cost of a conventional diesel TRU and maintenance cost savings are significant enough to at least partially offset the significant cryogenic fueling infrastructure costs. Cryogenic TRs are commercially available and hundreds of them are in use in Europe."[63]

R-507A, R-404A, R-406A, R407A/B/C/D, R-422C/D, R-421A/B, R-424A, and R-426A should be deemed as unacceptable for new and retrofit refrigerated transport equipment as of January 1, 2019. R-448A, R-449A, R-513A, R-450A should be deemed as unacceptable in refrigerated transport with immediate effect.

---

[57] Carrier Transicold NaturaLINE CO_2 refrigeration systems: http://www.esmagazine.com/articles/96715-carrier-transicold-honored-for-co2-refrigerant-trailer.

[58] Johnson Controls Marine ammonia/CO_2 refrigeration system: http://www.johnsoncontrols.com/content/us/en/products/building_efficiency/building/marine/fishery.html.

[59] Thermo King's (Ingersoll Rand) cryotech refrigeration system: http://europe.thermoking.com/cryotech/.

[60] http://naturefridge.com/

[61] Linde Frostcruise liquid nitrogen for refrigerated trailers and R744 for refrigerated cargo ships: http://www.linde-gas.com/en/products_and_supply/food_chilling_cooling/in-transit-refrigeration.html

[62] See: http://www.arb.ca.gov/msprog/tech/techreport/tru_07292015.pdf

[63] http://www.arb.ca.gov/msprog/tech/techreport/tru_07292015.pdf, Page IV-2

Household Refrigerators and Freezers

EPA should list the following substitute refrigerants as unacceptable in new and retrofit equipment as of January 1, 2017, with GWPs ranging from 1,200 to 3,990: R-404A, R-507, R-507A, R-428A, R-421B, R-434A, R-401B, R-402A, R-402B , R-409A, R-409B, R-406A, R-407C, R-407F, R-420A, R-422B, R-422C, R-422D, R-427A, R-426A, R-424A, R-426A (RS-24), KDD5/R-438A and KDD6. In addition, EPA should list R-134a as unacceptable in new and retrofit household refrigerators and freezers as of January 1, 2019. Finally, EPA should list R-450A and R-513A, both with GWPs around 600, as unacceptable in all new and retrofit household refrigerators and freezers, with immediate effect.

As most household refrigerators and freezers currently manufactured in the United States use R-134a, it should be quite feasible to remove the above list of alternatives from the list of acceptable substitutes with GWPs of 1200 and above. Similarly, having just been introduced, R-450A and R-513A can be easily discontinued as they have not yet been adopted by manufacturers for use in domestic refrigerators. A separate date of January 1, 2019 for R-134a will give more than ample time for reformation of standards and for producers to transition this end use entirely to proven and available low-GWP refrigerants that are widely used throughout the rest of the world with GWPs approximately between 4 to 8 including R-290, R-600a, and hydrocarbon blends.

Household refrigerators and freezers using R-290 and R-600a with a 150 gram charge limit, as opposed to the 57 gram charge size in effect in the U.S., have been shown to be safe, efficient, and environmentally friendly refrigerants for domestic refrigerators and freezers around the world. As a result, 100% of equipment sold on the European market and 75% in China are using these alternatives. The U.S. EPA should actively engage with Underwriters Laboratories (UL), which permits governmental participation to move quickly, and decisively to adopt reasonable and safe charge sizes to safely mitigate flammability risks for A2L and A3 refrigerants, based upon modern technologies, safety devices and warnings. Doing so will quickly open the U.S. market to the highly available and proven alternatives well within the suggested time frame for changing the listing status of R-134a on January 1, 2019.

R-404A, R-507, R-507A, R-428A, R-421B, R-434A, R-401B, R-402A, R-402B, R-409A, R-409B, R-406A, R-407C, R-407F, R-420A, R-422B, R-422C, R-422D, R-427A, R-426A, R-424A, R-426A (RS-24), KDD5/R-438A and KDD6 as unacceptable in new and retrofit household refrigerator and freezer equipment as of January 1, 2017. R-134a should be deemed as unacceptable in new and retrofit household refrigerators and freezers as of January 1, 2019. R-450A and R-513A should be deemed as unacceptable in all new and retrofit household refrigerators and freezers, with a date immediately following the final rulemaking.

