Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Air Conditioning Contractors Association

Chairman Barrasso:

1. What HFC replacements are the residential heating, ventilation, air-conditioning, and refrigeration (HVACR) industry planning to use?
   - **ACCA Response:**
     - Thus far, ASHRAE-designated A2L mildly flammable refrigerants are the only products that HVACR manufacturers have indicated will work for the residential air conditioning market - providing the cooling and efficiency needs and meeting the global warming and ozone depletion regulations that the industry is required to meet.

2. Can you explain why it is important to have sufficient lead time to implement a phasedown of HFCs?
   - **ACCA Response:**
     - As the industry transitions to A2L refrigerants there will be new safety issues that we need to address, including:
       - How will these products be transported in technicians' vehicles?
         - Some indications from the AHRI Safe Refrigerant Task Force state that refrigerant storage racks in work trucks and vans will need to be switched to vertical racks.
       - Will there be unique storage and warehousing requirements?
       - What sensors and leak detectors will need to be placed in residences?
       - How can we prevent the mixing of refrigerants?
       - Will contractors and technicians be required to switch to non-sparking tools, gauges, etc.?
       - Will fleet vehicles need to have placards on them and new fire extinguishers?
       - Which way will the locking caps, refrigerant bottles/jugs nozzles, and other fittings turn? Will the turn counterclockwise like propane tanks because they have flammable properties?
       - Will technicians and installers be allowed to braze refrigerant lines together, which requires an open flame?
     - We also need to be sure we can train hundreds of thousands of contractors, installers, and technicians on how to safely handle, install, and recover new refrigerants.
     - Ensuring all of this is done properly is ACCA's highest priority, and we believe that following the 2024 national model code cycles administered

by the International Association of Plumbing and Mechanical Officials, (IAPMO) and the International Code Council (ICC) gives our industry sufficient time to provide for a safe transition to flammable refrigerants.

3. How long can it take for building codes and standards, as well as contractor certifications, to be completed?
    - **ACCA Response:**
        - The code change cycle will culminate with the publication of the 2024 national model codes from IAPMO and ICC. Once these model codes are updated to reference the latest safety standards from UL and ASHRAE, the individual states will have to go through an adoption process to make them effective. Some states' adoption processes can take years while other states become effective more quickly. There are even some states that still enforce the 2015 editions of the codes.

4. If the schedule in the AIM Act is accelerated, could this eliminate the time needed to set codes and standards and to train contractors to safely install the replacement chemicals?
    - **ACCA Response:**
        - ACCA has not extensively studied the consequences of what would happen if the phasedown schedule is accelerated by the EPA. Any answer we provide would be speculative because ACCA does not know what refrigerants would be available in the late 2020s or early 2030s and if industry would unanimously support such an acceleration.

5. Can you estimate the average cost of training a new contractor to install a new class of refrigerants?
    - **ACCA Response:**
        - ACCA anticipates that our new refrigerant training program will cost less than $100, which is in line with what ACCA currently charges for the EPA 608 training program.

6. As you are aware, states like California have already implemented their own more stringent phasedown schedules. Can you explain why this is a problem from ACCA's perspective?
    - **ACCA Response:**
        - California, in particular, is working to phasedown HFC refrigerants in residential applications beginning in 2023, which is before the relevant safety standards will be able to be adopted into the state building code. The earliest the introduction of A2L refrigerants could be done safely is in the 2024 model code cycle because the relevant ASHRAE and UL safety standards will be completed by that time. Thus far, all attempts to update the Uniform Mechanical Code to allow typical quantities of flammable,

A2L refrigerants have been rejected largely due to safety concerns from key stakeholders.
- While some industry associations and environmentalist groups are aligned and helping California work towards that date, the industry is far from aligned on the 2023 date. In fact, many of the HVACR manufacturers and refrigerant producers have led the fight against the 2023 date in California for many reasons, including that contracting industry will not be trained on the new refrigerants by then. We have to have the ASHRAE and UL safety standards complete first followed by the adoption of those standards into the model building codes used by states. When these tasks are completed, we can begin to train contractors on the proper safety, handling, and installation requirements for A2L refrigerants.

7. In your testimony you state, "poor installation practices increase opportunities for refrigerant leaks, cause systems to operate at only 60-70 percent of their labeled efficiency and contribute to poor indoor air quality and mold and mildew growth." If your concerns regarding proper training for contractors are not addressed, do you foresee a similar situation occurring with equipment that uses HFC replacements?
    - **ACCA Response:**
        - Yes. Poor installation practices will continue until we change the focus from the equipment capabilities to the design, installation, and maintenance requirements that must be followed for equipment to operate safely and efficiently. For too long, environmentalists and policy makers have forced the HVACR industry to make more efficient products, which leads consumers to believe that when they buy a highly efficient system it will address their energy saving goals. However, HVACR systems are not "plug and play" appliances like a refrigerator or washing machine. An HVACR system needs to be properly designed, sized, installed, and maintained for it to operate according to its lab-tested efficiency label.
        - We must highlight the important role contractors play in ensuring systems operate according to consumers' expectations.
        - No matter the equipment or refrigerant being used, HVACR systems still need to be properly sized, the air flow needs to be precise, they need to have the accurate amount of refrigerant, and they require routine maintenance to ensure they are in operating optimally.

8. When contractors are not properly trained to install equipment, what impact does this have from an environmental perspective?
    - **ACCA Response:**
        - The National Institute of Standards and Technology studied the problems associated with poorly installed systems. NIST found that if a system is not properly sized and the airflow is not adequate, then that system will

operate 30-40 percent less efficiently. Poorly installed systems can also contribute to refrigerant leaks, which could either harm the ozone layer or contribute to additional gases with high global warming potential entering the atmosphere.

- Improperly installed systems also contribute to poor indoor air quality, which can increase opportunities for mold growth and mildew problems. These issues can also contribute to sicknesses, particularly those with allergies or respiratory issues. It is essential that HVAC systems be installed according to the nationally recognized quality installation standards, but the EPA estimates that only about half of all homes are.

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

9. The recently issued Fourth National Climate Assessment projects that if the global community does not act quickly, climate change will significantly affect our nation's infrastructure, public health and economy. Scientists reported that extreme weather events, like category five hurricanes and deadly wildfires, and pandemics, like COVID-19, are expected to become more commonplace and devastating as climate change worsens overtime. These climate-related events will economically devastate our country if we do not act on climate change. Do you agree with our nation's leading scientists that have concluded climate change is real, is caused by humans, and is impacting nation's environment and infrastructure? If not, why not?
   - **ACCA Response:**
     - ACCA appreciates the question, and at risk of sounding like we are avoiding an answer, we want Senators to know that ACCA is not an environmentalist organization, a scientific society, or an association that studies climate science. ACCA is an association of 3,000 HVACR contractors who likely share a variety of opinions on this issue. The Association does not have an official position on whether climate change is real, caused by humans, or is impacting our nation's environment and infrastructure.
     - With that said, every ACCA member cares deeply about the environment and for many years ACCA has been the only organization that has called for Congress to do more to support the proper installation of HVACR systems, provide funding for EPA enforcement actions on individuals who illegally vent refrigerants, and other issues that will protect consumers and the environment. ACCA also supported the Obama-era regulation that required leaking equipment with 50lbs or more of refrigerant to be repaired and recorded.
     - ACCA also created the ANSI-recognized Quality Installation and Quality Maintenance standards, which are recommended by DOE, EPA, and numerous state governments. ACCA's design and installation standards are also required by model building codes. If followed, these standards

provide contractors the exact steps to ensure HVACR system are installed properly and are providing the correct maintenance procedures.

- If we can ensure that HVACR systems are installed properly and that illegal venting is brought under control, then there would actually be no need for an HFC transition. HVACR systems are closed loop, so other than an equipment defect, refrigerants should not be entering the atmosphere. However, the EPA estimates that half of all systems are not installed correctly, which provides more opportunities for refrigerant leaks. And, the EPA enforcement programs have not been adequately funded by Congress. So, policy makers have not done a good job of supporting the HVACR contractors who are doing everything they can to protect the environment.
- Congress should be fully funding EPA's enforcement programs and conducting vigorous oversight to ensure they are enforcing the law on those who illegally vent refrigerants. We should also restrict the sale of refrigerants to only trained and certified individuals and create an exchange program, where a contractor is required turn in 25lbs of refrigerant for every 25lbs they purchase, which will ensure we have a good recovery program in place. Congress should also provide funding for the EPA's Verified Installation Program, which enables contractors to provide consumers a verification that their ENERGY STAR rated HVACR system was properly installed. This program has been on life support for several years and Congress has done nothing to support it, despite HVACR products being the largest consumer of energy in the country.
- While ACCA does not have an official position to the question you asked, you can see that everything ACCA has done and asked congress for has been to protect the environment, reduce energy consumption, and protect consumers. But, contactors have been let down by policy makers who only want to make our industry change refrigerants or push more higher efficiency ratings based on lab-tested conditions. These policies do a disservice to the work that ACCA members do, which is properly design, install, and maintain systems to ensure they operate safely and efficiently. If Congress would do more to support Quality Installation measures, we would have a significant impact on our energy consumption, air quality, and environmental impact.
- ACCA has done more than any other contracting association or organization to fight for policies that protect the environment and decrease opportunities for ozone depleting or high GWP substances from entering the atmosphere. Our record of being a champion for the environment is clear.

10. How has the COVID-19 crisis impacted your members and your industry? If so, how? What steps should the federal government consider taking to help your sector cope and recover from the COVID-19 crisis?

- **<u>ACCA Response:</u>**
    - Many ACCA members are struggling because consumers do not want people in their homes, commercial construction projects are on hold across the country, and countless other businesses are closed so contractors are not performing routine maintenance.
    - The lack of maintenance in the residential market is going to present a serious problem for consumers. Hundreds of millions of Americans are teleworking from home and many of their kids are also at home all day. Combine these factors with summer heat and there will be increased heat loads in homes and air conditioning systems will be running longer in the coming months. Because most consumers have forgone their maintenance plans, they will be entering the summer months unsure if their air conditioning system is in proper condition and if it will handle the increased heat loads. ACCA believes that there would be a greater number of breakdowns due to the lack of maintenance, which will mean more repair and replacement work.
    - What ACCA members need from Congress is a fully funded Paycheck Protection Program through the SBA. This is a critical lifeline for thousands of contractors. ACCA also seeks passage of the Home Energy Savings Act, legislation that would increase the residential HVAC efficiency tax credit and extend it through 2026. Most importantly, this legislation would require consumers to have their HVAC systems installed correctly to receive their tax credits. This would be a boon to professional contractors while also having a significant impact on our nation's efficiency portfolio.

11. Prior to 1990, there were over sixteen states that had taken action, or were in the process of taking action, to restrict the use of Chlorofluorocarbons (CFCs). In the Clean Air Act Amendments of 1990, Congress created a federal program to phase out CFCs in Title VI of the Clean Air Act. Rather than preempting state actions, Congress preempted the enforcement of state CFC regulations for two years. Once EPA had a strong CFC program in place, the state programs went away on their own and, as noted in your own testimony, the existence of federal rules created a "uniform national phasedown." Why specifically do you expect states will act differently in terms of HFCs if a federal regulatory program is created? Given the history why should HFCs be treated differently than CFCs in terms of state preemption?
    - **<u>ACCA Response:</u>**
        - ACCA wants all states to align with the federal phasedown schedule and is asking Congress to ensure they are required to do so. But, we know that not all states will follow the federal schedule. In fact, in the testimony submitted by California, New York, and Washington, they are demanding that Congress not preempt state action because they specifically want flexibility for each of their states. Such a staggered implementation will result in lower volumes for equipment manufacturers and will result in increased cost to consumers. This basic economic principle applies to all

products; if you make a product for a limited market its cost will be higher. A single nationwide transition will provide the lowest overall cost to consumers as well as eliminate enforcement issues along individual state borders.
- Rhetorically, if we are so certain that states will fall in line with the federal program, then what is the harm with including preemption language in the AIM Act?
- It would seem that if states are going to follow the "framework", then why not simply include the language in the AIM Act. Chairman Barrasso has indicated that it is a requirement for the legislation to advance and President Trump is unlikely to support legislation that would allow California to go beyond the federal phasedown schedule.

<u>Senator Wicker:</u>

12. The next generation of refrigerants includes hydrofluroolefins, or HFOs, which are a flammable product. Your written testimony states that the Environmental Protection Agency (EPA) may not be able to establish training and certification programs for next-generation refrigerants without a federal regulatory system in place for the phasedown of HFCs. Are states able to create and implement these training programs on their own? What are the risks that consumers could face if there is not a national standard to train HVACR technicians on proper installation techniques for HFOs or other next-generation refrigerants?
    - **<u>ACCA Response:</u>**
        - States may be able to create and implement their own training programs. However, ACCA does not believe that states are capable of creating robust training programs that will provide for the safe transition to A2L mildly flammable refrigerants, or HFOs. In the residential market, many states do not even require a contractor license or industry knowledge to operate a contracting business. Many simply require a general business license. Therefore, we are concerned that any state-led training and certification programs will not be adequate.
        - And, it is not just training programs. We also need to be mindful of the other questions that need to be answered:
            1. How will these products be transported in technicians' vehicles?
                a. Some indications from the AHRI Safe Refrigerant Task Force state that refrigerant storage racks in work trucks and vans will need to be switched to vertical racks.
            2. Will there be unique storage and warehousing requirements?
            3. What sensors and leak detectors will need to be placed in residence?
            4. How can we prevent the mixing of refrigerants?
            5. Will contractors and technicians be required to switch to non-sparking tools, gauges, etc.?

6. Will fleet vehicles need to have placards on them and new fire extinguishers?
7. Which way will the locking caps, refrigerant bottles/jugs nozzles, and other fittings turn? Will the turn counterclockwise like propane tanks because they have flammable properties?
8. Will technicians and installers be allowed to braze refrigerant lines together, which requires an open flame?

- ACCA does not believe that states can properly address all of these questions. And, many of these issues will certainly fall under interstate commerce for contractors who operate across state lines, particularly transportation issues.
    - For instance, ACCA has many contractors who operate in Mississippi and also serve customers in the surrounding states. If Mississippi does not authorize the use of HFOs in the residential market, but a neighboring state does, the Mississippi based business may have significant trouble transporting flammable refrigerants across the state line in their existing fleet if they do not have the appropriate storage racks, placards, and other safety features.
    - ACCA does not know if this exact scenario will occur, but it highlights one of the man unknowns that contractors are facing.
- Without a federally recognized training program, consumers will not have a guarantee that their contractors, technicians, and installers, have met the minimum qualifications to purchase, handle, install, and recover HFO refrigerants. States have never had to create refrigerant training and certification programs, only the EPA has a track record of building a robust certification program that is recognized by the industry.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Mr. Michael Armstrong, President, A-Gas

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

1. How has the COVID-19 crisis impacted A-Gas? What steps should the federal government consider taking to help our nation's manufacturing sector cope and recover from the COVID-19 crisis?

   COVID-19 has moderately impacted A-Gas' business in the United States. Our business is supported by three tiers: refrigerant recovery/reclamation, refrigerant sales, and government services.

   Our refrigerant recovery/reclamation business is an essential component of maintaining the existing air conditioning systems, safe cold food storage and transportation and many aspects of the medical and pharmaceutical industries. It has been impacted as a result of state level stay-at-home orders as our technicians are generally delayed in the completion of projects. Refrigerants sales are impacted across the sector by a lack of liquidity of our end-users/customers and we believe this to be impacting the entire sector. The market should rebound quicker than most due to the critical needs for refrigeration and air conditioning. Government support programs have been troublesome with lack of funding of critical programs and slow payment of invoices providing further challenges for our business.

   In the long term(next 6-18 months) industry in the United States will figure this out, will adapt, and will re-invent itself in many cases. The federal government should balance its support of industry with safeguarding the best working force in the world. Increasing our investments infrastructure would be a great way to inject stimulus into the economy. The manufacturing private sector does this frequently in various business cycles and a would be a great way for the US government to support the economy during this time. Distributing unlimited cash to everyone cannot last forever.

2. Do you support the AIM Act as introduced?

   The AIM Act as introduced is a very good concept, as we generally support it. It strongly supports Refrigerant Management as a key component to the technology transitions and HFC phasedown. Our company has provided this Refrigerant Management through previous transitions and recognize the essential stability and assurance it brings to the owners of existing equipment, not stranding them or requiring the purchase of new equipment before it is necessary, I appreciate that a key concern from Republican leadership and many equipment manufacturers is that states would potentially still be able to preempt this program. It's a fair point and something that should be resolved.

I am concerned that a lack of action on the AIM Act will further embolden states to implement their own regulations to phase down HFCs.   These programs are already underway, generally are more developed than the federal phasedown programs through the help of industry experts, and could be implemented quickly. Now more than ever, we need to US government to foster and support cooperation between the federal and state governments on things that matter: US jobs and the environment.

The other key concept in the AIM Act is that is lessens the dependence of the United States on Chinese industry to supply our current refrigerants. The Chinese refrigerant manufacturing industry has a long history of dumping its products illegally in the United States and damaging US industry, workers, and the investments we all make. More than 60% of our HFC volume requirements each year come in from China, and those profits simply head back to China.

The AIM Act creates more jobs for Americans, supports investments for American companies that develop new technologies and helps our country transition to cleaner and more efficient refrigeration and air conditioning systems.

/s/ Michael S. Armstrong
President
A-Gas Americas

AHAM
ASSOCIATION OF HOME APPLIANCE MANUFACTURERS

1111 19th Street NW ➢ Suite 402 ➢ Washington, DC 20036
t 202.872.5955 f 202.872.9354 www.aham.org

April 29, 2020

Senator John Barrasso, M.D.
Chairman
Senate Committee on Environment
and Public Works
410 Dirksen Senate Office Building
Washington, DC 20510

Senator Thomas R. Carper
Ranking Member
Senate Committee on Environment
and Public Works
456 Dirksen Senate Office Building
Washington, DC 20510

Via Email: QFR@epw.senate.gov

Dear Chairman Barrasso, Ranking Member Carper and Members of the Committee:

AHAM appreciates the opportunity to participate in the Committee's process of information-gathering on "*S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record*." Please find attached my responses to the Committee's follow-up questions.

I hope these responses assist the Committee in its consideration of S. 2754. Again, thank you for the opportunity to participate and we look forward to continuing to work with the Committee on this bill.

Sincerely,

Joseph M. McGuire
President & CEO

AHAM Responses
to
Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for the Association of Home Appliance Manufacturers

Chairman Barrasso:

1. In your testimony, you recommend amending the AIM Act to ensure that the Environmental Protection Agency (EPA) does not promulgate requirements that are duplicative. What impacts do duplicative reporting requirements have on your industry?

   Response: The spate of new state measures regulating refrigerants also authorize state agencies to promulgate new reporting obligations and other compliance requirements. Reporting information to governments can be necessary and important for enforcement. However, it is a very costly and burdensome to companies and to the government to maintain databases and should only be done where necessary and with an added state patchwork approach there is a substantial regulatory burden from duplicative reporting requirements. For example, we surveyed our member companies and companies in similar industries and found that the reporting burden to satisfy the Department of Energy and Federal Trade Commission energy conservation standards reporting requirements is on average 358 hours and nearly 750 hours for manufacturers with many models.

   Any reporting to the federal government should not be duplicative or redundant, but streamlined and focused. A broad view of reporting should be taken into account so that the same information is not being collected by different agencies. We also have the added burden of states collecting similar information in different ways. Some examples of this that exist today to show this is a real concern. The Department of Energy currently requires appliance manufacturers to submit data by model every year for the same product. Year after year, the same information is provided for a model that does not change. This is in addition to the data submission when the product is available for sale and the submission to terminate the product when it is discontinued. The annual reporting of the model information year after year, which will not change because it is a specific certified model number, is costly and time-consuming for appliance manufacturers and the Department of Energy. The Department of Energy is working to address this matter, but it has occurred for many years. Based on the estimated time to comply with annual reporting requirements determined by AHAM's member survey, we estimate that eliminating DOE's annual report would save manufacturers 126.6 hours per year on average, and up to a 438-hour reduction per year for manufacturers with more models.

   Another example is EPA reporting on Greenhouse Gas emissions. We are now seeing states ask for the exact same or very similar information. We realize that under present law the federal government cannot prevent the state governments from imposing their own reporting requirements, but it can look at information that has been collected by states to reduce reporting burden to the federal government.

The current version of S. 2754 does address this matter to some extent by allowing (not requiring) the EPA Administrator to combine information that is reported within EPA, but it does not prevent EPA from doing what the Department of Energy did, which is to require manufacturers to report the same information year after year, even if there is no change in the substance of the report.

2. In your testimony, you recommended a grandfather clause for products made up to 3 years after the publication of the final rule, and only regulating products that use more than 5 pounds of refrigerant product. In your view, what would be the impact to consumers of rapidly requiring substitute refrigerants for residential products?

   Response: Transitions to different substances used for refrigeration and cooling equipment requires substantial factory, tooling and product design changes. As this legislation provides, when further regulations are developed affecting a regulated substance for use in a particular application, that will almost certainly require additional investments and other changes. The appliance industry has transitioned to newer refrigerants many times and these transitions have always required major investments and factory and product changes. Further, AHAM's refrigeration and cooling products are also subject to federal mandatory energy efficiency standards. New refrigerants can affect an appliance's energy consumption, which necessitates additional product design changes.

   Congress recognized that manufacturers require time to redesign products, retool factories, test products for safety and quality standards. Under EPCA, appliance and other consumer product manufacturers are provided three years for this redesign effort. Under S. 2754, EPA could ban a refrigerant type for a particular application and make that effective with no statutory minimum transition period. Thus, this risks manufacturers being unable to make necessary product and component changes or to sell-through inventory before the compliance deadline. The bill should require that EPA cannot make a new regulatory transition effective except for products manufactured three years or more after the final rule is published. As with the DOE Appliance Standards program, manufacturers could comply earlier, and the agency could extend the time if necessary. Since this concept has been advocated and supported by many product manufacturers and advocacy groups in EPCA for over 40 years it should be readily accepted by them in this legislation.

   Regarding the five pounds of refrigerant, the Senate version of this bill requires EPA to issue one rule accelerating phase-out for one class of products. Five pounds is a threshold under EPA 608, which defines small appliances as products that are fully manufactured, charged, and hermetically sealed in a factory with five pounds or less of refrigerant. Such products are subject to less stringent management and disposal requirements. We recommend that any Rule under this Act also establish and consider different, less onerous requirements for these small HFC using products, including excluding them from this mandatory rulemaking. EPA has the authority under the bill to issue a rule for any products at any time. The House version of the bill does not include this provision, and we support that change.

3. Why, in your view, is it necessary to define "refrigerant" and specify that refrigerants are separate from insulating foam?

   Response: The bill contains different requirements that pertain to substances when used as refrigerants and foams. Defining the term "refrigerant" is necessary to provide clarification. In Section 9 (Management of Regulated Substances), the section uses the terms "regulated substance" and "refrigerant." The term "regulated substance" is defined in the bill. However, a regulated substance can be used as either a "refrigerant" or a "blowing agent." A refrigerant provides heat transfer for cooling. A blowing agent is used to prevent heat transfer and provide thermal insulation.

   a. How does Section 9 of this bill give EPA authority over insulating foam in household refrigerators?

      Response: Section 9 directs the EPA Administrator to "promulgate regulations to control, where appropriate, **any practice, process, or activity** regarding servicing, repair, **disposal**, or installation of equipment (including requiring, where appropriate, that any such servicing, repair, **disposal**, or installation be performed by a trained technician **meeting minimum standards, as determined by the Administrator**)." The paragraph then provides four areas where EPA's involvement will occur. Two areas are broadly defined as all regulated substances, which includes as presently drafted refrigerants and insulation foam blowing agents, and two are restricted to regulated substances used only as refrigerants. Therefore, the paragraph provides authority for the EPA Administrator to regulate any practice, process, or activity, including possibly establishing minimum standards, regarding the disposal of refrigerator foam blowing agents. The House version of the bill specially states that this provision does not apply with respect to a regulated substance or a substitute for a regulated substance that is contained in a foam, which we support. Since the bill's advocates tout that the bill is not intended to add to regulatory burdens and since previous EPA's have disclaimed authority to require this practice, this is not a controversial request.

   b. Does regulating foam within residential refrigerators provide an environmental benefit?

      Response: No. The studies on the Greenhouse Gas (GHG) emissions of refrigerator insulation foam consistently show no material environmental impact from foam insulation due to the refrigerator recycling process. Refrigerators are one of the most successfully recycled products. This recycling success is due to a highly diverse and effective system through several different collection channels, including retailer, municipalities, private entities, multi-unit residential units, and refurbishers. This success, attributable to its diverse and wide spread infrastructure, provides an infrastructure for the recycling and disposal of refrigerator foam. Typically, the refrigerator is recycled through a vehicle shredder and then the resultant shredder fluff is landfilled. For the most common type of foam blowing agent (HFC-245fa), this process captures more than 50% of the GHG emissions.[1] This process also has a "negative cost," which allows people to make money from this recycling process. A study was also commissioned by the California Air Resources Board (CARB) in this area, and this study found that emissions of HFC foam from refrigerators from landfills represent a very small portion of GHG emissions.[2] An overview of the CARB research project at https://ww3.arb.ca.gov/research/seminars/yesiller/yesiller.htm states:

> *Results showed that surface emissions of F-gases were negligible. Results also indicated that while F-gases were present in the intake piping of the methane collection system, more than 99% of the F-gases were destroyed by the very high temperatures in the methane combustion/destruction systems. Therefore, it was concluded that F-gas emissions estimates from landfills with active methane collection and destruction systems were approximately 90% lower than originally estimated.*

Further, HFCs are no longer in use for refrigerator foam blowing agents. The industry has transitioned to non-HFC foam blowing agents, such as Cyclopentane, which is a hydrocarbon with a very low Global Warming Potential.

4. As a "good government recommendation," you recommend that the EPA coordinate its rulemakings with the Department of Energy. Why is consistency between the two regulating agencies important for your association?

   Response: Coordination and consistency between EPA and Department of Energy (DOE) is important for home appliance manufacturers because both agencies regulate the same product, which impacts the products design and production. Each design change of an appliance is very costly. It takes engineering resources, capital expenditures for retooling factories, safety and durability testing, compliance costs, and many other factors that are required to ensure people have a safe, reliable and effective refrigerator, room air conditioner, portable air conditioner or dehumidifier in their homes. These appliances provide a safer and healthier home by preserving food and medicine and managing indoor air temperatures and quality. If EPA were to ban a refrigerant and force a redesign of all refrigerators one year and then DOE were to establish a new energy standards just a few years later, then significant cost will be borne by the manufacturers of these products that likely are passed down to consumers. If the two agencies were to coordinate and make new requirements effective at the same time, then manufacturers would only have to undergo one redesign cycle.

---

[1] *Assessment of Refrigerator/Freezer Foam End-of-Life Management Options*, ICF International, December 2010.
[2] Nazli Yesiller and James Hanson, *Emissions of Potent Greenhouse Gases from Appliance and Building Waste in Landfills* (California Polytechnic State University), May 31, 2016.

This is not a purely hypothetical example. Prior to EPA finalizing its SNAP 20 Rule, which banned HFC use in insulating foam for refrigerators, we requested EPA coordinate with DOE as it was considering a change to the energy standard. Ultimately, EPA moved forward unilaterally to ban HFCs in foam for home appliances as of January 2020 and DOE started the rulemaking process in December 2019 to consider changing the energy standard.

5. Is it true that the replacements for HFCs are more expensive than their counterparts? What impact could this have on the consumer?

   Response: Home appliance manufacturers are transitioning to different lower-GWP refrigerants depending on the product. For refrigerator/freezers, the industry is generally transitioning to Isobutane, which is a commodity product. For foam blowing agents, manufacturers are generally choosing between Cyclopentane or an HFO. I cannot get into price and cost issues, but manufacturers look at the per unit costs of the blowing agent as well as the capital costs needed to use that type of blowing agent in the factory. That calculation is company specific.

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

1. How has the COVID-19 crisis impacted your member companies? What steps should the federal government consider taking to help your sector cope and recover from the COVID-19 crisis?

   Response: At a time when nearly 300 million Americans are sheltering in place, home appliances are essential to helping families live in clean and sanitary environments, preserve food and medicine, and help to prepare meals. The Department of Homeland Security CISA guidance has recognized the essential role appliances are playing in the lives of consumers as the nation combats the COVID-19 epidemic.

   There has been no other time in modern American history that we have relied more upon our home appliances to provide comfort, cleanliness and care. Therefore, any stimulus effort should include a focus on empowering cash-strapped Americans to replace appliances that are under abnormally high stress or are broken. Such a stimulus will help jumpstart the recovery and provide much-needed assistance both to beleaguered American retailers and to consumers.

   The home appliance industry is critical to the U.S. economy. An economic stimulus will maintain the appliance industry's ability to continue operating, helping to assure that appliance companies will be there for their employees and communities as the economy recovers and enables the industry to return to generating an annual economic impact of $198 billion driven by $57 billion in wages, $23 billion in tax revenues, and almost 1 million direct and indirect jobs.

Home appliances are essential to helping people quarantined at home and front line workers who come home at the end of their shift to clean clothing and uniforms and to keep doctor/ nurse facial hair trimmed to help provide a good seal on facemasks. These products are critical to those who serve on the front lines keeping our economy and healthcare system moving forward. Appliances such as clothes washers, dishwashers, garbage disposers, personal care, and floor cleaning products are critical to a sanitary home. Further, home appliances help to dispose of food waste and provide filtered, cleaner air and water. The government has recognized the critical role appliances play in the lives of consumers during COVID-19. In fact, the Centers for Disease Control & Prevention (CDC) recommends washing machines for cleaning any cloth face covering.

Appliances also improve indoor air quality and comfort with central vacuums, range hoods, window and portable air conditioners, humidifiers and dehumidifiers. In fact, studies have specifically shown that keeping your indoor air at a relative humidity of 40% to 60% reduces the survival of flu and certain viruses on surfaces and in the air (to be clear it is not a study on COVID). With hot summer months coming soon, the CDC has suggested financial assistance for home air conditioner purchases, as it is likely that cooling centers, used most by low-income residents, may not be open during summer months.

2. Of the HFC compounds that are being used today by your members, on average how much does the industry use on an annual basis (in tons and GWP-weighted tons) now?

   Response: For refrigerant-containing products, AHAM represents manufacturers of home refrigerators/freezers, room air conditioners, portable air conditioners and dehumidifiers. Each product category is different in their use of HFCs. For refrigerator/freezers, the industry is transitioning out of HFCs and will have entirely stopped using HFCs by 2023. For room air conditioners and portable air conditioners, the industry is able to transition most of the products (not the very large room air conditioners) to a lower GWP HFC, such as R-32 or a similar substance in the coming years. EPA has not yet approved for dehumidifiers to use R32. Room air conditioners, portable air conditioners and dehumidifiers are pre-charged and hermetically sealed systems that cannot be legally vented into the atmosphere so there should be very little lawful emissions (other than negligible leaks over time). However, assuming the transition to R32 and the dehumidifiers continuing to use R-410A, the annual shipments contain approximately 3 million MtCO2eq of refrigerant.

3. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your member companies on an annual basis?

   Response: Refrigerator/freezers are transitioning or have transitioned out of HFCs. Most room and portable air conditioners and dehumidifiers are imported into the US with the refrigerant "pre-charged" in the product. Therefore, these products use very little of the HFC produced or imported in bulk into the US.

4. To what extent have home appliance manufacturers already begun transitioning to HFC substitutes?

   Response: For refrigerator/freezers, the industry is transitioning out of HFCs and will have entirely stopped using HFCs by 2023. For room air conditioners and portable air conditioners, the industry is able to transition most of the products (not the very large room air conditioners) to a lower GWP HFC, such as R-32 or a similar substance in the coming years. EPA has not yet recognized that dehumidifiers may use R32 .

5. What percentage of AHAM's membership is expecting to transition to substitutes or otherwise taking steps in consideration of a possible transition to substitutes at some point between 2025 and 2030?

   Response: AHAM member companies have been and continue to consider transitioning away from HFCs when regulatory barriers are gone and safety issues and standards are addressed.

6. On what basis does AHAM assume EPA would require regulated entities under the AIM Act to report repeatedly to the agency the same types of information without any real benefit or relevance to the implementation of the Act?

   Response: Reporting information to governments can be necessary and important for enforcement and in certain circumstances supports good policy decisions. However, it is a very costly and burdensome to companies For example, we surveyed our member companies and the companies in similar industries and found that the reporting burden to satisfy the Department of Energy and Federal Trade Commission energy conservation standards reporting requirements is on average 358 hours and nearly 750 hours for manufacturers with many models.

   Any reporting to the federal government should not be duplicative or redundant, but streamlined and focused. A broad view of reporting should be taken into account so that the same information is not being collected by different agencies. We also have the added burden of states collecting similar information in different ways.

   Some examples of this show this is a real concern. The Department of Energy currently requires appliance manufacturers to submit data by model every year for the same product. Year after year, the same information is provided for a model that does not change. This is in addition to the data submission when the product is available for sale and the submission to terminate the product when it is discontinued. The annual reporting of the model information year after year, which will not change because it is a specific certified model number, is costly and time-consuming for appliance manufacturers. The Department of Energy is working to address this matter, but it has occurred for many years. Based on the estimated time to comply with annual reporting requirements determined by AHAM's member survey, we estimate that eliminating DOE's annual report would save manufacturers 126.6 hours per year on average, and up to a 438-hour reduction per year for manufacturers with many models.

Another example is EPA requires reporting on Greenhouse Gas emissions. We are now seeing states ask for the exact same information. We realize that the federal government cannot prevent the state governments from imposing their own reporting requirements, but it can look at information that has been collected by other states to reduce reporting burden to the federal government.

The current version of S. 2754 does address this matter to some extent by allowing (not requiring) the EPA Administrator to combine information that is reported within EPA, but it does not prevent EPA from doing what the Department of Energy did, which is to require manufacturers to report the same information again and again, year after year, even if there is no change in the substance of the report.

7. Does AHAM believe EPA and DOE are unable to or otherwise prevented from considering the possibility of coordinated rulemakings unless it is expressly stated in the Act?

   Response: AHAM does not believe EPA and DOE are unable or prevented from coordinating their rulemakings. The two agencies have shown an unwillingness to coordinate. Coordination and consistency between EPA and DOE is important for home appliance manufacturers because both agencies regulate the same product, which impacts the products design and production. Each design change of an appliance is very costly. It takes engineering resources, capital expenditures for retooling factories, safety and durability testing, compliance costs, and many other costly activities to ensure people have a safe, reliable and effective refrigerator, room air conditioner, portable air conditioner or dehumidifier in their homes. These appliances provide a safer and healthier home by preserving food and medicine and managing indoor air temperatures and quality. If EPA were to ban a refrigerant and force a redesign of all refrigerators one year and then DOE were to establish a new energy standards just a few years later, significant costs will be borne by the manufacturers of these products that likely are passed down to consumers. If the two agencies were to coordinate and make new requirements effective at the same time, then manufacturers would only have to undergo one redesign cycle. This is not a purely hypothetical example. Prior to EPA finalizing its SNAP 20 Rule, which banned HFC use in insulating foam for refrigerators, we requested EPA coordinate with DOE as it was considering a change to the energy standard. Ultimately, EPA moved forward unilaterally to ban HFCs in foam for home appliances as of January 2020 and DOE started the rulemaking process in December 2019 to consider changing the energy standard.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Air-Conditioning, Heating and Refrigeration Institute

<u>Chairman Barrasso:</u>

1. **A number of industry associations and companies raised serious concerns with the bill in testimony, including the potential economic impacts of the bill on their operations and manufacturing. These groups include, for example, the Alliance for Automotive Innovation, Industrial Energy Consumers of America, National Automatic Merchandising Association, National Automobile Dealers Association, Society of Chemical Manufacturers and Affiliates (SOCMA), and Truck and Engine Manufacturers Association. The full list of those who submitted testimony is available at this link.**

    a. **You provide an "industry view" on pages 6-7 of your testimony but do not note any of these concerns. Does that mean you think all of the issues presented in those testimonies are not valid views? If so, why? If not, should the AIM Act be amended to address the issues identified by these testimonies?**

Answer:

Thank you for your question, Mr. Chairman.

My testimony was intended to reflect the views of the heating, ventilation, air conditioning, and refrigeration (HVACR) industry, which, as noted in my testimony, represents an estimated 70 percent of hydrofluorocarbon (HFC) use in the United States by volume and annually contributes 2.3 million jobs and $158 billion in goods and services to the U.S. economy.

AHRI would not seek to speak for other industries or groups, but would note that technical challenges any sector might face in making a transition are accounted for in the flexibility inherent in the AIM Act's design and structure. The sectors referred to in your question would not face jeopardy by the mere enactment of the AIM Act, as the AIM Act does not mandate transitions for any specific sector, but instead takes a gradual, market-driven, technology-sensitive approach over a 15-year period that allows those sectors able to transition quickly to do so while providing additional time and flexibility for those sectors facing challenges in identifying, testing, and marketing appropriate substitutes.

I also would emphasize that 15 percent of the HFC baseline is preserved for the continued use of HFCs in the U.S. economy, which AHRI estimates to be approximately 60,000 tons – a significant quantity, particularly for niche and specialty applications.

More broadly, my testimony sought to make clear that, if enacted, the AIM Act would guide a transition to next-generation technologies in a manner similar to the highly successful transition from ozone-depleting substances under Title VI of the Clean Air Act, as experienced by our sector and the sectors referred to in your question.

In that transition, concerns expressed at the time of enactment of Title VI about the cost and availability of substitutes, among other issues, proved entirely unfounded. The past 30 years have shown that costs declined over the course of the transition and temporary exceptions were granted for niche applications that lacked substitutes until appropriate substitutes that were safe, reliable, and affordable could be developed. No one suffered undue hardship as a result of Title VI. At no point was existing equipment affected, and no one was forced to transition from ozone-depleting substances before they were ready.

Indeed, the ozone-depleting substance transition is broadly considered a success in both commercial and environmental terms and represents a flexible, industry-friendly, common sense approach to technology choice and market-driven innovation embodied by the Ronald Reagan and George H.W. Bush Administrations principally responsible, in partnership with Congress, for devising the policies embodied by the Montreal Protocol and Title VI.

In expressing an "industry view" of the AIM Act, my testimony sought to highlight the similarities between both (i) Title VI and the AIM Act and (ii) the transition from ozone-depleting substances and the transition from HFCs. That is, we all are dealing with generally the same sectors, products, and equipment.

Experience has shown that the concerns of the industries referenced in your question can be adequately addressed by orderly transition following the enactment of the AIM Act. However, absent such enactment, and without the benefit of an orderly transition and a competent standard for HFCs at the federal level, our industry would share in those concerns and be almost certain to suffer far greater impacts, given the far greater share of HFC use we represent.

b. On page 7 of your testimony, you present potential economic impacts of the AIM Act to the heating, ventilation, air-conditioning, and refrigeration industry. To clarify, your study did not evaluate the impacts on other industries, correct? If it did, please explain how and whether your study addressed all of the concerns identified in the testimonies available at the website above.

Answer:

My testimony refers to the economic benefits associated with an orderly transition from HFCs and into next-generation technologies used by the U.S. HVACR industry. As noted in my answer to part (a) of your question, as well as in my testimony, the U.S. HVACR industry comprises a substantial majority of HFC use. AHRI thus believes the focus of the economic study on our industry was appropriate in light of this fact and remains highly relevant in the Committee's consideration of the AIM Act.

Additional information regarding the cost of transition for other market sectors can be found, according to Senator John Kennedy, in the EPA cost analysis of the transition, which has been reviewed by the Senator.

<u>Senator Capito:</u>

2. **Mr. Yurek, I appreciate your in-depth testimony. You state that sufficient legacy HFCs will be available for legacy equipment. Can you elaborate on that? What assumptions do you make about the amount of legacy equipment in operation, that fleet's remaining useful life, and the amount of HFCs available to serve that need over time? Does the legislation guarantee that states could not reduce the availability of HFCs through their own, stricter HFO transitions?**

Answer:

Thank you for your questions, Senator Capito.

The 30-year history of the transition from ozone-depleting substitutes under Title VI of the Clean Air Act, on which the AIM Act is based to a substantial degree, unequivocally shows that existing equipment and aftermarket supplies of ozone-depleting substances were not adversely affected. Supplies of CFCs, HCFCs, halons, and other ozone-depleting substances remain available to this day for older equipment.

About a decade ago, our industry and independent parties started examining what an HFC transition might entail. And in the years since then, HFC use has been subjected to rigorous research, modeling, and scenario planning to ensure that a transition from HFCs, if guided by a federal regulatory scheme, would go as smoothly and as successfully as the federally regulated transition from ozone-depleting substances. These models have researched HFC usage, market sizes, likely growth rates, lifetime of equipment, leak rates, and other features needed to forecast the reasonableness of this regulatory structure and how it might be best implemented.

Equipment lifetime is specific to equipment type and can range from less than ten years for some small equipment types to greater than 30 to 40 years (*e.g.,* industrial process refrigeration equipment, commercial refrigeration equipment, and large chillers in commercial buildings). As noted in my testimony, CFC-based chillers in commercial buildings were still operating and able to access supplies of reclaimed CFCs for servicing more than 20 years after CFCs were last produced or imported into the United States. Recovery, recycling, and reclamation of refrigerants has been key to this continued availability of these substances and will be important in the HFC transition as well.

To the final part of your question, the AIM Act, as you know, does not bear on state authority. I noted in my testimony that federal preemption of state authority was not necessary in the transition from ozone-depleting substances. The enactment of Title VI in 1990 filled the void, and states shifted their attention elsewhere. Section 614(a) of Title VI imposed a two-year "pause" in the enforcement of state standards, and following that pause, no state sought to regulate ozone-depleting substances in a manner that was more stringent than Title VI. Preemption simply was not an issue in the transition from ozone depleting substances.

As noted above and as discussed at great length in my testimony, the AIM Act is intended to reproduce for the HFC transition the experience of our industry with the transition from ozone-depleting substances under Title VI. This extends to the question of preemption. Our priority is to secure a federal standard for HFCs, not to address state standards.

It is tempting to conjecture that the political landscape in the states is somehow different today than it was in 1990 – that back then states were more willing to go along with what Congress did. I do not believe that to be true. If anything, the risk was greater in 1990 that states would continue to seek to regulate ozone-depleting substances no matter what Congress did.

By the late 1980s, public concern over the hole in the ozone layer and excessive exposure to ultraviolet radiation was intense and widely shared. Indeed, some states had been seeking to develop and deploy regulatory restrictions on ozone-depleting substances since the 1970s. These states were heavily vested in efforts to reduce, if not eliminate, ozone-depleting substances. By no means was it a foregone conclusion that federal legislation, championed and signed by a Republican president, would persuade states to set aside regulatory programs that, in some cases, had been in effect for more than a decade.

Today is markedly different. The relatively small degree of state activity on HFCs has emerged only in the past two years and only because of the absence of any competent federal means to regulate HFCs. Unlike with ozone-depleting substances, which were exclusively responsible for the depletion of the stratospheric ozone layer, HFCs are one of many drivers of climate change. States focused on climate change have many other areas on which to focus their attention once HFCs are subject to a federal standard.

Our industry is complicated. No state can seek to regulate HFCs without substantial technical input from AHRI and other organizations representing our industry; our expertise is just not found anywhere else. Given the limited time and resources at the state level, we think it extremely unlikely a state would continue to pursue HFCs once the main reason for their involvement in the first place – the lack of a federal standard for HFCs – has been addressed.

Finally, and also as discussed in significant detail in my testimony, HFCs are products and not by-product emissions.

No company will curb its HFC use gradually, in line with the phase down schedule in the AIM Act (unless, of course, some other regulatory regime might apply that might induce a company to undertake a gradual transition, such as the granting of "credits" for transitions to HFC substitutes contained in the tailpipe emission and fuel economy standards). Rather, companies will seek to transition to HFC substitutes by a date certain, because it is too costly for most manufacturers to maintain two lines of identical equipment – one that uses HFCs and one that uses substitutes.

Many companies will seek to transition from HFCs relatively early in the phase down schedule – likely around the mid-2020s. This is because the lion's share of the economic benefits reside in the market for next generation refrigerant technologies, and not in using HFCs for as long as possible. This is inherent in the distinction between HFCs as "products" and other focuses of regulatory programs, such as emissions and equipment standards, *e,g,*, for fuel economy.

This distinction is highly relevant to preemption because, once a company makes a transition from HFCs, there is nothing further a state can do. Or, put another way: if a state were to impose a more stringent HFC standard, it would not matter to the many companies already working to transition from HFCs. Most important, states know this and would not expend limited time and resources on additional regulation that confers virtually no benefit, environmental or otherwise.

3. **You suggest that the market will ultimately drive this transition and that states "cannot one up" the federal government, but that without federal legislation a "disorderly" transition is likely. I am struggling to square those two concepts with the legislation that is currently before us for consideration. On the one hand, if market innovations and energy efficiency savings will drive this transition via the "invisible hand," why is a regulatory mandate even necessary? On the other, the AIM Act does not prevent states establishing their own regulatory frameworks, so how can you guarantee no state will "one up" the federal government and contribute to a "disorderly" transition through a patchwork of state-by-state regulatory frameworks given the lack of federal preemption in the bill?**

Answer:

These are important issues, and I believe the entirety of my testimony speaks directly to these issues. To answer, I would emphasize the following points:

- The absence of a federal HFC standard puts American manufacturers and American workers and consumers at a significant competitive disadvantage in the global HVACR market. This is based on 30 years of industry experience with the transition from ozone-depleting substances under Title VI of the Clean Air Act. Transitioning without a federal framework jeopardizes the significant investments in innovation made to date and exposes U.S. manufacturers to predatory, anti-competitive practices by foreign-based manufacturers, as discussed on page 9 of my testimony.
- If enacted, the AIM Act would provide certainty, stability, and predictability – giving confidence and direction to American manufacturers to plan, invest, hire, and build.
- If not enacted, American manufacturers would lack this certainty, stability, and predictability. This would complicate decisions to invest, hire, and build, and the significant economic benefits associated with leading the transition to next-generation refrigerant technologies would be enjoyed by foreign competitors rather than American manufacturers and American workers.
- If not enacted, many manufacturers may find themselves forced to maintain two duplicate product lines, one with the current HFC technology and one with substitutes.
- As discussed in my testimony and in my answer to Question 2, above, the overriding priority for our industry is enacting a competent federal HFC standard.

- Also as discussed previously, the speed with which many companies will seek to transition from HFCs means states seeking to impose more stringent standards will not have an appreciable effect beyond the AIM Act; a state HFC standard has no impact on a company that has already fully transitioned from HFCs and into substitutes.
- In our view, states know this and would not expend their limited time and resources on something which confers no meaningful benefit.

4. **Your testimony included repeated references to Clean Air Act Title VI precedents. Why not just amend that section as necessary instead of, as the AIM Act proposes, standing up a separate regulatory program to affect an HFO transition? Given the federal judicial history of this issue, should not amending the Clean Air Act be the preferred vehicle for effecting changes to implementation of the Montreal Protocol provisions of the Clean Air Act to prevent duplication of regulatory authority and potential legal challenges?**

Answer:

AHRI does not have a formal position as to where the provisions of the AIM Act may be codified in the U.S. Code, if the AIM Act were to be enacted. We believe the AIM Act can accomplish its stated objectives as written and does not need to be folded into Title VI. We do not believe there is any risk of duplicative authority, given the distinct nature of the AIM Act's provisions and discrete focus solely and exclusively on HFCs. We believe the AIM Act's authority is clearly expressed and sufficiently limited so as to avoid undue litigation risk in its implementation.

5. **With that in mind, would ratification of the Kigali Amendment be a better vehicle for this regulatory change and also help ensure the equity of international competition in your industry?**

Answer:

The Kigali Amendment is an important addition to a multilateral environmental agreement and, as such, would not be an adequate or appropriate substitute for the federal standards contained in the AIM Act. Nor would ratification alone necessarily result in an orderly transition.

AHRI supports ratification of the Kigali Amendment, as a significant portion of the economic benefits associated with the transition to next-generation refrigerant technologies reside in expanding U.S. exports of American-made products and equipment. However, our immediate priority is the enactment of the AIM Act.

All prior amendments to the Montreal Protocol were ratified with unanimous bipartisan support in the United States Senate, although the lag between their adoption internationally and eventual U.S. ratification meant that implementation under domestic law always preceded ratification. This is expedient from a policy standpoint, but also essential from a commercial standpoint, given the globalized nature of the economy in which American HVACR manufacturers and workers seek to compete.

6. **How does the cost of reclaimed HFCs compare with that of virgin HFC feedstocks?**

Answer:

Reclaim costs are specific to the volumes recovered and evolve in step with the transition and the extent of demand. In particular, the costs of reclaim have been shown to decline significantly as economies of scale set in over the course of a refrigerant transition. Policies promoting reclaim also can significantly reduce cost; Section 9 of the AIM Act specifically encourages and promotes reclamation largely for this purpose.

The critical point with reclamation is that technologies exist to ensure the continued availability of refrigerants long after virgin production and the import of virgin product has ceased. As noted in my testimony, CFC-based chillers in commercial buildings were still operating and able to access supplies of reclaimed CFCs for servicing more than 20 years after CFCs were last produced or imported into the United States. If these supplies were not relatively economical, it is unlikely these old chillers would have been retired from service.

7. **How do the costs of reclaimed HFCs compare to recycled HFCs? Is there a strong policy justification for favoring one over the other legislatively or regulatorily?**

Answer:

Neither recycling nor reclaimed refrigerants should be favored from a policy perspective. They serve two different purposes.

As a general matter, recycling refers to the recovery and reuse of a refrigerant by a single business, such as the owner of a grocery store that might recycle the refrigerant from one piece of equipment in the store for use in another piece of equipment. Reclaim, by contrast, refers to the recovery and purification of a refrigerant such that it can be sold as effectively identical to virgin refrigerant.

For example, retailers might recover refrigerants from certain pieces of equipment and recycle them for use in their supermarket chains, while reclaimed refrigerant is not merely moved from one piece of equipment to another, but is purified to standard AHRI 700 to ensure the purchaser of that refrigerant is receiving top quality (like new) refrigerant.

8. **You praise the AIM Act for "dampening" states implementing their own standards, now and in the future. Your colleague recently noted that the AIM Act provides no guarantee of stopping state action. Francis Dietz, Vice President of AHRI, recently said: "In the past when we've done different transitions, states have fallen in line with the federal government. . . But I'm not certain that would be the case this time. I wouldn't tell people to bet on that." If you identify stopping separate state regulatory activity as a benefit and Mr. Dietz has observed states are not guaranteed to fall in line, why not include federal preemption language to ensure there will not be a state-by-state regulatory patchwork?**

Answer:

I would refer to my answer to Question 2 from Senator Capito and Question 13 from Senator Whitehouse regarding the issue of federal preemption of state authority. I also would note that AHRI's official position on HFCs and the AIM Act is contained in my testimony and in the answers to these questions.

9. **Can you please identify which, if any, members of AHRI oppose preemption and for what reasons?**

Answer:

Over the past three years, the federal void with respect to HFCs has driven some states to develop their own regulatory standards for HFCs. As mentioned previously, our industry is complicated and virtually impossible to regulate without substantial technical input and data from industry experts. Given the uncertainty at the federal level, it would have been irresponsible for our industry not to participate actively in state legislative and regulatory proceedings. In some cases, as a result of that participation, some companies have made substantial, multi-year investments to meet these state standards.

As discussed more fully above, our priority as an industry is not to do away with state standards – it is to fill the federal void with a competent, common sense federal standard, which we believe the AIM Act represents. Once that void is filled, also as discussed more fully above, we do not believe state standards will pose a problem, particularly given that once a company has transitioned from HFCs, there is nothing further for a state to regulate.

<u>Senator Cardin:</u>

10. **In the Air-Conditioning, Heating, & Refrigeration Institute (AHRI) written testimony, AHRI refers to large-volume sectors likely to transition to substitutes in the 2020s.**

    a. **What would be a rough estimate of the total volume of HFCs used today that would be likely to transition to substitutes by 2025 and 2028?**

Answer:

Thank you for your questions, Senator Cardin.

This is best understood as a percentage of the phase down, as AHRI is not in a position to speak specifically to the plans and possible decisions of any one sector. But, as a percentage, AHRI expects approximately 40 percent of HFC uses to have transitioned to substitutes by 2024 and 70 percent by 2029. The dates used in AHRI's models are 2024 and 2029, hence the percentages for those years provided here.

    b. **How much would this leave under the phasedown for other users going forward?**

Answer:

Based on these estimates, by 2036, the 15 percent "tail" of HFCs remaining for continued use is approximately 60,000 tons.

<u>Senator Whitehouse:</u>

11. **You state that roughly 230,000 tons of HFCs are produced or imported in the U.S. each year and that 70 percent is used for refrigeration or air conditioning. What percentage of total HFCs used in the U.S. are used by the aerospace, semiconductor, composites, foam, and defense sprays industries? Has this percentage of niche uses grown over the last five years, and if so, by how much?**

Answer:

Thank you for your questions, Senator Whitehouse.

It would not be appropriate for AHRI to speak specifically about another sector's use data.

But as a general matter, according to AHRI's knowledge and understanding of the EPA Vintaging Model of HFCs, the sectors referred to in your question use well less than ten percent of the HFC baseline each year.

The one exception to that is foams, which represent a larger portion of HFC use by volume, including a portion of the estimated 70 percent used by the HVACR industry. AHRI would respectfully defer on the specifics of this question to the foam sector industry groups, such as the Center for Polyurethanes Institute (CPI) and the Extruded Polystyrene Foam Association (XPSA).

I also would note that the AIM Act is designed to accommodate niche applications for which no substitute is currently available. The gradual phase down of production and consumption ensures a significant supply of HFCs for continued use for the next several decades. By 2036, when the phase down plateaus at 15 percent of the baseline, AHRI estimates approximately 60,000 tons of HFCs will be available. This is more than enough to satisfy the needs of the sectors referenced in your question.

Moreover, the AIM Act authorizes the provision of temporary exceptions for applications in need of additional time to identify, develop, and test substitutes to ensure they are safe, reliable, and affordable. Title of VI of the Clean Air Act, on which the AIM Act is based to a substantial degree, shepherded transitions in these same sectors from ozone-depleting substances without imposing hardship or otherwise forcing any of these applications into substitutes before such substitutes were available. AHRI would anticipate the same experience under the AIM Act and with HFCs.

12. **Numerous industries have provided written testimony stating that there are no acceptable substitutes for HFCs they use. Please comment on these claims with respect to the aerospace, semiconductor, composites, foam, and defense sprays industries. Please list all HFCs for which such claims have been made and state whether or not you agree with the claim that no acceptable substitute exists. If you do not agree, please provide the name of the substitute and why you believe it to be acceptable.**

Answer:

As discussed in significant detail in my testimony, the AIM Act is designed to accommodate applications for which no substitute is available, providing temporary exceptions until such substitutes can be identified, thoroughly tested for safety and reliability, and made available and affordable. These provisions of the AIM Act are modeled on similar provisions contained in Title VI, which confronted and successfully dealt with many of these same sectors and applications.

The point, therefore, is not whether a substitute exists now, but the extent to which current uses can be accommodated until such substitutes become available. The AIM Act effectively balances the fundamental fairness of subjecting every actor to the same general standard while providing a means for every actor that needs more time and flexibility under the standard to be granted such in accordance with demonstrated need.

13. **Please describe the transition from CFCs to HFCs, catalyzed by the Montreal Protocol and Title VI of the Clean Air Act. Did Title VI preempt or in any other way limit state regulatory action with respect to CFCs? After the implementation of Title VI and the accompanying two year pause in state enforcement of CFC regulations, did states adopt or resume enforcing CFC regulations? If so, how many and in what manner?**

Answer:

As discussed more fully in my testimony, the orderly transition from ozone-depleting substances, as facilitated by the enactment of Title VI of the Clean Air Act in 1990, is broadly considered a commercial and environmental success.

As discussed in my answer to Question 2, and partially reproduced here for reference, federal preemption of state authority was not necessary in the transition from ozone-depleting substances. The enactment of Title VI in 1990 filled the federal void, and states shifted their focus elsewhere. Section 614(a) of Title VI imposed a two-year "pause" in the enforcement of state standards, and following that pause, no state sought to regulate ozone-depleting substances in a manner that was more stringent than Title VI. Preemption simply was not an issue in 1990.

As noted above and as discussed at great length in my testimony, the AIM Act is intended to reproduce for HFCs the orderly transition from ozone-depleting substances experienced under Title VI. This extends to the question of preemption. The overwhelming priority for our industry is to fill the federal void with a competent HFC standard, not to address state standards.

It is tempting to conjecture that the political landscape in the states is somehow different today than in 1990 – that states were more willing to go along with what Congress did. I do not believe that to be true. If anything, the risk was greater in 1990 that states would continue to seek to regulate ozone-depleting substances no matter what Congress did.

By the late 1980s, public concern over the hole in the ozone layer and excessive exposure to ultraviolet radiation was intense and widely shared. Indeed, some states had been seeking to develop and deploy regulatory restrictions on ozone-depleting substances since the 1970s. These states were heavily vested in efforts to reduce, if not eliminate, ozone-depleting substances. By no means was it a foregone conclusion that federal legislation, championed and signed by a Republican president, would persuade states to set aside regulatory programs that, in some cases, had been in effect for more than a decade.

Today is markedly different. The relatively small degree of state activity on HFCs has emerged only in the past two years and only because of the absence of any competent federal means to regulate HFCs. Unlike with ozone-depleting substances, which were exclusively responsible for the depletion of the stratospheric ozone layer, HFCs are one of many drivers of climate change. States focused on climate change have many other avenues and areas on which to focus their attention once HFCs are subject to a federal standard.

Our industry is complicated. No state can seek to regulate HFCs without substantial technical input from AHRI and other organizations representing our industry; our expertise is just not found anywhere else. Given its limited time and resources, we think it extremely unlikely a state would continue to pursue its own HFC regulations once the main reason for their involvement in the first place – the lack of a federal standard for HFCs – had been addressed.

Finally, and also as discussed in significant detail in my testimony, HFCs are products and not by-product emissions.

No company will gradually curb its HFC use in line with the phase down schedule in the AIM Act. Rather, companies will seek to transition to HFC substitutes in one fell swoop, because it is too costly to maintain two lines of identical equipment – one that uses HFCs and one that uses HFC substitutes.

Many companies will seek to transition from HFCs relatively early in the phase down schedule – likely around the mid-2020s. This is because the lion's share of the economic benefits reside in the market for next generation refrigerant technologies, and not in staying in HFCs for as long as possible. This is inherent in the distinction between HFCs as "products" and other focuses of regulatory programs, such as emissions and equipment standards, *e.g.*,, for fuel economy.

This distinction is highly relevant to preemption because, once a company makes a transition from HFCs, there is nothing further a state can do. Or, put another way: if a state were to impose a more stringent HFC standard, it would not matter to the many companies already working to transition from HFCs. Most important, states know this and would not expend limited time and resources on additional regulation that confers virtually no benefit, environmental or otherwise.

14. **For HFCs where users claim that the current substitute is too expensive, based on your prior experience transitioning from CFCs to HFCs, what do you believe will occur with respect to the price of HFC substitutes? Please comment on old claims by the Heritage Foundation, the Competitive Enterprise Institute, and others the HFCs would be too expensive and compare them to these groups' current claims that HFOs will be too expensive. Do you find these groups' claims to be credible?**

Answer:

I would refer to pages 7-8 of my testimony, which discusses cost issues in detail. I also would refer to the EPA cost study of the AIM Act, which we understand Senator John Kennedy to have received and reviewed, which shows the HFC phase down will save American consumers and businesses $3.7 billion over 15 years.

As to the credibility of the claims made by various think tanks, I would consider these to be in the nature of reviews and commentary rather than empirical research or data-driven modeling.

Indeed, the Competitive Enterprise Institute published a paper in 1994, cited in my testimony, warning of cost increases and other hardships as a result of the transition from CFCs. Industry experience has shown that the concerns expressed in that paper, and other similar concerns expressed elsewhere in the late 1980s and early 1990s, were entirely unfounded. Costs declined and niche applications in need of more time to develop a safe, affordable, and reliable substitute were granted temporary exceptions for as long as needed.

The resurfacing of these same claims, some more than 30 years old and entirely controverted by industry and practical experience, merely repeats past mistakes and directly contradicts the lessons our industry has learned over the past three decades in competently managing refrigerant transitions.

15. **If the AIM Act were to be passed in its current form, based on your experience with Title VI, how do you believe that states would respond with respect to adopting and/or enforcing their own HFC laws and regulations?**

Answer:

As per my testimony and my answer to Question 2 from Senator Capito and Question 13 from Senator Whitehouse. Federal preemption of state authority was not necessary in the transition from ozone-depleting substances. The enactment of Title VI in 1990 filled the federal void, and states shifted their focus elsewhere. Section 614(a) of Title VI imposed a two-year "pause" in the enforcement of state standards, and following that pause, no state sought to regulate ozone-depleting substances in a manner that was more stringent than Title VI. Unlike with ozone-depleting substances, which were exclusively responsible for the depletion of the stratospheric ozone layer, HFCs are one of many drivers of climate change. States focused on climate change have many other avenues and areas on which to focus their attention once HFCs are subject to a federal standard. Given the limited time and resources at the state level, we think it extremely unlikely a state would continue to pursue its own HFC regulations once the main reason for their involvement in the first place – the lack of a federal standard for HFCs – had been addressed.

16. **Do you believe that passing the AIM Act in its current form will lead to more or less regulatory harmonization and certainty than would continued congressional inactivity in this space?**

Answer:

As discussed more fully in my testimony, the highest priority of our industry with respect to HFCs is filling the federal void with a competent regulatory regime, such as the AIM Act. We believe this will settle the regulatory landscape and provide certainty and predictability for companies to plan, invest, hire, and build. We believe the enactment of the AIM Act would, for reasons explained in significant detail in my testimony, discourage states from seeking to further regulate HFCs, as no meaningful benefit, for the environment or otherwise, would result.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Aerospace Industries Association

Chairman Barrasso:

1. Is the essential use provision, as currently written, unsatisfactory for the aerospace industry?

The current text constructs an administrative process to seek exemptions. It should be noted that an aerospace exemption is needed because many aerospace uses, including onboard fire suppression, have no viable alternative that will satisfy stringent FAA and DoD certification and fight safety requirements. We anticipate that despite ongoing efforts to identify suitable alternatives, fluorinated gases will be needed to support aerospace applications well beyond 2035. Even though the legislation would allow 15% of the baseline production and consumption values, the phase-down will nevertheless drive fundamental changes in the market for fluorinated gases, resulting in uneven distribution and availability of specific fluorinated gases for relatively niche uses like aerospace. The option for exemptions is included in the bill, but we wanted to be sure to raise awareness to our concerns so they are addressed as part of the process.

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

2. The recently issued Fourth National Climate Assessment projects that if the global community does not act quickly, climate change will significantly affect our nation's infrastructure, public health and economy. Scientists reported that extreme weather events, like category five hurricanes and deadly wildfires, and pandemics, like COVID-19, are expected to become more commonplace and devastating as climate change worsens overtime. These climate-related events will economically devastate our country if we do not act on climate change.

    a. Do you agree with our nation's leading scientists that have concluded climate change is real, is caused by humans, and is impacting nation's environment and infrastructure? If not, why not?

The global aviation industry takes its environmental impacts seriously. AIA and American manufacturers are committed to playing our part in reducing the climate, noise and air quality impacts of our products.

Given the global nature of aviation, addressing environmental impacts is most effective when it is done at the international level with common rules that apply to all countries. The International Civil Aviation Organization (ICAO) is a specialist branch of the United Nations concerned with aviation. One of its many roles is to set new standards and policies for aviation and its environmental performance.

While the emissions from aviation are lower than several sectors, roughly comparable to those from the IT sector, the industry understands how important it is to play our part in reducing climate impacts.

b. What steps are your members taking today to reduce greenhouse gases? In answering, please detail which actions are mandated by a federal or state government and which are voluntary actions.

Aircraft technology is a key measure to address climate change. Aircraft manufacturers have a strong track-record of delivering aircraft that are more environmentally friendly than their predecessors. Modern aircraft are now 80% more fuel efficient that the first airliners. A flight today produces 50% less CO2 that the same flight in 1990. Each new aircraft generation improves fuel efficiency by 15% to 25% on a per passenger mile basis. Today's latest airliners are now as fuel efficient as a hybrid electric car, all while making journeys that would not be possible or feasible by other transportation means. The U.S. manufacturers provide a significant portion of the on average $15 billion per annum spent by manufacturers worldwide on efficiency research and development.

c. As a result of any actions being taken today to address greenhouse gas emissions, what does AIA project will be the aerospace industry's net greenhouse gas emissions by 2035 compared to 2019 levels? By 2050?

In 2008, AIA and U.S. manufacturers were part of the industry-wide agreement that saw aviation become the first industrial sector to set goals to reduce its climate impact:

- **Short-term**: 1.5% per annum fuel efficiency improvements. Industry have exceeded this goal, realizing on average 2.3% per annum improvements so far.
- **Mid-term**: Carbon-neutral growth from 2020. With ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), aviation became the first industry to agree to a voluntary global cap on CO_2 emissions. International emissions above 2020 levels will be required to be offset by the aviation sector.
- **Long-term**: 50% reduction in net emissions by 2050, compared to 2005 levels.

d. Do you have an estimate of the cumulative economic costs incurred from damages caused by extreme weather events for the aerospace and defense industry in 2019? If so, please provide those estimates and how they were developed.

We do not have relevant estimates at this time.

3. In your testimony, you mention that there are not readily available HFC substitutes for onboard fire suppression agents on commercial and military aircraft.

a. What specific HFC compounds are your members using today that do no not have a readily available HFC substitutes?

Our members use HFC-125, HFC-227ea and HFC-236fa for onboard fire extinguishing and suppression in commercial and military aircraft. In addition, onboard commercial aircraft, galley refrigerators and chillers rely on HFC-134a. Currently, there is no ready substitute for HFC-134a that would satisfy the Federal Aviation Administration certification criteria, and in particular a substitute with the low flammability properties of HFC-134a.

b. Of the HFC compounds that are being used today, on average how much does the industry use on an annual basis (in tons and GWP-weighted tons) now?

We do not have precise figures for the industry overall, but we anticipate that aerospace uses total a small fraction of HFCs produced or imported in the United States annually.

c. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your member companies on an annual basis?

It's our understanding that 90% of the total is used for industrial, commercial, motor vehicle, and residential refrigerant and air conditioning purposes; whereas aerospace uses just a fraction of that.

d. Do your members project HFC usage will grow or shrink over the next 15 years?

We believe our members' HFC use rate has been fairly constant. HFC compounds have a number of unique properties that make them indispensable for onboard fire suppression. In relatively small quantities, they are highly effective at extinguishing a variety of fires, in extreme conditions including subfreezing temperatures as low as minus 40 degrees Fahrenheit. They are also "equipment safe" so they do not cause additional damage during an emergency situation and some are lower in toxicity or non-toxic so they are acceptable for use in occupied spaces. HFC-125 is currently used in engine nacelles and auxiliary power unit compartments on a number of military aircraft manufactured by our members. HFC-125 also has potential for some applications in commercial aircraft as a replacement for substances currently in use that have far greater ozone depletion potential. One of those applications is as a possible replacement for Halon 1301 in commercial aircraft engine compartments. While our members are pursuing non-HFC alternatives, in the event potential alternatives do not meet Federal Aviation Administration (FAA) certification requirements the industry needs to preserve the option to turn to HFCs, which have a proven record in military applications.

e. Have any of your members considered using HFC-alternatives? If not, why not? If so, please provide details of your efforts to develop or find substitutes for HFCs and if there is there anything about those alternatives that cause concern for future compliance with the bill.

Our members' highest priority is having access to proven fire suppression agents that meet FAA certification and Department of Defense specifications. HFC compounds are the aviation industry replacement for substances with far more environmental impact such as Halon 1211 and 1301. HFC compounds have a number of unique properties that make them indispensable for this aviation safety use. Regarding the point of developing alternative compounds, our members' experience has shown that identifying, testing and certifying the use of compounds for onboard use with the effectiveness and unique specifications described above can take nearly 30 years. That's the total amount of time our members needed to receive final federal approvals for 2-bromo-3, 3, 3-trifluoropropene (2-BTP) to be used in handheld extinguishers on commercial aircraft and the development of HFC-227ea as an alternative to Halon 1301 in lavatory waste bin fire extinguishers. Additional research projects have taken many years and resulted in test failures late in development, including HFC-125 in cargo fire suppression, 2-BTP in engine/APU fire suppression and 2-BTP in cargo fire suppression. The industry continues to search for Halon 1301 replacements that are not HFCs, but the continued availability of HFCs that are the only approved replacement for Halon 1301 is critical to the aviation industry.

4. If the AIM Act were implemented as written, does AIA believe the HFCs used in the aerospace industry will be eligible for essential use exceptions? If not, why not?

The current text constructs an administrative process to seek exemptions. It should be noted that an aerospace exemption is needed because many aerospace uses, including onboard fire suppression, have no viable alternative that will satisfy stringent FAA and DoD certification and fight safety requirements. We anticipate that despite ongoing efforts to identify suitable alternatives, fluorinated gases will be needed to support aerospace applications well beyond 2035. Even though the legislation would allow 15% of the baseline production and consumption values, the phase-down will nevertheless drive fundamental changes in the market for fluorinated gases, resulting in uneven distribution and availability of specific fluorinated gases for relatively niche uses like aerospace. The option for exemptions is included in the bill, but we wanted to be sure to raise awareness to our concerns so they are addressed as part of the process.

Senator Whitehouse:

5. What is the total volume of HFCs for which there is no acceptable substitute used by the aerospace industry? Please list each such HFC and the volume used. Please state the reasons why potential substitutes (if they exist) are unacceptable.

Our members' highest priority is having access to proven fire suppression agents that meet FAA certification and Department of Defense specifications. HFC compounds are the aviation industry replacement for substances with far more environmental impact such as Halon 1211 and 1301. HFC compounds have a number of unique properties that make them indispensable for this aviation safety use. Regarding the point of developing alternative compounds, our member's experience has shown that identifying, testing and certifying the use of compounds for onboard use with the effectiveness and unique specifications described above can take nearly 30 years. That's the total amount of time our members needed to receive final federal approvals for

2-bromo-3, 3, 3-trifluoropropene (2-BTP) to be used in handheld extinguishers on commercial aircraft and the development of HFC-227ea as an alternative to Halon 1301 in lavatory waste bin fire extinguishers. Additional research projects have taken many years and resulted in test failures late in development, including HFC-125 in cargo fire suppression, 2-BTP in engine/APU fire suppression and 2-BTP in cargo fire suppression. The industry continues to search for Halon 1301 replacements that are not HFCs, but the continued availability of HFCs that are the only approved replacement for Halon 1301 is critical to the aviation industry.

6. By what percentage has use of such HFCs been growing over the last five years? Please list each such HFC and its growth rate over the last five years.

We believe our members' HFC use rate has been fairly constant. As noted in the response to your first question, some HFC compounds have a number of unique properties that make them indispensable for onboard fire suppression. HFC-125 is currently used in engine nacelles and auxiliary power unit compartments a number of military aircraft manufactured by our member companies including the F/A-18 E/F, KC-46 Tanker, P-8 Poseidon, and V-22 Osprey. HFC-125 also has potential for some applications in commercial aircraft as a replacement for substances currently in use that have far greater ozone depletion potential. One of those applications is as a possible replacement for Halon 1301 in commercial aircraft engine compartments. While our members are pursuing non-HFC alternatives, in the event they do not meet FAA certification requirements they want to preserve the option to turn to HFC-125, which has a proven record in military applications.

The Honorable John Barrasso, Chairman
The Honorable Thomas Carper, Ranking Member
Committee on Environment and Public Works
US Senate
410 Dirksen Senate Office Building
Washington, DC 20510

Apr 29, 2020

Topic / Ref. : S.2754, The American Innovation and Manufacturing Act of 2019, Written Testimony and Questions for the Record

Air Liquide appreciates the opportunity given to us by the Committee to offer additional testimony in regards to S.2754 following our original written testimony of April 8, 2020 and hopes that the information provided herein will be informative to the Committee. We will answer the questions as they are numbered in the Committee's *Questions for the Record for Air Liquide*.

Chairman Barrasso

1. Semiconductor plasma etching is a process that selectively removes a substrate, typically silicon, by inducing a plasma in a gas at sub-atmospheric pressure with radio frequency energy. It serves as a circuit-defining step in integrated circuit manufacture by selectively carving out material. The silicon to be removed is converted into gaseous silicon tetrafluoride by fluorine ions produced from ionization of the etchant gas. Generally this requires a gaseous fluorinated organic compound, such as an HFC.
    a. HFCs serve as a source of the element fluorine, but with a lesser amount of fluorine in proportion to the other elements than other sources.
    b. While other fluorinated compounds such as perfluorocarbons (PFCs) and per- and hydrofluoroolefins (PFOs and HFOs) do find use in semiconductor etching, each combination of etchant gas, tool, and operating parameters has unique properties that are selected by the end user according to certain criteria such as etch rate, anisotropy, profile control, and creation of a protective layer. This leads to a lack of direct interchangeability.
2. It is our understanding that HFCs used in semiconductor etching are likely to be eligible for an essential use exception given their small volume and critical use, but that such an exception would have to be renewed every five years and would compete with other essential uses. We would support a critical use exemption for HFCs used in semiconductor processing. This exemption would have international precedent in EU HFC reduction regulations. EU Regulation 517/2014, Ch. IV, Art. 15, para. 2 states that "...This article also shall not apply to the following categories of hydrofluorocarbons", (e) "hydrofluorocarbons supplied directly by a producer or importer to an undertaking using it for the etching of semiconductor material or the cleaning of chemicals vapor deposition chambers within the semiconductor manufacturing sector".
3. Air Liquide has only a general awareness of other critical uses of HFCs.

Ranking Member Carper

4. a. through d. Regrettably, we are unable to provide the information you seek as it is confidential to us.

Air Liquide

   e. Air Liquide launched the enScribe™ portfolio of low-GWP etchants in October of 2016. We are not aware of any compliance issues our enScribe™ product line would have with S.2754.
5. Please refer to our testimony above to Chairman Barrasso, question 2.

Senator Whitehouse

6. and 7. Regrettably, we are unable to provide the information you seek as it is confidential to us.

Sincerely,

Eric KLEINSCHMIDT
4000 Nelson Ave
Concord, CA 94520
(925) 808-2606
eric.kleinschmidt@airliquide.com

Responses to Questions for the Record for the Alliance for Automotive Innovation
For the Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*

April 29, 2020

In response to the Questions for the Record regarding the Alliance for Automotive Innovation's[1] (Auto Innovators) testimony on S. 2754, *American Innovation and Manufacturing Act of 2019* (or AIM Act), we provide the following responses.

Chairman Barrasso:

1. Can you further elaborate on why you believe the bill needs to include an exemption for light-duty vehicle exports to countries that do not have an HFC phasedown in place?

Light-duty vehicles with HFC-134a air conditioner systems that are manufactured in the U.S. for export purposes only should be allowed to continue; these exports are important to our U.S.-based manufacturing sector and economy. Countries that do not have an HFC phasedown in place will not have access to infrastructure for alternative refrigerants, like HFO-1234yf for automobiles. This means that there could be issues with supply of HFO-1234yf and repair of mobile source air conditioner systems in those countries. It takes time to develop the infrastructure and repair network associated with new refrigerants. It is important to ensure that we provide our customers, wherever they are located, with high quality, long-lasting vehicles that can be reasonably, feasibly, and affordably maintained throughout the vehicle lifetime. If it is not possible to repair a vehicle's air conditioner system due to a lack of infrastructure and repair capability associated with a new refrigerant, then it is necessary to be able to export vehicles appropriate to the market for which they are intended.

2. Proponents of the AIM Act argue that most companies making a transition out of HFCs will do so in "one fell swoop." In your testimony, you highlighted how the auto industry has had a "progressive" transition spanning over many years. Can you explain why the auto industry is not able to transition in "one fell swoop?"

The auto industry has had a progressive transition for several reasons over the course of several years. First, at the time we began our transition, there was only one manufacturer of the alternative refrigerant, HFO-

[1] Formed in 2020, the Alliance for Automotive Innovation is the singular, authoritative and respected voice of the automotive industry. Focused on creating a safe and transformative path for sustainable industry growth, the Alliance for Automotive Innovation represents the manufacturers producing nearly 99 percent of cars and light trucks sold in the U.S. The organization, a combination of the Association of Global Automakers and the Alliance of Automobile Manufacturers, is directly involved in regulatory and policy matters impacting the light-duty vehicle market across the country. Members include motor vehicle manufacturers, original equipment suppliers, technology and other automotive-related companies and trade associations. The Alliance for Automotive Innovation is headquartered in Washington, DC, with offices in Detroit, MI and Sacramento, CA. For more information, visit our website http://www.autosinnovate.org.

1234yf.[2] Therefore, there were limited supplies of HFO-1234yf, and such supplies were costly. The auto industry has slowly moved to use of HFO-1234yf as the supplies increased.

Second, vehicles have a long design and product cycle. They are designed over a two- to four-year timeframe before coming to market, and once sold, a particular model will typically be in the market for four to seven years before undergoing a major redesign. Air conditioner systems are integral to a vehicle's operation. Thus, they are unlikely to undergo the required major redesign except at the time the overall vehicle is refreshed due to the cost, need to test and verify durability and quality, and ensure efficient operation in coordination with the vehicle's powertrain and electronic functions. Additionally, the adoption of alternative refrigerants requires new refrigerant storage and filling equipment at vehicle assembly plants. It is generally most cost-effective to make such changes when an assembly plant is retooled for a redesigned vehicle. A cost-effective and smart transition is aligned with our companies' abilities to update and install new air conditioner systems that run on HFO-1234yf in line with our industry's vehicle product cycles and balancing the overall additional costs and emissions benefits of GHG-reducing technologies via a holistic vehicle approach.

Third, when the auto industry began its transition, in addition to limited supplies of HFO-1234yf, the ability to repair these vehicles throughout their lifetime was nonexistent. Therefore, automakers and their dealers, as well as the aftermarket repair industry, needed time to invest in the necessary infrastructure and equipment to store, repair, and recycle HFO-1234yf in the event a vehicle's air conditioner system needed maintenance. Available supplies of the refrigerant to repair HFO-1234yf air conditioner systems were also needed. In addition, repair and maintenance training for the new air conditioner systems had to be developed and distributed.

Finally, at the beginning of this transition, the cost of HFO-1234yf was extremely high. It was necessary to consider the overall cost to the customer and be able to ensure a cost-effective and timely repair of any vehicles using HFO-1234yf. Thus, a progressive transition made it possible to align the market conditions with customers' needs, expectations, and ability to pay, while at the same increasing the use of HFO-1234yf and therefore decreasing GHG emissions associated with refrigerants, at a steady pace.

3. On page 20 of the Auto Alliance's comments to the Significant New Alternatives Policy (SNAP) Rule 20, the Alliance reports that "a comparison of auto parts store prices for HFO-1234yf (10 pound container for $1,279.00) and for HFC-134a (30 pound container for $179.99) shows that HFO-1234yf is currently 20 times the price of HFC-134a." Do HFOs remain more expensive than HFCs?

Although Auto Innovators is not privy to the high-volume prices paid by auto manufacturers for HFC-134a and HFO-1234yf, it is our understanding that HFO-1234yf remains more expensive than HFC-134a. For example, in the much smaller quantities used for aftermarket service, HFO-1234yf costs approximately $42-$55 per pound in comparison to HFC-134a at approximately $7 per pound. (Prices based on 25 lb. and 30 lb. cylinders, respectively.)[3]

---

[2] HFO-1234yf (R-1234yf) is the alternative refrigerant that light-duty vehicle manufacturers have generally adopted as an alternative to HFC-134a. Although other alternative refrigerants have been approved for use in light-duty vehicles, manufacturers have not implemented them for a number of reasons. When discussing "alternative refrigerants" in the context of light-duty vehicles, Auto Innovators is referring to HFO-1234yf.

[3] Refrigerantdepot.com.

4. What is the price difference between recycling and reclaiming refrigerants?

Reclaiming refrigerants requires returning the refrigerant to virgin specifications and is performed at an off-site facility designed and certified by the U.S. EPA for such purposes. Recycling is performed by on-site equipment and is not required to meet the same level of purity requirements.[4]

Auto Innovators does not have specific knowledge of the cost to reclaim refrigerant; the committee may wish to investigate these costs with EPA-certified refrigerant reclaimers.[5] On-site recycling equipment appears to cost approximately $1,000 to $7,000 upfront,[6] but allows the reuse of recovered refrigerant, thereby minimizing costs to consumers. However, because recycling is standard practice, the equipment to recycle HFC-134a is largely already in place. For most service locations, new equipment purchases would only be required to replace/upgrade older equipment or to increase service capacity.

5. Why is the ability to recycle refrigerants over reclaiming them important for older vehicles on the road?

As described in our response to question 4, reclaiming refrigerants involves sending them to a certified facility. For our customers, this means that the refrigerant removed from a vehicle during service cannot be used to refill it. This has cost implications for our customers, because "new" refrigerant must be used. It also has environmental implications associated with the transport of refrigerant to a certified reclaimer and the refrigerant's subsequent remarketing and reshipment in a new container.

For example, prior to the transition to HFC-134a, recycling of the prior automotive A/C refrigerant, CFC-12, became standard industry practice at auto service centers. As a result, the supply of CFC-12 was enough to service vehicles through the transition, and the number of expected expensive retrofits of CFC-12 systems to HFC-134a was minimal. In fact, even though the auto industry completed its transition to HFC-134a in model year 1995, CFC-12 is still available to service the remaining "classic" vehicles that use CFC-12.

Also, for older vehicles, there may also be concerns with the availability of the legacy HFC-134a refrigerant if reclaimed refrigerants from automotive applications are used by other sectors due to reduced availability of newly manufactured refrigerants under the draft bill's phasedown.

6. Are there technical limitations to HFCs in mobile source air-conditioning units such as flammability, toxicity, increased engineering and manufacturing requirements?

HFCs have been safely used in light-duty vehicles since the 90's and do not have technical limitations as asked. Regarding HFO-1234yf, U.S. EPA has specified use conditions for alternative refrigerants to address

---

[4] U.S. Environmental Protection Agency, "EPA Regulatory Requirements for MVAC System Servicing," https://www.epa.gov/mvac/epa-regulatory-requirements-mvac-system-servicing, accessed April 20, 2020. (See "Refrigerant Handling.")

[5] U.S. Environmental Protection Agency, "EPA-Certified Refrigerant Reclaimers," https://www.epa.gov/section608/epa-certified-refrigerant-reclaimers, accessed April 20, 2020.

[6] Google search of "1234yf service equipment". https://www.google.com/search?q=1234yf+service+equipment&rlz=1C1GCEA_enUS881US881&oq=1234yf+service+equipment&aqs=chrome..69i57.9205j0j7&sourceid=chrome&ie=UTF-8, accessed April 20, 2020.

flammability, toxicology, and breathability concerns.[7] These conditions require additional engineering of mobile air conditioning systems to address them. Each manufacturer addresses these requirements in their A/C system designs.

Manufacturers must also address flammability of HFO-1234yf for high-volume refrigerant storage and filling operations at assembly plants. Similarly, aftermarket service equipment must be appropriately designed for handling HFO-1234yf.

7. Do you have concerns that the broad language of phasedown provisions, including the technology transitions provision, do not adequately figure in cost considerations?

Any legislative or regulatory proposal should be carefully assessed to ensure that the economic and environmental benefits associated with such a significant change are aligned with the near-term challenges facing our nation as well as the longer-term potential benefits of this bill. The current automotive regulatory structure has meant that the light-duty automotive sector has been able to transition to a refrigerant with lower GWP at a slow but steady pace that is well-aligned with companies' product plans, investment strategies, and GHG reduction targets. As a result, most new light-duty vehicles now use the alternative refrigerant HFO-1234yf. In considering S. 2754's schedule, we believe the phase-down generally aligns with the light-duty vehicle sector's ongoing transition.

8. How do HFOs impact fuel economy?

In the United States, the fuel economy impact of HFO-1234yf is negligible; however, HFO-1234yf has a much lower global warming potential compared to HFC-134a.

Ranking Member Carper:

Please provide a response to each question, *including each sub-part.*

9. The recently issued Fourth National Climate Assessment projects that if the global community does not act quickly, climate change will significantly affect our nation's infrastructure, public health and economy. Scientists reported that extreme weather events, like category five hurricanes and deadly wildfires, and pandemics, like COVID-19, are expected to become more commonplace and devastating as climate change worsens overtime. These climate-related events will economically devastate our country if we do not act on climate change. Do you agree with our nation's leading scientists that have concluded climate change is real, is caused by humans, and is impacting nation's environment and infrastructure? If not, why not?

We agree that climate change is real, and as such every sector and every business should be investing in the cleanest and most efficient technologies to reduce GHG emissions and improve efficiency. We also need to create workable pathways to get there. Businesses that are investing in future technologies today also need to have sustainable and profitable business models to help fund the shift to the technologies of tomorrow. We hope to work hand-in-hand with the federal and state governments to identify policies that help

---

[7] U.S. Environmental Protection Agency, "Refrigerant Transition & Environmental Impacts," https://www.epa.gov/mvac/refrigerant-transition-environmental-impacts, accessed April 20, 2020 at "New Climate-Friendly Alternative Refrigerants" for a general description of the use conditions for various alternatives.

encourage continued efficiency gains with internal combustion engines, as well as the shift to vehicle electrification, which requires adequate charging and hydrogen refueling infrastructure.

10. Prior to 1990, there were over sixteen states that had taken action, or were in the process of taking action, to restrict the use of Chlorofluorocarbons (CFCs). In the Clean Air Act Amendments of 1990, Congress created a federal program to phase out CFCs in Title VI of the Clean Air Act. Rather than preempting state actions, Congress preempted the enforcement of state CFC regulations for two years. Once EPA had a strong CFC federal program in place, the state programs for the most part went away on their own. Why specifically do you expect states will act differently in terms of HFCs if a federal regulatory program is created? Given the history why should HFCs be treated differently than CFCs in terms of state preemption?

We believe that preemption of state actions would be appropriate for the regulation of HFCs because of the significant difference in approach to HFC regulation being taken by Congress and the states. While S. 2754 seeks to adopt a phased reduction approach similar to that in the Kigali Amendment to the United Nations' Montreal Protocol,[8] state actions to date have largely mirrored the approach laid out in EPA's Significant New Alternatives Policy (SNAP) Rule 20, which has since been partially vacated along with SNAP Rule 21 by the District of Columbia Court of Appeals. In the SNAP Rule 20, rather than a phased reduction, EPA listed HFC-134a "as unacceptable for newly manufactured light-duty motor vehicles beginning in Model Year (MY) 2021" with certain exceptions for vehicles to be sold in other countries without appropriate infrastructure to service alternative refrigerants. The state of Washington in 2019 passed a bill that will incorporate SNAP Rule 20 restrictions on new light duty vehicles within twelve months of another state's enactment of the same restrictions.[9] A proposed bill in Maine would prohibit HFC-134a for all newly manufactured vehicles as of model year 2021.[10] In the 2018 California Cooling Act, California incorporated SNAP Rules 20 and 21 by reference with the exception of vehicle air conditioning systems.[11]

Although there is currently no active state-level ban on HFC-134a for light-duty vehicles in model year 2021 or any future model year, state legislative actions and proposed actions have largely been aligned with the partially vacated SNAP Rule 20; again, SNAP Rule 20 would have banned HFC-134a for new light-duty vehicles for sale in the United States beginning in model year 2021, with some limited exceptions. Due to the difference in that approach and the phased reduction described in the AIM Act, we believe that preemption of state actions rather than temporary preemption of state enforcement would be appropriate for HFCs in order to avoid a patchwork system of state regulations that is also at odds with a federal program.

---

[8] Kigali Amendment (pdf) – English version p 26, https://treaties.un.org/doc/Treaties/2016/10/20161015%2003-23%20PM/Ch_XXVII-2.f.pdf.

[9] http://lawfilesext.leg.wa.gov/biennium/2019-20/Pdf/Bills/Session%20Laws/House/1112-S2.SL.pdf#page=1; Page 6, Line 27.

[10] http://www.mainelegislature.org/legis/bills/getPDF.asp?paper=HP1505&item=1&snum=129; Page 7, Line 6.

[11] California Cooling Act – note MVAC exception https://ww2.arb.ca.gov/node/3335/about.

11. Of the HFC compounds that are being used today, on average how much does the industry use on an annual basis (in tons and GWP-weighted tons) now?

Auto Innovators does not currently have this data available and could not obtain it within the timeframe of this response.

However, a very rough estimate of greater than 6,400 tons (9.2 million tons GWP-weighted) per year may be derived from various sources as follows. Note, these estimates are based on a number of assumptions, and therefore we highly recommend seeking more robust data from other sources.

- Roughly 40% of light-duty vehicles have not transitioned away from HFC-134a refrigerant (see response to question 13)
- A non-weighted average refrigerant charge per vehicle is approximately 700 grams per vehicle[12]
- Assuming a 17 million unit per year, U.S. new vehicle market: 17,000,000 x 40% x 700 grams x 1 ton per million grams = 4,800 tons (6.9 million tons GWP-weighted)
- Similarly, an additional 1,600 tons (2.3 million tons GWP-weighted) would be needed for service assuming the same average vehicle charge, a 1.8% leak rate (Minnesota data), and 124 million vehicle U.S. fleet[13]
- Additional refrigerant would be used by medium-duty pickup trucks and vans, plus heavier vehicles
- Additional HFCs may be used for foam-blowing or other uses not accounted for here

12. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your member companies on an annual basis?

Auto Innovators does not currently have this data available and could not obtain it from an alternative source within the timeframe of this response.

However, based on a rough estimate of greater than 6,400 tons developed in response to question 11, the percentage would be roughly 3 percent.

13. What percent of the light-duty automotive sector has transitioned away from HFCs? Since compliance credits for the transition are provided for in EPA's light duty vehicle greenhouse gas standards, could you also provide the percent of the light-duty automotive sector projected to have transitioned away from HFCs in each of the next five model years?

According to U.S. EPA's recent report "The 2019 EPA Automotive Trends Report: Greenhouse Gas Emissions, Fuel Economy, and Technology Since 1975" (March 2020), 61 percent of light-duty vehicles by production volume now use the alternative refrigerant HFO-1234yf. (Analysis by Auto Innovators based on volume indicated in Figure 5.8 online data tables and total MY 2018 production volume, Table 5.12.)

An aggregated, blinded survey of 10 automakers (representing approximately 85% of the U.S. light-duty market by volume) was conducted by the Alliance of Automobile Manufacturers and the Association of Global Automakers in 2014. The survey results are provided below. They indicate that at the time of the

---

[12] Minnesota Pollution Control Agency Mobile Air Conditioner Leakage Rate Data, 2020, available at https://www.pca.state.mn.us/air/ghg-reporting-requirements-hgwp-and-mobile-air-conditioners.

[13] ORNL Transportation Energy Data Book Table 3.2, 2017.

survey, the surveyed manufacturers anticipated transitioning 91% of their platforms away from HFC refrigerants by model year 2021, 94% by 2022, 98% by MY 2023, and 100% by MY2026.

Number of automobile manufacturers submitting information to blinded non-confidential summary: 10 (representing 85% of light duty vehicles sold in the U.S. in MY 2013)	
Total Number of platforms planned for MY 2021 by the 10 manufacturers in this non-confidential summary	139
Number of platforms that are planned to be converted to low-GWP refrigerants by MY2021	126
Number of platforms that are planned to be converted to low-GWP refrigerants in MY2022	5
Number of platforms that are planned to be converted to low-GWP refrigerants in MY2023	5
Number of platforms that are planned to be converted to low-GWP refrigerants in MY2024	0
Number of platforms that are planned to be converted to low-GWP refrigerants in MY 2025	0
Number of platforms that are planned to be converted to low-GWP refrigerants in MY2026	3

14. What percent of the medium- and high-duty automotive sector has transitioned away from HFCs?

The Alliance of Automotive Innovation focuses on light-duty vehicles, although some of our members sell Class 2b (medium-duty pickup trucks) and heavier vehicles. Our understanding from these manufacturers is that medium-duty complete pickup trucks and vans generally still use HFC-134a as a refrigerant (near or zero percent have transitioned away). To the best of our knowledge, EPA has approved the use of HFO-1234yf for complete pickup trucks and vans but has not approved it for use in heavier vehicles.

15. You mention in your testimony that you expect the light-duty sector will reach 100 percent use of alternative refrigerants, with some exceptions, in model year 2025. Why then are you asking for a 5-year delay to the phase-down schedule?

Every sector is at a different place in their transition, but the legislation suggests applying a 90% requirement for production and consumption starting with 2020. Given that we are already well into calendar year 2020, we suggest that the bill change the start time to provide five years of lead time as a consideration to all sectors. Lead time is needed to provide all sectors time to plan for a transition to alternatives. It is also appropriate to ensure EPA has adequate time to update reporting systems, collect and release baseline data, and consider SNAP approval for sectors that cannot currently use alternative refrigerants – all of these are necessary for a successful implementation of S. 2754. Thus, our suggestion to provide lead time is consistent with the overall needs of all sectors and in keeping with a legislative approach applying feasible requirements.

16. What percentage of U.S. auto manufacturers are expecting to transition to HFC substitutes or otherwise considering a possible transition to HFC substitutes between 2025 and 2030?

We do not expect any new light-duty vehicle uses for the United States beyond model year 2026 as noted in our response to question 13. However, HFC-134a will continue to be needed to service existing vehicles in the fleet, as well as for use in export models destined for locales lacking an infrastructure for the new refrigerant.

Senator Capito:

17. The Alliance raises concerns that reclamation of HFCs is prioritized in the AIM Act, at the expense of recycling and reuse. What is the differential in cost between the two approaches? Are they comparable in the risks of emissions?

Reclaiming refrigerants requires returning the refrigerant to virgin specifications and is performed at an off-site facility designed and certified by the U.S. EPA for such purposes. Recycling is performed by on-site equipment and is not required to meet the same level of purity requirements.[14] Auto Innovators does not have specific knowledge of the cost to reclaim refrigerant; the committee may wish to investigate these costs with EPA-certified refrigerant reclaimers.[15] On-site recycling equipment appears to cost approximately $1,000 to $7,000 upfront,[16] but allows the reuse of recovered refrigerant, thereby minimizing costs to consumers. However, because recycling is standard practice, the equipment to recycle HFC-134a is largely already in place. For most service locations, new equipment purchases would only be required to replace/upgrade older equipment or to increase service capacity.

For our customers, refrigerant reclamation means that the refrigerant removed from a vehicle during service cannot be used to refill it. This has cost implications for our customers because "new" refrigerant must be used. It also has environmental implications associated with the transport of refrigerant to a certified reclaimer and the refrigerant's subsequent remarketing and reshipment in a new container.

Although we cannot provide specifics, presumably refrigerant reclamation will involve at least minimally higher refrigerant emissions than recycling because there are at least two additional transfers of refrigerant between containers in the case of reclamation. In recycling, the refrigerant is transferred twice – once out of the vehicle, and once into the vehicle. In reclamation, the refrigerant must be transferred from the vehicle to the recovery equipment, from the recovery equipment to the offsite reclamation equipment, from the reclamation equipment to new shipping containers, and then finally back into an end-use.

---

[14] U.S. Environmental Protection Agency, "EPA Regulatory Requirements for MVAC System Servicing," https://www.epa.gov/mvac/epa-regulatory-requirements-mvac-system-servicing, accessed April 20, 2020. (See "Refrigerant Handling.")

[15] See U.S. Environmental Protection Agency, "EPA-Certified Refrigerant Reclaimers," https://www.epa.gov/section608/epa-certified-refrigerant-reclaimers, accessed April 20, 2020.

[16] Google search of "1234yf service equipment". https://www.google.com/search?q=1234yf+service+equipment&rlz=1C1GCEA_enUS881US881&oq=1234yf+service+equipment&aqs=chrome..69i57.9205j0j7&sourceid=chrome&ie=UTF-8, accessed April 20, 2020.

18. What are the economic impacts of exports of light-duty vehicles using HFC-134a being prohibited under the AIM Act on domestic automakers and their supply chains?

Exports are important for the U.S. automobile industry and the U.S. economy. Exports are very sensitive to competitive forces, because U.S. exports compete with local producers in these markets and other rising new export competitors from China.

In 2019, 1.9 million vehicles assembled in the United States were exported around the globe, supporting millions of American manufacturing, design, port facility and shipping jobs across the country. While there has been a downward trajectory in units since 2014, the value of exported vehicles has increased ten percent since 2018 for a total of $66 billion.[17] In 2019, the share of U.S. exports by region were[18]:

- Canada 45%
- EU 18%
- Mexico 7%
- Saudi Arabia 3%
- China 10
- Other 17%

While many of these markets may also be transitioning to low Global Warming Potential refrigerants, exports to those markets will not be impacted by this legislation. However, any markets where infrastructure or feasibility are a concern with the HFO-1234yf will need to continue to use HFC-134a in the interim, and therefore, the auto industry needs the capability to continue to producing and exporting vehicles appropriate to those markets, rather than risk losing that competitive advantage to other markets.

19. Without federal preemption, what will a potential patchwork of state regulations mean for the automotive sector and consumers?

A patchwork of state regulations may lead to differing requirements between states, including system design, reporting, and timing for requirements. This patchwork could result in multiple air conditioning system designs for otherwise identical vehicle models and complicate the industry's ability to smoothly and cost-effectively transition to HFO-1234yf. In addition, duplicative or overlapping requirements can increase regulatory costs with little to no additional environment benefit. Finally, since automakers are already transitioning to HFO-1234yf and are doing so at a steady and cost-effective pace, any state efforts to increase the pace would only lead to, on average, an increase in the price of all vehicles, again with little to no additional benefit.

---

[17] U.S. Census Bureau: Economic Indicators Division USA Trade Online, U.S. Import and Export Merchandise trade statistic, Accessed 4/24/20.

[18] United States Department of Commerce, Bureau of the Census, Foreign Trade Division, https://legacy.trade.gov/td/otm/assets/auto/New_Passenger_Exports.pdf

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Mr. Tim Keating, Executive Vice President, The Boeing Company

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

1. The recently issued Fourth National Climate Assessment projects that if the global community does not act quickly, climate change will significantly affect our nation's infrastructure, public health and economy. Scientists reported that extreme weather events, like category five hurricanes and deadly wildfires, and pandemics, like COVID-19, are expected to become more commonplace and devastating as climate change worsens overtime. These climate-related events will economically devastate our country if we do not act on climate change.

   a. Do you agree with our nation's leading scientists that have concluded climate change is real, is caused by humans, and is impacting nation's environment and infrastructure? If not, why not?

   Boeing recognizes climate change is a fundamental challenge of our time, and we're doing our part to reduce greenhouse gases — in the air and on the ground. Boeing recognizes that pollution, natural resource scarcity, and climate change are serious issues that require credible actions and global solutions. Aviation is an integral part of modern life. It links people, communities, cultures and countries around the globe. Aviation also affects the planet and our shared global environment. The air transport industry today supports an estimated 62.7 million jobs and $2.7 trillion in global gross domestic product (GDP), according to the Air Transport Action Group.

   b. What steps is Boeing taking today to reduce greenhouse gases? In answering, please detail which actions are mandated by a federal or state government and which are voluntary actions.

   Boeing and our industry recognize that climate change is one of the fundamental challenges of our time — and we are united in meeting our responsibility to reduce emissions. Together our efforts have kept aviation's global share of anthropogenic emissions at about 2% over the past two decades while air travel demand increased 175%. Boeing is using its leadership position in the aviation industry to make a meaningful difference to addressing aviation's impact on climate change. Modern aircraft are now 80% more fuel-efficient than the first airliners. A flight today produces 50% less CO_2 than the same flight in 1990. Boeing will continue to lead in reducing emissions by developing ever-more efficient airplanes, investing in the development and use of sustainable fuels, and working with our customers to improve the global fleet's operational efficiency. We have also begun research on electric propulsion, which is likely 20 years or more away from commercialization.

We're also exploring new ways to make a meaningful difference in addressing aviation's contribution to greenhouse gas emissions as part of our broader sustainability efforts. For example, our ecoDemonstrator program is using a 777 flying test bed to assess 50 promising technologies to improve aviation for airlines, passengers and the environment. While the aviation industry has made substantial progress, we'll continue our longstanding efforts to reduce emissions in collaboration with our customers and partners across the industry. We are committed to global sustainability across areas of environment, social and governance. We show global environmental leadership through aerospace innovation and a companywide focus on emitting less carbon, using less energy and water, and creating less waste while protecting human and environmental health in communities across the globe. Innovation in the 787 Dreamliner family, for example, has saved 48 billion pounds of fuel since it entered service, compared to the airplane it replaces.

Boeing has been a leader in advancing sustainable fuels for more than a decade — providing technical support to gain certification for commercial use and working with partners on six continents to catalyze broader production, distribution and use. About 200,000 passenger flights have flown using sustainable aviation fuel since it was certified in 2011 — a number that grows every day. We've pursued this quest since Boeing became a company in order to make flying more viable for airlines, attainable for more travelers and sustainable for our planet. Aviation has made the world a better place by efficiently and economically connecting billions of people and trillions of dollars in goods every year.

Boeing supports the commercial aviation industry's carbon reduction goal to halve the net aviation CO_2 by 2050 from a 2005 baseline. The industry is ahead of its initial goal to improve aircraft fuel efficiency by 1.5% per year from 2010 to 2020. The industry is working toward our subsequent goal to reach carbon-neutral growth from 2020 forward. Global agreements reached at the International Civil Aviation Organization in 2016 support achieving the industry-established goals and a global sectoral approach to controlling emissions: a fuel-efficiency performance standard for aircraft; and a global market-based measure system called Carbon-Offsetting and Reduction Scheme for International Aviation (CORSIA). It should be noted that aviation is one of the only sectors to have global goals and a framework to reach them.

c. As a result of any actions taken by your company, what will be your company's estimated net greenhouse gas emissions by 2035 compared to 2019 levels? By 2050? And how do these estimates compare to industry averages?

Through renewable energy, efficiency, and other efforts, since 2007, Boeing has decreased GHG emissions 29% at our manufacturing facilities while business increased

71%. From 2012 to 2017, we reduced these operational GHG emissions by 16%. Our bold target for 2025 is to reduce GHG emissions by 25% when compared to 2017.

d. Do you have an estimate of the cumulative economic costs incurred from damages caused by extreme weather events for the aviation industry in 2019? If so, please provide those estimates and how they were developed.

We do not have this economic estimate for the company or for the aviation industry. Our business may be impacted by disruptions including threats to physical security, information technology or cyber-attacks or failures, damaging weather or other acts of nature and pandemics or other public health crises. Any of these disruptions could affect our internal operations or our ability to deliver products and services to our customers. Any significant production delays, or any destruction, manipulation or improper use of our data, information systems or networks could affect our sales, increase our expenses and/or have an adverse effect on the reputation of Boeing and of our products and services.

2. In your testimony, you mention that there are not readily available HFC substitutes for some types of aviation industry needs.

a. Of the HFC compounds that are being used today, on average how much does the industry use on an annual basis (in tons and GWP-weighted tons) now?

We do not have precise figures for the industry overall. Boeing uses less than 1% of HFCs produced or imported in the United States annually. We believe the volumes would be relatively low because of the small quantities used in each relevant application. For example, there is a one-pound handheld extinguisher found on the KC-46 Tanker containing HFC-236fa, while its engines have 35-pound fire suppression units containing HFC-125. Similarly, cooling and refrigeration systems found on commercial aircraft are also relatively small, generally containing less than 15 pounds of HFC-134a refrigerant

b. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your member companies on an annual basis?

It's our understanding that 90% of the total is used are for refrigerant and air conditioning purposes. Boeing's portion is far less than 1% of what is produced or imported in the United States.

c. Does Boeing project HFC usage will grow or shrink over the next 15 years?

It's possible that it could grow. Some HFC compounds have a number of unique properties that make them indispensable for onboard fire suppression. In relatively small quantities, they are highly effective at extinguishing a variety of fires, in extreme conditions including subfreezing temperatures as low as minus 40 degrees Fahrenheit.

They are also "equipment safe" so they do not cause additional damage during an emergency situation and some are lower in toxicity or non-toxic so they are acceptable for use in occupied spaces. HFC-125 is currently used in engine nacelles and auxiliary power unit compartments on the F/A-18 E/F, KC-46 Tanker, P-8 Poseidon, and V-22 Osprey military aircraft that Boeing manufactures. HFC-125 also has potential for some applications in commercial aircraft as a replacement for substances currently in use that have far greater ozone depletion potential. One of those applications is as a possible replacement for Halon 1301 in commercial aircraft engine compartments. While we are pursuing non-HFC alternatives, in the event they do not meet Federal Aviation Administration (FAA) certification requirements we want to preserve the option to turn to HFCs, which have a proven record in military applications.

d. Has your company considered using HFC-alternatives? If not, why not? If so, please provide details of your efforts to develop or find substitutes for HFCs and if there is there anything about those alternatives that cause concern for future compliance with the bill.

Our foremost concern is having access to proven fire suppression agents that meet FAA certification and Department of Defense specifications. HFC compounds are the aviation industry replacement for substances with far more environmental impact such as Halon 1211 and 1301. As stated above, some HFC compounds have a number of unique properties that make them indispensable for this aviation safety use. Regarding the point of developing alternative compounds, our experience has shown that identifying and, if identified, testing and certifying the use of compounds for onboard use with the effectiveness and unique specifications described above can take more than 15 years. After a process of approximately that length, in 2017 Boeing received final federal approvals for 2-bromo-3, 3, 3-trifluoropropene (2-BTP) to be used in handheld extinguishers on commercial aircraft. This is a notable achievement with great environmental benefit, as 2-BTP is now an option to replace Halon 1211 in handheld extinguishers. The development of HFC-227ea as an alternative to Halon 1301 in lavatory waste bin fire extinguishers took almost as long. Other research projects have taken many years and resulted in test failures late in development, including HFC-125 in cargo fire suppression, 2-BTP in engine/APU fire suppression and 2-BTP in cargo fire suppression. We continue to search for Halon 1301 replacements that are not HFCs, but the continued availability of HFCs that are the only approved replacement for Halon 1301 is critical to the aviation industry.

3. If the AIM Act were implemented as introduced, does Boeing believe the HFCs used in the aerospace industry will be eligible for essential use exceptions? If not, why not?

The current text is insufficient because it constructs an administrative process to seek essential use exceptions that could lead to uncertain outcomes. A specific aerospace exception is needed because many aerospace uses have no viable alternative that will satisfy stringent certification and fight safety requirements, and we anticipate that despite ongoing efforts to identify suitable alternatives, fluorinated gases will be needed to support aerospace applications well beyond 2035.

In addition, the bill allows the EPA Administrator to regulate fluorinated gases in specific sectors and subsectors and for any person to petition the EPA to do so. Without an exception for aerospace specified in the legislation, this procedure and the discretionary nature of the essential use exceptions could allow the EPA to render fluorinated gases unavailable for critical aerospace uses.

4. Prior to 1990, there were over sixteen states that had taken action, or were in the process of taking action, to restrict the use of Chlorofluorocarbons (CFCs). In the Clean Air Act Amendments of 1990, Congress created a federal program to phase out CFCs in Title VI of the Clean Air Act. Rather than preempting state actions, Congress preempted the enforcement of state CFC regulations for two years. Once EPA had a strong CFC federal program in place, the state programs for the most part went away on their own. Why specifically do you expect states will act differently in terms of HFCs if a federal regulatory program is created? Given the history why should HFCs be treated differently than CFCs in terms of state preemption?

Our concern is that the current development of HFC statutes and regulations at the state level is creating a patchwork of different requirements that needs to be addressed. While as many as fifteen states have recently adopted regulations none of them currently regulate fire protection agents, but they provide states with the authority to do so, potentially resulting in inconsistent policies regarding the use of HFC agents onboard aircraft. For example, in 2019, Washington State passed a bill that prohibits the sale or installation of certain equipment that uses HFCs. The goal of that bill was to achieve technology change by requiring transition away from HFCs for many types of equipment sold or used in the State. While that bill specifically exempted aerospace fire extinguishing systems, we later discovered that the bill might still impact other aerospace equipment, such as galley refrigerators and chillers that rely on HFC-134a, and could require their redesign in order to allow continued import, installation, and sale in Washington State. Currently, the equipment has no ready substitute for HFC-134a that would satisfy the FAA certification criteria and in particular no substitute with the low flammability properties of HFC-134a. Therefore, we might need to pursue a state-specific exemption to ensure that the aircraft we have designed for safe worldwide operation and maintenance can continue to be built, maintained, and operated within Washington State. It's our understanding that the recent California HFC regulations focus on stationary sources and not mobile sources like aerospace, offering a potential model that the Committee should consider for the bill, allowing both the fire suppression and refrigeration uses in aerospace to continue.

<u>Senator Inhofe</u>:

5. Are you concerned that the essential use exemption provision as currently written is unsatisfactory for your business?

Yes. The current text constructs an administrative process to seek exemptions. A specific aerospace exemption is needed because many aerospace uses have no viable alternative that will satisfy stringent certification and fight safety requirements, and we anticipate that despite ongoing efforts to identify suitable alternatives, fluorinated gases will be needed to support aerospace applications well beyond 2035. Even though the legislation would allow 15% of the baseline production and consumption values, the phase-down will nevertheless drive fundamental changes in the market for fluorinated gases, resulting in uneven distribution and availability of specific fluorinated gases for relatively niche uses like aerospace. Given the limited availability of allowances across all regulated substances, we anticipate that producers of fluorinated gases will concentrate on larger volume uses and will not support lower volume uses of specific fluorinated gases needed for aerospace. Furthermore, regulated substances with higher exchange values will be more costly to produce, and this will drive the market towards fluorinated gases with lower exchange values, without consideration of other factors that drive fluorinated gas selection in aerospace like flammability, toxicity, and performance. Aerospace demand may therefore be crowded out by demand from higher volume industries and users.

In addition, the bill allows the EPA Administrator to regulate fluorinated gases in specific sectors and subsectors and for any person to petition the EPA to do so. Without a designation of essential uses for aerospace, this procedure could allow the EPA to render fluorinated gases unavailable for critical aerospace uses.

6. Did previous transitions of ozone depleting substances provide for exemptions?

Yes. In the 1990 Clean Air Act amendments when Congress prohibited the future manufacture of ozone depleting halons they recognized their unique effectiveness in aviation safety and included a provision for future manufacture of the substances in Section 604. With that precedent and the knowledge gained of the challenges over the past 30 years in seeking substitutes for halon fire suppression agents onboard aircraft, we believe the Committee can logically conclude that an exemption for onboard aerospace uses of HFCs which are halon replacements is warranted. In addition, the Committee can also look to the states for guidance. As many as fifteen states have recently adopted or proposed HFC regulations and none of them currently regulates fire protection agents with some such as California and Washington including specific aerospace exemptions as well.

7. You noted in your testimony a need to address state-specific requirements related to HFCs. Would it be useful for the bill to contain a preemption provision to ensure nationally consistent requirements?

Our concern is that the current development of HFC statutes and regulations at the state level is creating a patchwork of different requirements that needs to be addressed. While as many as fifteen states have recently adopted regulations none of them currently regulate fire protection agents, but they provide states with the authority to do so, potentially resulting in inconsistent policies regarding the use of HFC agents onboard aircraft. For example, in 2019, Washington State passed a bill that prohibits the sale or installation of certain equipment that uses HFCs. The goal of that bill was to achieve technology change by requiring transition away from HFCs for many types of equipment sold or used in the State. While that bill specifically exempted aerospace fire extinguishing systems, we later discovered that the bill might still impact other aerospace equipment, such as galley refrigerators and chillers that rely on HFC-134a, and could require their redesign in order to allow continued import, installation, and sale in Washington State. Currently, the equipment has no ready substitute for HFC-134a that would satisfy the FAA certification criteria and in particular no substitute with the low flammability properties of HFC-134a. Therefore, we might need to pursue a state-specific exemption to ensure that the aircraft we have designed for safe worldwide operation and maintenance can continue to be built, maintained, and operated within Washington State. In order to avoid such situations, the bill should contain an aerospace exemption and pre-empt state law from regulating HFC use in aerospace uses. It should also be noted that Congress has already recognized the unique nature of aerospace equipment and operations by providing a preemption provision for aircraft emissions in Section 233 of the Clean Air Act.

Senator Whitehouse:

8. What is the total volume of HFCs for which there is no acceptable substitute used by the aerospace industry? Please list each such HFC and the volume used. Please state the reasons why potential substitutes (if they exist) are unacceptable.

A unique challenge in securing substitutes for aerospace agents are the rigorous standards and certification requirements implemented by the Federal Aviation Administration and Department of Defense for their use.

For example, HFC-125, HFC-227ea and HFC-236fa are currently used for fire extinguishing and suppression in aviation. Some HFC compounds have a number of unique properties that make them indispensable for this use. In relatively small quantities, they are highly effective at extinguishing a variety of fires, in extreme conditions including subfreezing temperatures as low as minus 40 degrees Fahrenheit. They are also “equipment safe” so they do not cause additional damage during an emergency situation and some are lower in toxicity or non-toxic so they are acceptable for use in occupied spaces. HFC-125 is currently used in engine nacelles and auxiliary power unit compartments on the F/A-18 E/F, KC-46 Tanker, P-8 Poseidon, and V-22 Osprey military aircraft that Boeing manufactures. HFC-125 also has potential for some applications in commercial aircraft as a replacement for substances currently in use that have far greater ozone depletion potential. HFC-227ea is currently used in lavatory waste bin fire extinguishers on all commercial airplane models, including military derivatives, and HFC-236fa is used in handheld fire extinguishers onboard the KC-46 aircraft. In addition, onboard commercial aircraft, galley refrigerators and chillers rely on HFC-134a. Currently, the equipment has no ready substitute for HFC-134a that would satisfy the FAA certification criteria, and in particular a substitute with the low flammability properties of HFC-134a.

We anticipate that aerospace uses total less than 1% of HFCs produced or imported in the United States annually. We believe the volumes would be relatively low because of the small quantities used in each relevant application. For example, there is a one-pound handheld extinguisher found on the KC-46 Tanker containing HFC-236fa, while its engines have 35-pound fire suppression units containing HFC-125. Similarly, cooling and refrigeration systems found on commercial aircraft are also relatively small, generally containing less than 15 pounds of HFC-134a refrigerant.

9. By what percentage has use of such HFCs been growing over the last five years? Please list each such HFC and its growth rate over the last five years.

Based on airplane deliveries over the last five years, the HFC use rate has been fairly constant but has the potential to increase in the future. As noted in the response to your first question, some HFC compounds have a number of unique properties that make them indispensable for onboard fire suppression. HFC-125 is currently used in engine nacelles and auxiliary power unit compartments on the F/A-18 E/F, KC-46 Tanker, P-8 Poseidon, and V-22 Osprey military aircraft that Boeing manufactures. HFC-125 also has potential for some applications in commercial aircraft as a replacement for substances currently in use that have far greater ozone depletion potential. One of those applications is as a possible replacement for Halon 1301 in commercial aircraft engine compartments. While we are pursuing non-HFC alternatives, in the event they do not meet FAA certification requirements we want to preserve the option to turn to HFC-125, which has a proven record in military applications.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Questions for the Record for Mr. McCay, President, Composite Applications Group

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

1. In your testimony on behalf of Composite Applications Group, you stated that if HFC 134a is banned "Composite Applications Group will have a much more difficult development path to make the conversion from metals to composites possible. The Prisma technology has proven to be not only a good structural option but also a good economic comparison to conventional metals." The AIM Act would affect a phase down of the production and consumption of HFCs over a 15-year period, with 15 percent of the baseline period allowed to be produced and imported from 2036 onward. The AIM Act also contains provisions intended to increase to a significant degree the recovery and reclaim of HFCs. The purpose of these provisions, and other provisions in the Act, is to ensure the continued use of HFCs for decades to come, particularly in small or niche applications for which no substitute is available. In light of this, why does the Composite Applications Group believe the AIM Act represents a hard "ban" on HFCs that would prohibit their use upon enactment?
    - Thank you for the opportunity to respond. I am pleased to see that the AIM act would allow continued use of HFC 134a for this application. Preemption will make this workable. Structural Composite has asked for an exemption for Structural Composite Preforming and if that exemption is granted and the bill has preemption, we fully support moving forward. We are happy to look at recycled 134a and can support research into the same. Once the 134a is used as a blowing agent the vast majority of the 134a material is trapped for the life cycle of the product this can be 50 years for a rail car for example. THANK YOU FOR ACOMMIDATING THIS IMPORTANT GHG SAVING TECHNOLOGY. PLEASE INCLUDE PREEMPTION.

2. Of the HFC compounds that are being used by your member companies today, on average how much does the industry use on an annual basis (in tons and GWP-weighted tons) now?
    - I estimate that CAG technology deployers are using 25 tons (42,500 GWP)

3. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your member companies on an annual basis?
    - I estimate less than 0.01% which includes structural preforms supplied to the entire marine industry by members.

4. Do you project HFC usage will grow or shrink over the next 15 years?
    - We anticipate technology advances that will allow the phase down of 134a so we expect usage will shrink over the next 15 years as alternatives become available.

5. Have your companies considered using HFC-alternatives? If not, why not? If so, please provide details of your efforts to develop or find substitutes for HFCs and if there is there anything about those alternatives that cause concern for future compliance with the bill.
    - Yes, members have been working with global suppliers since 2015. Recent trials by two key members show severe instability with HFO blown foam. The issue is so severe as to very negatively impact the structural properties and make the end product useless. A picture from a recent trail is attached. The concerning aspect is the massive shrinkage did not occur until 14 days. This would cause safety issues in its marine and transportation applications.

6. If the AIM Act were implemented as introduced, does the Composite Application Group believe the HFCs used by the industry will be eligible for essential use exceptions? If not, why not?
    - Our recent member experience with SNAP gave us great concern that the process would be legislated out of business. One member a small business had to spend vast sums to file suit on the EPA. Prior phase out with R22 was done with industry co-ordination. The 134a phase out was an inflexible blunt instrument that would not recognize the GHG savings the technology offers and had no concern that it had no alternative. This cannot be repeated.

7. Prior to 1990, there were over sixteen states that had taken action, or were in the process of taking action, to restrict the use of Chlorofluorocarbons (CFCs). In the Clean Air Act Amendments of 1990, Congress created a federal program to phase out CFCs in Title VI of the Clean Air Act. Rather than preempting state actions, Congress preempted the

enforcement of state CFC regulations for two years. Once EPA had a strong CFC federal program in place, the state programs for the most part went away on their own. Why specifically do you expect states will act differently in terms of HFCs if a federal regulatory program is created? Given the history why should HFCs be treated differently than CFCs in terms of state preemption?

- The applications my members are using are a part of critical interstate infrastructure. It is untenable to have regulations that will require trucks/trailers/rail cars to stop at state boarders as they have 134a in their advanced lightweight fuel efficient GHG savings structures.
- Another member is a small business. They had to spend considerable effort to just get CARB to provide an exemption. It is nearly impossible for the small business who is aware of the issue to manage 50 state regulations. Think of all the HFC users today how have no idea of what is about to hit them.
- Preemption is a necessity.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020

Questions for the Record, Mary Nichols, Chair, California Air Resources Board

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

1. **Some industry stakeholders have expressed the need to provide an exemption for a specific industry or specific HFC end-use because there currently lacks a safe or economical substitute or because of related issues, such as dated building codes. What could happen to the overall integrity of the phase down if Congress allowed broad industrial sectors exemptions from enactment, without changing any other sections of the legislation?**

Broad exemptions are not necessary because the phase down does not prohibit any industrial sector from using their preferred HFCs. The whole purpose of a phase-down is to provide industry time to find alternatives. In many cases, obstacles can be addressed by the time the phasedown necessitates a transition. In addition, under the previous ozone depleting substances phasedown, United States Environmental Protection Agency (U.S. EPA) took obstacles into account in developing appropriate allowances. This effectively allowed continued use of ozone-depleting substances where significant obstacles existed without compromising the integrity of the phasedown. As drafted, S. 2754, would also achieve this balance.

Broad industrial sector exemptions would irreparably harm the integrity of the phase down. Any such exemption would allow more HFCs to be available for other non-exempt uses, thus making the phase down less effective. For example, if an industrial sector that uses 30 percent of HFCs is exempt from the phase down, then the result is the same as if the phase down allocation step were given 30 percent more refrigerant. The better option is to work during the time a phase down necessarily allows to address any issues, just as U.S. EPA has done in the past.

Exemptions would also make enforcement of allocations of HFCs made in the U.S. or imported very complex and burdensome. HFCs produced or imported are rarely sent directly to the end-user. With industrial sector exemptions, the HFC manufacturer or importer would have the added burden of tracking the entire chain of distribution of every pound of HFC to the ultimate end-user.

a. **The legislation phases down the production and consumption of HFCs, but is not a phase out. Can you explain why this should protect some sectors that may not have a safe or economic alternative during the timeframe of the legislation?**

The gradual phase down allows industries to adapt with years to plan ahead. HFC uses that cannot be replaced with non-HFCs are protected because the phasedown ends with 15 percent of the baseline supply (in carbon-dioxide equivalents). The 15 percent supply can be used by any industry that cannot find suitable substitutes. For example, medical dose inhalers (MDIs) and very low-temperature refrigeration may find it necessary to continue to use HFCs.

The phasedown, which is not a phase-out, will guarantee a supply of HFCs for sectors without suitable substitutes. That said, past experience has shown that once a phasedown provides suitable regulatory signals, substitutes very often are developed even for uses that initially seemed intractable. Indeed, these issues are more likely to be worked out if the legislation provides a strong and uniform signal to industry – rather than muddling that signal with exemptions based on today's limitations rather than tomorrow's innovations.

2. **Some industry stakeholders have expressed the need to exempt state programs that are currently regulating some end-uses of HFCs. The AIM Act has national targets for the production and consumption of HFCs, but does not include national targets for end-uses of HFCs. At the same time, the AIM Act gives the authority, but does not require action, for EPA to regulate end-uses of HFCs. Without set national targets for end-uses, could blanket state preemption mean there may never be action on the end-uses of HFCs?**

The first sentence states "exempt" state programs, but we assume it was meant to state "preempt" state programs.

Preemption of state programs would harm states, while departing from the successful cooperative federalism structure long reflected by the Clean Air Act. State laws are not in conflict with the phasedown, in fact they complement it. States such as California, with legislatively mandated HFC emissions reductions targets prior to the final phasedown step would not be able to meet their targets if state HFC regulations were preempted. State preemption would delay HFC emissions reductions goals of many states. In the time that it would take the U.S. EPA to finalize a national rulemaking, states would forsake meaningful emission reductions, while failing to achieve their own targets and their duty to protect public health. These state efforts accelerate progress towards the phasedown by creating opportunities for better substitutes and more efficient production. States that choose to regulate end-uses therefore provide benefits to the national program.

The Clean Air Act has long reflected this experience, as Congress has made clear that federal limits are a floor, not a ceiling, on state efforts. This is consistent with the federalism principles core to our environmental law, including that states' broad police powers make them best suited to protect public health and the environment, aided by federal baseline standards. State standards, in turn, are often later incorporated into federal laws, after being pioneered by the states – generating new industries and reducing overall costs. This approach, reflected in statute, ensures that states are allowed to enact their own laws as long as the laws are not less stringent than the federal rules (see, e.g., section 116 of the Clean Air Act).
The federal government can still enact specific HFC prohibitions or set national targets for end-uses even with state laws. In fact, previously, there was both a national program for leak inspection and repairs to refrigeration equipment containing HFCs (Rule 608) and a state program in California for refrigerant management of HFCs. These two programs did not conflict with one another.

3. **Prior to 1990, there were over sixteen states that had taken action, or were in the process of taking action, to restrict the use of Chlorofluorocarbons (CFCs). In the Clean Air Act Amendments of 1990, Congress created a federal program to phase out CFCs in Title VI of the Clean Air Act. Rather than preempting state actions, Congress preempted the enforcement of state CFC regulations for two years. Once EPA had a strong CFC federal program in place, the state programs for the most part went away on their own. Why specifically do you expect states will act differently in terms of HFCs if a federal regulatory program is created? Given the history why should HFCs be treated differently than CFCs in terms of state preemption?**

Preempting state programs would result in the removal of important funding sources to industry to help with the transition. Some states, like California, have incentive programs that encourage early adoption of innovative low-Global Warming

Potential (GWP) technologies. These industry incentives would go away if there were preemption. Not only do these important programs help manufacturers meet their consumption/production quotas and provides additional flexibility in how to use their allocation but they can also help lower cost and increase market adoption, which can help offset the challenges for other sectors needing more time. Now is not the time to remove financial incentives to industries that are making decisions to protect public health.

These types of programs are truly best implemented at the state level. The federal government lacks the resources to implement the types of regulations needed to control HFCs in every state.

HFCs should also be treated different from CFCs because the HFC phasedown is different from the CFC phase-out. First, in the case of CFCs, it was a total phase-out. The HFC phasedown is not a total phase-out, so it allows indefinite emissions of HFCs. Each state has a unique emission portfolio, HFC utilization needs, and HFC stakeholders. It is necessary for each state to maintain the ability to set and enforce their own standards to achieve the right balance for the people and the industry in their state.

HFCs should also be treated different because state actions on HFCs can support a federal framework. For example, California's Refrigerant Management Program (RMP) encourages best management practices that helped compliance at the federal level.

Last, it is very likely that some states, without specific state targets, will suspend their individual HFC activities if a strong federal phase down program is put into place, as occurred during the CFC phase-out, so preemptive language is not needed for many states. The states working on HFC regulations are coordinating for consistency so as to ease any regulatory burden.

4. **Are there any additional comments you would like to provide that you did not provide in your testimony?**

I would again emphasize the long history of states informing, improving, and creating air pollution control approaches that serve their publics and ultimately benefit the country as a whole. Congress was wise to recognize state primacy in these areas in the past, and should follow that successful model here.

In light of the current situation, I would also like to remind the committee that advancing S. 2754 is an opportunity to create American jobs, increase exports, and make America a global leader in HFC alternative technologies.

If you have any questions about our program, please contact Candace Vahlsing, Science and Technology Policy Advisor to the Chair, at candace.vahlsing@arb.ca.gov.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Justin Keppy, Carrier Corporation.

<u>Senator Braun:</u>

1. In your testimony you note, "A national phasedown of HFC refrigerants ensures a predictable regulatory path and provides certainty to refrigerant producers."

   How would a national phasedown affect employment and production at Carrier's Indianapolis manufacturing facility?

   Carrier Response:

   Carrier is a leading global manufacturer of heating, ventilating, and air conditioning (HVAC) products serving residential, commercial and heavy applied applications. Carrier's HVAC, refrigeration and fire and security businesses operate in over 180 countries and we go to market through over 80 industry-leading brands, such as Carrier, Bryant, and Kidde smoke and carbon monoxide detectors. Indianapolis, IN is the headquarters of our residential AC business and center for our world-class Research and Development (R&D) center.

   Some of the product categories designed and developed at the Carrier Indianapolis R&D facility including residential natural gas furnaces, air conditioning condensing units, indoor coils and air handlers.

   We could anticipate a range of employment outcomes at Carrier's R&D center based on how the Congress' consideration of S.2754, *The American Innovation in Manufacturing Act of 2019*. For example, if there is no national phase-down of hydrofluorocarbons (HFC) refrigerants in new AC equipment, but Europe and Asia move forward to transition to these refrigerants, Carrier would likely invest in those markets first to meet consumer demand. However, should the United States implement a national program and an orderly phase down of HFC refrigerants, Carrier would likely invest in the high-skill, high wage engineering jobs necessary to meet the increased design and testing requirements of a large national phase-down. Conversely, a state-by-state implementation will be very inefficient from many aspects of our business in addition to more costly. This inefficient implementation will thereby necessitate additional employment reducing means to compensate for those inefficiencies.

   An orderly national transition would likely also drive investment into the Carrier Corporation's commercial HVAC U.S. operations in Charlotte, North Carolina and Carrier's Refrigeration U.S. operations in Syracuse, New York and Stone Mountain. Georgia.

2. Carrier's Indianapolis, IN operations design, develop, and engineer residential air conditioning systems using HFC refrigerants. How would a phase down from HFCs to a next generation technology help Carrier maintain competitiveness around the globe?

   Carrier Response:

   Carrier competes globally and designs, engineers and manufactures a range of products to meet consumer needs. Our businesses enable modern life, from the cold chain using refrigeration technologies to residential and commercial heating, ventilating, and air conditioning solutions. Similar to the transition from ozone depleting substances to non-ozone depleting hydrofluorocarbons (HFCs), Carrier will lead the transition in manufacturing products using HFC replacements. Significant elements of the Research and Development (R&D) process of those products will occur in the United States so long as the domestic market supports the demand for these technologies. If other markets across the globe move earlier than the U.S., then Carrier will assess which global design centers will lead the R&D efforts to meet specific local market needs and make investment accordingly.

3. Will consumers who have preexisting equipment installed in their homes and businesses be required to replace that equipment under this law?

   Carrier Response:

   No, there is no requirement as part of the legislation that requires homeowners/end users to replace existing equipment with the new lower GWP refrigerants. Consumers with existing R410A or R-22A - HCFC and HFC refrigerants - systems can have that equipment serviced and charged for the remaining useful life of the products. As an example of market availability that should be considered is the similar phasedown of R-22 (aka "Freon") occurred over 10 years ago and we estimate that there are still approximately 39 million R-22 based systems, roughly 28% of all residential systems still in operation in 2019.[1]

[1] Internal Carrier Corporation statistical modeling data from USA Life Cycle Model assuming an 18 year life for residential split systems.

Responses to Questions for the Record
Competitive Enterprise Institute
S. 2754, The American Innovation and Manufacturing Act of 2019
Senate Committee on Environment and Public Works
April 27, 2020

Chairman Barrasso:

1. What are the effects of the AIM Act's failure to harmonize HFC phasedown requirements with Department of Energy efficiency standards?

Response: The proposed transition away from hydrofluorocarbons (HFCs) under the American Innovation and Manufacturing (AIM) Act is far from the only federal mandate affecting air conditioning and refrigeration equipment. However, the bill contains no measures to ensure proper coordination with these other federal programs. This includes the energy efficiency standards for appliances promulgated by the Department of Energy (DOE) pursuant to the Energy Policy and Conservation Act of 1975, as amended. Under these provisions, DOE sets and periodically revises efficiency standards for each category of air conditioning and refrigeration equipment. Doing so often necessitates a substantial redesign of the product and retooling of production, and under the AIM Act the same equipment may also have to undergo a separate transition to incorporate new refrigerants and foam-blowing agents. If the deadlines for both transitions are not coordinated, compliance will be considerably more difficult and costly. The Association of Home Appliance Manufacturers (AHAM) discussed this problem in its comments. AHAM suggests language requiring the U.S. Environmental Protection Agency (EPA) and DOE to coordinate their efforts.

Further, a number of industry commenters believe that several leading substitutes for HFCs may prove less energy efficient and thus pose an additional challenge in complying with DOE efficiency standards.

2. The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) submitted testimony claiming: Under Title VI [of the Clean Air Act], accelerating the schedule helped a number of sectors plan for equipment conversions. It also helped U.S. manufacturers stay ahead of the curve in global markets, which often lagged U.S. transitions and thus were more accessible as export markets for American made products. Do you agree with this assessment?

Response: The provisions in the AIM Act that allow the initial 15-year transition away from HFCs to be accelerated to as little as four years pose a risk of substantially increasing costs to maintain existing air conditioning and refrigeration equipment. There are literally hundreds of millions of pieces of equipment—most vehicle air conditioners, residential air conditioners and refrigerators, commercial refrigeration and air conditioning, and chillers used in many industrial processes—designed to use HFCs that need an adequate and affordable supply of them to stay in operation throughout their useful lives. An accelerated schedule not only boosts costs in the near term but also raises doubts about the future affordability and even availability of HFCs, thereby encouraging some owners to replace such equipment sooner than they otherwise would.

The only beneficiaries of an accelerated phaseout are the producers of costlier substitute refrigerants and equipment who want to push HFCs out of the way as quickly as possible and gain market share. In contrast, users of HFC equipment—homeowners, car owners, and business owners—would be hurt by an acceleration.

It is noteworthy how many business commenters came out strongly against allowing any acceleration. For example, the Industrial Energy Consumers of America demanded "a guarantee that sufficient supplies of phased-out HFCs will be available at reasonable costs, so that existing industrial chillers will not be forced to be replaced before their useful life. This is important for several reasons but also because the bill gives EPA the ability to accelerate the production phase-out."

The acceleration of the initial CFC phaseout in the 1990 Clean Air Act Amendments and its impact on vehicle air conditioner costs is illustrative of the risk. The EPA accelerated the original 1990 provisions in 1992. As a result, production of CFC-12 came to a complete halt on January 1, 1996. At that point, there were more than 100 million air conditioned vehicles on the road that still needed it. Not surprisingly, the price of CFC-12, which for years had been around $1 per pound, shot up above $30 per pound wholesale and even higher retail. The cost of vehicle air conditioner repairs were substantially and unnecessarily elevated for years to come. This is exactly the kind of result we should try to avoid under the AIM Act. The best way to do so is to eliminate the provisions that allow the initial deadlines to be accelerated.

Claims from the Air-Conditioning, Heating, and Refrigeration Institute that an accelerated schedule boosts exports of American equipment make no sense. S. 2754 is irrelevant to exports. If American manufacturers believe there is global demand for the new refrigerants and equipment, they can cater to that demand with or without this bill. The only thing the AIM Act does is restrict choices and raise prices on American consumers—all the more so if the HFC deadlines are accelerated.

3. AHRI also testified: [I]t is important to note that a change in the phase down schedule does not prohibit the use of existing equipment, which consumers and business owners are free to use through the equipment's lifetime. Existing equipment is not subject to the AIM Act. And the AIM Act does not in any way mandate or otherwise require consumers to buy new equipment. Do you agree?

Response: AHRI's argument is a straw man. CEI has never made the assertion that the AIM Act would outlaw existing HFC-using equipment, nor have the many industry commenters who criticized the bill done so. What CEI has said is that the bill would do the next worst thing—make the continued use of such equipment costlier and costlier over time.

Moreover, AHRI's claim that "existing equipment is not subject to the AIM Act" is not correct. Section 9 of the bill expands the EPA's current authority to regulate the servicing of HFC-using equipment, and the agency could exercise this authority to make such servicing significantly more expensive.

4. Proponents of the AIM Act state a federal framework is needed to provide regulatory certainty. How does including a citizen's suit provision assist or hinder certainty?

Response: Rather than foster certainty, the bill contains several provisions specifically designed to create uncertainty. In every case, the uncertainty can only be resolved on the side of making the initial provisions more stringent and costlier. These provisions include those that allow the EPA to accelerate the initial statutory targets and timetables for reducing HFC production and to ban HFCs in any category of equipment.

The uncertainty is further exacerbated by the lack of any state preemption provisions in the bill. This means that consumers and businesses will likely have to contend with a number of conflicting state HFC measures, on top of the federal restrictions on HFCs. Unless preempted, a raft of future state measures are as likely as they are unpredictable.

Perhaps worst of all from a certainty standpoint, the bill's overly broad citizen suit provisions give environmental groups a free hand to sue for changes that go beyond the provisions specified in the original bill. For example, even if the EPA were to decline to accelerate the deadlines or ban HFCs in any particular sector, it will almost certainly get sued by one or more environmental litigants attempting to force the agency's hand.

An HFC bill could be drafted to create certainty. At a minimum, it should set out statutory targets and timetables for reducing HFCs that cannot be subsequently accelerated, clearly preempt states from setting their own conflicting standards, and rein in environmental groups' attempts to reinterpret the bill. In other words, it should be a bill very different from the current one.

Of course, certainty is not always a good thing—it all depends on what the certainty entails. If certainty is merely a euphemism for handing a guaranteed domestic market to the sellers of more expensive new refrigerants and equipment, then we are better off without it.

5. Is it true that the replacements for HFCs are more expensive than their counterparts? What impact will this have on the consumer?

Response: Many of the leading substitutes for HFCs already carry a price premium, and their prices would very likely spike much higher if S. 2754 is passed. Not surprisingly, two of the strongest supporters of the bill are Honeywell and Chemours, both of which have patented a number of these substitutes. Both companies have informed shareholders that these products hold the potential for many billions of dollars in additional revenue compared to HFCs. For example, HFO-1234yf is a replacement for HFC-134a. The former is currently available from refrigerant supplier websites for about $50 per pound, while the latter is around $6 to $7 per pound. Honeywell and Chemours hold a joint patent for HFO-1234yf.

Beyond these patented products, there are other substitutes that are actually cheaper than HFCs. However, these compounds suffer from other drawbacks such as flammability or toxicity and thus are not suitable for many applications.

For consumers and businesses that use air conditioning and refrigeration equipment, the higher cost of replacement refrigerants can come into play multiple times—not just when they purchase equipment, but also when they have it serviced.

Oddly, some proponents of the bill have claimed that the cost of substitutes would decline. But the entire point of S. 2754 is to boost such prices by limiting competition with the cheaper HFCs.

The best way to ensure the most affordable prices for refrigerants is to allow for market competition where HFCs are not restricted and the new refrigerants must compete against them. Those who prefer the new refrigerants and equipment would be free to choose them, but they would not be limited to that choice and prices would be lower.

6. Do you have any concerns with the role the bill gives the Environmental Protection Agency in international cooperation under Section 11, given the U.S. has not ratified the Kigali Amendment?

Response: The AIM Act closely aligns with the provisions of the as-yet-unratified Kigali Amendment and therefore is an attempt at a legislative end-run around the treaty ratification process as set out in the Constitution. Further, it grants the EPA sole authority to deal with sovereign nations on trade-related issues, which properly resides with the State Department and the Office of the U.S. Trade Representative. Thus, the bill presents both Constitutional and legal issues that will seriously affect implementation should the current version become law.

7. Can you explain who owns most of the patents for HFC replacement chemicals? When do these patents expire?

Response: Two companies, Honeywell and Chemours, hold patents for a number of substitutes for HFCs. These compounds already sell for significantly more than the HFCs targeted by this bill, and prices would likely spike higher should it become law. In fact, in reports to shareholders and other communications, both companies have described these patented replacements as a major source of potential revenue growth stretching well into the billions of dollars in the years ahead. As noted, the patents for one replacement, HFO-1234yf, are jointly held by Honeywell and Chemours. It currently retails for about $50 per pound while the HFC it would replace sells for $6 to $7 per pound.

Certain provisions of the bill would especially benefit Honeywell and Chemours by strengthening the value of their patents. This is particularly true of the accelerated schedule provisions. Both companies want HFCs to become as scarce as possible, as quickly as possible, before their patents expire. In contrast, allowing the deadlines to be moved up can only be bad news for the owners of the hundreds of millions of refrigeration and air conditioning systems dependent on HFCs, be they homeowners, vehicle owners, or business owners.

Moreover, both companies hold patents not only for the compounds themselves, but for their use in many specific applications. Thus, they have multiple patents they can use to shield themselves from competition and keep prices high.

The fact that these companies hold patents is not the problem. The problem is that they are also lobbying for legislation to get cheaper competing products off the market.

8. Do you believe language should be added to ensure EPA appropriately considers potential increases in consumer costs when setting any regulations under the AIM Act?

Response: The AIM Act was drafted from the perspective of the producers of replacement refrigerants and equipment, but the bill has substantial impacts on consumers. It is safe to say that the vast majority of American households will be adversely impacted by this bill. Nearly every vehicle air conditioner and most residential air conditioners and refrigerators rely on HFCs. It would increase both the cost of maintaining all existing HFC-using equipment and the cost of buying and maintaining new equipment designed to use HFC replacements. Renters would probably be hit with rent increases as landlords pass on the higher costs of cooling. Nonetheless, the bill contains no consumer protections whatsoever.

Beyond costs, some homeowners may balk at the prospect of their air conditioners and refrigerators running on flammable refrigerants. As with costs, concerns about flammability are ignored in the current version of the bill.

Certain AIM Act provisions stand out as being especially anti-consumer, particularly the one allowing the initial HFC deadlines to be accelerated. There is no consumer benefit whatsoever to this provision. The only thing it does is threaten even steeper cost increases for the HFCs needed to maintain existing equipment.

At the very least, the most anti-consumer provisions in the bill, like the accelerated schedule clause, should be eliminated. Even better would be the addition of consumer protections against high costs or issues like flammability.

Ranking Member Carper:

9. The recently issued Fourth National Climate Assessment projects that if the global community does not act quickly, climate change will significantly affect our nation's infrastructure, public health, and economy. Scientists reported that extreme weather events, like category five hurricanes and deadly wildfires, and pandemics, like COVID19, are expected to become more commonplace and devastating as climate change worsens overtime. These climate-related events will economically devastate our country if we do not act on climate change. Do you agree with

our nation's leading scientists that have concluded climate change is real, is caused by humans, and is impacting nation's environment and infrastructure? If not, why not?

Response:

Anthropogenic global warming is real and has impacts on the nation's environment and infrastructure. However, some of those impacts, such as longer growing seasons and the carbon dioxide fertilization effect, are beneficial.

More importantly, the Fourth National Climate Assessment's (NA4) projections of devastating impacts are the product of overheated climate models, an inflated emissions baseline emission scenario, unrealistic pessimism about human adaptive capabilities, and rhetorical flimflam.

NA4 warns that unchecked climate change could increase global average surface temperature by 8°C and lop 10 percent off U.S. GDP in the 2090s. How did NA4 obtain those dire results?

First, NA4 used an ensemble of climate models, called CMIP5, that on average project twice as much warming as was observed in the lower atmosphere during 1979-2017. A key variable estimated by such models is climate sensitivity—the amount of warming after the climate system fully adjusts to a doubling of atmospheric carbon dioxide (CO2) concentration. Unsurprisingly, the average climate sensitivity estimated by the CMIP5 is 40 percent higher than the average in two-dozen recent empirically-constrained studies.

Second, NCA ran the CMIP5 ensemble with an emission scenario called RCP8.5. Although presented as a "no action" (business-as-usual) scenario, RCP8.5 is, in fact, an extreme scenario. To match RCP8.5's emission trajectory, global coal consumption would have to increase so rapidly that, by 2100, coal supplies nearly half of all global energy—a percentage not seen since 1940. This has no plausibility.

Third, NC4 neglected to mention that even with the biased combo of overheated models and inflated emission baseline, global temperatures reach 8°C in only 1 percent of CMIP5 model projections. Nor did NC4 mention that even if warming were to cut GDP by 10 percent in the 2090s, the economy could still be 10 times larger than it is today. In short, even in NC4's wildly improbable worst case, climate change does not rise to the level of an existential threat.

Finally, NC4 is silent about the amazing decline in weather-related deaths in the era of global warming. Since the 1920s, the global annual death toll from extreme weather declined by about 95 percent, despite a four-fold increase in global population. Individual risk of dying from extreme weather declined by 99 percent.

Although absolute damages from extreme weather are increasing, that is chiefly due to more development and wealth in flood plains and hurricane zones rather than any long-term change in weather. Since 1990, a period encompassing the top 10 warmest years in the instrumental temperature record, the relative economic impact of extreme weather has declined from about 0.31 percent of global GDP to 0.24 percent.

The dramatic decline in weather-related mortality and reduction in the relative economic importance of weather-related damages would not have been possible absent the prosperity and technological innovations supported by abundant supplies of affordable energy.

CEI will remain skeptical of catastrophic climate forecasts until solid empirical evidence persuades us otherwise.

10. The Competitive Enterprise Institute published a paper in June 1994 entitled "The High Cost of Cool: The Economic Impact of the CFC Phaseout in the United States.: The paper makes claims similar to those made by some, including CEI, about the HFC phasedown, such as that costs will be higher than anticipated and that equipment design will suffer and be less efficient, among other things. Since 1994, the record has proven CEI's predictions to be overwhelmingly false, as costs declined and equipment design, including energy efficiency, improved. In evaluating HFCs, did the failure of CEI's 1994 analysis factor into CEI's current work and testimony?

Response: CEI disagrees that its 1994 study, "The High Cost Of Cool: The Economic Impact of the CFC Phaseout," overstated the costs to consumers of the transition away from CFCs to HFCs under the Montreal Protocol and 1990 Clean Air Act Amendments. CEI's conclusions were similar to those of others at the time. For example a 1997 study conducted for Environment Canada, entitled "Global Benefits and Costs of the Montreal Protocol on Substances that Deplete the Ozone Layer," estimated global costs of the Montreal Protocol at $235 billion, comparable to CEI's estimate of $44 to $99 billion in the U.S., given that roughly 30 percent of affected equipment at the time was American-owned.

There is reason to believe that the proposed transition in the AIM Act from HFCs to HFOs and other replacements may prove to be more challenging than the transition from CFCs to HFCs undertaken decades ago. For example, while HFCs were more expensive than CFCs at the time (CEI's 1994 study estimated HFC-134a at $7 per pound retail), there were no refrigerant price jumps as dramatic as the current tenfold increase of HFO-1234yf as compared to HFC-134a. And while HFCs were no more flammable than CFCs, many post-HFC refrigerants are classified as flammable, which raises both safety and cost issues. Moreover, the installed base of HFC-dependent equipment today is larger than the installed base of CFC-dependent equipment then. Therefore, an accelerated phaseout that leaves American consumers and businesses competing over a dwindling supply of HFCs could prove very problematic.

CEI's 1994 study emphasized the sharp cost increases as a result of the original phaseout deadlines being accelerated and the impact over the first ten years of such restrictions. The accelerated schedule did not allow enough time for all the existing CFC-dependent equipment to live out its useful life undisturbed. For example, CFC-12 production ended on January 1, 1996, but at that point there were more than 100 million air conditioned vehicles on the road that still needed it. Not surprisingly, the price of CFC-12, which had been around $1 per pound, shot up above $30 per pound wholesale and even higher retail. The cost of vehicle air conditioner repairs was substantially and unnecessarily elevated for years afterwards. As noted, this is the kind of anti-consumer result we should try to avoid under the AIM Act. The best way to do so is to eliminate the provisions allowing the initial deadlines to be accelerated.

Prices for HFCs did eventually come down and the quality of HFC-using equipment did gradually improve, but most of that happened after the ten-year period of CEI's study. The added costs of the CFC phaseout, especially to existing CFC systems, in the years immediately after the accelerated deadlines made for a needlessly painful transition.

The claims of improved energy efficiency as a result of the CFC phaseout are erroneous. The efficiency gains were due to technological advances unrelated to the mandated refrigerant switch. Improvements likely would have been greater had CFCs remained an option in state-of-the-art systems. The same bait-and-switch should not be used to obscure the costs to consumers of the AIM Act.

Nothwithstanding CEI's concerns decades ago about the phaseout of CFCs, its present concerns about the AIM Act have been corroborated by business commenters making many of the same points. The comments from the Aerospace Industries Association, Alliance for Automotive Innovation, Association of Home Appliance Manufacturers, Boeing, First Continental International, Illinois Tool Works, Industrial Energy Consumers of America, National Automobile Dealers Association, National Automatic Merchandizing Association, National Environmental Development Association, National Marine Manufacturers Association, Compsys, New Era Group, ComStar International, Safariland Group, Security Equipment Corporation, Society of Chemical Manufacturers and Affiliates, Structural Composites, Truck and Engine Manufacturers Association, Wabash International, and others deserve this Committee's attention.

11. Shouldn't the generally positive industry experience with CFCs and other ozone depleting substances factor into any predictions about what will happen with HFCs? If not, why wouldn't industry experience, industry know-how, and industry data regarding fluorocarbons be relevant to CEI in the consideration of new fluorocarbon policies?

Response: Discussions about HFC restrictions have been dominated to date by a few loud parties that benefit from such measures and claim to represent all industry. This comment process was the first real chance for a diversity of industry voices to weigh in publicly. Many of these other industry commenters echoed the concerns raised by CEI.

CEI's comments acknowledge that the AIM Act will be a windfall for manufacturers of costlier HFC substitutes and equipment. However, there is a far larger industry segment that will be harmed by this bill—all companies that rely on HFCs and HFC-dependent equipment in their operations. Many of them raised one or more criticisms with the bill and/or are asking to be exempted from it.

CEI agrees with the thrust of the question that industry experts need to be heard. That is why we hope this committee heeds the comments of the industry experts at the Aerospace Industries Association, Alliance for Automotive Innovation, Association of Home Appliance

Manufacturers, Boeing, First Continental International, Illinois Tool Works, Industrial Energy Consumers of America, National Automobile Dealers Association, National Automatic Merchandizing Association, National Environmental Development Association, National Marine Manufacturers Association, Compsys, New Era Group, ComStar International, Safariland Group, Security Equipment Corporation, Society of Chemical Manufacturers and Affiliates, Structural Composites, Truck and Engine Manufacturers Association, Wabash International, and others who have raised concerns with the AIM Act. It is also noteworthy how many of these commenters say that these concerns have been ignored until now.

As far as claims of the "generally positive industry experience" with the phaseout of CFCs, it is certainly true that the makers of costlier substitute products had a positive experience. On the other hand, their customers who had to pay the higher prices, including industrial users of affected equipment as well as consumers, did not have as positive an experience.

12. Prior to 1990, there were over sixteen states that had taken action, or were in the process of taking action, to restrict the use of Chlorofluorocarbons (CFCs). In the Clean Air Act Amendments of 1990, Congress created a federal program to phase out CFCs in Title VI of the Clean Air Act. Rather than preempting state actions, Congress preempted the enforcement of state CFC regulations for two years. Once EPA had a strong CFC federal program in place, the state programs for the most part went away on their own. Why specifically do you expect states will act differently in terms of HFCs if a federal regulatory program is created? Given the history why should HFCs be treated differently than CFCs in terms of state preemption?

Response: Many proponents of the AIM Act insist that preemption of state HFC restrictions is not needed, but they are just as insistent that it be kept out of the bill. That alone is reason for suspicion.

CEI disagrees with the assertion that states stood down once the federal government started regulating CFCs under the 1990 Clean Air Act Amendments. In truth, soon after the bill was signed into law, the first Bush administration came under tremendous pressure to accelerate its deadlines, which happened in 1992. State governments, especially California, were among those bringing pressure to bear, and the implicit threat of tougher state-level requirements was a part of that.

In the years since, California and copycat states have repeatedly set more stringent standards—perhaps most notably for vehicle and appliance efficiency standards—than national ones set by the federal government, creating a costly patchwork. The AIM Act should anticipate and prevent this from happening in the context of HFCs.

Among the trade associations and individual companies who submitted comments critical of the AIM Act, the lack of state preemption was the most common criticism. It is fair to say that a larger segment of industry wants preemption than does not. Many speak from experience, having had to deal with other federal requirements that conflict with those set by California and other states. CEI's comments reflect these negative experiences.

If proponents of the bill are saying that state measures should be unnecessary once federal HFC restrictions are enacted, then CEI agrees. But CEI would insist that it be put in writing.

Senator Whitehouse

13. The Competitive Enterprise Institute (CEI) has long opposed federal action to reduce greenhouse gas emissions. It has been reported that CEI receives significant funding from the fossil fuel industry. So that the Committee may better understand CEI's Page 3 of 3 motivations for this testimony who may have paid for it, please disclose all the ultimate sources (i.e., the original source as opposed to a pass through entity such as Donors Trust or an LLC) of your funding over the last five years and the amount of their donations.

Response: CEI does not publicize the identities or contribution amounts of its supporters. Their confidentiality is important both to them and to us, and the Constitutional grounds for protecting it have been repeatedly emphasized by the Supreme Court.

14. As other testimony points out, in the early 1990s, CEI made wildly exaggerated claims about the cost of HFC substitutes for CFCs. Given your poor track record of estimating chemical replacement costs, why should this Committee believe your testimony that this bill will impose significant new costs on consumers?

Response: CEI disagrees that its 1994 study, "The High Cost Of Cool: The Economic Impact of the CFC Phaseout," overstated the costs to consumers of the transition away from CFCs to HFCs under the Montreal Protocol and 1990 Clean Air Act Amendments. It should be noted that CEI's conclusions were similar to those of others at the time. For example a 1997 study conducted for Environment Canada, entitled "Global Benefits and Costs of the Montreal Protocol on Substances That Deplete the Ozone Layer," estimated global costs of the Montreal Protocol at $235 billion, comparable to CEI's estimate of $44 to $99 billion in the U.S., given that roughly 30 percent of affected equipment at the time was American-owned.

There is reason to believe that the proposed transition in the AIM Act from HFCs to HFOs and other replacements may prove to be more challenging than the transition from CFCs to HFCs undertaken decades ago. For example, while HFCs were more expensive than CFCs at the time (CEI's 1994 study estimated HFC-134a at $7 per pound retail), there were no refrigerant price jumps as dramatic as the current tenfold increase of HFO-1234yf as compared to HFC-134a. And while HFCs were no more flammable than CFCs, many post-HFC refrigerants are classified as flammable, which raises both safety and cost issues. Moreover, the installed base of HFC-dependent equipment today is larger than the installed base of CFC-dependent equipment then. Therefore, an accelerated phaseout that leaves American consumers and businesses competing over a dwindling supply of HFCs could prove very problematic.

CEI's 1994 study emphasized the sharp cost increases as a result of the original phaseout deadlines being accelerated and the impact over the first ten years of such restrictions. The accelerated schedule did not allow enough time for all the existing CFC-dependent equipment to live out its useful life undisturbed. For example, CFC-12 production ended on January 1, 1996, but at that point there were more than 100 million air conditioned vehicles on the road that still needed it. Not surprisingly, the price of CFC-12, which had been around a dollar per pound, shot up above $30 per pound wholesale and even higher retail. The cost of vehicle air conditioner repairs was substantially and unnecessarily elevated for years afterwards. This is exactly the kind of anti-consumer result we should try to avoid under the AIM Act. The best way to do so is to eliminate the provisions allowing the initial deadlines to be accelerated.

Prices for HFCs did eventually come down and the quality of HFC-using equipment did gradually improve, but most of that happened after the ten-year period of CEI's study. The added costs of the CFC phaseout, especially to existing CFC systems, in the years immediately after the accelerated deadlines made for a needlessly painful transition.

The claims of improved energy efficiency as a result of the CFC phaseout are erroneous. The efficiency gains were due to technological advances unrelated to the mandated refrigerant switch. The improvements likely would have been greater had CFCs remained an option in state-of-the-art systems. The same bait-and-switch should not be used to obscure the costs to consumers of the AIM Act.

Notwithstanding CEI's concerns decades ago about the CFC phaseout, its present concerns with the AIM Act have been corroborated by many business commenters making the same points. The comments submitted by the Aerospace Industries Association, Alliance for Automotive Innovation, Association of Home Appliance Manufacturers, Boeing, First Continental International, Illinois Tool Works, Industrial Energy Consumers of America, National Automobile Dealers Association, National Automatic Merchandizing Association, National Environmental Development Association, National Marine Manufacturers Association, Compsys, New Era Group, ComStar International, Safariland Group, Security Equipment Corporation, Society of Chemical Manufacturers and Affiliates, Structural Composites, Truck and Engine Manufacturers Association, Wabash International, and others deserve this Committee's attention.

Ben Lieberman
Senior Fellow
The Competitive Enterprise Institute
1310 L Street, NW 7th Floor
Washington, DC 20005
(202) 331-1010
ben.lieberman@cei.org

Chemours™

Chemours Fluoroproducts
1007 Market Street
Wilmington, DE 19801

April 29, 2020

The Honorable John Barrasso
Chairman
Committee on Environment and Public Works
United States Senate
Washington, DC 20510

The Honorable Tom Carper
Ranking Member
Committee on Environment and Public Works
United States Senate
Washington, DC 20510

Chairman Barrasso and Ranking Member Carper,

I want to thank you for the holding the proceeding entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Testimony and Questions for the Record."* I applaud your courage to conduct this proceeding by unconventional, but appropriate means in response to the COVID-19 pandemic.

Our responses to Questions for the Record that were directed to me and The Chemours Company from Ranking Member Carper, Senator Capito and Senator Wicker are attached.

Finally, I want to reiterate Chemours support for S. 2754, and our willingness to work with you and your staffs toward resolving obstacles to its enactment.

Sincerely,

Edwin C. Sparks

Edwin Sparks
President, Fluoroproducts

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Chemours

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

1. Prior to 1990, there were over sixteen states that had taken action, or were in the process of taking action, to restrict the use of Chlorofluorocarbons (CFCs). In the Clean Air Act Amendments of 1990, Congress created a federal program to phase out CFCs in Title VI of the Clean Air Act. Rather than preempting state actions, Congress preempted the enforcement of state CFC regulations for two years. Once EPA had a strong CFC federal program in place, the state programs for the most part went away on their own. Why specifically do you expect states will act differently in terms of HFCs if a federal regulatory program is created? Given the history why should HFCs be treated differently than CFCs in terms of state preemption?

   We cannot speak for the states about how they will respond to federal legislation in the 2020's. For Chemours, this is a pragmatic business matter - politically and commercially. Politically speaking, the present impasse on AIM is in no small part the result of differing political views and objectives on preemption. Until preemption is negotiated to some, yet unidentified, but acceptable compromise, we do not foresee legislation advancing. In the meantime, commercial opportunities go unrealized or are delayed. We have invested in the development and commercialization of new products, and built U.S. manufacturing capacity to supply customers with newer, AIM Act compliant products. Our customers tell us they will not make wholesale transitions to these newer products until a predictable national program for HFC phasedown is in place. That is our commercial reality. The AIM Act is a means of delivering that national program. We, therefore, are caught between political impasse on the one hand, and stifled commercial demand resulting from that impasse on the other. The only practical solution to this dilemma is to break the impasse by addressing the root causes. Judging preemption to be a leading root cause, we urge all parties to work in good faith to find a solution, and repeat our willingness to work with you in that pursuit.

2. Are there any lessons learned from the implementation of the phase out of CFCs that we should apply to the phase down of HFCs?

   We highlight two:
   First, EPA should allocate allowances as they have for previous transitions since these have a proven track record of success. In earlier transitions companies that produced a regulated substance and that were subject to the phaseout of CFCs were most impacted by the regulation. In general, these companies had existing manufacturing and technology assets and invested in alternatives to create an orderly transition.

Recognizing this, EPA has previously apportioned baseline production and consumption allowances on the basis of prior production and consumption during a specified baseline period. And, EPA described this allocation system as one that facilitates "an orderly phase-out" (84 Fed Reg 41, 510, 41513 – Aug 14, 2019).

Secondly, the federal government will need to be diligent in enforcement to combat illegal activity designed to capitalize on this transition. We can expect this illegal activity to occur and we should prepare accordingly. During previous transitions, internet sales and importers created opportunities for illegal activity. Industry worked with EPA and the Department of Commerce to track and capture illegal sales & imports. One such program, Operation Cool Breeze, led to arrests and prosecutions of illegal importers.

3. Does Chemours support the bill as introduced?

   Chemours supports the AIM Act, but sees ambiguities in the text describing the allocation of allowances. The bill can be improved by directing EPA to allocate allowances as they have in previous transitions, and being explicit that the baseline for allocating allowances is the same baseline used to determine the number of allowances (where it is explicit). While we believe this is Congress' intent, the current language is sufficiently ambiguous to lend itself to alternative interpretations. We recommend this deficiency be remedied by amending the bill to make these points explicit. Doing so will create certainty rather than leaving the outcome to the discretion of EPA. Since the legislative record is not binding, relying upon that record will not create the same desired certainty.

4. Are there any additional comments you would like to provide that you did not provide in your testimony?

   We simply reiterate our interest in the enactment of HFC phase-down legislation and encourage the Committee to invest the time to resolve obstacles to moving the AIM Act forward.

   We again thank the Chairman and Ranking Member for their willingness to be innovative in the face of a global health crisis by receiving and processing input in an unconventional manner. It was a wise decision.

<u>Senator Capito:</u>

5. Mr. Sparks, your company manufactures both HFCs and HFOs across multiple facilities in multiple states. Is there any downside from a business perspective to a federal preemption provision being incorporated into the AIM Act that would guarantee national uniformity and consistency for your company? Is that preferable to a state-by-state regulatory patchwork?

While preemption has not traditionally been a significant component of refrigerant phase downs, a federal program, uniformly and consistently applied across the United States, has always been the ideal outcome. In the absence of federal policy, a number of states have already taken their own actions through legislation or regulation. Chemours has adjusted plans and taken actions so we and our customers are able to comply. Changing those plans and reversing those actions comes at increased risk and cost. So, details like how a preemption provision might work, what its scope might be, and when it might take effect, determine the business impact for Chemours.

It appears to us, that preemption is the chief obstacle that stands in the way of enacting this legislation. We urge all parties to negotiate to an acceptable outcome. We reiterate our offer to work with the Committee to find a practical solution that allows legislation to move forward. Absent a reasonable compromise the worst-case scenario for all in this process is a federal stalemate that results in only a growing patchwork of state policies.

6. You mentioned the need for consistency with previous transitions under the Montreal Protocol. Does that suggest that Senate ratification of the Kigali Amendment and enactment of implementing legislation is a preferable route for implementing an HFO transition policy? Is such an approach more consistent with the 1990 amendments to the Clean Air Act?

   Chemours is a proponent of ratification of the Kigali Amendment. Ratification and enactment of implementing legislation will certainly provide the legal framework for a transition from HFCs. Implementing legislation might take the form of an amendment to the Clean Air Act or the AIM Act. Indeed, we find its utility as a vehicle for implementing Kigali an attractive feature of the AIM Act.

   As a practical matter, ratification of international treaties has fallen on hard times in recent decades. With other priorities now taking center stage for the Administration and the Congress, Kigali is likely to wait some time before it is considered. In the meantime, enactment of the AIM Act will create greater certainty for our customers, and can create commercial opportunities for U.S. businesses at home and abroad. And when we do ratify Kigali, AIM can be amended to fulfill the requirements of implementing legislation.

7. You state that an HFO transition will help in addressing Chinese dumping of HFCs into the US market. How so, because I do not see any trade restrictions provided for in the AIM Act? What specifically in the AIM Act prevents Chinese dumping of HFO products and appliances once any regulatory transition mandate is made and can be used to bring enforcement actions against China?

   Chemours and other domestic HFC producers have been harmed by Chinese dumping of HFCs beginning about 2013. Chemours has spent millions of dollars tracking imports, validating data, investigating circumventions and bringing cases to the attention of the US Department of Commerce for action. Federal HFC phase-down legislation will give domestic producers additional support as follows:

The AIM Act establishes a phase-down schedule from a defined baseline for HFC consumption and production (including imports) through an allowance program. A company importing HFCs into the US would, like U.S. manufacturers, be allocated a share of these allowances.

If EPA follow past precedent, as they should, or better, if the bill is amended to give EPA explicit direction to allocate allowances as they have for previous transitions against the 2011-2013 baseline, they will allocate allowances in amounts that are calculated pro rata, from prior production and consumption during the (baseline) years 2011-2013. Chinese dumping of HFCs accelerated rapidly after the baseline period. Under this system we expect importation of Chinese HFCs will be limited to a share of their import volumes during 2011-2013. This will serve to immediately reduce volumes of Chinese imports being dumped on the U.S. market from those experienced in recent years. As the phase-down proceeds Chinese imports will decline according to the schedule (since they will be limited to a fixed share of the total). U.S. based suppliers' volumes will fall at the same rate. Enforcement will remain a challenge, but the AIM Act adds to the tools the U.S. Government has to combat dumping.

While the AIM Act will curtail Chinese dumping of HFCs, it will not prevent eventual dumping of next generation products like HFOs. In the near term, intellectual property owned by US companies provides a defense against Chinese dumping of HFOs, but the clock is ticking on patent protection. Delays in policy making reduce the value of these patents and erode the head start U.S. manufacturers currently have. Longer-term as product and process patents expire, dumping is likely a challenge we will face. We are hopeful that since antidumping lawsuits against Chinese HFC imports have generally been decided in favor of U.S. companies, an important precedent is in place for future HFO-related trade disputes.

Senator Wicker:

8. The companies that have produced HFCs will be the most directly affected by the AIM Act. Therefore, it is important that there is certainty regarding the amount of HFCs that manufacturers are authorized to produce and consume. The AIM Act requires the EPA Administrator to determine the quantity, or allowances, of HFCs that manufacturers are authorized to produce or consume each year during the scheduled phasedown. How has EPA determined allowances for the phasedown of substances in the past? Would the process mentioned in the AIM Act help the market transition to HFC alternatives?

   We agree that companies that have produced HFCs will be the most directly affected by the AIM Act. Specifically, Chemours has existing HFC assets in multiple states in the US and our investment continues for the HFO transition. The most recent asset investment is our HFO production site in Corpus Christi, Texas.

The allocation allowances are an important part of the transition for an orderly transition from assets producing HFCs to new investments to manufacturer products like HFOs.

Historically, EPA has apportioned baseline production and consumption allowances on the basis of prior production and consumption. And, EPA described this allocation system as one that facilitates “an orderly phase-out” (84 Fed Reg 41, 510, 41513 – Aug 14, 2019).

Further, these allowances in the past were provided over a multi-year period which allowed sufficient planning and certainty for that period of time. {example: 79 Fed. Reg 64,254 (Oct 28, 2014)-which provided a five-year allowance}.

The AIM Act can be improved by giving specific direction to EPA that allowances are to be allocated as they have been for previous transitions, and making clear that the baseline period for calculating allowances is the same baseline used for determining the total number of allowances. While these details may be inferred, we prefer that they be made explicit in the legislative text, limiting the interpretive discretion afforded the Administrator. Since it is not binding, the legislative record alone fails to deliver the same certainty we desire.

Chemours Primary Contact:
F. Edmond Johnston III
Director, Federal Government Affairs
Email: F-EDDIE.JOHNSTON-III-1@chemours.com
Phone: +1 302 743 4392
Mailing Address: 1007 Market Street; PO BOX 2047; Wilmington, DE 19899

UNITED STATES
CLIMATE ALLIANCE

April 29, 2020

The Honorable John Barrasso
Chairman, Committee on Environment and Public Works
U.S. Senate
307 Dirksen Senate Office Building
Washington, D.C. 20510

The Honorable Tom Carper
Ranking Member, Committee on Environment and Public Works
U.S. Senate
513 Hart Senate Office Building
Washington, D.C. 20510

RE: Response to follow-up questions regarding written testimony on S. 2754, American Innovation and Manufacturing Act of 2019.

Dear Chairman Barrasso and Ranking Member Carper,

The United States Climate Alliance appreciates the opportunity for continued dialogue regarding our written testimony to the U.S. Senate Committee on Environment and Public Works voicing our strong support for the bipartisan *American Innovation and Manufacturing Act of 2019*.

Senator Cardin of Maryland submitted two questions back to the US Climate Alliance following our written testimony.

1. Why do the states comprising the U.S. Climate Alliance support a strong federal standard as drafted?
2. How will a federal framework help member states implement HFC phasedowns efficiently?

This bill could bring as many as 33,000 new manufacturing jobs to our states and communities. At a time when a global pandemic has brought hardship, this bill could drive innovation and create jobs, contributing to the economic growth the nation needs.

In addition, much of the world is already transitioning away from HFCs under the Kigali Amendment to the Montreal Protocol, and a strong federal framework will increase the global competitiveness of American companies and their products, many of whom operate in our states and are asking for common sense regulation.

Furthermore, U.S. industries that produce or use HFC alternatives are best served by a strong national framework that provides certainty and consistency and allows states to pursue other emissions reductions opportunities. Although many Alliance states are developing substantially similar regulations to other Alliance states that would provide regulatory consistency, not all states have the same capacity to promulgate their own regulations to address HFCs. A strong federal framework, offered by the proposed bill as drafted, reduces coordination costs for states and industry, affords states flexibility in determining how to expend limited resources, creates markets of scale that will bring down the costs of technologies and alternatives, and allows consumers and industry across the country – not only in Alliance states – to benefit from the economic and environmental gains generated by this bill. The current bill provides a consistent phasedown that works in concert with efforts by states working on HFC reductions and protects states' rights to pursue other emission reduction opportunities in the sector. Further, many states rely on the EPA for the information infrastructure to implement their own rules and regulations and the authority given to EPA under this bill would strengthen that infrastructure.

Respectfully,

Julie Cerqueira
Executive Director, U.S. Climate Alliance
1750 Pennsylvania Avenue NW, Suite 300
Washington, DC 20006
jcerqueira@usclimatealliance.org
202-864-5652

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Mr. Scott Lewit, President, Structural Composites, Inc., Compsys, Inc

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

1. In your testimony you expressed concern that the AIM Act would ban HFC 134a. The AIM Act would affect a phase down of the production and consumption of HFCs over a 15-year period, with 15 percent of the baseline period allowed to be produced and imported from 2036 onward. The AIM Act also contains provisions intended to increase to a significant degree the recovery and reclaim of HFCs. The purpose of these provisions, and other provisions in the Act, is to ensure the continued use of HFCs for decades to come, particularly in small or niche applications for which no substitute is available. In light of this, why do you believe the AIM Act represents a hard "ban" on HFCs that would prohibit their use upon enactment?
    - Thank you for this statement Senator Carper. I am very pleased to see that you are willing to make accommodations for continued use of HFC 134a for this application in the AIM Act. We are fine if we are given exemption and the bill has Preemption. Structural Composite has asked for an exemption for Structural Composite Preforming and if that exemption is granted and the bill has preemption, we fully support moving forward. Compsys is happy to look at recycled 134a and can support research into the same. Once the 134a is used as a blowing agent the vast majority of the 134a material is trapped for the life cycle of the product this can be 50 years for a rail car for example. THANK YOU FOR YOUR WILLINESS TO ACOMMIDE THIS IMPORTANT GHG SAVING TECHNOLOGY. PLEASE INCLUDE PREEMPTION.

2. Of the HFC compounds that are being used by your company today, on average how much does the industry use on an annual basis (in tons and GWP-weighted tons) now?
    - CAG estimates that 25 tons (42,500 GWP) are used by its members. Compsys is about 50% of that value. This supplies several industries including marine, DOD and transportation. The industry is in transition to HFO for floatation applications thus this usage is projected to sharply decline in the future.

3. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your company on an annual basis?
    - On this basis we estimate we consume 00.005% of the annual us usage.

4. Do you project HFC usage will grow or shrink over the next 15 years?

- We believe it will decrease as alternatives displace HFC compounds.

5. If the AIM Act were implemented as introduced, do you believe the HFCs used by your company will be eligible for essential use exceptions? If not, why not?
    - This is the reason we are making congress aware of our issue. Our experience with the EPA on transition from R22 to H134a was fantastic, good collaboration that allowed us to validate and transition the alternative. The recent EPA experience with SNAP was the complete opposite. Our SBA advocate was the same person. We were all stunned by the complete inflexibility. The rule issued completely ignoring all our requests and writings and our lack of an alternative. It was as if we did not exist. When the rule came out this small business was forced to sue the EPA, hire expensive DC council, followed by years of meetings filings etc. The EPA was forced to rescind the rule, they were found to have misused their power trying to use laws for ozone regulation for GHG. The ruling specially addressed all of the users like Compsys that already moved from R22 to 134a now having to switch again even though 134a was ozone safe.
    - We learned that reason and science do not always guide these decisions, it is very easy for a small business to be caught in the wave of government regulation. That is why we are here to do all we can to make sure we tell you our story, tell you about all the great material innovations we are making, these innovations are creating more energy efficient durable transportation products. They do more, they last longer, they use less fuel they have economic and environmental benefit.
    - PLEASE EXPEMT COMPOSITE PREFORMS FROM THIS REGULATION ALLOW CONTIUNUED USE OF 134A IN STRUCTURAL COMPOSITE PREFORMS. PLEASE INCLUDE PREEMPTION AS INTERSTATE COMMERSE MAKES STATE BY STATE REGULATION UNWORKABLE.

April 21, 2020
The Honorable John Barrasso
Chairman
Environment and Public Works Committee
410 Dirksen Senate Office Building
Washington, DC 20510-6175

The Honorable Thomas Carper
Ranking Member
Environment and Public Works Committee
410 Dirksen Senate Office Building
Washington, DC 20510-6175

Re: American Innovation and Manufacturing Act (S. 2754)

Dear Chairman Barrasso and Ranking Member Carper:

In response to the questions attached to your letter of April 16, 2020, I submit the following comments and attached list of HFC refrigerant patents under which ComStar International Inc. manufactures and sell throughout the U.S., Exhibit A:

1. Re Question: HFC Import Allocation

The Bill, as written, sets the years of 2011 through 2013 as the base years to determine who will receive and how much of the HFC allocation will be allotted to those companies that imported HFC refrigerant during those "base" years. This means, companies like ComStar International Inc., who were active in the development of new HFC refrigerants to replace ozone depleting and high Global Warming refrigerants for the U.S. market, who did not import HFC refrigerant during the "base" years would not receive a share of the HFC import allocation under this Bill, as written. It was only after 2013 that the U.S. refrigerant market began in earnest to replace ozone depleting refrigerants and in 2016 to reduce the use of high Global Warming refrigerants.

ComStar International Inc.
20-45 128 Street
College Point, NY 11356
Phone: (800) 328-0142
Fax: (718)353-5998
Email: customerservice@comstarproducts.com
Website: www.comstarproducts.com

ComStar International Inc. needs a share of the HFC import allocation to assure access to the raw materials needed to product the patented refrigerants and to remain price competitive with those companies that are given a percentage of the total HFC import allocation. As a result, ComStar International Inc. supports a small business carve out of 25% for U.S. companies actively involved in the U.S. HFC refrigerant market.

2. Re Question: Noncompliance of mandatory EPA Green House Gas Reporting Program (GHGRP)

During the 2011-2013 base years, the U.S. International Trade Commission (ITC) import records show HFC imports amounted to 153,698,648 kg (338.1 million lbs); of which 90% of imports came from China. All importers of HFC's must, by law, report annually their imports via the EPA Green House Gas Reporting Program (GHGRP). Therefore, those companies that did not report their imports for the years of 2011-2013 in the time frame required by the EPA broke the law. It has recently become known that a number of companies have entered their imports for the years 2011-2013 on a retro-active basis staring in 2018. This action does not trump the fact that these companies broke the law. By checking the EPA's GHGRP by submission dates and the years covered for those import submissions will disclose those companies that entered import data on a retro-active basis. Companies making retro-active submissions should not receive a HFC import allocation. This Bill should give the EPA the authority to identify and eliminate companies that made retro-active submissions from receiving a HFC import allocation.

The Bills HFC import allocation proposal, as written, does not address those companies that have not complied with the EPA's mandatory reporting requirement in the GHGRP in a proper and timely manner. It is ComStar's opinion, along with other small U.S. businesses active in this market, that those companies that broke the law by not reporting their annual HFC imports to the EPA's GHGRP in a proper and timely manner should not be granted an HFC import allowance.

3. Re Question: Patents for HFC replacement Chemicals

ComStar International Inc. manufactures, packages, markets and distributes ten (10) active HFC patented refrigerants in and for the U.S., see attached list of patents with expiration dates, Exhibit A. In addition, there are two (2) new HFC refrigerant products that are pending as shown on Exhibit A.

ComStar International Inc.
20-45 128 Street
College Point, NY 11356
Phone: (800) 328-0142
Fax: (718)353-5998
Email: customerservice@comstarproducts.com
Website: www.comstarproducts.com

While ComStar does not have detailed patent information about other U.S. companies, we are aware that HFC refrigerant patents are currently held by Honeywell (≥ 2), Chemours (≥ 5), RMS (≥ 2) and Bluon (≥ 1).

On behalf of all the ComStar employees, I thank you for this opportunity to respnd to your questions. We hope, and respectfully request, that our response aids you in the final make-up of this Bill.

Respectfully,

Steven P. Mella
Chief Executive Officer

Attachment: Exhibit A

ComStar International Inc.
20-45 128 Street
College Point, NY 11356
Phone: (800) 328-0142
Fax: (718)353-5998
Email: customerservice@comstarproducts.com
Website: www.comstarproducts.com

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
4	4/18/2020																	
5													**EXHIBIT A**					
6																		
7																		
8																		
9		ComStar																
10																		
11																		
12	**PATENTS IN USA**																	
13																		
14				**(1) RS-45 (R434A)**		**(2) RS-45 (R434A)**			**(3) RS-45 (R434A)**									
15																		
16	Patent number			7,972,528 B2		8,465,664 B2			9,062,237 B2									
17	Filing data			15 March 2007		27 May 2011			13 May 2013									
18	Granted			15 July 2011		18 June 2013			23 June 2015									
19	Valid to			5 March 2027		5 March 2027			5 March 2027									
20																		
21				**(4) RS-70 (R453A)-1**		**(5) RS-70 (R453A)-2**							**(6) RS-52 (R428A)**			**(7) RS-50 (R552A)**		
22																		
23	Patent number			9,624,414 B2		9,708,522 B2							8,551,354 B2			9,023,231 B2		
24	Filing data			9 October 2014		13 February 2017							5 March 2007			21 October 2010		
25	Granted			18 April 2017		18 July 2017							8 October 2013			5 May 2015		
26	Valid to			9 October 2034		9 October 2034							5 March 2027			21 October 2030		
27																		
28				**(8) RS-44 (R424A)**						**(9) RS-24 (R426A)**							**(10) RS-100 (R464A)**	
29																		
30	Patent number			6,606,868 B1						6,629,419 B1							1,025,3233 B2	
31	Filing data			2 October 2000						29 September 2000							23 June 2016	
32	Granted			19 August 2003						7 October 2003							9 April 2019	
33	Valid to			31 December 2020						15 February 2021							23 March 2036	
34																		
35				**(11) RS-51 (R470B) & RS-53 (R470A)-1**						**(12) RS-51 (R470B) & RS-53 (R470A)-2**								
36																		
37	Patent number			PCT/EP2018/082583						PCT/EP2018/082597								
38	Filing data			26 November 2018						26 November 2018								
39	Granted			To be examined						To be examined								
40	Valid to			26 November 2037						26 November 2037								

Caesar Rodney Institute
Center for Energy & Environment
420 Corporate Blvd.
Newark, DE 19702
WWW.CaesarRodney.org

Senate Committee on Environment and Public Works 4/20/2020
410 Dirksen Senate Office Building
Washington, DC 20510-6175

RE: S. 2754, American Innovation and Manufacturing Act of 2019: **Response to Questions for the Record for the Caesar Rodney Institute**

Senators,

Thank you for the opportunity to respond to your questions regarding my testimony on S. 2754. Responses follow below for each question. Most links to sources can be found in my original testimony:

Chairman Barrasso:

1. Do you agree with the claim made by proponents of the AIM Act that the legislation will *prevent*, not encourage, monopolies from forming in the production of HFC replacements?

   Response – I do not agree banning HFC will prevent refrigerant monopolies. U.S. refrigerant manufacturers make both HFC and HFO, and could continue to offer either from the same manufacturing facilities in Louisiana and Texas. HFC's are an ideal refrigerant as it is economical and both inflammable, and non-toxic, along with having low ozone depletion potential. All of the replacement options have varying levels of flammability, and toxicity. There is already significant competition for HFC replacements in some applications, such as commercial refrigeration, where options include "natural" refrigerants such as ammonia, carbon dioxide, propane, ethane, and HFO's where flammability is not so much a concern. In other applications, such as air conditioning, flammability and toxicity are a very big concerns, and HFO's are the second best option to HFC. Two companies control the HFO market, Honeywell, and Chemours, through both patent protection, and a head start in having production scale manufacturing capacity. In applications where HFO is the best option, banning HFC eliminates the only real competitor. Common sense tells us banning a competitive product cannot possibly result in more competition. If competition is the goal, don't ban HFC. For a great discussion on industry trends and competition please see the Department of Energy, National Renewable Energy Laboratory (NREL) study, "Refrigerants: Market Trends and Supply Chain Assessment", https://www.nrel.gov/docs/fy20osti/70207.pdf

2. The Air-Conditioning, Heating, and Refrigeration Institute's (AHRI) testimony claims that the AIM Act will do away with the ongoing process known as "dumping," where overseas companies export inferior equipment to the U.S. at a price below the cost of manufacture. Do you agree with this claim? Why or why not?

   Response- I do not agree the AIM Act will prevent dumping. We note the claim made by AHRI was for dumping HFC refrigerant, not HVACR equipment, and that antidumping duties were put in place. While not condoning dumping, who exactly was buying the below market priced HFC? If it was aftermarket users in the repair and maintenance industry that would not impact equipment manufacturers. If it was equipment manufacturers buying the product, the industry itself, maybe even AHRI members, could have self-policed, or refused to buy these dumped products. Europe has already banned HFC in favor of HFO, and is complaining about black market imports of HFC from China. Apparently banning HFC won't stop illegal trade. In fact, it is more attractive to avoid $60/pound HFO, and by $4/pound HFC.

3. The current text of the AIM Act states it will:

> *Create 33,000 new jobs and sustain 138,400 existing jobs between now and 2030; Increase direct U.S. manufacturing output by $12.5 billion, and total (direct and indirect) U.S. manufacturing output by $38.8 billion between now and 2030; Improve the U.S. trade balance in equipment and chemicals by $12.5 billion; and Increase the U.S. share of the global HVACR market by 25 percent.*

Do you agree with these claims? Why or why not?

Response- I do not agree with these claims of economic gains. The claims made in the Act are identical to a refrigerant industry financed study, "Economic Impacts of U.S. Ratification of the Kigali Amendment" by JMS Consulting, published in April, 2018. In this report we see the net balance of trade on HVACR equipment was zero in 2000, but had grown to a $10 billion trade deficit by 2016. Eighty- five percent of the increase in the trade deficit was from U.S. equipment manufacturers themselves moving production to NAFTA countries Mexico and Canada, along with technology advances created in the U.S. Why would we expect these U.S. manufacturers to act any differently in the future? The economic growth numbers quoted in the AIM Act assume U.S. equipment manufacturers will obtain a larger share of the global market. Almost all global HVACR equipment growth will occur in Asia, and Latin America, and those areas have their own HVACR equipment industry. In fact, the first production scale HFO refrigerant manufacturing facility was built in China. The growth estimates in the AIM Act run through 2030. According to the Kigali Amendment, developing countries in the high growth HVACR countries will still be using HFC until 2030, and that equipment technology already exists in the U.S. for ready export. We are not exporting to these developing countries now, and the AIM Act won't change that.

4. The Nature Conservancy submitted testimony, stating:

> *U.S. companies are currently at the forefront of innovations for alternatives to hydrofluorocarbons and the United States is positioned to be a major production center for advanced refrigerants.*

Do you agree?

Response – I do not agree HFO refrigerant manufacturers have positioned the U.S. to be a major production center. According to the NREL study referenced above, foreign refrigerant manufacturers are quickly developing HFO variants (page 34). U.S. manufacturers Honeywell and Chemours have built HFO production facilities in China, Japan, and India (page 46). Both Honeywell, and Chemours have built HFO manufacturing facilities at the same facilities that produce HFC. Few new jobs will be created as production shifts from making HFC to making HFO. The same NREL report forecasts modest growth in synthetic fluorocarbon refrigerants which require recycling during repair, maintenance, and de-commissioning, with most of the growth moving to natural, low cost refrigerants requiring no recycling. As stated in my original testimony, since 2000, when imports and exports of US HVACR equipment were in balance, U. S. manufacturers have led the world in improving equipment energy efficiency by 40 to 750 percent[3]! However, during that same period export share of the US market grew only 10-percent while imports share increased 240-percent with imports exceeding exports by $10 billion a year. Clearly, our competitive technology advantage did not save American jobs in the past, and is unlikely to do so in the future.

5. The World Resources Institute testified:

> *The regulatory certainty provided by passage of the AIM Act could give rise to enhanced domestic demand, thereby incentivizing U.S. companies to build new next-generation facilities stateside.*

Do you agree?

Response – I do not agree the AIM Act will increase regulatory certainty. The refrigerant industry already has regulatory certainty. The Kigali Amendment lies dormant as neither President Obama, nor President Trump has sent it to the Senate for advice, and consent. The industry can assume the U.S. will not be joining the treaty. The Environmental Protection Agency (EPA) attempted an end run around the failed treaty. They used the Significant New Alternatives Policy (SNAP) regulatory policy to list HFC's as not acceptable for use in stationary products, such as freezers, foam products, and air conditioners. The EPA lost a lawsuit that claimed the EPA had misused the Clean Air Act in their findings thus overturning the SNAP determination. A request for rehearing to the U.S. Court of Appeals for the District of Columbia Circuit by the replacement HFO refrigerant suppliers Honeywell International, Inc., and Chemours Company, LLC, along with the National Resource Defense Council was denied. The EPA repealed the SNAP regulation in 2018. The refrigerant industry has clear certainty HFO's will have to be adopted in a competitive market, and can plan appropriately to invest in new products for the domestic, and global markets on that basis.

6. Is it true that the replacements for HFCs are more expensive than their counterparts? What impact will this have on the consumer?

Response – Price lists for HFO refrigerants are not public. A recent online search yielded prices of $3 to $4 a pound for HFC, and $60 to $65/pound for HFO. The NREL study provides a forecast price (page 44) of about $55 per pound in 2020, and about $35/pound in 2030. US fluorocarbon refrigerant use was about 123,000 tons in 2019. The current price premium for HFO's is over $50 per pound, or $100,000/ton. That cost differential between HFC and HFO yields $12.5 billion a year in added cost to U.S. households, motorists, and businesses that rely on air conditioning and refrigeration. For example, higher refrigerant cost will add about $100 per new car, and for new air conditioning equipment, or repair. Even at the 2030 differential price of $30 per ton, the impact would be an extra refrigerant cost of $7.5 billion a year.

7. Can you explain who owns most of the patents for HFC replacement chemicals? When do these patents expire?

   Response – The only good source for that information is the NREL study (pages 34-35) which estimates there are almost 400 patents just for one HFO version, HFO-1234YF, with Honeywell and Chemours owning about 40-percent of the patents. These are primarily application patents with the primary joint Honeywell/Chemours patents expiring in 2023 to 2025. Legal challenges abound.

8. Do you believe language should be added to ensure the bill appropriately addresses potential increases in consumer costs when setting regulations under the AIM Act?

   Response – The estimated benefit of the AIM Act is $12.5 billion in added export sales by 2030. The added refrigerant cost to consumers is initially $12.5 billion falling to $7.5 billion by 2030. Cost in Net Present Value probably exceed benefits with costs more in the early years and the claimed benefits in the later years. Let's not forget the underlying reason for this Act. It is to lower global warming. The latest EPA greenhouse gas inventory, just released, estimates fluorinated products account for 3-percent of net emissions. The EPA MAGICC climate change calculator yields an estimated 6 one-thousandths of a degree reduction in global warming by 2100 if all fluorinated emissions stop, essentially zero impact. Added language to the AIM Act is not the answer. This Act needs to fail in committee. Should the committee approve this Act then language is needed to protect consumers. The potential costs are very real, the economic benefits doubtful, and the environmental benefits essentially zero. Language should include including the premium cost of HFO refrigerant as forecast in the NREL study, the likely higher cost of new equipment as volumes ramp up, the cost of new refrigerant recycling equipment, and should exclude any benefits from Social Cost of carbon dioxide reduction. The bills claims of increased exports of HVACR equipment should be viewed with caution given the equipment industries record of out sourcing manufacturing to Mexico and Canada.

<u>Senator Whitehouse:</u>

9. You criticize a report funded by the refrigeration industry as unreliable. Your apparent belief that knowing an organization's funding source is relevant to understanding its potential biases is one I share. As such, please disclose to the Committee all the ultimate sources (i.e., the original source as opposed to a pass through entity such as Donors Trust or an LLC) of funding for the Caesar Rodney Institute over the last five years and the amount of their donations.

   Response – It is unfortunate we live in a world where illiberal activists will hound donors to non-profit entities they don't agree with. We have seen examples elsewhere of donors having protests at their homes, boycotts of their businesses, and receiving personal threats. As it is now, it was when the U.S. Supreme Court decided 501C (3) organizations were protected from disclosing donors in the case NAACP v. the State of Alabama. How much damage would have been done to supporters of the Civil Rights movement had their names become public? CRI protects donor privacy. We have about 650 individual donors, and receive a few grants each year from foundations.

10. It has been reported that the Caesar Rodney Institute has received funding from groups linked to the fossil fuel billionaire Koch brothers and their network of donors. Given their hostility to federal action to mitigate climate change, why should this Committee treat your testimony as credible?

    Response – Since we don't release donor information, how credible are those reports? I can tell you we are not funded by the Koch brothers even though they should be funding us. A major goal of the Koch Foundation is Criminal Justice reform. Last year I partnered with the American Civil Liberties Union in an educational program for Delaware legislators on problems in the state's criminal justice system. About a dozen bills were considered with most passing. My motivation is Delaware's poor recidivism rate of almost 75-percent, and high incarceration rates, especially for minorities. Ex-prisoners I have personally helped had a recidivism rate of about 15-percent.

    My opposition to S. 2754 should not be interpreted as opposing being good stewards of the environment. I am a cofounder of Delaware's Green Building Council, lobbied successfully for Delaware's 2014 Energy Efficiency Act, and designed, built, and live in a net zero energy house that includes rooftop solar. I believe we should be doing things that make economic sense like switching to lower CO_2 emission natural gas from coal that is saving American families $2,000 a year, developing small modular nuclear reactors that will run almost continuously without emissions while being competitively priced, and building utility scale solar in appropriate amounts that don't harm electric grid reliability. The U.S. has led the world since 2005 in reducing greenhouse gas emissions with three times the impact as the average of OECD countries. Banning HFC does not make the cut on ideas that make sense. My research follows the facts, not ideology.

Sincerely

David T. Stevenson
Director, Center for Energy & Environment
Caesar Rodney Institute
e-mail: DavidStevenson@CaesarRodney.org
Phone: 302-236-2050

ENGINEERING TOMORROW Danfoss

Danfoss
11655 Crossroads Cir
Baltimore, MD 21226
410-931-8256
www.danfoss.us

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020

Questions for the Record for John L. Sheff, Director of Public & Industry Affairs, Danfoss

Senator Cardin:

1. **The Committee heard from many American manufacturers supporting this legislation, particularly those in the heating, ventilation, air conditioning, and refrigeration (HVACR) industry. In expressing support for the AIM Act, many of these American manufacturers, along with industry groups such as the U.S. Chamber of Commerce and the National Association of Manufacturers, cited a study by Interindustry Forecasting at the University of Maryland (INFORUM) indicating that the phasedown of HFCs will create 33,000 new U.S. manufacturing jobs. When adding indirect and induced effects, this figure rises to 150,000 new U.S. manufacturing jobs.**

    a. **Given these and other economic benefits from phasing down HFCs, how would Danfoss characterize the overall opportunity for the U.S. HVACR industry if the AIM Act is enacted in terms of export markets and international trade?**

Thank you for your questions, Senator Cardin.