Vending Machines

In Rule 20, the EPA listed a number of refrigerants as unacceptable in new vending machines with GWPs from 600 to 3,920: FOR12A, FOR12B, HFC–134a, KDD6, R–125/290/ 134a/600a (55.0/1.0/42.5/1.5), R–404A, R–407C, R–410A, R–410B, R–417A, R– 421A, R–422B, R–422C, R–422D, R– 426A, R–437A, R–438A, R–507A, RS–24 as of January 1, 2019. Furthermore, EPA has listed also R-404A and R-507A as unacceptable in retrofit equipment as of July 20, 2016.

Given the proven availability and wide use of equipment using alternatives with GWPs ranging from 1 to 8, EPA should also list R-450A and R-513A (both also with GWPs of above 600, in the same range as other high-GWP refrigerants covered under Rule 20 as unacceptable in new vending machine equipment with immediate effect. The rationale for this short timeline is that R-450A and R-513A were only recently determined acceptable and therefore these substitutes are not yet in use for vending machines according to publically available sources. With the average lifespan of a vending machine being about 10-13 years[64], eliminating the use of all refrigerants with GWPs above 600 will have a significant impact on emissions from new equipment that will be in use for more than a decade to come. These chemicals could be used in limited instances in retrofit systems in order to allow for a smooth transition away from high-GWP alternatives in existing equipment manufactured prior to January 1, 2019 where their use results in a substantial reduction in the GWP over the current refrigerant.

The EPA should also expand the unacceptable listing of additional refrigerants in retrofit vending machines with GWPs above 600 as of January 1, 2022, including FOR12A, FOR12B, HFC–134a, KDD6, R–407C, R–410A, R–410B, R–417A, R– 421A, R–422B, R–422C, R–422D, R– 426A, R–437A, R–438A, and RS–24.

The EPA acknowledged in its proposal for Rule 20 that R-744 is already in use in the U.S. in vending machines, and with the publication of Rule 19, R-600a, R-290 and R-441A are now also listed as acceptable subject to use conditions. Based on the following examples of wide use of these low-GWP refrigerants in vending machines in the U.S. and around the world, there should be ample availability of low-GWP substitutes by the delisting date of January 1, 2019. Coca-Cola has also surpassed 1 million HFC-free vending machines using R-744.[65] Royal Vendors, a supplier of R-744 vending machines to Coca-Cola, has four different models available using R-744 refrigerant, including the RVCV-550-6, 660-8,804-8, and 500-64.[66] SandenVendo has supplied at least 1,200 R-744 vending machines in the U.S. to date.[67] Pepsi has more than 1 million HFC-free vending machines around the world, which use 20 percent

[64] https://www.sce.com/NR/rdonlyres/A152092A-9FC5-410C-80DC-F19257EC19EA/0/Refrigerated_Vending_Machine_Fact.pdf

[65] http://www.coca-colacompany.com/innovation/coca-cola-installs-1-millionth-hfc-free-cooler-globally-preventing-525mm-metrics-tons-of-co2

[66] EIA correspondence with Royal Vendors, 8/28/14

[67] Accelerate America, Edition 7, http://publication.shecco.com/upload/file/org/55bfa2b198da31438622385WjhMs.pdf

less energy than Energy Star requirements, and it plans to phase out HFCs in all vending machines, coolers, and fountain soda dispensers by 2020.[68]

FOR12A, FOR12B, HFC–134a, KDD6, R–407C, R–410A, R–410B, R–417A, R– 421A, R–422B, R–422C, R–422D, R– 426A, R–437A, R–438A, and RS–24 should be deemed as unacceptable for use in retrofit vending machines. R-450A and R-513A should be deemed as unacceptable in new vending machine equipment with immediate effect.

Retail Food Refrigeration

Supermarket systems and remote condensing units

In Rule 20, The EPA listed a number of refrigerants with GWPs from 2,729 to 3,985 as unacceptable in retrofit new supermarket systems and remote condensing units as of July 20, 2016 and in equipment as of January 1, 2017: HFC– 227ea, R–404A, R–407B, R–421B, R– 422A, R–422C, R–422D, R–428A, R–434A, and R–507A.

EPA should list the following substitutes with GWPs ranging from approximately 2,000 to 2,500 as unacceptable in new and retrofit equipment as of January 1, 2022: R-407A, R-407C, R-407F, R-427A, R-421A, R-410A, and R-410B. Additionally, the EPA should list R-448A, R-449A, R-513A, and R-450A with GWPs approximately ranging from 600 to 1400 as immediately unacceptable in new equipment, while these chemicals could be used in limited instances in retrofit systems in order to allow for a smooth transition away from high-GWP alternatives in existing equipment manufactured prior to January 1, 2019 where their use results in a substantial reduction in the GWP over the current refrigerant. Finally, the EPA should also list HFC-227ea with a GWP of 3,350 as unacceptable in retrofits as well as new equipment effective January 1, 2019, as it was the only substitute allowed for retrofits in retail food refrigeration with a GWP above 3,000 not covered by Rule 20.

The EPA also stated in Rule 20 that 70% of U.S. supermarket systems are direct expansion systems, while 30% are indirect systems, which include cascade and secondary loop systems. The rulemaking also stated that within the context of different types of systems that "EPA recognizes that there must be a range of options, and that the decision as to which option to select must remain with the owner and operator of the system."

With the increasing availability and use of cascade and secondary loop systems that offer significant refrigerant charge reductions, there are indeed a range of low-GWP options currently available to supermarket end users whether retrofitting an existing system or purchasing a new one. Thousands of supermarkets around the world have transitioned to R-744 (GWP of 1) and hydrocarbons (GWP of <10),

[68] White House Fact Sheet: https://www.whitehouse.gov/the-press-office/2014/09/16/fact-sheet-obama-administration-partners-private-sector-new-commitments- .Vending Times, PepsiCo to Phase Out HFC in Vending Machines, Coolers and Fountains by 2020, 9/19/2014, http://www.vendingtimes.com/ME2/dirmod.asp?nm=Vending+Features&type=Publishing&mod=Publications%3A%3AArticle&tier=4&id=09D204A3CBE14022AE4E167E7F2634B7

both demonstrating substantial energy savings over traditional HFC systems even in high ambient climates.[69] R-717, with a GWP of 0, when used as a primary refrigerant in a secondary loop system is also available as an alternative. R-717/R-744 cascade systems have been successfully piloted by supermarket chains, including Supervalu[70] and Whole Foods[71]. Carnot and others recommend the R-717/R-744 cascade systems as being particularly appropriate for larger stores such as those found throughout the United States.[72] The use of R-744 and R-717/R-744 cascade has even been employed by the U.S. government when it was recently announced that the US Defense Commissary Agency (DeCA), which operates 245 commissaries worldwide, would use R-717/R-744 cascade systems as their standard in warm climates and is considering transcritical CO_2 for other uses.[73] The DeCA's announcement came after a successful retrofitting of a R-404A system with a R-717/R-744 cascade system at Lackland Air Force Base in San Antonio, TX.[74] Wal-Mart has installed HFC-134a cascade systems with dramatically reduced charges sizes to retrofit more than 100 of its stores which adds to the variety of options available to transition supermarket systems to low-GWP alternatives and to control emissions of high-GWP HFCs in existing equipment.

R-407A, R-407C, R-407F, R-427A, R-421A, R-410A, and R-410B should be deemed as unacceptable as of January 1, 2022. R-448A, R-449A, R-513A, and R-450A should be deemed as unacceptable in new equipment with immediate effect, while these chemicals could be used in limited instances in retrofit systems in order to allow for a smooth transition away from high-GWP alternatives in existing equipment manufactured prior to January 1, 2019 where their use results in a substantial reduction in the GWP over the current refrigerant.HFC-227ea should be deemed as unacceptable in retrofits as well as new equipment effective January 1, 2019.

Stand-alone equipment (medium- and low-temperature)

The EPA took a truly significant step forward in Rule 20 in changing the status to unacceptable for a number of high-GWP substitutes in both new medium- and low-temperature stand-alone equipment with GWPs ranging from approximately 900 to 3,985, as well as R-404A and R-507A in retrofit equipment. In an additional rulemaking, EPA should also list the remaining substitutes with GWPs ranging from 900 to 3,985 as unacceptable in retrofit equipment with an effective date of January 1, 2022, two years following their last use in new equipment as follows: FOR12A, FOR12B, R–134a, HFC–227ea, KDD6, R–125/290/134a/600a (55.0/1.0/ 42.5/1.5), R–404A, R–407A/B,/C, R–407F, R–410A/B, R–417A, R–421A,/B, R–422A/B/C/D, R–424A, R–426A, R– 428A, R–434A, R–437A, R–438A, R–507A, RS-24 (2002 formulation), RS-44 (2003 formulation), SP34E, THR-03.