Danfoss would characterize the opportunity for the U.S. HVACR industry in a manner that is consistent with the economic benefits described in the INFORUM study.

Emerging economies worldwide are in the process of a refrigerant transition. This is a significant source of growth and of opportunity for HVACR manufacturers in the United States. One barrier to expanding the U.S. share of these emerging economy markets is the lack of a clear federal standard for HFCs in the United States.

These emerging economies frequently ask why they should select technologies developed in the United States when such technologies have not been broadly adopted in the United States. In the eyes of foreign-based purchasers, the AIM Act's enactment validates next generation refrigerant technologies developed and manufactured in the United States. This, in turn, will stimulate overseas demand for U.S. products and equipment.

Notwithstanding the significant impact and prevailing uncertainties arising from COVID-19, our long-term view of the export and trade advantages conferred to the U.S. HVACR industry by the AIM Act remains unchanged.

b. **Also from Danfoss's perspective, how important is it to the U.S. economy and to American consumers that we maintain a strong domestic manufacturing base for HVACR products and equipment?**

Refrigeration and air conditioning are fundamental to our modern way of life. Every home and every business relies on the HVACR industry for comfort, health, safety, and productivity.

This reliance has become only more apparent as the coronavirus pandemic has shown us which industries and technologies are vital to society. Refrigeration keeps food fresh, preserves medicine, and allows for its transportation over great distances. Air conditioning is critical to hospitals and nursing homes for comfort cooling and for dehumidification. Military installations and weapons platforms all utilize refrigeration, air conditioning, and other fluorocarbon technologies in their critical operations.

The value of the U.S. HVACR industry has become only more pronounced, given the many challenges our country is facing from COVID-19. We have found that the desire for American-made products in this industry is significant. Some purchasers have specifically requested that suppliers consider building capacity within the United States to ensure access during supply chain disruptions.

That the United States is home to many HVACR manufacturers is undoubtedly in the national interest and relevant to national security. The AIM Act is intended to maintain and expand the U.S. HVACR manufacturing base, which is why it has attracted such considerable industry and bipartisan political support.

April 29, 2020

The Honorable John Barrasso, Chairman
The Honorable Sheldon Whitehouse
U.S. Senate Committee on Environment and Public Works

Dear Senators,

Thank you for sending follow-up questions to me and Dr. Benjamin Zycher. I should point out that my principal employment is with the Competitive Enterprise Institute [CEI] in Washington, rather than being with the American Enterprise Institute [AEI] where Dr. Zycher is employed.

The questions from Chairman Barrasso appear to be directed towards Dr. Zycher's expertise, while the two from Senator Whitehouse seem more directed towards me. As a result, I will only address Senator Whitehouse's questions here.

Answer to Question 1 from Senator Whitehouse:

The specific question embedded here relates to "all of the ultimate sources…of your funding over the last five years". That follows three declarative statements about Intermountain Rural Electric Association, and having "met with Koch Industries and the Competitive Enterprise Institute to coordinate work in your domain. You have also admitted that 40 percent of your research is funded by the petroleum industry".

The statement about Intermountain is a matter of public record, as is the one to Dr. Fareed Zacharia on CNN regarding petroleum industry funding. They are from 14 and ten years ago, respectively, and have little if any bearing upon my current research. Regarding the claim that "I regularly met with Koch Industries and the [CEI] to coordinate work", I have occasionally attended meetings of CEI's Cooler Heads Coalition in the past (prior to joining CEI in September, 2019), and I continue to do so. These are large meetings of 30+ people at which I make occasional comments.

In regard to your question concerning funding for the last five years, I have had three employers during that period: Cato Institute, CEI, and the CO_2 Coalition. It is my understanding that, like many other non-profit organizations, these organizations fully comply with the law and IRS regulations concerning the reporting of their income, but do not choose additionally to publicize the identities or contribution amounts of their donors. The constitutional grounds for protecting this choice have been repeatedly emphasized by the Supreme Court.

Answer to Question 2

With regard to my March 25 testimony, I had consulted with Ben Lieberman of CEI and Ben Zycher of AEI. For the estimate of HFC warming that is anticipated, my source was the last comprehensive science summary of the United Nations' Intergovernmental Panel on Climate Change.

Thanks so much for your interest in my testimony, and I hope to serve your Committee in the future.

Cordially,

[signed] Patrick J. Michaels PhD
Center for Energy and Environment
Competitive Enterprise Institute

DuPont QFR from EPW on April 16, 2020 in response to April 8, 2020 testimony

This document has been submitted by DuPont on April 29, 2020

Introduction

DuPont supports the intention of the AIM Act to phase-down the use of HFCs over time, creating much needed alignment and therefore business certainty for national and multinational corporations. **In addition to our strong support for the AIM Act, we require a solution for a problem that we believe is unique to certain niche foam insulation products commonly known as XPS: the proliferation of varying state programs that reference SNAP lists at a point in time, early January 2017.** We have worked with each state considering HFC regulations to add language to conform their programs to the EPA lists of acceptable HFC blends and end-uses, so that as the EPA publishes updates, those additions are acknowledged and adopted by the states. Unfortunately, each state program is unique, and some require additional processes, resulting in an increasingly complex regulatory network and significant supply chain problems.

While we are in the process of transitioning to new production processes for the four states that have moved forward with programs, there are many requirements that still need to be completed (e.g., R&D to ensure safety and performance of our production process, and numerous building codes and other standards certification, etc.). Accordingly, we need sufficient lead time with any states considering additional programs to ensure viability for our industry's products.

As noted, our energy-efficient insulation products face unique challenges. We believe there is a creative solution that would achieve the objectives of the AIM Act and maintain the efficient production and cost-effective distribution of our carbon emission-reducing insulation products.

As noted in our testimony:

> *DuPont supports a harmonized regulatory framework for reducing HFCs through a phase-down approach, consistent with the intention of this bill. This timely, urgent, and much needed legislation has the opportunity to offer businesses certainty and predictability, which is especially important for companies with operations throughout the United States, such as ours.*

As noted in Question #9, we do not have industry information on HFC volumes. However, we have shared a calculation that estimates the HFC emissions attributed to XPS to be around 0.5% of all HFC emissions.

General issues with transitioning XPS B&C insulation foams:

- Individual components currently approved to replace HFC are flammable and require major changes to our manufacturing processes, which will require significant investments, delays in production, and higher costs for consumers.
- Foam manufacturers have their own manufacturing grids across the country to supply each state and must upgrade this network of facilities to handle the new flammable components which takes time to implement once viable solutions exist.

DuPont supports the approach to phasing down the use of HFCs in S. 2754. The legislation has the opportunity to provide certainty and predictability to HFC regulation of energy-efficient insulation products like ours which have greenhouse gas savings that far exceed any impacts from HFCs in our products. We look forward to continuing our work with the Committee towards the passage of the legislation and achieving that goal. As part of that process, we hope the Committee will collaborate with us to develop a workable solution, such as a specialty carve out in those states that are pursuing their own programs.

Answers to Questions for the Record from Chairman Barrasso

1. Can you elaborate more on the interstate commerce issues that wholesalers and retailers of insulation foams would face under the current patchwork of state regulations?

Individual states moving to a patchwork of requirements across the nation will add complexity and cost (transportation, inventory, production, warehousing) into the supply chain. Our ability to supply customers, as well as our customers' ability to service consumers is put at risk with inconsistent state approaches to HFC regulation. Our operations are well established at multiple sites across the country with production sites and warehouses that service local demand as much as possible, helping to reduce costs and emissions related to transportation of our products.

A patchwork of state regulations would be disruptive to our supply chain as we try to service multiple product formulations required in these local geographies from different locations. Each state has unique requirements for building insulation in order to meet building codes which are directly linked to climate zones. Just because an XPS product is manufactured for one state does not mean that product will meet the requirements for a different state. Climate zones are the basis for building codes per the ICC.[1] As manufactures of highly energy efficient building insulation, we must consider code requirement impacts on our products on thicknesses, insulation values, moisture resistance and compressive strength among others. To see how this correlates with climate zones, see IECC and ASHRAE 90.1 standard found in the document referenced.[2] **Every product specification must be tested and certified prior to use. These products have numerous end uses in the building and construction (B&C) markets, such as foundations, roofs, walls, bridges, roadways, and other infrastructure.**

Additionally, a distributor or retail customer located in a state that has adopted new regulations but which services states that have not converted will be limited to selling only new formulation products, which may put them at risk for losing business to competitors who do not face this same constraint. Many XPS customers are small businesses who will be even more at risk dealing with these supply chain challenges.

We understand that the Extruded Polystyrene Industry Association (XPSA) is providing additional comments and we fully support its points for consideration.

2. Could an amendment of the AIM Act that added a critical use exemption for use of HFCs in insulation foam manufacturing and a federal preemption provision to ensure the exemption applies across all states address your concerns?

Yes, so long as the federal preemption provision prevents states from enacting or enforcing laws that require either a phase-out of HFCs in the exempted use or the phase-down of HFCs in the exempted use on a more accelerated schedule than that proposed by the AIM Act. DuPont believes the phase-down schedule in the AIM Act would provide enough time to develop HFC substitutes for our XPS B&C insulation foam products, but shorter transition timelines could jeopardize the industry. The duration of the critical use exemption needs to be long enough to allow the industry to develop cost-effective, technically equivalent alternatives to transition away from HFCs.

[1] https://basc.pnnl.gov/images/iecc-climate-zone-map

[2] https://www.energy.gov/sites/prod/files/2015/10/f27/ba_climate_region_guide_7.3.pdf

3. Can you explain why it is important to have sufficient lead time to implement a phasedown of HFCs?

We are prepared and planning for the phase-down of HFCs as outlined in the AIM Act. As noted above, our issue is not with the phase-down of HFCs in the AIM Act, but with a patchwork of state programs which reference SNAP at a point in time without sufficient time to transition to new products or without consistency in the implementation lead times of the various programs. Some states provided over two years in order to comply, while others are pushing for six months.

Additionally, we need states to reference EPA lists as they are being updated for substances approved for use, so that we can continue to innovate, improve the environmental profile of blowing agents for our foams, and improve product performance. However, this potential may not be realized in those states that have not included language that would commit them to adopting federal determinations

As noted above and explained below, sufficient lead time is necessary to transition our plants to safely manufacture acceptable alternative products, for several reasons. Historically we know that, given the XPS industries complex supply network, we need to allow 12-18 months from regulatory enactment for supply chain transitions alone to create business certainty and ensure that we avoid major supply chain disruptions. The supply chain transition timing is a small part of the overall development process required for new blowing agents and accounts for implementation of third-party validated R&D solutions at a manufacturing scale to produce witnessed products for code testing and certification within building and construction applications. The recent Covid-19 pandemic has created unprecedented new challenges to this transition timing, due to mandated restrictions across North America. External and internal capabilities have been impacted, and it will be some time before all testing operations can resume safely. It is anticipated that this will cause a delay of at least eight months.

Building foams consist of 15-20 components on average, one of which is the HFC-based blowing agent. When it is replaced, the rest of the formulation needs to be adjusted to ensure the same level of performance, service life and compatibility with the other components and equipment. The last conversions took the entire XPS industry thirteen years (1987 to 2010) to fully transition to non-ODS HFC blowing agents, and subsequently the XPS industry approximated a minimum seven-year transition to reduce HFC usage. This information was publicly shared with the EPA in comments from the industry association (XPSA) during the SNAP 20 & 21 rule making.[3] From a safety standpoint, any new formulation represents a significant change that requires extensive new flammability and applications testing for the personal safety of workers and residents that work or live in or near the structures where the foam is installed.

The process involves extensive testing over the course of many months in the lab and at customer locations, customer acceptance of new products, and updates of specifications and building codes. All significant changes to formulations require multiple building code certification approvals by code officials. Products must be manufactured with a code official witnessing the production and that material is then shipped for certification testing to their third-party sites. Many of the certifications are application specific, require construction of structures for testing, and significant lead time to align with the end-use or state or locality in which the material is used.

- As noted in Question #2, there are specific products manufactured for specific end-uses and corresponding climate zones as required by building codes, which are not universally used by every state. This means each state needs its own lead time for conversions.

[3] Docket ID No. EPA-HQ-OAR-2014-0198, XPSA letter dated October 20, 2014.

- The individual HFC replacements that meet the required insulative properties are flammable, which changes the safe handling requirements. This requires that the processing equipment and the building in which the manufacturing process occurs must be properly rated and permitted. If changes are needed, they require time and substantial investment. Plant changes require multiple levels of engineering and safety checks as well as personnel training. We take the safety of our manufacturing locations very seriously as reflected in our Responsible Care® membership.
- In addition to technical and safety issues, commercial issues must be resolved such as the availability of new ingredients, storage requirements, transportation requirements, and supply agreements.
- Adding to the lead time complexity is the large and bulky nature of XPS foams. Shipping it long distances has a negative impact on the carbon footprint of the product and is cost-prohibitive.
- As noted, significant delays in certification of products are being seen as a result of Covid-19 mandates, which have negatively impacted the ability of test labs to operate. Shutdown of labs has created a backlog of testing, which in addition to other constraints such as cease travel orders is now anticipated to cause a minimum delay of approximately eight-months.

We believe we will need at least 12-18 months to address the above challenges even after viable alternative products are identified and approved for sale or distribution to avoid supply chain disruptions and avoid negative impacts on the building and construction (B&C) industries.

4. Can you provide current examples of differing state requirements?

States including California, Washington, New York, Maryland, New Jersey, Vermont, Delaware, Colorado, Massachusetts, Connecticut, Rhode Island, Maine, and Hawaii have either adopted or are in the process of adopting the remanded SNAP Rule 20 and Rule 21 language, which forces a phase-out of some HFCs by January 2021 in XPS B&C insulation foam end-uses, making these state programs inconsistent with the AIM Act's phase-down timetable. The net effect of the federal and state programs not aligning is that there could quickly be two independent and conflicting compliance programs between state programs that adopt the former EPA SNAP regulations as of January 2017as well as adhering to the federal AIM Act.

Differences among the state requirements also have the potential to create compliance challenges for the XPS B&C insulation foam industry. All of the states that have enacted HFC legislation use the provisions from EPA SNAP Rules 20 and 21; however, they differ with respect to the deference they intend to give to future EPA enactments, and the associated level of commitment they provide to adoption those federal determinations. For example:

- California S.B. 1013 provides: "If the United States Environmental Protection Agency approves a previously prohibited hydrofluorocarbon blend for foam blowing pursuant to the Significant New Alternatives Policy Program, adopted pursuant to Section 7671k of the federal Clean Air Act (42 U.S.C. Sec. 7401 et seq.), *the state board shall expeditiously initiate a rulemaking* pursuant to this section or other existing legal authority to conform its regulation with that federal action." (emphasis added).

- New Jersey's bill A5583 provides: "If the United States Environmental Protection Agency approves a previously prohibited hydrofluorocarbon blend . . . *the department may propose a rule* . . . to conform the requirements established under this section with that federal action." (emphasis added).

While the California law requires the state to conform its listing rules to those issued by EPA, the New Jersey law suggests only that the state may exercise its discretion in deciding whether to adopt a blend approved by EPA. Different state responses to future federal HFC listing rules could threaten the XPS B&C insulation foam industry by creating conflicting regulations, with some states adhering to the federal listings and some continuing to apply their own more prohibitive requirements. **This becomes a greater problem as the number of states creating inconsistent programs increases, as they are on track to do effective January 1, 2021.**

5. In addition to the study provided in footnote #7, is there more data you can provide showing the greenhouse gas (GHG) impacts of HFC foam building insulation?

Yes, there are numerous studies that support the improved GHG profile of buildings that use high quality XPS foam building insulation.

Footnote #7 in the DuPont testimony is a peer-reviewed study titled *Life Cycle Greenhouse Gas Emissions Reduction from Rigid Thermal Insulation Use in Buildings*, published in the Journal of Industrial Ecology. The study was administered using Styrofoam™ Brand building insulation in its current formulation, and therefore demonstrates that our current product saves 28 times the emissions required to manufacture it over the life of a building. In addition to the lengthy lead time requirements outlined in Question #3, when making blowing agent transitions, viable solutions must meet product performance and safety requirements, all local and national building codes and standards, be commercially available, and cost-effective. Moreover, a viable solution must also ensure environmental benefits of our products are met, so that building emissions reductions (and homeowner heating and cooling bill reductions) continue to result from the use of our product.

A separate study demonstrated that "the role of thermal insulation in the future reduction of carbon dioxide emissions is undeniable" by showing the technical saving potential through the more widespread use of thermal insulation on buildings in Europe alone is estimated at more than 350 Mtonnes CO2 -eq/yr. [4]

According to a recent McKinsey report on energy efficiency, insulation is a key lever for improving efficiency.[5] Heating accounts for 80% of the buildings' sector energy consumption, demonstrating that energy efficiency could provide significant energy savings.[6] Furthermore, it is reported in the recent C-40 & McKinsey report titled *Focused Acceleration: A strategic approach to climate action in cities to 2030* that "optimizing energy efficiency in buildings could yield 3X the reduction potential from current trends in meeting their Paris Agreement targets."[7] And it states new buildings with better insulation and older buildings with improved insulation "reduce building heating and cooling demand by about 40%". **This also enables the installment of fewer and smaller HVAC systems that "could also significantly reduce the emission of HFCs from cooling systems**."[8] Several other independent reports point to similar findings citing that the use of high performing building insulation and air sealing products can help to reliably meet energy demand and supports regional and international environmental goals.[9] [10]

---

[4] Petersdorff et al., 2002. https://archive.ipcc.ch/pdf/special-reports/sroc/sroc07.pdf

[5] Energy Efficiency: A Compelling Global Resource. McKinsey Sustainability & Resource Productivity. McKinsey & Company, 2010. Page 21. Last viewed on April 7, 2020. Downloadable online at https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/Sustainability/PDFs/A_Compelling_Global_Resource.ashx

[6] Energy Efficiency: A Compelling Global Resource. McKinsey Sustainability & Resource Productivity. Page 23.

[7] Focused Acceleration: A strategic Approach to Climate Action in Cities to 2030. Joint Report by McKinsey Center for Business & Environment & C40. November 2017. Last viewed on April 7, 2020. Downloadable online at https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/a-strategic-approach-to-climate-action-in-cities-focused-acceleration

[8] Focused Acceleration: A strategic Approach to Climate Action in Cities to 2030.

[9] Insulation" Webpage, Energy Saver, Office of Energy Efficiency & Renewable Energy, Department of Energy. Last viewed on June 6, 2018. https://www.energy.gov/energysaver/weatherize/insulation

[10] Building green with energy-efficient materials: Insulation. United States Green Building Council. Sep. 7, 2016. Last viewed on June 6, 2018. https://www.usgbc.org/articles/building-green-energyefficient-materials-insulation

6. Are there technical or safety limitations with HFOs that make them unsuitable for your end use?

Yes, there are many technical and safety concerns, and limitations with using HFO in XPS B&C insulation foam. When submitting for SNAP application approval listing, the blowing agent manufacturers are required only to test small scale gas samples showing that the blowing agent doesn't change chemical composition during the processing of XPS. **The blowing agent manufacturers lack our proprietary capability to test all of the XPS board types and the full range of required United States applications and fire testing standards that must be completed prior to commercializing XPS products.** As such, it is not surprising to find that assumptions concerning the use of HFOs in XPS were not entirely correct. HFOs are not drop-in replacements of HFCs.

As the original inventors of XPS technology, DuPont intimately understands foam technologies and is responsible for the performance and safety of our products during manufacture and in the markets we serve. Additionally, it is important to recognize that the XPS building and construction products manufactured, governed and sold in North America are unique and specific to the regional markets.

As the United Nations Environment Programme (UNEP) Technology and Economic Assessment Panel (TEAP) noted in 2014, there are no longer 'drop in solutions' for insulation products as these formulations are complex and substitutes are becoming increasingly more difficult to invent.

> *"Although it is assumed that initial screening of alternatives will determine their suitability for the applications previously served by ODS, it is not always the case. The recent experience with the stability of unsaturated gaseous HFCs/HCFCs in certain low-pressure PU formulations in the United States of America, serves as a timely reminder that* ***alternatives are unlikely to be absolute 'drop-in' replacements and, even with reformulation, are not guaranteed to meet the requirements of the application. In addition to the specific capabilities of an alternative, it is increasingly the case that the range of applications served by a single alternative is reducing.*** *This is partly because of the undeniable versatility of earlier technology options (e.g. CFCs), but the trend also reflects the fact that technological developments over the past 20 years have made the users of alternatives more discerning.* ***There are now many more solutions available to choose from, but a need to apply greater scrutiny in decision-making to ensure continuing competitiveness in an increasingly globalised market."*** [11]

Background: Desirable blowing agents have many requirements for achieving optimal performance

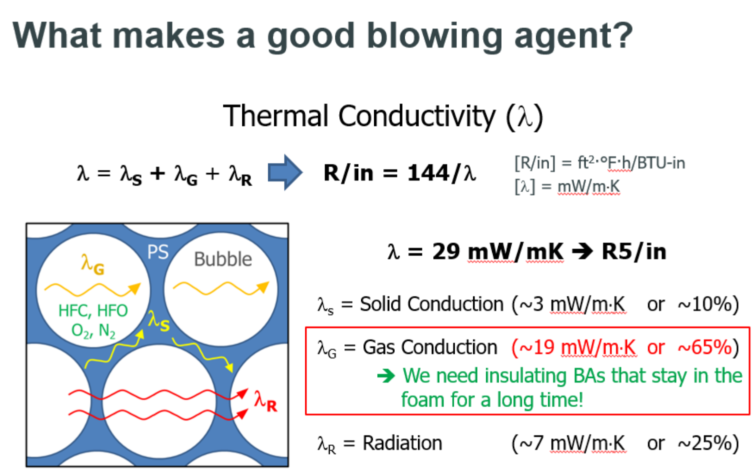
Regulation and legislation associated with foam blowing agents typically considers only the environmental aspects specific to a blowing agent. It is instructive to step back and consider the varied roles of the class of chemicals denoted as "blowing agents." **It is critical that foam blowing agents are considered viable alternatives only if they meet the requirements for manufacture and industrial hygiene, as demonstrated below.** Blowing agent alternatives must also meet environmental, hazard, economic and functional or performance properties to be considered a solution. Multiple building codes, industry standards and other certifications must also be met after the product is produced prior to commercialization. Therefore, R&D of blowing agent alternatives requires a complex product assessment that touches on a multitude of factors.

First and foremost, a blowing agent must have sufficient solubility in the polymer. Only by being sufficiently soluble can a uniform cellular structure be generated yielding desired mechanical properties. Blowing agents

[11] UNEP "Report of the Technology and Economic Assessment Panel" May 2014 Volume 4 Decision XXV/5 Task Force Report. Page 19 & 23.

should have sufficiently high vapor pressure, in other words they need to be gaseous, so that it can "blow" a low-density foam.

To achieve a thermal insulating foam, the blowing agent should have low thermal conductivity (i.e., it doesn't transfer heat) and low permeability (i.e., it stays put) to achieve long-term thermal insulation performance. The many desired requirements for a blowing agent are shown below to provide insight into the parameters considered when reformulating for closed cell blown foam applications. The closed cell structure of XPS foam is also depicted below on the right and illustrates how the blowing agent is a key component to high energy efficient building insulation. The closed cell structure refers to the fact that gas has to be confined in a closed cell or bubble, it needs to stay there for long term thermal performance (we guarantee our continued product performance through a 50-year warranty), and it needs to resist the transfer of heat.



<u>Lack of viable blowing agent alternatives to HFC for foam insulation</u>

Alternates promoted by refrigerant suppliers (such as HFO-1234ze) as a "drop-in" replacement for HFC-134a in XPS have proven to have challenges in practice. Research work by DuPont has shown that HFO-1234ze as a sole solution is insufficient in its ability to "blow" low density foam across the DuPont product mix. Additionally, HFO-1234ze presents challenges within the XPS process where humidity and elevated temperatures yield its flammability rating more stringent (A2-A2L) than initial technical data communicated to the industry suggested. Multiple published studies have uncovered these issues and were evaluated as a part of our R&D studies to fully understand the flammability rating relevant to the XPS process. Dow/DuPont undertook work to address design and safety factors necessary for engineering controls within manufacturing facilities. These studies were completed via external labs over the course of many months. All of this third-party data as well as studies performed by other entities was shared with the supplier and published publicly. [12]

Industrial hygiene safety concerns, and the capability of handling flammable blowing agents in a humid, elevated temperature process require investment and safety factors to be put in place to manage this risk at each unique manufacturing location across the United States. **There is also no clear agreement or industry protocol on how to**

---

9 Comprehensive Evaluation of the Flammability and Ignitability of HFO-1234ze; R.J. Bellair, L.S. Hood, Process Safety and Environmental Protection, In Press (2019).

handle HFO-1234ze, thus engineering controls specific for each installation that are required <u>must be developed</u>. Since this is a new conversion, there do not yet exist definitive Environmental Health & Safety guidelines on how to handle HFO-1234ze in all manufacturing end uses, adding another layer and scale of complexity.

<u>Engineering controls:</u>

- Under certain conditions, the HFO-1234ze is more flammable than A2L (behaves more like A2)[1]
- Flammability limits have proven highly dependent upon several factors
- Minimum ignition energy has also proven dependent upon the type of energy source
- No clear agreement on the best way to handle this material globally (UN & Japan & others) making it impossible to design appropriate engineering controls without site/process specific research

<u>Complexity at scale which must be addressed prior to implementation transitions and certifications:</u>

6.1.5 Safety Classification of Refrigerants

(add A2L and B2L classifications to Figure 1 as shown)

	Safety group	
Higher Flammability	A3	B3
Lower Flammability	A2 <u>A2L</u>*	B2 <u>B2L</u>*
No flame Propagation	A1	B1
	Lower Toxicity	Higher Toxicity

<u>*A2L and B2L are lower flammability refrigerants with a maximum burning velocity of ≤ 10 cm/s</u>

- Increased industrial hygiene safety concerns from formation of toxic Hydrogen Fluoride (HF) due to the HFO double bond
- XPS: Flammability performance during manufacturing with an A2L
- Implementation of engineering controls; storage, handling, product shipment
- Implementation times
- Permits and capital authorization for plant upgrades with A2L

DuPont is currently placing great effort in developing safe handling guidelines so that we can convert each manufacturing operation to use these new technologies. The development of these guidelines is complex and contributing to pushing out timelines for conversion solutions. Please also see our answer to Question #11 for further information.

Answers to Questions for the Record from Ranking Member Carper

7. Does DuPont support adding language to the AIM Act that would preempt states from regulating any action related to the production, consumption and usage of HFCs, knowing that this addition would prevent the passage of the legislation?

DuPont supports the approach to phasing down the use of HFCs set out in S. 2754. We also believe that the legislation presents an opportunity to provide certainty and predictability to the regulation of HFCs in energy-efficient insulation products, such as XPS foam. We look forward to continuing our work with you and Chairman Barrasso towards achieving that goal and the passage of the legislation.

DuPont is <u>not</u> promoting the idea that the AIM Act must include blanket/explicit state preemption. Rather, DuPont is asking for a unique, [time-limited?] carve-out for the XPS industry only to support alignment for states, so we can continue to supply states with our energy efficient building products which will help them achieve building efficiency improvements and their state climate/emissions reduction goals. **DuPont has been flexible in devising solutions to the issue and will continue to be creative in working with the Committee towards including a solution in the AIM Act.** Some examples include grandfathering states that have completed programs as of today, or within a short timeline, or providing a safe harbor for several years before states can create individual programs of their own.

To reiterate, DuPont is supportive of the AIM Act and hopes that the bill can become law as soon as possible, with a solution for our unique issue for XPS B&C insulation foam which is a niche use of HFCs compared with the HFC uses by other industries.

As mentioned in our testimony:

> *A potential path forward to achieving this goal would be a limited carve out for these highly energy efficient building insulation products that we could accomplish by deferring to EPA's determinations on whether to approve HFC blends in our industry and by prohibiting state laws that are inconsistent with those EPA determinations, while preserving existing state authorities to regulate HFC blends in this sector that have a higher global warming potential.*

8. Of the HFC compounds that are being used by DuPont for its XPS foam products, on average how much does the industry use on an annual basis (in tons and GWP-weighted tons) now?

DuPont is not a supplier of HFCs, nor can we speak on behalf of the XPS industry, as we do not have industry-wide data. DuPont's use of HFCs is proprietary, confidential business information (CBI) that we unfortunately cannot share in a public forum. Instead, we share information and examples compiled from a variety of EPA sources to demonstrate who is responsible for GHG reporting, and how those numbers have looked over time. Of note, the HFC emissions from closed cell foam relative to other applications is significantly lower since the HFC is purposely trapped in the foam (see Question #6 above).

The EPA has specific emissions reporting norms around HFC volumes[13] and CBI.[14] For more relevant information, please see references and quotes below:

> "The Greenhouse Gas Reporting Program (GHGRP) covers emissions of these compounds by requiring specific facilities **that emit** significant quantities of these compounds to report their annual emissions. These emitters include *producers* of fluorinated gases and *other emitters* of these gases. The GHGRP also requires companies **that supply** these compounds (i.e. *producers, importers* and *exporters*) to report the quantity of each gas supplied each year." [11]

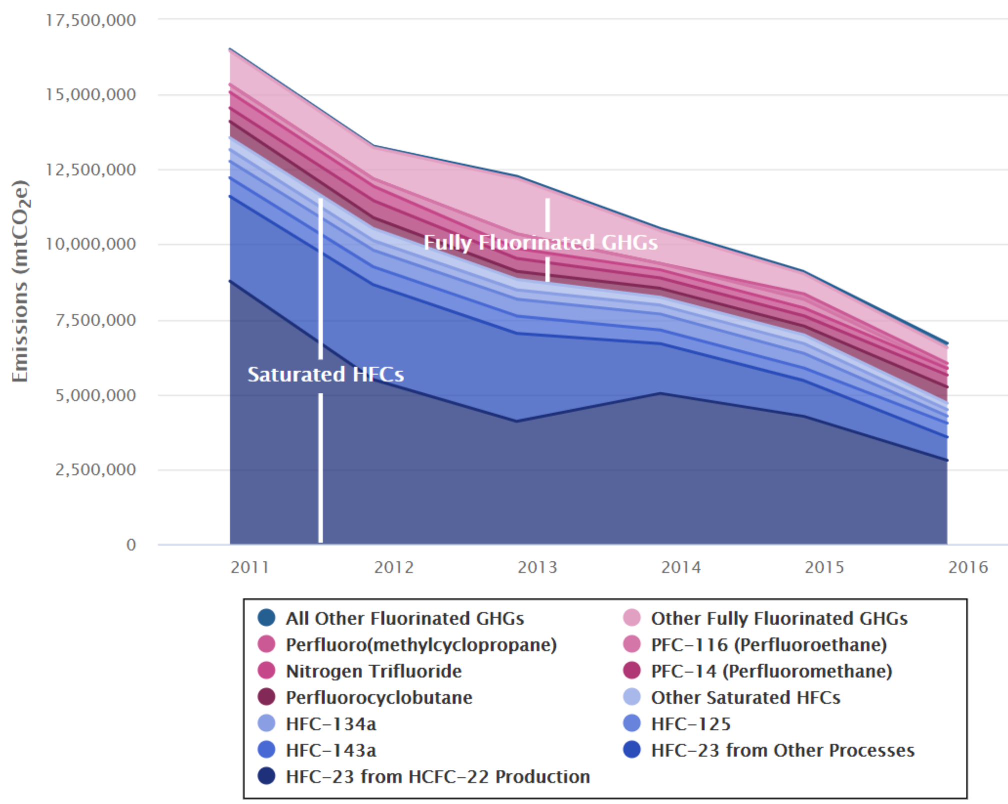
> *"In response to the FY2008 Consolidated Appropriations Act (H.R. 2764; Pub. L. 110–161), EPA created the GHGRP, 40 CFR part 98 (part 98), which requires reporting of greenhouse gas (GHG) data and other relevant information from large sources and suppliers in the United States. Some of the reported information is designated as CBI. Such information is handled in accordance with EPA's regulations in 40 CFR part 2, subpart B and in accordance with EPA procedures consistent with those regulations."* [12]

---

[13] Visit https://www.epa.gov/ghgreporting/fluorinated-greenhouse-gas-emissions for a diagram of the types of facilities that report and for links to the data.

[14] *For further information on CBI related to the GGRB, including a listing of reporting data elements and whether or not they have been determined to be CBI, please see the following site:* https://www.epa.gov/ghgreporting/confidential-business-information-ghg-reporting

According to the EPA website on Greenhouse Gas reporting, as of calculations on 8/5/2017 fluorinated gas emissions by producers had fallen by 9.7 MMT CO2equivalents from 2011 to 2016 to due increases in voluntary controls, as seen in the graph below.[15]



The EPA report also outlines the suppliers net supply of HFCs. **"**Suppliers of GHGs include producers, importers, and exporters of industrial gases (including F-GHGs) and importers and exporters of F-GHGs in pre-charged equipment (e.g. air conditioners, circuit breakers) and closed-cell foams. All producers must report." [16] **This report shown in the table below shows a small annual increased use in HFCs in all products and all foams, which should be expected as the 2011 to 2016 timeframe captures conversion from previous ozone depleting potential compounds to HFCs, as mandated by the EPA.**

Foam manufacturers that use HFCs fall under the Subpart QQ of the mandatory reporting included in this table. The EPA site clearly notes "This sector comprises industrial greenhouse gas (GHG) suppliers and entities that import or export certain products that contain fluorinated greenhouse gases. These suppliers **do not report direct emissions, but instead report the equivalent quantity of CO_2 that would be emitted if the gases that they produce, import, or export each year were released to the atmosphere**." In the case of XPS closed cell foam, the actual emissions based on $CO_{2(eq)}$ is a fraction of the amount used in the production of the foam.

Of important note in the table, within "foams", the EPA data below captures much more than just XPS foams. "Importers and Exporters of (1) equipment that is pre-charged with fluorinated greenhouse gases (e.g., electrical equipment and air conditioners) and (2) closed cell foams containing fluorinated greenhouse gases (e.g., insulation contained inside refrigerators; insulation boardstock) report under Subpart QQ."

[15] https://www.epa.gov/ghgreporting/fluorinated-greenhouse-gas-emissions
[16] https://www.epa.gov/ghgreporting/suppliers-industrial-ghgs-and-products-containing-ghgs

Quantities (Net Supply) of GHGs Reported
(Quantities are presented in million metric tons per year of net CO_2e^a)

Gas Type	2010	2011	2012	2013	2014	2015	2016	2017
Saturated HFCs in bulk, excluding HFC-23	235[c]	241[c]	227[c]	278[c]	254[c]	264	240[d]	285[e]
Sulfur hexafluoride (SF_6) in bulk	18	34	35[c]	27	30	25	25	22
Imports and exports of Saturated HFCs in products and foams	N/A	7.39	17.7	16.6	24.6	26.2	28.1	[b]
SF_6 imports and exports in pre-charged equipment	N/A	-0.25	[b]	-0.18	-0.16	-0.14	-0.13	-0.12

[a] Net supply or net CO_2e means CO_2e quantities of bulk gas produced + imported – exported – transformed – destroyed.
[b] At this time, the aggregation does not meet EPA's criteria for ensuring that CBI is protected.
[c] As of 8/15/15.
[d] As of 12/8/17.
[e] As of 11/19/18.
All other values are as of 8/5/17.

Bulk gas suppliers and importers and exporters of equipment containing fluorinated GHGs also report quantities of other fluorinated GHGs supplied (not shown).

As we have noted in Questions #6 and #11, **XPS is designed to retain blowing agents for maintenance of important performance criteria (e.g. thermal R-value, compressive strength),** and as a result blowing agent losses are low, particularly in the use phase, so short-term emissions from these foam insulation products will not be significant compared with the long-term GHG emissions reduction attributed to heating/cooling reductions when the foam is used.

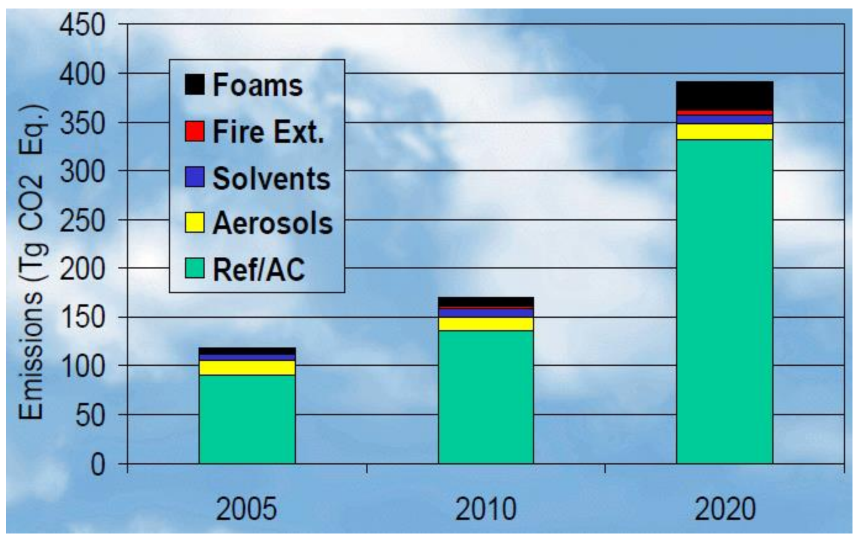
See Question #9 for further information on the foams portion of this emissions data quantity.

9. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your member companies on an annual basis?

As mentioned in the response to Question #8 above, DuPont is not a producer or supplier of HFCs, cannot divulge CBI in a public forum, and cannot speak on behalf of the entire XPS industry. However, we can show data from federal and California reports that illustrate the small HFC use of the XPS B&C insulation foam industry. As with information provided in response to the previous question, please note that the best publicly available data showing use of HFCs to illustrate the division of the market is based on HFC emissions percentages rather than quantities in tons.

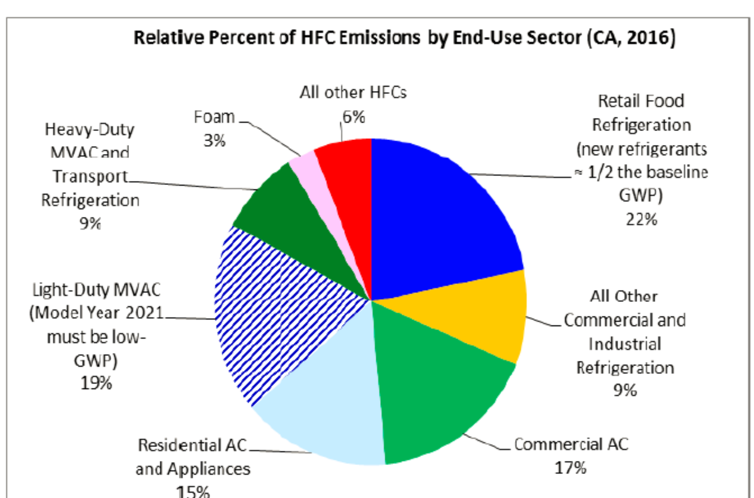
Additionally, please note that our XPS insulation products only use HFCs in the manufacture of the closed-cell foams to trap the gas and improve insulation values. Unlike HVAC and other larger user groups that must refill systems consuming new HFC material, **XPS products do not continue to consume or require new HFCs over time.**

The Climate Action Plan that was published June 2013 states that refrigeration and air conditioning are the primary industrial sectors that contribute to GHG emissions derived from HFCs. Foam insulation constitutes a small portion of the overall GHG emission profile of HFCs. As in Question #8, the graph below shows a small increased use in HFCs in all foams, which should be expected as EPA mandated these products move from HCFCs to HFCs and building energy efficiency codes required improved building profiles.



U.S. emission modeling profiles from HFC-based products within various market sectors. Modeling Emissions of High Global Warming Potential Gases, D.S. Godwin, M.M. Van Pelt, K. Peterson,2003.

Additionally, a chart by the California Air Resources Board (CARB) shows that foam end uses are only 3% of total HFC emissions in California. This California model is a reasonable base line for extrapolation.



"Figure H-1. Relative Percent of HFC Emissions by End-Use Sector (CA, 2016) of Total Estimated 19 MMTCO2E HFC Emissions," Potential Impact of the Kigali Amendment on California HFC Emissions. October 15, 2017, CARB

XPS insulation foams are designed to reduce building energy consumption over sustained time periods with very low diffusion rates of HFCs from the boards in use. In other words, our XPS insulation product is designed to retain its performance over the life of a building. DuPont's 50-year XPS product warranty is based on thermal insulative stability from the contribution of HFC gas remaining in the closed cell structure as noted in Question #6.

The calculated contribution of XPS emissions, based on published CARB and U.S. Climate Action data, is miniscule compared to the major industry uses for HFCs. When considering the XPS fraction of building foam (17.6%) and the fraction of emissions XPS foams yield as a result of low diffusion rates, the HFC emissions equate to less than 0.5% of the overall emissions yet the XPS foams have a favorable contribution toward the GHG reduction of buildings over their lifetime.

- The diagram below shows that building foam comprises 60.7% of all HFC using foams in California,
- And XPS comprises 29% of that building foam subset.
- Therefore, XPS represents 17.6% of all foam (0.607*0.29=0.176).
- Given that that foam end uses are only 3% of total HFC emissions in California, as noted above in the CARB pie chart, we can see how minimal the XPS emissions can be estimated to be.
    - The HFC emissions related to XPS are at most 0.5% of all HFC emissions (0.03*0.176=0.00528).
    - This assumes that it is not a closed cell foam, however, XPS B&C insulation foam is a closed cell foam, so in reality the emissions number is only a fraction of the 0.5%.

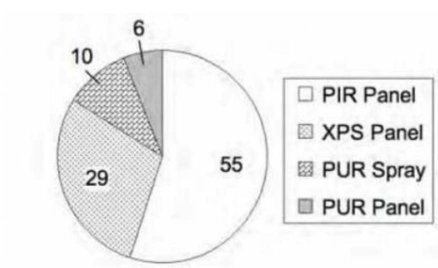


Figure 2.1 Average Building Insulation Foam Consumption in California by Material Fraction (Percentages) (1960-2009) (Caleb 2011)

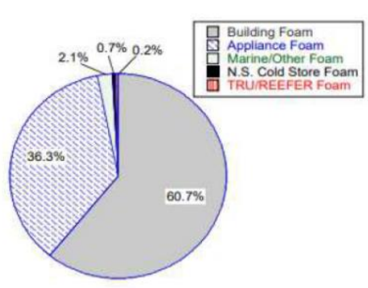


Figure 7. Foam Consumption in California by Application (from Caleb 2011)

Emissions of Potent Greenhouse Gases from Appliance and Building Waste in Landfills

Final Report

CARB Agreement Number: 11-308

Principal Investigators:
Nazli Yesiller
James L. Hanson
Jean E. Bogner

Prepared for:
The California Air Resources Board and The California Environmental Protection Agency

Prepared by:
Nazli Yesiller
James L. Hanson
Global Waste Research Institute
California Polytechnic State University
One Grand Avenue
San Luis Obispo, CA 93407
(805) 756-2932

May 31, 2016

10. Do you project HFC usage will grow or shrink over the next 15 years?

DuPont is a niche end user of HFCs for high energy efficiency B&C insulation foams. The largest users of HFCs are refrigeration and AC/HVAC. Accordingly, we cannot speak to the overall use of HFCs.

It is important to note that there are many types of HFCs, and they have varying global warming potential (GWP) and flammability profiles. It is our belief that the use of higher GWP HFCs for XPS will shrink in the next 15 years as the product is further refined. This is driven by our industry and our customers who constantly strive to improve the environmental profile of our products regardless of regulatory action. Our industry relies heavily on standardized processes to evaluate these profiles, such as Environmental Product Declarations and Life Cycle Analysis, which are required to obtain various accreditation prior to use in many required LEED building projects.[17]

It is very important that we have access to safe and cost-effective alternatives. Building infrastructures are already extremely costly, and ever-increasing demands for energy efficient buildings will continue.

11. Has DuPont considered using HFC-alternatives? If not, why not? If so, please provide details of your efforts to develop or find substitutes for HFCs and if there is there anything about those alternatives that cause concern for future compliance with the bill.

Yes, we have considered and evaluated alternatives and provide details below as well as above in Question #6. We do not manufacture blowing agents and are not developing new compounds for this use. Therefore, our efforts must focus on finding ways to use commercially available materials as alternatives to current blowing agents.

Our R&D program has been engaged on this issue since 2015. Following the 2017 legal roll-back of the SNAP rules that impacted our products, the R&D program was forced to focus more on changes in flame retardants to ensure ability to comply with those enforceable urgent regulations, which diverted resources from blowing agent optimization research which had been placed in a regulatory vacuum. Additionally, our blowing agent R&D program was forced to complete basic research on the flammability of HFO alternatives due to the lack of supplier and industry data relevant to our specialized handling process during the manufacturing of building insulation foams.

Finding a new blowing agent for XPS follows a multi-step iterative process which requires a <u>complete reformulation</u>, including raw material needs such as fire retardants, to capture a final product <u>that meets all regulatory requirements</u> (state and federal) for sale. This includes evaluating individual components for regulatory compliance with TSCA listing and other requirements including toxicology evaluations for safe handling.

As we have been developing formulations to meet regulatory requirements, we are managing properties and tuning the blowing agent compositions to align with performance metrics for building and construction applications. These formulations need to accommodate the breadth of our product offerings which range in vertical compressive strengths to accommodate high loads under concrete to those used in non-load bearing applications such as walls. A singular HFO blowing agent solution has not satisfied the requirements across this product mix.

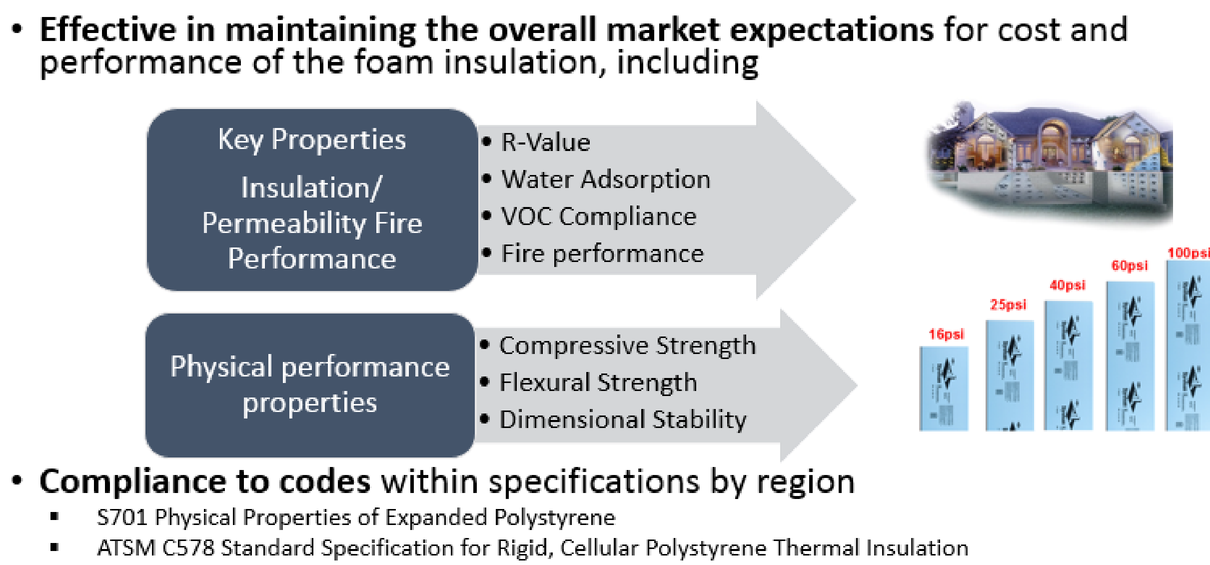
---

[17] https://www.usgbc.org/leed.

There are several **product factors** to consider when evaluating a blowing agent:

- Manufacturing sites do not currently handle flammable materials.
- We must take steps to mitigate risk during the shipment and storage of new materials at our sites.
- Use of flammable blowing agents presents unique challenges to making products which meet code qualification testing. This equates to longer development lead times.

Overview of the items that are considered "Critical to Quality" for XPS foam on performance testing which allow product to pass building codes tests:



Fire and application testing to comply with building code requirements include small scale tests such as LOI (which align well to pilot scale development) to application scale test such as NFPA286 which require manufacturing scale product and large-scale assemblies to complete testing. Application tests as a result are not completed until manufacturing production is feasible (late in the development phase). The flammable nature of the blowing agent can impact the performance of the foam in these tests which have a feedback timeline late in the development phase. Extruded Polystyrene (XPS) Boardstock fire and application testing required:

- ASTM C578 for durability/dimensional stability Types X/IV/VI/VII/V Also includes WVP, Water Absorption, compressive resistance, density, oxygen index, flexural strength, cell size
- Cell balance requirements for fabrication cut ability and routing where thermal performance is required
- ASTM E84 &/or UL 723 Flammability standards
- FM 4450/4470- class 1 Roof Decks fire and wind
- UL 263- hourly rated walls fire test
- UL-790/E108 exterior roof fire tests
- UL580 and UL1897 wind load test
- Energy efficiency (R-value) is included in C578, the method is C518 for 3 out of the 4 options granted we will not meet R-5
- For XPS we also have additional sustainability requirements: Environmental Product Declarations, ULE recycle content certification, C2C
- California requires our code reports from ICC-ES - tested per AC71 and UL723 and UL reports (C578)

We have evaluated numerous alternatives. None have proven to be singular drop-in solutions that are capable of meeting all performance metrics across our product portfolio.

- Hydrocarbon technology is well understood, and it has been broadly deemed as inappropriate for use as a blowing agent for XPS building and construction products. Additionally, hydrocarbons are considered volatile organic compounds which contribute to smog and other issues and are under other regulatory pressures to be phased down.
- Blowing agents such as HFC-152a and CO2 are not singular solutions for several reasons; chief among them are solubility and a high thermal conductivity which lowers insulation properties.
- Singular HFO-1234ze and singular HFO-1233zd present challenges to handle safely in production facility for several reasons including lack of expansion to fill out board which leads to process instability.

Please see our response to Question #6 for further details on blowing agent requirements and issues with HFO alternatives.

To respond to the question on future compliance with the bill, we are confident that we can successfully navigate the negotiated rule making process with the EPA for our end use as required by this bill. Our current concern is with states that are taking action without a federal framework and without providing appropriate lead time.

DuPont supports the approach to phasing down the use of HFCs set out in S. 2754. The legislation has the opportunity to provide certainty and predictability to the regulation of HFCs in energy-efficient insulation products, like ours. We look forward to continuing our work with you and Chairman Barrasso towards achieving that goal and the passage of the legislation.

12. Prior to 1990, there were over sixteen states that had taken action, or were in the process of taking action, to restrict the use of Chlorofluorocarbons (CFCs). In the Clean Air Act Amendments of 1990, Congress created a federal program to phase out CFCs in Title VI of the Clean Air Act. Rather than preempting state actions, Congress preempted the enforcement of state CFC regulations for two years. Once EPA had a strong CFC federal program in place, the state programs for the most part went away on their own. Why specifically do you expect states will act differently in terms of HFCs if a federal regulatory program is created? Given the history why should HFCs be treated differently than CFCs in terms of state preemption?

The 2-year preemption provision included in the 1990 Amendments, section 614(a) of the Clean Air Act, would not be workable for HFCs in XPS B&C insulation foam end-uses. Section 614(a) is limited to preempting states from *enforcing* their laws, rather than preempting states from *enacting or continuing* the application of their laws. If language for the AIM Act were based on section 614(a), during the 2-year block on enforcement, states could still have regulations on the books that prohibit certain HFC blends, thus putting companies in the untenable position of knowingly violating state laws.

Another concern is that after expiration of the 2-year period, state approaches would diverge, with some quickly taking measures to enforce existing regulations or enacting new regulations to restrict HFCs, and others continuing not to act. This would cause significant regulatory uncertainty and disruption to interstate commerce, whereas following the phase-down schedule set by AIM Act would allow a smooth transition. With CFCs, the potential for states to take different approaches after the 2-year enforcement ban was limited by the fact that the federal legislation mandated a phase-out of CFCs. Because the AIM Act only requires that HFCs be phased down, there is more room for states to adopt a conflicting approach, i.e., to force a phase-out.

The section 614(a) language is also not a good model for the HFC legislation because it applies only to state regulation of appliance designs, not to regulation of HFC blends. The scope of the 614(a) provision is limited, as "appliance" is defined to include only "any device which contains and uses a class I or class II substance as a refrigerant and which is used for household or commercial purposes, including any air conditioner, refrigerator, chiller, or freezer." This provision did not invalidate state statutes that regulate ozone-depleting substances outside of appliances, and as such, the fact that it was successful in this limited application pertaining to appliances does not mean that it would work in context of HFC blends in XPS B&C insulation foam.

Finally, only blocking state regulation for 2-years is not practical for HFCs. As noted the quote by the UNEP TEAP in Question #6, unlike in the case of the CFC/HCFC phase-out, where new substitutes were more readily available, conversions are becoming more difficult. Today we need greater flexibility to make the transition because some of our products have significant technical difficulties in moving away entirely from HFCs. Companies such as DuPont need more time to transition to technology that is not currently available and within our processes. The phase-down schedule proposed under AIM Act provides the time and flexibility that we need to effectively phase-down the use of HFC blends.

Answers to Questions for the Record from Senator Whitehouse:

13. What is the total volume of HFCs for which there is no acceptable substitute used by the foam industry? Please list each such HFC and the volume used. Please state the reasons why potential substitutes (if they exist) are unacceptable.

Please see our answers to Questions #8 and #9 on HFC volumes, and Questions #6 and #11 on substitutes.

14. By what percentage has use of such HFCs been growing over the last five years? Please list each such HFC and its growth rate over the last five years.

Please see our answers to Questions #8 and #9.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for
Truck & Engine Manufacturers Association

Chairman Barrasso

1. Because states are implementing differing regulations to phasedown HFCs, is EMA concerned about interstate commerce issues if federal preemption is not included in the AIM Act?

   RESPONSE: The Truck and Engine Manufacturers Association (EMA) and its member companies are concerned about states regulating HFCs. Truck and engine manufacturers produce heavy-duty vehicles that operate in interstate commerce. They are low-volume, highly customized vehicles designed and produced in an extremely wide variety of configurations to perform diverse commercial functions. It is crucial that heavy-duty truck and engine manufacturers have one set of nationwide regulatory requirements for their products. It is harmful to the heavy-duty industry for manufacturers to be required to develop and produce trucks to a state-by-state patchwork of regulatory requirements.

2. Can you provide any more information about the potential cost impacts of transitioning heavy trucks from HFC-134a to HFO-1234yf?

   RESPONSE: Heavy-duty trucks come with many different cab sizes, from small day cabs for an intracity delivery truck to "condominium" double-bunk sleeper cabs for cross-country team drivers, and those diverse cabs demand many unique air conditioning systems. Redesigning and validating those diverse air conditioning systems to utilize HFO-1234yf instead of HFC-134a would require extensive human and capital product development resources. Additionally, manufacturers would need to redesign manufacturing plants and service facilities to utilize HFO-1234yf, taking into account the higher flammability of the new refrigerant. Significant investments in heavy-duty product and facility upgrades would be needed to convert to HFO-1234yf, and it would take manufacturers approximately five years to complete the changeover.

   HFO-1234yf and the air conditioning system components needed for the new refrigerant currently cost significantly more than HFC-134a. Some of those costs may scale down as the higher-volume passenger car industry converts to HFO-1234yf; however, those lower costs may not be realized with air conditioning system components because heavy-duty vehicles often use unique parts and suppliers.

3. Can you explain why it is important to have sufficient lead time to implement a phasedown of HFCs?

RESPONSE: The Environmental Protection Agency's (EPA's) Significant New Alternatives Policy (SNAP) program currently identifies HFO-1234yf as ***unacceptable*** for use in vehicles with a gross vehicle weight rating (GVWR) greater than 14,000 pounds. Accordingly, before truck manufacturers can begin the process of transitioning their products and facilities from HFC-134a to HFO-1234yf, EPA must evaluate HFO-1234yf and complete a rulemaking to designate it is acceptable for use in vehicles with a GVWR greater than 14,000 pounds. Only after EPA completes that evaluation and rulemaking could heavy-duty truck manufacturers lawfully begin the long process of redesigning all of their air conditioning system variants for their diverse truck product lines, validating the new designs, and upgrading their plants and service facilities for the new refrigerant. In summary, two sequential developments must happen before a phase-down of HFC-134a: (i) EPA must complete a rulemaking to allow the use of HFO-1234yf in heavy-duty trucks, and (ii) truck manufacturers would then have to redesign their products and facilities to use the new refrigerant.

Heavy-duty truck and engine manufacturers generally require at least four years of leadtime to develop products to comply with a new regulatory standard from EPA, and at least three years of stability between regulatory changes to allow time to recoup the up-front investments in product development and production tooling. The minimum of four years of regulatory leadtime and three years of regulatory stability are codified in the Clean Air Act. See, 42 U.S.C. § 7521(a)(C). Heavy-duty manufacturers are currently developing products to must meet stringent new EPA greenhouse gas reduction standards in 2021, with further reductions in 2024 and 2027; and it is very likely that EPA will target 2027 for implementing the Cleaner Trucks Initiative NO_X emissions reduction program.

4. Do you have concerns that the broad language of the current phasedown provisions of the AIM Act, including the accelerated schedule and technology transitions provisions, do not adequately figure in cost and other considerations?

   RESPONSE: We are concerned that the AIM Act could restrict the availability and increase the price of HFC-134a before EPA approves HFO-1234yf for use in heavy-duty trucks, and following that before truck manufacturers are able to transition all of their products and facilities to the new refrigerant.

5. Do you have language recommendations for improving the AIM Act?

   RESPONSE: To protect truck manufacturers, the AIM Act should be modified to add the following targeted paragraphs:

   - **Sec. 6. Phase-Down of Production and Consumption of Regulated Substances.**
     (b)(5) Limitation - The Administrator shall not apply the production and consumption phase-down percentages under paragraph (b)(1) for HFC-134a until the period beginning January 1, 2029, or five years after designating HFO-1234yf as *acceptable for use* in vehicles with a GVWR greater than 14,000 pounds, whichever is later.

- **Sec. 7. Accelerated Schedule.**
  (e) Limitation – The Administrator may not promulgate a regulation under subsection (a) that establishes a production or consumption phase-down of HFC-134a that takes effect before January 1, 2029, or five years after designating HFO-1234yf as *acceptable for use* in vehicles with a GVWR greater than 14,000 pounds, whichever is later.

Ranking Member Carper:

6. Of the HFC compounds that are being used by your member companies today, on average how much does the industry use on an annual basis (in tons and GWP-weighted tons) now?

   RESPONSE: A preliminary and rough estimate is that the heavy-duty truck industry currently uses approximately 2,000 tons of HFC-134a per year.

7. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your member companies on an annual basis?

   RESPONSE: Less than one percent.

8. Do you project HFC usage will grow or shrink over the next 15 years?

   RESPONSE: Before the coronavirus pandemic, forecasters were estimating slow growth of U.S. heavy-duty truck sales over the next fifteen years. Until HFO-1234yf is approved by EPA and implemented by manufacturers, that growth in truck sales would result in corresponding growth in the usage of HFC-134a by the heavy-duty industry.

9. If the AIM Act were implemented as introduced, do you believe the HFCs used by your company will be eligible for essential use exceptions? If not, why not?

   RESPONSE: Since the AIM Act would not completely ban HFC-134a, instead only phasing down its production and consumption to fifteen percent of the baseline, truck manufacturers are more concerned with constraints on the availability and price increases of HFC-134a before EPA completes its rulemaking to allow HFO-1234yf in heavy-duty vehicles and after that truck manufacturers have time to changeover their products and facilities. Heavy-duty truck manufacturers are uniquely impacted by the proposed phase-down timeline due to the restrictive regulatory framework of EPA's SNAP Program that prevents them from beginning the transition to HFO-1234yf.

10. In your comments on behalf of the Truck & Engine Manufacturers Association, you stated that, "It could take more than five years to development those HVAC new systems and have them ready for production in a truck manufacturer's extensive product line." You further expressed concerns about the possible costs spikes of HFC-134a. Please provide the data, methodologies, assumptions, and other details of your economic analysis to support these concerns.

RESPONSE: The phase-down of HFC-134a could constrain the availability of the refrigerant and increase its price. Heavy-duty truck manufacturers could experience those obstacles before EPA designates HFO-1234yf as acceptable for use in heavy-duty trucks, and before the manufacturers have the time to changeover to the new refrigerant. In previous refrigerant upgrades, EPA provided adequate leadtime for truck manufacturers to transition.

11. The AIM Act would affect a phase down of the production and consumption of HFCs over a 15-year period, with 15 percent of the baseline period allowed to be produced and imported from 2036 onward. The AIM Act also contains provisions intended to increase to a significant degree the recovery and reclaim of HFCs. The purpose of these provisions, and other provisions in the Act, is to ensure the continued use of HFCs for decades to come, particularly in small or niche applications for which no substitute is available. In light of this, why do you believe the AIM Act represents a hard “ban” on HFCs that would prohibit their use upon enactment?

    RESPONSE: Truck manufacturers are concerned that a phase-down of HFC-134a could cause price increases before EPA permits its use in heavy-duty trucks and before they can completely transition their produces and facilities to HFO-1234yf.

Senator Capito:

12. Mr. Blubaugh, you state that the transition from HFCs to HFOs for your members may take up to five years and add major costs to the price of a truck. How long before a new model goes on sale are your members doing primary design and engineering work? Is it safe to say there is a runway of several years?

    REPONSE: Developing a completely new heavy-duty truck model from concept to production may take a manufacturer between five and ten years. Because heavy-duty trucks are sold in low volumes, manufacturers will often keep a model in production for twenty years or more in order to recoup the up-front capital investments in product development and production tooling. However, because the trucks also are highly customized for specific commercial applications, a manufacturer will produce each base model in a wide variety of configurations and expand the available variants over time. .

13. What sorts of costs or delays would the changing of the refrigerant specification mid-cycle confer on your members as they design a new truck or revise an existing model?

    RESPONSE: Since manufacturers introduce new heavy-duty truck models so infrequently, it is foreseeable that the changeover to HFO-1234yf would require revising almost all existing truck models.

14. Can you estimate the average cost increase for a heavy-duty truck resulting from a change to this refrigerant specification?

RESPONSE: The costs of HFO-1234yf and the air conditioning system components needed for the new refrigerant currently are significantly higher than HFC-134a. Some of those costs may scale down as the higher-volume passenger car industry converts to HFO-1234yf; however, those lower costs may not be realized with air conditioning system components because heavy-duty vehicles often use unique parts and suppliers.

Due to the diversity of heavy-duty products, the costs of product development and validation, and production and service facility upgrades, are very high on a per-vehicle basis. Therefore, those manufacturer investments may represent the largest contributor to heavy-duty truck cost increases from converting the HFO-1234yf.

118285_2

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Mr. Hardin, Compliance and Facilities Manager, Grady-White Boats

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

1. In your comments on the AIM Act on behalf of Grady-White Boats, you expressed concern that the polyurethane foam that is a "critical structural component" in some of your boats uses an HFC 134a blowing agent that would be phased out, and that the Act, therefore, should exempt such uses from the ban because "there are no acceptable substitutes." Please provide details of your efforts to develop or find acceptable substitutes for HFC 134a in your boats, including the identity of entities and individuals contacted, the procedures used to develop or find substitutes, the methodologies, data, analyses, field studies, experiments, lab results, sources, and biographies of participating researchers and subjects involved in such efforts, and the results of such efforts including why you found any substitutes "unacceptable."

   The main structural components are custom designed and built for our use by Compsys of Melbourne FL. Grady-White Boats is not involved with the research, development and qualifications of the raw material inputs used by our supplier. Compsys is reporting that the HFO's currently available are not acceptable for their applications. They are continuing to work with the foam suppliers and conducting the research you are describing. Please contact Compsys for the details of their changeover and qualification efforts.

2. In your testimony you expressed concern that the AIM Act would ban HFC 134a. The AIM Act would affect a phase down of the production and consumption of HFCs over a 15-year period, with 15 percent of the baseline period allowed to be produced and imported from 2036 onward. The AIM Act also contains provisions intended to increase to a significant degree the recovery and reclaim of HFCs. The purpose of these provisions, and other provisions in the Act, is to ensure the continued use of HFCs for decades to come, particularly in small or niche applications for which no substitute is available. In light of this, why do you believe the AIM Act represents a hard "ban" on HFCs that would prohibit their use upon enactment?

   The major concern is that by setting a limit of 15 percent the supply will be so limited, especially if suitable substitutes are not developed, the price of the 134a will increase so much that it will be a "de facto" ban. If the Act allows for continued use until a suitable and cost competitive alternative is available, then Grady-White would be satisfied.

3. Of the HFC compounds that are being used by your company today, on average how much does the industry use on an annual basis (in tons and GWP-weighted tons) now?

   Grady White is not in a position to be able to answer this question.

4. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your member companies on an annual basis?

   Compsys informs us that they use 0.49 tons of HFC annually and that this represents 0.0002148% of the 230,000 ton annual US usage.

5. Do you project HFC usage will grow or shrink over the next 15 years?

   As suitable substitutes are developed it is our belief that usage of HFCs will decrease.

6. If the AIM Act were implemented as introduced, do you believe the HFCs used by your company will be eligible for essential use exceptions? If not, why not?

   It is critical that we proactively address our concerns to become eligible for exemptions. In the past, Compsys had to sue the USEAP over the SNAP rule in order to continue to produce their end products.

7. Prior to 1990, there were over sixteen states that had taken action, or were in the process of taking action, to restrict the use of Chlorofluorocarbons (CFCs). In the Clean Air Act Amendments of 1990, Congress created a federal program to phase out CFCs in Title VI of the Clean Air Act. Rather than preempting state actions, Congress preempted the enforcement of state CFC regulations for two years. Once EPA had a strong CFC federal program in place, the state programs for the most part went away on their own. Why specifically do you expect states will act differently in terms of HFCs if a federal regulatory program is created? Given the history why should HFCs be treated differently than CFCs in terms of state preemption?

   There is a fear that individual state regulations will lead to a patchwork of state requirements for HFCs, causing headaches for manufacturers (such as Grady-White) that sell products across the U.S. If the EPA can establish a federal regulatory program in a timely fashion it may create an environment where the states will wait for the EPA program. The fear is that the states will not demonstrate patience and create regulations because of the delays caused by slow moving federal regulatory process. We do not need a hodge-podge of state regulations as this would be terribly interruptive for our distribution system (dealers) and would create an impossible situation because we don't build state-specific boats.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Hussmann Corporation

<u>Chairman Barrasso:</u>

1. In comments to the Significant New Alternatives Policy (SNAP) Rule 20 Docket, Hussman stated:

   > *Manufacturers are being pulled in different directions. [The Environmental Protection Agency] and the [Department of Energy] should be working together to promote better efficiency while considering lower GWP refrigeration.*

   Why is it important to ensure that the Environmental Protection Agency and Department of Energy requirements regarding equipment are not inconsistent?

Ms. Lange, EPW Staff,

Thank you for reviewing Hussmann Corporation's letter requesting the Senate to approve the American Innovation and Manufacturing Act of 2019 (AIM) S. 2754. Hussmann appreciates the opportunity to respond to the question raised by Chairman Barrasso regarding the necessity for alignment with both the Department of Energy and Environmental Protection Agency.

In comments to the Significant New Alternatives Policy (SNAP) Rule 20 Docket, Hussmann stated:

> ***Manufacturers are being pulled in different directions. [The Environmental Protection Agency] and the [Department of Energy] should be working together to promote better efficiency while considering lower GWP refrigeration***

Why is it important to ensure that the Environmental Protection Agency and Department of Energy requirements regarding equipment are not inconsistent?

It is inefficient and an excessive burden to product development and manufacturing when the DOE and EPA pass regulations which are not aligned. Alignment will allow manufacturers to redesign and build existing and new products to a set of consistent requirements which together provide more efficient and environmentally responsible products. Staggered regulations between the two agencies have and will continue to challenge manufacturers to incur unnecessary expenses which are passed along to the consumer and result in product which may not be fully optimized based on the technically feasible and economically justified component options available.   In addition to this regulations that are not aligned can potentially conflict one another and create significant confusion in the industry.

Thank you,

Ronald Shebik
Director, Government and Regulatory Affairs
Hussmann Corporation
12999 St. Charles Rock Road
Bridgeton, MO 63044
Office – (314) 298-6483
Mobile – (314) 550-8043
ron.shebik@hussmann.com
www.hussmann.com

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020

Questions for the Record for Industrial Energy Consumers of America (IECA)

<u>Chairman Barrasso:</u>

1. The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) submitted testimony claiming:

Finally, it is important to note that a change in the phase down schedule does not prohibit the use of existing equipment, which consumers and business owners are free to use through the equipment's lifetime. Existing equipment is not subject to the AIM Act. And the AIM Act does not in any way mandate or otherwise require consumers to buy new equipment.

Your testimony highlights your concern that industrial chillers could be forced to be replaced before their useful life. Do you agree with AHRI's claim above?

IECA REPLY:
AIM is a production phase-out program. It does not mandate the phase-out of existing HFCs using equipment. However, AIM does not guarantee that producers of HFCs will maintain sufficient supplies of existing HFC products to allow existing equipment to operate throughout its lifetime and without increased costs. Because of the mandated phase-out program, HFC producers may decide not to continue production of HFC products. Without sufficient supply of HFC products at reasonable costs, IECA companies would have no choice but to shutdown existing equipment prematurely.

2. AHRI submitted testimony claiming:

Under Title VI [of the Clean Air Act], accelerating the schedule helped a number of sectors plan for equipment conversions. It also helped U.S. manufacturers stay ahead of the curve in global markets, which often lagged U.S. transitions and thus were more accessible as export markets for American made products.

IECA requests a level playing field where the U.S. is not placed on an accelerated schedule that is quicker than other countries like China. Do you agree with AHRI that the acceleration provision in the AIM Act, which allows the AIM Act's schedule to be ramped up, is good for U.S. manufacturers?

IECA REPLY:
The AHRI reference to U.S. manufacturers is not manufacturers who are users of HFCs and HFC equipment. AHRI references to manufacturers are most likely companies who are in the business of producing HFCs and HFC consuming equipment.

For HFC users that do not compete with foreign competitors, competitiveness is not an issue. Those HFC users include homeowners, commercial real estate, and utilities.

Ramping up phase-out for manufacturers like chemicals, plastics, steel, iron ore, aluminum, paper, food processing, fertilizer, insulation, glass, industrial gases, pharmaceutical, building products, automotive, independent oil refining, and cement is definitely not good for manufacturing competitiveness. China has more manufacturing than the U.S. and they do not have an accelerated phase-out.

The AHRI assessment may be correct for U.S. manufacturers of refrigeration equipment, which is a small segmant of the U.S. manufacturing sector. We disagree with that assessment for the industries in other segments of the U.S. manufacturing sector especially those industries that compete in global markets.

3. Your testimony highlights an issue with the report entitled "Consumer Cost Impacts of U.S. Ratification of the Kigali Amendment Report Prepared for the Air-Conditioning, Heating, & Refrigeration Institute and the Alliance for Responsible Atmospheric Policy," where new heat transfer fluids do not perform as well as the chemicals they are replacing. Do you know why that is the case? Does it have to do with the chemical structure of HFC replacements?

IECA REPLY:
The chemistry of the HFC replacements have less heat transfer capacity.

Do you have concerns that the AIM Act, including the technology transitions provision, do not adequately figure in cost considerations?

IECA REPLY:
That is correct. The studies that we referenced to support AIM economics do not include all costs. They only consider front-end economics and not total system costs. Using a less efficient heat transfer fluid often requires increased capital expense to upgrade back-end equipment, such as requiring more compressor capacity, which in turns increases electricity costs. Other capital equipment cost examples include additional storage for refrigerants, raw materials and products, replacement of other secondary material handling equipment such as other pumps, and replacement of other condensing equipment such as distillation column overhead condensers.

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

4. The AIM Act would affect a phase down of the production and consumption of HFCs over a 15-year period, with 15 percent of the baseline period allowed to be produced and imported from 2036 onward. The AIM Act also contains provisions intended to increase to a significant degree the recovery and reclaim of HFCs. The purpose of these provisions, and other provisions in the Act, is to ensure the continued use of HFCs for decades to come,

particularly in small or niche applications for which no substitute is available. In light of this, why do you believe the AIM Act represents a phase out on HFCs?

IECA REPLY:
AIM is an HFC production and consumption phase-down bill that includes a defined phase-out timetable, which means less and less will be available. The legislation also gives the EPA the option to phase down more quickly or change the reduction volumes. The bill does not prevent recovery and reclaim. However, S. 2754 does not require that HFC supplies will be available for existing HFCs using equipment and at reasonable prices.

If EPA acts to accelerate phase down or if HFC manufacturers choose NOT to produce HFCs, supply becomes in jeopardy for existing equipment and the cost of replacement HFC refrigerant can escalate.

5. Of the HFC compounds that are being used by your member companies today, on average how much does the industry use on an annual basis (in tons and GWP-weighted tons) now?

IECA REPLY:
Our members have over 4,000 very large manufacturing complexes and each complex has several chillers. We have not surveyed the member companies. We do not intend to survey them because they have a COVID-19 and economic crisis to manage. The HFC industry knows how much is used by the U.S. manufacturing industry.

6. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your member companies on an annual basis?

IECA REPLY:
We have not surveyed the member companies to know the answer to this question. We do not intend to survey them because they have a COVID-19 and economic crisis to manage. The HFC and refrigeration industry knows how much is used by the U.S. manufacturing industry.

7. Do you project HFC usage will grow or shrink over the next 15 years?

IECA REPLY:
We have not surveyed the member companies to know the answer to this question. However, IECA companies assume that as new HFC replacements will be available, and when existing industrial chillers need to be replaced, they will use the HFC replacement products. Therefore, we would anticipate that HFC imports would decrease.

8. If the AIM Act were implemented as introduced, do you believe the HFCs used by your company will be eligible for essential use exceptions? If not, why not?

IECA REPLY:
First, the Essential Uses provision does not specify what type of HFC users qualify for "essential use" exceptions. So, we do not know whether we qualify. Second, the bill says that the Administrator "may" authorize production of regulated HFCs. It does not say that EPA "shall" authorize production. Therefore, there is no certainty that needed supplies would become available. Third, the EPA only would consider continued HFC production if no substitute will be available during the applicable period. Our existing equipment will not work properly without existing HFCs.

9. Are you aware that the Kigali Amendment to the Montreal Protocol has different phasedown timelines for different countries? The phasedown timeline you mention in your testimony is incorrect for the United States.

IECA REPLY:
Yes, we are aware that the Kigali Amendment has different phase down timelines for different countries. That is exactly why our comments address the need for Congress to always act to ensure a level playing field with countries with which U.S. manufacturers compete globally. The Kigali Amendment gives countries that have manufacturing capabilities equal or greater than ourselves a free pass for several years. We are not asking for an advantage, but to not be disadvantaged.

Senator Capito:

10. Mr. Cicio, you state the need for the regulatory exemption of HFCs usages throughout the useful lives of certain industrial equipment, which in some cases can be measured not only in years but decades. You also call for the need for any phaseout schedule to be equivalent to that of China – as well as India, Mexico, Malaysia, Thailand, and Brazil – to prevent disadvantaging US manufacturers and to prevent dumping into the US market. Would your preferred approach, to ensure international consistency, be ratification of the Kigali Amendment to the Montreal Protocol rather than a standalone regulatory program? Would that help some of the international trade concerns you raise?

IECA REPLY:
The most logical fix is simple. Because the bill mandates the reduction of HFCs, the bill should also mandate that there will be sufficient inventories of existing HFCs available at reasonable costs to allow existing industrial chillers to operate until a replacement is needed. New industrial chillers would use the new HFC replacements.

11. You note that the supporters of the AIM Act are suppliers of HFOs and associated products, while your members are the consumers, which affects different parties' assessments of the costs and benefits of this legislation. Do you feel that the suppliers, for whom the economic benefits are better defined and concentrated, have been more vocal than the consumers, for whom the costs are nebulous and diffuse? In the near-term, do you think the costs to the consumers are likely to outweigh the benefits to suppliers, economy-wide?

IECA REPLY:
IECA supports the transition to less GHG-intensive refrigerants. As industrial chillers can no longer operate efficiently, we support using the non-HFC refrigerants and new equipment.

It appears that the companies who produce refrigerants and associated equipment are almost exclusively the entities who have promoted the HFC accelerated production phase-out. They are the companies who would potentially financially benefit from the promoted changes. What makes this bill unbusinesslike is that it mandates the elimination of products that we use. Therefore, if companies want to mandate HFC reductions, then there should also be a mandate to assure sufficient supply at a reasonable cost to operate existing equipment for their useful life.

We believe the costs outweigh the benefits of switching. That said, it is appropriate to start the transition so long as existing industrial chillers will have sufficient inventory of current HFCs at a reasonable cost.

12. You note that HFOs do not work as well at removing heat, especially at industrial scales. With HFOs, some cooling equipment used in your members' manufacturing processes will be required to cycle more frequently, increasing electricity consumption, wear and tear on equipment, and its operation in its least efficient mode – namely getting up to operating speed. Do you have any sense that those effects were considered in economic analyses presented by supporters of the AIM Act? Do you think these effects will reduce the energy efficiency benefits propounded in those studies?

IECA REPLY:
Based upon the studies highlighted in our comments, they did not account for all costs to industrial chiller consumers. Failure to account for all costs do reduce the claimed benefits.

13. What would the costs be both to your members and to their downstream consumers of replacing industrial equipment with decades of remaining useful life due to a regulatory mandate or the lack of a sufficient supply of HFCs? Would there be a significant environmental cost for that premature replacement?

IECA REPLY:
We have not surveyed our companies to determine what the exact costs would be for several reasons. If we did, we are confident there would be a wide range of cost impacts from company to company. The number and size of chillers per company vary greatly. We do not intend to survey them because they have a COVID-19 and economic crisis to manage.

It would be very costly and disruptive to prematurely replace existing industrial chillers due to potential insufficient supply of HFCs. New industrial chillers cost millions or upward of tens of millions of dollars depending on the size.

However, today's economic crisis makes it easier to illustrate our point. When U.S. manufacturers are having a hard time keeping the doors open and keeping employees on the payroll, the U.S. manufacturer should not have to worry about being mandated to spend capital on switching to HFCs. China's manufacturing companies, as an example, do not have to worry.

14. Would you support a grandfathering provision for HFC use in existing equipment? What might that look like?

IECA REPLY:
IECA requests that a provision be added that guarantees sufficient supplies of phased out HFCs will be available at reasonable costs, so that existing industrial chillers will not be forced to be replaced before their useful life. This is important for several reasons but also because the bill gives the EPA the ability to accelerate the production phase-out. Any refrigerant phase-out should be set at the federal level and not a patchwork of state requirements. Congress should ensure that U.S. manufacturers are not placed on an accelerated phase-out trajectory over other manufacturers in other countries. We request a level playing field. U.S. manufacturers that compete in global markets will be at a disadvantage and higher costs will reduce competitiveness. China, as an example, should have the same phase-out schedule as the U.S. They do not.

In addition, there is a lot of uncertainty on what will be considered a next-gen refrigerant. Manufacturers are making decisions today to replace aging chillers and are relying on information from the vendors on what is next gen, suitable for their application and more environmentally friendly with no assurance that the replacement refrigerant will be considered next-gen under future legislation, international agreements, etc. A grandfather provision should also be included to protect companies who are making replacement choices today. It is important to not create stranded assets under new legislation by forcing units to be prematurely replaced before the end of their useful life. This can occur due to "new" next-gen determinations obsoleting the refrigerant and/or the refrigerant being "phased out" under a new mandate. Protections are needed to ensure there are sufficient supplies of these current next-gen refrigerants and they will be available at reasonable cost for the useful life of the equipment.

Senator Cramer:

15. On April 13, 2020, I received a letter about the AIM Act from a constituent, the Basin Electric Power Cooperative, whose headquarters are in Bismarck, North Dakota. That letter is attached. In its letter, the Basin Electric Power Cooperative highlights a number of concerns with the AIM Act, including potential cost impacts as well as fire safety impacts. Basin identifies a number of problematic provisions in the bill. Do you support the types of legislative changes to address cost and availability issues that Basin proposes in its letter?

IECA REPLY:
The Basin Electric Power Cooperative (BEPC) has the same challenges as IECA companies. They have large existing systems using HFCs. And, prematurely switching to non-HFCs is very costly. However, our solution to the problem presented by S. 2754 differs from BEPC.

IECA requests that a provision be added that guarantees sufficient supplies of phased out HFCs will be available at reasonable costs, so that existing industrial chillers will not be forced to be replaced before their useful life. If Congress is going to mandate a phase out of existing HFCs, then it should mandate that sufficient supplies will be available for the life of the equipment at reasonable costs.

The BEPC solution of relying upon the "essential uses" exemption is not a solution in our opinion. The EPA could decide that our applications do not qualify for exemption. S. 2754 also gives the EPA the ability to accelerate the production phase-out. If they do, and the bill requires HFC manufacturers to maintain inventory, then companies like IECA companies and BEPC will not have to convert equipment prematurely.

Sincerely submitted,

Paul N. Cicio
President
Industrial Energy Consumers of America
1776 K Street, NW, Suite 720
Washington, DC 20006
T: 202-223-1661
pcicio@ieca-us.org

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Illinois Tool Workers

Chairman Barrasso

1. In an article published in the Refrigeration and Air Conditioning Magazine entitled, "[Air-Conditioning, Heating, and Refrigeration Institute] presses for US-wide legislation to curb HFC use," Francis Dietz, vice president of public affairs for the Air-Conditioning, Heating, and Refrigeration Institute, stated:

   > *The DC Circuit Court decision was based on the essential premise that Congress had not provided authority to [the Environmental Protection Agency (EPA)] to regulate HFCs under the [Significant New Alternative Policy] Program. With legislation, [the Environmental Protection Agency] would be given that authority, so it could resume using the [Significant New Alternative Policy] program to implement a national phase down of HFCs.*

   Mr. Dietz is referencing a D.C. Circuit decision that invalidated prior SNAP regulations. Do you agree with Mr. Dietz that the AIM Act as written authorizes EPA to create a new SNAP program? If so, would this new program be identical to the previous SNAP program, or is it unclear?

   Illinois Tool Works Inc. (ITW) is aware of many bill proponents' stated *intent* for the AIM Act to ostensibly provide authority to the EPA for "regulated substances" with high global warming potential (GWPs), which would include hydrofluorocarbons (HFCs). Indeed, as noted in ITW's original written comments to the Committee, ". . . these provisions would suggest ongoing agency authority to regulate both HFCs and alternative substances without limitation, [a posture] with which we do not disagree[1]. As the Committee is well aware, and according to the Environmental Protection Agency (EPA) itself, its Significant New Use Program (SNAP) authority to regulate this way historically has rested under Sections 608 and612 of the federal Clean Air Act, among others.

   As a result of recent litigation and subsequent court rulings, we understand all stakeholders' need for clarity around the question of regulating refrigerants across a variety of end-using products, but we identify challenges with and within the AIM Act that would frustrate that intent. Specifically, as written, the bill – at best – falls short of accomplishing the stated objective with clarity; or at worst, the AIM Act includes provisions that conflict with the intended objective and proponent statements such as the one presented in the question above. As stated in our previous testimony on S.

[1] ITW written testimony on S. 2754 as submitted to the Senate Environment and Public Works Committee, April 7, 2020

2754, "[T]he bill does not expressly seat its provisions in any new or existing federal statute, thus failing to clarify the EPA's foundation of authority to regulate HFCs or successor alternatives."[2] So, while ITW is not in a position to dispute others' desired potential outcomes, it is our position that the AIM Act, as written, clearly does not appear to match those desires.

Finally, our written testimony also generally questioned the need for the AIM Act in light of initiatives undertaken by states to replicate recently litigated SNAP regulations and provide stakeholder and marketplace certainty. ITW was not alone in welcoming these state regulations, and continues to encourage states' activities through direct rulemaking participation and commentary on proposed HFC regulations, as do many other manufacturing voices[3] [4]. Beginning with California and currently through collaboration in the 26-member U.S. Climate Alliance, states began codifying HFC transitions through legislation and rules while the SNAP Rules were being litigated to keep up with equipment makers whose HFC transition efforts were well underway anyway. In fact, to date, 16 states have active HFC transition laws and / or regulations in force or in progress toward finalization, which is tremendous progress in the last 18 months alone.

2. The bill references certain provisions of the Clean Air Act but not others, such as Clean Air Act section 612. Is it clear how the legislation would interact with existing Clean Air Act programs?

   As stated above, one of ITW's primary observations about the AIM Act is that it is not specifically attached to existing or newly established citations within federal statute. Thus, ITW's concern that the legislation, if enacted as written, would only sew further confusion for all stakeholders, including regulators, as to how to proceed with meaningful regulatory oversight of HFCs (and their successor alternatives).

3. Do you have concerns that the AIM Act, including the technology transitions provision, do not adequately figure in cost considerations?

   Yes.

   First, Section 10 contains only two direct reference to costs, one relative to refrigerant substances, and the second to consumer costs.[5] Second, where cost may be an inherent consideration, other provisions gloss over to a perilous degree the complexities of

[2] Ibid.

[3] Ibid.

[4] AHRI stated in written comments, ". . . It is our goal to help states adopt and implement laws and regulations consistently, with standard requirements, across jurisdictions." (Draft Regulation 1151, Regulations for the Use and Manufacturing of HFCs, Delaware Department of Natural Resources and Environmental Control, January 17, 2020) http://www.dnrec.delaware.gov/Air/Documents/under-development/de-reg-1151-public-workshop-comments.pdf

[5] S. 2754 of the AIM Act, Section 10(e)(3).

manufacturing, among which is a higher burden to prove the increased costs of regulatory mandates.

For example, Section 10 enumerates evaluation requirements for the EPA Administrator, including "technological achievability, commercial demands, safety and other relevant factors."[6] Although the list may be an attempt to ensure a thorough and informed review by the Administrator before a regulation imposes costly requirements on manufacturers, each element individually, and even taken together, fails to be specific and measurable enough for manufacturers to know how to sufficiently inform an Administrator's position. Moreover, safety requirements for many refrigerant-using products are set and enforced by third-party consensus standard testing, certification and enforcement organization protocols; yet, the bill sets no standard as to exactly how data can provided or transparent, nor demonstrates how the agency would ensure important expertise is leveraged. How would the bill ensure state and local enforcement officials can weigh in to educate the process on how to make sure equipment can be installed under proposed mandates? If the EPA does not proceed proactively and thoroughly, (a repeat from the previous SNAP Rule proceedings') unintended consequences will follow, such as equipment that struggles to comply with refrigerant mandates because their products cannot be installed at local customer sites.

In addition, a unique dynamic for refrigeration equipment is that dual agency authority to which they are subject. The US Department of Energy (DOE), under the Energy Policy and Conservation Act (EPCA)[7], is required to periodically update minimum energy efficiency standards for a range of products, including commercial refrigeration equipment. In fact, the current DOE commercial refrigeration standards (based on HFC usage) regulatory review was underway concurrently with the EPA's consideration of Rule 20 (prohibiting HFCs). Manufacturers immediately recognized the potential for chaos if two regulations came into force; and, despite months of repeated protests, both the DOE and EPA continued crafting their respective, conflicting regulations. The AIM Act's technology transitions provisions insufficiently guard against repeat occurrences with future refrigerant alternatives.

4. Do you believe language should be added to ensure the EPA appropriately considers cost when setting regulations under the AIM Act?

   Yes.

   In addition to our question 3 comments, we would submit that the bill must incorporate cost threshold metrics such as those recently adopted by the DOE's process

[6] Ibid, Section 10(f).

[7] Public Law 94-163 (42 U.S.C. 6291-6309, as codified), added by Public Law 95-619, Title IV, section 441(a)

rule[8]. ITW believes that doing so will help EPA refrigerant regulations be less influenced by subjective, less empirical inputs. For example, where a product sector's aggregate costs would exceed the measurable benefits achievable by a new agency mandate would provide a clearer indicator that regulatory consideration may not be warranted at a given time. Under the AIM Act, as the agency continues reviewing successor refrigerants, all stakeholders would benefit from having better defined protocols in place that would support a regulatory proceeding.

5. Who holds most of the patents for HFC replacement chemicals? When do these patents expire?

   ITW is only a consumer of refrigerants and foam blowing agents for our commercial equipment. As such, we do not manufacture any HFC replacement chemicals and wholly rely on vendors to sell those products to us directly or through formulators who may provide us with specialized solutions.

   To our knowledge, the suite of manufactured HFC alternatives, the HFOs available and approved for commercial foodservice refrigeration equipment under SNAP Rule 20, is solely manufactured and owned by Honeywell. As such, ITW would not be in a position to further comment on the intellectual property around those products.

6. The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) testified that the AIM Act will do away with an ongoing process known as "dumping," where overseas companies export inferior equipment to the U.S. at a price below the cost of manufacture. There is no reference to dumping in the text of the bill. Does the bill prevent dumping?

   While product "dumping" is not uncommon across a range of products, historically these hostile trade actions are under the purview of Executive Branch agencies, such as the U.S. Commerce Department. To protect companies and our innovations, the U.S. has an established system to examine and combat dumping or countervailing market activities, which includes imposing monetary duties on products and parties found to violate our national trade laws. Refrigeration equipment, components and supplies from domestic manufacturers would certainly be protected under these existing provisions. Regulatory agencies such as the DOE, EPA or Federal Trade Commission (FTC) may play a role in informing dumping petitions, and where dumped products may also violate other federal laws, those agencies can even enforce against such products using their respective existing authority.

   Notwithstanding existing laws outlawing and enforcing against dumping activity, the AIM Act does not speak to authority that any federal agency beyond the Commerce Department would have in enforcing against dumping practices, nor could it. Even considering the possibility necessitates the bill's review by additional Senate

[8] Procedures, Interpretations, and Policies for Consideration of New or Revised Energy Conservation Standards for Consumer Products" ("Process Rule"), 10 CFR part 430, subpart C, appendix A

committees of jurisdiction, or the bill would likely face germaneness issues as it proceeded through the legislative process.

Never minding the island of authority that the AIM Act purportedly creates for the EPA over the use of HFCs generally, which remains problematic as explained above, ITW fails to see how the AIM Act would, singlehandedly, curb the unfair practice beyond the enforcement capabilities that rest in larger federal departments with the mission and dedicated resources for dumping prevention.

7. The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) testified in support of the accelerated schedule provision of the bill, stating:

Under Title VI [of the Clean Air Act], accelerating the schedule helped a number of sectors plan for equipment conversions. It also helped U.S. manufacturers stay ahead of the curve in global markets, which often lagged U.S. transitions and thus were more accessible as export markets for American made products.

Doesn't the potential for an accelerated phasedown schedule create more uncertainty?

ITW certainly acknowledges tools stakeholder that facilitate public policy changes in keeping with marketplace innovations. The petition process outlined in Section 7 of the AIM Act, with a long history of use across the federal government, is one such process. However, ITW has tremendous concern with a petition process-initiated rulemaking that would ill-afford opportunity for non-petitioning impacted stakeholders to represent potential and unforeseen consequences to that which a petition might seek.

It was a petition that initiated the EPA's consideration of SNAP Rule 20 in 2015. The EPA unveiled its proposed Rule 20 in August 2014; its substantive changes included dates by which an HFC transition for a product scope would be mandatory as quickly at 18 months following the proposed rule's introduction. Commercial foodservice equipment manufacturers uniformly presented volumes of data to the agency that outlined the re-engineering process for our complex equipment under normal circumstances – iterative processes that, for most equipment, requires several years of calculations, prototypes and testing before mass production even could begin. Doing so was meant to show how the proposed effective dates would be unreasonable and unduly burdensome on manufacturers, which would not only negate various the gains (and the minimal cost estimates) alleged in th proposal, but result in higher manufacturer and consumer costs while threatening the loss of jobs across the sector. When the EPA was not persuaded, commercial refrigeration manufacturers appealed to the Office of Management and Budget's regulatory review arm, which was the only way that compliance dates were made more reasonable once the final rule was published. Those outcomes were borne out by the final rule anyway: commercial foodservice equipment was still not without job loss, nor consumers a loss of consumer choice in the marketplace, even with more reasonable effective dates that allowed a more orderly and fulsome transition across the sector. Therefore, it is our view that the AIM Act's petition process would render the past as prologue, by not only empowering, but in all but certainty, forcing the EPA to accelerate its timelines for the transition of regulated substances.

Moreover, the AIM Act fails to include both data and participation benchmarks on which equipment manufacturers could rely that might mitigate against the risk of public policy getting ahead of marketplace innovation simply on the word of a petition's request. ITW raised great concerns in our previously written comments about Section 7 by summarizing that, ". . . we envision far more havoc if the EPA is provided a mandate supplanting thorough due diligence, thereby placing a negative burden on manufacturers and shortchanging intended consumer benefits.[9]"

8. Are HFOs a drop-in replacement for equipment that currently use HFCs?

   ITW disputes use of the term "drop-in" when referring to replacement substances for HFCs in commercial foodservice equipment as it connotes that using refrigerant alternatives is cost-free.

   It is true that several HFC alternatives now exist in the marketplace that can sufficiently meet manufacturers' product needs. However, there is no such term as "drop-in" when considering the diligence required to reconfigure complex, highly engineered products based on changes to any of their inputs, including the alternatives. Beyond the regulated community, the term implies switching a "like for like" substance with which the finished product can operate without further augmentation. Instead, the reality for our equipment is that refrigerant is a material change; its substitution can alter performance, however slightly, and also requires a comprehensive in-house review of whether the equipment is operable, followed by real-life trial or "field" testing and third-party certification, before the newly engineered product even can be sold to consumers without violating federal law. None of this diligence is cost-free for manufacturers.

   Based on the care any reasonable, responsible manufacturer must exercise across its product scope, ITW does not subscribe to the description of hydrofluoroolefins (HFOs) as "drop-in" HFC alternatives for our equipment.

9. Proponents of the AIM Act state a federal framework is needed to provide regulatory certainty. How does including a citizen's suit provision in the AIM Act through a cross-reference to the Clean Air Act assist or hinder certainty?

   ITW fails to see how inclusion of a citizen's suit provision aids in clarity for agency rulemakings or certainty for regulatees. We question which part(s) of the regulatory process would merit a complaint? If a stakeholder has concerns about the rule

[9] Ibid.

promulgated under regular order, the federal Administrative and Procedures Act not only outlines the "notice and comment" process and procedures for federal agencies to follow, and those provisions can serve as grounds for a challenge relying on supported harms. Beyond this, it is difficult to understand the importance of including such a provision.

Johnson Controls
5757 N. Green Bay Ave., Milwaukee, WI 53201
Tel (414) 524-1200

April 29, 2020

The Honorable John Barrasso
Chairman
Committee on Environment & Public Works
United States Senate
Washington, DC 20510

The Honorable Thomas Carper
Ranking Member
Committee on Environment & Public Works
United States Senate
Washington, DC 20510

Dear Chairman Barrasso and Ranking Member Carper:

In response to Johnson Controls' (JCI) April 8, 2020 written testimony on *The American Innovation in Manufacturing Act of 2019* (AIM Act) (S. 2754) the Committee has submitted four Questions for the Record (QFRs) from Chairman Barrasso. These questions are listed below and accompanied by our response. Again, Johnson Controls is grateful for the opportunity to submit comments as well as respond to the Committee's QFRs. Should you wish to discuss our QFR responses any further, please do not hesitate to contact me.

Question #1 from Chairman Barrasso:

What are the industry costs of having to design and market different equipment to sell in different states because of state-specific HFC requirements?

Johnson Controls response:

As with most other regulatory requirements, state-specific HFC requirements placed on our equipment will place tremendous additional costs on the heating, ventilation, air-conditioning, and refrigeration (HVACR) industry. JCI manufactures thousands of unique models of stationary air conditioning equipment (e.g. air conditioners and heat pumps), all of which are impacted by potential requirements to transition away from HFCs. This equipment is designed to optimize for performance, safety, energy efficiency, and consumer cost-effectiveness, and is rigorously tested and certified before it can be manufactured at scale. Since there are no known lower-GWP "drop-in" replacements to the commonly used refrigerants today, effectively all of our equipment will need to be redesigned in order to work with a new refrigerant. If only one – or even a small handful of U.S. states were to set new HFC requirements impacting our equipment, our product development costs, measured in the tens of millions of dollars, will double, but the size of the U.S. market will remain the same.

Further, a state-by-state HFC transition will create tremendous industry costs burdens from a logistics and marketing perspective. Enforcement at state boarders will result in increased cost to states and particularly those states moving to the new, low-GWP refrigerants whose volumes will be low. Each equipment model JCI manufactures must have a unique stock-keeping unit (SKU) number so that volume can be tracked nationwide, and must have unique installation guidance and marketing materials. If two sets of products were necessary for the U.S. market – one for state(s) that have new low GWP, HFC requirements and one for those that do not – the costs of stocking, marketing and enforcement of these different product types will be significantly higher, while our ability to maintain needed product volumes will be lessened. This will result in overall increased costs.

Unfortunately, these costs would ultimately have to be recouped through equipment price increases, meaning the HFC transition would be costlier for the consumers in all states; the volume of equipment for those states not transitioning would decrease, and the very limited volume for those states transitioning earlier will have a proportional impact on our ability to scale. Additionally, the additional costs JCI would incur from a state-by-state HFC transition will divert resources away from improving the safety, performance, energy efficiency, and cost-effectiveness of our equipment.

Question #2 from Chairman Barrasso:

In your letter, you suggest that the Environmental Protection Agency direct a nationwide HFC transition for stationary air-conditioning equipment with an effective date of January 1, 2025. Why is it important to have until 2025 to develop new equipment?

Johnson Controls response:

The known alternative, low-GWP refrigerants that can be used in stationary air conditioning equipment have differing properties from currently used refrigerants and are now classified by the American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) as mildly flammable. To ensure that these refrigerants are used and handled safely inside of residential and commercial buildings, the HVACR industry and other impacted stakeholders are conducting extensive research into their use, and developing Underwriters Laboratories (UL) and ASHRAE safety standards for the design and certification of equipment using these refrigerants as well as their application in the field. To date, both the national model codes which regulate HVACR equipment applications, the Uniform Mechanical Code (UMC) and the International Construction Codes (ICC), have declined to adopt the latest safety standards from UL and ASHRAE that would permit the use of these new mildly flammable refrigerants into residential and light commercial applications.

JCI does believe that these new low-GWP refrigerants can be safely applied once all research and testing has been completed, all the appropriate UL and ASHRAE safety standards issues have resolved, and these various are standards appropriately harmonized to remove conflicting requirements. A January 1, 2025 date not only allows for the issues with the safety standards to be resolved during the next regular code cycle, but it would permit states to adopt those standards into their state building codes across the nation thereby ensuring a uniform, safe transition. This date would also permit sufficient time for manufacturers of stationary air conditioning equipment to redesign their equipment and allow sufficient time for HVACR contractors to be trained, certified and licensed. Building inspectors would also be trained on how to enforce these new standards. JCI is confident that we can have our product offerings and distribution chain prepared, and that the installation community can be trained, by January 1, 2025.

Question #3 from Chairman Barrasso:

Can you explain why it is important to have sufficient lead time to implement a phasedown of HFCs?

Johnson Controls response:

The phasedown of HFCs will require the use of new refrigerants for the stationary air conditioning sector that cannot be used in existing equipment designs. The design and marketing of new equipment in and of itself requires considerable lead time so that manufacturers can maintain comprehensive portfolios of cost-effective products. Further complicating the phasedown of HFCs in stationary air conditioning is that the known alternative, low-GWP refrigerants have differing properties and are now classified as mildly flammable by ASHRAE. To responsibly phase down HFCs, these properties must be fully researched, safety standards must be completed, building codes must be updated, new products must be certified, and the technician community must be trained and licensed to handle the new refrigerants and equipment. Taken together, the entire supply chain, from manufactures, to distributors, to contractors and inspectors, must have sufficient lead time in order to ensure a safe and cost-effective phasedown of HFCs.

Question #4 from Chairman Barrasso:

You request the AIM Act be amended to ensure an orderly, national transition for your particular *products. Would the addition of federal preemption language for stationary air-conditioning, heat pumps, chillers, and other heating, ventilation and air-conditioning equipment help to ensure an orderly transition?*

Johnson Controls response:

Johnson Controls maintains that in order to maximize the user safety, minimize the consumer costs, and maximize the emissions reductions of an HFC transition in the United States, the entire country must implement a phasedown of HFCs in the stationary air conditioning sector on one single date. Individual states transitioning early will serve to ensure a multiple refrigerant landscape within the United States for many years to come. We urge the Committee to find an acceptable approach to ensure an orderly, national transition strictly limited to HFCs only within the language of the AIM Act.

Respectfully,

Joe Oliveri
Vice President & General Manager, Global Ducted Systems
Johnson Controls
500 Bi-County Boulevard
Suite 470
Farmingdale / New York, 11735 / USA
516-369-5078 Cell
Joe.Oliveri@JCI.com

cc:

The Honorable James M. Inhofe
The Honorable Shelley Moore Capito
The Honorable Kevin Cramer
The Honorable Mike Braun
The Honorable Mike Rounds
The Honorable Dan Sullivan
The Honorable John Boozman
The Honorable Roger F. Wicker
The Honorable Richard Shelby
The Honorable Benjamin L. Cardin
The Honorable Bernard Sanders
The Honorable Sheldon Whitehouse
The Honorable Jeff Merkley
The Honorable Kristen Gillibrand
The Honorable Cory A. Booker
The Honorable Edward Markey
The Honorable Tammy Duckworth
The Honorable Chris Van Hollen

Johnson Controls
5757 N. Green Bay Ave., Milwaukee, WI 53201
Tel (414) 524-1200

The Honorable Joni Ernst

Alternate Contact Information:

Chris M Forth
Executive Director, Regulatory, Codes & Environmental Affairs
Johnson Controls
5005 York Drive North
Norman, Oklahoma, 73069
(405) 826-5802
chris.m.forth@jci.com

LENNOX INTERNATIONAL

John J. Hurst
Vice President, Government Affairs / Communications
Lennox International Inc.
2140 Lake Park Boulevard (T-8)
Richardson, Texas 75080

April 29, 2020

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Lennox International

Senator Wicker:

1. In your written testimony, you mention that "consumer cost will decrease as a result of a rational federal transition". How would a patchwork of state laws regulating the phasedown of HFC refrigerants increase costs for consumers? How would the American Innovation and Manufacturing (AIM) Act provide the federal regulatory certainty needed to keep consumer costs down?

Lennox Response:

Senator Wicker,

As a manufacturer in the State of Mississippi, Lennox International appreciates your desire to better understand the impact of the HFC transition on the American consumer.

1. **How would a patchwork of state laws regulating the phasedown of HFC refrigerants increase costs for consumers?**

Answer:

A patchwork of state-by-state regulations requires manufactures to produce redundant product lines, which significantly increases cost. Industry will be forced to manufacture, inventory, distribute, sell, install and service two separate product lines. Without a federal transition, Lennox will effectively need to double (at a minimum) the models of equipment produced to satisfy state-level refrigerant requirements. Today our products are varied by model, size, efficiency and various features to provide consumers with a "good, better, best" offering. Industry will need to double the offering to comply with two separate refrigerant standards implemented on a state-by-state basis. Doubling (at a minimum) the number of models produced significantly increases cost and these costs are ultimately borne American consumers.

Additionally, industry must also comply with Department of Energy "regionalized" energy conservation standards, which mandates three separate product lines for three separate regions of the country (north, south and southwest). Each product line is typically produced in multiple sizes to meet varying needs in varying applications. At a minimum, a state-by-state transition forces industry to double the number of models produced to satisfy new state-by-state requirements, again significantly increasing cost, which is ultimately borne by American consumers.

Doubling the number of models produced requires an increase in inventory (hundreds of millions of dollars annually), which increases cost. Manufacturing complexity will increase with the need to produce equipment with different types of refrigerant, resulting in inefficiency, shorter equipment runs and increased cost. A state-by-state transition will require redundant training, marketing materials, bills of material, selling expenses, sub-component inventory, parts and supplies. This redundancy adds additional cost, which is borne by the American consumer.

American companies will be saddled with the crushing regulatory burden of an array of state-by-state regulations and transition timelines, losing share to Chinese and EU competitors along the way. This industry needs certainty and regulatory relief in a time when our country is facing the highest unemployment rate in eighty-five years.

The market will transition to HFC replacements without a federal mandate, but over a longer period and in a more costly manner. While other countries are guided by their federal mandates, foreign competition will be able to transition in a more cost-effective manner, gaining global market share in the process, due to lower transition costs.

2. How would the American Innovation and Manufacturing (AIM) Act provide the federal regulatory certainty needed to keep consumer costs down?

Answer:

The transition from HFC refrigerants will not increase the cost of HVACR products to consumers if done in an efficient, predictable and cost-effective manner at the federal level.

The cost of cooling consumer homes has decreased significantly over the past twenty-five years. Since the mid-1990s, the HVACR industry successfully transitioned from CFC refrigerants to HCFC refrigerants to lessen the impact of refrigerants on the thinning ozone layer. In 2010, our industry made yet another transition from HCFC refrigerants to HFC refrigerants, again lessening the impact on the environment, while simultaneously reducing the cost of cooling to consumers and businesses alike. Both Energy Information Agency and Department of Energy studies suggest the cost of cooling has decreased by 50% since 1990.

Twenty-five years ago, approximately two thirds of American homes had an air conditioner. Today, after two refrigerant transitions, over 90 percent of American homes are now equipped with an air conditioner, due to the improved consumer economics.

The American HVACR industry continues to find innovative ways to reduce manufacturing cost through improved efficiency, material cost through better sourcing, and reduce logistics and transportation costs through better routing and inventory management. Some of the new replacement refrigerants are less expensive and improve the efficiency of the system, while requiring a smaller charge size (less refrigerant per unit), further reducing consumer cost. The price of replacement refrigerants is expected further decrease when broadly commercialized due to economies of scale when produced in much larger quantities. Competitive pressures will significantly reduce the cost of replacement refrigerants as has occurred in previous refrigerant transitions (CFCs to HCFCs and HCFCs to HFCs).

These economies of scale are best achieved with an efficient, predictable and cost-effective federal transition, but are lost or sub-optimized by a state-by-state transition. Furthermore, Senator John Kennedy received and reviewed a recent EPA consumer cost study, which shows a rational federal HFC phase down will save American consumers and businesses $3.7 billion over 15 years.

A uniform federal program that is broadly supported by industry, is the quickest path to the greatest environmental benefit for the nation and the most cost-effective for industry and consumers.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Nick Loris

<u>Chairman Barrasso</u>

1. Do you have any concerns with the role the bill gives the Environmental Protection Agency in international cooperation under Section 11, given the U.S. has not ratified the Kigali Amendment?

   Senator Barrasso, thank you for the questions. I do have concerns. Precedent indicates that the advice-and-consent process is required for the Kigali amendment. If the Senate believes there is a cause to regulate a substance or pollutant at a global level, they should go through the proper channels. Relatedly, the Kigali Amendment itself is an inappropriate effort to use a narrow treaty focused on ozone-depleting substances to address climate change. The impact of HFCS on the ozone layer is very small. A 2015 NASA finds that "HFC emissions cause increased warming of the stratosphere, speeding up the chemical reactions that destroy ozone molecules, and they also decrease ozone levels in the tropics by accelerating the upward movement of ozone-poor air. According to the model, their impact is such that HFCs will cause a 0.035 percent decrease in ozone by 2050."[1] In the context of climate change, a more appropriate venue to discuss the costs and benefits of phasing out HFCs at the international level would be through the United Nations Framework Convention on Climate Change.

2. Do you believe language should be added to ensure the bill appropriately considers potential increases in consumer costs when setting regulations under the AIM Act?

   Yes. Policymakers should consider the cost and benefits of phasing out HFCs as fully as possible. That should include costs to families, businesses, and the U.S. economy weighed against any global ozone, climate and any other environmental benefits. Policymakers should also consider the public choice effects of the regulations set under the AIM Act. As my former colleague David Kreutzer described, "Public choice theory predicts the regulatory process will be bent toward the goals of private enrichment as politicians and rent-seekers (a term coined by Anne Krueger in her 1974 analysis of this behavior in India and Turkey) do what economists assume all business owners and consumers do—look out for themselves." [2] The AIM Act is a clear example of politicians and specific companies enriching themselves while American and international consumers pay the price.

---

[1] News release, "NASA Study Shows That Common Coolants Contribute to Ozone Depletion," National Aeronautics and Space Administration, October 22, 2015, https://www.nasa.gov/press-release/goddard/nasa-study-shows-that-common-coolants-contribute-to-ozone-depletion (accessed April 27, 2020).
[2] David Kreutzer, "Climate and Rent Seeking," The Heritage Foundation, February 11, 2010 https://www.heritage.org/nuclear-energy/commentary/climate-and-rent-seeking (accessed April 27, 2020).

Ranking Member Carper
Please provide a response to each question, including each sub-part.

3. The recently issued Fourth National Climate Assessment projects that if the global community does not act quickly, climate change will significantly affect our nation's infrastructure, public health and economy. Scientists reported that extreme weather events, like category five hurricanes and deadly wildfires, and pandemics, like COVID-19, are expected to become more commonplace and devastating as climate change worsens overtime. These climate-related events will economically devastate our country if we do not act on climate change. Do you agree with our nation's leading scientists that have concluded climate change is real, is caused by humans, and is impacting nation's environment and infrastructure? If not, why not?

   Senator Carper, thank you for the questions. Climate change is real and it is clear that man-made emissions are having an impact. The Intergovernmental Panel on Climate Change 5th Assessment (IPCC AR5) attributes at least half of the warming from 1951–2010 to human activities. The 2018 National Climate Assessment says the same. However, distinguishing what climatologists know, what they do not know, and what they might know is necessary so that objective, transparent science can guide public policy. For instance, uncertainty exists with regard to the accuracy of climate models, how a doubling of carbon-dioxide emissions impacts global temperatures, changes in natural climate variation and which trajectory greenhouse gas concentrations most accurately reflects the future.

   Whether carbon-dioxide levels rise, fall, or stay the same, the United States and the rest of the world will experience extreme weather events climate change. That is going to challenge and affect the nation's infrastructure. Investing in durable infrastructure will enhance resiliency and protect human lives. Learning lessons from previous storms and using the best scientific and technical information available improve our ability to reduce dangers from future climate-related challenges, no matter the cause. Establishing thorough readiness plans in coordination with the private sector, local communities, and first responders and identifying future vulnerabilities is simply commonsense policy. Costly, ineffective regulations and mandates will little to improve the resiliency of our nation's infrastructure. In fact, the costs will leave us with fewer resources to allocate toward energy and infrastructure.

4. The Competitive Enterprise Institute published a paper in June 1994 entitled The High Cost of Cool: The Economic Impact of the CFC Phaseout in the United States. The paper makes claims similar to those made in your testimony about the HFC phase down, such as that costs will be higher than anticipated and that equipment design will suffer and be less efficient, among other things. Since 1994, the record has proven CEI's predictions to be overwhelmingly false, as costs declined and equipment design, including energy efficiency, improved. In evaluating HFCs, were you aware of the successes of the phase down of CFCs and did this factor into your current testimony?

I did not say the costs would be higher than anticipated. I pointed out what the costs of HFOs are now and provided a range of cost estimates. My written testimony did not say that equipment design will suffer or that equipment will be less efficient. There may be unintended consequences with regard to safety (flammability) and efficiency, though newer versions of HFOs are either low-flammable or non-flammable.

5. Prior to 1990, there were over sixteen states that had taken action, or were in the process of taking action, to restrict the use of Chlorofluorocarbons (CFCs). In the Clean Air Act Amendments of 1990, Congress created a federal program to phase out CFCs in Title VI of the Clean Air Act. Rather than preempting state actions, Congress preempted the enforcement of state CFC regulations for two years. Once EPA had a strong CFC federal program in place, the state programs for the most part went away on their own. Why specifically do you expect states will act differently in terms of HFCs if a federal regulatory program is created? Given the history why should HFCs be treated differently than CFCs in terms of state preemption?

   I do not know or expect how states will act, but I do not believe the federal government should preempt state action. States can and should have the ability to set up and enforce their own HFC regulatory regimes. Fifteen states already do.[3] One state can decide which products and refrigerants should be sold and consumed within its state while another state could adopt another set of standards or none at all. The same holds true for energy efficiency standards for appliances and products not covered by the Department of Energy.

   Policymakers should protect states' regulatory freedom taking into a few issues into consideration. The first is that one state's decision could become a de facto national standard and one state should not set the regulatory path for the entire nation. The second is that the Commerce Clause expressly empowers Congress to regulate interstate and foreign commerce and, as the Supreme Court has construed it, implicitly forbids the states from discriminating against or burdening interstate commerce.

<u>Senator Whitehouse</u>

6. In your testimony, you criticize certain studies as industry-funded. Your apparent belief that knowing an organization's funding source is relevant to understanding its potential biases is one I share. As such, please disclose to the Committee all the ultimate sources (i.e., the original source as opposed to a pass through entity such as Donors Trust or an LLC) of funding for the Heritage Foundation over the last five years and the amount of their donations.

---

[3]David Doniger and Christina Theodoridi, "More States Announce HFC Action, Raising Tally to Fifteen," Natural Resources Defense Council, February 18, 2020, https://www.nrdc.org/experts/david-doniger/more-states-announce-hfc-action-raising-tally-fifteen (accessed April 27, 2020).

Senator Whitehouse, thank you for the questions. The nonpartisan analysis and research of public policy conducted by The Heritage Foundation enjoy a strong reputation for clarity and independent thought. Heritage comports with the highest standards of research integrity and fiercely protects its intellectual independence. Additionally, Heritage prides itself on being the Nation's most broadly supported public policy research institution, with more than a half-million members. Heritage relies on the private financial support of the general public — individuals, foundations, and corporations — for its income, and accepts no government funds and performs no contract work. Such a broad base of members guarantees that no donor or group of donors has the ability to direct the views or activities of Heritage.

Furthermore, my criticism of the industry-funded study I referenced is more centered on the flaws of input-output economic models. They are used to sell regulations as boosting economic growth and employment while failing to take into account opportunity costs.

7. You state that CFCs are "believed" to be harmful to the ozone layer. Should that statement be taken to mean it is your view that there is not a scientific consensus that CFCs are harmful to the ozone layer? If that is your view, please list the peer-reviewed scientific studies on which you base your opinion.

   No, I simply meant that because CFCs are an ozone depleting substance, and that was the impetus for enacting a ban, though there are natural changes that also affect the ozone layer.

8. Do you accept the scientific consensus that combustion of fossil fuels is the primary driver of climate change? Does the Heritage Foundation?

   Climate change is real and it is clear that man-made emissions are having an impact. The Intergovernmental Panel on Climate Change 5th Assessment (IPCC AR5) attributes at least half of the warming from 1951–2010 to human activities. The 2018 National Climate Assessment says the same. However, distinguishing what climatologists know, what they do not know, and what they might know is necessary so that objective, transparent science can guide public policy.

   For instance, uncertainty exists with regard to the accuracy of climate models, how a doubling of carbon-dioxide emissions impacts global temperatures, changes in natural climate variation and which trajectory greenhouse gas concentrations most accurately reflects the future.

9. Do you accept the scientific consensus that HFCs are a significant contributing cause of climate change? Does the Heritage Foundation?

HFCs certainly have a warming effect. Their significant is subjective. There are some estimates, including those by Intergovernmental Panel on Climate Change climatologists, which estimate that the continued use of HFCs could lead to only an additional tenth of a degree Celsius warming. A study by Guus Velders of the National Institute for Public Health and the Environment in the Netherlands gave an upper bound estimate of 0.5 degrees Celsius, though that number was taken out of context because it was the highest estimate in the range. Velders said there is more uncertainty in the estimated abated warming from an HFC phase out than politicians have led the public to believe.

10. In 1990, the year Congress passed amendments to the Clean Air Act including Title VI phasing out CFCs, the Heritage Foundation for which you work published a document (attached) in "celebration" of Earth Day in which the author stated:

> "CFCs contribute greatly to the welfare of modern man. […] Alternatives may turn out to be toxic to humans, corrosive to existing equipment, less energy-efficient in use, may decay over time requiring frequent replacement, *and are certain to be more costly*." (emphasis added)

However, as other testimony points out, the Heritage Foundation and others were wrong about almost all of this, and HFC substitutes for CFCs proved to be much less expensive than Heritage and others predicted. Given that much of your testimony is based on alarmist predictions that HFOs will be much more expensive than HFCs, why should this Committee believe your testimony given your organization's history of having made similar erroneous predictions?

The pull out of the quote merely states that CFCs are certain to be more costly, which was true. The Environmental Protection Agency projected $36 billion in costs for the CFC phase out.[4] If a cheaper substitute were available, a switch would be made without a phase out. There was a consensus that there would be a cost; the question was how much. Moreover, I disagree with the notion that my testimony is based on alarmist predictions. I simply pointed out how costly HFOs are now, while readily acknowledging the costs will come down with more widespread adoption. I provide a range of what the projected costs may be from an HFC phase out.

Nevertheless, I do agree with the notion that "It is difficult to make predictions, especially about the future." When economic models project costs decades into the future, it strains their credibility. We also know that models can produce widely different results based on reasonable changes to their inputs. That is not to suggest that models are useless. It would be prudent for policymakers to consider the full range of cost forecasts, the full range of projected benefits to guide public policy decisions.

[4] Martha M. Hamilton, "The Costly Race to Replace CFCs," *The Washington Post*, September 29, 2991, https://www.washingtonpost.com/archive/business/1991/09/29/the-costly-race-to-replace-cfcs/86e250e5-6031-4b77-88c4-9f9b6963b6b7/ (accessed April 27, 2020).

NAMA
Bringing convenience to life.®

April 29, 2020

The Honorable John Barrasso
Chairman
Committee on Environment & Public Works
United States Senate
Washington, DC 20510

The Honorable Thomas Carper
Ranking Member
Committee on Environment & Public Works
United States Senate
Washington, DC 20510

NAMA Response to the United States Senate Committee on Environment and Public Works Questions for the Record on S. 2754, the American Innovation and Manufacturing Act.

Chairman Barrasso and Ranking Member Carper,

The National Automatic Merchandising Association (NAMA), and its members, thank you for the opportunity to provide additional feedback regarding our testimony on S. 2754, the American Innovation and Manufacturing Act.

1. Attached is a joint letter the Committee received prior to the beginning of the comment period from the Chief Executive Officers of three vending machine manufacturing companies. The companies are Crane Merchandising Systems, Seaga Manufacturing, Inc., and The Wittern Group. Do you agree with the concerns raised in this letter?

   Yes, NAMA strongly supports and holds the same position expressed in the letter from the machine manufacturing companies.

2. How has California's regulation of new vending machines impacted the supply chains and distribution networks of your members?

   The unique placement restrictions enforced by building codes and standards organizations have prohibited our industry from transitioning away from HFCs immediately. Because California banned new vending machines with R-134a refrigerant from entering the state, members had to stockpile older equipment to meet the demand in California. In many cases these stockpiles have been depleted and the industry has been forced to use older, less energy efficient machines.

3. Can you explain why it is important to have sufficient lead time to implement a phasedown of HFCs?

   While many industries have had ample lead time to prepare for a transition, the convenience services industry is uniquely impacted by the need to navigate placement restrictions around natural, flammable refrigerants like R290 (propane). Currently, these standards are in the process of being amended and the industry is not yet able to operate vending machines that use

R290, the only refrigerant that provides a global solution for the industry. Once these standards are amended, it will take time for the industry to increase manufacturing to accommodate the demand for machines charged with non-HFC refrigerants.

4. In your comments to the Significant New Alternative Policy (SNAP) Rule 20 Docket, you raised issues with the SNAP Rules' inconsistencies with Department of Energy (DOE) efficiency standards. Given these concerns, do you support language being added to the AIM Act to ensure consultation between Environmental Protection Agency and DOE?

   Yes, NAMA would be supportive of any language to ensure that the Department of Energy and the Environmental Protection Agency are both aware of the impact of refrigerant types on energy efficiency. In fact, in terms of data on energy efficiency related to types of refrigerants, NAMA is currently involved with a Cooperative Research and Development Agreement (CRADA) with the DOE to research energy efficiency and risk mitigation of using propane based R-290 refrigerant in vending machines. We hope that the valuable data collected through this CRADA will be shared by the DOE with EPA and other agencies to inform decisions on alternative refrigerants for other industries in the future.

5. It is apparent that a patchwork of differing state regulations has already formed. My understanding is that there are inconsistent compliance dates either already in effect or under consideration that apply to vending machines in California, Washington, Maine, and Vermont. Can you please provide more information about requirements that apply in these or other states?

   NAMA, on behalf of the industry, mobilized quickly to request that any states considering HFC phase out language, change the compliance date for new vending machines from immediate adoption to January 2022. Currently Washington, Maine, Vermont, New Jersey, Maryland, and other states have accommodated our request. California is the only state where an HFC ban on vending has already taken effect. As dozens of additional states consider similar regulations, it will not be feasible to expect that every state will adopt identical phase out dates.

   Additionally, some states have considered onerous labeling, disclosure, and recordkeeping mandates in their regulations that go beyond what California and other states have implemented. This will be nearly impossible to honor given the distribution channels and ease of mobility of vending machines. It is very likely that other states will consider not only varying effective dates but other measures like labeling and disclosure that would be incredibly difficult for industries to adapt to across multiple states without federal preemption.

6. Can you elaborate further about why HFC replacements are not "drop in candidates" for vending machines?

Vending machines are not unique in the design of their refrigeration systems; however, they must operate within a very narrow set of performance, safety, energy, and sustainability parameters.

To change from HFC refrigerants such as R-134a or R-410a to a replacement refrigerant is very complex. Performance, safety, and energy testing must be performed in order to find a successful replacement at a business tenable cost to the vending operator.

In refrigeration there is rarely, if ever, something that qualifies as a "drop-in" replacement. A change from an HFC refrigerant such as 134a or 410a to one of the HFO replacements or a blend of HFO with another refrigerant have advertised that they are replacements for HFC refrigerants, but will not provide "drop-in" solutions simply due to their closed loop capabilities.

Refrigerants must operate in a set of design parameters for the environment in which the machine is operating. Vending machines have very wide ranges of ambient temperatures – from operating in unheated outdoor locations in winter to the outdoor locations in the summer. This means a machine must operate in an ambient temperature from Zero (0) degrees Fahrenheit (f) to 130 deg f. Many of the HFO refrigerants particularly cannot operate efficiently across this type of a temperature extreme.

Additionally, HFO refrigerants are, for the most part, still considered to require Environmental Protection Agency (EPA) Section 608 special handling and replacement activities. These refrigerants must be withdrawn from the machine carefully at end of life or during service, stored separately, and reclaimed separately. This is not true of hydrocarbon refrigerants, where EPA determined that they may be vented safely and properly into the atmosphere.

Below are some, but not all, of the additional factors that go into determining the most suitable replacement refrigerant.

- ***Cost of refrigerants –*** *While the amount of refrigerant in a vending machine may seem small, the profit margin on a machine is very low. Many of the proprietary blends are produced by one or two companies. The raw cost of these refrigerants is often 6-10 times that of HFC 134a. This is not true of refrigerant propane (R-290) which is produced world-wide in large volumes.*

- ***Components –*** *In the refrigerant loop, the heart of the system is the compressor. There are only a very few manufacturers that make compressors in the size and functional range necessary for vending machines. Some have compressors available for "blend" materials, but we are not aware of any that are available for pure HFO refrigerants. Because there are so many blends being introduced, many compressor manufacturers have focused on what they see as the long-term solution – R290 and similar HCs.*

- ***Energy Efficiency -*** *Many HFO refrigerants do not reduce the energy use of the appliance, but rather actually require more energy to operate than either HFC or of the Hydrocarbon refrigerants. In the same vending machine design, if the appliance is redesigned to utilize hydrocarbon refrigerants, the product will generally use 5-8% less energy across the entire* *cycle, whereas there is either no energy improvement or even an energy "penalty" by using HFO or blend refrigerants.*

- ***Energy Voluntary Measures*** - *The convenience services industry is very supportive of the voluntary ENERGYSTAR® program, and many customers request only ENERGYSTAR® recognized machines. To meet the new 2020 ENERGYSTAR® voluntary guidelines a machine must operate significantly above the energy efficiency mandated by the required Department of Energy (DOE) minimum levels. One method of operating at the ENERGYSTAR® levels is to use a more efficient refrigerant and compressor. ENERGYSTAR® compliance is driven by the market and the customers, many of whom have environmental and climate change initiatives that demand both high energy efficiency and use of "natural" refrigerants.*

- ***Lifespan –*** *A vending machine must operate in a closed-loop system for 15-20 years with extremely infrequent service to the refrigeration system. There is considerable data to support the design and operation of vending machines with hydrocarbon refrigerants. There is far less data available to show that vending machines using HFO or HFO blend refrigerants can operate for 15-20 years with very little need for service. As mentioned, vending machines operate in some very diverse environments over this expected lifespan. Everything from indoor, climate controlled "clean" locations to factories and warehouses that are cold in the winter and hot in the summer. In locations such as Florida and Arizona for example, it is quite typical for glass-front vending machines to be located outdoors in breezeways subject to the widely varied ambient conditions that can be environmentally harsh. To prove a new design with new refrigerants can take several years.*

- ***Compatibility*** - *Within the refrigerant system, not only the compressor must operate efficiently with any new refrigerant blend, but also the compressor oils, seals, and metals. At the present time, there is not enough data to show that many of these new "blend" refrigerants will be completely compatible with all materials over a projected 15-20-year machine life.*

These are just a few of the many considerations that convenience services industry has about changing a refrigerant.

7. In a document entitled, "*NAMA Position Paper Submitted to the U.S. Climate Alliance on HFC Refrigerant Phase Out in the Vending Industry,"* NAMA noted cost differences between different refrigeration chemicals:

   HFO's cost a minimum of three times what R134a and R290 cost, per pound. Transitioning to propriety chemicals would represent a triple digit percentage increase in commodity costs making them prohibitively more expensive.

   What are "proprietary chemicals" and why do transitions to proprietary chemicals cost more?

A "proprietary chemical" is a reference to a chemically engineered HFO refrigerant that is designed by a company that holds exclusive rights to the sale and distribution of the refrigerant. These refrigerants are, understandably, more expensive than natural refrigerants like propane because they are only made by one company. Further many of these HFO refrigerants have a GWP that will render them unusable in other global jurisdictions, meaning they do not provide a global solution.

Again, thank you for the opportunity to provide further detail as to why federal preemption in S. 2754, the American Innovation and Manufacturing Act is necessary for the convenience services industry. We look forward to continuing working with the committee as it continues to work toward passing positive policies for both industry and the environment.

cc:

Members of the US Senate Committee on Environment & Public Works

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Responses for the Record to the Chairman's Questions for National Environmental Development Association's Clean Air Project
April 29, 2020

Chairman Barrasso:

1. The Air-Conditioning, Heating, and Refrigeration Institute testified:

   [I]t is important to note that a change in the phase down schedule does not prohibit the use of existing equipment, which consumers and business owners are free to use through the equipment's lifetime. Existing equipment is not subject to the AIM Act. And the AIM Act does not in any way mandate or otherwise require consumers to buy new equipment.

   Can you respond to this statement? Does the AIM Act affect existing equipment?

   NEDA/CAP's Response – It does not matter that the AIM Act does not mandate the retirement of existing refrigerant systems or related equipment if the next generation of refrigerants is not compatible with existing industrial process refrigeration (IPR) and comfort cooling appliances, if additional capital expenditures to such equipment is necessary for them to be made compatible, or if the phase-down of existing refrigerants causes an exponential price increase for these refrigerants.

   NEDA/CAP has three inter-related concerns --

   First, even if the use of existing equipment is not prohibited, the proposed hydrofluorocarbon (HFC) phase-down would economically render obsolete the fleet of existing HFC equipment as the cost of available HFCs increase as the phase-down makes them less available in the market. In other words, the issue that will drive retrofit or replacement of existing equipment is the cost and availability of HFCs upon phase-down, and the significant cost increase to maintain equipment with limited reclaimed/recycled refrigerant in the market as its driver. The unbounded discretionary authority of the EPA, or a citizen, to accelerate phase-out of existing refrigerants creates further risk that could restrict the ability of a facility to realize the useful life of refrigerant equipment.

   Second, our understanding is that the retrofit of HFC equipment with the new refrigerant, such as hydrofluoroolefin (HFO) refrigerants, often will necessitate additional, potentially sizeable, investments in order to continue to operate existing equipment (e.g., the thermodynamic properties of HFOs can require larger compressors and the chemical properties can require the replacement of seals and gaskets, etc.). Therefore, the premature retirement of refrigerant equipment before the end of its useful life is likely.

Third, if the AIM legislation is implemented through the existing EPA refrigerant leak management regulations (to avoid time delays occasioned by new rulemaking), unclear provisions in that regulation could result in early retirement of existing comfort cooling, commercial, and industrial refrigerant systems. So while the legislation is silent on whether early retirement of refrigeration systems is mandated (and when), the cost of the program is irretrievably linked to price/availability of HFCs and the compatibility of existing refrigerant equipment in markets, nursing homes and other institutions and industrial applications processes with the new refrigerants, such as HFO.

2. Your testimony highlighted that the AIM Act lacks language to prevent increases in consumer costs. Do you believe language should be added to ensure the bill appropriately considers potential increases in consumer costs when setting regulations under the AIM Act?

   NEDA/CAP's Response – Yes. In addition to the concerns about the price/availability of HFCs and the equipment retrofit/replacement costs of transition to new refrigerants such as HFOs, it appears that the proposed class of replacement refrigerants cost significantly more than current refrigerants, based on the analysis by the Competitive Enterprise Institute (CEI) and others. (See B. Lieberman's Response to Questions from EPW on the AIM Legislation.) NEDA/CAP is concerned that while the AIM Act is designed to "create" manufacturing jobs and profits, it purposely ignores consumer costs for both more expensive refrigerants (e.g., HFCs and the new refrigerants) and the new or retrofit equipment required to use those refrigerants.

   However, NEDA/CAP is not sure how cost-controls could be implemented. In our view, the EPA would not be the appropriate agency to oversee such conditions. Perhaps an ENERGY STAR-like program or the Consumer Protection Agency could be charged with overseeing the costs to consumers and authorized to intercede with price controls or slowing the phase-out schedule, if the price or rate of price increase) of HFCs, new refrigerants, or equipment that can use the new refrigerants exceeds certain price levels.

3. Can you explain in greater detail your concerns about the AIM Act's relationship with the Clean Air Act? Do you have concerns about the current cross-references in the AIM Act to the Clean Air Act?

   NEDA/CAP's Response – Although the AIM Act does not clearly assign authority to any specific agency to implement the law -- or more particularly, does not amend the Clean Air Act for this purpose -- the AIM Act specifically utilizes the general enforcement authorities of the Clean Air Act including but not limited to the citizen suit authority that might be used to compel the EPA Administrator to accelerate the phase-out of existing refrigerants HFC. This is one of the curious aspects of S. 2754. Another is that S. 2754 would appear to legislate the Kigali agreement, without ratification of the Treaty as an amendment to the Montreal Protocol and also legislatively circumvent recent court cases that limit EPA's ability to require manufacturers to phase-out HFC refrigerants.[1]

Both oddities would be resolved if S. 2754 were designed to amend the Clean Air Act, rather than be bootstrapped into implementation under the Clean Air Act Amendments of 1990, which amended the 1977 Clean Air Act to provide EPA with the regulatory authority it needed to implement the Montreal Protocol to phase out Ozone Depleting Substances (ODS) as refrigerants and for EPA to regulate substitutes to existing refrigerants on this basis. Yet, the legislation does not vest EPA with authority for assuring that the AIM Act's goals are implemented and/or verified, or that a federal set of goals preempts state authority to also regulate in the subject area.

The AIM legislation, in NEDA/CAP's view, cannot be self-implementing. What part of the U.S. government will oversee the phase-out of greenhouse gas refrigerants set forth in the legislation? Will it be implemented under new or existing regulations, or a combination of the two? By whom, how, and to whom will the manufacturing information on the phase out of existing refrigerants be reported, and how will it be verified? Will an agency or some other body oversee new certification of refrigerant technicians, under the existing provisions of the Clean Air Act--or under other independent standards? Will the Congress and/or the General Services Administration or General Accounting Office oversee these aspects of the new law? Will another entity ensure energy efficiency of the new refrigerants in existing and/or new refrigerant systems?

4. Is it true that the replacements for HFCs are more expensive than their counterparts? What impact will this have on the consumer?

    NEDA/CAP's Response – NEDA/CAP is not an expert on this issue, but understands this is the case. We also anticipate that installation/retrofit costs will be higher because of potential flammability and other safety issues that need to be addressed with some of the new refrigerants that take the place of the existing generation of refrigerants, even if the existing equipment does not need to be retired and/or retrofitted. NEDA/CAP also has no direct knowledge of the energy-efficiency

[1] In *Mexichem Fluor v. EPA*, 866 F.3d 451 (D.C. Cir. 2017), the D.C. Circuit vacated portions of the SNAP #20 rule requiring replacement of GHG substitutes for ODS substitutes. Petitions for Certiorari of the D.C. Circuit findings were denied. *Nat. Res. Defense Council v. Mexichem Fluor* 2018 WL 3210813 (U.S. Oct. 9, 2018). The Court also heard argument in the related SNAP II case D.C. Cir. 17-1024 (Snap #21) that presented a similar issue, after which it issued a terse *per curiam* order on Apr. 5, 2019 reaffirming Mexichem Fluor I based on the doctrine of judicial preclusion.

associated with the new substitutes (e.g., HFOs) versus existing HFCs, but that issue is also critical for commercial and industrial users as well as private consumers. As do others, we rely on publicly available research. For instance, a recent SAE International paper reported that two HFCs for certain mobile air conditioning systems were $5 to $8 per kilogram, whereas the HFO replacement was $100 per kilogram wholesale, with an even greater price differential for retail customers ($10 to $15 per kilogram vs. $310 per kilogram).[2]

5. Do you have concerns that the broad language of the AIM Act's phasedown provisions, including the technology transitions provision, do not adequately figure in cost considerations?

<u>NEDA/CAP's Response</u> – Yes. High on our list of cost concerns would be considerations of retrofitting existing equipment for use of new refrigerants, such as HFOs and/or the cost of accommodating other substitutes, many of which appear to be highly flammable (e.g., propane- and butane-based compounds) and/or toxic (e.g., ammonia-based compounds). NEDA/CAP, therefore, is concerned about the cost of additional safeguards necessary to safely use such materials. We also would like to know the respective views of the Insurance Industry and entities such as the National Fire Protection Association on these additional costs associated with the use of the new class of refrigerants, particularly as the EPA correctly continued to state in the most recent March 11, 2020 refrigerant management rulemaking that "refrigerant systems unavoidably leak."[3] The assessments of the latter stakeholders could affect which substitutes are available for certain uses and affect their costs. If there are sacrifices that new-users will make in terms of cost and safety, even if retrofitting existing equipment to use the new refrigerants is technically feasible, NEDA/CAP is concerned that those sacrifices too will drive the cost of a new fleet of air conditioners, before the end of the useful life of existing equipment. How much less efficient (and costly) is new equipment, and does new equipment offer any safety/flammability/leakage safeguards?

6. Proponents of the AIM Act state that a federal framework is needed to provide regulatory certainty. How does inclusion of a citizen's suit provision assist or hinder certainty?

<u>NEDA/CAP's Response</u> – The citizen suit provision at Section 12 of S. 2754 at Section 12 would allow the EPA to restrict /phase-out regulated substances in industry sectors and subsectors, and for any person to petition the EPA to issue a

[2] Andersen, S., Chowdhury, S., Craig, T., Kapoor, S. et al., "Comparative Manufacturing and Ownership Cost Estimates for Secondary Loop Mobile Air Conditioning Systems (SL-MACs)," SAE Technical Paper 2017-01-0173, 2017, doi:10.4271/2017-01-0173.

[3] EPA has previously recognized that refrigeration equipment inherently will leak refrigerant over time. See, e.g., 80 Fed. Reg. at 69486:3 ("few appliances are leak-free"); 83 Fed. Reg. at 49338:2 ("refrigeration and air-conditioning equipment often does leak").

rule to restrict a regulated substance. The process could create potentially inconsistent administration of the program, regulatory and financial uncertainty, and thus, risk for owners of large and complex refrigeration systems or those used in niche markets. State programs regulating HFCs creates additional potential regulatory inconsistency and uncertainty. We stress that any federal program should be designed to provide manufacturers and other businesses with predictable conditions to direct their planning, infrastructure investment, and material purchases. Legislation, therefore, should ensure a consistent nationwide program that preempts states from setting different standards.

While NEDA/CAP again states its lack of certainty about what existing regulatory authority will be used to implement the AIM Act, if we assume that it will be regulated under the Clean Air Act, then the citizen's suit provisions of the CAA would apply within the context of the existing architecture and federal framework of the Act.

THE NEW ERA GROUP INC.

April 29, 2020

The Honorable John Barrasso
Chairman
Environment and Public Works Committee
410 Dirksen Senate Office Building
Washington, DC 20510-6175

Re: American Innovation and Manufacturing Act (S. 2754) Information Gathering Responses

Dear Chairman Barrasso:

The New Era Group and its represented small businesses thank you for allowing us to respond to questions that arose from our testimony on the American Innovation and Manufacturing Act S 2754. We have given your questions considerable attention and submit the following:

1. ***Your testimony states that the baselines considered in the AIM Act do not accurately represent current U.S. stockpiles. Can you provide us with data outlining the current stockpile of HFCs in the U.S. that would better inform the setting of baselines?***

To best answer the issue of stockpiles, we draw from several sources. On April 3, 2020 the US Department of Commerce released a memo that outlines significant data on stockpiles. "***From September 2016, through June 2019, monthly average exports of HFC components from China to the United States surged to 2,707,659 Kg; an increase of 411.31 percent. Likewise, over the same time periods, the monthly average import quantity of HFC components from China into the U.S. increased from 599,875 Kg per month to 2,247,874 Kg per month; a 274.72 percent increase.”***

Table 1

Year of Import	HTSUS 2903.39.00 Imports From All Countries (Kgs)	HTSUS 2903.39.00 Imports From the Peoples Republic of China (Kgs)	% of Imports From the Peoples Republic of China	HTSUS 3824.78.00 Imports From all Countries (Kgs)	HTSUS 3824.78.00 Imports From the Peoples Republic of China (Kgs)	% of Imports From the Peoples Republic of China
2009	21,053,364	17,348,881	82%	227,038	59,356	26%
2010	40,148,371	34,198,346	85%	922,052	153,903	16%
2011	48,886,250	43,438,720	89%	1,113,250	426,105	38%
2012	49,322,588	44,477,385	90%	3,893,459	3,092,456	79%
2013	55,489,810	51,099,265	92%	5,817,298	5,362,443	92%
2014	52,567,253	45,631,267	87%	4,238,803	3,710,170	88%
2015	76,214,335	70,040,654	92%	10,514,341	9,013,944	86%
2016	66,234,936	56,547,312	85%	12,161,730	11,229,888	92%
2017	72,726,852	59,387,355	82%	9,342,624	6,222,964	67%
2018	80,302,564	67,043,152	83%	7,556,627	4,926,765	65%
Total Annual	562946323	489,212,337	87%	55,787,222	44,197,994	79%

There are two primary chapters of the Harmonized Tariff System of the United States (HTSUS) that cover the products associated with refrigerant known as hydrofluorocarbons (HFC). The United States imports single components from 43 separate countries. These imports can be reviewed under 2903.39.2005, 2903.39.2015, 2903.30.2020, 2903.39.2030, 2903.39.2035, 2903.39.2045, 2903.39.2050. The finished blended HFC Refrigerants are imported from 22 countries. The blended, finished refrigerants are correctly imported under 3824.78.0000, 3824.78.0020, 3824.78.0050.

Data has been compiled from the International Trade Commission (ITC) https://dataweb.usitc.gov.

Along with these sources, we used an imports data-tracking firm, Datamyne, to analyze elements such as the cylinders used to package refrigerant.

US DOT-39 non-refillable cylinders have been imported at such elevated levels that Worthington Industries has now filed an anti-dumping and countervailing petition[1] on imports of these packaging cylinders.

This event should not be considered anecdotal.

From January 2011-December 2018, 3.3 million cylinders were imported. With a normal fill weight of 25 lbs of HFC blends refrigerant, this quantity represents 81 million lbs of refrigerant! For the one-year period of January 2019-December 2019, 546 thousand cylinders were imported, representing 13 million lbs of HFC refrigerant—more indications of the massive stockpiling of components and blended HFCs[2].

Apply this to US population numbers, and there's enough packaged refrigerant to supply every American citizen with a pound of it. And these numbers don't even reflect the pre-charged air-conditioning units that have been imported.

What is also not factored into analysis is the air-conditioning equipment (that operates on HCFCs) that has been retired and replaced due to catastrophic tornados, hurricanes, and wildfires that have been a recent regular occurrence.

Here again we know that the small business community has not been a contributor to this build up. Yet going forward these small companies will be disqualified from participating in the HFC consumptions allowance going forward, thus the request for the minimum 25% small business carve out.

2. ***We have noted that the baselines used in the bill do not reflect the most recent global warming potential (GWP) exchange values. Is this a problem?***

We believe that allocation of allowances should be based on GWP exchange values. To assign allowances on weight alone prioritizes the system's monetary value over its environmental goals. Using weight as the only criteria will create the need for inter-pollutant transfers. The allocation by GWP would not impede development of lower GWP blends.[3] Based on weight alone, the system has operated against the environmental benefits intended. This is illustrated in Table 2, which shows that the current system allows trading-up to higher GWP chemicals. You can, of course, control trade-ups by using a "worst-first" policy, as

EPA did with CFCs and HCFCs.

The following table is an example of the way inter-pollutant transfers have been applied. The HCFC-225ca and HCFC-225cb were transferred for HCFC-22. As completed, this transfer allowed a lower ODP substance to be transferred to a higher ODP substance. For the purpose of this bill, and using GWP as the basis of the phase-down, the transfer went in the wrong direction. As defined in the bill, this type of transfer will be allowed when agency action is taken.

Table 2

Chemical Name	Lifetime in years	ODP1(Montreal Protocol	ODP2 (WMO) 2011	GWP1 (AR4)	GWP2 (AR5)	Cas Number
HCFC-22 (CHF2Cl) Monochlorodifluoromethane	11.9	0.055	0.04	1810	1760	75-45-6
HCFC-225ca (C3HF5Cl2) Dichloropentafluoropropane	1.9	0.025	0.02	122	127	422-56-0
HCFC-225cb (C3HF5Cl2) Dichloropentafluoropropane	5.9	0.033	0.03	595	525	507-55-1

Take the use of HFC-143a as an example. An allocation of 2 million kgs of HFC-134a can be converted to 1,980,000 kgs of HFC-143a. This transaction will net an increase, not a decrease, in GWP.

Table 3

Chemical Name	Common Name	Exchange Value	Chemical Name	Common Name	Exchange Value
CHF2CHF2	HFC-134	1100	CH2FCF2CHF2	HFC-245ca	693
CH2FCF3	HFC-134a	1430	CF3CHFCHFCF2CF3	HFC-43-10mee	1640
CH2FCHF2	HFC-143	353	CH2F2	HFC-32	675
CHF2CH2CF3	HFC-245fa	1030	CHF2CF3	HFC-125	3500
CF3CH2CF2CH3	HFC-365mfc	794	CH3CF3	HFC-143a	4470
CF3CHFCF3	HFC-227ea	3220	CH3F	HFC-41	92
CH2FCF2CF3	HFC-236cb	1340	CH2FCH2F	HFC-152	53
CHF2CHFCF3	HFC-236ea	1370	CH3CHF2	HFC-152a	124
CF3CH2CF3	HFC-236fa	9810	CHF3	HFC-23	14800

The authors of this bill provide a novel term "exchange value". The definition is vague. The bill appears the term “exchange value” might be a substitute for inter-pollutant transfers. This new term represents a new and ambiguous departure from prior phase-outs. The use of the term is confusing to its application to inter-pollutant transfers and has to be clarified.

(5) EXCHANGE VALUE. —The term ''exchange value'' means the value assigned to a regulated sub- stance in accordance with sections 4 and 6, as applicable.

As with the Kigali Amendment which is the model for this bill, the exchange value that uses AR4 values is higher than the most recent AR5 values; and the use of older values provides higher allocations that are less favorable to the environment at the outset.

(G) For trades of consumption allowances, production allowances, export production allowances, or Article 5 allowances, the quantity of the 0.1 percent offset applied to the unweighted quantity traded that will be deducted from the transferor's allowance balance.[4]

We feel that it is essential that we point out that it is a mistake to allow chemical transfers across markets. There should not be an ability to transfer “exchanges” across markets, say from a chemical that is only used as a blowing agent such as R-142b for R-22 sold into the refrigerant market.

This has and in fact has had the effect of enormous market disruption and has the potential to expose the agency to litigation.[5] So, in light of past problems, we believe that allowances based on GWP would be the best option, with a few, very important recommendations.

1. Divide the HFCs into groups by primary use award
   a. Refrigerants
   b. Solvents
   c. Foam-blowing agents
   d. Fire suppressants
2. Do not allow inter-pollutant transfers between these groups
3. Base allocations on GWP as CO2 equivalent values
   a. Use A4 for the duration of the phase-down and decrease overall allocations to reflect future assessments, rather than trying to redefine a baseline. EPA must have the ability to update based on subsequent assessments at its discretion.
   b. Established a clearer definition of the term “exchange rate”

3. In your testimony, you state:

Senate Bill 2754, through a generous allowance system for production and consumption, promotes continued imports of HFCs from countries that have been identified as sellers of HFCs in the United States at less than fair value (LTFV).

Air-Conditioning, Heating, and Refrigeration Institute (AHRI) testimony states that the AIM Act will end the ongoing process known as "dumping," where overseas companies export inferior equipment to the U.S. at a price below the cost of manufacture. Will the AIM Act prevent dumping? Will it have other effects on trade?

We should not conflate imports with the issue of dumping because one does not simply follow the other.

AHRI fails to acknowledge that imports of HFCs have been going on at high levels for quite some time. We ask that the testimony of the Competitive Enterprise Institute, offered by Ben Lieberman, become part of the record here.[6] There are significant investments that have been made overseas.[7] "This includes Honeywell and Chemours, which located their first refrigerant-making facilities in China before breaking ground in the United States."[8]

We do believe that AIM will stop dumping in the long term by setting limits. However, it is imperative to collect data through an expanded Greenhouse Gas Reporting to set realistic allocations. Do not award allocations for stockpiles and for non-compliance with GHG reporting.

We ask you to consider the following:

- ITC report on US capacity of HFCs R-125[9]
- Honeywell notices of price increase R-143a
- Datamyne on imports of R-152a
- Issues of enforcement as to CBP "Entry Summary"
- Under-reporting and non-reporting under current law GHG
- US Flight Report "OO" and "QQ"
- US industry standard AHRI-700 places burden on reclaim and not on virgin products

4. Are you concerned that the AIM Act focuses too much on reclaiming refrigerants as opposed to recycling? What impact does this focus have from an environmental perspective?

The issue of reclaim vs. recycling continues to be an area that the reclaim industry and the sellers of refrigerants struggle with. That an owner can take refrigerant from one system and use it in another without going through the process of cleaning, recordkeeping, or reporting the re-use is an argument that continues. For obvious reasons these activities are frowned on by the reclaim industry and the refrigerant sellers.

There is no data collected that can support recycling. Absent this, it is reasonable to say that re-use without reclaiming has and continues to be an element of the refrigerant servicing industry.

The matter of reclaim overlaps here. We will roll question 5 into this response.

We do believe that AIM focuses too much on reclaim that it needs to recognize emerging technologies, which are developing largely through the efforts of small business.

We would point out, California's SB-1013 advances for the first time, destruction of high-GWP refrigerants.

DIVISION 45. Fluorinated Refrigerant

76008. (4) Identify opportunities to increase the recovery, reclamation, or destruction of existing high-GWP refrigerants.[10]

Nothing in this bill addresses the high-GWP refrigerants end of life, that stockpiles created by oversupply will be accumulated or vented as a result of new equipment and new refrigerants being installed. Sadly, the attitude in general is to simply whistle past the graveyard. There is a whole new industry that has been sidelined. Transformation technology exists to convert HFCs into other usable commercial chemicals.[11]

It must be recognized, however, that reclaim has always been underutilized. Small businesses were hampered by the previous system. Because the HCFC allocation system was inequitable, did not afford for pertinent data collection, and was fraught with litigation, it fostered a surplus of HCFCs and created enormous market instability. Unstable pricing, reduction in the HFC market in Europe due to of F-gas regulation, and speculation on regulation phasing down HFCs in the US, made the US market a target for Chinese dumping of HFCs into the US at less than fair market value which has further hampered reclaiming. Reclaim has declined over the prior 2 years and is expected to fall again for 2019.

Standards on reclaim product are higher than virgin. This further hinders reclaim whose ARI 700 products are competing with Chinese virgin imports that are under no legal obligation to meet ARI 700 industry standard.

Reclaimed product cannot currently compete with imported and stockpiled Chinese gas. Passing the AIM bill appropriately amended to include 25% of allocations for small companies in the associated industry and meaningful reporting requirements will foster reclamation and advancing technologies by allowing them the chance to be competitive. It can also give EPA the tools it needs to set appropriate allocation levels.

See Attachment 1 North American Refrigerants to Senator Baldwin 4-22-2020

> ***5. Your testimony highlights how the "reclaim/reuse of all regulated substances has declined consistently since 2016." Given this information, do you believe sufficient quantities of HFCs will remain available for needed use?***

Reclaim has and continues to be seen as a sustainable alternative in servicing existing equipment. In Tables 4 and 5, the history of reclaim speaks for itself.

Factually, reclaim has never reached the estimated levels suggested in reports commissioned by EPA. We requested the EPA disclose what was being collected regardless of the end-of-life use with a goal of demonstrating the importance of this activity.

Table 4

HFC Refrigerant Reclamation Totals by Year (pounds)

	HFC-23	HFC-134a	HFC-227ea	HFC-404A	HFC-407A	HFC-407C	HFC-410A	Other HFCs	Total
2017	1,175	1,858,132	154,655	486,719	111,255	167,445	2,103,404	119,036	5,001,821
2018	841	1,910,240	248,178	506,639	143,254	167,248	2,043,667	138,920	5,158,987

Total Refrigerant Received by Year (pounds)

2010	2011	2012	2013	2014	2015	2016	2017	2018
9,236,784	9,126,931	10,517,538	11,615,679	10,240,152	11,880,770	16,156,808	17,349,088	18,025,930

**Reclaimers were not required to include HFC refrigerants in reports of total amount received until 2017.

Mixed Refrigerant Received Totals by Year (pounds)

2010	2011	2012	2013	2014	2015	2016	2017	2018
77,038	121,718	86,146	93,807	113,883	221,159	924,475	375,671	975,271

***Mixed refrigerant is material received by reclaimers that contains multiple refrigerants, including ODS and HFCs, potentially in unknown quantities and composition. These are not blends, which contain specific constituents at specific ratios. Mixed refrigerant totals are included in the Total Refrigerant Received table.

Table 5

ODS Refrigerant Reclamation Totals by Year (pounds)												
	CFC-11	CFC-12	CFC-13	CFC-113	CFC-114	CFC-502	HCFC-22	HCFC-123	HCFC-124	HCFC-500	HCFC-503	Total
2000	1,548,734	1,679,526	1,978	229,954	182,544	619,579	7,094,995	250,811	-	245,530	-	11,853,651
2001	1,182,130	1,296,745	1,485	162,572	100,581	249,604	4,320,103	212,568	-	188,981	-	7,714,769
2002	1,411,133	1,237,060	343	143,404	288,084	330,170	4,915,809	179,481	-	184,104	8,591	8,698,179
2003	903,731	623,245	-	110,425	394,091	90,749	4,356,619	110,022	-	90,344	-	6,679,226
2004	1,188,360	720,181	-	129,134	281,958	105,536	7,231,013	250,842	-	137,300	-	10,044,324
2005	985,184	593,345	-	107,985	70,086	55,181	6,172,133	319,539	-	74,278	-	8,377,731
2006	1,188,230	738,482	-	133,511	48,824	113,879	8,535,423	318,241	-	96,668	-	11,173,258
2007	891,687	460,594	1,389	162,773	26,400	75,431	8,191,322	227,323	-	41,518	-	10,078,437
2008	989,234	476,726	-	175,568	310,321	88,040	10,045,071	272,583	-	195,724	60	12,553,327
2009	1,026,824	212,638	224	135,301	16,554	136,936	7,544,327	436,463	-	118,847	46	9,628,160
2010	713,747	350,139	212	170,130	77,161	27,522	7,907,536	316,595	270	107,808	13	9,671,133
2011	719,036	291,869	68	151,887	327,537	41,448	8,290,406	335,760	74	43,430	30	10,201,545
2012	784,061	328,582	357	306,157	39,797	30,748	9,401,446	316,340	439	108,221	148	11,316,296
2013	736,126	372,521	185	36,166	415,399	15,689	8,701,264	445,854	1,088	48,616	395	10,773,303
2014	812,357	406,436	849	22,293	18,238	24,587	7,823,982	374,357	3,611	42,453	108	9,529,271
2015	740,543	288,302	118	217,007	6,370	15,771	7,811,832	399,683	199	33,171	32	9,513,028
2016	574,826	155,254	155	30,710	182,121	15,719	9,408,329	415,516	4,251	16,842	30	10,803,753
2017	905,045	263,957	1,292	86,361	10,461	27,206	8,680,022	592,256	396	32,665	184	10,599,845
2018	565,158	191,711	521	25,757	4,067	28,767	8,041,474	535,673	1,059	51,366	103	9,445,656

*Other CFCs and HCFCs that are reported in small quantities (e.g., CFC-115 and HCFC-142b) or that are contained in blends with non-ODS (e.g., R-408A) are excluded. EPA also revised the 2017 data based on updated reporting.

Tables 4 and 5 speak to the decline, as reported by the industry. There are several factors that come into play that have suppressed this segment of the industry.

Consider:

- The inter-pollutant transfer debacle of 2013
- Abundance of both finished product and components
- Regulatory uncertainty
- Natural disaster
- Industry of reclaim has changed

Historically, when CFCs were phased out, reclaim was introduced. Economics drove CFC owners to reclaim and reuse CFC. The IRS imposed a “Floor Stocks Tax” and “Excise Tax” on ozone-depleting chemicals.[12] As of 2016, that tax grew to $14.80 based on the ozone depletions factor and pounds associated with the transaction.

Table 6[13]

Recycling

No tax is imposed on any ODC that is diverted or recovered in the United States as a part of a recycling process. The diverted or recovered ODCs may not be a part of the original manufacturing or production process. The exemption also applies to recycled Halon-1301 and recycled Halon-2402 imported from any country that is a signatory to the Montreal Protocol on Substances that Deplete the Ozone Layer. **Cite:** IRC §4682(d)(1).

These taxes made the economics of reclaiming using CFCs hugely beneficial. Large stakeholders were able to justify the exemptions they received by using AHRI and EPA-certified reclaimers. AHRI-member reclaimers were given labels to place on finished product, meeting the AHRI Standard 700.

Unfortunately, this tax did not carry over to the Class II ozone-depleting chemicals. As the phase out of the Class II ODC approached, alternatives became more prevalent. The price of HCFC-22, the workhorse of the industry, began to rise and it was rumored that shortages would occur. As mentioned before in Question 2, there was an unforeseen inter-pollutant transfer case that resulted in there being a large reapportionment of HCFC-22 allowance called the “recoupment allowance”. With no tax on warehouse HCFCs, the surplus grew. This drove prices of HCFC-22 down.

During this time the alternative non-ozone-depleting refrigerants lost traction. After the final control period for HCFCs was established again, speculation and rumor again drove prices of HCFC-22 to an all-time high of over $600 a cylinder, making the retrofit alternative market attractive again. Within the reclaim industry, "cross contamination" of zeotropic blends grew. At the same time, the imports of foreign HFC components grew. All of this market instability negatively impacts reclamation. In fact, why recover and reuse or reclaim when the price of new product remains depressed?

The notion that reclaim is sustainable is not supported by current conditions. In this age where there is such a tremendous amount of inexpensive material, the sustainability of this segment of the industry is seriously in question.

Again, the data clearly shows that one of three things are going on: 1) material is being vented 2) the material is being re-cycled by owners or service companies for reuse in equipment against EPA regulations, or 3) systems are leaking.

We would also point out in the California's SB-1013 advances for the first time destruction of high-GWP refrigerants.

Considering all the changes that have occurred to include the oversupplies resulting in stockpiles being created along with end of life equipment, nothing in this bill addresses the high-GWP refrigerants that will be accumulated or vented as a result of new equipment and new refrigerants being installed. Sadly, the attitude in general is to simply whistle past the graveyard. There is a whole new industry that has been sidelined. Transformation technology exists to convert HFCs into other usable commercial chemicals.[14]

6. Would the AIM Act prevent dumping of chemicals and products as some supporters of the AIM Act have asserted? Why or why not?

This bill will not affect the practice of dumping or selling imports at LTFV in the near term. In the event that S.2754 is passed, in the Senate and then reconciled with the House version H.R.5544, signed by the president and forwarded to EPA to write a rule. EPA has not done the data collection to evaluate and understand the baselines defined in the bill. Realistically, by the time a rule is enacted, the scores of imports that will have cleared US borders will add to the already huge stockpiles[15]. (increase in imports shown in question number 1)

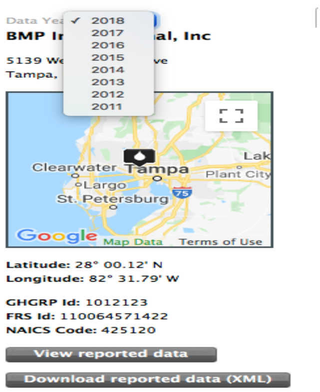
Table 7[16]

Date	Percentage of Production Baseline	Percentage of Consumption Baseline
2020–2023	90 percent	90 percent
2024–2028	60 percent	60 percent
2029–2033	30 percent	30 percent
2034–2035	20 percent	20 percent
2036 and thereafter	15 percent	15 percent.

There remains various anti-dumping petitions, circumvention petitions and tangential actions that have yet to be decided. On this matter, we recommended that this bill be amended to give significant weight to the GHG regulation. While 2018 saw a 47% increase over 2014 in the sector of Subpart "OO" Industrial Gas Suppliers, there needs to be careful review of how targets of the anti-dumping actions have retroactively reported in order to position themselves to participate in the distribution of allowances, when they have failed to comply with GHG reporting until very recently.

THE NEW ERA GROUP INC.

Table 8[17]



2018 – Industrial Gas Importers – Total Reported GHG Quantity by Facility in Metric Tons of CO_2e

	Facility	City	State	Total Reported GHG Quantity
!	3M COMPANY	ST PAUL	MN	
	Accella Polyurethane Systems	Cartersville	GA	
	Advance Auto Parts	Roanoke	VA	
	Air Liquide Electronics U.S. LP	Morrisville	PA	
	Airgas USA, LLC	Houston	TX	
	ALTAIR PARTNERS LP	MILLBURN	NJ	
	Arkema Inc.	King of Prussia	PA	
	Aspen Refrigerants, Inc.	Atlanta	GA	
	AutoZone Parts Inc.	Memphis	TN	
	BMP International, Inc	Tampa	FL	
	Brooks Automation, Inc	Chelmsford	MA	
	CC Packaging LLC	Levittown	PA	
	Certified Specialty Gases, Inc.	Reno	NV	
	Combs Gas, Inc.	Magnolia	TX	
	ComStar International, Inc.	College Point	NY	

7. Who holds most of the patents for HFC replacement chemicals? When do these patents expire?

While we have not researched all of the patents, we would refer to the ITC final staff report.[18] ITC has established a record on patented and/or proprietary alternatives (pages 1-37 and 1-38 and Attachment A within). It would be reasonable to conclude that companies such as Chemours, Honeywell, Arkema, and Diakin hold the majority of the patents.

HFCs continue to be the basic component of low GWP refrigerants. The newest class of refrigerants is HFOs. HFOs are blended with HFCs to make alternatives. Small businesses need the HFOs to develop and bring these new innovative refrigerants to market under patent. The issue of patents on the HFOs is still in the courts.[19]

8. Can you explain why it is important to have sufficient lead-time to implement a phasedown of HFCs?

This question is best answered by segments of the regulated community that are affected by the last phase-down. In the interest of open transparency, we suggest that the committee invite experts in each segment of the regulated community to present specific challenges that this bill, as written, will present.

Whatever the baseline and whatever the lead-time to implement it, stockpile will flood in before this act is implemented.

Adequate data needs to be collected during the lead-time to adjust the baseline. Improved reporting and data collection will allow EPA to amend the multiplier to the baseline during or after a control period. In the past EPA used bottom up Vintaging models that were extremely inaccurate. Reporting will provide concrete information to guide EPA decisions. Given the growing stockpiles and EPAs past decisions concerning baseline and phasedowns, the only chance that EPA will do anything but set the baseline initially at an enormous surplus relies on data collection during the lead time.

Baseline should not give undue reward to Chinese based and backed companies that have flooded the market. An additional 25% of baseline without an annual retirement (use it or lose it) requirement, assigned to a small business reserve will ensure uninterrupted supply and increase market stability. If the baseline established is inadequate, the 25% will provide additional market elasticity. The 25% allocations to small business we are requesting will be of little value in the beginning of the phase down while the market is in surplus. While the market is depressed, and in surplus, it will be too risky for this group to use allocations. As the supply tightens, those allocations will come into play to stabilize the market. We firmly believe that surplus will be verified in the first few years of reporting and that EPA will be able to adjust the phasedown multiplier accordingly.

9. Do you believe language should be added to ensure the bill appropriately considers potential increases in costs when setting regulations under the AIM Act?

We do not feel that cost of administration will increase if our recommendations to amend the bill are implemented. Reporting and data collection will avoid the cost of convoluted analysis such as the Vintaging model and ambiguity leading to costly litigation. Additionally, expanded reporting can be added to an existing GHG reporting system.

We do not feel that the cost to the regulated community for expanded reporting is significant as any company that uses allocations should already have all of the information EPA would be requesting. Not to mention that much of this information should be already compiled by these stakeholders for compliance with TIER reporting etc.

The wholesale price of refrigerant has seen price swings as wide as 75% from 2017. If our recommendations are taken to amend this bill, the cost to the consuming public will not increase but will stabilize by reducing the impact of feral companies operating in the US, rumor and speculation.

We hope that if this bill is to be considered by the committee, the amendments that we have advanced will find there're way into the bill. We must stress that this bill excludes small bossiness concerns. The failure here is that the allowances are not rights and should be apportioned in such away as to not overlook the unfair burden that has been placed on small business, that have not be adequately represented, in the past

Thank you for allowing us to answer your questions, and for your time and attention to these important economic and environmental matters.

Sincerely,

Peter Williams

Attachment A

Table of GWP Values: The tables below provides a detailed list of the GWPs* of various fluids that are impacted by the Kigali Amendment. Colour coding based on Figure 1.

Group	Fluid	GWP
HFCs	HFC-23	14 800
	HFC-32	675
	HFC-41	92
	HFC-125	3 500
	HFC-134	1 100
	HFC-134a	1 430
	HFC-143	353
	HFC-143a	4 470
	HFC-152a	124
	HFC-227ea	3 220
	HFC-236cb	1 340
	HFC-236ea	1 370
	HFC-236fa	9 810
	HFC-245fa	1 030
	HFC-365mfc	794
	HFC-4310mee	1 640
HCFCs	HCFC-22	1 810
	HCFC-123	77
	HCFC-124	609
	HCFC-141b	725
	HCFC-142b	2 310
CFCs	CFC-11	4 750
	CFC-12	10 900
	CFC-113	6 130
	CFC-114	10 000
	CFC-115	7 370
HFOs	HFO-1234yf	4
	HFO-1234ze	7
	HFO-1233zd	4
	HFO1336mzz	9
Other	Ammonia	0
	CO_2	1
	Propane	3
	Iso-butane	3
	Pentane	5
	Propylene	2

Blend	GWP
R-401A	1 182
R-401B	1 288
R-402B	2 416
R-403A	3 124
R-403B	4 457
R-404A	3 922
R-407A	2 107
R-407C	1 774
R-407F	1 825
R-408A	3 152
R-409A	1 585
R-409B	1 560
R-410A	2 088
R-411A	1 597
R-412A	2 826
R-413A	2 053
R-415A	1 507
R-415B	546
R-416A	1 084
R-417A	2 346
R-418A	1 741
R-419A	2 967
R-420A	1 536
R-421A	2 631
R-421B	3 190
R-422A	3 143
R-422B	2 526
R-422C	3 085
R-422D	2 729
R-423A	2 280
R-424A	2 440
R-425A	1 505
R-426A	1 508
R-427A	2 138
R-428A	3 607
R-429A	14
R-430A	95
R-431A	38
R-432A	2
R-433A	3
R-433B	3
R-433C	3
R-434A	3 245
R-435A	26

Blend	GWP
R-436A	3
R-436B	3
R-437A	1 805
R-438A	2 265
R-439A	1 983
R-440A	144
R-441A	3
R-442A	1 888
R-444A	93
R-444B	296
R-445A	135
R-446A	461
R-447A	583
R-448A	1 387
R-449A	1 410
R-449B	1 412
R-450A	605
R-451A	149
R-451B	164
R-452A	2 140
R-452B	698
R-453A	1 765
R-454A	239
R-454B	466
R-454C	148
R-455A	148
R-456A	687
R-457A	139
R-458A	1650
R-459A	460
R-459B	145
R-460A	2103
R-461A	2767
R-502	4 657
R-507A	3 985
R-508A	13 214
R-508B	13 396
R-510A	1
R-511A	9
R-512A	189
R-513A	631
R-513B	596
R-514A	7
R-515A	393

OzonAction
UN Environment (UNEP) Economy Division
1 rue Miollis, Building VII Paris 75015, France
www.unep.org/ozonaction
ozonaction@unep.org

Attachment B

Also, Confidential Exhibit 4 contains email correspondence between BMP to a large retailer in the automotive aftermarket. The relevant portions of the email are circled. The email discusses six-and-a-half (6.5) million pounds of Chinese product that BMP is carrying in inventory into the 2017 season. The email underscores BMP's commitment to sell at 10-15% below other suppliers' prices, and on occasion at even lower prices, in order to – in BMP's words – get their customers "hooked on our crack." This is what we face day-in and day-out in the marketplace.

Honeywell

Performance Materials and Technologies
Honeywell
115 Tabor Road
Morris Plains, NJ 07950

4 March 2020

Dear Honeywell Refrigerants Customer:

Honeywell is carefully monitoring the global supply of refrigerants and the impact changing conditions at world ports is having on material availability and our ability to meet customer commitments. Effective immediately, key refrigerant blends containing R-143a (R404A, R507) will be sold at list price only and volumes limited to one truck load, or 15 tons, per customer until further notice.

Please contact your Honeywell Sales Representative for a copy of the new price list and with any questions you may have. Thank you for your understanding and continued business with Honeywell.

Sincerely,

K.Gaglione
Honeywell Fluorine Products

cc. J. Wilson ■

[1] https://www.trade.gov/press-release/us-department-commerce-initiates-antidumping-duty-and-countervailing-duty-3

[2] https://enforcement.trade.gov/download/factsheets/factsheet-prc-non-refillable-steel-cylinders-ad-cvd-initiation-41720.pdf

[3] https://www.epa.gov/ozone-layer-protection/ozone-depleting-substances

[4] https://www.law.cornell.edu/cfr/text/40/82.23

[5] *https://www.courtlistener.com/opinion/174208/arkema-inc-v-epa*

[6] https://cei.org/sites/default/files/Ben_Lieberman_-_AIM_Act_Myth_vs_Fact.pdf

[7] https://www.honeywell.com/en-us/newsroom/pressreleases/2016/04/honeywell-partners-with-chinese-manufacturing-leader

[8] https://www.chemours.com/en/news-media-center/all-news/press-releases/2015/chemours-doubles-china-based-hfo-1234yf-supply-to-meet-growing-customer-demand

[9] https://www.usitc.gov/publications/701_731/pub4629.pdf

[10] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB1013

[11] https://midwestrefrigerants.com

[12] https://www.law.cornell.edu/cfr/text/26/52.4682-1

[13] https://www.irs.gov/pub/irs-mssp/ozone_depleting_chemicals.pdf

[14] https://midwestrefrigerants.com

[15] https://www.usitc.gov/press_room/documents/testimony/731_1313_005_0.pdf

[16] https://www.congress.gov/116/bills/s2754/BILLS-116s2754is.pdf

[17] https://ghgdata.epa.gov/ghgp/main.do#/listSector/?q=Find%20a%20Facility%20or%20Location&st=&bs=&fid=&sf=11001000&sc=41&so=0&ds=S&yr=2018&tr=current&cyr=2018&ol=0&sl=0&rs=ALL

[18] https://www.usitc.gov/publications/701_731/pub4629.pdf

[19] https://www.c2es.org/site/assets/uploads/2016/07/status-legal-challenges-patents-related-hfo1234yf-auto-ac.pdf

North American Refrigerants, Inc.

NORDIC™ Brand Refrigerants
P.O. Box 677 Kewaskum, WI 53040
www.NorthAmericanRefrigerants.com

April 22, 2020

The Honorable Tammy Baldwin
United States Senate
709 Hart Senate Office Building
Washington DC 20510

Re: S.2754 American Innovation & Manufacturing Act of 2019

Dear Senator Baldwin:

Before this bill is brought to a vote, I write to bring attention to the inequity of EPA's past Refrigerant Allowances System, a system that has negatively impacted small businesses including my own.

I am asking for an amendment to this bill to prevent EPA from repeating the inequities and environmental inefficiencies of the past allocation system. As written, this bill promotes the same allocation structure for HFC's that was implemented for HCFC's. A system that has disenfranchised small diverse stakeholders for the past 30 years and has not had the environmental benefit that could have been achieved with a more equitable system. We can so easily do much, much, better for the environment, the people, and the economy of the United States.

Small companies will be severely impacted by this legislation as written. We support the phase-down of harmful hydrofluorocarbons, but there is nothing in this bill that includes small businesses who make a living cleaning up our environment. Many of these companies are women-owned and minority-owned.

Without going into the history of the Clean Air Act, the EPA's HCFC Allowances System served to establish a financial windfall for large companies and wealthy individuals through granted federal privilege. In past phase-outs of CFCs and HCFCs, grantees have realized significant corporate and personal profit at the expense of small business and the environment. This legal privilege created an oligopoly of large wealthy stakeholders, which has often manipulated the market (frequently through misinformation about contrived shortages) to artificially escalate pricing, sometimes inflating the market as much as 300%. As the past ineffective allowance system had no reporting requirement for stockpiled refrigerants, it allowed for an enormous surplus. This surplus creates a prisoner's dilemma in which one of the players inevitably cheat setting off a race to the bottom price war, were stockpiling allocation holders compete with one another for the additional profits. The price drops to the point that stakeholders begin withholding product and the cycle begins again.

The big losers in this yo-yo cycle are small business and consumers.

Small businesses suffer disproportionately when their inventory of reclaimed and virgin product is undersold by the very same allocation holders they have been forced to buy from. Consumers loose because prices are inflated and decreases take a long time to trickle back down to consumers. We are being taken advantage of.

Cost of goods for the allocation stockpile holders changes very little if at all during this cycle, they make money whether the market is up or down. Profit margins and inventory for this group are higher than they would be in a more diverse competitive market. A more equitable allocation system will allow the price to be taken from the market rather than it being set by a few privileged entities.

Incredibly this bill gives an unfair advantage to large companies and individuals that were able to secure allowances during *prior* phase-outs— including an additional 15% of allocations based on prior hydrochlorofluorocarbons allocations from a *1989 baseline – 31 years ago!*

"*'(3) CONSUMPTION BASELINE DESCRIBED.—The consumption baseline referred to in paragraph
(1)(B) is the quantity equal to the sum of—
(A) the average annual quantity of all regulated substances consumed in the United States during the period—
(i) beginning on January 1, 2011; and
(ii) ending on December 31, 2013;
(B) the quantity equal to the sum of—
(i) 15 percent of the consumption level of hydrochlorofluorocarbons in calendar year 1989; and
(ii) 0.42 percent of the consumption level of chlorofluorocarbons in calendar year 1989."*

EPA's Allowance System became a significant financial windfall to large interests (in particular one large foreign interest) from 2015-2019. Let's give the EPA the guidance, tools and legal authority put these US assets to work where they will benefit us more—including small diverse US companies that need federal support in their effort to make our environment cleaner. Banning companies like ours from the allowance system is not only a lack of support but is hindrance to our efficiency and success. Locking us out of this system also creates a REDISTRIBUTION of profit from the small businesses by forcing us to purchase from the wealthy allocation holders at a premium. These same allocation holders often undersell the more environmentally friendly blended and reclaimed product produced by our small businesses with an ocean of cheap virgin product imported with their privileged allocations.

Not only did the previous HCFC allocation system encourage stockpiling, but anticipation of a new similar system for HFCs, which sets a baseline by only looking at a set of years of imports and manufacture, has already created a large stockpile of HFCs in the US today. Large (often Chinese and other foreign backed and financed) interests, have speculated on future allocation systems, bringing in large quantities of the chemicals to be regulated in anticipation of having a large percentage of imports (consumption) in the look back period which will be used for establishing the allowance baseline. Many of these importers have not complied with or have falsified Greenhouse Gas Reporting and have been dumping HFC's into the US market at less than fair market value, and additionally have been holding stockpiles imported to speculate on a future HFC allowance system.

Because of the flood of cheap Chinese HFC's in the U.S., imported for this speculation and stockpiling, a lot of off specification HFC's are either turned away by reclaimers or require a charge for the reclaimer to take in. And worse still, instead of incurring this "end of life" expense, most of these refrigerants are ultimately vented by technicians and generators, in an effort to save costs.

This is a perfect time to implement an allowance system that not only works to improve our environment, but gives opportunity for income equality for small, minority and woman owned companies and allows for new entries to foster new more environmentally friendly technologies. Considering that the purpose of federal grants is to achieve the overarching goal of even distribution and thus, environmental justice, steps for consideration are:

1. Amend this bill to provide for disenfranchised stakeholders

It is unnecessary to award an additional "(i) 15 percent of the consumption level of hydrochlorofluorocarbons in calendar year 1989; and (ii) 0.42 percent of the consumption level of chlorofluorocarbons in calendar year 1989."for entities entitled to allocations 31 years ago, the same interests that will already be receiving allocations under the proposed allocation system. Instead apply this fabricated 15% and .42% of the allocation collectively toward a total set aside of 25%, earmarked for small disenfranchised stakeholders that have a proven track record of environmental stewardship in the industry during the HCFC allocation period.

We recommend an amendment to the consumption baseline as follows:

"*'(3) CONSUMPTION BASELINE DESCRIBED.—The consumption baseline referred to in paragraph
(1)(B) is the quantity equal to the sum of—
(A) the average annual quantity of all regulated substances consumed in the United States during the period—
(i) beginning on January 1, 2011; and
(ii) ending on December 31, 2013;*
(B) the quantity equal to 25% of the consumption calculated in (3)(A) BE RESERVED FOR—

(i) small business with a reserve for WBE and MBE business that have demonstrated responsible environmental stewardship in the HCFC allocation period.

2. Amend the bill to use best practices with system allowances for all stakeholders

Recognize in the bill that allowances to import or manufacture environmentally harmful chemicals are **US assets**. Support US jobs by giving preference to US manufacturers by incentivizing for production over consumption. Provide incentive for responsible environmental stewardship by rewarding small businesses with proven track records of environmental benefit in reclamation, refrigerant sales, participation in government actions, and inventorying practices during the HCFC allocation period. Do not reward violators of Greenhouse Gas Reporting requirements with allocations.

3. Amend the bill to include expanded reporting on HFC's

Greenhouse Gas Reporting can, I believe without major expense, require expanded reporting and enforcement to include:

- Blending associated with the reclaim industry to assess the environmental value of all allocations.
- The disposition of these potent greenhouse gases. Whether they are sold, stockpiled or transformed
- Penalties for companies that do not comply with or falsify Greenhouse Gas Reporting

There is no way to assess the success of any EPA regulation implementing this bill without knowing how much chemical is being manufactured, imported, stockpiled, blended and reclaimed.

4. Amend the bill to give EPA specific instruction in the rule making

Incorporating specific guidelines into the AIM bill will allow EPA to develop an allowance system that less subject to litigation by enormous corporate interests and allows for growth and diversity in environmentally friendly technologies.

In its current form the AIM bill will perpetuate a trade practice that advantages large allocation holders at the expense of American small business, and American workers and consumers. As written the AIM bill promotes business as usual; excessive importation will continue to be rewarded, and U.S. manufacturing and middleclass jobs will continue to erode and be eliminated.

The proposed HFC allocation system is a duplicate of the allocation system employed in the HCFC phasedown which *institutionalized the disenfranchisement of small business stakeholders* by locking them out of opportunity for innovation and expansion for decades. We have been locked out for the past 30 years.

All of the small business owners we refer to have been involved with this industry since before the HCFC allocation system was implemented. This is not the first time we have called attention to the inequities. The previous allocation system has fostered anticompetitive activity in this market by creating an unnecessary and destructive government sanctioned oligopoly.

The economic and legal concern is that unless this bill is amended to include small environmentally beneficial companies, a repeat of prior allocation system structure and the oligopoly it creates will once again block new entrants, slow innovation, and increase prices, all of which harm consumers. We need to be freed from the oligopolistic market cycle of collusion and price war.

Reclaim and associated business will likely not survive another round of institutionalized economic inequity and discrimination that this bill will continue if passed in its present form.

Disenfranchisement of diverse stakeholders suppresses innovation and recycling/reclamation efforts. Every pound of environmentally harmful chemical we are able to reclaim in the US means another pound does not have to be manufactured. As small businesses we have a greater motivation to optimize these allocations which will result in the greatest environmental and economic benefit, bring stability to the market, promote a robust reclamation industry and allow for a smooth transition to new technologies. Including us in the allocation system along with expanded reporting and data collection will provide a barometer for the success and maximize benefit of the allocation system.

This bill focuses on job creation. Allowing allocations for small business will create jobs here in the US instead of overseas. Increasing diversity and competition in this market which will not only benefit the environment but benefit consumers by helping to stabilize and lower prices.
We CAN do much better and be guaranteed that this work and the jobs it creates will stay in the US.

The past allocation system was inflexible and inequitable and did not maximize environmental benefit. It is not necessary to repeat the mistakes of the past.

Please amend the AIM bill.

Thank you,

Jill Tronca

President – North American Refrigerants, Inc

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for National Marine Manufacturers Association

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

1. Of the HFC compounds that are being used by your member companies today, on average how much does the industry use on an annual basis (in tons and GWP-weighted tons) now?

   Recreational boat builders are required by the U.S. Coast Guard to equip vessels under 20 feet with flotation foam. This foam was originally blown using R-22; however, following the R-22 phase out, boat builders have eliminated the use of HFC-134a for flotation foam and have been using methylformate and HFO formulations. NMMA can estimate that this accounts for approximately 90 percent of the HFC-134a use in marine manufacturing, but that is just an estimate. That being said, the only process for which an alternative has yet to be developed is structural composite preforms. Boat builders are downstream customers, breaking down the estimated tons and GWP- weighted tons is a question that would need to be directed to BASF, the company that provides our manufacturer's suppliers with the HFC blowing agent.

2. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your member companies on an annual basis?

   Recreational boat manufacturers do not fabricate these components, rather they purchase and install them, so this question would need to be directed to the companies that supply recreational boat builders. NMMA boat builders have eliminated the use of HFC-134a for flotation foam. However, some recreational boat builders purchase the structural components using HFC-134a (e.g. bulkheads, stringers), which are necessary to being able to fabricate these critical components, from these suppliers.

3. Do you project HFC usage will grow or shrink over the next 15 years?

   NMMA would like to see HFC to be eliminated and replaced with a suitable alternative for structural composite preforms, just as our industry has already done with floatation foam. We understand that chemical companies are working diligently to find an alternative, and with the beneficial downstream applications for structural composite preforms in truck trailers, bridge decking and many other applications, NMMA anticipates a solution to be forthcoming. NMMA's hope is to see HFCs eliminated from *recreational boat manufacturing in the next five years, if not sooner, but our industry needs chemical suppliers working with the structural composite preform companies to develop a suitable alternative.*

4. If the AIM Act were implemented as introduced, do you believe the HFCs used by your company will be eligible for essential use exceptions? If not, why not?

   California has already implemented a ban on HFCs, which used the Environmental Protection Agency (EPA)'s rule that was remanded by the courts. As a result, in California, marine flotation foam using HFC-134a is banned and structural composite preforms are not – we are happy to provide you more details about this, if you would prefer. NMMA believes that the AIM Act will provide the necessary time needed to find an alternative, but if states have shorter timeframes, boat builders would need to build to meet the requirements of a state with the most stringent regulations while a suitable alternative may not exist within a state's shortened timeframe

5. In your comments on behalf of the National Marine Manufacturers Association, you asserted that "more time is needed until a suitable HFC replacement is developed" for boat manufacturers to reformulate a suitable alternative for structural composite preforms and that, without such relief, your members "will face great hardship at a time when they can least afford it."

   a. Please provide details of your efforts to develop or find a suitable HFC replacement for boat manufacturers to reformulate a suitable alternative for structural composite preforms, including the identity of entities and individuals contacted, the procedures used to develop or find substitutes, the methodologies, data, analyses, field studies, experiments, lab results, sources, and biographies of participating researchers and subjects involved in such efforts, and the results of such efforts.

      NMMA has worked with EPA, CARB, and more recently the State of New Jersey to explain the downstream benefits of using this small amount of HFC to produce a structural beam that is one third the weight of the standard wooden and fiberglass beams previously used for the bulkheads and ribs that make the frame of a fiberglass boat. Structural preform companies suppliers and chemical companies, such as BASF, DOW, and Carpenter, are working closely together to test HFC alternatives as the chemists develop them. Once the chemical companies have a suitable alternative, recreational boat builders would be able to make the transition, just as they have done with flotation foam. If not, boat builders will have to go back to using heavy wood and fiberglass bulkheads and ribs, which would require larger engines emitting far more downstream GHG.

   b. Please provide the data, methodologies, assumptions, and other details of your economic analysis to support your conclusion that without more time to find such an alternative, your members “will face great hardship at a time when they can least afford it.”

Since the outbreak of COVID-19, recreational boat manufacturing in the U.S. has shut down in large part. The recreational boating industry supports 700,000 jobs across 35,000 U.S.-based marine businesses. Boat building is a labor-intensive activity and the vast majority—85 percent—of recreational boat manufacturers are small businesses. The outdoor recreation economy, as a whole, represents 2.2 percent of the U.S. GDP and more than five million jobs. Boat builders purchase these structural composites preform kits that are installed during the fabrication of the boat hull. The investment would be significant as boat builders would have to make equipment and repurpose staff to design and fabricate these components in-house or locate suppliers who can outsource them using alternative materials, such as wood or heavy molded fiberglass – which was the process decades ago prior to the availability of structural composite preforms.

c. The AIM Act would affect a phase down of the production and consumption of HFCs over a 15-year period, with 15 percent of the baseline period allowed to be produced and imported from 2036 onward. The AIM Act also contains provisions intended to increase to a significant degree the recovery and reclaim of HFCs. The purpose of these provisions, and other provisions in the Act, is to ensure the continued use of HFCs for decades to come, particularly in small or niche applications for which no substitute is available. In light of this, why do you believe the AIM Act represents a hard “ban” on HFCs that would prohibit their use upon enactment?

   NMMA is more concerned with states immediately banning HFC 134a without the availability of a suitable alternative or without considering the downstream GHG reduction benefits of structural composite preforms. If states have shorter timeframes, boat builders would need to build to meet the requirements of a state with the most stringent regulations while a suitable alternative may not exist within a state’s shortened timeframe. If the AIM Act would provide a federal rule that preempts states with a transition period for this unique process, this would provide boat manufacturers time to find an alternative non-HFC blowing agent. How much time for the transition needs be addressed by the chemical companies working on an alternative and the structural composite preform suppliers qualifying the materials.

d. Prior to 1990, there were over sixteen states that had taken action, or were in the process of taking action, to restrict the use of Chlorofluorocarbons (CFCs). In the Clean Air Act Amendments of 1990, Congress created a federal program to phase out CFCs in Title VI of the Clean Air Act. Rather than preempting state actions, Congress preempted the enforcement of state CFC regulations for two years. Once EPA had a strong CFC federal program in place, the state programs for the most part went away on their own. Why specifically do you expect states will act differently in terms of HFCs if a federal regulatory program is created? Given the history why should HFCs be treated differently than CFCs in terms of state preemption?

Structural composite preforms are installed in recreational boat manufacturing plants throughout the U.S., and thus, boats are sold and operated worldwide. Without a federal rule that includes preemption, boat builders would need to build to meet the requirements of a state with the most stringent regulations which will eliminate the use of HFC's in structural composite preforms. Perhaps, the best approach would be for legislation that preempts states for five years just for this process, which should be enough for suitable alternative to be developed.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Michael Baker, National Propane Gas Association.

Senator Braun:

As Congress considers the ongoing challenge of phasing down the use of HFCs and CFCs, it needs to consider the availability of practical alternatives.

Major national retailers like Target are utilizing refrigerant grade propane, better known as R-290, as a refrigerant in their stores in the state of Indiana and across the country to eliminate HFCs.

Additionally, Roche, an international healthcare company with operations in my state, has rolled out R-290 at a number of their facilities to make progress towards emissions reduction targets. Roche's Indiana facility utilizes R-290 in freezers designed and manufactured by Polar King in Fort Wayne, IN.

1. How does the development of R-290 demonstrate that the private sector is able to develop and adopt more environmentally friendly alternatives to HFCs and CFCs?

The development of R-290 shows the vital role that private industry plays in the creation and adoption of new technology. As a result of the Montreal Protocol and subsequent agreements, the United States was able to play a role in shaping new requirements for refrigeration technology around the world. While overregulation in any sector poses a serious threat to innovation, technology neutral public policy often enables the private sector to find pragmatic solutions to difficult challenges. R-290 is an excellent example of private sector leadership.

The United States is a global leader in the propane industry with an abundant supply of the clean-burning alternative fuel. More than half of domestic production is exported around the world. The development of R-290 is a result of private industry recognizing the availability of the fuel as a green and domestic alternative to HFCs and CFCs. Proliferation of this technology has occurred since the Environmental Protection Agency approved R-290 as a refrigerant in April of 2015. EPA also recognizes propane's attractive environmental profile with a low Global Warming Potential (GWP) of 3 and zero Ozone Depletion Potential (ODP).[1]

Propane can also be used in many other applications to reduce the global economy's environmental impact. The private sector has played a leadership role in developing new propane technologies in vehicle engines, combined heat and power (CHP) systems and other energy needs. Propane vehicle engines produce 24 percent fewer greenhouse gas emissions, 20 percent fewer NOX emissions, and 60 percent fewer CO emissions than gasoline engines.[2] Propane CHP

[1] https://www.epa.gov/snap/substitutes-residential-and-light-commercial-air-conditioning-and-heat-pumps
[2] ROUSH CLEANTECH: PROPANE VISION, https://www.roushcleantech.com/blue-bird-vision-propane/#benefit-down (last visited Oct. 25, 2019).

systems operate at 80% efficiency while traditional systems using boilers and power plant-generated electricity operate at 45% energy efficiency.[3] The utilization of renewable propane, which is currently being produced in small quantities in the United States, is another growing technology that further increases the environmental case for propane utilization.

Despite the environmental advantages of propane, some of these innovations are threatened by overly prescriptive and politically-motivated government actions. This has resulted in a recent shift in U.S. policy that commits the country to a one-size fits all approach that would move the country to an all-electric energy and transportation structure. Even if the federal government eventually reverses course on the electrification movement, significant damage will be done to private sector innovation in areas outside of the government's envisioned framework.

NPGA appreciates Senator Braun's interest in the application of R-290 technology and the role the government should play in addressing global environmental challenges. We look forward to working with Congress to continue to find pragmatic solutions to these threats and advocating for the flexible approaches that allow private industry to thrive.

[3] https://energy.mo.gov/clean-energy/combined-heat-power

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
April 29, 2020
Questions for the Record for Natural Resources Defense Council

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

1. Some industry stakeholders have expressed the need to provide an exemption for a specific industry or specific HFC end-use because there currently lacks a safe or economical substitute or because of related issues, such as dated building codes.

    b. What could happen to the overall integrity of the phase down if Congress allowed broad industrial sectors exemptions from enactment, without changing any other sections of the legislation?

    Historically, CFCs and other chemicals regulated under Title VI of the Clean Air Act of 1990 have been controlled in several complementary ways:

    - *Through progressive limits on domestic production and consumption of regulated substances. Production is the total amount of each chemical manufactured in the U.S. Consumption is defined as domestic production plus bulk imports and minus exports.*
    - *Through limitations on specific uses as safer alternatives are developed.*
    - *Through requirements to prevent leakage or recover chemicals during equipment service and at end of life.*

    Excluding some industrial sectors from any of these requirements would significantly undermine the effectiveness of the HFC phasedown. The AIM Act sets forth a flexible, economy-wide program to gradually reduce HFCs. EPA will monitor and enforce it by tracking national HFC production, importation, reclamation, and other data. Excluding sectors of any size from the program will threaten to create side markets for HFCs, for example, that could then be illegally diverted to uses controlled by the AIM Act. For this reason and many others related to it, excluding sectors would threaten the integrity of a tried and true national phasedown system that has worked under the Clean Air Act for thirty years.

    Excluding sectors is also unnecessary. The AIM Act does not call for any immediate prohibitions on HFC use in sectors where there are no proven, viable alternatives. The HFC phasedown will be a gradual reduction in HFC supply over 15 years, which provides the few remaining sectors having yet to identify suitable alternatives time to do so. For those that are unable to do so, the AIM Act also provides a 15% residual allowance of HFC allocations, which can be drawn upon indefinitely, plus essential use exemptions for more exceptional cases.

Reclaimed HFCs will also supply a significant portion of the market once the phasedown gets underway.

Taken together, excluding sectors from the program will put it at significant risk, and comes at no benefit. Granting a broad exemption for any sector would also likely lead to more requests for such sectoral exemptions, unraveling the program further and fatally undermining its effectiveness.

c. The legislation phases down the production and consumption of HFCs, but is not a phase out. Can you further explain why this should protect some sectors that may not have a safe or economic alternative during the timeframe of the legislation?