[69] https://eia-international.org/wp-content/uploads/Chilling-Facts-VI.pdf
[70] http://supermarketnews.com/technology/supervalu-pleased-ammonia-refrigerant
[71] http://www.atmo.org/presentations/files/416_1_EILINGER_WHOLEFOODS.pdf
[72] http://www.ammonia21.com/articles/6275/nh_sub_3_sub_heat_pumps_and_nh_sub_3_sub_-co_sub_2_sub_systems_grow_in_popularity_at_iiar_show-part_1
[73] http://www.coolingpost.com/features/us-defence-agency-adopts-co2-refrigeration/.
[74] http://www.coolingpost.com/features/us-defence-agency-adopts-co2-refrigeration/.

The EPA should also change the listing status of the four recently listed high-GWP substitutes: R-448A, R-449A, R-513A, and R-450A with GWPs ranging from approximately 600 to 1,400 to unacceptable effective immediately in both new and retrofit equipment for the medium- and low-temperature application where they have been listed. There is not yet a market for equipment using R-448A, R-449A, R-513A, and R-450A, therefore, their status should be changed immediately. R-448A and R-449A were only listed in low-temperature applications, while the R-513A and R-450A were listed for both medium- and low-temperature equipment. These sectors have abundant low-GWP alternatives and the approval of new high-GWP alternatives is directly contrary to the mandate given to the EPA in the CAP.

The above changes in listing status are feasible due to the wide availability of low-GWP substitutes in these standalone, factory sealed equipment. In section VC3(a) of the proposed rulemaking for Rule 20, the EPA acknowledged that for new stand-alone equipment, R-290 and R-600a could satisfy the vast majority of the current market:

> "We understand that R-290 is already in use globally, including in the United States, and that R-600a is in use outside of the United State as well as in test market trials in the United States. We believe that these two refrigerants can satisfy the vast majority of the current market for use in stand-alone equipment. We note that there may be a need to modify the equipment design in order to meet the use conditions for R-290 and the proposed use conditions for R-600a and R-441A (July, 9, 2014; 79 FR 38811)."[7576]

In Rule 20 and Acceptability Determination 30, EPA sub-divided the stand-alone equipment end use between medium and low temperature equipment in response to comments that limited charge sizes for hydrocarbon refrigerants restrict their use as alternatives in low temperature equipment. In Acceptability Determination 30, EPA listed R-448A and R-449A, with GWPs between 1300 and 1400, as acceptable in both new and retrofit equipment for low-temperature standalone applications with the following reasoning.

In Rule 20, the EPA stated that:

> As with ''large'' equipment, discussed below, commenters, including Hussmann and Hillphoenix, indicated that the charge size limits that apply to the hydrocarbon refrigerants could limit their use in low-temperature equipment, although for some equipment, it may be possible to redesign equipment to use multiple circuits. In addition, these commenters further noted that HFC–134a was not a workable refrigerant for low temperature applications, and thus some of the HFC/HFO alternatives, specifically R–450A and R–513A, which were designed to perform similarly to HFC–134a, would likewise not be workable in these applications. However, other HFC/HFO alternatives,

[75] http://www.coolingpost.com/features/us-defence-agency-adopts-co2-refrigeration/, see also, http://www.epa.gov/ozone/snap/download/DeCA_Commercial_Refrigeration_Case_Study.pdf

[76] http://www.epa.gov/ozone/downloads/SAN_5750_SNAP_Status_Change_Rule_NPRM_signature_version-signed_7-9-2014.pdf, p142.

such as R–448A and R–449A, designed to perform similarly to R–404A could be available for low-temperature uses.[77]

The above statement about limited use of hydrocarbons in freezer applications is contradictory to the large range of stand-alone equipment that has been introduced to the international market in low temperature applications within the 150 gram charge limit. Nor do all stand-alone equipment models use multiple circuits to achieve low-temperatures in stand-alone equipment. For example, AHT offers integrated commercial display freezers with cooling down to -23°C.[78] Liebherr-International offers a laboratory freezer using R-600a that cools down to -30°C.[79] Unilever has more than 900,000 Ben & Jerry's ice cream freezers that use R-290, and are 10 percent more energy efficient than HFC models. 4,588 of these freezers had been used within the U.S. as of the end of 2013.[80] Other European companies including Lekkerland and Vestfrost, use R-600a for their chest freezers, as cited above. In Europe, McDonalds has rolled out R-290 equipment widely, including 3,811 meat freezers and 2,802 frozen dry dispensers, and 1,614 blended ice machines.[81]

R-600a and R-290 can supply the market for new stand-along medium- and low-temperature equipment in the 2019 and 2020 dates when substitutes with greater than 900 GWP go off the market.