The legislation is deliberately designed as a phase-down, not a phase-out. It provides for a gradual ramp down of production and consumption over 15 years, stopping at an 85% reduction from baseline.

Most industries now using HFCs have already identified alternative chemicals or products to meet their needs. Some firms (e.g., makers of household aerosol products) have already completed their transitions. Others (e.g., automobile air conditioning) are already well along in converting to alternatives. Many others (e.g., in commercial refrigeration and air conditioning) have concrete plans to complete transitions in the mid-2020s. And firms that may not yet have identified sufficient alternatives have 15 years for their development and adoption.

The current usage by all industries that have submitted testimony suggesting the need for broad exemptions would fit well within that 15% remainder. If there is any dispute about this, the Committee should request data from any industry suggesting the need for broad or earlier exemptions on:

- *Their current and projected HFC usage.*
- *Detailed information on the alternatives they have assessed, and their plans for further developing and applying alternatives, including the RD&D expenditures they are undertaking.*
- *Their efforts to reduce HFC leakage and to recover reusable amounts in their processes, and from products downstream, and their assessment of the potential to supply their needs through the reclaim market.*

d. Can you further explain why the essential uses section should address these concerns and explain why it is important for the essential uses section to be available at the end of the phase down, rather than at the beginning?

It is important to recall the origin of the essential use provisions in the 1990 Clean Air Act provisions. The goal of those provisions was a 100% phase-out of CFCs and certain other chemicals, as opposed to a phase-down. The Clean Air Act provided for limited essential use exemptions to accommodate the possible need that adequate substitutes might not be found by the phase-out deadlines for *some small applications (e.g., metered dose inhalers, aircraft fire protection). It was in the context of a 100% phase-out that the question of essential uses arose. The AIM act already accommodates these concerns by requiring an 85% HFC phase-down, not a 100% phase-out.*

Nevertheless, as an extra measure of insurance, the bill allows for essential use exemptions that could enlarge the 15% remainder of HFC production and consumption allowed after the 15-year phase-down period, if it is demonstrated both that (1) adequate alternatives are not available for particular uses and (2) that HFC supplies – from the 15% remainder and the reclaim market – are insufficient to meet those needs.

Again, the Committee should ask for the data described in our answer to the previous question before changing any of the exemption provisions in the bill.

e. Prior to 1990, there were over sixteen states that had taken action, or were in the process of taking action, to restrict the use of Chlorofluorocarbons (CFCs). In the Clean Air Act Amendments of 1990, Congress created a federal program to phase out CFCs in Title VI of the Clean Air Act. Rather than preempting state actions, Congress preempted the enforcement of state CFC regulations for two years. Once EPA had a strong CFC federal program in place, the state programs for the most part went away on their own. Why specifically do you expect states will act differently in terms of HFCs if a federal regulatory program is created? Given the history why should HFCs be treated differently than CFCs in terms of state preemption?

For 50 years, the Clean Air Act has set strong minimum national standards while respecting the authority and responsibility of states to take stronger action. That is a critical policy to maintain.

States began to take action on CFCs as early as the 1970s, when state leaders restricted aerosol uses even before they were banned at the federal level. With renewed concern over the ozone hole in the 1980s, a number of states took the lead in regulating additional uses, e.g., by requiring CFC recycling in the servicing of motor vehicle air conditioning.

When Congress adopted Title VI in 1990, it maintained the same approach, respecting state authority to act beyond the federal minimum requirements. The lone exception, mentioned above, was a two-year pause in state enforcement for several narrowly-defined appliances; when that two-year period expired in 1992, full state authority was restored.

As mentioned, the 1990 amendments required a vigorous federal program to phase out CFC production, eliminate nonessential uses, require leak prevention and recovery and reclaim, assure the safety of alternatives.

For most of the next three decades, because the federal program was so successful, states did not find it necessary to undertake additional CFC regulation on their own, and acted as partners and co-enforcers with EPA.

The federal role included managing the safety of the alternatives – the so-called "Significant New Alternatives Program" or "SNAP." Under Section 612, EPA issued lists of alternatives deemed acceptable and unacceptable. Until 2015, no one questioned EPA's authority under Title VI to prohibit alternatives with unacceptable health and environmental impacts – including climate change impacts.

EPA issued two SNAP rules in 2015 and 2016 reflecting new information on HFCs, including the emergence of safer, climate-friendlier alternatives, and calling for a transition from HFCs to such alternatives in particular end-uses by specified deadlines. By and large, industry found those rules workable and acceptable. In 2017, however, a federal court ruled that (while EPA could prevent users of ozone-depleting substances from adopting HFCs in the first place) EPA may not make a current HFC user shift to alternatives.

(EPA took overly broad reading of that court decision and in 2018 decided to lift the entirety of the SNAP rules from 2015 and 2016. The same federal court recently rejected that action and restored the part of the regulations that banned users of ozone-depleting substances from adopting HFCs.)

EPA recently also weakened basic HFC leak detection and repair requirements for industrial and commercial equipment under Section 608.

These developments have created major holes in the federal program. States have stepped back into the arena to plug these holes and to maintain the continuity of the transition from HFCs. Some 15 states have adopted or are adopting programs to replicate and restore the SNAP and leak detection rules in order to support the transition from HFCs.

The actions the states are taking are squarely in their traditional role. They started regulating CFC end-uses in the 1970s, and again in the 1980s, well before the federal government. They did not then regulate national production and consumption, and they are not doing so now.

If the AIM Act passes as proposed, it will plug these specific holes in the HFC transition program and provide a strong federal program again. There is every reason to expect that states then will primarily rely on the federal program as they have in the past. They have many calls on state resources, and they do not lightly expend them in this area when the federal government is doing its job.

It has never been necessary or desirable to preempt the states to achieve this result. There is no such need now. Rather, the focus by some on preemption is *creating an unnecessary obstacle to proceeding on the practical pathway that has worked for decades.*

2. Are there any additional comments you would like to provide that you did not provide in your testimony?

Senator Cardin:

3. Are there any significant differences between the proposed phasedown of HFCs under the AIM Act and prior phasedowns that the United States has implemented for ozone-depleting substances under the Clean Air Act that would affect the need for states to retain their rights to tailor and target their regulatory programs to their needs?

   As indicated in responses to question 1 from Senator Carper, states have played an important leadership and gap-filling role over the past decades, but have largely relied on EPA when it is effectively implementing a federal program that addresses key health and environmental protection needs. We expect the same constructive relationship between the states and EPA, and the same predictable regulatory environment for business, if Congress enacts the AIM Act as proposed. There is no reason to restrict state authority in this bill.

Senator Whitehouse:

4. What percentage of total HFCs used in the U.S. are used by the aerospace, semiconductor, composites, foam, and defense sprays industries? Has this percentage of niche uses grown over the last five years, and if so, by how much?

   We estimate that, collectively, these sectors constitute somewhere in the single digit percentages of total U.S. annual HFC use. Absent data reported directly by the affected industries, the committee may wish to use this approximation in evaluating the reasonableness of exemption requests.

   In our view, granting exemptions to specific industries, including those on this list, is unnecessary. The AIM Act sets forth a flexible program for gradually reducing the supply of HFCs nationwide. It follows the proven approach of Clean Air Act Title VI, which has worked to transition these and other industries to less environmentally harmful chemicals for thirty years. For any sector, particularly those that are relatively small, there are a variety of mechanisms which ensure that transitions are not required until viable alternatives emerge.

   We are limited in our ability to quantify the sizes of these markets because there are no publicly available data on HFC use by these industry subsectors. Several, such as defense sprays, represent such a small fraction of the total markets to which they belong, e.g. aerosol propellants, that market analysis is largely unavailable. We urge the

Committee to request that each applicable commenter provide the following list of information:

- *Their current and projected HFC usage.*
- *Detailed information on the alternatives they have assessed, and their plans for further developing and applying alternatives, including the RD&D expenditures they are undertaking.*
- *Their efforts to reduce HFC leakage and to recover reusable amounts in their processes, and from products downstream, and their assessment of the potential to supply their needs through the reclaim market.*

We also believe there are several suitable alternatives that can meet the needs of the industry subsectors in this list. Please see our response to Question 5 from Senator Whitehouse.

5. Numerous industries have provided written testimony stating that there are no acceptable substitutes for HFCs they use. Please comment on these claims with respect to the aerospace, semiconductor, composites, foam, and defense sprays industries. Please list all HFCs for which such claims have been made and state whether or not you agree with the claim that no acceptable substitute exists. If you do not agree, please provide the name of the substitute and why you believe it to be acceptable.

Summary of industry requests in the aerospace, semiconductor, composites, foam, and defense sprays industries

Industry	***Use***	***HFCs currently used***	***Mentioned alternatives***	***NRDC's conclusion***
Aerospace Industries Association	*Onboard fire suppression agents on commercial and military aircraft*	*Not provided*	*Not provided*	*Inadequate information*
Dupont	*XPS, low-pressure two-component spray foam and foam sealants*	*Not provided*	*Not provided*	*Alternatives are available*
Air Liquide	*Semiconductor Etching*	*Not provided*	*Not provided*	*Inadequate information*
Iofina Chemical	*Semiconductor Etching*	*HFC-41*	*Not provided*	*Alternatives are <u>not</u> available*
Security Equipment Corporation	*Defense sprays*	*HFC-134a*	*HFO 1234ze*	*Inadequate information*
Boeing	*Fire extinguishing systems*	*HFC-125, HFC-227ea, HFC-236a*	*Not provided*	*Inadequate information*

Structural Composites/Compsys, Grady-Whiteboats, Composite Applications Group, HCB Center Console Yachts, National Marine Manufacturers Association (NMMA), Parks Manufacturing, LLC, Wabash National	*Composite foam product for boats and refrigerated trailers*	*HFC-134a*	*Not provided*	*Inadequate information*

As noted, contrary to previous transitions, HFCs will not be entirely phased out. Instead, a 15% remainder allowance of HFCs will be available for end-uses where substitutes are not available. In addition, essential use exemptions are available starting in 2034. Reclaimed HFCs will also be a significant source of additional HFCs above the allowable limit of virgin material.

Aerospace

In comments, the Aerospace Industries Association raised issues regarding HFC-substitutes for onboard fire suppression agents on commercial and military aircraft. The stakeholder did not specify which HFCs the industry is currently using for fire suppression. In addition, the stakeholder recognized that there is an option for exemptions already included in the bill.

Boeing seeks exemptions for various aviation uses of HFCs. Given the small volume of these uses, the absence of any near-term regulations affecting these applications, and the flexibility built into the AIM Act, no additional exemptions are necessary. To our knowledge, the aerospace industry is developing and testing new fire-suppressing agents such as 2-BTP[1] and FK-5-1-12[2].We are aware that aerospace applications face technical challenges. The aerospace industry has in the past demonstrated its ability to continue using halons long after the end of new production, through recycling of material from existing equipment

Foams

Dupont asserts that it does not have a viable alternative for extruded polystyrene (XPS) and two component low pressure spray polyurethane foam insulation and sealants. Dupont did not clarify which specific HFCs it is currently using in its XPS and spray foam products. However, the U.S. Environmental Protection Agency identified several HFC-alternatives for these end-uses, including carbon dioxide, water and HFO-

[1] https://www.icao.int/Meetings/a39/Documents/UPDATE_ON_THE_DEVELOPMENT_OF_HALON_ALTERNATIVES_FOR_FIRE_SUPPRESSION_SYSTEMS.pdf

[2] https://www.fike.com/products/fk-5-1-12-fire-suppression-system/

1234ze(E).[3] *These alternatives have a low impact on climate and provide similar performance. In the United Kingdom, Dupont markets a low-GWP XPS product under the XENERGY product line which – according to the company's brochure – has better insulation properties and a GWP less than 5.*[4] *The main blowing-agent used in the XENERGY XPS product is carbon dioxide, which has already been approved by the EPA for this use.*

Structural Composites/Compsys, Grady-Whiteboats, Composite Applications Group, HCB Center Console Yachts, National Marine Manufacturers Association (NMMA), Parks Manufacturing, LLC, and Wabash National assert that they utilize specialized composite foam product for boats and refrigerated trailers blown with HFC-134a. More information is needed regarding the specific applications and technical constraints; EPA has identified several HFC-alternatives for marine floatation foams used in boats, such as HFO-1234ze, HFO–1336mzz(Z), saturated light hydrocarbons, and carbon dioxide, among others.

To our knowledge, the recreational boating industry is no longer using HFC-blown vessel flotation foams and foam used for sound and vibration reduction, which accounted for 80-90% of the industry's HFC use. We are not aware of any substitutes for the remaining fraction of the industry that currently uses structural HFC-containing composite preforms.

Given the small size of these uses, the lack of imminent regulations affecting these applications, and the flexibility built into the AIM Act, no amendment appears necessary.

Semiconductors

Air Liquide indicated that they use "ultra-high purity HFCs for use as semiconductor etchants". The company did not specify the specific HFCs sold to clients in the semiconductor industry but indicated that HFCs used as etchants account for approximately 0.01% of the total HFC volume.

Iofina Chemical produces HFC-41 for use in the semiconductor industry. We are not aware of any viable alternatives to HFC-41 for use as an etchant in semiconductor manufacturing. Given the small size of this use, the lack of imminent regulations affecting it, and the flexibility built into the AIM Act, no amendment appears necessary.

Defense spray industry

Security Equipment Corporation mentioned that it uses HFC-134a for defense spray applications and identified three specific areas of concern with HFO 1234ze. However, according to the EPA products using HFO–1234ze(E) already exist or are in development for these uses.[5]

---

[3] https://www.epa.gov/snap/substitutes-polystyrene-extruded-boardstock-and-billet, and https://www.epa.gov/snap/substitutes-rigid-polyurethane-spray

[4] https://www.dupont.com/content/dam/Dupont2.0/Products/Performance-Building-Solutions/literature/291-03425.pdf

[5] https://www.regulations.gov/document?D=EPA-HQ-OAR-2014-0198-0001

6. Please describe the transition from CFCs to HFCs, catalyzed by the Montreal Protocol and Title VI of the Clean Air Act. Did Title VI preempt or in any other way limit state regulatory action with respect to CFCs? After the implementation of Title VI and the accompanying two year pause in state enforcement of CFC regulations, did states adopt or resume enforcing CFC regulations? If so, how many and in what manner?

   As described in answer to question 1 from Senator Carper, state activity to address CFCs and other ozone-depleting chemicals began in the 1970s, and again in the 1980s, in advance of federal legislation and regulation. When EPA implemented an effective program (banning aerosols under the 1977 Clean Air Act amendments, comprehensively phasing out CFCs and other ozone-depleting chemicals under the 1990 Clean Air Act amendments), the need for state initiatives declined. States relied on the federal program, but retained their authority. Now we see some 15 states moving to fill the gap in HFC controls left by the 2017 court decision and the more EPA recent rollbacks. If Congress enacts the AIM Act as proposed, we foresee a return to the same pattern of state reliance on the federal program while retaining their authority. For this reason, there is no reason now for a conflict over preemption provisions that were never before included in federal legislation governing this area.

7. For HFCs where users claim that the current substitute is too expensive, based on the nation's prior experience transitioning from CFCs to HFCs, what do you believe will occur with respect to the price of HFC substitutes?

   There is ample experience from the replacement of CFCs, halons, HCFCs, methyl bromide, and other controlled substances that the phase-down process creates the conditions for successfully developing safe, effective, and affordable alternatives. The phase-down process allows time and creates incentives for RD&D into alternatives. Experience has repeatedly and almost universally shown that alternatives become available faster than originally anticipated, and at lower cost. This has enabled many phase-down schedules to be accelerated, often with broad industry support.

   Further, these chemicals generally account for only a small, unnoticeable fraction of the cost of finished products, such as appliances, automobiles, airplanes, and refrigeration or cooling equipment.

   Even for intermediate products, such as insulating foams, there already are available substitutes – both fluorinated and non-fluorinated – with equal or greater energy efficiency and other characteristics. Chemical costs will come down over the phase-down period as new alternatives appear and as current chemicals become commodities with the imminent expiration of patents.

Nevertheless, the AIM Act includes multiple safety valves, as explained in our testimony and in the previous answers: it is a phase-down, not a phase-out (allowing the 15% residual production); an equal if not larger amount is available for reuse through recycling and reclaim; and essential use exemptions are available if the 15% remainder and reclaim should prove insufficient.

8. If the AIM Act were to be passed in its current form, based on your experience with Title VI, how do you believe that states would respond with respect to adopting and/or enforcing their own HFC laws and regulations?

   Please see our response to question 1 from Senator Carper.

9. Do you believe that passing the AIM Act in its current form will lead to more or less regulatory harmonization and certainty than would continue congressional inactivity in this space?

   The AIM Act, in its current form, enjoys support from organizations across the political spectrum, from the Natural Resources Defense Council to the Chamber of Commerce and the National Association of Manufacturers. The vast majority of the regulated community supports this bill, including the Air-conditioning, Heating, and Refrigeration Institute (AHRI) and the Alliance for Responsible Atmospheric Policy, the major fluorinated gas trade group. Environmental groups support the AIM Act as well.

   The single biggest reason is that the AIM Act, as drafted, will lead to dramatically greater regulatory harmonization and certainty than would congressional inactivity.

   If the bill is not enacted, however, we expect more states to continue adopting programs similar to those that have been adopted since the 2017 court decision. In other words, inaction at the federal level is the primary driver for state activity.

10. If the Committee were to consider some form of state preemption language, would it be possible to develop a conditional form of state preemption that would only enter into force if EPA implemented the phase down as intended and would be suspended if EPA at any subsequent point in time relaxed the phase down in any substantive way? Please provide the Committee with your thoughts on conditional state preemption, any possible historical precedents for such language, as well as any suggested language you might recommend for such a conditional state preemption clause.

    NRDC strongly urges the committee not to entertain any preemption of states. A strong federal program, such as the one proposed in S. 2754, will greatly reduce the number of states working in this area. But states have stepped up at times where the federal program was not what it should be. Congress should focus on putting a proper federal program in place that will, in practical effect, reduce the need for state regulatory activity.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*

Response to Question Submitted by
Senator Kirsten Gillibrand
to
New York State Attorney General Letitia James

April 29, 2020

<u>Senator Gillibrand:</u>

1. Attorney General James, on April 7, 2020, the US Court of Appeals for the District of Columbia Circuit issued a ruling in the case of *NRDC, Inc. v. Wheeler*, vacating the Environmental Protection Agency's 2018 HFC rule. Given that your office participated in the case as a State Petitioner, please describe any impacts this decision has on the need for Congress to enact S. 2754.

   a. Does the court's decision in any way change the views expressed in your written testimony?
   b. Please include anything you wish to add to your written testimony in light of the court's decision.

<u>Attorney General James:</u>

The recent decision by the U.S. Court of Appeals for the D.C. Circuit in *NRDC v. Wheeler*, 2020 U.S. App. LEXIS 10846 (D.C. Cir., Apr. 7, 2020) reaffirms the need for Congress to move ahead with the passage of the American Innovation and Manufacturing Act of 2019 (S. 2754 and its companion bill in the House, H.R. 5544) ("AIM Act"). The AIM Act would facilitate the comprehensive national phase out of hydrofluorocarbons (HFCs), creating thousands of manufacturing jobs while helping to address the endangerment to public health and welfare from one of the most potent greenhouse gases. Although the court's decision in *NRDC v. Wheeler* is a welcome step forward, the decision does not address the limitations on EPA's authority to fully phase out HFCs under existing law.

In *NRDC v. Wheeler*, the court granted petitions for review filed by NRDC and a group of States led by New York and vacated an EPA guidance document that unlawfully authorized businesses using ozone-depleting substances to replace them with HFCs. The court held that the guidance was in fact a legislative rule that could not lawfully be issued without first undergoing the notice-and-comment requirements of the Clean Air Act, which EPA had not done. We estimate the court's ruling will prevent the release of approximately 200 million metric tons of carbon dioxide-equivalent pollution by 2030.

The EPA guidance document at issue in *NRDC v. Wheeler* stemmed from an earlier decision by the D.C. Circuit in *Mexichem Fluor, Inc. v. EPA*, 866 F.3d 451 (D.C. Cir. 2017). In *Mexichem*, the D.C. Circuit vacated in part a 2015 EPA regulation that barred certain regulated entities (largely supermarkets and auto manufacturers) from replacing ozone-depleting refrigerants with HFCs or HFC blends. The 2015 rule also required regulated entities that had already switched to HFCs to stop using them. Mexichem and another HFC manufacturer sued, and the D.C. Circuit granted the petition for review *in part*. The court held that EPA had statutory authority to prohibit the use of HFCs as replacements for ozone-depleting chemicals, but lacked authority to force regulated entities that had already switched to HFCs to replace them with a different, less harmful substitute refrigerant. The court went on to reject industry petitioners' arbitrariness arguments, thus upholding the 2015 rule to the extent it barred current users of ozone-depleting substances from replacing those substances with HFC-based refrigerants.

In response to the *Mexichem* decision, EPA issued its 2018 guidance document, purporting to interpret the court's decision as requiring vacatur of the 2015 rule "in its entirety" because, according to EPA, implementing the court's partial vacatur was unworkable. NRDC and a group of States (New York, California, Delaware, Illinois, Massachusetts, Minnesota, New Jersey, Oregon, Pennsylvania, Vermont and Washington) and the District of Columbia filed suit, arguing that EPA could not expand the scope of the court's decision in *Mexichem* without undergoing notice-and-comment rulemaking and that that guidance was arbitrary and capricious. EPA argued in response that the guidance was unreviewable because it was not final agency action and did not constitute a legislative rule. The D.C. Circuit disagreed with EPA, holding instead that the guidance was a final agency action; that it was a legislative rather than an interpretive rule; and that EPA had unlawfully issued it without prior notice and an opportunity for public comment. The court vacated the guidance, but did note that it was not ruling on the substance of the guidance, meaning that EPA could seek to implement that same interpretation through notice-and-comment rulemaking.

As explained in our testimony to the Committee, the AIM Act would comprehensively address the use of HFCs, resulting in a coordinated phase down of the use of this harmful pollutant. Although the court's decision in *NRDC v. Wheeler* should result, as noted above, in reductions of HFCs in certain uses in the near term, it neither provides the type of comprehensive and orderly transition that the AIM Act would provide, nor yields the enormous climate and economic benefits of such a transition. Moreover, the court invalidated the EPA guidance on procedural grounds, meaning that EPA could attempt to rescind HFC restrictions through rulemaking.

In summary, the recent court decision in *NRDC v. Wheeler* does not alter the compelling reasons set forth in our testimony for Congress to proceed with passage of the AIM Act. Thank you for the opportunity to provide our views on this matter for the record.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Parks Manufacturing

<u>Ranking Member Carper:</u>

Please provide a response to each question, ***including each sub-part.***

1. In your comments on behalf of Parks Manufacturing, LLC, you noted that you use HFC 134a to make your boats lighter and more fuel efficient but expressed concern that, "If HFC 134a is banned for this process, we will be forced to return to heavier materials, requiring our boats to be equipped with more powerful engines and that will create more downstream greenhouse gases than the small amount currently required for the structural composites in our boats." Please provide details of your efforts to develop or find acceptable substitutes for HFC 134a in your boats, including the identity of entities and individuals contacted, the procedures used to develop or find substitutes, the methodologies, data, analyses, field studies, experiments, lab results, sources, and biographies of participating researchers and subjects involved in such efforts, and the results of such efforts.

    Parks Manufacturing LLC. does not create material systems, we use these to produce our boats. For floatation applications HFO is a viable alternative, our supplier of composite preforms informs us that HFO is not yet ready. Alternative building methods exist but these are heavier, wood is heaver and has become much less accepted by the industry due to its durability. Fiberglass grids is another alternative these are also heaver, require expensive space consuming tooling and are not adaptable to product changes in the way the preform technology works. Reducing the weight of the boat reduces the engine size along with the purchase and operational cost.

2. The AIM Act would affect a phase down of the production and consumption of HFCs over a 15-year period, with 15 percent of the baseline period allowed to be produced and imported from 2036 onward. The AIM Act also contains provisions intended to increase to a significant degree the recovery and reclaim of HFCs. The purpose of these provisions, and other provisions in the Act, is to ensure the continued use of HFCs for decades to come, particularly in small or niche applications for which no substitute is available. In light of this, why do you believe the AIM Act represents a hard "ban" on HFCs that would prohibit their use upon enactment?
    a. **That would be great if you would give this application the additional time it needs. That is really all we are asking for.**

3. Of the HFC compounds that are being used by your company today, on average how much does the industry use on an annual basis (in tons and GWP-weighted tons) now?
    a. **Sorry, we do not have this data.**

4. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your company on an annual basis?
    a. **I requested an estimate from Compsys on the amount of 134a that is going into the preform products we purchase; they estimate the products they supply use 0.075 tons of H134a.**

5. Do you project HFC usage will grow or shrink over the next 15 years?
    a. **We think it will shrink with the transition to alternatives.**

6. If the AIM Act were implemented as introduced, do you believe the HFCs used by your company will be eligible for essential use exceptions? If not, why not?
    a. **We hope so that is the reason for the letter. If we did not tell congress about this how would you know. Also, Preemption is very important as we sell product to numerous states and we cannot manage 50 states with independent regulations.**

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for
Plumbing Heating Cooling Contractors National Association

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

1. *How has the COVID-19 crisis impacted PHCC?*

   PHCC appreciates the Ranking Member's concerns regarding the impact the COVID-19 pandemic has had on our membership. Plumbing and HVAC contractors are classified as "essential" critical infrastructure workforce, a designation that has provided continuity to our members' business operations; however residential and commercial plumbing and HVAC contractors have certainly felt the negative economic impact of the COVID pandemic.

   A recent survey PHCC conducted of its membership provides a window into the extent of the economic impact on plumbing and HVAC contractors. 80% of respondents report the pandemic has had a medium to high impact on their business, and 75% report they planned on or were already in the process of applying for an emergency small business loan via the Paycheck Protection Program (PPP). Several respondents reported 50%-90% reductions in their workforce because of the downturn in business.

   Public health concerns have resulted in very little new work being requested. Customers are hesitant to let strangers in or near their homes, and employees are likewise concerned about health risks and are reluctant to work. Commercial service and maintenance calls are down due to the many businesses that are closed. In the cases where work needs to be performed, technicians responding to calls take extra precautions, including:

   - dispatching one technician per vehicle per call;
   - wearing personal protective equipment (PPE);
   - keeping a safe distance from customers; and
   - performing only outdoor work to the extent possible.

   Further inhibiting the ability for contractors to perform work are disruptions in the supply chain, with 35% of respondents reporting they were prevented or delayed from acquiring tools, building supplies, PPE, and other critical equipment needed for the safe and efficient completion of projects. Sourcing PPE has become a major concern for contractors. As the Committee is no doubt aware, many states require essential workers to wear PPE in order to perform their duties.

The COVID pandemic is also having an impact on PHCC job training and apprenticeship programs. Online instruction has supplanted classroom instruction, which keeps apprentices engaged but prevents them from hands-on tutorials that help them learn their trade. The fact that most service calls are limited to one technician means an apprentice cannot accompany a supervisor to a job site, creating another missed opportunity for hands-on instruction while keeping them from earning revenue. The decline in new projects or service requests means apprentices aren't working, aren't getting paid, and are delayed from entering the workforce. At least one of our partners reported that apprentices are prevented from taking their state's journeyman's exam, which keeps them from obtaining the occupational licensure they need to advance their careers.

What steps should the federal government consider taking to help our nation's manufacturing sector cope and recover from the COVID-19 crisis?

For the PHCC contractors fortunate enough to obtain loans via the PPP, they should be able to maintain their payrolls and have a chance to keep their businesses afloat for the duration of the pandemic. However, as we have witnessed across all industries since the passage of the CARES Act, the application process for PPP loans is extremely competitive, and initial funding for the program was not sufficient. Contractors believe businesses that seemingly do not have a demonstrable need for funding have been able to secure loans while smaller businesses that are truly in need have been denied assistance. Steps must be taken to ensure businesses that are truly in need are prioritized for loan approval.

An increased and continued flow of PPE to essential workers will both protect public health and benefit the economy by allowing contractors and technicians to continue their work with minimal disruption. Most importantly, the federal government must take a balanced and careful approach to reopening the economy that recognizes that public health and the economy are inextricably intertwined: by placing public health first, we can prevent or mitigate a new spike in COVID infections which in turn prevents or mitigates the resulting negative economic effects.

Furthermore, with commercial buildings across the country having been nearly or completely vacant for almost two months, water quality inside these buildings are likely to have deteriorated and pose a public health risk. Because people are not regularly using water in commercial buildings, water quality will tend to degrade as it sits idle in piping systems.

Recent studies by Purdue University point out that stagnant or standing water can cause conditions that increase the risk for growth and spread of Legionella and other biofilm-associated bacteria.[1] It also can lead to low or undetectable levels of disinfectant, such as chlorine, in the water system. Heavy metals may also leach into water as it stagnates inside of water pipes. It may be incumbent upon the federal government to raise awareness of these issues so that property managers take the necessary precautions when reopening commercial buildings, including but not limited to flushing stagnant water from pipes and conducting the necessary testing to ensure water is safe for building inhabitants to use.

[1] https://www.purdue.edu/newsroom/releases/2020/Q2/water-quality-could-change-in-buildings-closed-down-during-covid-19-pandemic,-engineers-say.html

2. *Do you support the AIM Act as introduced?*

   PHCC supports the AIM Act as introduced. As we pointed out in our testimony, passage of the AIM Act is critical for maintaining the American lead in manufacturing and delivering the highest level of technology. The AIM Act would allow manufacturers to proceed with product design, building designers could plan how to proceed, the distribution chain could implement processes for handling equipment, and installing contractors such as those represented by PHCC could develop and train the next generation of HVACR technicians. The expeditious advancement of the AIM Act as written will allow the HVACR industry to move forward in its work.

Again, we thank the Ranking Member and the Committee for its diligence on this matter and appreciate your seeking PHCC as a resource. Please contact Chuck White, Vice President of Regulatory Affairs or Mark Valentini, Director of Legislative Affairs at government@naphcc.org if we can answer any further questions or concerns.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for John Kapeles, Safariland Group

<u>**Chairman Barrasso**</u>

1. You have tested substitutes for HFCs in your products, and found, among other things, a reduction in stand-off distance with HFO-1234ze. What would the practical effects be if you are forced to utilize HFOs in your defense spray products?

RESPONSE: The most noticeable practical effect of the reduction in stand-off distance would be a change in the way defense sprays are used by police officers to de-escalate a situation through the application of less lethal force. Deployment of a defense spray is typically done to gain control of a subject and prevent other use-of-force measures from being needed, such as baton impacts or hands-on techniques, which can result in greater risk of injury to both the officer and the subject. Stand-off distance provides officers with time to react and gain control of a situation without further escalation of force. Reduction in stand-off distance will significantly reduce the effectiveness of defense sprays as a de-escalating tool in these situations and will result in increased injury rates to the officer, the subject, and the public.

In the special case of a defense spray used as a bear deterrent, maintaining the stand-off distance is critical to stop a charging bear before it can close the distance to the user. Decreasing the current stand-off distance would make the bear spray ineffective and result in greatly increased risk of injury and death.

2. This legislation provides multiple avenues to potentially accelerate the phasedown schedule of HFCs. Given that HFC replacements can be flammable, why is this a concern for you?

RESPONSE: Flammability concerns would severely limit the operational scenarios where the defense spray products incorporating HFOs can be effectively deployed. Law enforcement officers currently depend on the non-flammability of the defense sprays they carry so that they can be used with confidence in hazardous situations or when used with Conducted Energy Devices such as Tasers. If the defense spray products cannot be used with confidence in all engagements, it would effectively remove this tool as a less lethal force option, which would increase the risk of injury to the officer and the public.

3. Have you heard from customers or groups that you have trained with your products about concerns with decreased performance using HFC substitutes?

RESPONSE: Yes, we have received comments and feedback from end-users regarding the loss of performance experienced with the defense sprays incorporating HFO propellants. Some agencies have submitted letters stating their concerns with the performance impact of using HFO propellants in defense sprays, and others have cancelled orders due to the concerns with performance or flammability.

4. Why is the AIM Act's essential use exemption provision, as currently written, unsatisfactory for your business?

RESPONSE: Two areas of the AIM Act's essential use exemption provision, as currently written, are unsatisfactory for our business:

(1) The phase down approach described in S.2754 outlines various percentage reductions in consumption beginning with 90 percent of the baseline in the 2020 – 2023 time frame and decreasing to 20 percent of the consumption baseline in 2034 – 2035. The consumption baseline is based largely on the average annual quantity of all regulated substances consumed in the U.S. during the 2011 – 2013 time frame. Using the quantities consumed in the 2011 – 2013 time frame does not allow for changes that have occurred in our business since 2013 that may have significantly changed the consumption. It also does not allow for potential increases in consumption due to introduction of new product offerings in the law enforcement or personal defense markets since 2013 or looking forward beyond 2020.

(2) The AIM Act does not provide for an exemption for essential uses to be considered before January 1, 2034, and then only after notice and opportunity for public comment. The AIM Act further restricts the quantity covered under the exemption to no more than 10 percent of the quantity consumed to contribute to the production baseline (10 percent of the average annual quantity of all regulated substances consumed in the 2011 – 2013 timeframe). For the reasons stated in (1) above, this would severely limit our ability to meet customer demand assuming that an effective substitute has not been developed, is available, and affordable.

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

5. In your testimony you expressed concern that the AIM Act would ban the HFCs used in defense sprays. The AIM Act would affect a phase down of the production and consumption of HFCs over a 15-year period, with 15 percent of the baseline period allowed to be produced and imported from 2036 onward. The AIM Act also contains provisions intended to increase to a significant degree the recovery and reclaim of HFCs. The purpose of these provisions, and other provisions in the Act, is to ensure the continued use of HFCs for decades to come, particularly in small or niche applications for which no substitute is available. In light of this, why do you believe the AIM Act represents a hard "ban" on HFCs that would prohibit their use upon enactment?

RESPONSE: While the AIM Act would not represent a total ban on HFCs (since it allows for a small fraction of the baseline consumption to continue to be used), it would severely limit Safariland's ability to meet customer demand for products that utilize HFC-134a as the propellant. As written, the AIM Act would require our business to reduce production of law enforcement and personal defense products that utilize the HFC propellant by 85 percent. Even without considering growth due to increased demand or new product introductions between now and 2034, this would effectively eliminate this part of our business unless a suitable, affordable replacement propellant is developed. Based on our work with Honeywell over the past several years, we have serious concerns whether this could be realized.

6. Of the HFC compounds that are being used by your company today, on average how much does the industry use on an annual basis (in tons and GWP-weighted tons) now?

RESPONSE: Safariland usage of HFC-134a propellant varies by demand and product mix between law enforcement and personal defense (bear spray) products. Using a multi-year average our annual usage calculates as approximately 116,000 lbs or 58 tons. The total industry usage is unknown but is estimated to be 5 to 10 times the Safariland usage. The GWP-weighting for HFC-134a is 1300 (1300 times the effect of CO_2).

7. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your company on an annual basis?

RESPONSE: Safariland usage varies by demand and the product mix between law enforcement and personal defense (bear spray) products, but the average annual usage over a four-year period was approximately 116,000 lbs, or 0.025% of the annual total of 230,000 tons of HFCs. All HFC-134a used by Safariland is procured domestically.

8. Do you project HFC usage will grow or shrink over the next 15 years?

RESPONSE: We project that law enforcement and military usage of products that utilize HFC propellants will be relatively constant or experience modest increases in demand due to world events. The personal defense (bear spray) market would be expected to increase over time as populations continue to encroach on bear habitats, increasing the incidence of encounters with bears.

9. If the AIM Act were implemented as introduced, do you believe the HFCs used by your company will be eligible for essential use exceptions? If not, why not?

RESPONSE: Yes, we believe our products that utilize the HFC propellant would be eligible for essential use exceptions, due to their function as a less lethal force option for law enforcement, military, and personal defense applications. However, the restrictive wording of the AIM Act as written would severely limit the amount of the HFC propellant that could be used for the exempted products. Without the development of a suitable, affordable substitute for the HFC propellant, this would severely impact our ability to meet customer demand for these products.

10. In the 1990s, the United States transitioned out of ozone-depleting substances used as propellants in the types of applications referenced by your testimony. Are you aware of any instance where an application using an ozone-depleting substance as a propellant was "forced" to transition by Title VI of the Clean Air Act before substitutes were properly tested and available?

RESPONSE: Safariland did not manufacture aerosol defense sprays utilizing liquified propellants during that time frame, but it is our understanding that other companies in the industry were forced to replace the ozone-depleting substances with the HFC propellants. According to reports from individuals that were involved in this process, the date to transition to the HFC propellants was moved up from January 1,1995 to January 1, 1994. HFC propellants were only available in limited sample quantities in 1993, which did not allow adequate time for the necessary formulation studies to be conducted prior to the transition deadline in 1994.

<u>Senator Whitehouse:</u>

11. What is the total volume of HFCs for which there is no acceptable substitute used by the defense sprays industry? Please list each such HFC and the volume used. Please state the reasons why potential substitutes (if they exist) are unacceptable.

RESPONSE: Safariland usage of HFC-134a propellant varies by demand and product mix between law enforcement and personal defense (bear spray) products. Using a multi-year average our annual usage calculates as approximately 116,000 lbs or 58 tons. The total industry usage is unknown but is estimated to be 5 to 10 times the Safariland usage.

The major reasons why potential substitutes (such as HFO-1234ze) are unacceptable are summarized below.

- Lower Vapor Pressure. HFO-1234ze propellants have significantly lower vapor pressure than HFC-134a, which results in lower internal can pressure, especially at lower temperature ranges. The lower internal pressure results in decreased spray distance and spray volume. Operationally, this translates to decreased stand-off distance. Maximizing the standoff distance is critical for law enforcement and personal defense scenarios to prevent physical contact and reduce the risk of injury to both the operator and assailant. For the special case of defense against a charging bear, it is absolutely critical to have a maximum standoff distance where the spray can take effect before the animal can close the distance to the user. Products using the new propellants will have decreased range and standoff distance, and exceptionally poor performance at lower temperatures.

- Flammability. Initial formulations developed using the alternate propellants failed flame extension tests. It was proposed by Honeywell, that HFC-134a provided some flame suppressing properties that HFO-1234ze does not. Further testing demonstrated the flammability of the neat HFO-1234ze, which is an area of concern for law enforcement operators, who must deploy defense sprays in all conditions and in the presence of Electrical Discharge Weapons. Flammability is unacceptable for use in hazardous environments where law enforcement or military defense sprays could be deployed.

- Formulation stability. One of the most important factors in forming an effective fog, foam, or vapor discharge is the solubility of the liquid formulation with the liquid propellant used in the aerosol canister. Formation of a stable solution or emulsion ensures that a consistent amount of active ingredient (OC) is discharged during deployment, and that an excessive amount of shaking is not required to maintain consistent properties. The proposed replacement propellants did not have good solubility with formulation ingredients, resulting in ineffective discharge characteristics that affected the content, pattern, and discharge characteristics of the spray.

12. By what percentage has use of such HFCs been growing over the last five years? Please list each such HFC and its growth rate over the last five years.

RESPONSE: Safariland's history with HFC usage is limited to HFC-134a. Allowing for fluctuations in demand and product mix between law enforcement and personal defense (bear spray) applications, Safariland's average annual usage over the last 5 years has been relatively flat at approximately 116,000 lbs. Usage in 2018 was very low due to the SNAP ruling taking effect, so this year was not included in the estimate.

SOCMA Response
Robert F. Helminiak
rhelminiak@socma.org

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for SOCMA

Chairman Barrasso:

1. Can you provide examples of some non-coolant critical uses for HFCs?

   a. What properties of HFCs make them suitable candidates for this purpose?

A. Non-coolant applications of HFCs include semiconductor etch gases, fire retardants and pharmaceuticals. It is our understanding that there are a number of proprietary process considerations when choosing etch gases and the desired outcome of the etch process. These are intricate systems as the world demands faster, smaller circuits, sometimes less than 100 atoms wide, to be developed for applications. The reaction of the fluorine specie created in the plasma and its interaction with the Silica is critical in the end product created. The fire-retardant uses are widely known for both fire prevention and fire suppression. Finally, HFCs are used in proprietary processes in the pharmaceutical industry.

   b. Why are HFC replacements unsuited for this use?

A. HFC replacements are unsuited for semiconductor applications because manufacturers have developed specific recipes to etch silicon wafers and the ingredients in the recipes are not changeable. In these recipes, HFCs are used to etch the surface by creating silicon fluoride species. Semiconductor manufacturers will likely seek gases to improve this process, but modification is extremely costly, the development time is unknown and once developed there is a prolonged qualification period. Further, any gas used will likely be fluorinated.

2. Would you support amendment of the current language of the AIM Act to add an exemption for non-coolant critical uses of HFCs and a federal preemption provision to ensure that exemption applies uniformly across the country?

A. This is not ideal but acceptable. The European Union (EU), for example, adopted several exempted uses for hydrofluorocarbons (HFCs) including use in military equipment, etching of semiconductor materials, and pharmaceutical technologies, which may serve as a model for U.S. exemptions and ensure regulatory harmonization. See here. Replacing HFCs by HFOs will likely increase cooling costs for both industry and the general homeowner.

Further, federal preemption is absolutely required to validate the exemption. It is possible that, without federal preemption, the legislation could provide an appropriate exemption, but be invalidated by states. Hence, federal preemption is a requirement for this legislation.

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

3. In your comments on behalf of the Society of Chemical Manufacturers & Affiliates (SOCMA), you stated that, "Certain listed hydrofluorocarbons (HFCs) have non-refrigerant applications, e.g. as components in semiconductor and healthcare products, and so domestic manufacturers may be unreasonably burdened by the broad sweeping nature" of Sections 5, 6 and 9 of the Act. You also noted that, "Certain specialty chemical manufacturers use HFCs in industrial process refrigeration (IPR) for their manufacturing processes" and a change in refrigerant as required by the Act "could potentially require a manufacturing process to be redesigned." Please describe the "unreasonable burden" that domestic manufacturers may face under Sections 5, 6, and 9, how that burden was calculated, and precisely how specialty chemical manufacturers may need to redesign their IPR manufacturing processes as a result of the Act, including the reasons, costs, and timing.

A. The specialty chemical industry is very different than the commodity chemical industry. In this case, the applicable difference which must be understood is the difference between "batch" manufacturing and "continuous process" manufacturing. The specialty chemical industry relies on batch manufacturing which is fundamentally different than continuous process because batch manufacturers do not run the same process and produce the same chemical 24/7. The specialty chemical industry produces low volume, high value chemicals. These chemicals are produced in small batches and the equipment used to manufacture is reconfigured to make different batches of chemicals. Hence, the overarching configuration of a facility is extremely problematic in a specialty chemical facility because flexibility is required for the chemistry itself.

   The monetary value cannot be calculated across the industry and would have to be studied for each individual company because of the variety of configurations in the industry.

4. Of the HFC compounds that are being used by your company today, on average how much does the industry use on an annual basis (in tons and GWP-weighted tons) now?

A. We cannot estimate the average annual use for the industry. SOCMA, as most trade associations, does not have access to sales volume of products nor do we have individual product recipes. Primarily for anti-trust considerations, that is information that SOMCA is not properly equipped to manage.

5. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your member companies on an annual basis?

A. Again, for anti-trust purposes among others, SOCMA does not collect or analyze this data. However, anecdotally we can state that one member company produces an HFC for semiconductor and other non-refrigerant applications. Assuming a total of 230,000 tons, this manufacturer produces <0.015 percent of the total HFCs. Broadly speaking, a large number of SOCMA members service the semiconductor and electronics industries, and may reasonably be anticipated to produce HFCs for such manufacturing applications.

6. Do you project HFC usage will grow or shrink over the next 15 years?

A. With phasedowns focused on encouraging shifting refrigerants in multiple countries it is likely HFC use will shrink, but the manufacturing applications, which likely comprise a small amount of HFC use are unlikely to change because alternatives are scarce if they exist.

7. If the AIM Act were implemented as introduced, do you believe the HFCs used by your company will be eligible for essential use exceptions? If not, why not?

A. We do not use HFCs but represent companies that both use and manufacture HFCs. It is unlikely that the essential use exemptions apply based on the specific language in the legislation. The language in the bill suggests "… entirely consumed (except for trace quantities) in the manufacture of another chemical; or… used and not entirely consumed… if the remaining amounts of the regulated substance are subsequently destroyed." The language needs to be more specific. SOCMA prefers language that exempts specific uses similar to EU legislation. See here. The terms "trace", "destroyed" and others in this bill are inadequately defined.

Senator Capito:

8. Mr. Helminiak, in your testimony you raised concerns SOCMA has about the AIM Act's impact on non-refrigerant applications for HFCs, such as in the manufacture of semiconductors, a sector in which the United States has always been a leader and key innovator. Much has been made of the purported benefits of an HFO transition mandate for domestic job creation and reducing the trade deficit, but it seems these analyses have been limited to primary chemical manufacturing and the use of HFOs in applications like HVAC equipment. Does SOCMA feel that this may come at the expense of other, value-added industries like semiconductors?

A. Yes. While there has been work done in analyzing the HVAC space, minor uses of HFCs (e.g. semiconductor etch gases) are a significant component for the electronics industry and need to be better understood before potentially phasing out.

SOCMA Response
Robert F. Helminiak
rhelminiak@socma.org

9. What are additional examples of other non-refrigerant industries that may be negatively impacted by this legislation?

A. Semiconductor, pharmaceutical and fire-retardant industries.

10. In order to prioritize the "onshoring" of jobs related to HFO production and its refrigerant applications, are we risking offshoring value-added manufacturing in other sensitive industries?

A. If HFCs are regulated for all applications, industries where HFOs cannot replace HFCs may be forced to move production (and use of HFCs) to non-regulated countries. It should also be noted that, while the HFC volume is low, these are lucrative fields and high paying American jobs at stake.

11. Do you feel that risk has been sufficiently studied?

A. No, further analysis is required, specifically for non-refrigerant uses. The additional analysis will provide a path to develop appropriate exclusions which are not provided in the legislation.

12. Is this risk adequately addressed in the regulatory discretion provided by the AIM Act? If not, what improvements need to be made to ensure avoidance of unintended consequences for your members that could harm American jobs and raise prices for American consumers?

A. The risk of unintended consequences, the elimination of non-refrigerant uses of HFCs (which in turn eliminates sales and potential export markets along with American jobs) is absolutely not mitigated by providing regulatory discretion. These exclusions must be included in the legislative language. Different equipment needed for HFOs, cost of the gas itself and safe use of HFOs (some of which are flammable) needs to be better understood, especially in batch manufacturing scenarios, and could harm the American consumer. See here.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Structural Composites

<u>Senator Braun</u>

1. Can you describe some of the ways your products are used in infrastructure projects?
   a. Senator Braun Thank you for your question. Prisma Preforms have been used in several infrastructure development projects. In a Missouri DOT funded project Prisma was the down-selected technology based on cost and performance. It was a comprehensive qualification of composite bridge decking for new highway constructions. The technology was fully qualified and found to meet or exceed all AASHTO requirements. A reference to the published MDOT project can be found below. We are seeking federal funding to move this validated technology to deployment. We are currently working a small 20ft drop in bridge demonstration project in Tennessee, with the Institute for Advanced Composites Manufacturing and Innovation (IACMI) with collaborations with TDOT.

   b. In Florida we have conducted several infrastructure developments projects in conjunction with FDOT. These include movable Prisma composite bridge decks, Prisma Composite Wind/Sound panels for conventional bridges, Crash Safety Prisma Composite sign posts, and a modular Prisma drop in rural bridge.

STRUCTURAL COMPOSITES PANEL UNDERGOING QUALIFICATION TEST AT FLORIDA DOT MOVEABLE DECK

c. Composites for Infrastructure such as bridge decks create an opportunity to change how we do highway construction and civil infrastructure. The life cycle and durability benefits of composites reduces recurring maintenance cost and provides extended service. We are happy to brief you further on this technology as infrastructure is considered in congress. In conjunction with the American Composites Manufacturers Association there are many exciting developments in Infrastructure that can be used to restore and harden our infrastructure. Our approach accelerates installation and minimizes traffic impacts by moving infrastructure manufacturing from the field to and into American factories. HR1159 the Image Act is a good start it needs to be passed, more needs to be done as this shovel ready technology can quickly enhance US advanced manufacturing, create jobs and restore our increasingly vulnerable infrastructure.

2. Does your composite manufacturing process require a large volume of HFCs?
   a. No the process uses a small amount of H134a as a blowing agent for the polyurethane foam used to produce Prisma. Prisma production at our only operation uses approximately 12 tons of H134a annually. The vast majority of the blowing agent remains in the foam for the products 20+ year life for boats or longer depending on the disposal method of the end product. Navy SBIR efforts further advanced Prisma based lightweight structures for the Navy and broader composites industry. The technology reduces the overall non-recurring environmental impact of boat manufacturing (HAP reductions). The Navy craft was over 30% lighter than its baseline, the Hydrasport 53 also shown has about the same hull and deck weight as the older Hydrasport 42 which uses non-Prisma technology. Reduced consumption of composite materials has related reductions in HAP emissions, The extended life cycle and all of the GHG to produce these products we eliminated with the lightweight design should really be considered as we look at the full cradle to grave impacts. The positive GHG impact can be rationalized on fuel emissions alone, with cradle to grave analysis it would be even more compelling.

3. Can you describe your process of receiving an exemption from California?
    1. Working with NMMA we approached CARB with the data package we presented to the EPA during SNAP. CARB was able to rapidly understand the information presented and it seems they already understood the difference between recurring and non-recurring pollution. They quickly made the determination that Structural Composite Preforms were exempt from CARB due to its GHG life cycle benefits and the lack of an alternative. The process took less than 2 months, in comparison we tried to work with the EPA for years on SNAP, having to result in this small business having to hire expensive DC council and expending vast sums of funding to sue the EPA or else be regulated out of business with no recourse. Once a rule is published if you don't sue you are gone even if you are a small business. The experience shows that modernization the EPA is needed, methods need to factor recurring and non-recurring pollution and not penalize a process that has large recurring pollution reductions but has a small non-recurring pollution during manufacture. The EPA SNAP approach nearly crushed our innovation, it took us off our focus and drained internal funding much better used on innovation in the transportation and infrastructure markets. CARB recognized the innovation, overall pollution reduction, the lack of an alternative we hope that congress follows the CARB approach in the AIM act.

Senator Whitehouse:

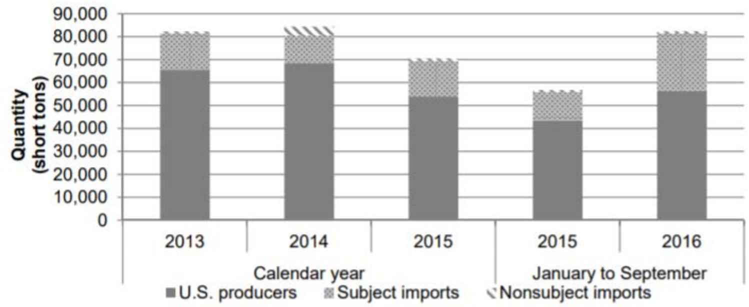
4. What is the total volume of HFCs for which there is no acceptable substitute used by the foam and composites industries? Please list each such HFC and the volume used. Please state the reasons why potential substitutes (if they exist) are unacceptable.
    1. Thank you Senator Whitehouse for the question and your strong support of NMMA and ACMA. As far as we know Composite Preforming is the only process that has no acceptable substitute in the composite's material space. Composite Application Group (CAG) estimates is members (which includes SC and Wabash National) use approximately 25 Tons of H134a per year. This is about 0.01% of the stated annual US usage. One other company, smaller than ours and is outside of CAG and produces composite preforms we estimate their H134a usage at 3 Tons/year. Thus, we estimate the total US usage for this process at 28tons/year out of the estimated 230,000 tons used annually in the US.
    2. HFO has been touted as the alternative for all things 134a by the patentholders. Since SNAP started on H134a regulation we have engaged our supply chain to do the R&D to adapt HFO blowing agent so as to be suitable for our use. Numerous trails have now been performed with more than one supplier. This has helped eliminate some of the issues, however the last recurring issue is product stability. Recent trials by SC and Wabash using two different manufacturers showed serious product stability issues. SC's trial product exhibited severe shrinkage but what was concerning was it did not manifest in the product for 14 days. If this product were to be installed into a boat and it subsequently did shrink the boat would be a total loss and we could have tremendous liabilities as it could become

a safety at sea issue. We are not talking small companies as our suppliers; our current supplier is BASF it is the worlds largest chemical company.

5. By what percentage has use of such HFCs been growing over the last five years? Please list each such HFC and its growth rate over the last five years.
    1. We do not sell or produce HFC, Our supplier, currently BASF purchases the material and incorporates it into or foam raw materials. Thus, we do not have good data on the overall HFC market. We can say from what we are seeing much of the current HFC usage will be declining. We are ready to switch when a suitable alternative is available. Some data we were able to obtain on US usage follows:
    2. Source:

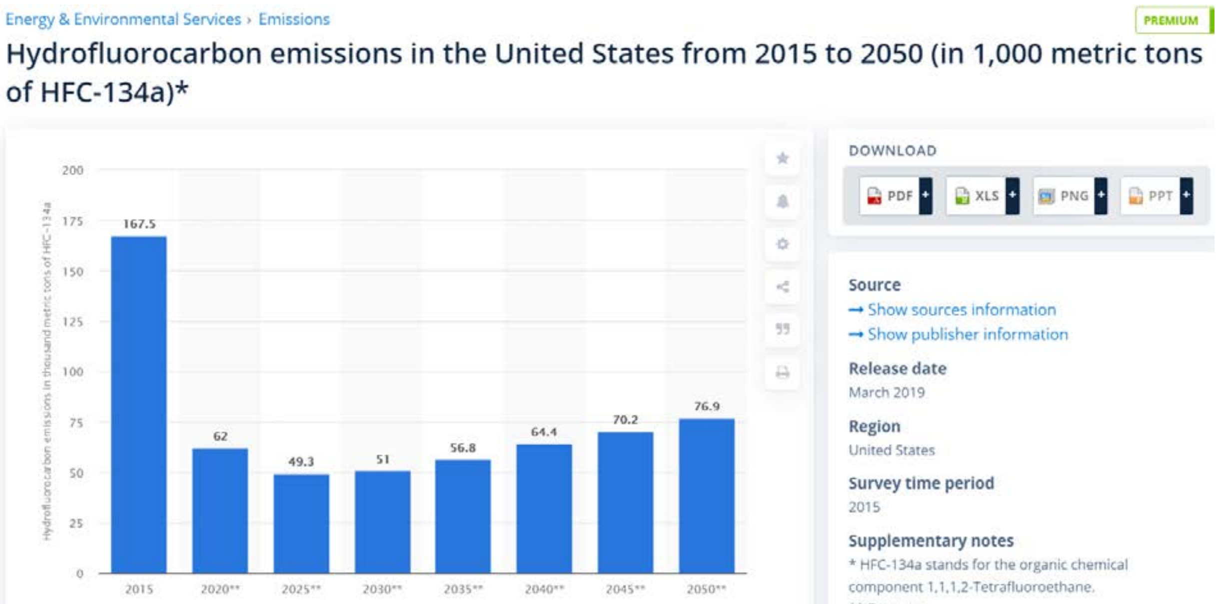
https://www.usitc.gov/publications/701_731/pub4679.pdf
This shows domestic and import consumption. The data indicates that the US largely supplies itself with domestic production of 134a, indicating US producers may be greatly impacted as HFO is patented. As the Chairman states HFO manufacturers are selling the patented product for 10 times the cost of H134a and with this regulation H134a will not be a competitive force.

Figure IV-3
R-134a: Apparent U.S. consumption, 2013-15, January to September 2015, and January to September 2016



Source: Official Commerce statistics under HTS statistical reporting number 2903.39.2020, accessed December 20, 2016, and data submitted in response to Commission questionnaires (adjusted with proprietary Customs data for *** in 2013).

https://www.statista.com/statistics/1014161/hydrofluorocarbon-emissions-us/
this projects emissions with 2015 as a baseline, this indicates a significant drop occurring now in 2020, this is emissions and not usage, however this emission reduction would be expected as less units (AC/refiguration/heat pump) no longer use HFC and these units get replaced with Non-HFC refrigerants.



Thank you for allowing us to comment.

Please exempt Structural Composite Preforms from regulation and allow continued use of H134a until such time as a suitable alternative is available. Please include preemption as these materials are used in critical interstate commerce.

SUB·ZERO GROUP, INC.

2866 Buds Drive, Fitchburg, WI 53719
P: 800.532.7820 P: 608.271.2233

April 27, 2020

By E-mail

The Honorable John Barrasso
Chairman
Committee on Environment & Public Works
United States Senate
Washington, DC 20510

The Honorable Thomas Carper
Ranking Member
Committee on Environment & Public Works
United States Senate
Washington, DC 20510

Via Email: QFR@epw.senate.gov

Dear Chairman Barrasso and Ranking Member Carper:

Sub Zero Group, Inc. (Sub Zero) appreciates the opportunity to participate in the Committee's process of Information-gathering on "***S.2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record.***" Please find attached my responses to the Committee's follow-up questions.

I hope these responses assist the Committee in its consideration of S. 2754. Again, thank you for the opportunity to participate and we look forward to continuing to work with the Committee on this bill.

Respectfully Submitted,

Christopher M. Jessup
Director of Quality & Regulatory Compliance, Sub Zero Group, Inc.
Email: Christopher.Jessup@Subzero.com
Phone: 608.270.3364
Website: https://www.subzero-wolf.com

Cc: James Bakke, President/CEO, Sub-Zero Group, Inc.
Paul Sikir, Vice President of Design Engineering, Sub Zero Group, Inc.
Robert Schroeder, Vice President of Quality & Reliability, Sub Zero Group, Inc.
Peggy Petersen, Vice President of Supply Chain, Sub Zero Group, Inc.

Sub Zero Responses
to
Senate Committee on Environment and Public Works
Information-Gathering Process entitled, "*S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record*"
March 25, 2020
Questions for the Record for Sub Zero

Chairman Barrasso:

1. **Can you provide examples of the difficulties small manufacturers face when asked to comply with regulatory changes, especially if the deadlines for regulatory implementation differ across states?**

Response: As a small, niche market manufacturer, we require years of planning, developing and testing to comply with regulatory changes such as converting the refrigerant used in our refrigeration system from HFC 134a to HC R600a. The reason for this stems from the fact that regulatory compliance does not scale with the size of the manufacturer; meaning, there is no linear relationship between a company's market volume and the actual cost and effort of transitioning for compliance. We offer our market a very broad lineup of specialized refrigeration, in many different configurations, which makes the effort to redesign the entire product lineup very challenging with our limited resources as compared to larger manufacturers.

Most regulatory compliance projects require significant changes to an existing design. A great example of this is what all manufacturers must do to comply with adjustments to the federal energy standard regulated by the Department of Energy (DOE) under the Energy Policy and Conservation Act. While this has been a huge success story in terms of greatly reducing energy consumption, it has required appliance manufacturers and their respective supply chain partners to evolve technologies and materials in effort to comply. Wholesale platform changes that render current manufacturing equipment and tooling obsolete are often required to comply. Thankfully, in the case of appliance energy standards, we have federal preemption that allows the DOE to regulate for all fifty states, which provides the necessary harmonization across the entire U.S. market. Without federal preemption, it would be nearly impossible for smaller, niche manufacturers to make the necessary investments knowing that the minimum energy performance standard may change in other states within only a few years of implementation.

In addition to heavy capital investments involving manufacturing equipment, tooling and fixturing, there is an extensive amount of research and development cost into new technologies, materials and manufacturing processes. That reality requires a company like Sub Zero to combine compliance requirements with product performance initiatives to maximize the value of the company's investment by ensuring that we are relevant and desired by consumers in our market. Allowing states to regulate as they see fit with varying degrees of performance requirements or reductions in certain chemicals, pollutants, etc, with potentially different deadlines, invites significant impediments to a smaller manufacturer's strategic initiatives simply due to the uncertainty.

2. **In your testimony, you cite the difficulties that social distancing measures have placed on Sub Zero's ability to research and test new prototypes. The COVID-19 pandemic has disrupted supply chains worldwide, and the long-term effects are not yet fully known.**

    a. **How has the pandemic affected Sub Zero's supply chain, and what potential difficulties does that pose in meeting California's (or any other state's) HFC phasedown deadlines?**
    b. **How has COVID-19 impacted Sub Zero's ability to conduct research and develop substitutes for HFCs?**

Response: Sub Zero, along with other appliance manufacturers, successfully negotiated with the state of California's legislators and the California Air Resources Board (CARB) back in 2018 in having appropriate compliance deadlines written into the law for our three major residential refrigeration product classes:

Compacts: January 1, 2021
Freestanding: January 1, 2022
Built-In: January 1, 2023

At that time, prior to any notion that the world would be impacted by a pandemic, Sub Zero had the utmost confidence in making the necessary platform changes required for meeting the deadlines for the Compacts and Built-In product classes, respectively. Sub Zero invented the Built-In product class decades ago and considers it to be the hallmark of our niche market; however, COVID-19 is seriously threatening our launch readiness for meeting the first deadline set for the Compacts product class as well. The new reality for our product development schedule is one of uncertainty. Although our product development process continues to progress slowly during the pandemic, it has been severely constrained with respect to our original schedule in two key areas. The delivery of a critical new piece of manufacturing equipment has been delayed coming out of Italy. As you are well aware, the country of Italy has been greatly affected by COVID-19; consequently, its government has been attempting to flatten the infection curve by keeping people quarantined, which has impeded the completion of our order.

The second factor that has severely disabled our product development and testing progress is our supply chain partners, particularly those operating in Mexico. Much of the appliance industry's supply chain operates in Mexico and while the appliance industry carries an ***Essential Business*** status here in North America, we are struggling to get the Mexican government to share that perspective. As recently as April 20, 2020, the North American appliance industry's trade association, Association of Home Appliance Manufacturers (AHAM), sent a joint letter (affixed) with Mexico's own appliance trade association, National Association of Manufacturers of Domestic Appliances (ANFAD), to the Mexican Ministers of Health, Foreign Affairs and Economy with copies sent to several people including the President of Mexico, the US Ambassador to Mexico, the Mexican Ambassador to the US, and all the Governors of the Mexican States, in hopes of persuading the Mexican government to share the North American view that the appliance industry is essential from a food and medicine preservation standpoint. The outcome of that effort is unknown at this point in time, but we've lost well over a month of product development time with no certain date set for restarting.

As a direct consequence of being unable to receive needed materials, components and assemblies from supply chain partners operating in Mexico, particularly in, but not limited to, the states of Sonora and Tamaulipas, Sub Zero has been displaced from the once confident trajectory course for a January 1, 2021 and 2023, respectively, compliance deadline in California and other states. It is absolutely critical that the Mexican government begin to share our country's perspective that the appliance industry value chain is essential. Critical suppliers of non-commodity based components and assemblies cannot easily be replicated or transferred to alternate sources in a timely manner. Customized tooling, equipment and manufacturing processes cannot be re-sourced without many months of lead time for logistics, qualification and supply chain maneuvers for raw materials. In addition to the amount of lead time that would be necessary, sourcing changes carry risks, particularly in the area of quality and reliability.

In an effort to underscore the real constraints being experienced by U.S. manufacturers due to supply chain partners with operations in Mexico, it is clear that this is not a unique issue to Sub Zero or even the appliance industry. A recent article released on April 22, 2020 by CNBC cited that even the Pentagon is actively lobbying the Mexican government to open "manufacturing facilities during the Coronavirus pandemic in order to support a crucial supply chain for U.S. defense companies." In the same article, Ellen Lord, Defense Undersecretary for acquisition and sustainment, made the following comment, "Mexico right now is somewhat problematic for us." The bottom line is, COVID-19 is a significant headwind on many industries, which makes regulatory deadlines extremely disconcerting.

3. **If you cannot develop alternative products in time, is there significant concern that Sub Zero will be cut off from selling products in California?**

Response: Given the current state of the Sub Zero supply chain, we do have concerns about meeting the deadlines for both Compacts and Built-Ins. The COVID-19 pandemic has placed us on a trajectory where we will eventually have to make a very difficult business decision concerning how we deal with the compliance deadline. Opting to cut ourselves off from the markets of California and other states with the same deadline would be a huge detriment to our viability. Conversely, should we opt to circumvent our conventional product development process, we assume a high level of quality and reliability risk by limiting or eliminating valuable long term testing that correlates to customer satisfaction. The sole purpose of a manufacturer's product development process is the study of design and process robustness, which involves a lengthy iteration of building and testing in pursuit of discovering all of the relevant factors that go into producing a great product in a manufacturing environment. Although it is always advantageous to expedite the product development processes in effort to accelerate market availability, a manufacturer must balance that initiative by employing a development process that protects the consumer from being exposed to safety, quality or reliability issues over the expected useful life of the product. The COVID-19 related supply chain constraints are testing that balance and placing Sub Zero in quite the predicament; hence, why it is so important that we gain federal preemption on the HFC phasedown schedule and push out the deadline for all three product classes at least six months.

4. **In its testimony, the Air-Conditioning, Heating, and Refrigeration Institute states that "As a general matter, for our industry, it is the *presence* of a [phasedown] schedule that provides certainty, not the *specifics* of that schedule" (emphasis added). For Sub Zero, are the specifics of the schedule and having sufficient lead time to implement it important?**

Response: Sub Zero made the commitment to transition away from HFCs back in 2016, so the mere presence of a phasedown schedule, while important, isn't nearly enough for a company of our size with our brand promise. As the proverbial saying goes, the devil is always in the details and complying with a compliance deadline that involves the redesign of all Sub Zero models takes a great deal of time. Sub Zero's entire portfolio of products cannot be redesigned and qualified for market availability in parallel. Given the limitation of resources, we have been aggressively trying to execute lengthy product development projects across our breadth of products. The compliance deadlines have always been considered an aggressive schedule; however, with the implications of COVID-19 on the supply chain, we face enough headwinds that our predicted lead time for market compliance has been compromised. For all of the reasons stated throughout Sub Zero's answers, we need more lead time than originally expected and would ask the Committee to put forth a bill with preemptive measures with adjusted deadlines, or at the very least, help advocate for extensions in the states that have already enacted HFC phasedown laws.

Mexico City, April 20th 2020.

Subject: **Industry of Appliances essential to the contingency by COVID-19**

PhD. Jorge Carlos Alcocer Varela
Minister of Health

B. Marcelo Luis Ebrard Casaubón
Minister of Foreign Affairs

PhD. Graciela Márquez Colin
Minister of Economy

Present.

Distinguished Secretaries

Given the evolution of the health contingency caused by the COVID-19 virus, the Industries represented by the **Association of Home Appliance Manufacturers of the United States and Canada** (AHAM) and the **National Association of Manufacturers of Domestic Appliances** (ANFAD), are convinced of the need to contain and confront the sanitary emergency with actions such as the isolation of people at home and to strengthen hospital systems.

The Appliances, including their technical services, are essential in the phases that we go through to contain and mitigate COVID-19, hence we highlight the relevance of attending the households, operating our production plants with the required preventive sanitation measures and safeguarding the value chains declared essential in the United States and Canada.

AHAM and ANFAD represent a value chain built on decades of work and investments, which we will strengthen with the update of the USMCA Trade Agreement that will be ready for July 1st, 2020, in order to strengthen and deepen the production chain.

For the United States and Canada, one of the priorities in this sanitary emergency is to keep the strategic infrastructure operating, with the appliance industry being an essential part of it. Therefore, the United States Department of Homeland Security recommended on March 28th, 2020, that appliances should be considered essential, as also did the Canadian Department of Public Safety updated on April 16th, 2020.

Appliance companies in the United States and Canada, consider similar companies associated to ANFAD as part of its value chain, by providing parts, components, and products necessary for its industrial process or that are part of a portfolio of products in the market from North America. Therefore, the suspension of operations of the ANFAD Industry jeopardizes the value chain that we have with the United States and Canada, when today we are concerned with continuing operations in the recently announced opening processes.

Indeed, keeping the Appliance Industries in North America running, even more when personal hygiene and proper food preservation are good prevention practices. Given this, we require household appliances and their technical services, for example, to:

- The proper preservation and preparation of food in homes, such as refrigerators and food cooking appliances, such as stoves, grills, ovens, and microwaves.
- The Proper cleaning of personal items, as well as the home and its environment, such as washing machines, air conditioner and vacuum cleaners, especially to ensure the cleanliness of the garments of healthcare workers and other first responders.

We are ready for the new stage that we are certain to promote with the USMCA, being essential that in Mexico we can participate in economic activities, and thus continue to strengthen the North American value chain.

We come to you, because the **Appliance Industries of North America are ready, as essential Industries**, to ensure that the manufacturing, distribution, service, and maintenance of our products continue to arrive at these times when it is most needed.

AHAM

Joseph M. McGuire

Joseph M. McGuire
President & CEO

ANFAD

E Elizondo Williams

Eduardo Elizondo Williams
President

C. c. p. B. Andrés Manuel López Obrador, Constitutional President of The United Mexican States.
Eng. Francisco Cervantes Díaz, President of the Confederation of Industrial Chambers of the United Mexican States.
PhD. Hugo López-Gatell Ramírez, Undersecretary of Prevention and Health Promotion of the Ministry of Health.
PhD. Martha Delgado Peralta, Undersecretary for Multilateral Affairs of the Ministry of Foreign Affairs.
PhD. Jesús Seade Kuri, Undersecretary for North America of the Ministry of Foreign Affairs.
PhD. Luz María de la Mora Sánchez, Undersecretary of Foreign Trade of the Ministry of Economy.
PhD. Christopher Landau, United States of America Ambassador to Mexico.
B. Martha Bárcena Coqi, Mexican Ambassador to United States of America.
Governors of the Mexican States.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
April 29, 2020
Questions for the Record for Chuck Chaitovitz, Vice President of Environmental Affairs and Sustainability at the U.S. Chamber of Commerce

<u>Chairman John Barrasso (R-WY):</u>

1. Does the Chamber support essential use exemptions being available before 2034 for HFC uses where there is not a viable, feasible, or cost-effective substitute for HFCs?

Yes, and it is important to note that specific essential use exemptions are not needed in perpetuity, but until effective and commercially-viable substitutes are available during the transition.

2. The bill contains no provisions to evaluate or minimize impacts on small businesses of a HFC phasedown. Does the Chamber support revisions to the bill to lessen burdens on small businesses?

We are not aware of any issues facing small businesses. If challenges are raised, we are open to discussions on their concerns.

3. The Committee received testimony raising concerns and requesting changes to the bill from a number of trade associations, some of whose members overlap with membership of the U.S. Chamber, such as the Aerospace Industries Association, Alliance for Automotive Innovation, Industrial Energy Consumers of America, National Automatic Merchandising Association, National Automobile Dealers Association, Society of Chemical Manufacturers and Affiliates (SOCMA), and Truck and Engine Manufacturers Association, as well as a number of companies. The full list of those who submitted testimony is available at this site. Based on review of the testimony received, it appears that most industry stakeholders in the heating, ventilation, air-conditioning, and refrigeration sector are supportive of the bill as drafted. Outside of that industry sector, it appears that most industry sectors who submitted testimony have serious concerns with the bill and based on their breadth of comments, do not appear to have been consulted in the legislation's development. Do you believe the AIM Act should be amended to address concerns from business sectors outside the HVACR industry sector before any votes occur on the legislation?

We are working to coordinate across the trade associations, companies, and sectors you mention to develop appropriate compromises that could be reflected in the bill.

Senator Whitehouse:

4. You state that there are "several creative preemption models for federal-state environmental partnerships that could be used." If the Committee were to consider some form of state preemption language, would it be possible to develop a conditional form of state preemption that would only enter into force if EPA implemented the phase down as intended and would be suspended if EPA at any subsequent point in time relaxed the phase down in any substantive way? Please provide the Committee with your thoughts on conditional state preemption, any possible historical precedents for such language, as well as any suggested language you might recommend for such a conditional state preemption clause.

We anticipate that EPA will meet the required phasedown established under the bill. If enacted into law, EPA would not have discretion to ignore the phasedown schedule mandated by Congress. Its role would be focused on the appropriate allocation of the allowances among HFC producers and consumers. We have been working with our members on creative approaches, urge a solution that would provide the business community with a predictable environment in which to invest and plan, and ensure a consistent national program that takes into account existing state programs that support the transition to alternatives. The bill also could mandate a mid-term review of the feasibility of accelerating the phasedown called for by the legislation, a process that could take into account a more rapid transition to commercially- acceptable alternatives.

5. You also express concerns about HFCs for which there may not be substitutes. What percentage of total HFCs are represented by HFCs for which you believe that there are no effective substitutes? Please list each such HFC and the volume used. Please state the reasons why potential substitutes (if they exist) are unacceptable.

According to EPA and industry data, the percentage of HFCs used in the U.S. for which there are no substitutes is small — in most uses less than one percent of the total volume of HFCs used. This small category of HFC-use includes niche and specialty applications, such as for national security and protection of life and property that require time and testing to identify appropriate substitutes.

For instance, some of our member companies manufacture aircraft that have onboard uses for HFCs including for fire suppression. HFCs used onboard commercial and military aircraft include HFC-125, 227ea, 236fa, and 134a. The unique challenges in securing substitutes for aerospace agents are the rigorous standards and certification requirements implemented by the FAA and Department of Defense. The agents must be highly effective, have low toxicity to be used in occupied spaces, and be "equipment safe" so they do not cause additional damage.

This same issue presented itself during the transition out of halon fire suppressants in the 1990s. Unlike in the transition away from CFCs and HCFCs, the HFC transition is a phasedown, not a complete phase-out, which means that at the end of the 15-year transition period, there will still be 15% of the HFC baseline, or about 50,000 tons, available in perpetuity. This process allows for those niche or critical end uses that may not have viable alternatives to continue to use HFCs if required.

As a safety net, EPA can also authorize additional HFC production or imports in the unlikely event that there are insufficient quantities of HFCs available for a particular sector.

Halons are ozone-depleting substances that were phased out under Title VI of the Clean Air Act. Given the importance of ensuring that next generation fire suppressants worked as effectively and as safely as the halons they were replacing, halon fire suppressants were eligible for temporary regulatory exceptions to the phase-out requirements until substitutes were identified, tested, and deployed. The temporary exceptions balanced the need to incentivize investment in new technologies with the time and flexibility to ensure the transition was made on a commercially prudent timeline.

The AIM Act is based substantially on Title VI, and so we encourage that the essential use exceptions similarly be made available to niche and specialty applications for as long as needed until effective and affordable substitutes are commercially available. EPA has worked effectively and cooperatively with manufacturers over the past 30 years on such exceptions under Title VI, in both Republican and Democratic administrations, providing a model for the AIM Act and HFCs.

6. By what percentage has use of such HFCs been growing over the last five years? Please list each such HFC and its growth rate over the last five years.

EPA has collected data on HFC emissions by specific HFC chemical, not by use.[1] The Chamber is willing to continue to explore this issue.

7. Please describe the transition from CFCs to HFCs, catalyzed by the Montreal Protocol and Title VI of the Clean Air Act. Did Title VI preempt or in any other way limit state regulatory action with respect to CFCs? After the implementation of Title VI and the accompanying two-year pause in state enforcement of CFC regulations, did states adopt or resume enforcing CFC regulations? If so, how many and in what manner?

Title VI of the Clean Air Act was enacted in 1990 and resulted in a gradual restriction of the production and the consumption of CFCs and other ozone-depleting substances. As with the AIM Act, the production and consumption restrictions did not affect existing equipment. Nor was the aftermarket supply of CFCs subject to the phase-out. Instead, the gradual slope of the phase-out and the ability to recycle and reclaim used CFCs assured sufficient supplies of CFCs for existing equipment — supplies that in some cases continues to this day despite no new CFCs being produced or imported in 25 years. This approach provides a potential model for the AIM Act and HFCs.

---

[1] https://www.epa.gov/sites/production/files/2020-04/documents/us-ghg-inventory-2020-main-text.pdf, table 104-4.

The transition out of CFCs and other ozone-depleting substances in the 1990s and early 2000s under Title VI is broadly recognized as a commercial and environmental success, with a reasonable approach to technology choice and sufficient flexibility for those applications for which no substitutes existed. In short, Title VI created an effective partnership between industry and government, which is why we support legislation, built on this template.

Section 614(a) of Title VI imposed a two-year pause on state enforcement of requirements regarding the design of new or recalled appliances using CFCs, but Title VI did not otherwise affect state authority. However, the presence of a comprehensive federal program led states to abandon efforts to regulate CFCs and other ozone-depleting substances in the 1990s. We are not aware of any state that continued to develop new regulations for CFCs after the two-year enforcement pause.

Following the enactment of the 1990 Clean Air Act Amendments, states faced three key barriers in attempting to continue to regulate CFCs and other ozone-depleting substances:

1) Title VI filled the federal void, thereby eliminating the primary driver of state action.
2) States required significant industry technical expertise to formulate and implement regulatory standards for fluorocarbons.
3) Many companies, particularly those in sectors that used CFCs and other ozone-depleting substances in high volumes, had little incentive not to transition, so state implementation of more stringent rules was moot once the federal rule was in place.

8. For HFCs where users claim that the current substitute is too expensive, based on the nation's experience transitioning from CFCs to HFCs, what do you believe will occur with respect to the price of HFC substitutes?

Over the course of the transition out of CFCs, HCFCs, and other ozone-depleting substances, the costs of substitutes have declined over time, as a direct result of investment in new domestic production facilities, which led to lower production costs and greater supply.

In the immediate term, before economies of scale set in and based on industry experiences, prices for certain HFC substitutes may be higher. The costs for some substitutes for niche or specialty applications could be higher at the outset of the transition, but may likely decrease over time. It should be noted that cost is already an operative criterion for evaluation of the availability of substitutes under the AIM Act.

As Steve Yurek, president and CEO of the Air-Conditioning, Heating and Refrigeration Institute wrote on page 8 of his April 7, 2020 testimony, with respect to the HVAC sector:

Many U.S. manufacturers have already announced new product and equipment lines using next generation refrigerants, such as HFOs. With an orderly transition from HFCs, the average price among all refrigerants is expected to be approximately $7 per pound. HFO refrigerants are *currently priced 2 percent to 7 percent higher than HFCs but are expected to be priced approximately the same as soon as 2022.*

Experience with past transitions has shown that as a transition progresses, manufacturing costs and consumer prices are reduced due to economies of scale, with larger facilities coming online to produce new classes of refrigerants to meet growing demand. Plus, some next generation refrigerants are simpler versions of current products, which also yields reductions in cost.

Moreover, new HFO-based products and equipment can be up to 18 percent more energy efficient, which lowers operational costs. New products and equipment also will have smaller refrigerant charge sizes and lower leak rates, which lowers maintenance and servicing costs.

9. If the AIM Act were to be passed in its current form, based on the nation's experience with Title VI, how do you believe that states would respond with respect to adopting and/or enforcing their own HFC laws and regulations?

The experience with Title VI suggests that enactment of the AIM Act in its current form, and under which the federal government would assume authority for regulating HFCs, states would defer to the federal government for the regulation of these products. Even assuming that the political and regulatory landscape in some states is different today from the way it was in the 1990s and early 2000s, we understand that the primary driver of existing state activity regarding HFCs is the absence of a federal standard. Fluorocarbons are complicated and difficult for a state to try to regulate without substantial technical input from industry. Consistent with this challenge, most states contemplate that they will conform their laws to any new HFC listing rules promulgated by EPA, once rules are finalized. Further, the relatively swift transitions by some large-using sectors out of HFCs would reduce, potentially to a significant degree, the environmental benefit of further state regulation, since such a large share of the market would already be entirely out of HFCs.

10. Do you believe that passing the AIM Act in its current form will lead to more or less regulatory harmonization and certainty than would be continued with congressional inactivity in this space?

More harmonization will occur especially if the right balance and partnership of federal-state implementation is reached.

11. You write "[i]f the U.S. does not pass the legislation, other countries could surpass the U.S. as the global leader in the sector." Please discuss why it is economically important for the U.S. and American companies to be leaders in the development and commercialization of new technologies. Please also discuss what it would mean for the American economy and American workers if new technologies are developed overseas by foreign companies.

Other countries will move forward on the HFC transition even if the U.S. does not. In that scenario, the billions of dollars invested in the transition by American companies to establish the U.S. as a technology leader will be severely diminished, as the U.S. market is over-taken by foreign competitors who have not made similar investments.

The U.S. will not realize the significant economic benefits projected if the legislation is not adopted. As we and several others have testified, those benefits are:

- Create 33,000 new jobs and sustain 138,400 existing jobs between now and 2030.
- Increase direct U.S. manufacturing output by $12.5 billion, and total (direct and indirect) U.S. manufacturing output by $38.8 billion between now and 2030.
- Improve the U.S. trade balance in equipment and chemicals by $12.5 billion.
- Increase the U.S. share of the global HVACR market by 25 percent.

In the absence of a workable legislative compromise that ensures realization of these benefits, this job creation and economic development will occur outside of the U.S.

###

CHAMBER OF COMMERCE
OF THE
UNITED STATES OF AMERICA

CHUCK CHAITOVITZ
VICE PRESIDENT, ENVIRONMENTAL
AFFAIRS AND SUSTAINABILITY

1615 H STREET, NW
WASHINGTON, DC 20062
(202) 463-5316

April 8, 2020

The Honorable John Barrasso
Chairman
Committee on Environment
and Public Works
United States Senate
Washington, DC 20510

The Honorable Tom Carper
Ranking Member
Committee on Environment
and Public Works
United States Senate
Washington, DC 20510

Re: The Business Community's Comments on HFC Phasedown Legislation

Dear Chairman Barrasso and Ranking Member Carper:

The U.S. Chamber of Commerce is pleased to provide our feedback on S. 2754, the "American Innovation and Manufacturing (AIM) Act of 2019," a bill to phase down hydrofluorocarbons (HFCs) over a 15-year period.

We appreciate the significant economic and environmental goals of this legislation and the committee's commitment to engage all stakeholders. We are committed to working cooperatively with you, your committee, and all interested parties to develop a consensus compromise that enjoys broad bipartisan support. By engaging with our member companies and fellow trade associations, we believe such an outcome is possible, allowing for quick approval by your committee, the full Congress, and the president.

Preemption is one area that lacks agreement. We urge a solution that would provide the business community with a predictable environment in which to invest and plan, and ensure a consistent national program that takes into account existing state programs that support the transition to alternatives. There are several creative preemption models for federal-state environmental partnerships that could be used.

The HFC phase down envisioned by this bill is achievable~~,~~ as these compounds have many useful industrial applications for which substitutes are readily available. However, there are a limited number of uses, which may not have readily available substitutes, such as for onboard fire suppression agents on commercial and military aircraft, metered dose inhalers, and personal defense spray applications. While the legislation already provides an exemption process for essential uses, we want to emphasize the importance or retaining this critical language in the bill and to ensure essential uses that have no commercial substitutes receive an exemption. We also want to recognize the language in the bill that encourages the continuing recovery of HFCs for reuse in existing equipment during the transition.

Developing HFC replacement technologies is well underway and is critical to creating U.S. manufacturing jobs**.** A report published in April 2018 by two trade groups—the Air-Conditioning, Heating, and Refrigeration Institute and the Alliance for Responsible Atmospheric Policy—found that phasing down HFCs would by 2027 increase jobs by 33,000, grow U.S. exports by $5 billion, and reduce imports by nearly $7 billion. Additionally, phasing down HFCs would avoid more than 70 billion metric tons of carbon dioxide equivalent emissions by 2050. Solutions are available to replace HFCs in many sectors and reduce emissions.[1]

U.S. companies have traditionally led the development of refrigerant products used in air-conditioning, appliances, and other important sectors, as well as the products themselves. The bill would create new demand for such expertise and products across the globe. If the U.S. does not pass the legislation, other countries could surpass the U.S. as the global leader in the sector.

We welcome the opportunity to discuss these issues with you further. For more information, here is a link to our previous coalition letter. I will be following up with your staffs. Thank you for your leadership.

Sincerely,

Chuck Chaitovitz
Vice President, Environmental Affairs and Sustainability

cc: Members of the Senate Committee on Environment and Public Works

[1] https://www.ccacoalition.org/fr/slcps/hydrofluorocarbons-hfc

Senate Committee on Environment and Public Works

S. 2754, American Innovation and Manufacturing Act of 2019

April 8, 2020

WRITTEN TESTIMONY SUBMITTED FOR THE RECORD

Submitted by email: qfr@epw.senate.gov

Submitted by:

Most Reverend Paul S. Coakley
Archbishop of Oklahoma City
Chair, Committee on Domestic Justice and Human Development
United States Conference of Catholic Bishops

Most Reverend David J. Malloy
Bishop of Rockford
Chair, Committee on International Justice and Peace
United States Conference of Catholic Bishops

On behalf of the United States Conference of Catholic Bishops' (USCCB) Committee on Domestic Justice and Human Development and Committee on International Justice and Peace, we are grateful for the opportunity to offer written testimony on S. 2754, the American Innovation and Manufacturing Act of 2019 (AIM Act). This bipartisan legislation seeks to mitigate climate change and ozone depletion by initiating a regulatory phase-down of powerful greenhouse gases.

As Pope Francis has written, climate change "represents one of the principal challenges facing humanity in our day" (*Laudato Si'*, no. 25), threatening the wellbeing of peoples and the environment. Catholic social teaching envisions a sustainable and authentic human development, where technological solutions respect the principle of integral ecology and take into account social, economic and ecological considerations. In his address to the joint meeting of the U.S. Congress, Pope Francis stated that "building a future of freedom requires love of the common good and cooperation in a spirit of subsidiarity and solidarity."[1]

The phase-down of Hydrofluorocarbons (HFCs) respects the principle of integral ecology by protecting the atmosphere from harmful substances, promoting public health and stimulating sustainable economic development. The AIM Act is an opportunity for the United States to build a better future for our nation and the world.

HFCs, used predominantly in the air conditioning and refrigeration industry, affect atmospheric warming and indirectly contribute to ozone depletion. Developed to replace ozone-depleting

[1] Pope Francis, Address of the Holy Father to the Joint Meeting of the United States Congress, September 24, 2015.

substances under the Montreal Protocol, HFCs were useful alternatives to harmful chlorofluorocarbons (CFCs), and helped contribute to the recovery of the ozone layer. Despite this success, HFCs have a global warming potential hundreds to thousands of times greater than that of carbon dioxide. In 2019, the Kigali Amendment to the Montreal Protocol initiated a global phase-down of HFCs to mitigate climate change. Our Committees supported this improvement to the Montreal Protocol, stating that "decisive action by the United States in support of the amendment will be a sign of our nation's moral leadership and solidarity."

Once again, our country has the opportunity to play a leading role in environmental stewardship. The AIM Act would establish a federal regulatory framework to incrementally phase-down the production and consumption of HFCs. This legislation will deliver economic and environmental benefits, and is the product of fruitful dialogue among scientists, politicians, and members of the economic and industrial sectors. The orderly implementation of new technologies will ensure U.S. competitiveness in the global marketplace, and for this reason the bill has been endorsed by the U.S. Chamber of Commerce and numerous industry stakeholders.

We commend the Senate Committee on Environment and Public Works for pursuing this spirit of cooperation by engaging multiple stakeholders, and we pray that this dialogue will be a sign of our nation's moral commitment to protect human dignity and care for our common home.

Most Reverend Paul S. Coakley
Archbishop of Oklahoma City
Chair, Committee on Domestic Justice and Human Development

Most Reverend David J. Malloy
Bishop of Rockford
Chair, Committee on International Justice and Peace

Contact:
Meghan E. Goodwin
Associate Director of Government Relations
United States Conference of Catholic Bishops
3211 Fourth Street, NE
Washington, DC 20017
MGoodwin@usccb.org
(202) 541-3445

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *“S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record”*
March 25, 2020
Questions for the Record for Wabash National

<u>Chairman Barrasso</u>

1. Can you describe in more detail the potential greenhouse gas emissions reduction benefits of using composite materials that require HFCs to produce?

Wabash’s MSC trailers with Prisma composite materials are significantly lighter weight, resulting in less consumption of diesel fuels and thus reduced GHG emissions. Although the specific weight reductions will vary by customer specifications and application, in a side-by-side comparison for one large fleet, Wabash was able to remove 600 pounds of weight compared to a conventional trailer.

<u>Ranking Member Carper:</u>

Please provide a response to each question, ***including each sub-part.***

2. In your testimony you expressed concern that the AIM Act would ban HFC 134a. The AIM Act would affect a phase down of the production and consumption of HFCs over a 15-year period, with 15 percent of the baseline period allowed to be produced and imported from 2036 onward. The AIM Act also contains provisions intended to increase to a significant degree the recovery and reclaim of HFCs. The purpose of these provisions, and other provisions in the Act, is to ensure the continued use of HFCs for decades to come, particularly in small or niche applications for which no substitute is available. In light of this, why do you believe the AIM Act represents a hard “ban” on HFCs that would prohibit their use upon enactment?

We are pleased to see that the AIM act would allow continued use of HFC 134a for this application.

3. Of the HFC compounds that are being used by your company today, on average how much does the industry use on an annual basis (in tons and GWP-weighted tons) now?

It is estimated that CAG technology deployers are using 25 tons (42,500 GWP)

4. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your company on an annual basis?

It is estimated that less than 0.01% which includes structural preforms supplied to the entire marine industry by members.

5. Do you project HFC usage will grow or shrink over the next 15 years?

We anticipate technology advances that will allow the phase down of 134a so we expect usage will shrink over the next 15 years as alternatives become available.

6. If the AIM Act were implemented as introduced, do you believe the HFCs used by your company will be eligible for essential use exceptions? If not, why not?

Potentially yes, if we cannot find an available substitute during the applicable period. We are actively trying to find a substitute with many failed attempts.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for World Resources Institute

Senator Whitehouse:

1. What percentage of total HFCs used in the U.S. are used by the aerospace, semiconductor, composites, foam, and defense sprays industries? Has this percentage of niche uses grown over the last five years, and if so, by how much?

   WRI does not have access to a publicly-available source for these exact figures. However, proxy data indicate these subsectors encompass a minority of the total HFC market in the U.S.

2. Numerous industries have provided written testimony stating that there are no acceptable substitutes for HFCs they use. Please comment on these claims with respect to the aerospace, semiconductor, composites, foam, and defense sprays industries. Please list all HFCs for which such claims have been made and state whether or not you agree with the claim that no acceptable substitute exists. If you do not agree, please provide the name of the substitute and why you believe it to be acceptable.

   For some HFC uses it is not clear an adequate substitute currently exists. However, the AIM Act calls for a phase-down, not a phase-out. Thus, HFCs will be available for end-uses without adequate substitutes which will be for a minority of applications.

3. For HFCs where users claim that the current substitute is too expensive, based on the nation's previous experience transitioning from CFCs to HFCs, what do you believe will occur with respect to the price of HFC substitutes?

   Based on similar transitions, including from CFCs to HFCS, we expect that the AIM Act will put in place the very conditions that bring down costs of substitutes. By creating market certainty and incentivizing RD&D, the transition away from HFCs may very well be more rapid and lower cost than anticipated, as has happened with previous transitions from similar technologies.

EXTRUDED POLYSTYRENE FOAM ASSOCIATION

1280 National Press Building
529 14th Street, NW
Washington, DC 20045
Phone: (202) 591-2466
Fax: (202) 591-2445
Website: www.xpsa.com

Answers to Questions for the Record for the Extruded Polystyrene Foam Association, provided to Senate Committee on Environment and Public Works as part of Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
Submitted April 29, 2020

Michael Taylor
Executive Director
Extruded Polystyrene Foam Association (XPSA)
529 14th Street NW, Suite 1280
Washington, DC 20045
Direct: (202) 207-1113
Mobile: (703) 623-8995
mdtaylor@xpsa.com
mdtaylor@kellencompany.com

Chairman Barrasso:

1. Can you explain why it is important to have sufficient lead time to implement a phasedown of HFCs?
    a. Changing the blowing agent used in the manufacturing of XPS would likely change the following performance characteristics of the XPS insulation:
        i. Thermal performance of the insulation (R-value per inch of thickness).
        ii. Density of the foam to achieve the desired thermal performance.
        iii. The fire performance of the XPS insulation; and
        iv. Water vapor permeability.
    b. Once the initial development phase is completed the BA solution must be qualified against various customer fitness-for-use criteria (XPS product standards and custom test-protocols) and certified by various regulatory agencies (Underwriters Labs, Factory Mutual, Product Standards Testing Agencies and Building Code authorities). Finally, the entire existing product-line must be replaced in the supply-chain (retail, dealers etc.) and labelled to meet Country and State labeling requirements before it is available for final sale.
    c. Concurrent with the qualification process, the cost impact of using alternative BAs and associated market challenges need to be assessed and addressed. Product containing new BAs are likely to be more expensive to manufacture than product with existing BAs, and using

1280 National Press Building
529 14th Street, NW
Washington, DC 20045
Phone: (202) 591-2466
Fax: (202) 591-2445
Website: www.xpsa.com

multiple BAs creates manufacturing challenges, marketing challenges and market disruption for XPS manufacturers. A reasonable phase out period for HFCs will significantly reduce these impacts.

   d. Additionally, the XPS industry is particularly sensitive to the issue of timing presented by proposed regulations. XPS foam is sold primarily in large, lightweight board stock forms, as this product design maximizes efficiency for shipping and usability in construction applications. However, since the boards take up considerable shipping space due to their size and shape, XPS materials must be produced close to their eventual point of sale. As a result, the XPS industry's production infrastructure is decentralized and our supply chains are very complex. A patchwork of state HFC regulations could cause major logistical issues for our industry. Introducing new product types made without the proposed prohibited HFCs for some markets but not others will further complicate an already intricate supply chain, and impose serious limitations on our member companies' ability to provide XPS products to the construction industry.

2. In a letter previously submitted to the Committee, attached here, XPSA presented information about requirements that apply in some states. In which states do these requirements apply and why are these requirements unattainable for your industry?
   a. There are currently 15 states taking action on HFCs. These are California, Washington, Vermont, New Jersey, Delaware, Maryland, Pennsylvania, Hawaii, Maine, New York, Massachusetts, Colorado, Oregon, Rhode Island, and Connecticut.
   b. Of these 15, two states have finalized their HFC regulatory process. Those two are California and Washington.
   c. Two other states have passed legislation, and are in the process of completing their regulatory actions. Those states are Vermont and New Jersey.
   d. There are an additional 11 states with "proposed" actions in various phases of completion. Ten of these have started the HFC legislative or regulatory process: DE, MD, NY, ME, CO, OR, RI, MA, HI, and PA. One of them, Connecticut, has announced that they plan to address the HFC issue but has not yet taken any specific actions.
   e. While the specific HFCs banned in the various states are similar across the board, the states are also adopting labelling and reporting requirements which are not standardized.
   f. Additionally, EPA's SNAP rules were not meant to be a static "snapshot" – EPA adds and removes substances from the SNAP lists as its knowledge about the environmental and health impacts of listed alternatives and available substitutes evolves. Adopting SNAP as it was on a single date (1/3/2017) does not allow the

1280 National Press Building
529 14th Street, NW
Washington, DC 20045
Phone: (202) 591-2466
Fax: (202) 591-2445
Website: www.xpsa.com

inclusion of new EPA approvals that came after that date. While some state laws have a provision directing their environmental regulatory departments to follow the listing of new blowing agent products approved by EPA, others do not require this. In those states that currently have published legislation on this issue, the most common legislative solution adopted has been to refer to the list of restricted HFCs from the SNAP rules *as they read on January 3rd, 2017*, and to leave the process of regulating or approving any substitutes for these restricted HFCs up to the respective states' departments of environment.

g. This is a very serious issue because it creates inconsistency in the potential formulations that will be allowed for XPS foam in each state. Some may allow new formulations based on a potential new EPA listing, whereas others will only allow formulations based on the old SNAP 20 and 21 rules (with a list of allowable substitutes developed independently by their regulatory bodies). Still other states will allow a product with an unchanged formulation.

h. In addition, because regulatory specifics and processes are different from state to state, there are further inconsistencies in actual ban dates. Additionally, they are not providing a consistent amount of lead time for conversions. Some states with HFC regulations in the pipeline will only publish final regulations after other states have already reached their ban dates. The most common ban date so far seen has been January 2021, but it seems likely that most states currently working on their HFC regulations will not finalize them before that date.

i. A smooth transition away from the banned HFC substances is therefore a serious difficulty without a single federal standard which XPS manufacturers can adhere to. There is also a lack of certainty when states are left as the lone regulators in this sphere, as there is no federal standard in place to preclude some states from eventually introducing new regulation banning whatever HFC alternatives XPS manufacturers are forced to move towards.

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

3. In your testimony supporting the AIM Act on behalf of the Extruded Polystyrene Foam Association, you expressed concern that, "wholesalers and retailers of XPS with multi- state operations would have a challenging time dealing with the supply chain issues of multiple products using different technologies" and you note that, "This supply chain complexity will ultimately increase the consumer cost of the product across the patchwork of states which could lead to use of less robust and energy efficient building insulations."

   a. Please provide the data, methodologies, assumptions, and other details of your analysis to support your assertion that, "wholesalers and retailers of XPS with multi- state operations would have a challenging time dealing with the supply

XPSA
EXTRUDED POLYSTYRENE FOAM ASSOCIATION

1280 National Press Building
529 14th Street, NW
Washington, DC 20045
Phone: (202) 591-2466
Fax: (202) 591-2445
Website: www.xpsa.com

chain issues of multiple products using different technologies" and please describe in detail what are those challenges.

a. Because some states are adopting regulations modelled on the remanded EPA SNAP rules 20 and 21 as they were on January 3rd, 2017, and other states are not adopting such regulations, there are at least two potential formulations of XPS which could be sold in the future. Additionally, the states are adopting labelling and reporting requirements which are not necessarily consistent. The burden would be on retailers to ensure that they are buying the type of XPS which is legal for sale and usage in their own jurisdiction and is labelled in a way that complies with their local labelling requirements. Retailers would also need to ensure that any formulation they sell complies with ASTM standards and relevant building codes.
b. Without intimate knowledge of how building products retailers handle their inventories, it is impossible to provide specific data or projections on how this will actually impact specific retailers. However, transportation of a product like XPS board stock is logistically complex due to the bulky nature of the product, which means that XPS supply chains are distributed rather than centralized. This makes sourcing the product in an economic fashion a challenge even in a scenario without differing regulatory standards in neighboring states. A state patchwork of regulations, which is what is developing under the status quo, would transfer the burden of compliance with regulations to the retailer/wholesalers who are selling XPS. Many of these retailers sell our product in multiple states. To have them selling one product in one state and a different product in a different state could add significant logistical complexity to their supply chains. Additionally, there is a serious question surrounding who would be legally liable should a product which is legally purchased in one state be taken across state lines to a jurisdiction where HFC restrictions have been passed.
c. Here is a hypothetical scenario to further illustrate our concerns:
    i. Factory A in Kansas produces XPS which supplies the markets in Kansas and surrounding states, specifically Colorado, Nebraska, and Oklahoma.
    ii. Colorado has proposed regulation which would ban the use of certain HFCs in XPS foam insulation end-uses. Nebraska, Kansas, and Oklahoma have no such regulations.
    iii. A change in formulation predicated by regulations would require retesting of a product, and a new formulation could require significant changes to the manufacturing process of the product. All of these changes would likely increase the base cost of the product to manufacture. Since retesting is expensive, and since increased cost of an end product may impact how much of it will be sold, manufacturers have a serious incentive to ensure that product

EXTRUDED POLYSTYRENE FOAM ASSOCIATION

1280 National Press Building
529 14th Street, NW
Washington, DC 20045
Phone: (202) 591-2466
Fax: (202) 591-2445
Website: www.xpsa.com

formulation changes only occur in jurisdictions where they are legally mandated.

iv. In the scenario described above, then, Factory A will need to re-tool product lines to produce two very different types of products. Vendors who previously loaded a single trucking fleet to carry product to all four states will now need to devise a system by which they can ensure that only Colorado-compliant product is shipped to retailers in Colorado, but that the product shipped to Nebraska, Kansas, and Oklahoma retail locations is the traditional formulation approved for use by the building codes adopted in those states.

v. Additionally, retailers with locations near state lines would need to somehow ensure that they are selling product which can be used in both jurisdictions. If the "new" Colorado compliant formulation is eventually able to meet codes standards which apply in the other states, this will not be as significant an issue, but during the period of retesting and verification required to ensure standards compliance, the "new" Colorado compliant product would not be valid for use in jurisdictions which mandate the usage of a building code compliant product in new construction.

vi. Retailers in the other states bordering Colorado would also need to be careful to ensure they are not potentially allowing Colorado end-users from across the state line to purchase XPS insulation which is not compliant with Colorado's HFC regulations.

vii. Now suppose Factory B in California supplies product to California, Oregon, Washington, and Nevada. As it is located in a state with strict HFC regulations, Factory B now manufactures a single product line, one which complies with California's regulations. An XPS retailer in Reno, NV would have to make the choice between purchasing the inevitably more expensive California-compliant product, which may or may not comply with building codes, or having a "regular", code compliant product trucked in at increased expense from the nearest alternative factory.

b. Please provide the data, methodologies, assumptions, and other details of your economic analysis to support your assertion that, "This supply chain complexity will ultimately increase the consumer cost of the product across the patchwork of states which could lead to use of less robust and energy efficient building insulations."

    a. The association does not collect this type of economic data, however, the assumption behind this assertion is that even a marginal increase in the cost of producing XPS products would logically be transferred from manufacturers to vendors, from vendors to retailers, and from retailers to consumers

XPSA
EXTRUDED POLYSTYRENE FOAM ASSOCIATION

1280 National Press Building
529 14th Street, NW
Washington, DC 20045
Phone: (202) 591-2466
Fax: (202) 591-2445
Website: www.xpsa.com

b. When considering the economic impact of this cost increase, it is valuable to consider how insulation is used. A small difference in the "per square foot" cost of competing products is magnified significantly when looking at the cost of properly insulating an entire building. Building assemblies can encompass thousands of square feet. A slight price difference per square foot between product A and product B could ultimately become a matter of hundreds or even thousands of dollars difference in the end cost of the building. Therefore, any marginal increase in the cost of an XPS product makes it less competitive with other insulation alternatives, although it is higher performing as compared with many insulation alternatives. The majority of XPS business today is for wall applications which would be particularly vulnerable to alternative types of insulation if the cost of XPS insulation increases substantially. XPS would likely retain floor and roof applications due to the high compressive requirements for which XPS board stock is ideally suited, however the loss of production volume for wall applications would impact the manufacturing efficiency for all remaining XPS business.

c. XPS has a higher R-value than many competing insulation products, which gives it a competitive edge in terms of insulation performance. However, that edge will be mitigated by increased costs. When the difference in costs is significant, developers, architects, and building owners will be less likely to choose the better-performing but more expensive insulation product when producing and approving building specifications. This will be especially true for applications where XPS's other advantages, such as moisture and corrosion resistance, are less critical. The knock-on effect of this is that more buildings will be constructed with less effective insulation, and the beneficial impacts of insulation on collective energy efficiency will be reduced.

d. This is significant because insulation is a key lever for improving energy efficiency.[1] Because heating accounts for 80% of the building sector's energy consumption, energy efficiency increases provide significant energy savings globally.[2] Furthermore, it is reported in the recent C-40 & McKinsey report titled *Focused Acceleration: A strategic approach to climate action in cities to 2030* that "optimizing energy efficiency in buildings could yield 3X the reduction potential from current trends in meeting their Paris Agreement targets."[3] Other independent reports point to similar findings, showing that high performance insulation products can

---

[1] Energy Efficiency: A Compelling Global Resource. McKinsey Sustainability & Resource Productivity. McKinsey & Company, 2010. Page 21. Last viewed on June 6, 2018. Downloadable online at https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/Sustainability/PDFs/A_Compelling_Global_Resource.ashx

[2] Energy Efficiency: A Compelling Global Resource. McKinsey Sustainability & Resource Productivity. Page 23.

[3] Focused Acceleration: A strategic Approach to Climate Action in Cities to 2030. Joint Report by McKinsey Center for Business & Environment & C40. November 2017. Last viewed on June 6, 2018. Downloadable online at https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/a-strategic-approach-to-climate-action-in-cities-focused-acceleration

EXTRUDED POLYSTYRENE FOAM ASSOCIATION

1280 National Press Building
529 14th Street, NW
Washington, DC 20045
Phone: (202) 591-2466
Fax: (202) 591-2445
Website: www.xpsa.com

significantly aid in efforts to meet environmental goals.[4] [5] [6] XPS insulation is a high-performance insulation product, and as such, should be evaluated in light of the overall effect it has on energy use and environmental issues.

e. One study on the life cycle of XPS products found that XPS insulation as currently formulated prevents at least 28 times more greenhouse gas emissions than are generated in producing it.[7] Since HFCs used as blowing agents in the product have an impact on the product's thermal performance, product formulation changes aimed at removing HFCs from the product could reduce the degree to which XPS insulation used in construction reduces overall GHG emissions. Additionally, formulation changes which result in a more expensive product could reduce the degree to which XPS is used in the competitive construction marketplace, leaving a niche opening which cheaper but less effective insulation products may fill. Therefore, any formulation change must not only meet performance characteristics and standards required for the product, but also mitigate these risks.

f. It is difficult to speak in more specific terms without revealing proprietary information about product formulations, which XPSA members do not make public and have not provided to the association. Information about pricing and market share is also not available to the XPSA, so the above analysis must necessarily be understood to be general in scope and based on reasonable assumptions and generalizations. This analysis is not based on specific data, which could not be easily anonymized due to the small number of XPS manufacturers active in the United States.

4. In your testimony, you stated "we ask that you modify S.2754 to eliminate the potential for much inconsistency at the state level for HFC regulations impacting the XPS industry." Since the AIM Act authorizes EPA to regulate end-uses of HFCs, but does not set national end-use targets, nor does the legislation require EPA to take action, how do you recommend the legislation address these concerns? Is there agreement within your organization on the legislative changes that need to occur?

   a. There is agreement on the conceptual framework. XPSA members agree that an inconsistent regulatory standard across the United States is sub-optimal and will cause significant disruption to supply chains. The members are also collaborating to advocate for alignment at the state level, specifically concerning the individual programs and labelling requirements. XPSA members believe that S. 2754 can help encourage greater regulatory

[4] "Insulation" Webpage, Energy Saver, Office of Energy Efficiency & Renewable Energy, Department of Energy. Last viewed on June 6, 2018. https://www.energy.gov/energysaver/weatherize/insulation

[5] Life Cycle Greenhouse Gas Emissions Reduction From Rigid Thermal Insulation Use in Buildings M.H. Mazor, J.D. Mutton, D.A.M. Russell, G.A. Keoleian, J. Ind. Ecology, 15, 2, pp 284–299, April 2011.

[6] Building green with energy-efficient materials: Insulation. United States Green Building Council. Sep. 7, 2016. Last viewed on June 6, 2018. https://www.usgbc.org/articles/building-green-energyefficient-materials-insulation

[7] Life Cycle Greenhouse Gas Emissions Reduction From Rigid Thermal Insulation Use in Buildings M.H. Mazor, J.D. Mutton, D.A.M. Russell, G.A. Keoleian, J. Ind. Ecology, 15, 2, pp 284–299, April 2011.

XPSA
EXTRUDED POLYSTYRENE FOAM ASSOCIATION

1280 National Press Building
529 14th Street, NW
Washington, DC 20045
Phone: (202) 591-2466
Fax: (202) 591-2445
Website: www.xpsa.com

alignment in the states and will continue to propose ideas for achieving that goal.

5. Of the HFC compounds that are being used by your member companies, on average how much does the industry use on an annual basis (in tons and GWP-weighted tons) now?
    a. This information is proprietary to our manufacturer members and has not been made available to the XPSA.

6. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your member companies on an annual basis?
    a. This information is proprietary to our manufacturer members and has not been made available to the XPSA.
    b. However, analysis by other groups has consistently indicated that refrigeration, air-conditioning, and heat-pump applications account for the majority of the HFCs used globally. In 2015, the UNEP Ozone Secretariat, in analyzing data from 2012, found that the air-conditioning and refrigeration industry accounted for 86% of the total "GWP-weighted tonnes of CO2 equivalent" HFCs. Foams, a broad category of which XPS is only a portion, constituted only 7%.[8]

7. Do you project HFC usage will grow or shrink over the next 15 years?
    a. XPSA cannot make prognostications about HFC usage by other industries, and most HFCs in the United States are likely used in non-XPS applications
    b. Speaking of the XPS market specifically, which is a small user of HFCs, as described above, assuming that the status quo holds and no further HFC-reduction legislation is advanced in the United States, then the growth or shrinkage of the XPS industry's HFC usage will be predicated on individual companies drive towards lower-GWP blowing agents, and on the demand for XPS in the US building products market.
    c. We project that HFC usage by the XPS industry will likely decline as manufacturers shift to lower GWP solutions. XPSA members have plans to lower the GWP values of their XPS products in the coming years, as the industry is committed to sustainability, energy efficiency, and carbon-neutrality goals. These lower-GWP solutions may or may not be HFC products, since it is possible that innovation could occur within the HFC realm and new, lower GWP molecules could be introduced. However, the net

[8] UNEP Ozone Secretariat Workshop on HFC management: technical issues Bangkok, 20 and 21 April 2015 FACT SHEET 2 Overview of HFC Market Sectors page 4. Last viewed on April 21, 2020. Downloadable online at http://conf.montreal-protocol.org/meeting/workshops/hfc_management-02/presession/English/FS%202%20Overview%20of%20HFC%20Markets%20final.pdf

EXTRUDED POLYSTYRENE FOAM ASSOCIATION

1280 National Press Building
529 14th Street, NW
Washington, DC 20045
Phone: (202) 591-2466
Fax: (202) 591-2445
Website: www.xpsa.com

result, and the commitment of the industry as a whole, is the reduction of the GWP footprint of XPS products.

d. Since XPS is a relatively expensive, premium insulation product, XPS sales could be impacted both by increasing energy-efficiency requirements in the building codes, and by an overall decrease in commercial building projects due to the projected economic impact of the 2020 coronavirus pandemic.
e. Increased energy-efficiency requirements could drive up demand for premium insulation like XPS, which could lead to an increase in XPS sales and potentially XPS production.
f. However, if the 2020 coronavirus pandemic impacts construction markets in the same way the 2008 financial crisis did, a reduction in the number of new commercial and residential construction projects seems likely. Additionally, cheaper but less efficient insulation may be more appealing to those constructing new buildings during this period, which may reduce demand for premium insulation products like XPS. This will be doubly true if there are indeed cost increases, as discussed above, due to formulation changes. XPS is a high performing insulation in terms of thermal value and structural integrity (moisture resistance, compressive strength, corrosion resistance etc.), which makes it a compelling choice when examining cost savings over a building's lifetime. However, competing products may be more appealing in a period of economic distress, due to lower up-front costs. This may hold true even if competing products are not be able to provide the same performance, as developers will be looking for ways to save costs *now*, and may not consider the cost savings XPS could provide over a building's *entire lifetime*.

8. Have your companies considered using HFC-alternatives? If not, why not? If so, please provide details of your efforts to develop or find substitutes for HFCs and if there is there anything about those alternatives that cause concern for future compliance with the bill.
    a. All member companies participate in R&D projects that are proprietary and all have different processes. Exact information concerning blowing agent research and development is proprietary to our manufacturer members and has not been made available to the XPSA. However, some XPSA members manufacture and/or sell XPS in Canada, which has a clear national regulatory framework in place to advance specific GWP-reduction goals. Consequently, it is likely that HFC alternatives have been evaluated in member R&D programs in order to achieve these GWP-reduction targets.
    b. XPSA is also aware in a general sense of certain challenges that exist in moving away from HFCs in XPS products. These challenges include flammability issues with alternative chemicals, the previously described cost increases which could make the product uneconomical to produce, and the aforementioned issues with producing a "new" XPS formulation that

XPSA
EXTRUDED POLYSTYRENE FOAM ASSOCIATION

1280 National Press Building
529 14th Street, NW
Washington, DC 20045
Phone: (202) 591-2466
Fax: (202) 591-2445
Website: www.xpsa.com

could meet 3rd party product testing standards without the use of HFCs in the product.

c. It is XPSA's belief that all XPS manufacturers are at least *considering* HFC alternatives due to the uncertainty of the regulatory landscape at the state and federal level.

9. Prior to 1990, there were over sixteen states that had taken action, or were in the process of taking action, to restrict the use of Chlorofluorocarbons (CFCs). In the Clean Air Act Amendments of 1990, Congress created a federal program to phase out CFCs in Title VI of the Clean Air Act. Rather than preempting state actions, Congress preempted the enforcement of state CFC regulations for two years. Once EPA had a strong CFC federal program in place, the state programs for the most part went away on their own. Why specifically do you expect states will act differently in terms of HFCs if a federal regulatory program is created? Given the history why should HFCs be treated differently than CFCs in terms of state preemption?
    a. XPSA members are not familiar with the state programs in place prior to passage of Title VI. The two year enforcement preemption in Title VI only addressed state or local requirements concerning the design of any new or recalled appliances using CFCs. XPS and other ridged foam insulations were not included in this provision of Title VI, so XPSA has no historical perspective to rely on when it comes to predicting future state action. We do know that the political climate is very different today than it was in 1990. In 1990 the US was a signatory to and a significant participant in the Montreal Protocol addressing the threat to stratospheric ozone. There is no similar Federal motivation to address climate change. This makes it difficult to assess how states will react to a Federal regulatory program that does not explicitly create nationwide consistency regarding HFC use in XPS insulation products.
    b. Also, it is worth pointing out that the above assessment within question 9 seems to be suggesting that the CFC phase out was successful at least in part because the federal government *did* preempt the *enforcement* of a patchwork of state regulations, which likely would have caused chaos in a similar fashion to the current status quo on HFCs. The XPS industry at present has no such federal protection to prevent the states from enforcing HFC regulations, which would provide additional time for a clear federal regulatory solution.
    c. From a historical perspective, XPSA members have indicated to XPSA that the CFC phase-out also had a much smaller projected impact on product costs than the anticipated impact of a change from HFCs to HFC alternatives like HFOs. Economically feasible alternatives to CFCs were available for many businesses, so the change did not cause a major shift in market dynamics. This is not currently true for HFCs in the status quo.

1280 National Press Building
529 14th Street, NW
Washington, DC 20045
Phone: (202) 591-2466
Fax: (202) 591-2445
Website: www.xpsa.com

d. Additionally, is it not at all clear that all states would fall in line with a federal regulatory framework (as suggested in the above CFC example) if the EPA were to develop an HFC program. Some states, having developed a preference for and experience with running their own EPA-like state agencies, may continue to implement additional regulations which are out of step with the federal EPA.

a. One of the issues that XPSA members have had with the HFC state patchwork is that, in absence of a federal regulatory solution, it is not clear whether and when certain states will eventually move to ban any HFC-alternative formula that XPS manufacturers may move to. It is also unclear whether and when states which currently have no plans to regulate HFCs may decide there is a need to do so. Federal regulatory standards are preferable because of their ubiquity. The lack of a ubiquitous regulatory standard and the uncertainty around what future actions state regulators may take have already caused significant problems for XPSA members. We hope that federal action may help to alleviate those problems by reducing uncertainty and inconsistency around this issue.

Contact: Benjamin Zycher
Mailing address: 15310 Sandridge Road, Long Beach, WA 98631-6311
Email: benjamin.zycher@aei.org
Phone: landline 360-665-2617 (pacific time zone); mobile 818-383-6499

Benjamin Zycher Responses to Questions for the Record from Chairman Barrasso and Senator Whitehouse on the Prepared Statement for the Record of Dr. Benjamin Zycher and Dr. Patrick J. Michaels on S. 2754, "American Innovation and Manufacturing Act of 2019"

Committee on Environment and Public Works
U.S. Senate

April 2020

Benjamin Zycher*

Introduction. This note offers responses to the questions posed by Chairman Barrasso and Senator Whitehouse attendant upon the prepared statement for the record of Dr. Benjamin Zycher of the American Enterprise Institute and Dr. Patrick J. Michaels of the Competitive Enterprise Institute on the proposed S. 2754, "American Innovation and Manufacturing Act of 2019."[1] The responses offered below are those of Benjamin Zycher only; Patrick J. Michaels may respond separately and independently.

Housekeeping Correction. The questions for the record were received by Benjamin Zycher as an attachment to an email sent on April 16, 2020 from Ms. Beth Lange of the staff of the Senate Environment and Public Works Committee. The heading on the attachment is "Questions for the Record for Dr. Zycher and Dr. Michaels, AEI." Please note for the record that Benjamin Zycher is a resident scholar at the American Enterprise Institute. Patrick J. Michaels is a senior fellow at the Competitive Enterprise Institute; he has no affiliation with the American Enterprise Institute.

Responses to Questions from Chairman Barrasso:

1. *Do you agree with the Air-Conditioning, Heating, and Refrigeration Institute's (AHRI) statement in its testimony that the bill will prevent, not encourage, monopolies?*

---

* Resident scholar, American Enterprise Institute. The views expressed are solely those of the author.

[1] That statement can be found at https://www.epw.senate.gov/public/_cache/files/c/1/c1f54e32-6643-4138-93c6-208d0fdada5d/C9DE8CAF5469D4ABBA941D24F2A81904.04.07.2020-dr.-benjamin-zycher-and-dr.-patrick-j.-michaels.pdf.

The AHRI argument about the prevention of "monopoly" is flawed analytically, as it amounts to an argument that competition would be strengthened by legislation that would restrict the market supply of one particular subset of substitutes (HFCs). That is a premise not to be taken seriously. AHRI argues as follows:

> Finally, there has been the suggestion that the AIM Act would create a "monopoly" for certain producers of HFC substitutes or otherwise afford insurmountable commercial advantages to a few large equipment manufacturers. In fact, the opposite is true. The AIM Act would accelerate the already healthy competition over HFC substitutes, which feature some new entries, including new technologies such as HFOs and HFO blends, and also a range of existing products, such as ammonia, carbon dioxide, hydrocarbons, and others – all of which have been available for decades. Moreover, the orderly transition created by the AIM Act will help smaller manufacturers remain competitive against larger firms. This is because, in a disorderly transition, these smaller companies will lack the resources to sustain duplicative product lines and be forced to operate in some regions and not in others due to the extra costs. Therefore, a disorderly transition, with no new federal standard, will be what leaves the United States with a commercial landscape where only large manufacturers can survive (and even then, a disorderly transition hurts large manufacturers, too).

This argument is utterly confused. To say that the AIM Act would "accelerate" the replacement of HFCs is to say that the Act would substitute a shorter transition period determined politically over a longer one driven by market competition, if indeed market forces can be predicted to engender a substitution away from HFCs, an assumption very far from obviously correct. (If the substitutes for HFCs are competitive in terms of cost, performance, and other relevant parameters, why is such legislation as AIM needed to "accelerate" "competition" that supposedly is "already healthy?") Whatever the merits of the AIM Act as a "climate" policy---as discussed in the Zycher/Michaels Statement, it would have a climate impact virtually undetectable---such transitions in resource allocation are costly in terms of resource consumption, and faster transitions are more costly than slower ones. It might be the case that some faster transitions are worth the extra costs economically, but as a general proposition it is market forces that can be predicted to balance in an unbiased fashion the marginal costs and benefits of such faster versus slower transitions.

AHRI attempts to obfuscate this basic truth about dynamic market adjustments by describing a market-driven transition as "disorderly" and a transition driven by AIM as "orderly." That characterization is preposterous. The market process of resource allocation and reallocation, driven by price incentives both current and anticipated, is not centrally planned; that does not mean that it is "disorderly," and only those harboring a profound misunderstanding of the operation of competitive markets can believe otherwise. The description of a policy-driven---that is, centrally planned---process of resource allocation as “orderly” is amusing in light of the last century of global experience. AHRI may or may not actually believe that market competition is a “disorderly” process; no one else should believe something so profoundly at odds with analytic rigor. I recommend that the Committee not allow such verbiage to obscure the central analytic issues.

It is the producers of substitutes for HFCs that would be the central beneficiaries of the AIM Act generally, and the holders of patents on such substitutes in particular. Honeywell and Chemours are prominent among the latter; their substitutes are substantially more costly than HFCs, as discussed below, and AIM would exacerbate that disparity by restricting the supply of HFCs. AHRI argues that there already exists “healthy competition over HFC substitutes, which feature some new entries, including new technologies such as HFOs and HFO blends, and also a range of existing products, such as ammonia, carbon dioxide, hydrocarbons, and others – all of which have been available for decades.” Well then: Why is AIM needed? Why have the substitutes for HFCs not been adopted widely as a result of that “healthy competition?” Obviously it is because they must be afflicted with cost or other disadvantages; and the standard climate/externality response is incorrect because AIM would do effectively nothing to address any such externality even under the assumption that it is important.

Also preposterous is AHRI’s assertion that AIM would aid smaller producers of refrigerants by limiting the range of products that they would have to produce. Suppose hypothetically that legislation were to limit the legal range of refrigerants to a single type, whether or not protected by a patent held by some given producer. Would that environment make other producers, whether large or small, better off? Of course not: Producers specializing in the production of HFCs cannot be made better off by constraining their market opportunities; they can always choose not to produce some subset of competitive products. It is both production costs and sales revenues that are relevant.

AHRI argues as well that “in a disorderly transition, these smaller companies will … be forced to operate in some regions and not in others due to the extra costs.” The meaning of “extra costs” in the AHRI discussion is wholly unclear, but the most reasonable interpretation from the AHRI “monopoly” discussion quoted above is that the “extra costs” are those engendered by the purported need to “sustain duplicative product lines.” All producers must incur “extra costs” for production of a range of products broader rather than narrower, and an offering of a broader range of products yields both increased costs and increased sales revenues. Is there a reason to believe that the multi-region cost/revenue relationship is systematically less favorable for smaller producers than is the case for larger ones? AHRI offers no justification for any such assumption---perhaps it does not understand its own argument---but it cannot be the case that smaller producers receive lower prices for a standardized product (refrigerants) than that received by larger ones. Accordingly, if the cost/revenue relationship systematically is worse for the smaller producers, that condition must be caused by scale economies, that is, a cost advantage enjoyed by larger producers. But AHRI already has told us that small producers compete in the market alongside larger ones, a reality that demonstrates the unimportance of scale economies or diseconomies. The AHRI argument refutes itself.

Moreover, not every producer has to produce every substitute in a given application, and there is no reason that different competitors, again whether large or small, cannot specialize in the production of a subset of those substitutes. If one were to argue that producers cannot compete effectively without offering a full range of the relevant products, the smaller ones could purchase one or more on the wholesale market for resale to their respective customers. Or we might observe mergers among producers specializing in different segments of the overall market. Again, the AHRI reference to "smaller manufacturers" in the passage quoted above suggests that smaller ones coexist successfully in the market alongside larger ones; that means that scale economies or diseconomies are not important. In short, the AHRI argument about smaller producers is not to be taken seriously.

At a more basic level, the "monopoly" argument is confused because the very concept of "monopoly" is far less concrete than many assume. The concept depends crucially upon the definition of the relevant market, a definition fraught with difficulty and subject to a number of biases driven by considerations political rather than analytic in nature. It is far more rigorous to view the "monopoly" issue as the change in the demand elasticity confronting a given producer as a policy change is implemented. A lower demand elasticity (in absolute value) yields greater pricing power. In that framework, the proposed AIM Act unambiguously would reduce competition by restricting the supply of HFCs, whether over a period longer or shorter, and thus would reduce the demand elasticity confronting producers selling the substitute favored by the legislation, in particular those with patents on the refrigerants so favored.[2] Producers specializing in the production of HFCs would be confronted with a decline in the demand for their products, that is, an increase in the demand elasticity that they face. If proposed legislation allows one set of producers to enjoy less elastic demand (greater pricing power) while afflicting other producers with more elastic demand (less pricing power), then the proposed legislation unambiguously would increase the "monopolization" of the market for refrigerants. That would be the effect of the AIM legislation, again unambiguously. Accordingly, the AHRI "monopoly" argument quoted above is fundamentally confused.

2. *AHRI states that the AIM Act will do away with the ongoing process known as "dumping," where overseas companies export inferior equipment to the U.S. at a price below the cost of manufacture. Do you agree with this claim? Why or why not?*

I have not conducted an analysis of the cost conditions characterizing the overseas production of refrigeration equipment and refrigerants. But any calculation of the "cost of manufacture" is vastly more complex than the prototypical "dumping" allegation assumes. Does "cost" mean average total cost? Average variable cost? Marginal cost? In the short

---

[2] On the issue of the time period over which competition from HFCs would be eliminated, see the Comments of the Competitive Enterprise Institute, April 6, 2020, at https://www.epw.senate.gov/public/_cache/files/b/2/b223f883-984b-4300-91b4-bbaaa952f58d/7589F18BE4F5A42BD2DDCCF961A2E9BB.04.06.2020-competitive-enterprise-institute.pdf.

run or long run? There are several conditions in strongly competitive markets that would lead sellers to ask for prices below "cost," depending on how "cost" is defined. An obvious example is a decline in demand conditions leading firms to charge prices lower than those that would compensate for all fixed costs. Another: the behavior of new entrants attempting to establish themselves in the market. How would the definition of "cost" be affected by shifting exchange rates? By supply chains crossing several international boundaries? The list of such complexities is not short. The central point here is that an allegation of "dumping" must be based, by definition, upon some calculation of "cost," and there exists no single methodology that is obviously correct for the choice among such alternative calculations.

With respect to the specific AHRI argument cited above: AHRI refutes its own "dumping" argument with its description of the foreign-made equipment as "inferior," a characterization that raises a number of questions. If indeed that foreign equipment is "inferior" in some sense, then it is unsurprising that it would command market prices lower than those received by the producers of purportedly superior equipment. Does the AHRI "dumping" assertion account for that lower market value? Moreover, an "inferior" product presumably is less costly to produce, for obvious reasons. Does the AHRI dumping assertion account for that?

In other words, the inferiority assertion by AHRI inescapably implies downward shifts in both demand and cost conditions for the equipment produced overseas. "Quality" is very difficult even to define, let alone quantify, and *a fortiori* for the definition and quantification of quality differences. AHRI in its "dumping" assertion pretends to know not only how to quantify "quality" differences, but also how to measure the downward demand shift attendant upon that quality differential. Moreover, it is very complex to calculate "costs" for a standardized good, even if we can agree upon a given definition; the calculation of a cost difference driven by a quality differential is ever-more difficult. The AHRI "dumping" and "inferiority" assertions taken together amount to a claim by AHRI that it knows the competitive price effect of a simultaneous shift in both demand and cost conditions. This implicit claim is both disingenuous and preposterous; it is not to be taken seriously.

3. *Can you elaborate more on the "broken windows fallacy" and why this impacts the environmental benefits of the AIM Act?*

The broken windows fallacy takes several forms, but in the context of the AIM Act it is the assertion that a mandated shift from existing refrigerants to new ones, on a timetable faster than that driven by market forces, would yield stronger economic growth and an economy larger in real terms, greater employment, and so forth, than otherwise would be the case.[3] These beneficial effects would be the result of new investment, a

[3] The illusory nature of these economic benefits is discussed in section IV of the Zycher/Michaels Statement.

purported artificial competitive advantage for domestic producers resulting from the favoritism engendered by the legislation, and similar processes of economic adjustment.[4]

This general assertion is incorrect, because it does not account for the economic costs of the (faster) transition, in particular the destruction of some or all of the economic value of the existing capital stock specializing in the production and use of equipment and refrigerants that would be reduced by the supply restriction of HFCs attendant upon AIM. When a window is broken, the individual hired to replace it, and his suppliers, etc., are better off. But the resources used to replace the broken window are available no more for use in other sectors. The broken window unambiguously is a net cost for the economy writ large.[5] AIM would destroy the economic value of some substantial part of the refrigerant-producing and -using capital stock, including some portion of the stock of human capital (expertise) specializing in the refrigeration subsector oriented toward HFCs; it must make the economy smaller in real terms unless it were to yield environmental or other benefits greater than that economic loss.

The environmental benefits of AIM would be illusory, as discussed in the Zycher/Michaels Statement, because the climate impacts of the AIM-driven replacement of refrigerants would be virtually unmeasurable. Note clearly that this reality is independent of the assumptions one might adopt on the science and evidence of anthropogenic climate change. Accordingly, under a broken windows justification for AIM, the absence of environmental benefits might be offset by economic benefits; but that justification is false.

4. *Is it true that the replacements for HFCs are more expensive than their counterparts? What impact will this have on the consumer?*

Of course that is true. Any producer, whether domestic or foreign, is free to produce refrigerants without (purported) climate impacts and to offer them for sale, and the absence of the AIM Act has no effect on that condition. That such refrigerants are not sold widely is *prima facie* evidence that they are more expensive and/or that they carry with them parameters that yield consumer disadvantages relative to HFCs. The central purpose of AIM is to reduce or prevent competition from HFCs, an outcome that can be predicted with high confidence to increase consumer costs. An example: HFC-134a sells currently for less than $7 per pound. HFO-1234yf, a patented replacement (Honeywell), sells currently for about $55 per pound.[6] Note that if AIM is enacted, this cost differential is certain to increase

[4] Note that the purported competitive advantage assumes a global demand shift toward the refrigerants favored by the legislation. This assumption is deeply dubious, because, as discussed below, the substitutes for HFCs unambiguously are more substantially more costly than HFCs---Why else would legislation be needed?---and it is very safe to assume that the international demand for (or choices among substitute) refrigerants will be driven heavily by cost differentials.

[5] See the classic essay by Frédéric Bastiat, "What Is Seen and What is Not Seen," at https://www.econlib.org/library/Bastiat/basEss.html?chapter_num=4#book-reader.

[6] See, e.g., respectively, https://www.refrigerantdepot.com/product/r-134a/ and https://www.refrigerantdepot.com/product/honeywell-hfo-1234yf-10-lbs-free-shipping-refrigerant-depot/.

because the central purpose of AIM is to restrict the demand for and supply of HFCs, thus increasing the market power enjoyed by the producers of substitutes for HFCs.

5. *An industry report entitled, "Consumer Cost Impacts of U.S Ratification of the Kigali Amendment: Report Prepared for the Air-Conditioning, Heating, and Refrigeration Institute and the Alliance for Responsible Atmospheric Policy," assumes on page 30 an average increase in consumer purchase costs of 10% for equipment using HFC replacements. Do you believe language should be added to ensure the bill appropriately considers increases in consumer costs when setting regulations under the AIM Act?*

I oppose enactment of the AIM Act regardless of whether it were to contain such language, as the proposed Act would inflict significant economic costs upon the U.S. economy in the aggregate while engendering environmental effects effectively equal to zero. Such legislative language included in an attempt to constrain the analytic efforts of the regulatory agencies is unlikely to produce adverse effects, but I do not believe that such language would yield salutary outcomes. The processes of regulatory impact analysis by regulatory agencies are highly susceptible to the use of assumptions, methodologies, and procedures yielding net benefit calculations driven by political imperatives rather than aggregate economic or consumer wellbeing.[7] It would be difficult at best for the Congress to monitor and to constrain such agency behavior with or without such legislative language.

Responses to Questions from Senator Whitehouse.

6. *It has been reported that you were paid by the Intermountain Rural Electric Association to combat "climate alarmism" and that you regularly met with Koch Industries and the Competitive Enterprise Institute to coordinate your work in this domain.*

I have never received any payments from the Intermountain Rural Electric Association for any purpose; and I am certain that I have never communicated with any of its officials or staffers. I have not "met with Koch Industries," and the meaning of that phrase is wholly unclear in any event. I do speak once or twice a year with the energy/environment expert at the Charles Koch Institute for the purpose of exchanging ideas. I speak regularly with several individual experts at the Competitive Enterprise Institute on a wide range of topics in energy and environmental policy; the same is true for other experts in academia and at research institutions. I often send drafts of writings to various individuals for comment, and they do the same with me. I do not "coordinate" work with them---my work is wholly self-directed---but the original impetus for the Zycher/Michaels Statement was an inquiry from a CEI staffer as to whether I would be

[7] For a detailed discussion of this problem in the context of climate policy and the social cost of carbon, see Benjamin Zycher, "The Social Cost of Carbon, Greenhouse Gas Policies, and Politicized Benefit/Cost Analysis," *Texas A&M Law Review*, Fall 2018, at https://scholarship.law.tamu.edu/cgi/viewcontent.cgi?article=1154&context=lawreview.

interested in writing an economic analysis of the industry arguments in favor of the Kigali Amendment to the Montreal Protocol.

7. *You have also admitted that 40 percent of your research is funded by the petroleum industry. So that this Committee may fully understand the interests behind your testimony, please disclose all the ultimate sources (i.e., the original source as opposed to a pass through entity such as Donors Trust or an LLC) of your funding over the last five years and the amount of their donations.*

I have never "admitted that 40 percent of [my] research"---or any other quantitative characterization---"is funded by the petroleum industry," and any such statement would be false.

8. *Please disclose a list of all individuals and organizations with whom you discussed your testimony.*

During the preparation of the Zycher/Michaels Statement, I discussed the various topics to be addressed with my co-author, Patrick J. Michaels, and with Myron Ebell and Ben Lieberman, both staff experts at the Competitive Enterprise Institute who have developed substantial expertise on the policy issues attendant upon the proposed AIM Act.

I do not know what it means to "discuss" something with an "organization."

The Alliance
for Responsible Atmospheric Policy

April 29, 2020

The Honorable John Barrasso
Chairman
Committee on Environment & Public Works
United States Senate
Washington, D.C. 20510

The Honorable Thomas Carper
Ranking Member
Committee on Environment & Public Works
United States Senate
Washington, D.C. 20510

Dear Senators Barrasso, Carper, Capito, Whitehouse, and Committee Members:

On behalf of the Alliance for Responsible Atmospheric Policy, I am pleased to provide these responses to the Questions for the Record which you have sent to us. We appreciate the time and attention you are giving to consideration of S. 2754, the AIM Act, and look forward to working with you on a version that can be completed by the Senate Environment & Public Works Committee and passed by the Senate. In addition, we are providing for the record the recent study by the Clean Energy Manufacturing Analysis Center (CEMAC) dated February 2020.

Please do not hesitate to contact us if you have any additional questions with regard to the information enclosed in these answers. Again we look forward to working with you and your staffs.

We also hope that in this time of concern with the coronavirus that you are staying safe and well.

Best regards,

Kevin J. Fay

Executive Director
Alliance for Responsible Atmospheric Policy

2111 WILSON BOULEVARD, 8TH FLOOR, ARLINGTON, VIRGINIA 22201
Phone: 703-243-0344 • Fax: 703-243-2874 • Web: www.alliancepolicy.org

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for the Alliance for Responsible Atmospheric Policy

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

1. How has the COVID-19 crisis impacted your member companies? What steps should the federal government consider taking to help your sector cope and recover from the COVID-19 crisis?

   Answer: The COVID-19 crisis has significantly reduced demand for our products. With employment soaring past 20%, our consumer base has effectively decreased by the same percentage. This decline has already resulted in furloughs and layoffs and this trend is expected to continue. Additionally, our industry has faced supply chain disruptions first from China and then from suppliers in Mexico. Domestic factories are now being impacted and may be forced to close as the lack of supplies is critical to continue domestic production.

   Our industry needs certainty with respect to maintaining its operations and supply lines in order to keep businesses open and functioning. The industries that rely on HFCs are critical to the comfort, safety, and productivity of our citizens, as well as maintenance of things such as food safety, energy efficiency, life safety, and other factors integral to the quality of life. The industries servicing the products and equipment we produce provide an essential service, so it is important that they be available to function in manner that ensures our product performance. Finally, certainty regarding a "return to normal" includes a testing regimen that allows us to maintain our workforce in our plants and in our businesses, maintains supply lines to our factories, maintain our service networks and ultimately, achieves a timely and safe reopening of our economy.

2. Some industry stakeholders have expressed the need to provide an exemption for a specific industry or specific HFC end-use because there currently lacks a safe or economical substitute or because of related issues, such as dated building codes.

   a. What could happen to the overall integrity of the phase down if Congress allowed broad industrial sectors exemptions from enactment, without changing any other sections of the legislation?

   Answer: We know of no "broad industrial sectors seeking exemption." The known exemptions account for well less than ten percent of the baseline. The phasedown schedule is designed to work in conjunction with the sectoral transitions provided for in Section 10 of the legislation, and ultimately if necessary, the use of the essential use exemption provision in Section 6. Requests for exemptions currently are based on assumptions of lack of availability of economically and environmentally effective substitutes and a presumption of regulatory decisions not yet made. Modeled after the Title VI program of the Clean Air Act, the AIM Act is derived from the experiences from three decades of implementation in the phaseout and transition from ozone depleting substances. Wholesale sector exemptions would upset the balance of the gradual phasedown schedule, which is designed to allow for timely user transitions, with the flexibility to consider specific user needs or substitute problems and would diminish the effectiveness of the refrigerant management efforts.

The biggest difference between the Title VI phaseout and the AIM Act phasedown is the 15% of baseline that is meant to serve uses that currently may not have substitutes. Based on the comments filed with the committee, a few users cited concerns on the state of the transition, but very few requested exemptions. Again, the Title VI experience is relevant, where essential use exemptions over the last 30 years, were primarily in the aerospace, defense, and metered dose inhaler uses, but never actually exceeded 1% of the ODS baseline. Based on the wide range of identified substitute compounds and technologies, both fluorinated and not-in-kind substitutes, it is apparent that a significant percentage of most user sectors already have multiple technology solutions available to them.

The AIM Act provides protection for the remainder: first with the gradual phasedown schedule, second with the 15% residual of baseline, third with the flexible authority contained in Section 10 on Technology Transition to develop flexible schedules and coverage, instead of an "on/off" approach, fourth with the emphasis on Refrigerant Management to ensure availability of reclaimed material that could be used for service of existing equipment or in ongoing specific uses that have not found an alternative, and fifth, with the essential use exemption process contained in Section 6.

b. The legislation phases down the production and consumption of HFCs but is not a phase out. Can you further explain why this should protect some sectors that may not have a safe or economic alternative during the timeframe of the legislation?

Answer: In addition to the detailed points above, we learned from the Title VI experience over three decades that the "phaseout" component was one of the most significant challenges to achieve cost-effective implementation. The phasedown schedule to 85% of baseline over 15 years was designed precisely to provide a cushion for those uses that may not currently have cost-effective technology options. Continued innovation by industry, sound judgment by EPA staff and dialogue with industry and environment groups will ultimately lead to options in the future, but in the meantime, this cushion provides flexibility to protect impacted industry, workers and consumers.

c. Can you further explain why the essential uses section should address these concerns and explain why it is important for the essential uses section to be available at the end of the phase down, rather than at the beginning?

Answer: Based on the wide array of technology solutions available, the 15% baseline residual should provide an adequate cushion for users concerned about ability to comply with the phasedown. In the current draft of the legislation, the essential use exemption does not begin until the end of the phasedown because of this substantial 15% residual. It is also assumed that with continued technology development and commercialization of alternatives over the next 15 years, most users who may believe they do not currently have an acceptable alternative, will likely have choices developed over this time period. As happened during the Title VI implementation, once the long-range goals are established, it is difficult to keep up with the pace of industry innovation. In order to address the concerns of those users, it may be helpful to start the essential use exemption process in the beginning in order to better identify the sectors who are concerned, well in advance of any final deadlines.

3. Prior to 1990, there were over sixteen states that had taken action, or were in the process of taking action, to restrict the use of Chlorofluorocarbons (CFCs). In the Clean Air Act Amendments of 1990, Congress created a federal program to phase out CFCs in Title VI of the Clean Air Act. Rather than preempting state actions, Congress preempted the enforcement of state CFC regulations for two years. Once EPA had a strong CFC federal program in place, the state programs for the most part went away on their own. Why specifically do you expect states will act differently in terms of HFCs if a federal regulatory program is created? Given the history why should HFCs be treated differently than CFCs in terms of state preemption?

   Answer: From our recollection, there were more than 20 states that quickly adopted CFC legislation in the early 1990s. Within a few years, these laws were irrelevant, particularly as the Federal implementation proved credible. To our recollection, no major state regulatory program on ozone depleting substances was adopted after the "enforcement pause" that was included in title VI of the CAA. We would expect a similar result with state HFC programs going forward if the AIM Act is adopted. As we have made clear, our goal is the adoption of a uniform Federal program.

   The reason that we have state programs today on HFCs is precisely because the Federal government has not provided what has been recommended and sought by industry, the environment community and a growing bipartisan list of policymakers. However, today we are in a hyper-partisan political climate with respect to environmental policy and the industry finds itself the pawn in the challenge between the federal government, state governments and the environment community. Ironically, the uniform federal program that is broadly supported by industry, is the quickest path to the greatest environmental benefit for the nation and the most cost-effective for industry, workers and consumers.

   The success of the Title VI program, and its global complement under the Montreal Protocol, was built on an environment of trust and credibility, action and successful implementation. There is no reason to expect any difference with these HFC initiatives. These policy options would not be before us today without the industry support that emerged from the previous Montreal Protocol successes and that were developed in cooperation with bipartisan Administrations.

Additionally, in our discussion with policymakers at the state level, the states would prefer not to have to spend resources on an environmentally beneficial program that can and should succeed at the federal level. The dominant theme expressed to industry in the conversation is "lack of trust" apparently applicable to the Federal and State governments, environment groups and industry alike. The success of these programs over the last 3 decades, and the credible response from the industries over that time period, provide no basis for "lack of trust." The industry recognized the environmental challenges, invested its own money in technology and solutions, announced its intent to resolve the problem around the globe by 2050, and lent its support for development of policy frameworks around the globe and here in the United States. If the industry can do all that it has done in the last decade and is committed to doing in the next 30 years, policymakers should also be able to find an acceptable bipartisan solution to the issue of preemption.

4. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your member companies on an annual basis?

   Answer: First to clarify, the 230,000-ton figure is not weighted according to the exchange values contained in the legislation. It is our understanding that the projected baseline for HFCs based on the definition in the legislation is the equivalent of 300 million metric tons of CO2. Alliance members account for more than 90% of the production and consumption of HFCs in the United States.

5. Are there any additional comments you would like to provide that you did not provide in your testimony?

   Answer: We would like to stress 2 critical points. First, the integration of the sections of the AIM Act is critical to its success and cost-effectiveness for industry and for American consumers. The allocation schedule in Section 6 contains the overall gradual phasedown and long-term market signal for the HFC transition. The technology transition provisions in Section 10 provide for flexible approaches for user sectors to identify appropriate schedules and timing for investment in transition activity. In many cases, this timing could be consistent with normal or typical design cycles and coordination with other programs, such as energy efficiency standards. The Section 10 emphasis on negotiated rulemaking process encourages a consensus-based approach where possible. The refrigerant management provisions in Section 9, provide assurance of HFC supply and utilization and protection for existing equipment owners. It also provides an additional "supply" safety-valve for those still in search of technology solutions, or may who absolutely may need an exemption at the end of the phasedown schedule in 2036. The experience in Europe, where extraordinary costs and disruption occurred at the beginning of the European F-gas program, demonstrated the flaws when a policy is implemented without careful integration such as the kind contained in the AIM Act.

The second point is to reiterate the critical importance of the Refrigerant Management program. More than 60% of "virgin" or newly produced (not reclaimed) refrigerant sales of HFCs is for aftermarket service. Our national capacity for refrigerant reclamation is woefully underutilized. The refrigerant management program should also be considered a safety-valve to remove stress from the phasedown schedule in the event of transition challenges for users. EPA estimates the current capacity for reclaim in the United States of at least 30 million pounds. This estimate is very conservative. At current rates, we are reclaiming less than 25% of that capacity. Much more can and should be done in this regard.

Several commenters expressed concern for the impacts on existing equipment, both commercial and residential. The AIM Act follows the longstanding practice from the Title VI programs and does not regulate the use of existing equipment. The policy principle is that all equipment owners will receive the full useful life of their equipment. To provide examples of this in practice, CFC-11 chiller sales ceased in the mid-1990s when production of CFC-11 refrigerant ceased. At the time of CFC 11 production cessation, there were more than 30,000 chillers in service, in 2005, there were nearly 20,000 CFC-11 chillers still operating. CFC-11 chillers are still being serviced, and reclaimers report that they are still recovering CFC-11 refrigerants from CFC-11 equipment today. Further, industry market survey information estimates that more than 20,000 HCFC-123 chillers were sold between the mid-1990s and 2019. It is estimated that 15,000 of those chillers are still operating today. In the residential sector, sales of R-22 unitary air conditioning systems (the type that cools homes or small businesses) ceased in 2010, and 10 years later, it is estimated that 39 million R-22 systems are still operating out of a national total of 139 million systems. These figures reflect typical market attrition rates for these products.

It is an effective refrigerant management program, including recovery, recycle and reclamation, that helps facilitate this insurance for existing equipment owners and much more can be done to improve this effort. Existing equipment and existing equipment owners are protected.

Senator Capito:

6. Mr. Fay, you say that HFCs "were perhaps the most thoroughly studied family of compounds ever introduced" at the time of commercialization. If so, why did industry call for the transition to HFCs, when they were known greenhouse gases with a high atmospheric warming potential? Has there been a comparable level of study of HFOs?

   Answer: In 1990, the environmental imperative was to achieve as rapidly as possible the transition away from ozone depleting substances. HFCs, which have a zero ozone depletion potential, offered that potential, plus had the benefit of meeting the requirements for safety, toxicity, flammability and performance. Also, at that time, there was only a cursory policy discussion on climate change and greenhouse gas emissions.

On that basis HFCs have been extraordinarily effective in the reduction of greenhouse gas emissions. As an example, HFC 134a is 85% better than the CFC it replaced (R-12). HFC 134a has a global warming potential of 1,300, while R-12 has a global warming potential of 8,000. This environmental benefit was widely understood and appreciated at the time. The transition from CFCs to HFCs and HCFCs during the 1990s achieved a reduction of greenhouse gas emissions of 80% or more, on average. That is why implementation of the Montreal Protocol and Title VI of the Clean Air Act have helped to heal the ozone layer, and are also the single most effective policies for reducing greenhouse gas emissions around the globe to date.

The climate change policy debate started in 1990, and with the urgency now being given to the issue, the fluorocarbon solutions that helped to save the ozone layer still have a relatively higher GWP than the unit of measure, carbon dioxide. That is also why the industry has worked for the last two decades to develop sustainable technology solutions as well as cost-effective policy mechanisms to achieve them. Today, the predominant substitute for HFC 134a is HFO 1234yf, and the 1,300 GWP of HFC 134a has improved to less than1 for HFO 1234yf.

7. You cite analyses that a uniform federal policy will create 33,000 US manufacturing jobs and improve the US trade balance by $12.5 billion. Did these analyses consider the net costs to manufacturers that use processes or produce goods for which there is no adequate alternative to HFCs? Do these analyses consider the trade balance and employment impacts outside of the primary chemical manufacturing and HVACR sectors?

   Answer: Yes. The analysis considers the net costs to manufacturers. In fact, many of these investment have already been made and are now a sunk cost awaiting a transition. Our independent economic analysis, performed by the University of Maryland (INFORUM) and JMS Consulting, is a macro-analysis not designed to consider specific transition costs for a particular use or sector. The analysis assumes the availability of alternative technology and solutions because the availability of these alternatives is already well-understood, and the industry has already invested billions of dollars in research and development for next generation fluorocarbon technologies as well as numerous not-in-kind technologies. The analysis looked at the employment and trade balance impacts and found that there were very few outside the primary chemical manufacturing and HVACR sectors.

   The HVACR sector is of paramount importance from a trade and employment standpoint because air conditioning, and fluorocarbon using technology are signature American technologies. The global market in the HVACR industry is highly competitive and is projected to achieve significant growth in the next two decades. The competitive battle has started as to whose technology will be the leader. The jobs component results from the investment in the United States to introduce the next generation technologies and to meet the growing global export market demand.

   Other significant user sectors, for example foam insulation, fire protection, and metered dose inhalers, are very important industries and of importance with respect to energy efficiency and structural attributes, life safety performance and medical well-being, but they are not currently considered to be a significant export industry.

8. You say that the "future success of our industries is dependent upon a rational federal transition." Why is that the case? Is your industry going to struggle for lack of a federal mandate to use a more expensive version of its products?

   Answer: No. Industry will be forced to manufacture, inventory, distribute, sell, install and service two separate product lines, doubling cost. As we have stated many times, the transition away from high-GWP technologies is underway, both in the US and around the globe. This will happen in the United States, even without a federal policy, but it will take much longer and will ultimately be much more costly to industry and consumers.

   The lack of a rational federal policy, and the inevitable emergence of a multitude of varied programs individual states, will add significant costs, complexities and inefficiencies to the supply chain, delay the full realization of the environmental benefits, and destroy the competitiveness of our industries in the global marketplace. The choice for the industry is whether to invest in the United States or invest in international locations that are transitioning to innovative new products. Without a uniform federal domestic policy, the incentive is to invest outside the United States. A recent study completed by the Department of Energy (attached) identifies this as precisely one of the challenges facing the industry.

   As to the second part of your question, we don't agree with the premise that the AIM Act "mandate(s). . .use of a more expensive version of its products." <u>The AIM Act does not mandate any particular product or technology</u>. The AIM Act would limit the use of a technology that has been determined to have unacceptable environmental impacts. The range of technology options today is a far broader than it has ever been, including next-generation fluorocarbon technologies, and other not-in-kinds, such as hydrocarbons, carbon dioxide, ammonia and others. Some of these alternatives are less expensive than the substances used today.

   It is not unusual for new products to have some cost factors or portions that fluctuate and may increase. In fact, it is well understood that the new HFO compounds may initially have a higher cost than some of the HFCs they displace. Additionally, some are less expensive. The products in which they are used have not been significantly impacted by these costs. In our study on consumer costs, we learned, for example, that the refrigerant costs for an air conditioning unit is less than 1% of the price of ownership, and for commercial chillers, less than 0.25% of the price of ownership. Importantly, the INFORUM study also projected that the cost of refrigerants would equilibrate around the current average of existing refrigerant costs.

   As to the products that use these technologies, the U.S. government's own studies have shown the prices of these technologies have continued to decline over the last two decades. These studies were cited in the INFORUM analysis. EPA analysis of the Title VI program found that the transition over the last 30 years produced $billions in consumer cost savings, and many more $billions in health benefits from ozone protection. Further, it is our understanding that preliminary analysis by EPA of the effects of the implementation of the AIM Act projects consumer cost saving over the next 15 years of $3.7 billion or more. The market-based approach first used under Title VI, and the even more flexible market-based approach for technology transition contained in the AIM Act is designed to achieve the technology transition while leaving the choice to the user sectors.

9. Why are the purported energy efficiency savings of HFC replacements insufficient to drive the market this direction without a federal regulatory mandate?

   Answer: The market will transition to HFC replacements without a federal mandate, but over a longer period and in a more costly manner. While other countries are guided by their federal mandates, foreign markets will be able to transition in a more cost-effective manner, gaining global market share in the process, due to lower transition costs. Meanwhile, American companies will be saddled with the crushing regulatory burden of an array of state-by-state regulations and varying transition timelines, losing share to Chinese and EU-based competitors along the way. This industry needs certainty and regulatory relief in a time when our country is facing the highest unemployment rate in eighty-five years.

   Industry product development requires the balancing of many factors, including energy efficiency, cost, reliability, durability and innovative features when developing a product portfolio. No one factor is determinative of what drives the market. But we do know that different consumer segments may or may not pay for environment improvements. Overall, however, price and performance are key. It is the ingenuity of the private sector that has allowed it to achieve the technology transitions of the last three decades while reducing the cost of ownership over the life of the product. The AIM Act will allow that to happen in the future with respect to the HFC transition, but it will also prevent global competitors from attempting to undermine the market and dump less desirable technologies into the United States.

10. You state that "failure to pass the AIM Act into law will significantly increase our regulatory burden and may potentially lead to a costly localized refrigerant transition." We have heard from other stakeholders in the information-gathering process who are already facing current, conflicting state requirements that burden their businesses. Do you believe states should retain this authority to impose these currently existing, inconsistent requirements if the AIM Act is enacted?

    Answer: No. As we stated previously, the existence of state programs on HFCs is primarily driven by the failure to adopt a uniform federal program. Four states have currently adopted varying requirements on HFC transition, at least another eight states are believed to be in the process of developing their own unique transition timelines and regulatory requirements. The market inefficiencies from inconsistent state regulations will only drive user and consumer costs higher and force industry to seek alternative investment options. Given the time frame of the phasedown schedule contained in the

AIM Act, and the emphasis on consensus-based user sector discussions, there will be little or no environmental benefit for a state to pursue their own regulatory regimes or enforce measures in lieu of those adopted at the federal level.

11. Can you please identify:

    a. What patents exist relating HFOs;
    b. What companies own those patents;
    c. When those initial patents expire;
    d. Any licensing agreements that exist for those patents enabling other manufacturers besides the patent holders to produce patented HFO formulations; and
    e. Which of the entities that hold these patents or are licensed to manufacture under said patents are members of your organization?

Answer: In the US, there are over 1,000 patents and patent applications owned by many different entities related to next generation technologies. These are well summarized with respect to the most important alternatives in a recent study from the U.S. Department of Energy's Clean Energy Manufacturing Analysis Center (CEMAC). The broadest patents are also the earliest, having expiration dates in 2023 and 2025. The more recent and more numerous patents are typically much narrower. The number of participants in recent patent activity is indicative of a very competitive market.

Major U.S. chemical producers own the earliest patents and have filed continuations and use or application patents. The overall patent activity includes both non-U.S. major producers and several other market participants. There are also conflicts within the patent estate and several legal actions challenging validity of patents. This is normal activity for this industry and industry participants expect legal conflicts to continue until the patents expire, are cross-licensed or successfully challenged.

The level of involvement has created a competitive situation where cross-licensing overlapping patents is often the preferred resolution. Similar cross-licensing also occurred with prior generations of fluorocarbons. For example, the HFC refrigerant blends used today such as R-410A have been cross-licensed to multiple refrigerant producers since they were first commercialized. More recently, several companies have made announcements about R-454B.

The level of innovative activity in the industry has led to multiple products available for most equipment types from multiple suppliers. For example, U.S. industry members all offer very similar commercial products for refrigeration systems used in grocery stores. For many applications, there are also non-patent-protected refrigerants available. And non-fluorocarbon alternatives are also important in providing these market competition.

Another important implication of the patent activity is the heavy presence of U.S. companies, helping to strengthen their roles as world industry leaders. There are also new entrants in the market indicating broad interest. Overall, the patent activity indicates a strong market with a variety of competitive offerings, along with strong U.S. leadership.

Among the most active in the patent activities and also Alliance members are AGC Chemical, Arkema, Chemours, Daikin, Honeywell, and Koura.

Some have expressed concern about the potential for monopolies as a result of adoption of the AIM Act or questioned the urgency to act. The government's own study says it best, as was stated by this recently completed study for **U.S. DOE's CEMAC by the National Renewable Energy Laboratory and the Oak Ridge National Laboratory:**

"The global refrigerants market is large and is projected to grow rapidly as developing countries in warmer areas of the globe continue to grow, become more affluent, and consume more and more air conditioning, refrigeration, foam, and aerosol product and services. Innovation in this global refrigerants market is often led by major U.S. companies, however, the markets for their products are global. Understanding this global market landscape is a critical component for maintaining U.S. leadership in innovation and manufacturing in a strategically important industry." (February 2020)

The CEMAC report also contains specific information with regard to corporate patent activity on next generation fluorocarbon development.

Senator Whitehouse:

12. What percentage of total HFCs used in the U.S. are used by the aerospace, semiconductor, composites, foam, and defense sprays industries? Has this percentage of niche uses grown over the last five years, and if so, by how much?

    Answer: The percentage of total HFCs used in the U.S. for aerospace, defense, metered dose inhalers, or personal protection sprays, and semiconductors is projected to be well less than 10% of U.S. baseline consumption. Foams is a broad category of products, only a few of which may be "niche" applications still searching for substitutes. Overall, these uses collectively have not grown significantly over the last five years. As we testified earlier, under Title VI, the essential use exemption process was primarily aerospace, defense and metered dose inhalers, and in the last 30 years, never exceeded 1% of baseline.

13. Numerous industries have provided written testimony stating that there are no acceptable substitutes for HFCs they use. Please comment on these claims with respect to the aerospace, semiconductor, composites, foam, and defense sprays industries. Please list all HFCs for which such claims have been made and state whether or not you agree with the claim that no acceptable substitute exists. If you do not agree, please provide the name of the substitute and why you believe it to be acceptable.

Answer: To our knowledge, of the above listed entities, only aerospace, marine structural foam, some limited building insulation foams and personal protection or defense sprays have requested exemptions. It would not be appropriate to comment on these or any other requests without a more detailed understanding of their particular use. It would also be inappropriate to deny relief if they in fact have a need. Data on use categories has been tracked regularly by EPA through its vintaging model, which tracks more than 60 sector or subsector categories. The number of specific requests for essential use consideration is very small in comparison. But all these requests are important to the individual user. These are precisely the types of considerations that should involve EPA, both in analysis of up-to date use data and in determination of sectoral schedules under Section 10, and/or under the essential use exemption process in Section 6. The AIM Act establishes a process for flexible implementation of transitions in order to account for the needs of users. Further, the phasedown schedule leaves residual the 15% of baseline to allow for those without options.

We believe that flexibility is broad in the bill language and that no essential use should be denied, if necessary. It is also expected that an extraordinary amount of additional innovation will take place over the next 15 years and that based on the Title VI experience, most if not all uses would be expected to find multiple technical options for implementation. As an example, metered dose inhalers were specifically listed in Title VI for an essential use exemption, currently that industry has not indicated a need for such an exemption going forward. The 15% residual baseline should be more than adequate to deal with the use sectors that have requested consideration, and the essential use exemption process should allow them protection beyond the completion of the US phasedown in 2035.

14. Please describe the transition from CFCs to HFCs, catalyzed by the Montreal Protocol and Title VI of the Clean Air Act. Did Title VI preempt or in any other way limit state regulatory action with respect to CFCs? After the implementation of Title VI and the accompanying two year pause in state enforcement of CFC regulations, did states adopt or resume enforcing CFC regulations? If so, how many and in what manner?

    Answer: The transition away from CFCs in the first decade of the Montreal Protocol and Title VI of the Clean Air Act was a frenetic race to rapidly reduce reliance on ozone depleting substances. State laws focused on limited prohibitions, such as polystyrene food packaging containers, and automobile service requirements. Title VI, in section 603, contained a two year pause in enforcement of state laws on ozone depleting substances. To our recollection, no new state laws were enacted or enforced after that to regulate ozone depleting substances.

15. For HFCs where users claim that the current substitute is too expensive, based on your prior experience transitioning from CFCs to HFCs, what do you believe will occur with respect to the price of HFC substitutes?

Answer: In analysis performed by INFORUM, and provided with our written testimony, it was determined that the next-generation fluorinated substitutes would equilibrate to the current average cost of refrigerants in the marketplace today. Both chemical producers and user sector customers will continue to seek to find cost-effective technologies that balance the performance, safety, toxicity, and flammability, issues that may be associated with their utilization. And, given the long-term policy signal to all to reduce reliance on high-GWP compounds, the industry will continue to innovate and introduce products that will succeed in the highly competitive, and increasingly global marketplace.

16. If the AIM Act were to be passed in its current form, based on your experience with Title VI, how do you believe that states would respond with respect to adopting and/or enforcing their own HFC laws and regulations?

Answer: It is our view that most if not all states would decline to further regulate HFCs if a credible uniform Federal program were adopted as is contained in the AIM Act.

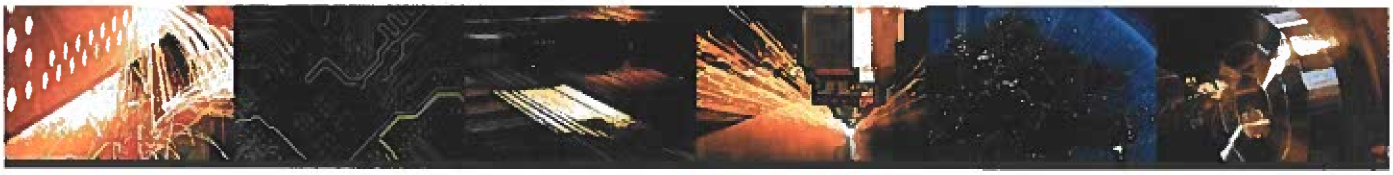
17. Do you believe that passing the AIM Act in its current form will lead to more or less regulatory harmonization and certainty than would continued congressional inactivity in this space?

Answer: The transition away from high-GWP HFCs is underway and will continue. The only debate is the speed of the transition and whether or not U.S. workers and consumers will realize the projected consumer cost savings and job growth, whether the industries and the U.S. economy will realize the projected economic growth and improvements in trade balance, and whether U.S. industry technology leadership will remain preeminent in these signature U.S. industries. The longer Congress delays affirming the policy approach, the less certain are the economic and consumer benefits, and the slower will be the capture of the environmental benefit.

Attachment: Refrigerants: Market Trends and Supply Chain Assessment, for the Clean Energy Manufacturing Analysis Center, U.S. Department of Energy, February 2020: Executive Summary and Conclusions and Insights

Submitted April 29, 2020

CEMAC Clean Energy Manufacturing Analysis Center



Refrigerants: Market Trends and Supply Chain Assessment

Chuck Booten, Scott Nicholson, Margaret Mann

National Renewable Energy Laboratory

Omar Abdelaziz

Oak Ridge National Laboratory

CEMAC is operated by the Joint Institute for Strategic Energy Analysis for the U.S. Department of Energy's Clean Energy Manufacturing Initiative.

Technical Report

NREL/TP-5500-70207

February 2020

Contract No. DE-AC36-08GO28308

Executive Summary

The National Renewable Energy Laboratory (NREL), in partnership with Oak Ridge National Laboratory, under the Clean Energy Manufacturing Analysis Center (CEMAC)[1] umbrella, assessed the current state of existing and low-global-warming-potential (GWP) refrigerants for major end-use applications, including heating, ventilating, and air conditioning (HVAC) and those outside of the HVAC industry. The project incorporated a market overview and supply chain assessment to determine the production, distribution, consumption, costs, and potential operating efficiency impacts of new and alternative refrigerants entering the market. Market trends and ongoing research are also documented. This work supplements other U.S. Department of Energy efforts to support research activities on refrigerants and their applications, including a refrigerant research and development roadmap (Goetzler et al. 2014) and an outlook into global air-conditioning markets (Goetzler et al. 2016).

Key Objectives of This Report:

- Document existing refrigerant global supply chain, including production and distribution, usage, and intellectual property.
- Analyze major current end uses of refrigerants. Forward-looking estimates will have an emphasis on low-GWP refrigerant applications and the implications of scaling-up production and usage of the refrigerants.
- Estimate and document production and development of alternative refrigerants.
- Support U.S. Department of Energy's Building Technologies Office goals of increasing the deployment of energy efficiency technologies through evaluation of market and cost barriers.

The global refrigerants market is large and is projected to grow rapidly as developing countries in warmer areas of the globe continue to grow, become more affluent, and consume more and more air conditioning, refrigeration (Goetzler et al. 2016), foam, and aerosol products and services (Grand View Research 2017). Innovation in this global refrigerants market is often led by major U.S. companies; however, the markets for their products are global. Understanding this global market landscape is a critical component for maintaining U.S. leadership in innovation and manufacturing in a strategically important industry.

> "The U.S. chemical industry is the major innovator in creating the replacements [for hydrofluorocarbons]. This is a matter of industrial policy for the United States so our manufacturers have access to these huge growing export markets." (E&E News 2017).

[1] www.manufacturingcleanenergy.org

Key Findings From This Report:

- Refrigerant markets are global and growing rapidly.
    - o 2010–2050: 4.5x increase in air conditioning for non-Organization of Economic Coordination and Development (OECD) countries, and 1.3x increase for OECD countries.
    - o Regional, national, and international commitments will create large market opportunities for innovative refrigerants and products that use them.
    - o U.S.-based companies are leaders in intellectual property and production of advanced refrigerants.
    - o China has aggressively expanded production of conventional refrigerants for domestic use as well as export.

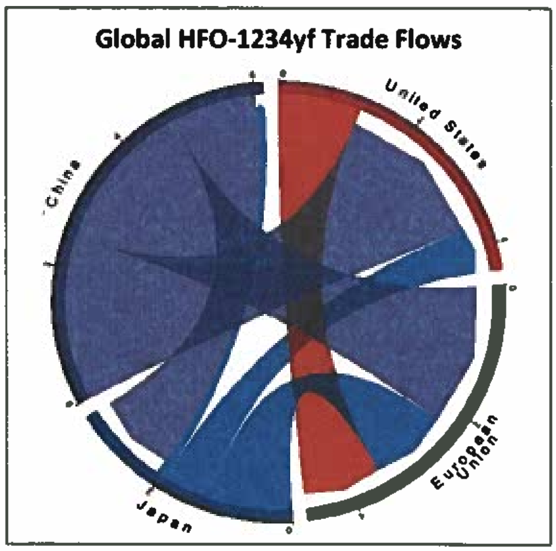


Figure ES-1. Global HFO-1234yf trade flows in 2015 (ktons)

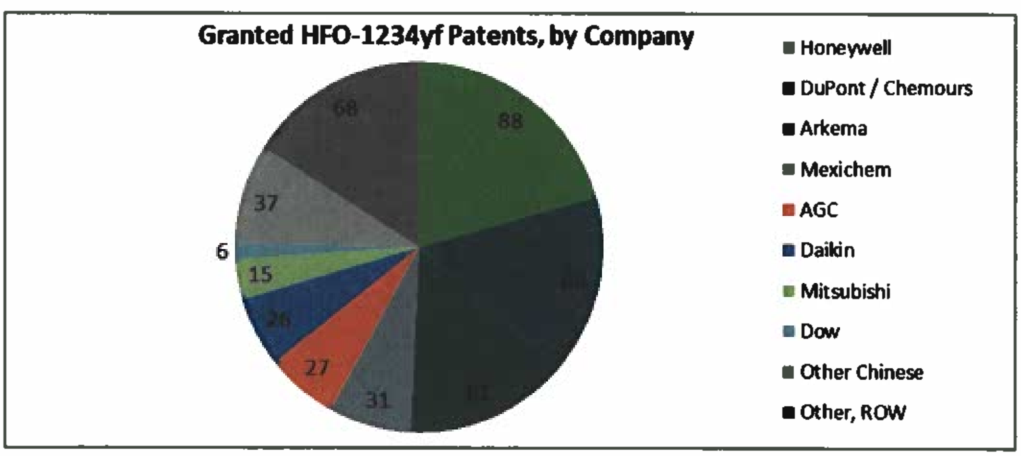


Figure ES-2. Granted patents related to HFO-1234yf

- Refrigerants are used in large quantities for more than just cooling.
  - Foam production, aerosols, fire suppression, and chemical production are important end uses for these materials.

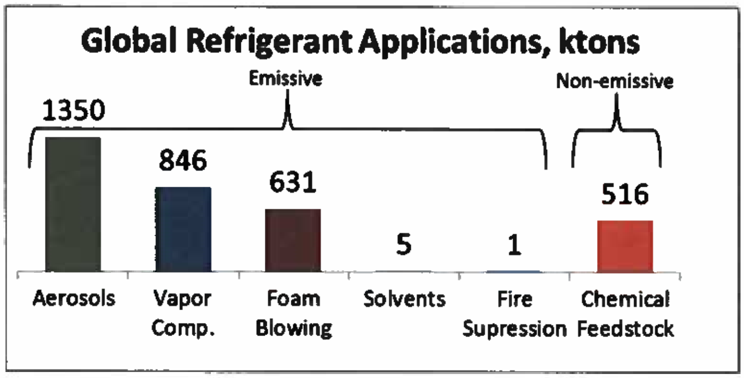


Figure ES-3. Global refrigerant usage, by application

- **Vapor compression systems** primarily use fluorocarbon refrigerants.
  - This is the **most difficult and impactful area** for refrigerant innovation.

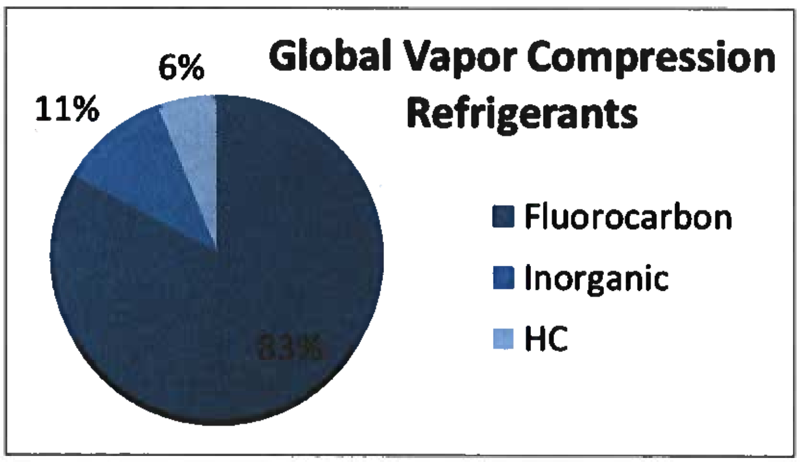


Figure ES-4. Global vapor compression refrigerant types

- Alternative refrigerants to fluorocarbons are well established.
  - The refrigerant market is defined as all materials used in applications where fluorocarbons are used: vapor compression, foam blowing, aerosols, chemical feedstock, fire suppression, and solvents.
  - Alternative refrigerants comprise more than 50% of the total market as it exists today.
  - Common natural/hydrocarbon refrigerants include ammonia, pentane, carbon dioxide, propane, and butane.
  - They have substantially lower global warming potential than most fluorocarbons.
  - Nonfluorinated refrigerants may provide comparable or superior performance to fluorocarbons in some end uses.

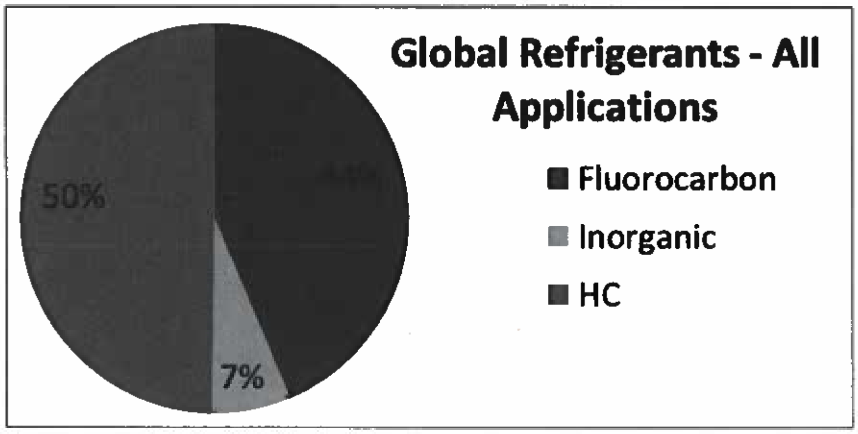


Figure ES-5. Global refrigerants for all applications

- **Advanced fluorocarbon refrigerants are commercially available** that reduce environmental impact while maintaining or potentially improving performance.
  - **One size doesn't fit all**—some common applications are more difficult to solve than others; this necessitates ongoing research and development.
  - **U.S. companies are currently at the forefront of this innovation.**
  - The hydrochlorofluorocarbon phaseout is nearing completion in developed countries; attention has formally turned to the phasedown of high GWP hydrofluorocarbons with the passage of the Kigali Amendment in 2016. Significant global adoption of advanced fluorocarbon refrigerants and hydrocarbon alternatives will be instrumental to the success of this imminent HFC phasedown.

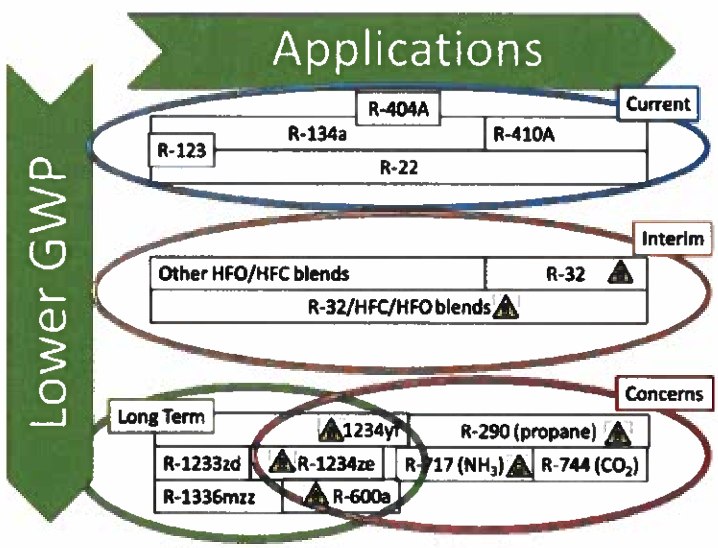


Figure ES-6. Groupings of refrigerants by GWP

- Refrigerant manufacturing locations are primarily guided by:
    - Proximity to fluorspar, hydrofluoric acid, or other chemical feedstock
    - Existing refrigerant manufacturing capital and experienced labor force
    - Availability of cheap energy and labor
    - Financial incentives from local governments or development authorities.
- The United States is positioned to be a major production center for advanced refrigerants, including hydrofluoroolefins (HFOs) and their blends.
    - Market share of production is likely to be larger if there is a substantial U.S. market for advanced refrigerants.
    - Fluorspar will remain in demand as manufacturers transition to producing HFOs, and the U.S. fluorspar supply is stable. Demand is now supplied mainly by Mexico, whereas historically, China had been the leading supplier.
    - U.S. companies, such as Honeywell and Chemours, own much of the intellectual property associated with the production and usage of HFOs.
    - Antidumping lawsuits regarding Chinese imports have played a major role in shaping this industry. Decisions on HFC imports have generally been in favor of U.S. companies, setting an important precedent for any future HFO-related trade disputes.
    - Recently constructed HFO production capacity in Louisiana serves as an example of the effect that financial incentives from development authorities can have on manufacturers' plant location decisions.

4 Conclusions and Insights

NREL, in partnership with Oak Ridge National Laboratory and under the CEMAC umbrella, assessed the current state of existing and low-GWP refrigerants for major end-use applications, including HVAC and those outside of the HVAC industry. The project incorporated a market overview and supply chain assessment to determine the production, distribution, consumption, costs, and potential operating efficiency impacts of new and alternative refrigerants entering the market. Market trends and ongoing research are also documented. This work supplements other U.S. Department of Energy efforts to support research activities on refrigerants and their applications, including a refrigerant R&D roadmap and outlook into global air-conditioning markets (Goetzler et al. 2014; Goetzler et al. 2016).

The global refrigerants market is large and is projected to grow rapidly as developing countries in warmer areas of the globe grow, become more affluent, and consume more air conditioning, refrigeration, foam, and aerosol products and services. Innovation in the global refrigerants market is often led by major U.S. companies; however, the markets for their products are global. Understanding this global market landscape is critical to maintaining U.S. leadership in innovation and manufacturing in this strategically important industry.

Key Findings From This Report:

- Refrigerant markets are global and growing rapidly
  - 2010–2050: 4.5x increase in air conditioning for non-OECD countries, and 1.3x increase for OECD countries (IEA 2013).
  - Regional, national, and international commitments will create **large market opportunities for innovative refrigerants and products** that use them.
  - **U.S.-based companies are currently leaders in innovation and production of advanced refrigerants.**
  - **China is aggressively expanding production** of refrigerants for domestic use as well as export.
- Refrigerants are used in large quantities for more than just cooling.
  - Foam production, aerosols, fire suppression, and chemical production are important end uses of these materials.
- **Vapor compression systems** primarily use fluorocarbon refrigerants.
  - Vapor compression is the **most challenging but also the most impactful area** for refrigerant innovation.
- Alternative refrigerants to fluorocarbons are well established.
  - They account for more than 50% of the total market as it exists today.

- Common natural/hydrocarbon refrigerants: ammonia, pentane, carbon dioxide, propane, and butane.
  - Substantially lower GWP than most fluorocarbons.
  - Often provide comparable or superior performance to fluorocarbons.
- **Advanced fluorocarbon refrigerants are commercially available** that can reduce unintended environmental impacts while maintaining or potentially improving performance.
  - **One size doesn't fit all**—some common applications are more difficult to solve than others, therefore there is a need for ongoing R&D.
  - U.S. companies are currently at the forefront of this innovation.
- Refrigerant manufacturing locations are primarily guided by:
  - Proximity to fluorspar, hydrofluoric acid, or other chemical feedstock
  - Existing refrigerant manufacturing capital and experienced labor force
  - Availability of cheap energy and labor
  - Financial incentives from local governments or development authorities.
- The United States is positioned to be a major production center for advanced refrigerants, including HFOs and their blends.
  - Market share of production likely to be larger if there is a substantial U.S. market for advanced refrigerants
  - Fluorspar will remain in demand as manufacturers transition to producing HFOs, and U.S. fluorspar supply is stable. Demand is now supplied mainly by Mexico, whereas historically, China had been the leading importer.
  - U.S. companies, such as Honeywell and Chemours, own much of the intellectual property associated with the production and usage of HFOs.
  - Antidumping lawsuits regarding Chinese imports have played a major role in shaping this industry. Decisions on HFC imports have generally been in favor of U.S. companies, setting an important precedent for any future HFO-related trade disputes.
  - Recently constructed HFO capacity in Louisiana serves as an example of the effect that financial incentives from development authorities can have on manufacturers' plant location decisions.

CEMAC Clean Energy Manufacturing Analysis Center

Refrigerants: Market Trends and Supply Chain Assessment

Chuck Booten, Scott Nicholson, Margaret Mann
National Renewable Energy Laboratory

Omar Abdelaziz
Oak Ridge National Laboratory

CEMAC is operated by the Joint Institute for Strategic Energy Analysis for the U.S. Department of Energy's Clean Energy Manufacturing Initiative.

Technical Report
NREL/TP-5500-70207
February 2020

Contract No. DE-AC36-08GO28308

Refrigerants: Market Trends and Supply Chain Assessment

Chuck Booten, Scott Nicholson, Margaret Mann
National Renewable Energy Laboratory

Omar Abdelaziz
Oak Ridge National Laboratory

CEMAC is operated by the Joint Institute for Strategic Energy Analysis for the U.S. Department of Energy's Clean Energy Manufacturing Initiative.

Clean Energy Manufacturing Analysis Center
15013 Denver West Parkway

Golden, CO 80401

303-275-3000

www.manufacturingcleanenergy.org

Technical Report
NREL/TP-5500-70207
February 2020

Contract No. DE-AC36-08GO28308

NOTICE

This work was authored in part by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Building Technologies Office. The views expressed herein do not necessarily represent the views of the DOE or the U.S. Government.

Available electronically at SciTech Connect: http:/www.osti.gov/scitech

Available for a processing fee to U.S. Department of Energy
and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
OSTI http://www.osti.gov
Phone: 865.576.8401
Fax: 865.576.5728
Email: reports@osti.gov

Available for sale to the public, in paper, from:

U.S. Department of Commerce
National Technical Information Service
5301 Shawnee Road
Alexandria, VA 22312
NTIS http://www.ntis.gov
Phone: 800.553.6847 or 703.605.6000
Fax: 703.605.6900
Email: orders@ntis.gov

Cover Photos: (left to right) iStock 2225189; iStock 16687273; Oak Ridge National Laboratory; iStock 24304597; iStock 26005993; iStock 2069560

NREL prints on paper that contains recycled content.

Acknowledgments

This work was funded through the U.S. Department of Energy Building Technologies Office. The authors would like to thank Karma Sawyer, Antonio Bouza, and Sven Mumme for their support of this project.

Nomenclature and Acronyms

BSRIA	Building Services Research and Information Association
CFC	chlorofluorocarbon
CEMAC	Clean Energy Manufacturing Analysis Center
ECHA	European Chemical Agency
EPA	U.S. Environmental Protection Agency
GWP	global warming potential
HCFC	hydrochlorofluorocarbon
HF	hydrofluoric acid
HFC	hydrofluorocarbon
HFO	hydrofluoroolefin
HVAC	heating, ventilating, and air conditioning
IGSD	Institute for Governance and Sustainable Development
kton	one thousand metric tons
MAC	mobile air conditioning
MMT CO_2e	million metric tons of carbon dioxide equivalent
NREL	National Renewable Energy Laboratory
PTFE	polytetrafluoroethylene
ODS	ozone-depleting substance
OECD	Organization of Economic Coordination and Development
R&D	research and development
REACH	Registration, Evaluation, Authorization and Restriction of Chemicals
U.S. ITC	U.S. International Trade Commission
WTO	World Trade Organization
XPS	extruded polystyrene

Executive Summary

The National Renewable Energy Laboratory (NREL), in partnership with Oak Ridge National Laboratory, under the Clean Energy Manufacturing Analysis Center (CEMAC)[1] umbrella, assessed the current state of existing and low-global-warming-potential (GWP) refrigerants for major end-use applications, including heating, ventilating, and air conditioning (HVAC) and those outside of the HVAC industry. The project incorporated a market overview and supply chain assessment to determine the production, distribution, consumption, costs, and potential operating efficiency impacts of new and alternative refrigerants entering the market. Market trends and ongoing research are also documented. This work supplements other U.S. Department of Energy efforts to support research activities on refrigerants and their applications, including a refrigerant research and development roadmap (Goetzler et al. 2014) and an outlook into global air-conditioning markets (Goetzler et al. 2016).

Key Objectives of This Report:

- Document existing refrigerant global supply chain, including production and distribution, usage, and intellectual property.
- Analyze major current end uses of refrigerants. Forward-looking estimates will have an emphasis on low-GWP refrigerant applications and the implications of scaling-up production and usage of the refrigerants.
- Estimate and document production and development of alternative refrigerants.
- Support U.S. Department of Energy's Building Technologies Office goals of increasing the deployment of energy efficiency technologies through evaluation of market and cost barriers.

The global refrigerants market is large and is projected to grow rapidly as developing countries in warmer areas of the globe continue to grow, become more affluent, and consume more and more air conditioning, refrigeration (Goetzler et al. 2016), foam, and aerosol products and services (Grand View Research 2017). Innovation in this global refrigerants market is often led by major U.S. companies; however, the markets for their products are global. Understanding this global market landscape is a critical component for maintaining U.S. leadership in innovation and manufacturing in a strategically important industry.

> "The U.S. chemical industry is the major innovator in creating the replacements [for hydrofluorocarbons]. This is a matter of industrial policy for the United States so our manufacturers have access to these huge growing export markets." (E&E News 2017).

[1] www.manufacturingcleanenergy.org

Key Findings From This Report:

- Refrigerant markets are global and growing rapidly.
  - 2010–2050: 4.5x increase in air conditioning for non-Organization of Economic Coordination and Development (OECD) countries, and 1.3x increase for OECD countries.
  - Regional, national, and international commitments will create large market opportunities for innovative refrigerants and products that use them.
  - U.S.-based companies are leaders in intellectual property and production of advanced refrigerants.
  - China has aggressively expanded production of conventional refrigerants for domestic use as well as export.

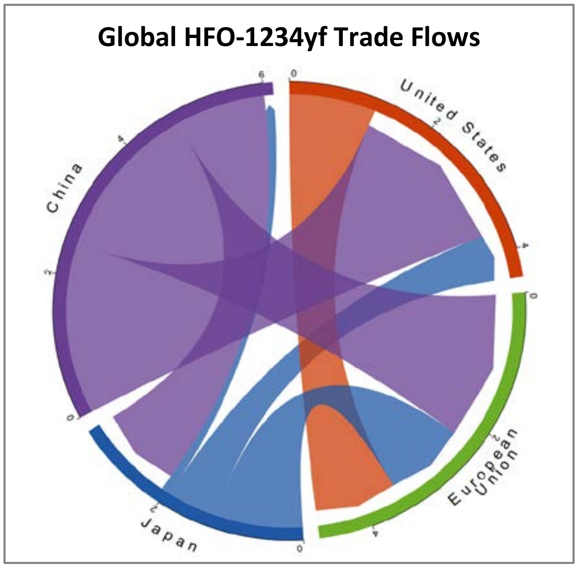


Figure ES-1. Global HFO-1234yf trade flows in 2015 (ktons)

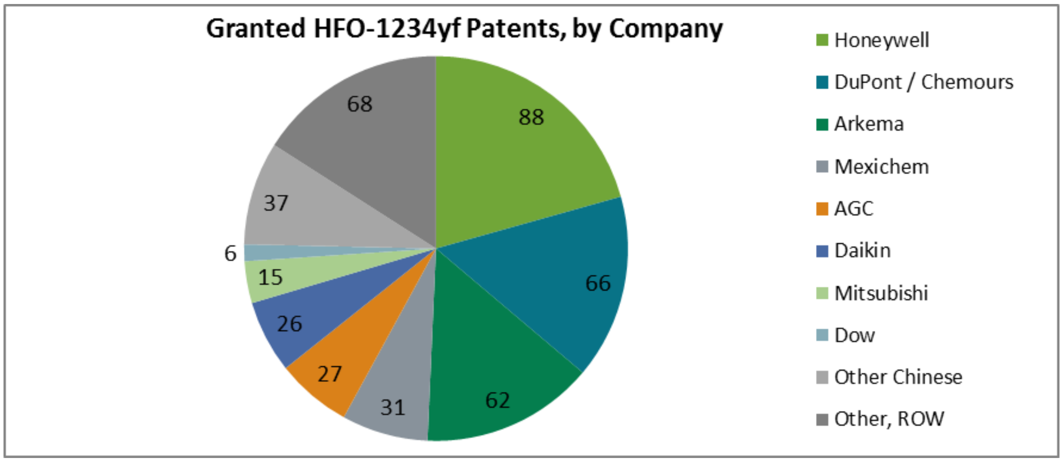


Figure ES-2. Granted patents related to HFO-1234yf

- Refrigerants are used in large quantities for more than just cooling.
    - Foam production, aerosols, fire suppression, and chemical production are important end uses for these materials.

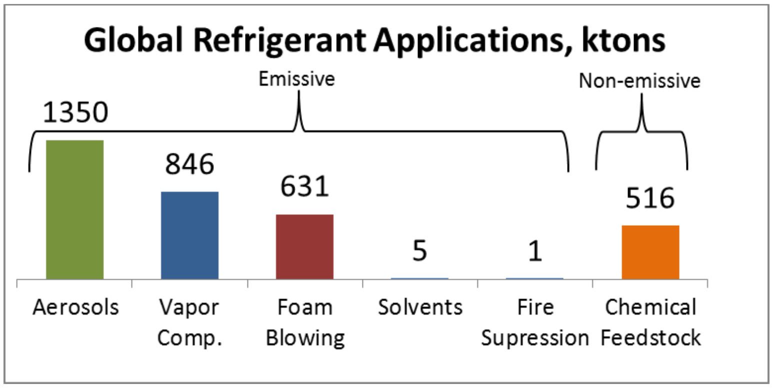


Figure ES-3. Global refrigerant usage, by application

- **Vapor compression systems** primarily use fluorocarbon refrigerants.
    - This is the **most difficult and impactful area** for refrigerant innovation.

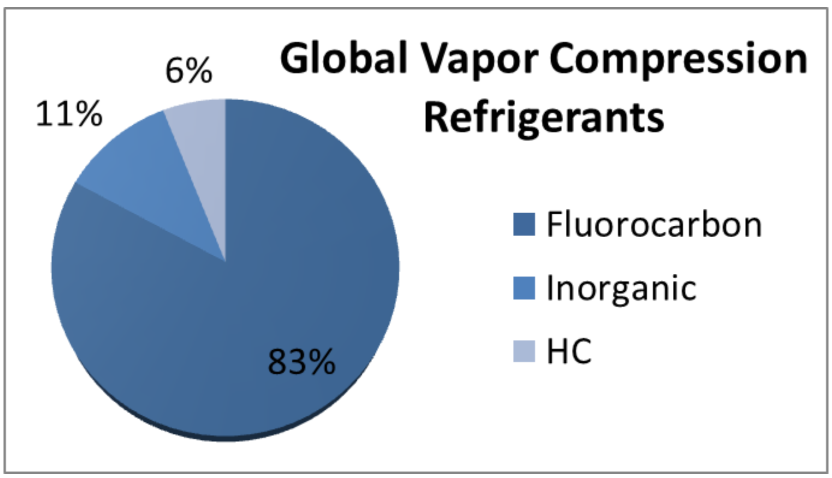


Figure ES-4. Global vapor compression refrigerant types

- Alternative refrigerants to fluorocarbons are well established.
    - The refrigerant market is defined as all materials used in applications where fluorocarbons are used: vapor compression, foam blowing, aerosols, chemical feedstock, fire suppression, and solvents.
    - Alternative refrigerants comprise more than 50% of the total market as it exists today.
    - Common natural/hydrocarbon refrigerants include ammonia, pentane, carbon dioxide, propane, and butane.
    - They have substantially lower global warming potential than most fluorocarbons.
    - Nonfluorinated refrigerants may provide comparable or superior performance to fluorocarbons in some end uses.

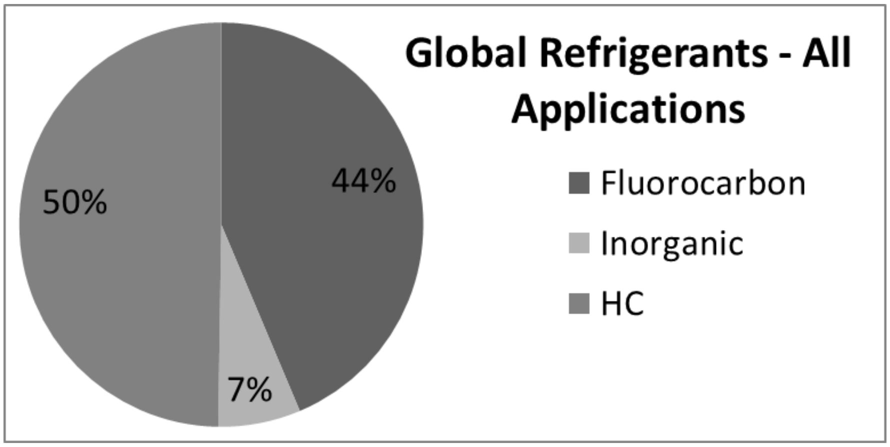


Figure ES-5. Global refrigerants for all applications

- **Advanced fluorocarbon refrigerants are commercially available** that reduce environmental impact while maintaining or potentially improving performance.
  - **One size doesn't fit all**—some common applications are more difficult to solve than others; this necessitates ongoing research and development.
  - **U.S. companies are currently at the forefront of this innovation.**
  - The hydrochlorofluorocarbon phaseout is nearing completion in developed countries; attention has formally turned to the phasedown of high GWP hydrofluorocarbons with the passage of the Kigali Amendment in 2016. Significant global adoption of advanced fluorocarbon refrigerants and hydrocarbon alternatives will be instrumental to the success of this imminent HFC phasedown.