Water Coolers

The EPA should change the listing status to unacceptable in new and retrofit equipment as of January 1, 2019 for the following substitutes with GWPs above 3,000: R-404A, R-507, and R-507A. Additionally, EPA should change the listing status to unacceptable in new and retrofit equipment as of January 1, 2022 for the following substitutes with GWPs approximately between 1,430-3,000: R-134a, R-421A/B, R-424A, R-426A, R-438A, R-422A/B/C/D, R-407A/B, and R-407F. Finally, R-513A and R-450A, with GWPs of approximately 600, should be listed unacceptable in new equipment with immediate effect, while these chemicals could be used in limited instances in retrofit systems in order to allow for a smooth transition away from high-GWP alternatives in existing equipment manufactured prior to January 1, 2019 where their use results in a substantial reduction in the GWP over the current refrigerant..

Recent developments encouraging market uptake of low-GWP water coolers demonstrate the availability of low-GWP substitutes will be achievable by the above proposed delisting dates, provided the EPA lists R-290 and R-600a as acceptable under the SNAP program for use in water coolers. The availability of low-GWP water coolers is wide spread in international markets and could greatly increase in the U.S. market once the EPA lists R-290 and R-600a as acceptable. Already in the U.S. several companies are poised to provide low-GWP water coolers on a commercially available scale. Blupura, an

[77] http://www.gpo.gov/fdsys/pkg/FR-2015-07-20/pdf/2015-17066.pdf, p42914.
[78] http://www.hydrocarbons21.com/web/assets/companybrochure/file/652_paris_hc_cabinet.pdf
[79] http://www.hydrocarbons21.com/products/view/liebherr_lab_refrigerators_and_freezers
[80] http://www.hydrocarbons21.com/articles/6243/atmosphere_europe_2015_end_users_ask_technology_providers_to_close_gap_in_the_natural_refrigerant_market
[81] http://www.hydrocarbons21.com/articles/6243/atmosphere_europe_2015_end_users_ask_technology_providers_to_close_gap_in_the_natural_refrigerant_market

Italian water cooler company that manufactures an array of water coolers using R-290 and R-600a[82], opened a sales office in the U.S. more than a year ago and has recently obtained UL certification for its products.[83] The company already has installations in U.S. hotels, restaurants, tech companies, and universities. Blupura's products are used throughout the European market and are increasing in South Africa[84], the Middle East, and other parts of the world.[85] Recently in February 2015, Elkay, a global manufacturer of water coolers based in Illinois, agreed to a partnership with Blupura to distribute Blupura products in the U.S. and Canadian foodservice and hospitality markets[86], which will have significant impact on market availability of low-GWP water coolers in the U.S. and Canadian market. In addition to Blupura and Elkay, Oasis, an international company headquartered in Ohio, manufactures water coolers using R-600a[87] with sales in more than 80 countries.[88] Allowing that the EPA lists R-290 and R-600a as acceptable in water coolers under the SNAP program in the immediate future, the U.S. market for low-GWP water coolers will experience significant growth making the above recommended delisting dates achievable.

Commercial Ice Machines

The EPA should remove R-507A and R-404A from the list of acceptable equipment in new and retrofit commercial ice machines effective as of January 1, 2019. Additionally, EPA should remove R-134a, R-421A/B, R-424A, R-426A, R-438A, R-422A/B/C/D, R-407A/B, R-407F from the list of acceptable equipment in new and retrofit commercial ice machines effective as of January 1, 2022. Finally, given there is not yet a market for equipment using the, EPA should remove the following substitutes from the acceptable list effective immediately: R-448A, R-449A, R-513A, and R-450A.

Given the commercial availability of R-290 and R-744 ice makers on the international market, the EPA should move quickly to allow these substitutes in the U.S. market. In the meantime, currently acceptable alternatives under SNAP for this sector include ammonia absorption, ammonia vapor compression, and Stirling cycle.

R-717 (ammonia) with a GWP of zero, is a widely used alternative for commercial ice machines. Companies currently manufacturing low-GWP technologies available for the U.S. market include Howe Corporation's ammonia ice flaking machines[89], Automatic Ice Systems Turbo C-Line Ice Generators[90], Energy Concept's ISAAC Solar Ice Maker ammonia-water absorption cycle[91], Morris & Associates tube ice makers[92], and C&R Refrigeration.[93]