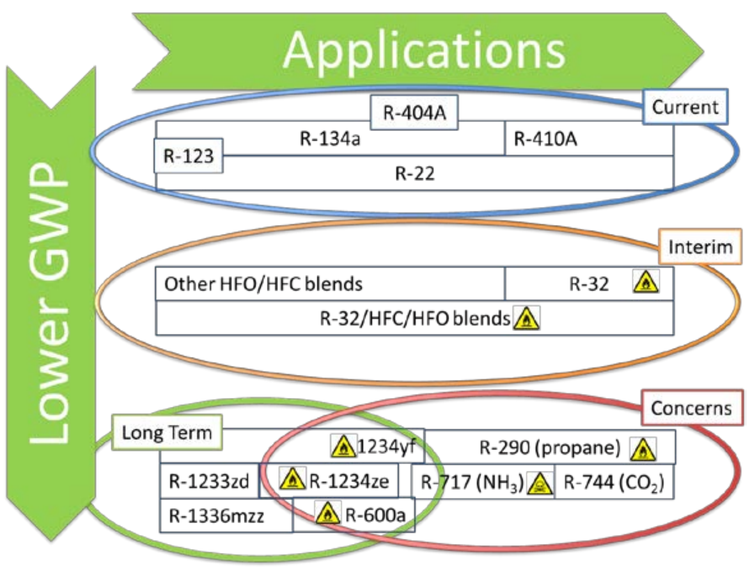


Figure ES-6. Groupings of refrigerants by GWP

- Refrigerant manufacturing locations are primarily guided by:
    - Proximity to fluorspar, hydrofluoric acid, or other chemical feedstock
    - Existing refrigerant manufacturing capital and experienced labor force
    - Availability of cheap energy and labor
    - Financial incentives from local governments or development authorities.
- The United States is positioned to be a major production center for advanced refrigerants, including hydrofluoroolefins (HFOs) and their blends.
    - Market share of production is likely to be larger if there is a substantial U.S. market for advanced refrigerants.
    - Fluorspar will remain in demand as manufacturers transition to producing HFOs, and the U.S. fluorspar supply is stable. Demand is now supplied mainly by Mexico, whereas historically, China had been the leading supplier.
    - U.S. companies, such as Honeywell and Chemours, own much of the intellectual property associated with the production and usage of HFOs.
    - Antidumping lawsuits regarding Chinese imports have played a major role in shaping this industry. Decisions on HFC imports have generally been in favor of U.S. companies, setting an important precedent for any future HFO-related trade disputes.
    - Recently constructed HFO production capacity in Louisiana serves as an example of the effect that financial incentives from development authorities can have on manufacturers' plant location decisions.

Table of Contents

List of Figures

List of Tables

1 Refrigerant Applications

The current global refrigerant market is $14 billion/year (Markets and Markets 2017) and covers a variety of applications, which often comprise a range of products. An overview of this market will be provided in this report, with an emphasis on understanding the breadth of applications, international trade flows, supply chain, and regulatory factors that impact the market.

Despite its maturity, the refrigerant industry is rapidly changing. Historically, much of the change in this industry has been driven by international cooperation to avoid the ozone-depleting characteristics of an early class of refrigerants—chlorofluorocarbons (CFCs). Since the passage of the Montreal Protocol in 1987 and subsequent phaseout of CFCs, attention has turned to the environmental impact of the halogenated CFC replacements (hydrochlorofluorocarbons [HCFCs] and hydrofluorocarbons [HFCs]). These include the energy efficiency of products using refrigerants as a working fluid (indirect global warming potential [GWP]) as well as their direct impact when released into the atmosphere (direct GWP). With the negotiation of the Kigali Amendment to the Montreal Protocol in 2016, countries are formally agreeing to take action to reduce the aggregate GWP of the global refrigerant industry. The U.S. Department of Energy has developed a roadmap for research and development (R&D) activities related to refrigerants, which highlights the potential for impactful research (Goetzler et al. 2014) as well as developing a detailed outlook for certain refrigerant markets, such as air conditioning (Goetzler et al. 2016). That roadmap focused on technical initiatives and priorities for refrigerants in vapor compression systems. This report considers many of the other components of the refrigerant market, including non-vapor-compression applications, techno-economic analysis, the interaction of innovation and regulation, and the perspective of industry stakeholders.

1.1 Overview

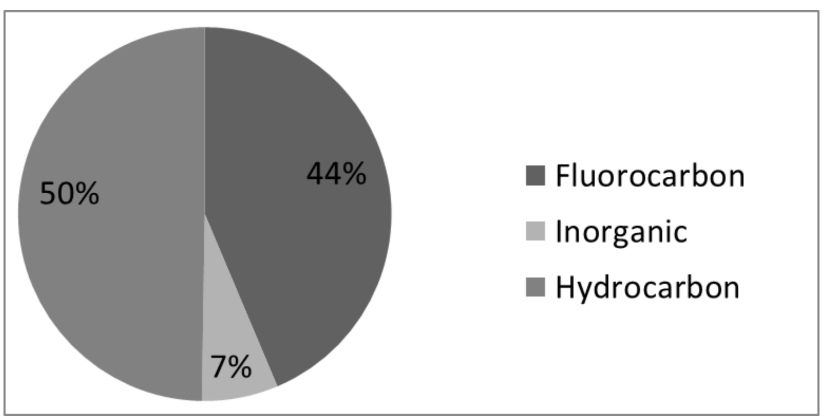


Figure 1. Total global refrigerants market for all classes of refrigerants

Refrigerant chemicals are used in many applications, some of which have nothing to do with refrigeration. Figure 1 shows the percent of the total refrigerant market occupied by the three major classes of refrigerants: fluorocarbons, inorganic, and hydrocarbons. Hydrocarbons and inorganics are often collectively described as “natural” refrigerants, but they are listed separately here to highlight that hydrocarbons alone comprise nearly half of the global refrigerant market today. That market share could well grow in the near future due to low cost and favorable performance for many applications. Figure 1 shows the approximate global breakdown of end uses where at least a portion of the market uses fluorinated refrigerants. For example, some of the aerosol and foam blowing markets use fluorinated refrigerants; the markets are included here, even though a substantial portion of those markets use hydrocarbons and inorganics. This distinction bounds the topic such that other end uses of hydrocarbons (e.g., fuel) or inorganics (e.g., fertilizer) are excluded from discussion in this work. Consumption as a chemical precursor (feedstock use) is an important, but sometimes overlooked, use of several refrigerants, primarily HCFC-22, HCFC-142b, and HFC-152a. The use of HFCs and HCFCs as chemical feedstocks is not prohibited by international agreements because the chemicals are never released into the atmosphere. Therefore, substantial production capacity of HFCs and HCFCs for feedstock use will likely continue into the foreseeable future. When only emissive uses of fluorocarbons are considered, vapor compression systems (refrigeration and heating, ventilating, and air conditioning [HVAC]), polymer foam production, fire suppression, aerosols, and chemical solvents are the major end uses.

There are two major refrigerant end uses where hydrocarbons are the dominant refrigerant: foam blowing agents and aerosols, as shown in Figure 2 and Figure 3. The most common foam blowing agents are pentanes, whereas aerosols typically use propane or butane. The importance of hydrocarbons in these areas is likely to increase as regulations reduce the availability of existing fluorocarbons for these applications. In regions such as Europe, where HCFC blowing agents have already been phased out, foam manufacturers may be less likely to transition to newly developed fluorocarbon blowing agents (such as hydrofluoroolefin [HFO]-1234ze or HFO-1233zd) due to cost. However, in regions that still use HFC blowing agents, such as Japan and the United States, HFO blowing agents may gain market acceptance as HFCs are phased out. The choice between hydrocarbons and HFOs could be influenced by many factors, including material compatibility and insulating value (UNEP 2015). For example, some HFOs have better insulating properties than hydrocarbons (McMenamin et al. 2009; Loh et al. 2010). However, if costs are the most important consideration, hydrocarbons are the more appropriate choice. Unlike vapor compression applications, where concerns persist about flammability, safety issues have largely been identified and overcome in the foam blowing sector. Instead, the challenges impeding adoption of HFC substitutes include transition cost, material compatibility, and thermal performance (Desjarlais 2017; Walters-Terronini 2017).

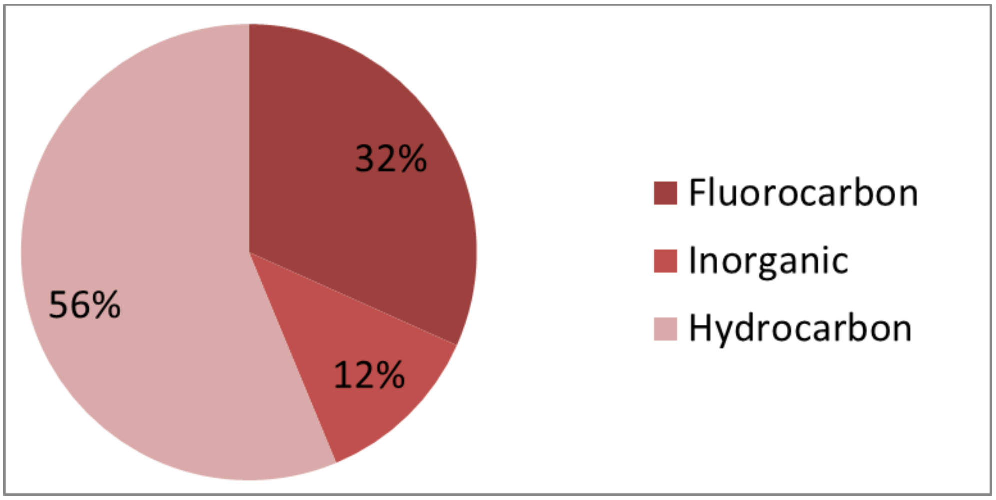


Figure 2. Foam blowing agent use by refrigerant type. As existing fluorocarbon refrigerants are phased out, many of those uses will transition to hydrocarbons, while others may transition to newer fluorocarbons (HFOs).

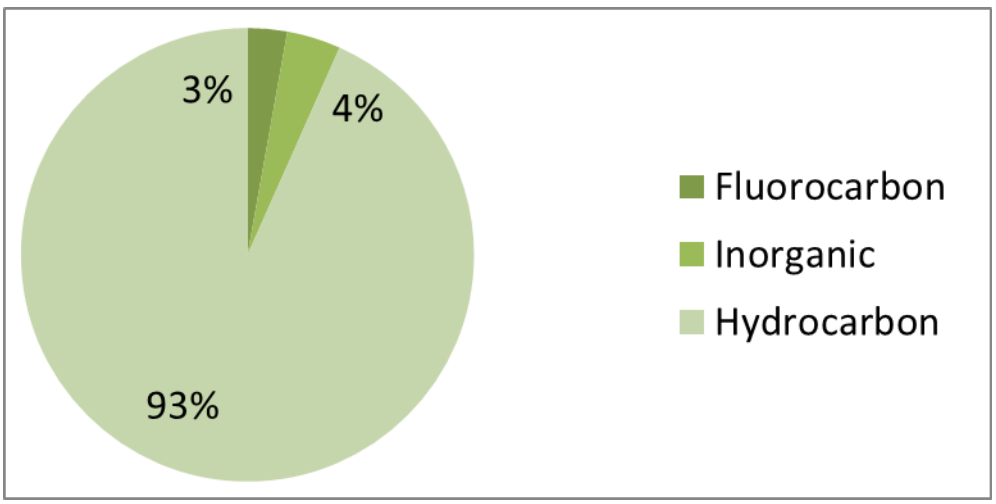


Figure 3. Aerosol use by refrigerant type. The dominance of hydrocarbons in this market is not likely to change substantially with the development of new fluorocarbon refrigerants.

Figure 4 shows the end uses of fluorocarbon refrigerants only. In this context, vapor compression systems used for refrigeration and HVAC dominate the end uses. Vapor compression systems are the dominant technology used for residential and commercial air conditioning and refrigeration as well as mobile air conditioning. Figure 5. breaks down vapor compression into three main categories and shows that the stationary HVAC and refrigeration markets are of comparable size and are much larger than the mobile vapor compression market. Figure 5 includes fluorinated as well as inorganic and hydrocarbon refrigerants, although the vast majority (~95%) used in vapor compression are fluorinated (Building Services Research and Information Association [BSRIA] 2015b). The nonfluorocarbon refrigerants are dominated by ammonia (R-717), which is used almost exclusively for industrial applications; hydrocarbons are a small but growing portion of the market in terms of tons of refrigerant used. Because hydrocarbons are typically used in small quantities, the number of products using them as a refrigerant is large even though the tonnage is relatively small. Figure 6 focuses on refrigeration applications and the relative refrigerant consumption in each of the four main areas: commercial, industrial, transportation, and domestic/other.

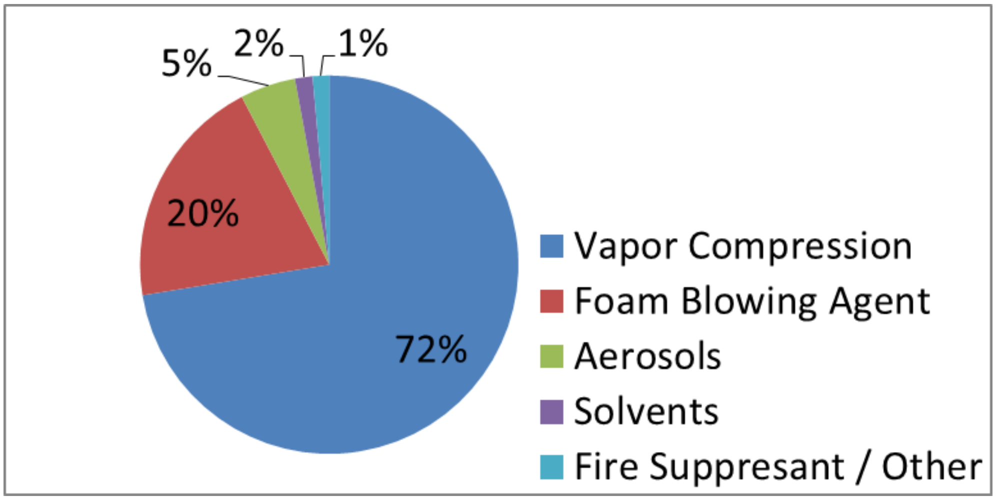


Figure 4. Global end uses of fluorocarbon refrigerants

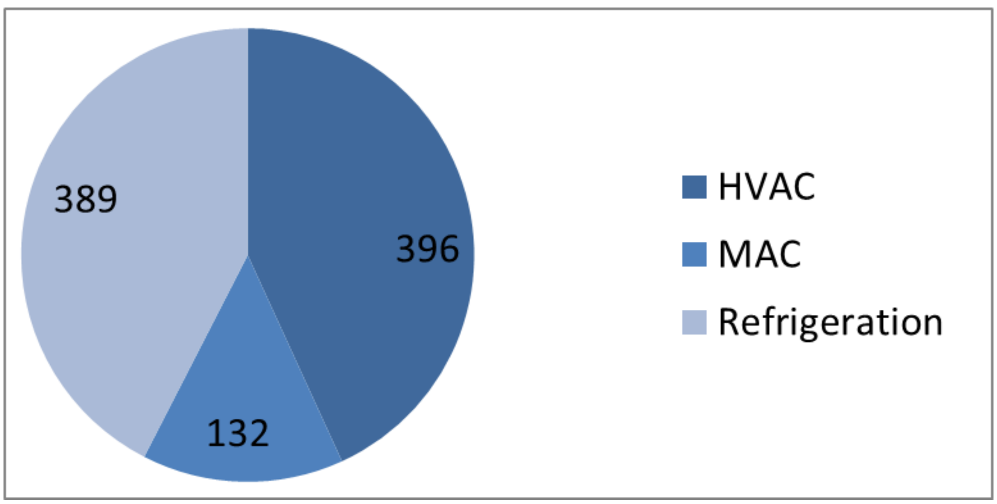


Figure 5. Global vapor compression use of refrigerant, in ktons

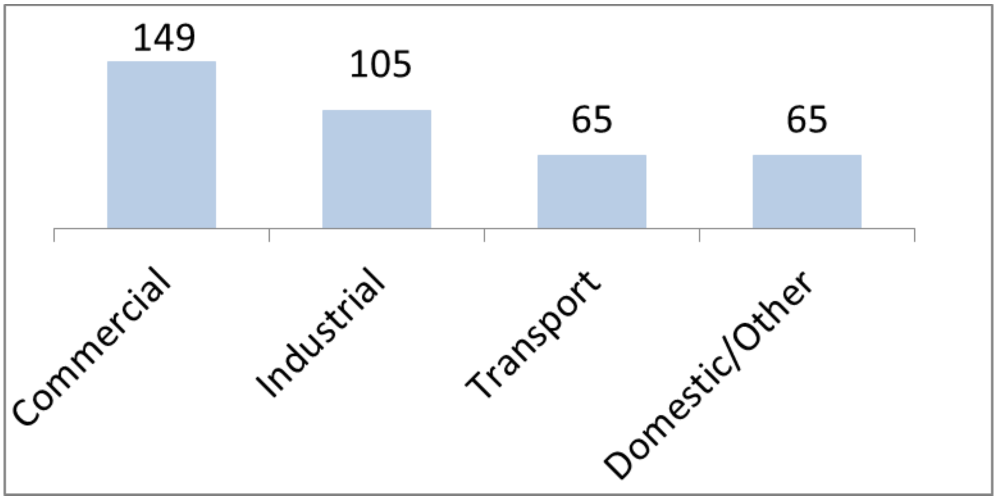


Figure 6. Global refrigerant consumption by refrigeration application (excluding HVAC), in ktons (BSRIA 2015b)

It is also important to understand the volumes of different refrigerants that are used in refrigeration, as shown in Figure 7. This figure does include nonfluorocarbon refrigerants; however, they are used in such small quantities for refrigeration applications that they are combined with the "other" category. Refrigerant volumes are in metric tons, not unit sales. This is an important distinction because the global domestic refrigerator market is approximately 50% isobutane (R-600a) by unit sales, but the low charge quantities per unit mean that the total amount of R-600a used is ~6 ktons, less than 3% of global refrigerant volume (Clodic et al. 2006; BSRIA 2015b).

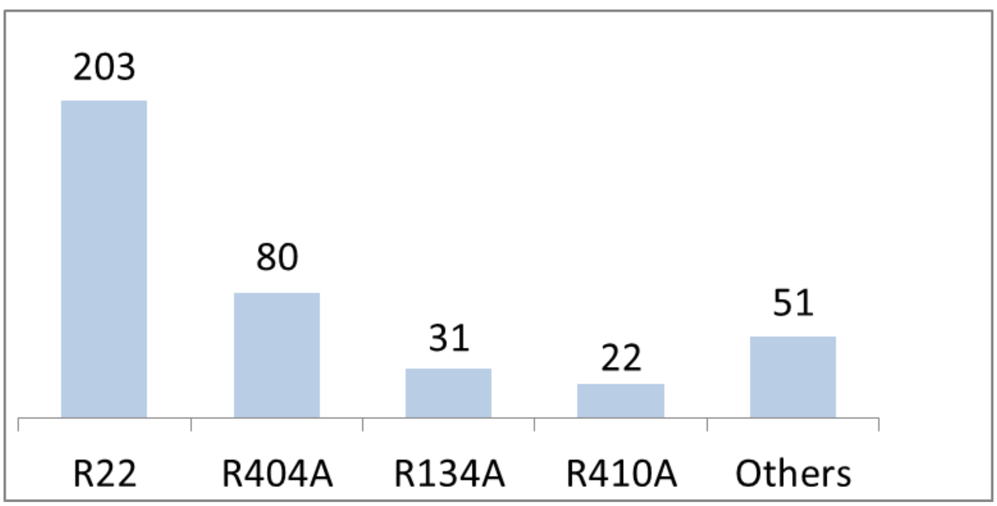


Figure 7. Major refrigerants used globally for refrigeration (excluding HVAC), in ktons (BSRIA 2015b)

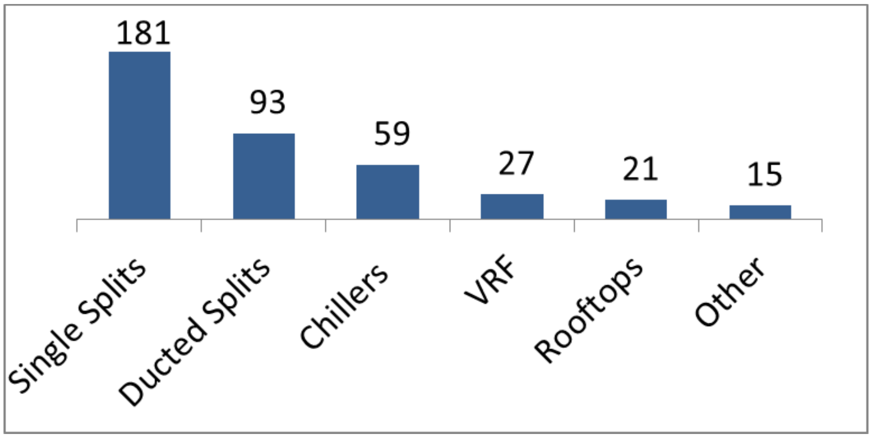


Figure 8. Global refrigerants used in HVAC (excluding refrigeration) applications, in ktons (BSRIA 2015a; BSRIA 2015b)

Sales of refrigerants for HVAC end uses are given in Figure 8, similar to the end-use splits for refrigeration given in Figure 6. Single splits are another term for ductless or minisplit air conditioners or heat pumps, which are by far the largest end use of refrigerants for HVAC globally. The ducted splits are primarily sold in the United States (~73% of total unit sales) with the balance going to markets in Asia (BSRIA 2015b). The ducted split market, while much smaller than that of single splits on a per-unit basis, is the second largest use of refrigerant due to the larger refrigerant charge per unit.

Figure 9 shows the major refrigerants (including blends) that are used in HVAC applications; hydrocarbons and other natural refrigerants are included but account for less than 1% of the total volume. Even with international agreements and the phaseout of HCFCs and HFCs, R-22 is still the second most commonly used refrigerant in HVAC applications. These data account for blended refrigerants separately from pure refrigerants. For example, pure R-32 accounts for ~3% of the total; however, R-410A consists of 50% R-32 by mass.

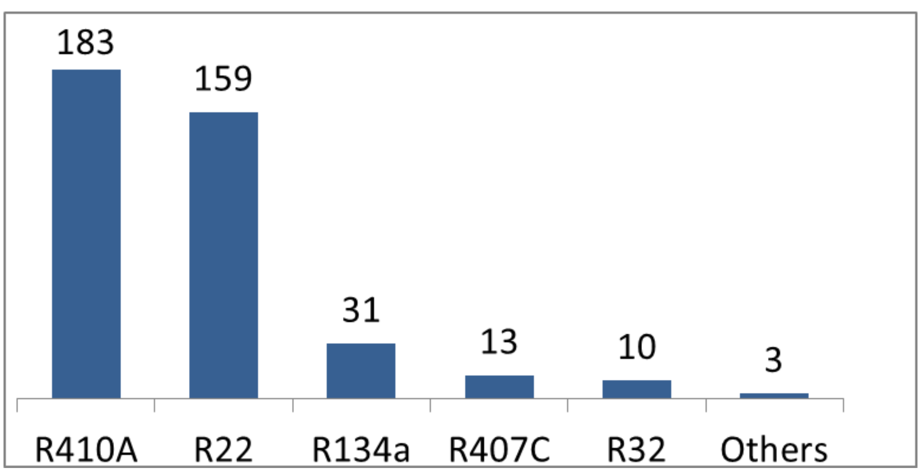


Figure 9. Major refrigerants used in HVAC (excluding refrigeration) applications globally, in ktons (BSRIA 2015b)

Within each end-use category, many different fluorocarbons are used. Table 1 provides quantitative use estimates for the most common refrigerants, disaggregated by end-use category. This does not consider uses in blends. Although HCFC-22 is being phased out in developed countries, it is still the most produced fluorocarbon globally. Approximately half of HCFC-22 production is for nonemissive uses in chemical production, most notably as a feedstock for polytetrafluoroethylene (PTFE), which is sold under the brand-name Teflon. However, if only emissive uses are considered, HCFC-22 is still the most produced fluorocarbon refrigerant for any application and is used in quantities that are comparable to those of any individual hydrocarbon used in aerosols.

Table 1. Global Annual End Uses of Major Refrigerants in ktons[a]. This excludes blends, in North America, European Union, China and Japan. Other refrigerants are also used in these applications; however, they are in much lower quantities.

Refrigerant	Polymer Precursor	Refrigeration & A/C	Foam Blowing Agents	Aerosols	Solvents	Fire Suppression
HCFC-22	360	248-400	34	-	-	-
HCFC-141b	-	-	60	-	5	-
HCFC-142b	106	6	11	-	-	-
HFC-32	-	10	-	-	-	-
HFC-125	-	83	-	-	-	0.4
HFC-134a	-	190-240	70	-	-	-
HFC-152a	50	17	16	38	-	-
HFC-245fa	-	-	28-62	-	-	-
HFC-143a	-	29	-	-	-	-
HFC-365mfc	-	1	8	-	-	-
HFC-227ea	-	-	-	-	-	0.6
HFO-1234yf	-	15-30	-	-	-	-
HFO-1234ze	-	<1	1-4.5	Unk	-	-
HFO-1233zdE[k]	-	<1	4	-	-	-
HFO-1336mzz[l]	-	Neg	Neg	-	-	-
Pentane (R-601c)	-	-	355	-	-	-
CO_2 (R-744)	-	70-80	15[d]	52	-	-
Propane (R-290)	-	37-46	-	420	-	-
Ammonia (R-717)	-	9-26	-	-	-	-
Isobutane (R-600a)	-	6-11	-	420	-	-
n-butane (R-600)	-	-	-	420	-	-
Total[b]	522	749-949	610-649	1510	14	13

[a] Greenpeace 2012, True Manufacturing 2017, Clodic et al. 2006, IHS 2014, BSRIA 2015b, Building Green 2010, Business Wire 2016 Transparency Market Research 2016, Grand View Research 2016, CNCIC Consulting 2015, Shecco 2012, 2013, 2015, 2016, Hella 2011, Chemours 2016b, EJARN 2015a, EJARN 2015b, Godwin et al. 2014, Eurostat 2017, U.S. Environmental Protection Agency (EPA) 2016a

[b] Includes minor refrigerants not listed here; rows may not sum to the total.

There are regional differences in refrigerant use, as shown in Table 2. This table includes all refrigerants currently used for stationary HVAC and refrigeration applications but does not include mobile applications. Note that this table represents the installed base of refrigerants, not new equipment sales. This is an important distinction because there are some refrigerant applications, such as R-123 in chillers, where sales of new equipment will soon be phased out while servicing use continues for existing equipment. Similarities in refrigerant selection can be seen across regions, with some important exceptions. R-600a is a substantial portion of domestic refrigeration markets outside of the United States which uses R-134a almost exclusively in this end use. Other major differences can be traced to developing versus. developed countries and the use of R-22 in direct expansion air conditioning or chillers.

Table 3 lists common refrigerant blends for vapor compression applications. These include HFC blends as well as HFC/HFO blends. Note that there are a few component refrigerants that are present in most of these blends, including upcoming and newly developed HFC/HFO blends. R-32, R-125, R-134a, and R-1234yf appear in most blended refrigerants, with the differences being in the percent composition of the components or the addition of other components such as R-1234ze(E). This relatively large selection of new blends is aimed at replacing just a few current refrigerants/blends, so there may be multiple options available to replace an existing refrigerant depending on the particular end use.

Table 2. Dominant Installed Refrigerants for Vapor Compression Applications (BSRIA 2015a). Other refrigerants may be used in these applications but in smaller quantities.

Application	United States	Rest of Americas	Europe	Asia	Middle East/Africa
Domestic Refrigeration	R-134a	R-134a R-600a	R-600a	R-600a R-134a	R-600a R-134a
Commercial Refrigeration	R-404A R-134a	R-404A R-134a	R-404A R-134a Hydrocarbons R-744	R-404A R-134a R-22	R-404A R-134a R-22
Industrial Refrigeration	R-717 R-22	R-717 R-22	R-717 R-744	R-717 R-22 R-744	R-717 R-22
Direct Expansion Air Conditioning	R-410A	R-410A R-22	R-410A	R-410A R-22 R-32	R-22 R-410A
Chillers	R-134a R-410A R-123	R-134a R-410A R-22 R-123	R-410A R-134a R-407A R-407C	R-134a R-410A R-407C R-22 R-123	R-410A R-22 R-134a R-123

Table 3. Typical End Uses of Refrigerant HFC and HFC/HFO Blends and What Refrigerant(s) They Replace. Most refrigerants used for non-vapor-compression applications are not blended (Abdelaziz et al. 2016; Wang and Amrane 2016; Kujak 2017; Goetzler 2016; Honeywell 2015a; Chemours 2017a; Chemours 2017b).

	Refrigerant	Producer(s)	Components	Replaces	Typical End Uses
Current HFC Blends	**R-404A**	(many)	R-125/143a/134a	R-22, R-502	Commercial refrigeration
	R-407C	(many)	R-32/125/134a	R-22	Commercial AC, positive displacement refrigeration
	R-410A	(many)	R-32/125	R-22	Residential, small commercial stationary AC systems
Upcoming HFO/HFC Blends	**R-444B**	Honeywell	R-32/152a/1234ze(E)	R-404A, R-407C, R-22	Low- and medium-temperature refrigeration
	R-447A	Honeywell	R-32/125/1234ze(E)	R-410A	Residential, small commercial stationary AC systems
	R-447B	Honeywell (not in production)	R-32/125/1234ze(E)	R-410A	Residential, small commercial stationary AC systems
	R-448A	Honeywell	R-32/125/1234yf/134a/1234ze(E)	R-22, R-404A,	Low- and medium-temperature refrigeration
	R-449A	Chemours	R-32/125/1234yf/134a	R-22, R-404A/R-507, R-407A/F	Low- and medium-temperature refrigeration
	R-452B (DR-55)	Chemours, Honeywell[a]	R-32/125/1234yf		Residential, small commercial stationary AC systems
	R-454B	Chemours	R-32/1234yf	R-410A	Residential, small commercial stationary AC systems
	R-513A	Chemours	R-1234yf/134a	R-134a	Centrifugal, screw chillers
	R-514A	Chemours	R-1336mzz(Z)/R-1130(E)	R-123	Centrifugal chillers

[a] Trane owns patent rights for use in HVAC equipment but has made its patents available on a royalty-free basis (Ingersoll-Rand 2016).

2 Existing Refrigerant Landscape

This section provides details on the current refrigerant landscape with additional background, production, and historical information for the most common individual refrigerants currently in use globally.

2.1 Individual Refrigerant Market Overviews

2.1.1 Chlorofluorocarbons (CFCs)

By 1996 and 2010, all CFCs had been phased out in developed and developing countries, respectively, in accordance with the Montreal Protocol (UNEP 2016a). The focus of this report is on the classes of chemicals that replaced CFCs in this industry: HCFCs, HFCs, HFOs, and nonfluorinated refrigerants.

2.1.2 Hydrochlorofluorocarbons (HCFCs)

2.1.2.1 Chlorodifluoromethane (HCFC-22)

Production

China, the United States, and Europe account for the majority of HCFC-22 production. China produced 418 ktons of HCFC-22 in 2016 (ChinaIOL 2017). The United States reportedly produced 135 ktons in 2011 (EPA 2016a). No more than 56 ktons of U.S. production may be produced for emissive uses through 2019, pursuant to the EPA’s HCFC Phaseout Schedule (EPA 2014). Currently, China consumes about 70% of the HCFC-22 it produces, and of that fraction, about 60% goes to emissive uses (e.g., refrigeration), while the remaining 40% is used as a feedstock (e.g., in the production of PTFE). As shown in Figure 10, approximately 40% of the HCFC-22 produced in the United States is used for emissive applications. The remaining 60% is used as a feedstock. Although aggregate European production of HCFC-22 is not directly available from public sources for confidentiality reasons, an idea of the size of this market can be estimated from aggregate HCFC production quantities. The European Union produced 120 ktons of HCFCs in 2015 (EEA 2015a), the vast majority of which was HCFC-22 to be used as a feedstock.[2] Several other countries, such as Japan, India, and Argentina, also produce HCFC-22 in lesser amounts (IHS 2014).

[2] In 2016, three ktons of HCFC-22 were also exported to Japan (Trade Map) for ultimate use as a feedstock.

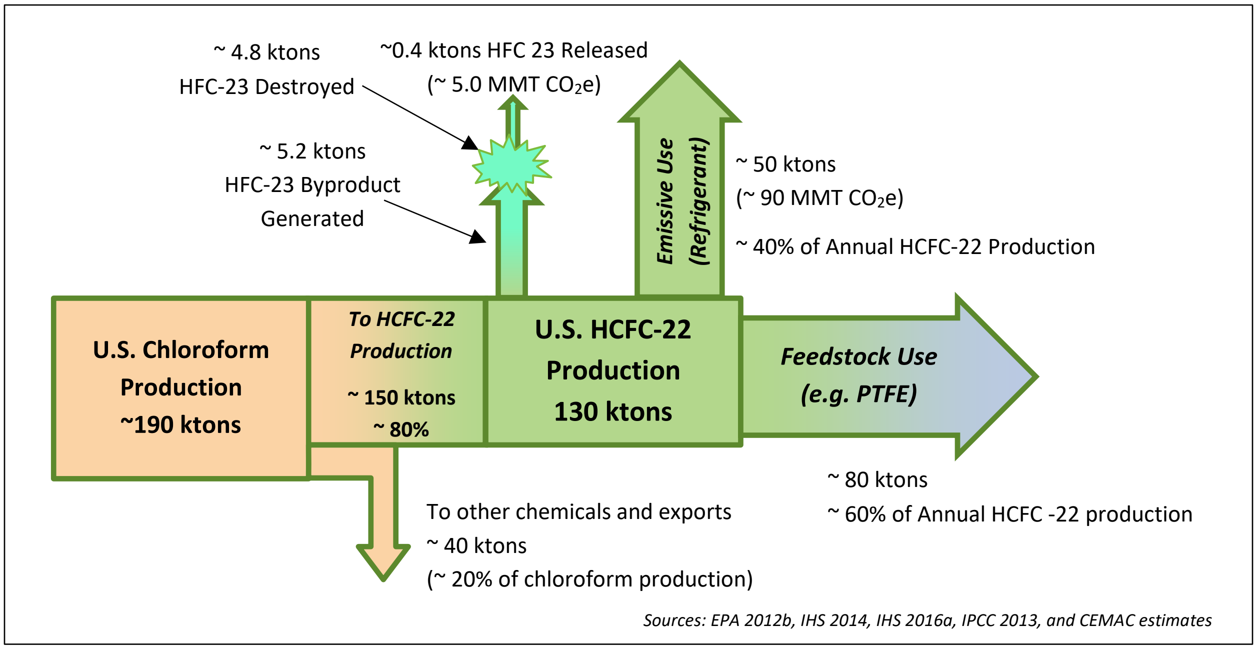


Figure 10. Simplified flow diagram of U.S. HCFC-22 supply chain, as of 2014. HFC-23 is a byproduct of HCFC-22 production, and most HFC-23 is now intentionally destroyed to avoid emitting it to the atmosphere, because it has a high global warming potential (GWP) of 12,400 (IPCC 2013).

Distribution

China accounted for 112 ktons (73%) of the 150 ktons of HCFC-22 exported globally in 2016, followed by India with 20 ktons (13%) and the Netherlands with 6 ktons (4%) (Trade Map). Chinese HCFC-22 exports were distributed to many countries, with the highest fraction (23%) going to Japan.[3] Globally, Japan accounted for 16% of HCFC-22 imports in 2016, the highest of any country. Japan was followed by Germany with 12% of imports and Brazil with 8% (Trade Map). Being an Article 5 country subject to the longer Montreal Protocol phaseout schedule, Brazil still imports HCFC-22 for refrigeration purposes, whereas Germany, like Japan and the other non-Article 5 countries, now consumes HCFC-22 nearly exclusively for nonemissive feedstock applications.

Regulatory Factors

HCFC-22 is an ozone depleting substance (ODS) subject to phaseout under the Montreal Protocol, which mandates stepwise reductions in consumption leading up to a complete phaseout of all HCFCs in non-Article 5 parties by 2030 and in Article 5 parties by 2040. In addition, several parties have introduced stricter measures to reduce HCFC-22 consumption.

---

[3] Like the United States, Japan banned the use of HCFC-22 in new refrigeration systems as of 2010 (UNEP 2003), so nearly all Japanese imports of HCFC-22 are for feedstock uses, aside from a small "use or servicing tail" for existing refrigeration equipment. HCFC-22 for servicing will be banned in Japan after 2020 (UNEP 2003).

In Europe, the use of virgin (new) HCFC-22 for emissive uses was banned in 2010. From 2010–2014, only recycled or reclaimed HCFC-22 could be used to service refrigeration equipment. On January 1, 2015, a Europe-wide ban on HCFC use for emissive applications went into effect (Milieu Ltd. 2007).

In the United States, the use of HCFC-22 in new equipment was banned in 2010; it may only be used to service equipment manufactured prior to 2010. By 2020, in accordance with the Montreal Protocol, HCFC-22 production for emissive uses will be banned entirely, and only recycled or reclaimed HCFC-22 will be able to be used to service equipment. By 2030, servicing and any other emissive use HCFCs, including HCFC-22, will be prohibited in the United States (and in all developed countries, pursuant to the Montreal Protocol).

Intellectual Property

Manufacture of HCFC-22 was first described in the patent literature by Thomas Midgley Jr., Albert L. Henne, and their colleagues at General Motors Corp with the landmark CFC patents filed in the 1930s (Henne 1934; Midgley et al. 1934; Henne 1935). Patents for the large-scale, commercial manufacture of HCFC-22 have long since expired—HCFC-22 is considered “off-patent” (no longer subject to patent restrictions).

Summary

- China leads the world in HCFC-22 production, followed by the United States and Europe.
- A significant fraction of HCFC-22 is used as a feedstock to make other chemicals. This use is not impacted by Montreal Protocol or other regulations, except to the extent that the emission of HFC-23, a byproduct of HCFC-22 production, is regulated.
- The Montreal Protocol calls for a phaseout of HCFC-22 in all developed countries by 2020 and in all developing countries by 2040.
- Europe has already banned all HCFCs, including HCFC-22, for emissive use.

2.1.2.2 2,2-Dichloro-1,1,1-trifluoroethane (HCFC-123)

Production

China, the United States, and Canada account for the majority of HCFC-123 production. China had a production quota of 2.8 ktons of HCFC-123 in 2016, which was issued to a single company—Zhejiang Lantian Environmental Protection Hi-Tech Co., Ltd. (CCM 2016b). The United States produced between 0.5 and 5.0 ktons of HCFC-123 in 2015 (EPA 2016a). Canada produced approximately 2.0 ktons of HCFC-123 in 2016 (UNEP Ozone Secretariat 2017).

Distribution

China accounted for 44% of global HCFC-123 exports in 2016, followed by Canada with 38% and the United States with 15% (Trade Map). Chinese HCFC-123 exports were mainly to Germany

(72%). Globally, Germany accounted for 2.3 ktons (33%) of HCFC-123 imports in 2016, the highest of any country. It was followed by the United States with 30% of imports (98% of which came from Canada) and South Korea with 8% (Trade Map). All of HCFC-123 imported into Germany is intended for feedstock use (EEA 2015a), whereas some of the HCFC-123 imported into the United States can still be used in new centrifugal chillers until 2020.

Regulatory Factors

HCFC-123 is an ODS subject to regulation under the Montreal Protocol, which mandates stepwise reductions in consumption leading up to a complete phaseout of all HCFCs in non-Article 5 parties by 2030 and in Article 5 parties by 2040. In addition, several parties have introduced stricter measures to reduce HCFC-123 consumption.

In Europe, the use of virgin (new) HCFC-123 was banned in 2010. From 2010–2014, only recycled or reclaimed HCFC-123 could be used to service refrigeration equipment. On January 1, 2015, a Europe-wide ban on HCFC use for emissive applications went into effect (Milieu Ltd. 2007).

In the United States, the use of HCFC-123 in new equipment is allowed until 2020, after which it may only be produced or imported for servicing existing equipment. U.S. production of HCFC-123 for emissive uses will cease by 2030, pursuant to the Montreal Protocol. (See Section 3.1.3 “Other HFOs” for more information on potential replacements for HCFC-123 in commercial chillers).

Intellectual Property

Patents covering the production of HCFC-123 can be traced back to the original 1930s CFC patents assigned to General Motors after the discovery of CFCs by Thomas Midgley and others. However, modern commercial-scale patents specifically focusing on HCFC-123 production are concentrated in the late 1980s, with patents filed largely by DuPont (Manzer and Rao 1988; Gumprecht et al. 1989). These patents expired in the early 2000s, and HCFC-123 is now considered off-patent.

Summary

- Global production of HCFC-123 is small compared to that of HCFC-22 and is relatively evenly distributed between China, the United States, and Canada.
- Germany imports HCFC-123 but only for feedstock use (emissive use of HCFCs has been banned in Europe since 2015).
- The Montreal Protocol calls for a phaseout of HCFC-123 production for use in all developed countries by 2030 and in all developing countries by 2040.

2.1.2.3 Other HCFCs

The only other HCFCs used commercially are HCFC-124, HCFC-141b, and HCFC-142b. HCFC-124 is used as a refrigerant and fire suppressant but is only produced in negligible quantities. HCFC-141b is still used as a blowing agent for polyurethane production in developing countries (especially China). HCFC-142b is mainly consumed as a feedstock but does have some refrigerant applications. As the amounts produced for refrigeration purposes are rather small, these HCFCs will be discussed only briefly.

China produces about 0.3 ktons of HCFC-124 annually and is likely the only significant producer globally, although Canada may also be a producer (Vithoontien 2016). China also produces about 90 ktons of HCFC-141b annually and exports 40% of it to other Article 5 countries (Vithoontien 2016). China produces 80 ktons of HCFC-142b annually (Vithoontien 2016; ChinaIOL 2017), but only about 17 ktons of that is for emissive uses (the remaining 64 ktons is consumed as a feedstock). China exports about 5 ktons of HCFC-142b annually to other Article 5 countries (Vithoontien 2016). The United States also produces HCFC-142b, but production is almost exclusively for feedstock uses as required by the phaseout schedule established by the EPA's HCFC production allowance system (EPA 2014). The production or import for nonfeedstock uses will be prohibited in the United States (and all developed countries) starting in 2020, pursuant to the Montreal Protocol.

2.1.3 Hydrofluorocarbons (HFCs)

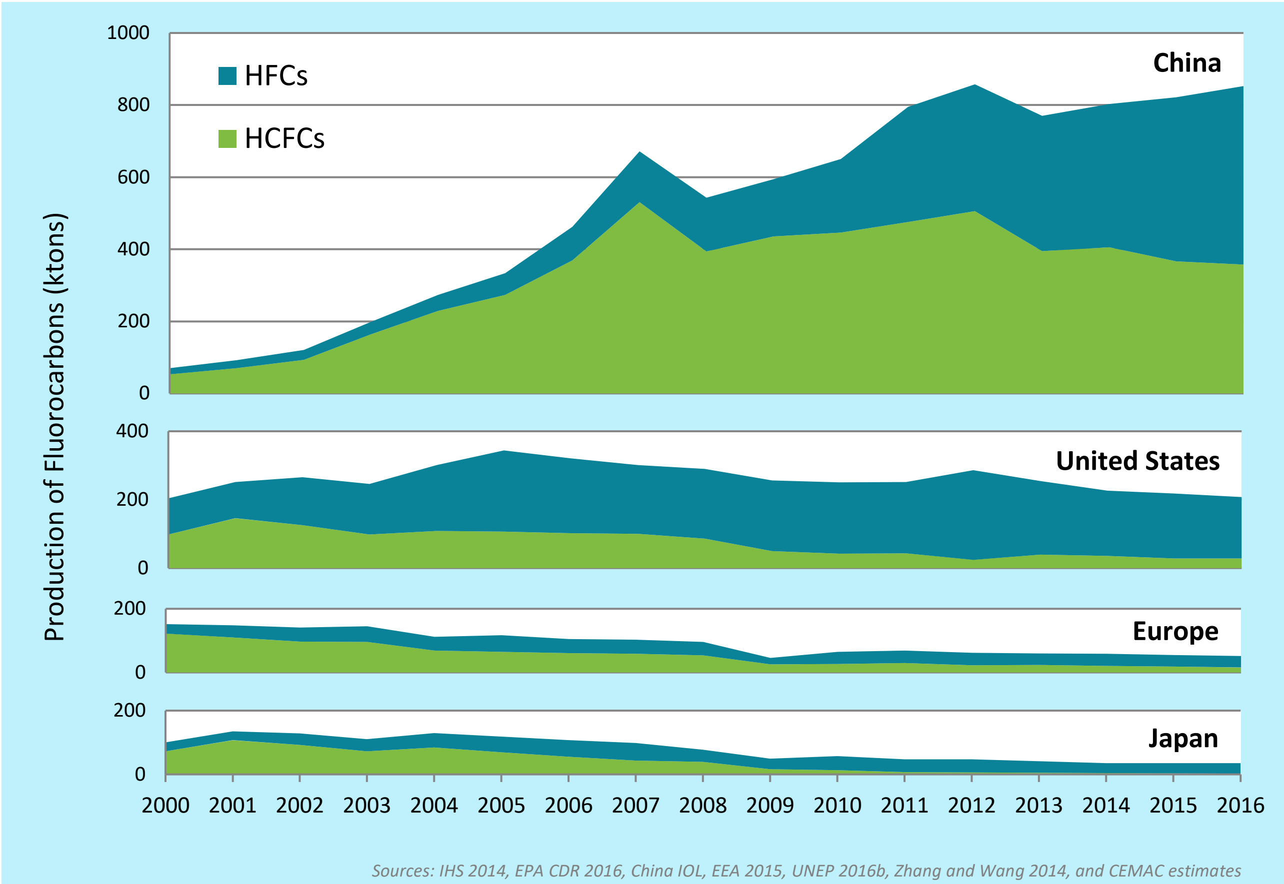


Figure 11. Metric tons of annual HCFC and HFC production for emissive use, by region (2000–2016). China is now the world's largest producer of both HCFCs and HFCs.

2.1.3.1 1,1,1,2-Tetrafluoroethane (HFC-134a)

Production

China and the United States are the major producers of HFC-134a. Chinese companies produced 150 ktons of HFC-134a in 2016 (ChinaIOL 2017); the United States produces roughly 100 ktons of HFC-134a annually (EPA 2016a; IHS 2014). Lesser amounts are produced in the European Union, Japan, and India (EEA 2015b; IHS 2014; Rao 2016).

Distribution

China accounted for approximately 60% of global HFC-134a exports in 2016, followed by the United States with approximately 30% (Trade Map and CEMAC estimates). Chinese HFC-134a exports were mainly to the United States and EU, while U.S. exports were mainly to the European Union (Trade Map).

There have been two separate antidumping lawsuits brought by U.S. HFC-134a manufacturers against their Chinese competitors. In the first, a 2013 suit filed by Mexichem, the U.S. International Trade Commission (U.S. ITC) determined that the U.S. refrigerant manufacturing industry was *not* materially injured (U.S. ITC 2014) because of insufficient evidence that the increase in Chinese imports was responsible for the decrease in HFC-134a selling prices. However, in a more recent 2017 ruling, the causal link between Chinese HFC-134a imports and less than fair value prices was found to be more substantiated. The U.S. ITC ruled that Chinese imports *were* being imported for sale at less than fair value and imposed antidumping duties (U.S. ITC 2017). The approximate inverse relationship between HFC-134a unit value and quantity of Chinese imports is exhibited in Figure 12.

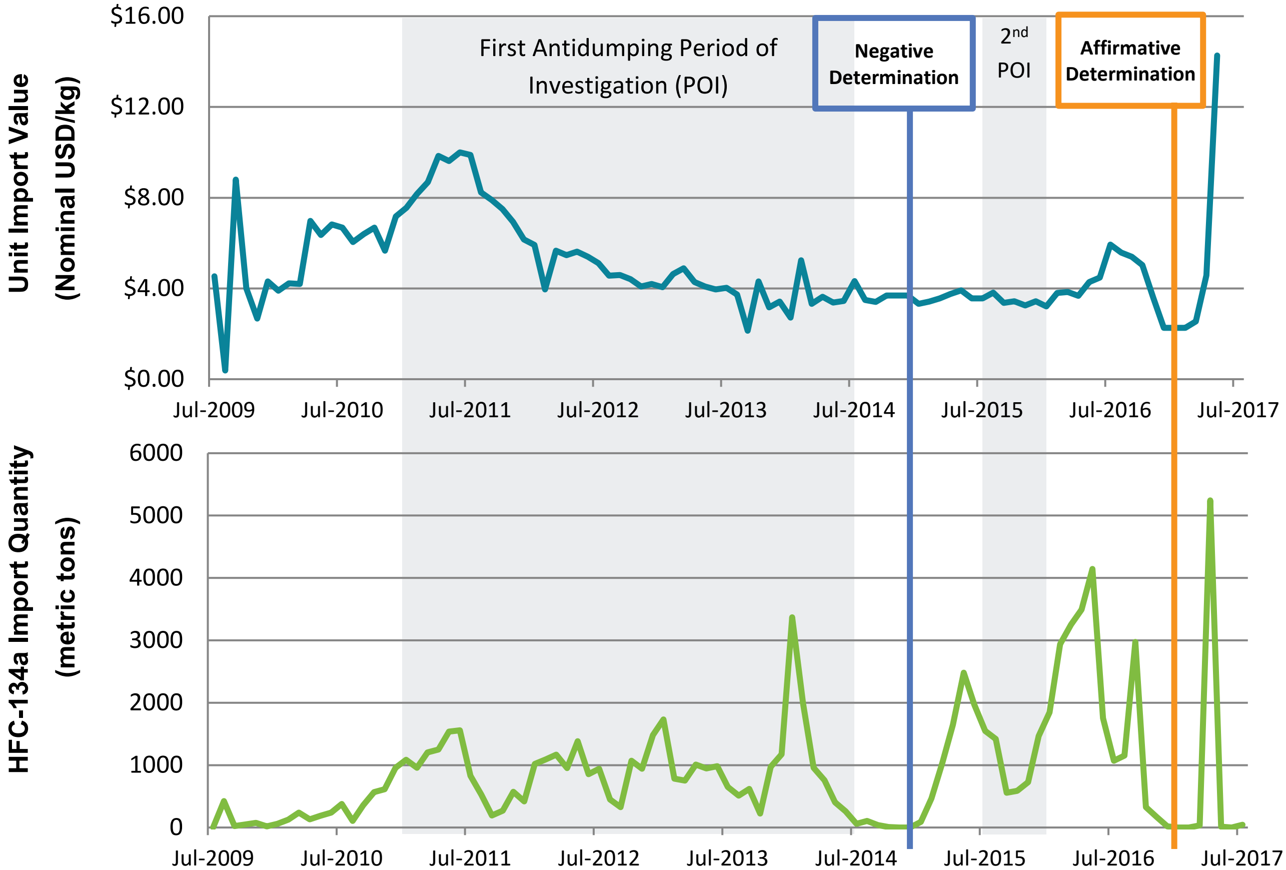


Figure 12. Unit values and quantities for U.S. imports of HFC-134a from China, July 2009–July 2017. The vertical lines represent the dates of final decisions issued by the U.S. International Trade Commission (U.S. ITC) in the two antidumping lawsuits concerning HFC-134a imports from China. The recent spike in unit values is indicative of the antidumping duties going into effect.

Regulatory Factors

HFC-134a is not an ODS, but its GWP is 1,300 (see IPCC 2013 for full list of chemicals and their GWPs). For this reason, HFC-134a production and consumption, like that of most HFCs, will be phased down under the Kigali Amendment to the Montreal Protocol. Some developed countries have already implemented regulations aimed at reducing HFC-134a consumption, as described briefly below.

The EU F-gas Mobile Air Conditioning (MAC) Directive prohibits the use of any refrigerant with a GWP higher than 150, including HFC-134a, in all new vehicles as of 2017 (European Parliament Council Directive 2006).

In SNAP Rule 20 (finalized July 20, 2015), EPA determined that HFC-134a will be unacceptable for use in new U.S. automobiles beginning in 2021 (EPA 2015a). This SNAP Rule, however, would not impact the use of HFC-134a to service vehicles manufactured prior to 2021. On August 8, 2017, a federal appeals court ruled in favor of Mexichem in determining that the EPA did not have authority under the Clean Air Act to regulate HFC-134a via SNAP Rule 20 (Chemical & Engineering News 2017). The EPA has yet to respond, and the ultimate fate of SNAP Rule 20 is unclear at this time.

Japan has enacted regulations that will phaseout the use of HFC-134a in light-duty vehicles by 2023 (MOE 2016).

Intellectual Property

The earliest HFC-134a manufacturing techniques were patented by Imperial Chemical Industries (ICI) in the late 1970s (Bell 1978; Potter 1979). DuPont was granted a patent for an HFC-134a manufacturing process in 1982 (Gumprecht 1982). By the time that the Montreal Protocol was agreed to in the late 1980s, significant research attention had been given to HFC-134a as a replacement for CFCs, and the patents followed—roughly half of all patents referencing HFC-134a were granted between 1990 and 1999 (see Figure 21 in Section 3.1.1). The initial production patents filed in the early 1980s expired in the early 2000s, after which an increase in off-patent HFC-134a manufacturing was observed in Article 5 countries, especially China.

Summary

- China and the United States will continue to be the dominant producers of HFC-134a.
- Imports of HFC-134a from China to the United States are now subject to antidumping tariffs.
- Europe, the United States, and Japan all have regulations in place to reduce the use of HFC-134a in automotive air-conditioning systems. Phaseout dates for HFC-134a in new vehicles manufactured for these regions are 2017, 2021, and 2023, respectively. However, due to a recent court ruling, the U.S. regulation may be in jeopardy.

2.1.3.2 Blend Components

Production

China and the United States are the largest producers of the following three HFCs, which are principally used as components in refrigerant blends: HFC-125, HFC-32,[4] and HFC-143a. Lesser amounts are produced in the European Union and Japan (IHS 2014). Combined annual production of these blend components in China totaled 205 ktons in 2016 (ChinaIOL 2017). Annual U.S. production is approximately 30–60 ktons of blend components (EPA 2016a; Vithoontien 2016). HFC-125 and HFC-32 account for the majority of global blend component production—R-410A, the most widely used HFC refrigerant blend, is composed 50%/50% (by weight) of HFC-125 and HFC-32.

Distribution

China is by far the largest exporter of HFC blends and HFC blend components, at 110 ktons and 22 ktons in 2016, respectively (Trade Map). These amounts are each approximately 80% of their respective global totals. Roughly half of Chinese blend component exports are shipped to the United States, with the balance split between Japan and the European Union. Refrigerants blended in China, on the other hand, are distributed to many countries, with the highest amounts going to Europe and Thailand (10% each), followed by the United States (9%) (Trade Map).

Regulatory Factors

HFC blend components are not ODS, but they do have significant GWPs (see IPCC 2013). Therefore, HFC blends and their components will be subject to phasedown under the Kigali Amendment to the Montreal Protocol.

In a 2016 antidumping lawsuit brought by U.S. refrigerant manufacturers against importers of Chinese HFC blends and blend components, the U.S. ITC found that the U.S. refrigerant industry was materially injured by Chinese imports, but only by the import of blends themselves. HFC blends imported from China are now subject to antidumping duties ranging from 101.82% to 216.37% (U.S. ITC 2016). In that same decision, however, import of Chinese blend components was found not to be in violation of U.S. antidumping laws. U.S. refrigerant manufacturers argue that this decision creates a loophole, allowing the duty-free import of Chinese blend components and subsequent blending once those imports clear U.S. Customs (American HFC Coalition 2016). For this reason, the American HFC Coalition filed an appeal of the decision in late 2016, which is still pending (American HFC Coalition 2016).

---

[4] HFC-32 is also used on its own as a refrigerant. Production for this purpose is included in the totals for blend components since HFC-32 production is only reported in aggregate.

Intellectual Property

The blend of HFC-125, HFC-134a, and HFC-143a now known as R-404A was first patented by DuPont in 1987 (Bivens and Connon 1989). The blend of HFC-125 and HFC-143a now known as R-507A was patented by Allied Signal (now Honeywell) in 1989 (Shankland et al. 1993). The blends of HFC-125, HFC-134a, and HFC-32 now known as R-407A and R-407C were first patented by DuPont in 1990 (Shiflett 1993). The blend of HFC-32 and HFC-125 now known as R-410A was patented by Allied Signal (now Honeywell) in 1991 (Bivens et al. 1994).

Given the similar timeframe for the patenting of these major refrigerant blends, it is not surprising that these blend patents all expired around the same time, between 2009 and 2011. Because the blend compositions are no longer under patent protection, any company may now choose to produce or purchase the blend components and combine them to create the HFC refrigerant blends for resale. The degree to which this practice of off-patent blending, on its own, would have lowered blend and component prices (i.e., in the absence of increasing quantities of cheaper Chinese imports) became a central point of contention in the 2016 U.S. antidumping case (see the previous “Regulatory Factors” section).

Summary

- China is by far the largest producer of HFC blend components, followed by the United States.
- The widely used R-410A refrigerant blend is a key driver in this market—any regulations targeting the use of R-410A will significantly affect the HFC component market.
- U.S. imports of Chinese HFC blends, but not their constituent blend components, are subject to antidumping tariffs. This may create a loophole for domestic refrigerant blending operations, and an appeal of the decision is pending.

2.1.3.3 Other HFCs

2.1.3.3.1 HFC-152a

HFC-152a is primarily used as an aerosol propellant, but does have refrigeration applications. Volumes produced for refrigerant applications remain relatively small; adoption has been minor at least in part due to flammability concerns. The following is a brief market summary and overview of major HFC-152a developments.

China and the United States are the largest producers of HFC-152a. China produced 64 ktons in 2016 (ChinaIOL 2017), and the United States produced 23-45 ktons in 2015 (EPA 2016a). The specific amount of U.S. production is likely near the lower end of this range, given the estimated ~20 ktons of HFC-152a capacity (Vithoontien 2016). Lesser amounts are produced in the European Union (5 ktons capacity) (Vithoontien 2016). IHS estimates that in 2012, about 54% of the HFC-152a consumed in the North American market went to aerosol applications, with about 20% used as a blowing agent, and 17% as a feedstock. Just 8% of the HFC-152a consumed in the North American market was for refrigerant uses. Approximately one-third of the 2012 European HFC-152a consumption went to refrigeration applications, but overall consumption of HFC-152a in this region was less than 10 ktons.

A Chinese venture to commercialize refrigerators using HFC-152a for the domestic market, with financial support from the Multilateral Fund, proved to be unprofitable (Andersen et al. 2012). Attention has since turned to the possibility of using HFC-152a in MAC. HFC-152a is being trialed as a refrigerant within a secondary loop system in India as part of a collaborative project headed by the Institute for Governance and Sustainable Development (IGSD) (IGSD 2017).

2.1.3.3.2 HFC-245fa, HFC-365mfc, and HFC-227ea

These three HFCs are used almost exclusively as foam blowing or fire suppression agents, so they will not be covered in detail in this report. However, restrictions on their production and use could increase the adoption of HFO-1233zd(E) and HFO-1336mzz(Z) (see “Other HFOs” section).

The United States produced between 4.5 and 22.7 ktons of HFC-245fa in 2015 (EPA 2016a). The most recent exact production data from Honeywell’s Geismar, Louisiana, plant—the only major U.S. production location—was 21 ktons in 2011 (EPA 2016a). This is consistent with current estimates of installed U.S. HFC-245fa capacity (~20 ktons) (Vithoontien 2016). The only other major producer, China, is estimated to have approximately 15 ktons per year of HFC-245fa capacity (Vithoontien 2016).

The European Union is currently the only region that produces HFC-365mfc, with 15 ktons per year of capacity at a single Solvay plant in Tavaux, France (the actual production tonnage range for HFC-365mfc is listed as confidential within the European Chemical Agency’s [ECHA] Registration, Evaluation, Authorization and Restriction of Chemicals [REACH] database) (UNEP 2002; ECHA 2012a). China is the only region with HFC-227ea capacity, at around 9 ktons per year (Vithoontien 2016).

2.2 Supply Chain Considerations: Fluorspar and Hydrofluoric Acid

Essentially all major commercial manufacturing routes used in the production of HCFCs, HFCs, and HFOs start with a chemical reaction involving a chlorine-containing hydrocarbon with hydrofluoric acid (HF) (IHS 2014). HF is produced by reacting the mineral fluorspar with sulfuric acid. Even with the global phaseout of HCFCs and phasedown of HFCs, fluorspar and HF will remain in demand (if not more so) as HFO production increases to meet demand. Reliance on the mineral fluorspar could be reduced by obtaining fluorine from other natural resources, such as phosphate rock. Global reserves of phosphate rock are extensive, but current fluorine yields from this source are not economical when compared to the high fluorine content and relatively low price of acid-grade fluorspar (IHS 2016b). Fluorine extraction from phosphate rock is currently limited to fluosilicic acid byproduct recovery from phosphoric acid fertilizer production, but remains an active area of research (Dahlke et al 2016).

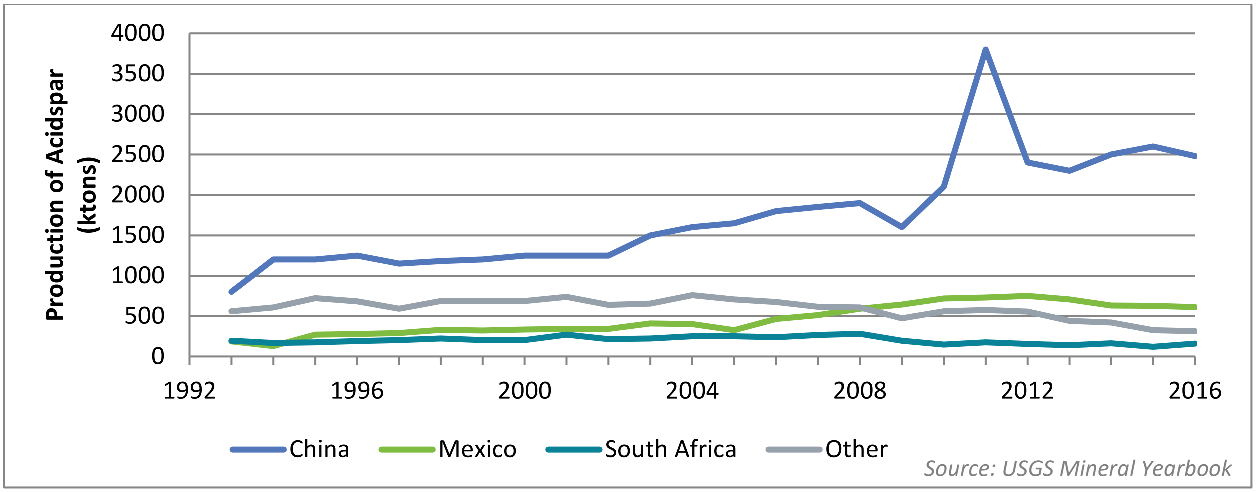


Figure 13. Global mined quantities of acid-grade fluorspar ("acidspar"), 1993–2016

As shown in Figure 13, China mines more acid-grade[5] fluorspar than any other country in the world, at 2,500 ktons annually (USGS 2017). Mexico is the second-largest producer of acid-grade fluorspar at around 600 ktons annually, followed by South Africa (150 ktons). Contributions from the rest of the world have declined since the mid-2000s, with the remaining balance of acid-grade fluorspar production at about 300 ktons in 2016.

From the mid-1990s to early 2000s, most of the acid-grade fluorspar mined in China was exported to the major refrigerant producing regions (United States, EU, Japan). Starting from around 78% in 1999, however, the fraction of all mined acid-grade fluorspar in China that was exported has declined substantially. As a result of the dramatic expansion of the Chinese refrigerant manufacturing industry in the 2000s, most acid-grade fluorspar mined in China is now consumed domestically. Just 8% of the acid-grade fluorspar mined in China in 2016 was exported (Trade Map; USGS 2017). In 2008, Mexico overtook China as the leading exporter of acid-grade fluorspar to the United States and in 2009 became the largest fluorspar exporter globally (Trade Map). In 2016, Mexico supplied about 65% of the acid-grade fluorspar imported into the United States (see Figure 14).

[5] Acid-grade fluorspar (also known as "acidspar") has a higher fluorine content than its metallurgical-grade counterpart ("met-spar"). Acid-grade fluorspar has a CaF_2 content of at least 97% by weight (USGS 2017).

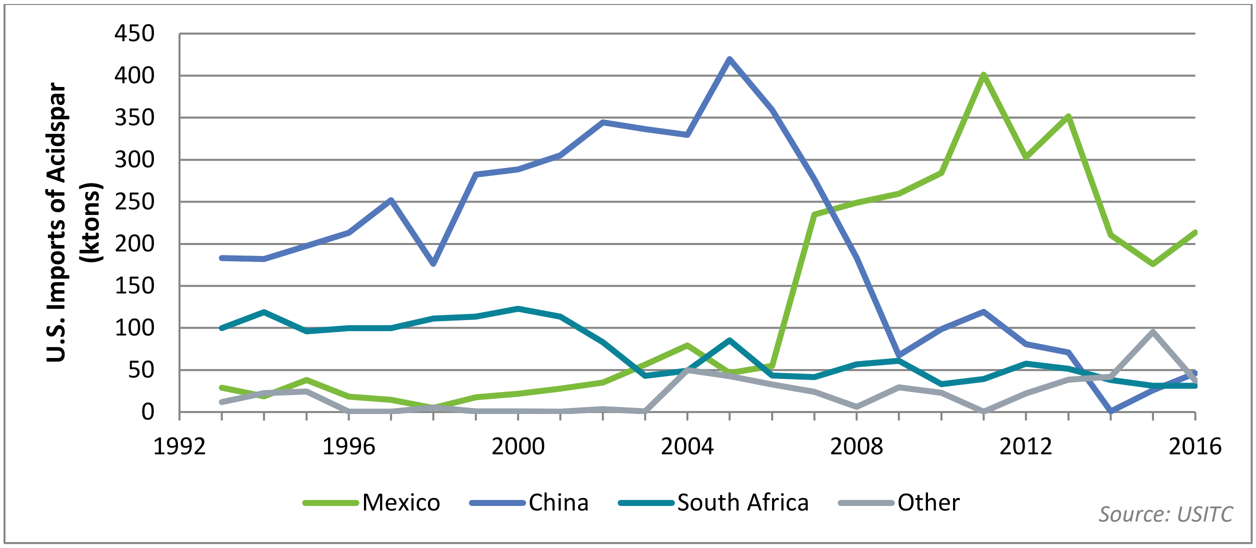


Figure 14. Annual U.S. import quantities of acid-grade fluorspar ("acidspar"), 1993–2016. Mexico, China, and South Africa are the major countries of origin for acidspar. Other countries that have imported significant quantities of fluorspar to the United States include Vietnam, Spain, the United Kingdom, and Mongolia.

The price of fluorspar rose significantly from the early 2000s through 2011. This was mainly due to a restriction of fluorspar exports from China (BGS 2011; IHS 2014). The Chinese government began implementing export restrictions in January 1999 with the formation of an export quota licensing system (IHS 2014). China then added more controls, including export tariffs, quotas, licenses, and minimum export prices, and fluorspar prices continued to rise through the 2000s (see Figure 15). In 2009, the United States and several other parties, including the European Union and Japan, filed a complaint with the World Trade Organization (WTO) alleging that these export restrictions were inconsistent with China's WTO obligations (WTO 2011). China had argued that such restrictions were enacted for resource conservation and environmental protection purposes (USGS 2012), but the 2011 WTO ruling found Chinese export restrictions to be inconsistent with WTO rules (WTO 2011). After an unsuccessful appeal, China was required to remove export restrictions on fluorspar and the other raw materials covered by the WTO complaint, but Chinese fluorspar export quantities continued to fall after 2011 (see Figure 14).

The subsequent decrease in price level for fluorspar after the WTO ruling had little to do with the lessening of Chinese export restrictions. In the wake of the ruling, the Chinese government took alternative steps to ensure domestic fluorspar supply was consumed internally in the manufacture of higher-valued products (Stewart 2012). The fluorspar price decrease has been attributed more to the reduced demand for raw material feedstocks triggered by the overall lessening of demand for virgin refrigerants themselves, which in turn is due to existing or anticipated phaseouts (Salwan 2015). In other words, the price increase prior to 2011 was driven more by supply constraints, whereas the price decrease after 2011 was caused by lower global demand despite a continued decline in Chinese fluorspar exports.

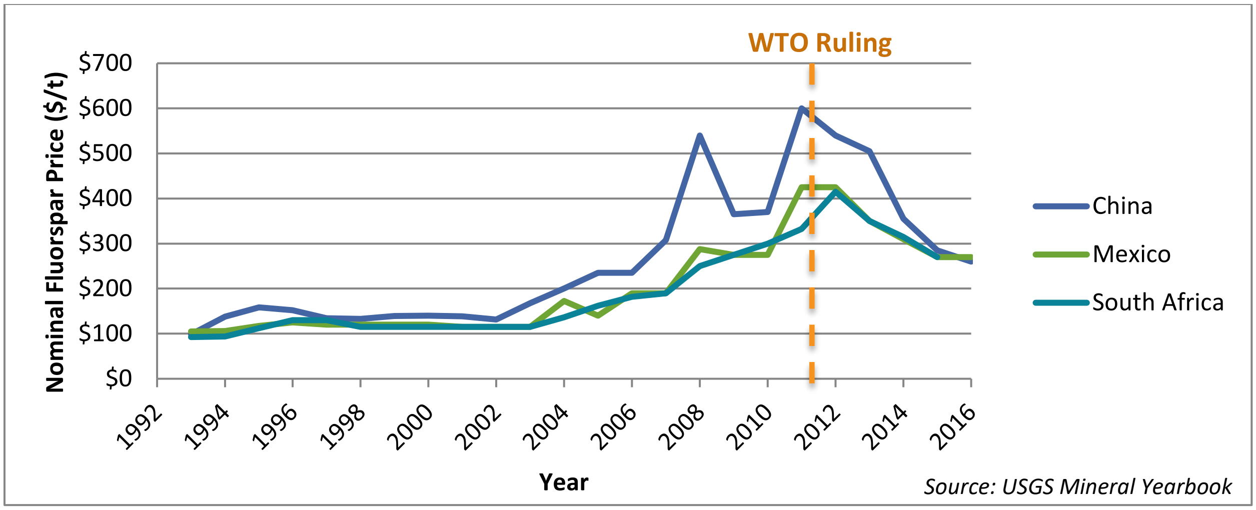


Figure 15. Nominal prices of acid-grade fluorspar ("acidspar") imported into the U.S. market, by country of origin, 1993–2016

HF itself is also traded globally; however, it is both toxic and corrosive (Mexichem 2013), making it difficult to transport great distances. For this reason, exported quantities are substantially lower than those of fluorspar, and HF export is mostly limited to nearby countries. For example, China primarily exports HF to Japan and South Korea, whereas nearly all Mexican HF exports go to the United States (Trade Map). Likewise, most HF imported into the United States comes from Mexico (see Figure 16).

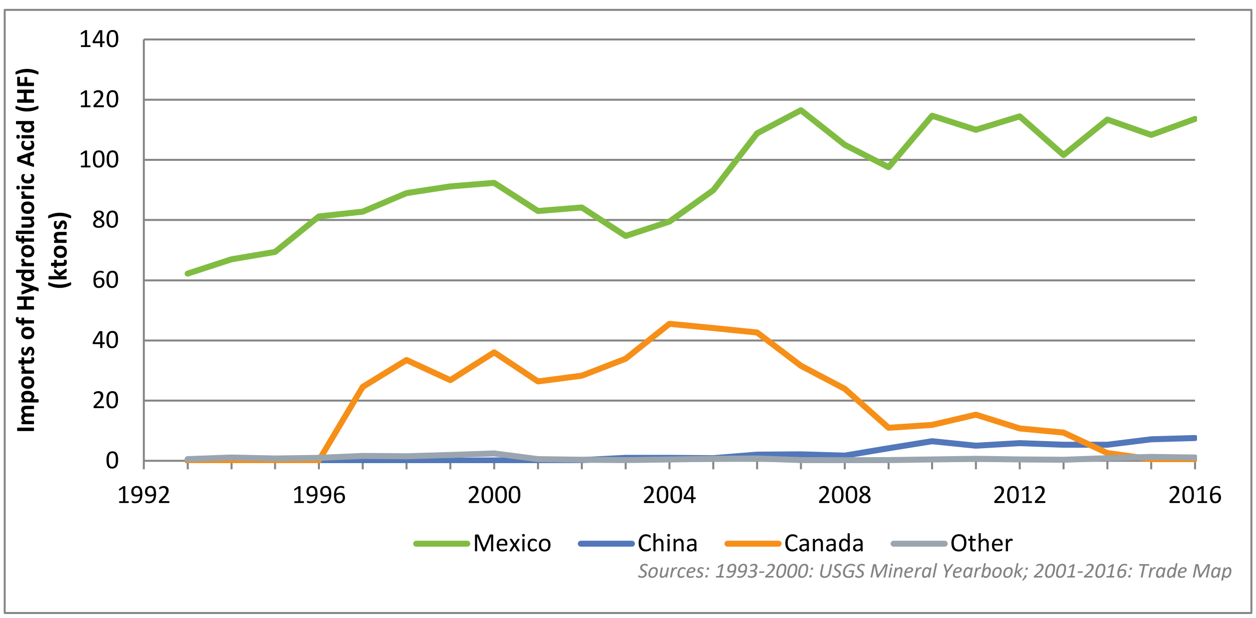


Figure 16. U.S. imports of hydrofluoric acid, 1993–2016

2.3 Refrigerant Manufacturing Locations

At the time CFCs were phased out in the mid-1990s, refrigerant manufacturers were already beginning to produce commercial quantities of the HFCs that would eventually replace the HCFC "transitional substances." DuPont, for example, already had 50 ktons of global HFC-134a capacity by January 1993, with plants located in the United States and Japan (Roberts 1993). ICI[6] had an HFC-32 plant in the United Kingdom as well as HFC-134a plants in both the United States and Japan (Roberts 1993). Indeed, refrigerant manufacturing during this period tended to be located in the regions with major end-use markets for the refrigerants: the United States, European Union, and Japan.

More recently, China has become a major refrigerant manufacturer and now accounts for the majority of annual fluorocarbon production. Figure 17 and Figure 18 show the locations of HCFC and HFC capacity as of 2016, respectively. Inexpensive feedstocks derived from China's extensive fluorspar mining operations (see Section 2.2), cheaper labor and processing energy, and the formation of Chinese chemical manufacturing "centers of excellence" all facilitated this growth (Seidel et al. 2015). Furthermore, the rise of Chinese bulk refrigerant manufacturing paralleled an increase in Chinese refrigeration and air-conditioning equipment production,[7] and this was cited as a key driver for a 2004 joint venture between DuPont and Chinese company Zhonghao New Materials (now known as Shanghai 3F New Materials Co., Ltd.) to manufacture HFC blends (Sheridan 2004). Partnerships between major Western chemical companies and Chinese producers are now common in the refrigerant industry and have continued with the transition to HFO production. In 2010, Shanghai 3F and DuPont formed another partnership, this time to manufacture HFO-1234yf at a jointly operated plant in Changshu, China (CCM 2012).

Nevertheless, the United States has been and continues to be a major producer of HFCs and now HFOs. In 1949, the Pennsylvania Salt Manufacturing Company (now known as Arkema) constructed an HF plant in Calvert City, Kentucky, utilizing the fluorspar from nearby mines as feedstock (Arkema 2017). Although fluorspar has not been mined in Kentucky since 1992 due to lower import prices (Walker 2010), the Calvert City plant still remains and has undergone several expansions—it now produces HFC-134a and HFC-32. The HFC-32 expansion was announced in 2007 and precipitated the 2014 closure of Arkema's aging HFC-32 and HFC-143a plant in Zaramillo, Spain. The Spanish plant was closed due to the "competitiveness gap with China and the United States," as well as the significant capital expenditures that would have been required to bring the plant into compliance with EU regulations (Arkema 2014).

[6] ICI was acquired by AkzoNobel in 2008 (Akzo Nobel 2008).

[7] Air-conditioner production alone was growing at about 10% per year in China in 2004 (ICIS 2004).

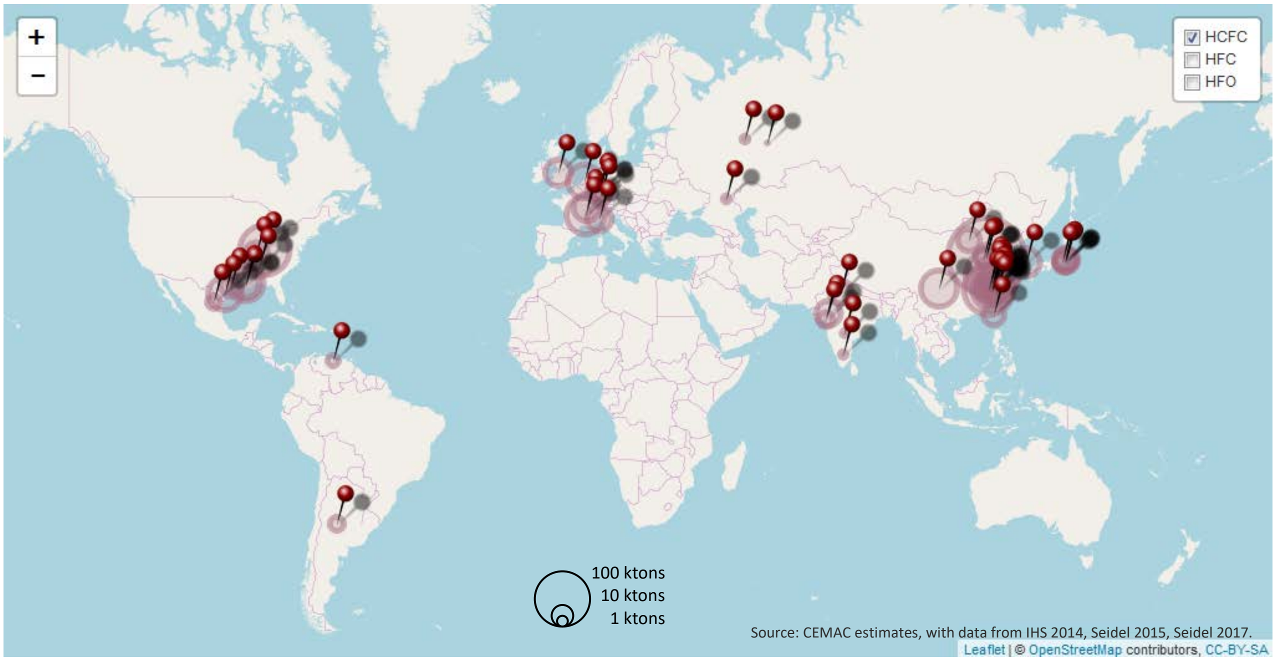


Figure 17. Locations and estimated capacities of HCFC manufacturing plants as of 2016. HCFC capacity is concentrated in China, with significant additional capacity in the United States, Europe, and Japan. Lesser capacities are scattered across various other countries.

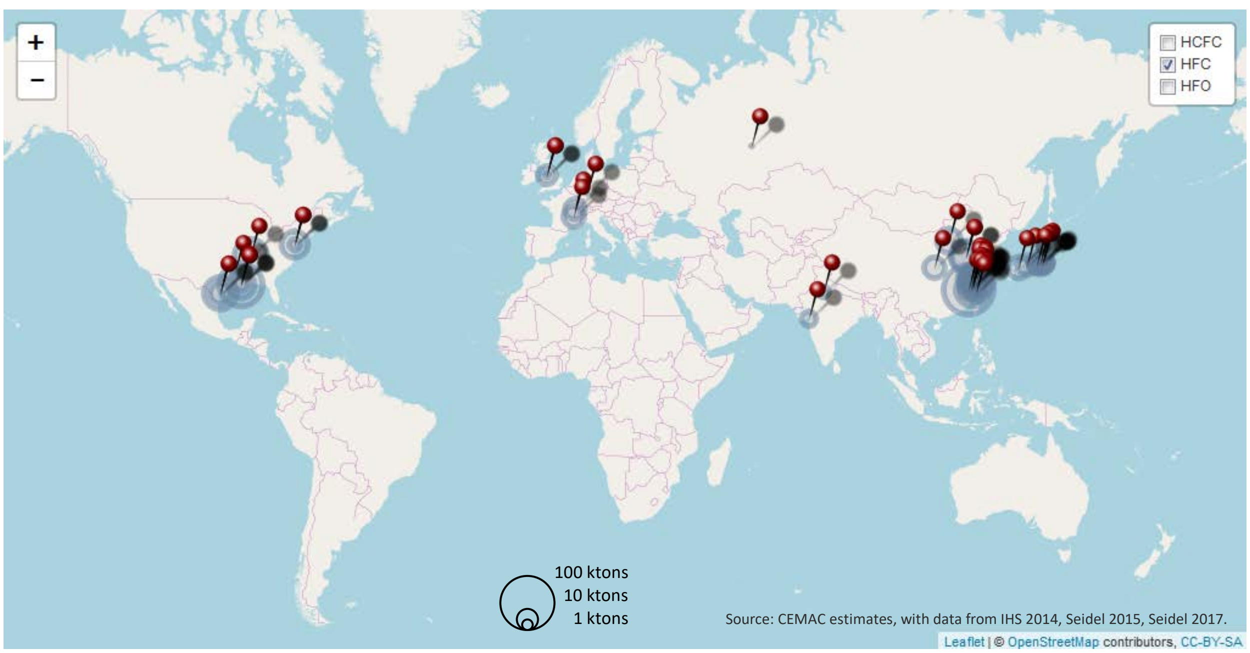


Figure 18. Locations and estimated capacities of HFC manufacturing plants as of 2016. HFC capacity is concentrated in China, with significant additional capacity in the United States and Japan. Lesser capacities are scattered across various other countries.

Figure 19. Locations and estimated capacities of HFO manufacturing plants, projected for 2018. By 2018, the major HFO capacity is expected to be relatively evenly spread between the United States and China, followed by Japan and India. Note: capacities for HFO plants are not typically disclosed and may vary widely from the estimates shown here.

In 1991, DuPont began constructing an HFC-134a plant in Corpus Christi, Texas (ICIS 1991). This location was chosen by DuPont at least in part because of the plant's existing capital; HFC-134a production was to utilize the same equipment and feedstock that had been used previously to make CFCs and HCFCs. Still, the HFC-134a production process itself would be "substantially different, both in terms of engineering and process operating parameters" (ICIS 1991). In 1995, DuPont added capacity for HFC-152a at Corpus Christi in order to meet U.S. demand for volatile organic compound-exempted aerosol propellant (ICIS 1995; CARB 1997)[8].

Honeywell invested over $200 million to build HFC-245fa and HFC-125 plants at Geismar, Louisiana in the early 2000s. By constructing them simultaneously, the company was able to reduce overall plant construction costs (Powell 2003). This was the preferred location of the plants due to Honeywell's existing HFC and HCFC capacity at Geismar—the company was able to take advantage of "an experienced workforce and a proven supply chain" (Powell 2003). Honeywell had negotiated a contract with Vulcan Materials Company, which was building a hydrochlorocarbon plant in Geismar, Louisiana to obtain a necessary feedstock chemical for HFC-245fa production (Kamalick 2000). Most recently, Honeywell built an HFO-1234yf facility at

[8] Although not directly related to the refrigerant market, this example is worth mentioning because of the parallels to the refrigerant manufacturing industry with regard to pricing disparity. Original equipment manufacturers voiced concern about HFC-152a supply shortage and thus higher prices—quoted prices at the time were $1.95/lb for HFC-152a compared to $0.20/lb for original (hydrocarbon) propellant (CARB 1997). That said, prices were already decreasing in November 1996: $1.95 to $1.85/lb.

Geismar, which began production in 2017. When the plant was announced in 2013, Honeywell cited incentives from the Louisiana Economic Development authority as a key driver in choosing Geismar for additional HFO capacity. The project was estimated to create 1,363 construction jobs as well as 55 permanent jobs (LED 2017). Projections for HFO manufacturing locations and capacities are shown in Figure 19 and indicate that by 2018, HFO production will be relatively evenly distributed between the United States, China, and Japan.

In summary, refrigerant manufacturing plants historically have been constructed in locations with one or more of the following characteristics (roughly in order of chronological relevance):

1. Proximity to fluorspar, HF, or other chemical feedstock
2. Within a country with strong refrigerant demand
3. Proximity to refrigeration and/or HVAC equipment manufacturers
4. Near a port city to facilitate import of raw material and/or export of finished product
5. Existing refrigerant manufacturing capital and experienced labor force
6. Availability of cheap energy and labor
7. Financial incentives from local governments or development authorities.

3 Alternative Refrigerants

3.1 Overview of Types and Applications

The term "alternative refrigerants" generally refers to any refrigerant outside the major fluorocarbons currently in use. This designation includes ammonia, carbon dioxide (CO_2), and propane, which have all been used to some extent for decades as refrigerants, as well as newly developed, man-made fluorocarbons such as HFOs (including HFO-1234yf) or blends of HFOs with other substances (typically HFCs). They are frequently classified into three categories, as shown in Table 4. Recent research and development in this area has focused on CO_2-based systems and in HFO commercialization. Data on costs, prices, trading patterns, and production are often not available for these materials. This is partly due to the nascent and dynamic market for these products, but also because these data are typically business sensitive and/or proprietary. However, market trends and other qualitative information are available as well as some quantitative data, which are presented here.

Ammonia is a toxic refrigerant that is widely used in industrial refrigeration. Due to toxicity there is limited opportunity for expanding applications beyond this large but somewhat niche market.

Table 4. Common Alternative Refrigerants (EFCTC 2017)

Category	Common Refrigerants	Typical Applications
Inorganic (Natural)	Ammonia (R-717)	Industrial refrigeration
	CO_2 (R-744)	Commercial refrigeration, foam blowing agent, heat pump water heaters, combo (space conditioning and water heating) systems
Hydrocarbon (Natural)	Propane (R-290)	Small self-contained commercial refrigeration, small stationary heat pumps, aerosol
	Isobutane (R-600a)	Residential/small commercial refrigerators, aerosol
	n-butane (R-600)	Aerosol
	Cyclopentane (R-601c)	Foam blowing agent
Hydrofluoroolefin (HFO)	R-1234yf	Mobile, stationary HVAC, refrigeration
	R-1234ze(E)	Refrigeration, HVAC, aerosol, blowing agent
	R-1233zd(E)	Chillers, blowing agent, solvent, waste heat recovery (organic Rankine cycles)
	R-1336mzz(Z)	Chillers, blowing agent

CO_2 has seen a surge in popularity in recent years for cascade systems, where it has been shown to be an efficient and promising system in supermarket refrigeration (Fricke and Sharma 2016). However, in direct expansion systems such as beverage vending machines, initial momentum in using CO_2 has been tempered largely due to the high system cost and low reliability that result from the high operating pressures in these systems (Hon 2017; VTech 2017).

Hydrocarbon refrigerants (also referred to as "natural" along with ammonia and CO_2) have gained traction in vapor compression systems in many areas of the world outside the United States (BSRIA 2015a). Small, self-contained systems, such as those used for household refrigeration, commonly use isobutane with more than 600 million units in operation globally and annual sales of 35–40 million units (Greenpeace 2012). Propane is gaining popularity for use in smaller stationary air-conditioning and small commercial refrigeration systems such as vending machines. Safety limitations (due to flammability) are currently limiting use to smaller systems with less than 150g of propane per refrigerant loop in many countries, although there is momentum building for increasing that charge, potentially up to 500g (Hydrocarbons21 2017) and a kilogram or more for some commercial and industrial uses (Kandi 2015). Asian countries are adopting propane devices in large numbers (BSRIA 2015b), with major manufacturers such as Gree developing ductless heat pumps that operate on propane (Hasse 2009). These devices have not made it to the U.S. market as of yet, although they are allowed under the EPA's SNAP program for certain applications (EPA 2017).

The major HFO refrigerants are listed in Table 4; more detail is provided on these HFOs in Goetzler et al. (2014). HFOs are often used in blends with HFCs for vapor compression systems. These blends are not listed here because there are a very large number of them. For a detailed list of refrigerants, including HFO blends, see ASHRAE Standard 34-2016 (ASHRAE 2016). However, the most common compounds in HFO blends are the HFOs listed in the table, plus the HFCs R-32, R-134a, R-125, and R-152a.

Although blending of HFOs is common, the largest application of HFOs currently is R-1234yf for mobile applications, where it is replacing R-134a. R-1234yf is by far the most common HFO in production (~3x the production of all other HFOs combined [BSRIA 2015]) and is being adopted globally by the automotive industry.

Prices for HFOs are sometimes a concern; most of the available cost information is for HFO-1234yf. Sherry et al. (2017) provide a detailed analysis of different production methods for HFO-1234yf and determine that although costs in the short term are ~10x that for HFC-134a, long-term costs are likely to be 2–3x that cost. An example cost comparison between HFC-134a and a hypothetical HFC/HFO blend is presented in Section 3.1.1.

HFO-1234ze(E) is the second-most-developed HFO in terms of production capacity; there could actually be temporary excess capacity in preparation for major equipment shifting to HFOs and blends (Walters-Terronini 2017). It can be used as an aerosol propellant (Rivoira 2014). It is also marketed by Honeywell under the name Solstice Gas Blowing Agent. It is a component in many blends such as HFO-444A, -444B, -445A, -447A, and -447B and is suitable for use in low- and medium-temperature refrigeration and stationary air-conditioning/heat pump applications as listed in Table 3. It is SNAP listed in the United States for use in chillers and certain foam blowing agent applications (EPA 2017; Goetzler et al. 2014).

HFO-1233zd(E) is marketed by Honeywell as Solstice LBA liquid blowing agent (EJARN 2016). It is a substitute for HFC-245fa with commercial applications in domestic appliances (EJARN 2015b). It is also used as a replacement for R-123 in centrifugal chillers (EJARN 2015b; EJARN 2016) and is SNAP listed for both of those applications (EPA 2017). This refrigerant is designated "A1," meaning it is nonflammable as well as nontoxic (Goetzler et al. 2014), which is a distinct advantage in terms of regulatory approval and consumer acceptance over many other HFOs.

HFO-1336mzz(Z) has been branded by Chemours as Opteon 1100 (formerly Formacel 1100) and marketed for use as a blowing agent. It has ~5% better R-value for polyurethane foams than if produced using HFC-245fa (McMenamin et al. 2009). It is also SNAP listed for use in chillers, is nonflammable, and can potentially be used for high temperature heat pumps and organic Rankine cycles (EJARN 2015b; Konstantinos 2014).

Other emerging applications for HFOs, primarily in blends, are for chillers, stationary air conditioners and heat pumps, refrigeration, and as blowing agents. Table 3 and Table 4 provide more detail about which new refrigerant or blend is used in each application.

The following sections provide more in-depth market statistics for the four HFOs that have been commercialized to date: HFO-1234yf, HFO-1234ze(E), HFO-1233zd(Z), and HFO-1336mzz(Z).

3.1.1 HFO-1234yf

Production

2,3,3,3-Tetrafluoropropene, better known as HFO-1234yf, is the highest volume HFO refrigerant worldwide. The United States, China, and Japan are the leading producers of HFO-1234yf. Specific plant capacities for this relatively new refrigerant are confidential in some cases, so it is difficult to estimate production quantities. Honeywell began operation at its newly constructed HFO-1234yf plant in Geismar, Louisiana, in May 2017 (Honeywell 2017). That plant has an estimated annual capacity of 10–15 ktons (Sherry et al. 2017). Chemours has announced plans to triple its HFO-1234yf capacity by constructing a plant in Corpus Christi, Texas, to be operational by the end of 2018 (Allgood 2017). China has at least 6 ktons/year of HFO-1234yf capacity from the Shanghai 3F/Chemours jointly operated plant, and this total does not include the additional 7 kton capacity from an Arkema plant not yet operational and an undisclosed additional capacity from an agreement between Honeywell and Juhua Corp. (PRLog 2012; ACHR NEWS 2016). Two Japanese plants produce smaller quantities of HFO-1234yf, estimated at less than 1 kton capacity each (Sherry et al. 2017).

Distribution

Europe has been the focal point of international trade in HFO-1234yf because it was the first region to legislate a phaseout of HFC-134a in mobile air conditioning (see "Regulatory Factors," below). In 2016, more than 4 ktons of HFO-1234yf was imported by Europe, mainly from China and Japan (see Figure 20) (Eurostat 2017). HFO-1234ze(E) is registered in the highest tonnage band (>1 ktons annually) under ECHA's REACH program, meaning there are would be no limitation on further increases in imports of HFO-1234yf into the European Union (Achaichia 2014; ECHA 2010). Exact Chinese and Japanese imports to the United States are uncertain, but the quantities are assumed to be sufficient to meet growing demand for the manufacture of vehicles in the United States by companies such as GM, Ford, Fiat Chrysler, and Tesla. These companies and others are adopting HFO-1234yf in some of the newer model years of American-made and imported cars and trucks (Chemours 2017c). The United States is expected to take over a broader share of the export market from 2017 onward as domestic HFO-1234yf production has begun at the Honeywell's Baton Rouge plant in 2017 and is expected to begin at the Chemours plant in Corpus Christi, Texas, in 2018.

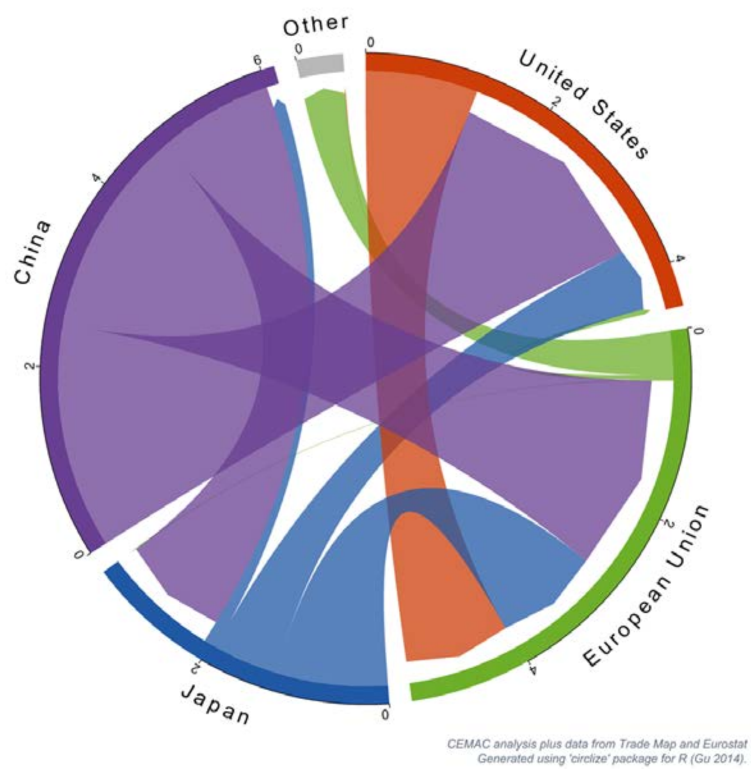


Figure 20. 2016 trade flows of HFO-1234yf in ktons. Trade flows not involving the European Union, which reports import and export data specifically for HFO-1234yf, should only be viewed as rough estimates. The "Other" category includes all other countries listed as receiving HFO-1234yf imports from Europe, most notably Turkey and South Africa. It is anticipated that U.S. production (and exports) will increase significantly in 2017 with the opening of Honeywell's Louisiana plant, and this growth in U.S. market share will continue when the Chemours plant in Texas begins operation in 2018.