[82] http://www.blupura.com/en/products-water-purification.asp.
[83] http://www.hydrocarbons21.com/articles/6593/chilled_water_anyone_blupura_obtains_ul_certification_in_u_s.
[84] http://www.blupura.com/en/news.asp.
[85] http://www.watercoolerseurope.eu/interview/interview-to-luca-costantini-blupura.
[86] http://www.elkay.com/news-blupura-products.
[87] http://www.oasiscoolers.com/index.php/technology/hydro-carbons.html.
[88] http://www.oasiscoolers.com/index.php/about-us.html.
[89] http://equipment.howecorp.com/viewitems/ice-flakers/ammonia-flake-ice-machines
[90] http://automaticice.com/turbo-c-line-ice-generators/
[91] http://www.energy-concepts.com/_pages/app_isaac_solar_ice_maker.htm
[92] http://morris-associates.com/products/ice-production/tube-cube-ice-maker/

Although not yet SNAP approved, many companies are manufacturing ice machines using R-290 and R-744 for use in other countries. Manitowoc, a Wisconsin based manufacturer, has developed two models of under counter commercial ice machines that are cooled using R-290.[94] Gram Commercial[95], Hoshizaki[96], and Scotsman[97] are among other companies offering R-290 ice cube and ice flaking machines for the European markets. Howe Corporation has also introduced model R-744 ice flakers for use in subcritical or transcritical direct expansion systems.[98] Brema, a European company, is moving to transition its entire production line of ice machines to R-744.[99] While commercial ice machines were considered in a study commissioned by the EPA examining the potential effect of hydrocarbons on ground level ozone[100], they were not included in the rulemaking as an acceptable sector for additional listings under Rule 19. The EPA should promulgate another rulemaking to grant SNAP approval of the numerous low-GWP substitutes for these sectors, which are in wide use in the EU and other countries.

III. Conclusion

The EPA has taken a significant step toward implementing the directive in the President's Climate Action plan by implementing Rules 19 and 20, but much more can be done. The EPA should approve this petition to remove high-GWP HFC alternatives on a graduated basis to allow for a smooth transition to low-GWP alternatives. The high-GWP HFCs which are the subject of this petition were primarily approved by the SNAP program during the CFC and HCFC phase-outs, but are now often the most damaging of the alternatives listed for particular end-uses. EPA must now remove the above listed high-GWP HFCs from the list of acceptable alternatives on a swift and progressive basis.

The EPA risks following a different path than the rest of the world by granting SNAP approval for the new high-GWP HFC blends R-448A, R-449A, R-513A, and R-450A for uses in new equipment where there are abundant low-GWP alternatives. These chemicals should be immediately removed from approved alternatives for new equipment. The widespread use of these chemicals in new equipment is not necessary in any sector where they have been listed, will undermine the uptake of low-GWP alternatives and the related infrastructure, and finally will result in massive emissions of HFCs for decades to come given the useful life of the equipment in the sectors for which they have been approved. The EPA should conduct a careful review to determine whether there are sectors where these chemicals are really needed for retrofits. If such sectors are identified, the use of these products should be limited to equipment manufactured before January 1, 2019 where their use substantially reduces the GWP over the existing refrigerant, so that use of these chemicals does not become widespread, or a way for the use of HFCs to continue beyond the time when they are absolutely necessary.

---

[93] http://www.crrefrig.com/c-r-tubular-ice-makers

[94] http://refrigerants.danfoss.com/technicalarticles/rc/energy-efficient-hydrocarbon-ice-makers/?ref=17179885516

[95] http://gram-commercial.com/gb/en-gb/ice-makers-under-the-gram-name

[96] http://www.hydrocarbons21.com/web/assets/companybrochure/file/759_hoshizaki_ice_machines_issue4_gb.pdf.

[97] http://www.scotsman-ice-on-tablet.com/Food_SuperFLAKE_MF.html

[98] http://equipment.howecorp.com/viewitems/ice-flakers/co-sub-2--sub--flake-ice-machines

[99] http://www.bremaice.it/en/prodotti/cold-flakes/muster/m-split-1000-co2.html See also http://www.carel.com/documents/10191/171507/R744,02-03-15.pdf/c12ab59d-336f-4697-8309-3159ae4135ee

[100] See ICF 2014a, in docket for proposed Rule 19.

If you or your staff wishes to discuss this petition or have any questions, please contact me or my coauthors to this petition at the contact information provided below.

Very truly yours,

The Environmental Investigation Agency



By: Mark W. Roberts, Senior Counsel

Lisa Handy, Senior Policy Advisor
Christina Starr, Climate Policy Analyst
Lowell Chandler, Climate Policy Analyst

markroberts@eia-global.org
lisahandy@eia-global.org
cstarr@eia-global.org
lchandler@eia-global.org

Appendix: Summary of EIA's October 6, 2015 SNAP Petition for Additional Listings of High-GWP ODS Substitutes as Unacceptable

End-Uses	New/ Retrofit	High-GWP ODS Substitute	Approx. GWP-100 Range	Date	Proven Alternatives	GWP-100	Use Restrictions/Notes
Fire Suppression (Total Flooding)	N/A	SF_6, HFC-23, and HFC-23 blends (R-508A, R-508B)	13,000-22,800	January 1, 2017 or one year after final rule	Carbon dioxide, nitrogen, argon	0-1	
					Water, Water mist systems	0	
	N/A	HFC-236fa, HFC-125, HFC-227ea, PFC-218, PFC-410	3,000-8,860	January 1, 2019	Powdered Aerosol A	0	Consider narrowed use restrictions for HFC-134a.
					HFC-134a	1430	
Fire Suppression (Streaming Agents/ Portable Extinguishers)	N/A	HFC-227ea, HFC-236fa, PFC-614	3,350-9,160	January 1, 2019	Carbon dioxide, nitrogen, argon	0-1	Dry chemical agents are widely used for Class B fire suppression in applications including petroleum refineries and aircraft Carbon dioxide and the other inert gases are available and sufficient for most applications requiring a 'clean agent'.
					Water	0	
					Dry chemical (Sodium bicarbonate, potassium bicarbonate and monoammonium phosphate)	0	
Cold Storage Warehouses	New and retrofit	R-507A, R-404A, HFC-227ea, R-407A, R-410A, R-410B	2000-3,985	January 1, 2019	R-717	0	
	New and	R-134a,R-407F, R-407C, R-	1,430-2,000	January 1, 2022	R-744	1	

	retrofit	420A					
	New	R-513A, R-450A	604-700	Immediate	Evaporative/ Desiccant Cooling	0	

Industrial Process Refrigeration	New and retrofit	HFC-23, and HFC-23 blends (R-508A, R-508B)	13,000-14,800	January 1, 2017 or one year after final rule	R-290 R-600a R-1270	<5	
	New and retrofit	HFC-236fa, R-507A, R-404A, HFC-227ea	3,350-8,060	January 1, 2019	R-744	1	
	New and retrofit	R-407A, R-410A, R-410, R-134a	1,430-3,000	January 1, 2022	R-717	0	
					Stirling Cycle	0	
	New	R-513A , R-405A	604-700	Immediate	Evaporative /Desiccant Cooling	0	
Very Low Temperature Refrigeration	New and retrofit	HFC-23, and HFC-23 blends (R-508A, R-508B)	13,000-14,800	January 1, 2017 or one year after final rule	R-170 Ethane R-1150 Ethene	<6	
	New and retrofit	R-507A, R-404A, R-422, R-422B, R-422C	3,000-3,985	January 1, 2019	R-744, liquid CO_2, liquid argon, R-728 (liquid nitrogen)	0-1	
Refrigerated Transport	New and retrofit	R-507A, R-404A, R-406A, , R407A/B/C/D, R-422C/D, R-421A/B, R-424A, R-426A	1,500-3,985	January 1, 2019	Cryogenic liquids: R-744, liquid CO_2, liquid argon, R-728 (liquid nitrogen and direct nitrogen expansion)	0-1	January 1, 2022 effective date provides the time required to develop infrastructure for cryogenic TR refueling.
	New	R-448A ,R-449A, R-513A, R-450A	604-1,400	Immediate	R-717*[101]	0	
	New and Retrofit	HFC-134a	1,430	January 1, 2022			
Industrial	New and	R-507A, R-404A	3,900-3,985	January 1, 2019	R-717 vapor	0	

[101] e.g. ammonia or ammonia/CO_2 cascade systems for marine refrigeration

Process Air Conditioning	retrofit				compression and absorption		
	New and retrofit	R-407C/F, R-410A/B, HFC-134a	1,430-2,230	January 1, 2022	R-744* including in ammonia/CO_2 cascade	1	
	New	R-513A, R-450A	604-700	Immediate	Evaporative Cooling	0	
Reciprocating, Screw, Scroll and Centrifugal Chillers	New and retrofit	HFC-236fa, R-417A (ISCEON 59), R-404A, R-507, R-507A, HFC-134a, HFC-245fa, HFC-227ea, KDD6, R-410B, R-421A, R-422D, R-424A, R-434A, R-422B, R-422C, R-427A, R-423A, R-420A, SP34E, R-414B (Hot Shot), Hot Shot 2, FOR12A, FOR12B.	1,430-8,060	January 1, 2019	R-717 Vapor compression & absorption	0	2019 timeline allows time to transition centrifugal chillers to HFO1233zd and time for revision of standards for GWP<20 alternatives in other chillers including A2, A2L, and A3 refrigerants. R-410A is only widely used in scroll chillers and if not listed unacceptable across the board, could be restricted only to use in scroll chillers after 2019.
					Water/Lithium Bromide	0	
					Stirling cycle	0	
	New and retrofit	R-410A		January 1, 2022	R-290/R-600a/R-441A*	<4	
					HFO-1234ze (medium pressure) HFO-1233zd (low pressure)	1-7	
	New	R-513A, R-450A	604-700	Immediate	Evaporative Cooling	0	
Household refrigerators and freezers	New	R-507, R-507A, R-404A, R-428A, R-421B, R-434A, R-401B, R-402A, R-402B , R-409A, R-409B, R-406A, R-407C, R-407F, R-420A, R-422B, R-422C, R-422D, R-427A, R-426A, R-424A, R-	1,200-3,985	January 1, 2017	R-600a R-290	<4	January 1, 2019 timeline for R-134a allows sufficient time to develop revised standards for GWP<20

		426A (RS-24), KDD5/R-438A and KDD6					alternatives to allow safe and cost effective equipment using A2, A2L, and A3 refrigerants to enter the U.S. market.
	New	R-513A, R-450A	604-700	Immediate			
	New	R-134a	1,430	January 1, 2019			
Vending machines	New	R-450A, R-513A	604-700	Immediate	R-744	1	
	Retrofit	FOR12A, FOR12B, HFC–134a, KDD6, R–125/290/134a/600a (55.0/1.0/42.5/1.5), R–404A, R–407C, R–410A, R–410B, R–417A, R–421A, R–422B, R–422C, R–422D, R– 426A, R–437A, R–438A, R–507A, RS-24 (2002 formulation), SP34E.	1,100-3,985	R-507A and R-404A as of January 1, 2019 and the rest January 1, 2022	R-290 R-600a R-441A	<4	These have already been listed unacceptable in new equipment under Rule 20.
Commercial ice machines	New	R-448A, R-449A, R-513A, R-450A	604-1,400	Immediate	R-717	0	
	New and retrofit	R-507A, R-404A	3,000-3,985	January 1, 2019	R-290* R-600a*	<4	
	New and retrofit	HFC-134a, R-406A, R-407A/B/C, R-411A/B	1,430-3,000	January 1, 2022	R-744*	1	
Supermarket Systems and remote condensing units	New	R-448A, R-449A, R-513A, R-450A	604-1,400	Immediate	R-744	1	
	New and retrofit	R-407A, R-407C, R-407F, R-427A, R-421A, R-410A, R-410B	2,000-2,500	January 1, 2022	R-717 with secondary loop	0	
	Retrofit	HFC-227-ea	3,350	January 1, 2019	R-290, R-600a and R-	<4	

					441A in condensing units*		
Medium-temperature Stand-alone equipment	New and retrofit	R-513A, R-450A	604-700	Immediate	R-290 R-600a R-441A	<4	
Low-temperature stand-alone equipment	New and retrofit	R-448A, R-449A, R-513A, R-450A	604-1,400	Immediate	R-290 R-600a R-441A	<4	
Medium- and Low-temperature stand-alone equipment	Retrofit	FOR12A, FOR12B, R–134a, HFC–227ea, KDD6, R–125/290/134a/600a (55.0/1.0/ 42.5/1.5), R–404A, R–407A/B,/C, R–407F, R–410A/B, R–417A, R–421A,/B, R–422A/B/C/D, R–424A, R–426A, R– 428A, R–434A, R–437A, R–438A, R–507A, RS-24 (2002 formulation), RS-44 (2003 formulation), SP34E, THR-03.	900 to 3,985	January 1, 2022	R-290 R-600a R-441A	<4	These have already been listed unacceptable in new equipment under Rule 20.
Water coolers	New	R-513A, R-450A	604-700	Immediate	R-290* R-600a*	<4	HCs not SNAP listed, but UL has certified for sale in U.S.
	New and retrofit	R-404A, R-507, R-507A	3,000-3,985	January 1, 2019			
	New and retrofit	R-134a, R-421A/B, R-424A, R-426A, R-438A, R-422A/B/C/D, R-407A/B, R-407F	1,430-3,000	January 1, 2022			