Regulatory Factors

The EU F-gas MAC Directive prohibits the use of any refrigerant with a GWP higher than 150, including HFC-134a, in all new vehicles as of 2017 (European Parliament Council Directive 2006). Most automakers have decided on HFO-1234yf as the replacement of choice, so most new EU vehicles now use HFO-1234yf in their mobile air-conditioning systems.

In SNAP Rule 20 (finalized July 20, 2015), the EPA determined that HFC-134a is unacceptable for use in new U.S. automobiles beginning in 2021 (EPA 2015a). Following Europe's lead, several U.S. automakers have already begun transitioning MAC systems to HFO-1234yf (see "Distribution," above), with adoption in the remaining U.S. vehicles expected by 2021.

As of July 16, 2015, the EPA has determined that R-513A, a blend of HFO-1234yf and HFC-134a, is acceptable for use in centrifugal chillers in the United States (EPA 2015b). Trane has offered chillers using R-513A since this SNAP ruling was published (Trane 2015). Johnson Controls has offered R-513A chillers since 2016 (Johnson Controls 2016). More recently, Dunham-Bush announced the use of R-513A in chillers marketed for the Asia Pacific region (Cooling Post 2017).

In Notice of Acceptability 31, published on May 23, 2016, the EPA lists R-513A as an acceptable substitute in retail food refrigeration systems (EPA 2016b).

Intellectual Property

HFO-1234yf production is still a relatively young industry, so most information on the manufacture of this chemical is still considered proprietary and confidential. Much of the relevant HFO-1234yf intellectual property has been disclosed in patents filed by the major refrigerant producers. As shown in Figure 21, the number of granted patents involving HFO-1234yf has risen sharply since 2010. The rate that patents are now being granted for inventions related to HFO-1234yf—more than 100 per year as of 2016—is now close to double the rate that HFC-134a-related patents were being granted at their peak in the late 1990s and early 2000s. Honeywell and Chemours have the largest shares of HFO-1234yf-related patents, as shown in Figure 22.

A notable subset of HFO-1234yf-related patents is the so-called "use" or "application" patents first issued to Honeywell starting in 2003 (Singh et al. 2009; Wilson et al. 2012). Instead of describing the invention of a method of manufacture, these patents describe the *use* of HFO-1234yf in automobile air-conditioning systems and have been the subject of several legal disputes concerning their validity as "novel" inventions (Seidel 2015. Companies outside the Honeywell-Chemours HFO-1234yf development partnership, most notably Arkema, have challenged these patents and, in most cases, succeeded in having them revoked. However, there is an extensive appeals process, and Honeywell has appealed each of the patent-revoking decisions. While most of the challenges await a ruling on an appeal, the application patents remain in effect.

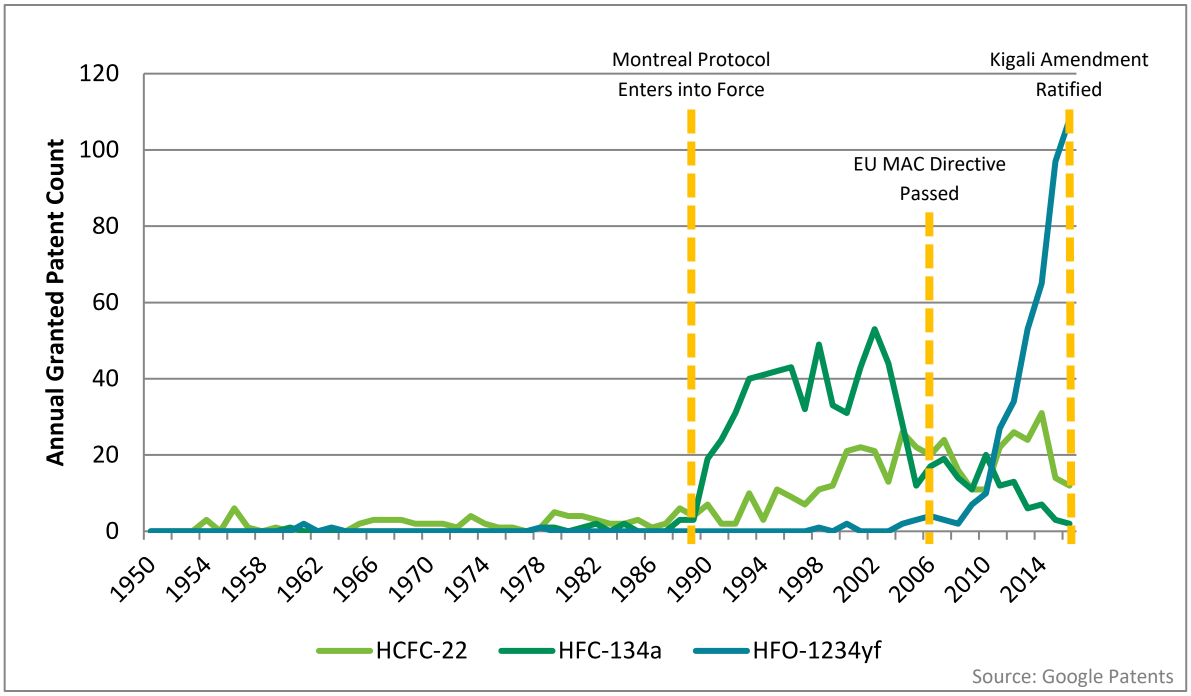


Figure 21. Fluorocarbon-related patents, by grant year. On an annual basis, the rate patents are being granted for technologies and applications relating to HFO-1234yf is unprecedented in the history of the fluorocarbon industry.

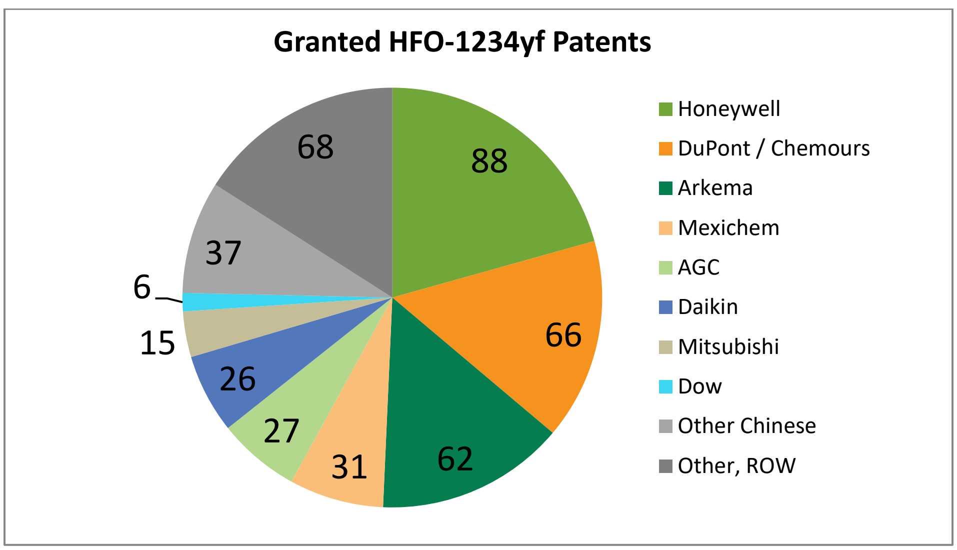


Figure 22. Granted HFO-1234yf patent count, by company. Of the many companies involved in refrigerant research and development, U.S. companies Honeywell and DuPont/Chemours have been granted the highest and second-highest number of patents related to HFO-1234yf, respectively.

To complicate matters further, additional HFO-1234yf patents (known as "continuing applications") have been granted to Honeywell in the time since the original legal challenges began, and these continuing applications would require separate legal challenges if a competitor wishes to contest them. Some industry experts expect that this cycle of legal challenges, appeals, and filing of continuing applications will continue until the original application patents expire between 2023 and 2025 (Seidel 2015, Seidel 2017).

Summary

- Continued demand in the EU automotive sector and growing demand in the U.S. automotive sector ahead of the SNAP Rule 20 going into effect mean HFO-1234yf manufacturing is expected to increase significantly.
- The United States will join China as a principle manufacturer now that the Honeywell plant has been completed and the Chemours plant is under construction.
- Legal challenges to the validity of Honeywell's HFO-1234yf application patents have been launched by competitors, and most of the disputes are now in the appeal phase.
- Some experts expect that litigation involving HFO-1234yf application patents will continue until the hard expiration deadline established by the priority date of the original application patents (2023–2025).

3.1.2 HFO-1234ze(E)

Production

The chemical *trans*-1,3,3,3-tetrafluoroprop-1-ene, better known as HFO-1234ze(E) and simply referred to as HFO-1234ze in this report from now on, is exclusively manufactured by Honeywell at two locations: Honeywell's Buffalo, New York, research lab, which tripled its capacity in 2011, and at a Baton Rouge, Louisiana, plant, which came online in early 2015 (Honeywell 2015b). The EPA reports that production of HFO-1234ze has been between 0.4 and 4 ktons annually since 2011 (EPA 2016a). Specific capacities at the Honeywell plants have not been disclosed.

Distribution

The biggest market for HFO-1234ze is currently in Europe, supplied almost entirely by the United States. 0.9 ktons of HFO-1234ze were shipped from the United States to the European Union in 2016 (Eurostat 2017). A small amount of 2016 EU HFO-1234ze imports were reported to come from India (0.03 ktons) and Japan (0.02 ktons) (Eurostat 2017). Presumably, these small quantities are a combination of re-exports of U.S.-produced bulk HFO-1234ze and quantities contained in imported products. U.S.-based Trane, along with Mitsubishi Heavy Industries in Japan and Kirloskar in India, have all announced the adoption of HFO-1234ze in new chiller product lines (Trane 2017; Mitsubishi 2017; Honeywell 2017). HFO-1234ze is registered in the highest tonnage band (>1 ktons annually) under ECHA's REACH program, meaning there would be no limitation on further increases in imports of HFO-1234ze to the European market (Achaichia 2014; ECHA 2012b).

Regulatory Factors

As of June 16, 2010, when the EPA issued Notice of Acceptability 25, HFO-1234ze has been an acceptable substitute in refrigeration applications in the United States (EPA 2010). By 2024, HFC-134a will not be permitted in new commercial chillers in the United States, with the exception of some military and spacecraft applications (EPA 2016c). HFOs, including HFO-1234ze, are expected to capture a significant share of the U.S. chiller market in the years leading up to the HFC-134a phaseout (BSRIA 2015a).

EU F-gas Regulation 517/2014 mandates automatic leak detection systems to be used in stationary air-conditioning systems charged with more than 500 metric tons CO_2 equivalent ($MTCO_2e$) of refrigerant (European Parliament 2014). This would apply to large commercial chillers charged with more than 350kg of HFC-134a (GWP = 1,300). In addition, leak checks must be performed every three months[9] for systems with more than 500 $MTCO_2e$. Another EU regulation, known as Ecodesign, mandates minimum seasonal space cooling energy efficiency standards for commercial “comfort cooling” chillers, which will go into effect starting in 2018 (European Commission 2016). These two regulations were cited by Carrier Corporation as reasons for introducing HFO-1234ze in its newest fleet of chillers (Gaved 2016). HFO-1234ze has a sufficiently low GWP to reduce the frequency of leak checks for large chiller systems while also having a sufficiently high seasonal cooling energy efficiency to meet the Ecodesign standards.

Extruded polystyrene (XPS) is a frequently used insulation foam for building applications, especially in Europe and North America (IHS 2014b). XPS foam production often uses HFC-134a as a blowing agent (Gluckman Consulting 2015), but EU Regulation 517/2014 calls for XPS foam blowing agents with a GWP above 150 to be phased out by 2020. Because HFC-134a has a GWP above that threshold (1,300), it will no longer be acceptable for use as an XPS blowing agent in Europe starting in 2020.

Similarly, in accordance with EPA SNAP Rule 20, HFC-134a will not be permitted as a foam blowing agent for XPS boardstock in the United States starting in 2021. HFO-1234ze has been listed as acceptable for XPS foam blowing applications in the United States since Sept. 30, 2009, when the EPA issued Notice of Acceptability 24 (EPA 2009).

HFO-1234ze has already gained traction as a substitute for HFC-134a in the European XPS foam market, and this trend is likely to follow in the U.S. XPS market.

Intellectual Property

The earliest mention of HFO-1234ze in the patent literature is in several patents granted between 1998 and 2002 on the manufacture of HFC-245fa, where HFO-1234ze may be created as a byproduct (Tung 1998; Sakyu et al. 2000; Yates and Gaita 2002; Yamamoto et al. 2002).

[9] This frequency drops to every six months if an automatic leak detection system is installed.

However, the first on-purpose production patents for HFO-1234ze were filed by Honeywell in 2003–2004 and granted as early as 2007 (Mukhopadhyay et al. 2007; Merkel et al. 2007; Tung et al. 2009). Honeywell was then granted several application patents involving HFO-1234ze, beginning in 2009 (Singh, Pham, et al. 2009; Singh, Wilson, et al. 2009). Honeywell, Central Glass Company (Japan), and DuPont/Chemours hold the largest portfolios of HFO-1234ze-related patents, as shown in Figure 23.

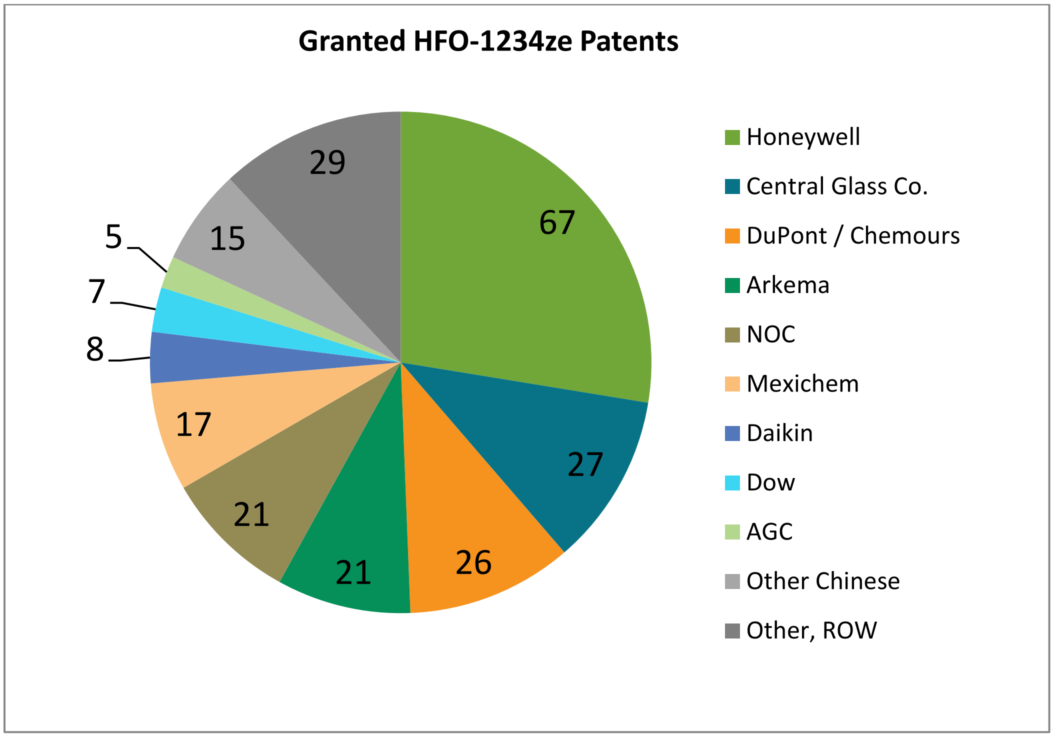


Figure 23. Granted HFO-1234ze patent count, by company. U.S.-based Honeywell holds the highest number of patents related to HFO-1234ze, followed by Japanese company Central Glass Co., U.S.-based Chemours, and the French company Arkema.

Summary

- U.S. company Honeywell holds the most HFO-1234ze-related patents and is currently the only commercial producer worldwide.
- The biggest market for HFO-1234ze is currently in Europe, where it is used both as a refrigerant and as a foam blowing agent in polystyrene manufacturing.
- HFO-1234ze demand in the United States for stationary cooling (commercial chiller) applications is expected to rise in the lead up to a 2024 phase out of HFC-134a in new equipment.

3.1.3 Other HFOs

Production

The chemicals *trans*-1-chloro-3,3,3-trifluoropropene and *cis*-1,1,1,4,4,4-hexafluoro-2-butene, better known as HFO-1233zd(E) and HFO-1336mzz(Z) and referred to simply as HFO-1233zd and HFO-1336mzz, respectively, in this report from now on, are the two other HFOs with ongoing or planned commercialized manufacture in 2017. HFO-1233zd is targeted both as a replacement for HFCs in foam blowing applications and as a single-component substitute for HCFC-123 in commercial chillers. Central Glass Company (Japan) was the first company to begin manufacturing HFO-1233zd when it started production at its Kawasaki plant in 2012 under a purchase agreement with Honeywell. Central Glass has since formed a new partnership with Arkema to manufacture HFO-1233zd for the Japanese market and opened an additional plant in Ube, Japan in early 2017 (CGC 2017). Capacities for the Central Glass plants have not been disclosed. Honeywell began production of HFO-1233zd at its Baton Rouge facility in 2014 and now produces 4+ ktons annually (EPA 2016a).

HFO-1336mzz is currently marketed as a foam blowing agent and as a component in refrigerant blends like R-514A designed to be replacements for HCFC-123 in commercial chillers. Chemours will become the first company to commercialize the production of HFO-1336mzz when operation at the Chemours/3F Zhonghao plant in Changshu, China begins during the third quarter of 2017 (Chemours 2015; Chemours 2017d). Capacity at this plant is unknown but is likely to be relatively small, assuming modest initial demand for this newly commercialized HFO.

Distribution

The major markets for these HFOs are currently in Japan and Europe, with U.S. demand also expected to grow in coming years. European imports are between 0.1 and 1 ktons per year for HFO-1233zd (ECHA 2014) and between 0.01 and 0.1 ktons for HFO-1336mzz (ECHA 2012c). Japanese import quantities of HFO-1233zd are unknown but likely to be small or zero assuming production by Central Glass Co. is sufficient to meet domestic demand. HFO-1336mzz imports to regions besides Europe are unknown but likely negligible at this time since commercial production is only just beginning.

Several major refrigeration equipment manufacturing companies are anticipating growth in HFO use for commercial cooling applications and have started to offer HFOs in some of their newest chiller models. In 2014, Trane was the first company to commercialize the use of HFO-1233zd in large-scale, low-pressure chillers; these were offered in the European market (Cooling Post 2014). HCFCs have been banned in all emissive uses in Europe since 2015, but Europe was never a significant adopter of HCFC-123 in the first place due to toxicity concerns (Cooling Post 2013). Most HFO chiller adoption in Europe will be for reasons similar to those mentioned in the HFO-1234ze section—namely, meeting the minimum seasonal cooling energy efficiency standards of the Ecodesign program and reducing leak-checking frequency.

In 2015, Mitsubishi Heavy Industries (Japan) released an HFO-1233zd chiller model for the Japanese market (Mitsubishi 2015). More recently, Trane has expanded its HFO chiller portfolio, and as of 2017 is offering North American HFO chiller options including smaller models that can use the R-514A refrigerant, which is a blend comprised mostly of HFO-1336mzz[10] (Trane 2016). Carrier introduced an HFO-1233zd chiller for the U.S. market at the start of 2017 (Carrier 2017).

By the time Europe phased out HCFC-141b in foam blowing applications in 2004, EU polyurethane foam producers had switched primarily to pentane and water, and to a lesser extent HFC-365mfc, HFC-227ea, and HFC-245fa (IHS 2016c). Pentane and water are not subject to regulatory phaseout, so further adoption of HFO-1233zd in Europe will be limited to producers using the HFCs or blends thereof. In contrast, a larger share of the Japanese polyurethane market chose the HFC blowing agents over hydrocarbon options following the HCFC-141b phaseout, and this explains the pronounced interest in supplying HFO-1233zd to the Japanese market (IHS 2016c). Rigid polyurethane producers in the United States are expected to more closely follow their Japanese counterparts in transitioning to low-GWP HFO blowing agents since a significant fraction of U.S. polyurethane producers had also adopted HFCs rather than hydrocarbons following the phaseout of HCFC-141b. Once these HFCs themselves are phased out in 2020 (see "Regulatory Factors" section below), it is anticipated that HFO-1233zd and/or HFO-1336mzz could see more widespread and significant adoption in the U.S. for rigid polyurethane manufacturing.

Regulatory Factors

HCFC-123 has a relatively low ozone-depleting potential and GWP (0.02 and 79, respectively), and there is no EPA SNAP rule which specifically identifies HCFC-123 as being unacceptable for use in chillers. However, pursuant to the Montreal Protocol, developed countries may only use HCFCs (including HCFC-123) for servicing existing equipment, and not for any new equipment, starting in 2020. By 2030, servicing or any other use of all HCFCs will be phased out in developed countries. Therefore, demand for alternatives to HCFC-123 in commercial chillers, such as HFO-1233zd and HFO-1336mzz (or blends thereof), is expected to grow in the U.S. by 2020 for new equipment and by 2030 for all equipment.

Within the U.S. market, HFO-1233zd has been an acceptable substitute for HCFC-123 in chillers and as a foam blowing agent since Aug. 10, 2012, when the EPA released Notice of Acceptability 27 (EPA 2012a). HFO-1336mzz has been listed as acceptable for use as a foam blowing agent, with some restrictions,[11] since the EPA's Notice of Acceptability 30 on July 16, 2015. HFO-1336mzz has been approved for use in chillers both on its own and as a component in a

[10] R-514A is 74.7% HFO-1336mzz and 25.3% R-1130(E) (Majurin et al. 2017).
[11] HFO-1336mzz was approved with narrowed use limits as a foam blowing agent under EPA SNAP—it may be used for high pressure, two-part polyurethane foam production.

refrigerant blend (R-514A) since the EPA in Notice of Acceptability 31 on May 23, 2016 (EPA 2016b).

EU F-Gas regulations prohibit the use of HFCs with a GWP over 150 in the production of polyurethane foam starting in 2023. This would include HFC-245fa as well as HFC-365mfc and HFC-227ea (and blends thereof).

With the support of the Japan Urethane Foam Association, Japan has set a goal of reducing the GWP of foam blowing agents to below 100 by 2020 (Honeywell 2016). All of the HFCs currently used in polyurethane manufacturing (HFC-245fa, HFC-365mfc, HFC-227ea, and any blends of these) have a GWP above 100, so HFO adoption for foam blowing applications in Japan is expected to be significant by 2020.

Intellectual Property

As shown in Figure 24, HFO-1234yf has been referenced in the greatest number of HFO-related patents to date, followed by HFO-1234ze. HFO-1233zd and HFO-1336mzz are in earlier stages of adoption compared to the more mature HFO-1234yf and HFO-1234ze, but references to these HFOs in granted patents has also grown in recent years.

No lawsuits involving patents related to HFO-1233zd or HFO-1336mzz have been identified to date; all HFO-related patent disputes appear to be focused solely on HFO-1234yf. Nevertheless, intellectual property continues to play a role in the adoption of these newest commercialized HFO chemicals due to patents on production methods.

As shown in Figure 25, Honeywell holds nearly half of all granted patents related to HFO-1233zd as of 2016, followed by Central Glass Co. of Japan. These two companies have undertaken the majority of commercialized production of HFO-1233zd globally as of 2017.

As of 2016, Arkema has been granted the highest number of patents referencing HFO-1336mzz, followed closely by Honeywell and DuPont/Chemours, as shown in Figure 26. Despite this ordering of companies in this approximate patent count, Chemours seems to be the most heavily invested in commercializing HFO-1336mzz. This reinforces the caveat that company patent counts are not perfect indicators of investment or capacity; these counts are best used as a qualitative guide to identify the major players in an industry.

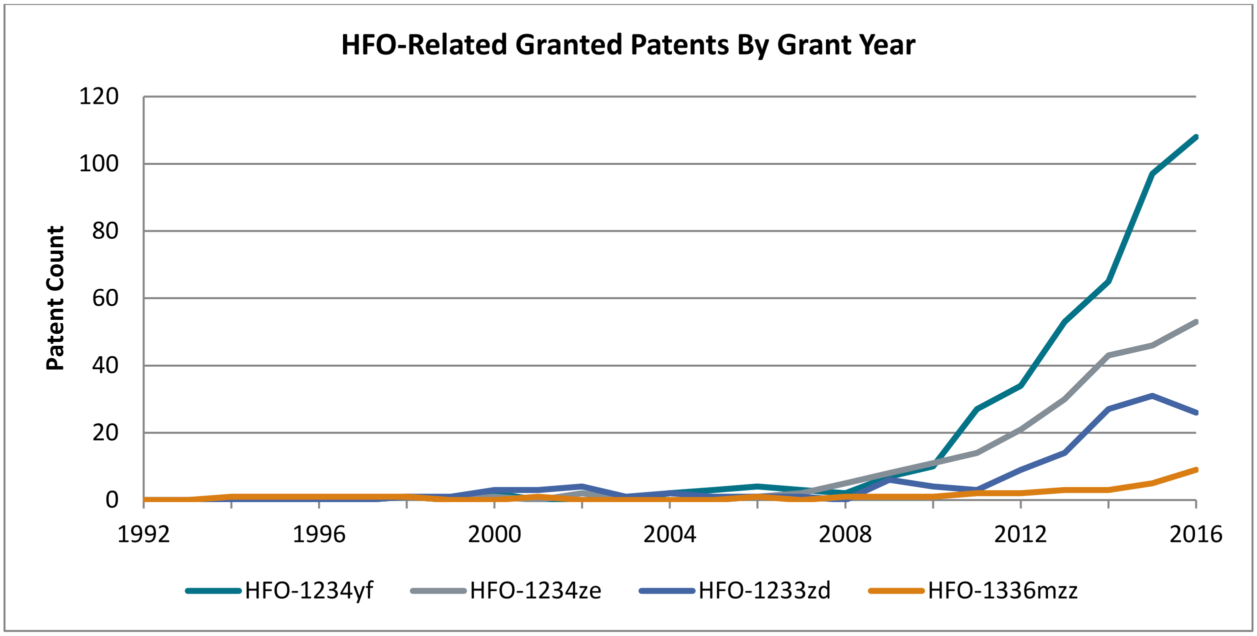


Figure 24. HFO-related granted patents, by grant year, 1992–2016

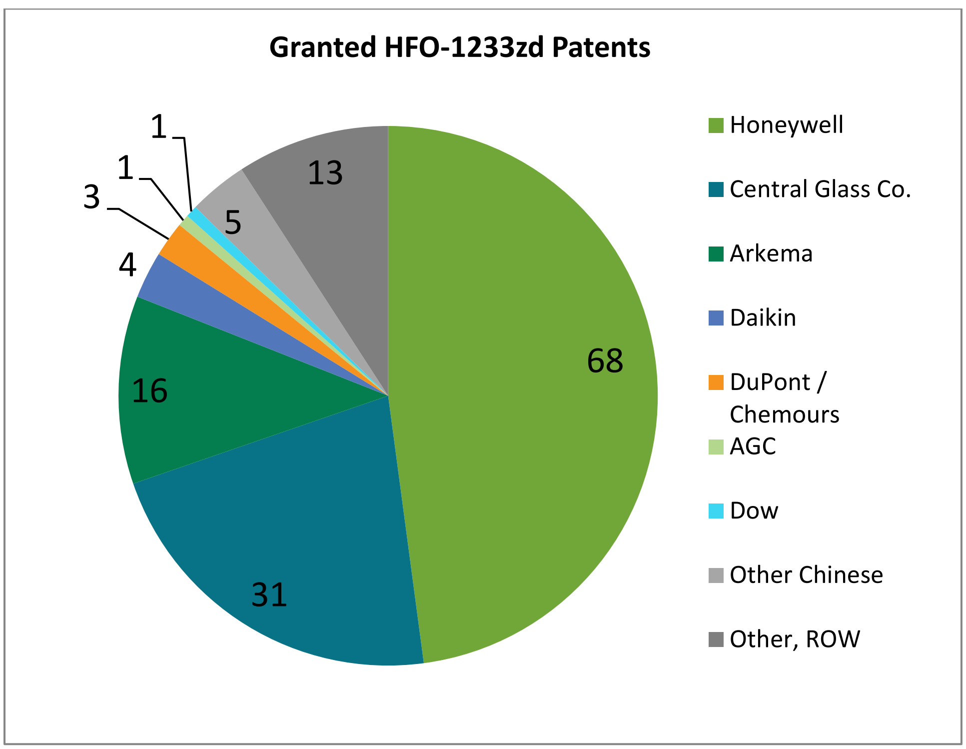


Figure 25. Granted HFO-1233zd patent count, by company, though 2016

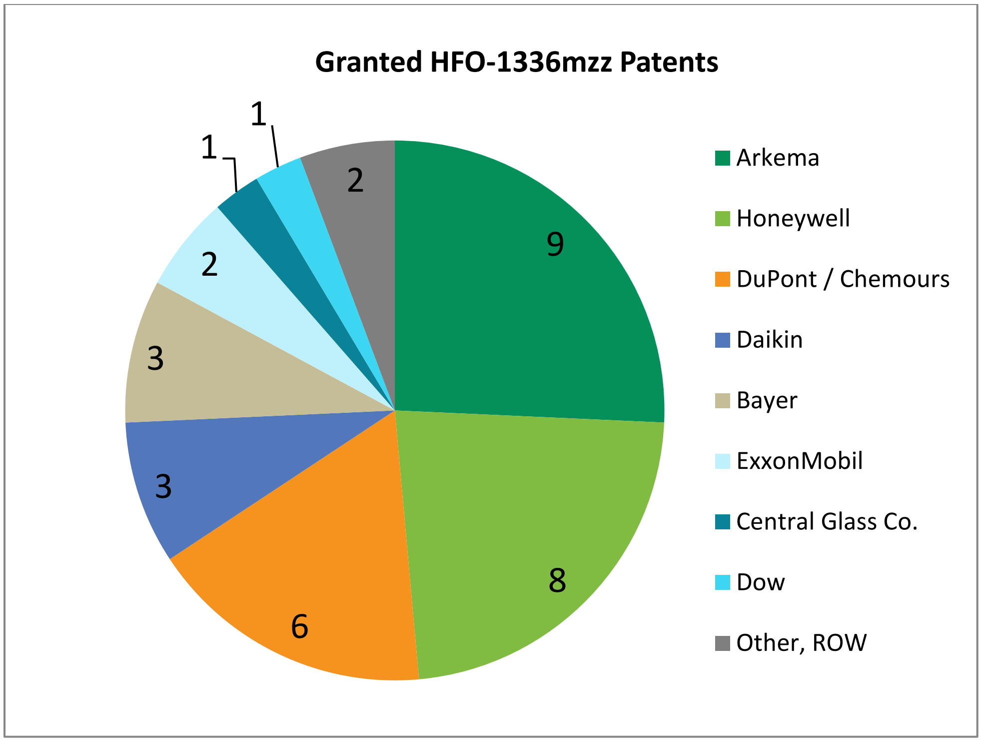


Figure 26. Granted HFO-1336mzz patent count, by company, through 2016

Summary

- The United States and Japan are the leading producers of HFO-1223zd and HFO-1336mzz, currently supplying the Japanese and European markets for commercial comfort cooling (chillers) and polyurethane foam manufacturing.
- U.S. demand for these HFOs is projected to increase prior to the 2020 ban on HCFC-123 in new chiller equipment.
- Demand for these HFOs as foam blowing agents is expected to increase in Japan by 2020 and, to a lesser extent, in Europe by 2023 due to the respective phaseouts of high-GWP HFCs in the polyurethane manufacturing sector.

3.2 Limitations

Existing "alternative" refrigerants have limitations (e.g., toxicity, flammability, efficiency) that have restricted their use until now. Newly formulated and/or developed refrigerants and blends (i.e., HFOs and HFC/HFO blends) generally have drawbacks as well, which are typically around flammability, material compatibility, and cost. Most major refrigerants today have alternatives that are similar in efficiency and capacity, but are inferior in one or more of these other ways.

3.2.1 Flammability

There are different designations for flammability, determined by the test method in ASTM E681 and listed in ASHRAE Standard 34-2016 (ASHRAE 2016). This is the most common, unanswered concern about alternative refrigerants. Some natural refrigerants, such as CO_2, are nonflammable, as are some of the most promising HFOs, HFO-1233zd and HFO-1336mzz. However, hydrocarbon refrigerants, ammonia, and most HFC/HFO blends that are considered top candidates for replacing common refrigerants are flammable.

Flammability concerns involve more than whether equipment and buildings catch fire during certain kinds of refrigerant leakage situations. However, this is one of the major concerns and there is active research in understanding this problem (Goetzler et al. 2014; Goetzler et al. 2016; Gandhi et al. 2017). An additional concern is whether the byproducts of combustion are toxic. Fluorocarbon combustion can result in hydrogen fluoride or carbonyl fluoride, which are both extremely toxic (Laboratory News 2014; Ito et al. 2014).

Another concern is about the impact on the supply chain. Dealing with flammable substances as part of the manufacturing process can require higher operating costs through higher insurance and/or bonding costs, additional safety measures, oversight, and compliance with more restrictive regulations, in addition to the engineering and design costs of redesigning components and the added expense of the components themselves. These costs are distributed throughout the entire supply chain and can result in a substantial cost increase (Kujak 2017).

3.2.2 Cost

The increase in cost of new refrigerants is often cited as a concern for the industry. Although natural refrigerants (ammonia, CO_2, hydrocarbons) are cheap relative to HFCs, next-generation fluorocarbons, HFOs, are currently much more expensive—up to eight times the price of HFCs. In addition, there can be large transition costs associated selecting new refrigerants. These issues have been discussed in many places (Goetzler 2016; Calm 2012; Sherry et al. 2017). Previous refrigerant transitions have shown that upfront costs for new equipment tend to increase, but that life cycle cost increases are often offset by improved product efficiency, production process improvements, and economies of scale.

The cost of HFO refrigerant blends amid the transition to large-scale production is a topic that has not been explored in great depth. Figure 27 shows a hypothetical HFC/HFO blend with an HFC/HFO ratio of 75%/25%. This is a representative mix of HFC/HFO for several promising blends: 447A, 447B, 448A, 449A, 452B, and 454B. Costs were estimated assuming the HFC component costs are those of HFC-134a and HFO costs are those of HFO-1234yf because those are common constituents whose costs are well established. Year 1 is assumed to be 2017; where current costs are known and components are commercially available. Current and high-volume HFO costs are approximated from Sherry et al. (2017). This comparison shows that although the cost premium of a blend could be substantial today, ~300%, at very high-volume production, the premium is modest, ~25%. This price premium is for the refrigerant only. Refrigerant costs are a small portion of total system costs, typically <1% (Goetzler et al. 2016;

Geister 2017), meaning that total system cost increases due to a “drop-in” replacement HFC/HFO blended refrigerant could be ~3% now, but as low as 0.25% at sufficiently high production volume. Note that this does not account for the costs of any system design or component changes required to use the blended refrigerant.

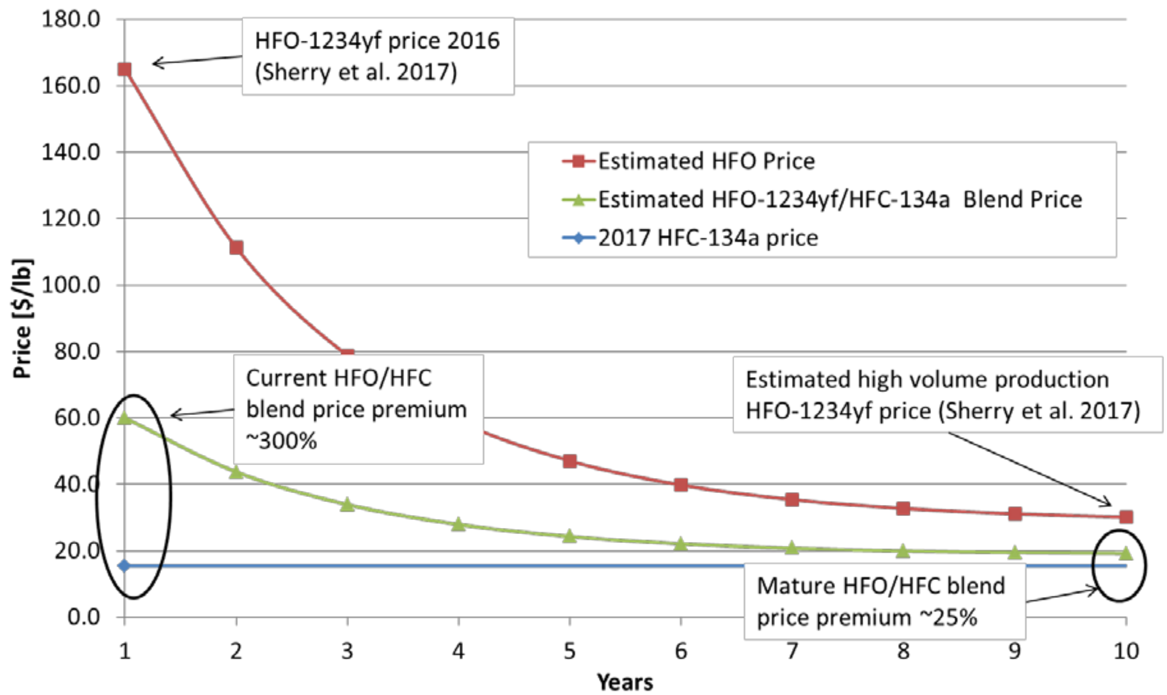


Figure 27. Price estimates for a generic HFC/HFO blended refrigerant with 75% HFC and 25% HFO. The current cost premium is high (~300%), but not as high as might be expected because most blends are predominantly HFC. Long-term cost premiums are small (~25%). Because refrigerant costs are 1% or less of total system costs for most systems (Goetzler et al 2016; Geister 2017) the high-volume price premium of a system using an HFC/HFO blend will be ~0.25%.

3.2.3 GWP

In many applications, HFC-based refrigerants do not meet long-term goals for direct GWP; thus, they are often viewed as interim solutions. This results in hesitation and uncertainty among manufacturers about whether to make a switch to new refrigerants given the potentially high transition costs associated. Many stakeholders prefer a “wait and see” approach.

This dilemma is illustrated in Figure 28, which shows refrigerant solutions for vapor compression systems over a range of applications and direct GWP of the refrigerant. For some applications, such as chillers and MAC, alternative refrigerants currently exist that meet long-term direct GWP goals, such as Europe’s GWP threshold of 150. For other systems, such as stationary air conditioning and many refrigeration applications, the long-term options are less clear. Interim options are available that have comparable capacity and efficiency to established refrigerants; however, they have moderate GWPs (150–700) that make their long-term viability questionable. Options that have acceptable, long-term GWPs have other concerns such as flammability (hydrocarbons, R-290 and R-600a, HFOs), toxicity (NH_3), or efficiency and equipment cost concerns (CO_2).

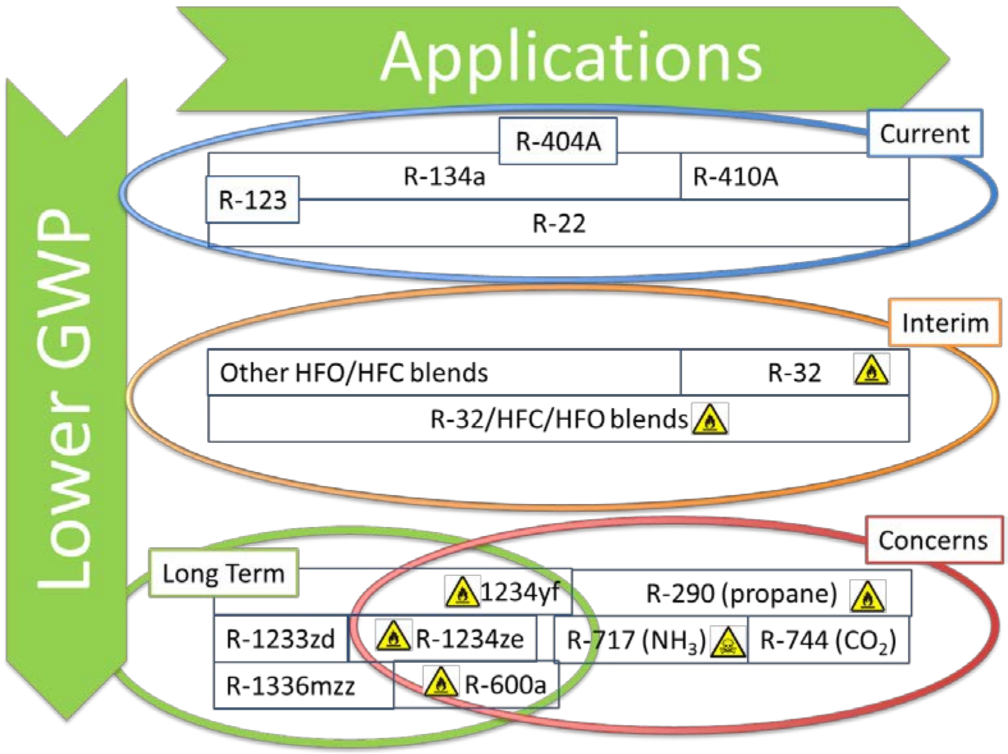


Figure 28. Vapor compression refrigerant applications and direct GWP. Long-term solutions exist for lower operating pressure systems. At higher operating pressures, alternatives are often highly flammable (hydrocarbons), have intermediate GWP (150–700), or have potential efficiency or toxicity constraints (CO_2, NH_3).

3.2.4 Regulatory Uncertainty

The global refrigerant industry has evolved in the context of safety and efficiency regulations; therefore, it is not surprising that stakeholders pay close attention to changes in laws and regulations across multiple markets.

Equipment manufacturers have some hesitation in embracing new refrigerants and technology given the uncertainty in future regulations. The primary uncertainties are associated with flammability and end goals for direct GWP of refrigerants. Currently available solutions meet established criteria in some applications but not others, as shown in Figure 28. Some manufacturers are unsure whether it is worth investing in products and technologies that could prove to be transitional, rather than waiting for longer-term technical solutions or additional clarity on regulatory requirements, not just in the United States but globally. This uncertainty has been highlighted in the United States by a recent court decision striking down EPA regulations requiring the phaseout of R-134a (Chemical & Engineering News 2017).

3.3 Market Trends

Globally, there is substantial momentum for transition away from HCFCs and HFCs to alternative refrigerants. This is manifest in the Kigali amendment to the Montreal Protocol, the European F-gas Regulations, and the EPA's SNAP Program. Manufacturers have already transitioned substantially away from high-GWP refrigerants for many applications, such as aerosols, whereas the transition is underway for other applications such as MAC, foam blowing agents, and small, self-contained refrigeration systems. Production of alternative refrigerants is growing rapidly on a global scale to match this increasing demand. However, regulation is still an important consideration for companies when selecting new refrigerants or designing new equipment.

Production capacity is difficult to quantify for the newly developed HFO refrigerants. Production plant locations have been quantified in Table 5, which is an updated and expanded version of a similar table in Seidel et al. (2015). Production of these chemicals is global and is becoming concentrated in China, even though many of the producers are U.S.-based companies. All of these facilities have opened within the past several years, reflecting current trends in production location decision-making.

The global nature of HFO production is important because much of the demand for these products is in developed countries (because developing countries are exempt or have delayed implementations of regulations the require the use of these refrigerants). This highlights how the United States does not have a "lock" on production, even for refrigerants that are shipped to other developed countries.

Table 5. HFO Production Locations (adapted from Seidel et al. 2015)

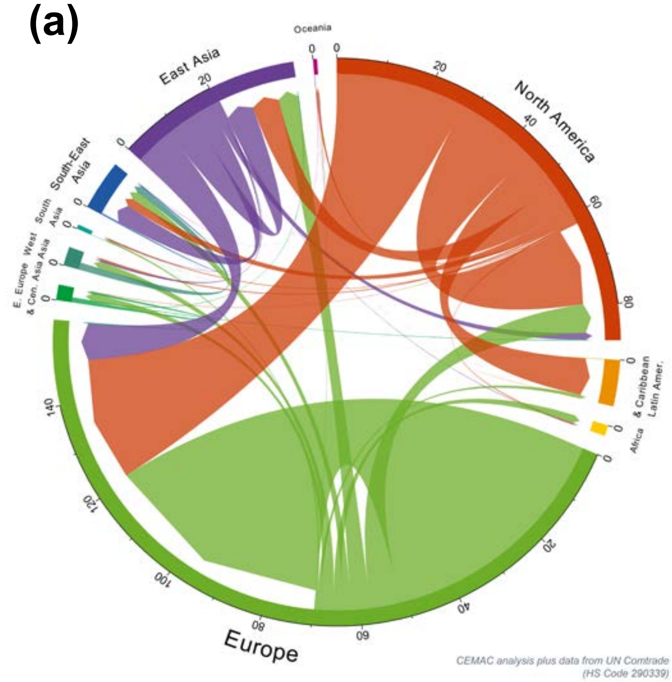
Chemical	Producer	Location	Startup Year and Capacity
HFO-1234yf	Arkema Changshu	China	2016, 7 kton/yr[c]
	Chemours	Japan	In production
	3F Zhonghao (Chemours)	China	Up to 6 kton/yr[a]
	AGC (Honeywell)	Japan	2015, up to 1,000 t/yr[b]
	Honeywell	U.S.	2017, 10-15 kton/yr[b]
	Juhua Corp. (Honeywell)	China	2016
	Navin Fluorine Int'l Ltd. (Honeywell)	India	2016 (small-scale)
	Chemours	U.S.	2018
HFO-1234ze	Honeywell	U.S.	2015
HFO-1233zd	Central Glass Co.	Japan	2012
	Honeywell	U.S.	2014, 4+ ktons/yr[d]
HFO-1336mzz	Chemours	China	2016
	Chemours	U.S.	2017

[a] CCM 2016a
[b] Sherry et al. 2017
[c] Business Standard 2013, PRLog 2012
[d] EPA 2016a

This point is solidified by looking at HFC trade data from 2000 and 2015, shown in Figure 29. These plots show trade data from 2000 and 2015 (ITC 2016). The clear trend is for reduced exports from the United States and EU and increasing exports from Asia, mostly China. This is a familiar trend that supports the idea that the United States is losing market share in export markets despite having large U.S. companies as major market participants; they think globally about supply chains and logistics and think less about national borders (Seidel 2017).

HFO-1234yf is the dominant HFO refrigerant and has the most quantitative production/consumption information available. It is estimated that by 2017, 40 million vehicles will use it (Chemours 2016a), correlating to ~15–30 ktons per year of consumption. This is the most widely produced HFO, with production or planned production in at least eight locations globally, as shown in Table 5. It is estimated that more than 100 million vehicles with HFO-1234yf air-conditioning systems will be sold from 2018 to 2020 (Chemours 2016a). Personal vehicles average ~700 g of R-134a (interpreted from Hella 2011); because the volumetric capacity of R-1234yf is ~7% less than R-134a (Leck 2009), the charge per vehicle with R-1234yf should be ~750 g. This equates to ~24 ktons/year demand, on average, for vehicle applications alone in the near future. Therefore, production is substantial for this industry and is balanced with near-term demand.

(a)



(b)

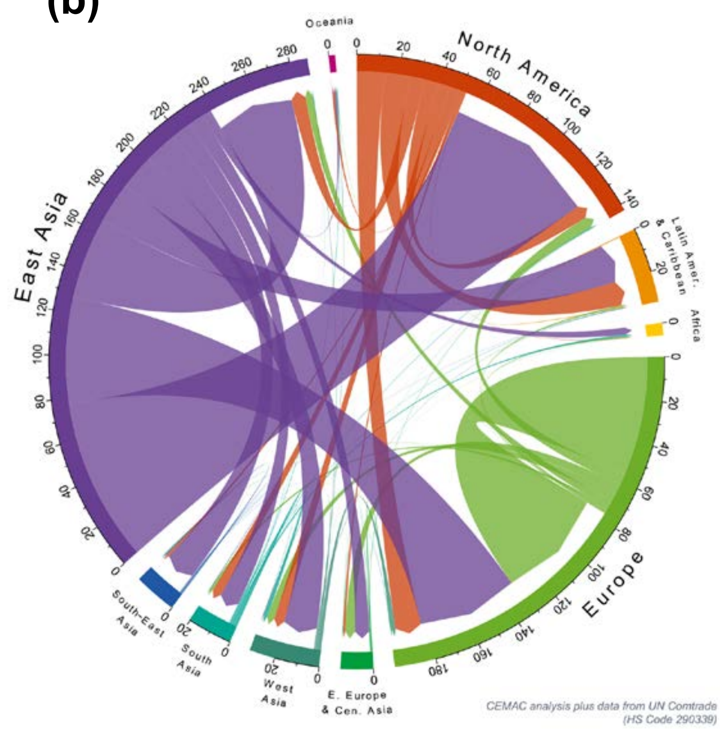


Figure 29. International HFC trade flows in 2000 (a) and 2015 (b), in ktons. There is a clear trend of reduced exports from the United States and EU and increasing exports from Asia, mostly China.

4 Conclusions and Insights

NREL, in partnership with Oak Ridge National Laboratory and under the CEMAC umbrella, assessed the current state of existing and low-GWP refrigerants for major end-use applications, including HVAC and those outside of the HVAC industry. The project incorporated a market overview and supply chain assessment to determine the production, distribution, consumption, costs, and potential operating efficiency impacts of new and alternative refrigerants entering the market. Market trends and ongoing research are also documented. This work supplements other U.S. Department of Energy efforts to support research activities on refrigerants and their applications, including a refrigerant R&D roadmap and outlook into global air-conditioning markets (Goetzler et al. 2014; Goetzler et al. 2016).

The global refrigerants market is large and is projected to grow rapidly as developing countries in warmer areas of the globe grow, become more affluent, and consume more air conditioning, refrigeration, foam, and aerosol products and services. Innovation in the global refrigerants market is often led by major U.S. companies; however, the markets for their products are global. Understanding this global market landscape is critical to maintaining U.S. leadership in innovation and manufacturing in this strategically important industry.

Key Findings From This Report:

- Refrigerant markets are global and growing rapidly
    - 2010–2050: 4.5x increase in air conditioning for non-OECD countries, and 1.3x increase for OECD countries (IEA 2013).
    - Regional, national, and international commitments will create **large market opportunities for innovative refrigerants and products** that use them.
    - **U.S.-based companies are currently leaders in innovation and production of advanced refrigerants.**
    - **China is aggressively expanding production** of refrigerants for domestic use as well as export.
- Refrigerants are used in large quantities for more than just cooling.
    - Foam production, aerosols, fire suppression, and chemical production are important end uses of these materials.
- **Vapor compression systems** primarily use fluorocarbon refrigerants.
    - Vapor compression is the **most challenging but also the most impactful area** for refrigerant innovation.
- Alternative refrigerants to fluorocarbons are well established.
    - They account for more than 50% of the total market as it exists today.

- Common natural/hydrocarbon refrigerants: ammonia, pentane, carbon dioxide, propane, and butane.
- Substantially lower GWP than most fluorocarbons.
- Often provide comparable or superior performance to fluorocarbons.

* **Advanced fluorocarbon refrigerants are commercially available** that can reduce unintended environmental impacts while maintaining or potentially improving performance.
  - **One size doesn't fit all**—some common applications are more difficult to solve than others, therefore there is a need for ongoing R&D.
  - U.S. companies are currently at the forefront of this innovation.
* Refrigerant manufacturing locations are primarily guided by:
  - Proximity to fluorspar, hydrofluoric acid, or other chemical feedstock
  - Existing refrigerant manufacturing capital and experienced labor force
  - Availability of cheap energy and labor
  - Financial incentives from local governments or development authorities.
* The United States is positioned to be a major production center for advanced refrigerants, including HFOs and their blends.
  - Market share of production likely to be larger if there is a substantial U.S. market for advanced refrigerants
  - Fluorspar will remain in demand as manufacturers transition to producing HFOs, and U.S. fluorspar supply is stable. Demand is now supplied mainly by Mexico, whereas historically, China had been the leading importer.
  - U.S. companies, such as Honeywell and Chemours, own much of the intellectual property associated with the production and usage of HFOs.
  - Antidumping lawsuits regarding Chinese imports have played a major role in shaping this industry. Decisions on HFC imports have generally been in favor of U.S. companies, setting an important precedent for any future HFO-related trade disputes.
  - Recently constructed HFO capacity in Louisiana serves as an example of the effect that financial incentives from development authorities can have on manufacturers' plant location decisions.

References

Abdelaziz, O., S. Shrestha, B. Shen, A. Elatar, R. Linkous, W. Goetzler, M. Guernsey, and Y. Bargach. 2016. "Alternative Refrigerant Evaluation for High-Ambient-Temperature Environments: R-22 and R-410A Alternatives for Rooftop Air Conditioners." Oak Ridge, TN: ORNL/TM-2016/513. https://energy.gov/sites/prod/files/2016/09/f33/ORNL%20High%20Ambient%20RTU%20Testing%20Report.pdf.

Achaichia, N. 2014. "Low GWP Chillers Development Update." Presentation at Chillventa 2014. Nuremberg, Germany. October 14–16, 2014. https://www.honeywell-refrigerants.com/europe/wp-content/uploads/2014/11/Honeywell-chillers-update-2014-10.pdf.

ACHR NEWS. 2016. "Honeywell Partners with Juhua to Produce 1234yf in China." May 2, 2016. http://www.achrnews.com/articles/132395-honeywell-partners-with-juhua-to-produce--yf-in-china.

Akzo Nobel. 2008. "Akzo Nobel Completes ICI Acquisition." January 2, 2008. https://www.akzonobel.com/for-media/media-releases-and-features/akzo-nobel-completes-ici-acquisition.

Allgood, C. 2017. "The Future of Refrigerants." Presentation at 2017 HVAC Excellence. Orlando, FL. https://www.chemours.com/Refrigerants/en_US/assets/downloads/the-future-of-refrigerants-hvac-excellance-2017.pdf.

American Hydrofluorocarbon (HFC) Coalition. 2016. "The American HFC Coalition Appeals the International Trade Commission Decision Regarding Chinese Imports of Dumped HFC Components." http://www.prnewswire.com/news-releases/the-american-hfc-coalition-appeals-the-international-trade-commission-decision-regarding-chinese-imports-of-dumped-hfc-components-300368053.html.

Andersen, S. O., K. Madhava Sarma, and K. N. Taddonio. 2012. *Technology transfer for the ozone layer: Lessons for climate change*. Routledge, 2012. pp.151

ANSI/ASHRAE Standard 34-2016. "Designation and Safety Classification of Refrigerants." 2016.

Arkema. 2014. "Proposed shutdown of fluorogas production in Zaramillo, Spain." http://emea.forane.com/en/forane-foams-solvents-and-aerosols/our-products/news-details/Proposed-shutdown-of-fluorogas-production-in-Zaramillo-Spain/?back=true.

Arkema. 2017. "Arkema Inc. history (before 1950)." http://www.arkema-americas.com/en/arkema-americas/arkema-inc-history/before-1950/.

ASHRAE. 2016. “Designation and Safety Classification of Refrigerants.” ANSI/ASHRAE Standard 34-2016. https://www.ashrae.org/news/2017/2016-versions-of-ashrae-refrigerant-standards-published.

Bell, S. L. 1978. “Manufacture of Halogenated Compounds.” U.S. Patent 4,129,603, filed February 7, 1978, and issued December 12, 1978.

BGS. 2011. “Fluorspar.” British Geological Survey. http://www.bgs.ac.uk/mineralsUK/statistics/mineralProfiles.html.

Bivens, D. B., and H. A. Connon. 1989. “Halocarbon blends for refrigerant use.” U.S. Patent 4,810,403 filed February 5, 1988, and issued March 7, 1989.

Bivens, D. B., M. B. Shiflett, and A. Yokozeki. 1994. “Near-azeotropic blends for use as refrigerants.” U.S. Patent 5,277,834 filed December 22, 1992, and issued January 11, 1994.

Building Services Research and Information Association (BSRIA). 2015a. “Global Refrigerant Policies and Trends 2015: Outlook to 2035.” Report 58445/1.

Building Services Research and Information Association (BSRIA). 2015b. “Global Overview Analysis Refrigerants.” Report 58312/1.

Building Green. 2010. “Avoiding the Global Warming Impact of Insulation.” https://www.buildinggreen.com/news-article/avoiding-global-warming-impact-insulation.

Business Standard. 2013. “Arkema to invest Euro 200 million in two plants for 1234yf refrigerant gas.” http://www.business-standard.com/content/b2b-chemicals/arkema-to-invest-euro-200-million-in-two-plants-for-1234yf-refrigerant-gas-113091000163_1.html.

Business Wire. 2016. "High Demand From Emerging Economies to Boost the Global Polyurethane Foam Market Through 2020." http://www.businesswire.com/news/home/20161214005038/en/High-Demand-Emerging-Economies-Boost-Global-Polyurethane.

Calm, J. 2012. “Refrigerant Transitions … Again.” *Moving Towards Sustainability*, proceedings of the ASHRAE/NIST Conference. Gaithersburg, MD. October 29-30, 2012. http://www.techstreet.com/standards/refrigerant-transitions-again?product_id=1845779.

CARB. 1997. “Initial Statement of Reasons for Proposed Rulemaking—Volume II: Technical Support Document.” California Air Resources Board. https://www.arb.ca.gov/regact/conspro/midterm/tsd.pdf.

Carrier. 2017. “Carrier Previews AquaEdge 19DV Centrifugal Chiller with Environmentally Sustainable Refrigerant.” Carrier Corporation. Las Vegas, NV. http://www.carrier.com/carrier/en/us/news/news-article/carrier_previews_aquaedge_19dv_centrifugal_chiller_with_environmentally_sustainable_refrigerant.aspx.

CCM. 2012. “China expected to be largest production base of HFO-1234yf worldwide.” https://www.prlog.org/12050134-china-expected-to-be-largest-production-base-of-hfo-1234yf-worldwide.html.

CCM. 2016a. “Chemours to double HFO-1234yf production capacity in China.” CCM Data & Business Intelligence. http://www.cnchemicals.com/Press/88399-CCM:%20Chemours%20to%20double%20HFO_1234yf%20production%20capacity%20in%20China.html.

CCM. 2016b. “The Chinese government keeps eliminating the HCFC’s production.” http://eshare.cnchemicals.com/publishing/home/2016/01/20/2042/the-chinese-government-keeps-eliminating-the-hcfc%E2%80%99s-production.html.

CGC. 2017. “Notice about Collaboration on HFO-1233zd(E) with Arkema.” Central Glass Com., Ltd. http://v4.eir-parts.net/v4Contents/View.aspx?template=announcement&sid=37030&code=4044.

Chemical & Engineering News. 2017. “Court strikes down U.S. restrictions on HFCs.” ISSN 0009-2347. http://cen.acs.org/articles/95/web/2017/08/Court-strikes-down-US-restrictions-on-HFCs.html.

Chemours. 2015. “Chemours Breaks Ground for World's First Full-Scale Production of HFO-1336mzz.” Wilmington, DE. https://investors.chemours.com/investor-relations/investor-news/press-release-details/2015/Chemours-Breaks-Ground-for-Worlds-First-Full-Scale-Production-of-HFO-1336mzz/default.aspx.

Chemours press release. 2016a. “Chemours to Invest in Expanded Capacity for High Growth Opteon Products.” May 2, 2016. http://www.prnewswire.com/news-releases/chemours-to-invest-in-expanded-capacity-for-high-growth-opteon-products-300261094.html.

Chemours press release. 2016b. “Chemours Announces Major Investments in New U.S. HFO-1234yf Plant.” https://www.chemours.com/Refrigerants/en_US/assets/downloads/20160502-HFO-1234yf-plant-triple-opteon-product-supply.pdf.

Chemours. 2017a. “Opteon XP40 (R-449A) refrigerant.” https://www.chemours.com/Refrigerants/en_US/products/Opteon/Stationary_Refrigeration/products/Opteon_XP40.html.

Chemours. 2017b. “Opteon XL41 (R-454B) Refrigerant.” https://www.chemours.com/Opteon_Stationary/en_GB/products/opteon-xl41.html.

Chemours. 2017c. “The Exponential Growth of HFO-1234yf in Automotive Air Conditioning.” The Chemours Company. https://www.chemours.com/Refrigerants/en_US/assets/downloads/opteon-yf-automotive-brochure.pdf.

Chemours. 2017d. “Big Impact, Small Footprint.” Foam Expo North America. May 8, 2017. http://www.foam-expo.com/press-room-articles/2017/05/08/big-impact,-small-footprint/.

ChinaIOL. 2017. Beijing Zhixindao Sci-Tech Corp., Ltd. Beijing, China. http://data.chinaiol.com/ECData.

Clodic, et al. 2006. “Global inventories of the worldwide fleets of refrigerating and airconditioning equipment in order to determine refrigerant emissions. The 1990 to 2006 updating.” Centre Energetique Et Procedes.

CNCIC Consulting. 2015. “The Alternative Process is Irreversible, But FCs Market Remains Growth.” http://en.chemconsulting.com.cn/cnt_152.html.

Cooling Post. 2013. “Finally, a replacement for R123?” Cooling Post (London). http://www.coolingpost.com/world-news/finally-a-replacement-for-r123/.

Cooling Post. 2014. “Trane introduces five new chillers.” Cooling Post (London). http://www.coolingpost.com/products/trane-introduces-five-new-chillers/.

Cooling Post. 2017. “Dunham-Bush chiller to use R134a replacement.” Cooling Post (London). http://www.coolingpost.com/world-news/dunham-bush-chiller-to-use-r134a-replacement/.

European Parliament Council Directive 2006/40/EC. 2006. “Relating to emissions from air-conditioning systems in motor vehicles and amending Council Directive 70/156/EEC.” http://data.europa.eu/eli/dir/2006/40/oj.

Dahlke, T., O. Ruffiner, and R. Cant. 2016. "Production of HF from H_2SiF_6." *Procedia Engineering* 138 (2016): 231-239.

Desjarlais, A. 2017. Oak Ridge National Laboratory. Personal communication. June 2017.

E&E News. 2017. “Staying cool makes Earth warmer. There's help for that.” July 7, 2017.

ECHA. 2010. “Polyhaloalkene.” European Chemicals Agency. Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Registration Database. First published March 24, 2010. Last modified September 1, 2017. https://echa.europa.eu/registration-dossier/-/registered-dossier/16012.

ECHA. 2012a. "1,1,1,3,3-pentafluorobutane." European Chemicals Agency. Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Registration Database. First published April 27, 2012. Last modified August 14, 2017. https://echa.europa.eu/registration-dossier/-/registered-dossier/3527.

ECHA. 2012b. "(2Z)-1,1,1,4,4,4-hexafluorobut-2-ene." European Chemicals Agency. Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Registration Database. First published July 14, 2012. Last modified April 26, 2017. https://echa.europa.eu/registration-dossier/-/registered-dossier/10030.

ECHA. 2012c. "HFO-1234ze." European Chemicals Agency. Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Registration Database. First published April 27, 2012. Last modified April 18, 2017. https://echa.europa.eu/registration-dossier/-/registered-dossier/15736.

ECHA. 2014. "(1E)-1-chloro-3,3,3-trifluoroprop-1-ene." European Chemicals Agency. Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Registration Database. First published September 15, 2014. Last modified July 13, 2017. https://echa.europa.eu/registration-dossier/-/registered-dossier/10762.

EEA. 2015a. "Ozone-depleting substances 2015." EEA Report No 19/2016. https://www.eea.europa.eu/publications/ozone-depleting-substances-2015.

EEA. 2015b. "Fluorinated greenhouse gases 2015." EEA Report No 33/2016. https://www.eea.europa.eu/publications/fluorinated-greenhouse-gases.

EJARN. 2015a. January 6, 2015. "Japanese company to produce 1233zd." https://www.ejarn.com/news.aspx?ID=32859.

EJARN. 2015b. "Afinox picks 1233zd(E) after successful tests." June 17, 2015.

EJARN. 2015c. November 17, 2015. "Chemours to build HFO-1336mzz plant." http://ejarn.com/news.aspx?ID=37144.

EJARN. 2015d. "Chemours to build HFO-1336mzz plant." November 20, 2015.

EJARN. 2016. "Honeywell Solstice 1233zd & 1234ze Gaining Attention in Chiller Industry." July 24, 2016. https://www.ejarn.com/news.aspx?ID=40725.

EPA. N.D. "Significant New Alternatives Policy (SNAP) Program." Environmental Protection Agency. https://www.epa.gov/snap.

EPA. 2009. "Protection of Stratospheric Ozone: Notice 24 for Significant New Alternatives Policy Program." Environmental Protection Agency. September 30, 2009. 74 FR 50129. https://www.gpo.gov/fdsys/pkg/FR-2009-09-30/pdf/E9-23470.pdf.

EPA. 2010. “Protection of Stratospheric Ozone: Notice 25 for Significant New Alternatives Policy Program.” Environmental Protection Agency. June 16, 2010. 75 FR 34017. https://www.gpo.gov/fdsys/pkg/FR-2010-06-16/pdf/2010-14510.pdf.

EPA. 2012a. “Protection of Stratospheric Ozone: Determination 27 for Significant New Alternatives Policy Program.” Environmental Protection Agency. August 10, 2012. 77 FR 47768. https://www.gpo.gov/fdsys/pkg/FR-2012-08-10/pdf/2012-19688.pdf.

EPA. 2012b. “Direct Emissions from Fluorinated Chemicals (Including HCFC-22) Production.” *GHGRP Industrial Profiles.* https://www.epa.gov/sites/production/files/2016-11/documents/fluorinated_chemicals_sector_2012_112516.pdf.

EPA. 2014. “Protection of Stratospheric Ozone: Adjustments to the Allowance System for Controlling HCFC Production, Import and Export, 2015–2019". Environmental Protection Agency. October 28, 2014. 79 FR 64253. https://www.gpo.gov/fdsys/pkg/FR-2014-10-28/pdf/2014-25374.pdf.

EPA. 2015a. Protection of Stratospheric Ozone: Change of Listing Status for Certain Substitutes Under the Significant New Alternatives Policy Program. Federal Register, 80(138), 42870. https://www.gpo.gov/fdsys/pkg/FR-2015-07-20/pdf/2015-17066.pdf.

EPA. 2015b. “Protection of Stratospheric Ozone: Determination 30 for Significant New Alternatives Policy Program.” Environmental Protection Agency. July 16, 2015. 80 FR 42053. https://www.gpo.gov/fdsys/pkg/FR-2015-07-16/pdf/2015-17469.pdf.

EPA. 2016a. “2016 Chemical Data Reporting Results.” https://www.epa.gov/chemical-data-reporting/2016-chemical-data-reporting-results.

EPA. 2016b. “Protection of Stratospheric Ozone: Determination 31 for Significant New Alternatives Policy Program.” Environmental Protection Agency. May 23, 2016. 81 FR 32241. https://www.gpo.gov/fdsys/pkg/FR-2016-05-23/pdf/2016-12117.pdf.

EPA. 2016c. “Protection of Stratospheric Ozone: New Listings of Substitutes; Changes of Listing Status; and Reinterpretation of Unacceptability for Closed Cell Foam Products Under the Significant New Alternatives Policy Program; and Revision of Clean Air Act Section 608 Venting Prohibition for Propane.” Environmental Protection Agency. December 1, 2016. 81 FR 86778. https://www.gpo.gov/fdsys/pkg/FR-2016-12-01/pdf/2016-25167.pdf.

EPA. 2017. “SNAP Substitutes by Sector.” https://www.epa.gov/snap/snap-substitutes-sector.

European Commission. 2016. "Commission Regulation (EU) 2016/2281 of 30 November 2016 implementing Directive 2009/125/EC of the European Parliament and of the Council establishing a framework for the setting of ecodesign requirements for energy-related products, with regard to ecodesign requirements for air heating products, cooling products, high temperature process chillers and fan coil units." http://data.europa.eu/eli/reg/2016/2281/oj.

European Parliament. 2014. "Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006." European Parliament, Council of the European Union. April 16, 2014. http://data.europa.eu/eli/reg/2014/517/oj.

Eurostat. 2017. "International Trade in Goods." http://ec.europa.eu/eurostat/data/database.

Fricke, B. and V. Sharma. 2016. "High Efficiency, Low Emission Refrigeration System." Oak Ridge, TN: ORNL/TM-2016/363. https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Ref-system.pdf.

Gandhi, P., G. Hunter, R. Haseman, and B. Rodgers. 2017. "Benchmarking Risk by Whole Room Scale Leaks and Ignitions Testing of A2L Refrigerants." AHRTI Report No 9007-01. http://www.ahrinet.org/App_Content/ahri/files/RESEARCH/Technical%20Results/AHRI_9007-01_Final_Report.pdf.

Gaved, A. 2016. "Carrier opts for HFO 1234ze refrigerants for global chiller range." RAC Magazine (London). February 26, 2016. https://www.racplus.com/news/carrier-opts-for-hfo-1234ze-refrigerants-for-global-chiller-range/10003440.article.

Geister, W. 2017. "Refrigerant Update: The Next Transition Has Begun." Trane. http://nccashrae.org/images/meeting/022217/ashrae_trane_refrigerant_presentation___feb_2017_v1c.pdf.

Gluckman Consulting. 2015. "EU F-Gas Regulation Guidance—Information Sheet 7: Foam Insulation Products." February 2015. http://www.gluckmanconsulting.com/wp-content/uploads/2015/02/IS-7-Insulating-Foam-v3.pdf.

Godwin, D., M. Van Pelt, and B. Ferenchiak. 2014. "Modeling Emissions in Fire Extinguishing." June 12, 2014. https://wescohmb.wordpress.com/2014/07/03/modeling-emissions-in-fire-extinguishing/.

Goetzler, W., T. Sutherland, M. Rassi, and J. Burgos. 2014. "Research & Development Roadmap for Next-Generation Low Global Warming Potential Refrigerants." U.S. Department of Energy. DOE/EE-1154. https://energy.gov/sites/prod/files/2014/12/f19/Refrigerants%20Roadmap%20Final%20Report%202014.pdf.

Goetzler, W., M. Guernsey, J. Young, J. Fuhrman, and O. Abdelaziz. 2016. "The Future of Air Conditioning for Buildings." DOE/EE-1394. July 2016. https://www.energy.gov/sites/prod/files/2016/07/f33/The%20Future%20of%20AC%20Report%20-%20Full%20Report_0.pdf.

Grand View Research. 2016. "Aerosol Propellant Market Analysis By Product (Hydrocarbons, Dimethyl Ether (DME) & Methyl Ethyl Ether, Nitrous Oxide And Carbon Dioxide), By Application (Personal Care, Household, Automotive & Industrial, Food, Paints, Medical) And Segment Forecasts, 2014 – 2025." http://www.grandviewresearch.com/industry-analysis/aerosol-propellants-market.

Grand View Research. 2017. "Polyurethane (PU) Market Analysis By Product (Rigid Foam, Flexible Foam, Coatings, Adhesives & Sealants, Elastomers), By End-Use (Furniture & Interiors, Construction, Electronics & Appliances, Automotive, Footwear, Packaging), & Segment Forecasts, 2014 – 2025." Report ID: 978-1-68038-262-4. http://www.grandviewresearch.com/industry-analysis/polyurethane-pu-market.

Greenpeace. 2012. "Cool Technologies: Working Without HFCs." http://www.ammonia21.com/files/GP_report.pdf.

Gumprecht, W. H. 1982. "Process for the Manufacture of 1,1,1,2-Tetrafluoroethane." U.S. Patent 4,311,863, filed June 11, 1980, and issued January 19, 1982.

Gumprecht, W. H., L. E. Manzer, V. N. Mallikarjuna Rao. 1989. "Process for the manufacture of 1,1,1-trifluorodichloroethane and 1,1,1,2-tetrafluorochloroethane." U.S. Patent 4,843,181 filed Octobe 22, 1987, and issued June 27, 1989.

Hasse, V. 2009. "R290 Air Conditioner." Presented on behalf of GREE, Joint West Asia and South Asia Network Meeting. May 10, 2009. http://hydrocarbons21.com/knowledge/papersView/gree_electric_r290_air_conditioner.

Hella KGaA Hueck & Co. 2011. "Refrigerant and compressor oil filling quantities 2010/2011." http://www.autototal.ro/dmdocuments/Catalog%20Behr%20Hella.pdf.

Henne, A. L. 1934. "Method of manufacturing halofluoro hydrocarbons." U.S. Patent 1,978,840, filed January 30, 1931, and issued October 30, 1934.

Henne, A. L. 1935. "Fluoration in the presence of chlorine as a catalyst." U.S. Patent 1,990,692, filed January 30, 1931, and issued February 12, 1935.

Hon, C. 2017. True Manufacturing. Personal communication. April 2017.

Honeywell. 2015a. "Low GWP Refrigerants for Refrigeration: Solstice HFOs and HFO Blends." May 2015. https://www.honeywell-refrigerants.com/americas/?document=may-20-presentation-national-refrigerants&download=1.

Honeywell. 2015b. “Honeywell starts full-scale production of low global-warming propellant, insulating agent, and refrigerant.” Morris Township, NJ. January 6, 2015. https://www.honeywell.com/newsroom/pressreleases/2015/01/honeywell-starts-full-scale-production-of-low-global-warming-propellant-insulating-agent-and-refrigerant.

Honeywell. 2016. “Foam Insulation Using Honeywell’s Ultra-Low Global-Warming-Potential Material Added To Japanese Industrial Standard.” Tokyo, Japan. January 27, 2016. https://www.honeywell-lgwp.com/?press_release=foam-insulation-using-honeywells-ultra-low-global-warming-potential-material-added-to-japanese-inustrial-standard.

Honeywell. 2017. “Kirloskar Adopts Honeywell’s Solstice® Ze Refrigerant For Breakthrough Chiller Line In India.” New Delhi, India. February 23, 2017. https://www.honeywell-refrigerants.com/europe/?press_release=kirloskar-adopts-honeywells-solstice-ze-refrigerant-for-breakthrough-chiller-line-in-india.

Hydrocarbons21. 2017. “NEXT Series: Hydrocarbon charge limits under spotlight in 2017” January 10, 2017. http://hydrocarbons21.com/articles/7371/next_series_hydrocarbon_charge_limits_under_spotlight_in_2017.

ICIS. 1991. “Du Pont gives green light to HFC 134a facility.” *ICIS Chemical Business*. September 2, 1991. https://www.icis.com/resources/news/1991/09/02/14355/du-pont-gives-green-light-to-hfc-134a-facility/.

ICIS. 1995. “HFC-152a plant for DuPont.” *ICIS Chemical Business*. February 10, 1995. https://www.icis.com/resources/news/1995/02/10/20455/hfc-152a-plant-for-dupont/https://www.icis.com/resources/news/1991/09/02/14355/du-pont-gives-green-light-to-hfc-134a-facility/.

IGSD. 2017. “Tata Motors and MAHLE partner together to develop a prototype Secondary Loop Mobile Air Conditioning System on a vehicle.” Institute for Governance & Sustainable Development. July 13, 2017. http://www.igsd.org/tata-motors-and-mahle-partner-together-to-develop-a-prototype-secondary-loop-mobile-air-conditioning-system-on-a-vehicle/.

IHS. 2014a. “Fluorocarbons.” IHS Chemical Economics Handbook. February 2014. https://www.ihs.com/products/fluorocarbons-chemical-economics-handbook.html.

IHS. 2014b. “Polystyrene.” IHS Chemical Economics Handbook. December 2014. https://www.ihs.com/products/polystyrene-chemical-economics-handbook.html.

IHS. 2016a. “Chlorinated Methanes.” IHS Chemical Economics Handbook. December 2016. https://www.ihs.com/products/chlorinatedmethanes-chemical-economics-handbook.html.

IHS. 2016b. “Fluorspar and Inorganic Fluorine Compounds.” IHS Chemical Economics Handbook. January 2016. https://www.ihs.com/products/fluorspar-and-inorganic-fluorine-chemical-economics-handbook.html.

IHS. 2016c. “Polyurethane Foams.” IHS Chemical Economics Handbook. October 2016. https://www.ihs.com/products/polyurethane-foams-chemical-economics-handbook.html.

Ingersoll-Rand. 2016. “Ingersoll Rand Innovates HVAC Portfolio Using Next Generation, Low Global Warming Refrigerant, R-452B.” https://company.ingersollrand.com/content/dam/ir-corp/documents/pdf/2016-DR55-Update-Release-FINAL.pdf.

International Energy Agency (IEA). 2013. “Transition to Sustainable Buildings: Strategies and Opportunities to 2050.” OECD/IEA. https://www.iea.org/media/training/presentations/etw2014/publications/Sustainable_Buildings_2013.pdf.

IPCC. 2013. Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura, and H. Zhang. *Anthropogenic and Natural Radiative Forcing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf.

Ito, M., C. Dang, and E. Hihara. 2014. “Thermal Decomposition of Lower-GWP Refrigerants.” Herrick Laboratories. Purdue University. http://docs.lib.purdue.edu/iracc/1538.

Johnson Controls. 2016. “YORK® YVWA and YMC2 chillers offer unique solutions for customers investing in low-GWP refrigerants.” Milwaukee, WI. October 11, 2016. http://www.johnsoncontrols.com/media-center/news/press-releases/2016/10/11/r513a.

Kamalick, J. 2000. “Vulcan to build $50m HCC-240fa plant in Louisiana.” ICIS News. April 5, 2000. https://www.icis.com/resources/news/2000/04/05/109570/vulcan-to-build-50m-hcc-240fa-plant-in-louisiana/.

Kandi, V. 2015. “Hydrocarbons – A Viable Natural Refrigerant Solution For Medium Temperature Commercial Refrigeration Applications.” ATMOsphere. March 16–17, 2015. Brussels, Belgium. http://hydrocarbons21.com/files/1734_venugopal_kandi_emerson.pdf.

Kontomaris, K. 2014. "HFO-1336mzz-Z: High Temperature Chemical Stability and Use as A Working Fluid in Organic Rankine Cycles." *International Refrigeration and Air Conditioning Conference.* Paper 1525. http://docs.lib.purdue.edu/iracc/1525

Kujak, S. 2017. Trane. Personal communication. February 2017.

Laboratory News. 2014. "Refrigerant replacement highly toxic on combustion." April 17, 2014. https://www.labnews.co.uk/news/refrigerant-replacement-highly-toxic-on-combustion-17-04-2014/.

Leck, T. 2009. "Evaluation of HFO-1234yf as a Potential Replacement for R-134a in Refrigeration Applications." 3rd IIR Conf. on Thermophysical Properties and Transfer Processes of Refrigerants. Boulder, CO. http://www.autototal.ro/dmdocuments/Catalog%20Behr%20Hella.pdf.

LED. 2017. "Honeywell Dedicates $300 Million Mobile Refrigerants Facility In Louisiana." Louisiana Economic Development. May 16, 2017. https://www.opportunitylouisiana.com/led-news/news-releases/news/2017/05/16/honeywell-dedicates-$300-million-mobile-refrigerants-facility-in-louisiana.

Loh, G., J. Creazzo, and M. Robin. 2010. "Further Development of FEA-1100: a Low GWP Foam Expansion Agent." Polyurethane 2010 Technical Conference. Houston, TX. https://www.chemours.com/Formacel/en_US/assets/downloads/20101011_CPI_paper.pdf.

Majurin, Julie, E. Sorenson, D. Steinke, and M. Herried. 2017. "Chemical Stability Assessments of R-514A and R-1233zd(E)." Proceedings of the ASHRAE 2017 Winter Conference. Las Vegas, NV. January 28–February 1, 2017. https://www.trane.com/content/dam/Trane/Commercial/global/products-systems/education-training/industry-articles/ASHRAE012017_Chemical%20Stability%20Assessments%20of%20R-1233zd(E)%20and%20R-514A.pdf.

Manzer, L. E., and V. N. Mallikarjuna Rao. 1988. "Gas-phase fluorination process." U.S. Patent 4,766,260 filed July 7, 1987, and issued August 23, 1988.

Markets and Markets. 2017. "Refrigerant Market by Type (HCFC, HFC, HFO, Isobutane, Propane, Ammonia, and CO2), Application (Refrigerators, Large-scale Refrigerators, Chillers, Air Conditioners, and Heat Pumps), Region - Global Forecast to 2022." Report Code: CH 1536, May 2017. http://www.marketsandmarkets.com/Market-Reports/refrigerant-market-1082.html.

McMenamin, J. M. Robin, G. Loh, and J. Creazzo. 2009. "Development of Novel Blowing Agents for Polyurethane Foams." UTECH Europe 2009, Maastricht, Netherlands, March 31–April 2, 2009. https://www.chemours.com/Formacel/en_US/assets/downloads/UTECH_presentation_20090331.pdf.

Merkel, D. C., R. R. Singh, and H. S. Tung. 2007. "Process for producing fluoropropenes." U.S. Patent 7,230,146 filed October 27, 2003, and issued June 12, 2007.

Mexichem 2013. “Safety Data Sheet – Hydrogen Fluoride (Anhydrous).” March 2013. http://www.mexichemfluor.com/wp-content/uploads/2016/01/ahf-uk-ghs02.pdf.

Midgley, T. Jr., A. L. Henne, and R. R. McNary. 1934. “Heat Transfer and Refrigeration.” U.S. Patent 1,968,050, filed November 19, 1931, and issued July 31, 1934.

Milieu Ltd. 2007. “Review of the implementation of Regulation (EC) No 2037/2000 on substances that deplete the ozone layer—Summary Report.” December 14, 2007. http://ec.europa.eu/dgs/environment/pdf/summary_report.pdf.

Mitsubishi. 2015. “MHI Develops ‘ETI-Z Series’ of Next-generation Centrifugal Chillers.” Mitsubishi Heavy Industries, Ltd. Tokyo, Japan. June 10, 2015. http://www.mhi.com/news/story/1506101900.html.

Mitsubishi. 2017. “MHI Thermal Systems Develops "GART-ZE/ZEI" Series as Next-Generation Large-Capacity Centrifugal Chillers Adopting Low-GWP Refrigerant.” Mitsubishi Heavy Industries, Ltd. Tokyo, Japan. February 16, 2017. http://www.mhi.com/news/story/1702162051.html.

MOE. 2016. “Act on Rational Use and Proper Management of Fluorocarbons JAPAN.” Ministry of the Environment, Government of Japan. March 2016. https://www.env.go.jp/en/earth/ozone/laws/ozone4.pdf.

Mukhopadhyay, S., H. K. Nair, H. Tung, and M. Van Der Puy. 2007. “Processes for synthesis of tetrafluoropropene.” U.S. Patent 7,189,884 filed April 29, 2005, and issued March 13, 2007.

Potter, S. E. 1979. “Manufacture of Halogenated Compounds.” U.S. Patent 4,158,675, filed February 7, 1978, and issued June 19, 1979.

Powell, P. 2003. “Honeywell’s R-125 Plant Comes On Line.” ACHRNews. May 23, 2003. http://www.achrnews.com/articles/95037-honeywell-8217-s-r-125-plant-comes-on-line.

PRLog. 2012. “China expected to be largest production base of HFO-1234yf worldwide.” December 28, 2012. https://www.prlog.org/12050134-china-expected-to-be-largest-production-base-of-hfo-1234yf-worldwide.html.

Rao, R. 2016. “SRF to set up pilot plant for next-gen refrigerant gas HFO 1234yf.” Business Standard, April 1, 2016. http://www.business-standard.com/content/b2b-chemicals/srf-to-set-up-pilot-plant-for-next-gen-refrigerant-gas-hfo-1234yf-116040100307_1.html.

Rivoira. 2014. “Refrigeration & Air Conditioning” PE-172-UK 09/14.

Roberts, G. 1993. “Carving up the HFC Market.” *ICIS Chemical Business*. January 10, 1993. https://www.icis.com/resources/news/1993/01/10/34782/carving-up-the-hfc-market/.

Sakyu, F., Y. Hibino, S. Yoshikawa, R.Tamai, and Y. Gotoh. 2000. "Method for producing 1,1,1,3,3,-pentafluoropropane." U.S. Patent 6,111,150 filed December 12, 1996, and issued August 29, 2000.

Salwan, S. 2015. "Fluorspar Price Tracker: February 2015." Industrial Minerals. February 18, 2015. http://www.indmin.com/Article/3429446/Fluorspar-Price-Tracker-February-2015.html.

Seidel, S., J. Ye, and S. O. Andersen. 2015. "Technological Change in the Production Sector Under the Montreal Protocol." Center for Climate and Energy Solutions. October 2015. https://www.c2es.org/publications/technological-change-production-sector-under-montreal-protocol.

Seidel, S. 2017. Personal communication.

Shankland, I. R., T. Atwood, E. A. E. Lund, and H. T. Pham. 1993. "Azeotrope-like compositions of pentafluoroethane and 1,1,1-trifluoroethane." U.S. Patent 5,211,867 filed July 30, 1991, and issued May 18, 1993.

Shecco Publications. 2012. "The GUIDE 2012: Natural Refrigerants - Market Growth for Europe." https://issuu.com/shecco/docs/guide_2012_nr_final.

Shecco Publications. 2013. "2013: Natural Refrigerants Market Growth for North America." http://www.zero-c.com/wp-content/uploads/2014/01/the-guide-2013-Natural-Refrigerants-Market-Growth-for-North-America2.pdf.

Shecco Publications. 2015. "GUIDE to Natural Refrigerants in China—State of the Industry 2015." http://publication.shecco.com/publications/view/2015-guide-china-natural-refrigerants.

Shecco Publications. 2016. "GUIDE to Natural Refrigerants in Japan—State of the Industry 2016." https://issuu.com/shecco/docs/guide_japan-2016.

Sheridan, M. 2004. "DuPont, China's Zhonghao New Materials finalise HFC jv." *ICIS Chemical Business*. March 15, 2004. https://www.icis.com/resources/news/2004/03/15/566205/dupont-china-s-zhonghao-new-materials-finalise-hfc-jv/.

Sherry, D., M. Nolan, S. Seidel, and S. O. Andersen. 2017. "HFO-1234yf: An Examination of Projected Long-Term Costs of Production." Center for Climate and Energy Solutions. April 2017. https://www.c2es.org/docUploads/hfo-1234-yf.pdf.

Shiflett, M. B. 1993. "Constant boiling compositions of pentafluoroethane, difluoromethane, and tetrafluoroethane." U.S. Patent 5,185,094 filed February 1, 1991, and issued February 9, 1993.

Singh, R. R., D. P. Wilson, I. Shankland, and H. T. Pham. 2009. "Azeotrope-like compositions of tetrafluoropropenes and bromofluoropropenes." U.S. Patent 7,597,818 filed February 27, 2007, and issued October 6, 2009.

Singh, R. R., H. T. Pham, D. P. Wilson, R. H. Thomas, and I. Shankland. 2009. "Compositions containing fluorine substituted olefins." U.S. Patent 7,534,366 filed October 27, 2003, and issued May 19, 2009.

Singh, R. R., H. T. Pham, G. M. Knopeck, L. E. Herena, and J. N. Diringer. 2009. "Azeotrope-like compositions of tetrafluoropropene and hydrofluorocarbons." U.S. Patent 7,524,805 filed April 29, 2004, and issued April 28, 2009.

Smithers Rapra. 2014. "Polymer Foams Market Expected to Consume 25.3 Million Tonnes by 2019." http://www.smithersrapra.com/news/2014/may/polymer-foam-market-to-consume-25-3-million-tonnes.

Stewart, T.P. 2012. "China's Export Restraints on Fluorspar: The WTO Dispute and its Aftermath." From the Proceedings of the Fluorspar 2012 Conference. Vancouver, Canada. October 22–24, 2012. http://www.indmin.com/events/download.ashx/document/speaker/6558/a0ID000000X0jZAMAZ/Presentation.

Trade Map. International Trade Centre. http://www.trademap.org/.

Trane. 2015. "Trane Sintesis™ Air-Cooled Chillers are Now Available to Help Reduce Greenhouse Gas Emissions." Trane Inc. Davidson, NC. June 15, 2015. http://www.trane.com/commercial/north-america/us/en/about-us/newsroom/press-releases/trane-sintesis_-air-cooled-chillers-are-now-available-to--help-r.html.

Trane. 2016. "Trane Announces Significant Centrifugal Chiller Line Expansion and Services for the United States and Canada." Trane Inc. Davidson, NC. June 15, 2016. http://www.trane.com/commercial/north-america/us/en/about-us/newsroom/press-releases/centrifugal-chiller-line-expansion.html.

Trane. 2017. "Trane Expands XStream™ Portfolio of Water-Cooled Chillers with the Addition of a High-Efficiency and Low-Environmental Impact Model." Trane, Inc. Brussels, Belgium. April 5, 2017. http://www.trane.com/commercial/europe/uk/en/about-us/newsroom1/press-releases/trane-expends-xstream.html.

Transparency Market Research. 2016. "Aerosol, SPF (Spray Polyurethane Foam) and Aerosol Propellants (CFC, Hydrocarbons, DME and Others) Market for Paints, Coatings, Medical and Household Applications—Global Industry Analysis, Size, Share, Growth, Trends and Forecast, 2013–2019." http://www.transparencymarketresearch.com/aerosol-propellants-market.html.

Tung, H. S. 1998. "Vapor phase process for making 1,1,1,3,3-pentafluoropropane and 1-chloro-3,3,3-trifluoropropene." U.S. Patent 5,710,352 filed September 19, 1996, and issued January 20, 1998.

Tung, H. S., R. C. Johnson, and D. C. Merkel. 2009. "Process for the manufacture of 1,3,3,3-tetrafluoropropene." U.S. Patent 7,592,494 filed July 25, 2003, and issued September 22, 2009.

UNEP. 2002. "Report of the Technology and Economic Assessment Panel—Progress Report." Volume I. April 2002. http://www.unep.fr/ozonaction/information/mmcfiles/3924-e.pdf.

UNEP. 2003. "Report of the Technology and Economic Assessment Panel: HCFC Task Force Report." p.86 http://wedocs.unep.org/bitstream/handle/20.500.11822/8112/77.pdf.

UNEP. 2016a. "The Montreal Protocol on Substances that Deplete the Ozone Layer." Section 1.1. http://ozone.unep.org/sites/ozone/files/Publications/Handbooks/Montreal-Protocol-English.pdf.

UNEP. 2016b. "Project Proposals: China." United Nations Environment Programme. 76th Meeting of the Parties. Montreal, Canada. May 9–13, 2016. http://www.multilateralfund.org/76/English/1/7625.pdf.

UNEP Ozone Secretariat. 2015. "Fact Sheet 13 Insulating Foam." Workshop on HFC management: technical issues. Bangkok, Thailand. April 20-21, 2015. http://conf.montreal-protocol.org/meeting/workshops/hfc_management-02/presession/English/FS%2013%20Insulating%20Foam%20final.pdf.

UNEP Ozone Secretariat. 2017. Data Access Centre. http://ozone.unep.org/reporting/.

U.S. ITC. 2014. "1,1,1,2--Tetrafluoroethane from China." Pub. 4503. U.S. International Trade Commission. December 2014. https://www.usitc.gov/publications/701_731/pub4503.pdf.

U.S. ITC. 2016. "Hydrofluorocarbon Blends and Components from China." Pub. 4629. U.S. International Trade Commission. August 2016. https://www.usitc.gov/publications/701_731/pub4629.pdf.

U.S. ITC. 2017. "1,1,1,2--Tetrafluoroethane (R-134a) from China." Pub. 4679. U.S. International Trade Commission. April 2017. https://www.usitc.gov/publications/701_731/pub4679.pdf.

USGS. 2012. "Fluorspar [Advance Release]." In 2012 Minerals Yearbook. U.S. Geological Survey. https://minerals.usgs.gov/minerals/pubs/commodity/fluorspar/myb1-2012-fluor.pdf.

USGS. 2017. "Fluorspar." In Mineral Commodity Summaries 2017. U.S. Geological Survey, p. 62–63. https://doi.org/10.3133/70180197.

Vithoontien, V. 2016. "Global Supply and Demand of HCFCs and HFCs." Presentation at Workshop on Implementation Progress of HCFC. World Bank, Washington, D.C. April 1, 2016. http://www.ozonediw.org/attach/56/PresentationWorldBank.pdf.

VTech Process Equipment. 2017. "CO_2: End-user Driven Change in Vending Machines and Other Applications." http://www.vtechonline.com/pdf/News-PDFs/CO2%20--%20End-user%20Driven%20Change%20in%20Vending%20Machines%20and%20Other%20Applications.pdf.

Walker, J. 2010. "Fluorspar mining makes comeback." Paducah Sun (KY), March 7, 2010. http://www.paducahsun.com/business/fluorspar-mining-makes-comeback/article_9c11537c-5a8f-11e7-ae50-10604b9f0f42.html.

Walters-Terronini, H. Chemours. 2017. Personal communication.

Wang, X., and K. Amrane. 2016. "AHRI Low Global Warming Potential Alternative Refrigerants Evaluation Program (Low-GWPAREP) Summary of Phase II Testing Results." International Refrigeration and Air Conditioning Conference. Paper 1586. Purdue University. http://docs.lib.purdue.edu/iracc/1586.

Wilson, D. P., R. R. Singh, R. H. Thomas, and H. T. Pham. 2012. "Compositions containing fluorine substituted olefins." European Patent 7,534,366 filed October 27, 2003, and issued May 2, 2012.

WTO. 2011. "Panel Report, CHINA—Measures Related to the Exportation of Various Raw Materials." World Trade Organization. WT/DS394/R. July 5, 2011. https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds394_e.htm

Yamamoto, A., N. Shibata, T. Nakada, and T. Shibanuma. 2002. "Process for producing 1,1,1,3,3-pentafluoropropane." U.S. Patent 6,472,573 filed February 5, 1999, and issued October 29, 2002.

Yates, S. F. and R. Gaita. 2002. "Purification of 1,1,1,3,3-pentafluoropropane (R-245fa)." European Patent EP0902776B1, filed April 4, 1997, and issued June 19, 2002.

Zhang, J. and C. Wang. 2014. "China's hydrofluorocarbon challenge." Nature Climate Change 4, no. 11 (2014): 943. doi:10.1038/nclimate2377.

Shaping Tomorrow's Built Environment Today

1791 Tullie Circle NE ▪ Atlanta, Georgia 30329-2305 ▪ Tel 404-636-8400 ▪ http://www.ashrae.org

Response to Questions for the Record for

Darryl K. Boyce, P. Eng.

ASHRAE President

Regarding S. 2754, American Innovation and Manufacturing Act of 2019

From Senator Whitehouse

1. What percentage of total HFCs used in the U.S. are used by the aerospace, semiconductor, composites, foam, and defense sprays industries? Has this percentage of niche uses grown over the last five years, and if so, by how much?

   This question is outside of ASHRAE's areas of expertise. Although ASHRAE is aware of the various uses of HFCs, as a professional society, ASHRAE does not have or maintain market data on refrigerant sales or market segmentation. This question can likely be better addressed by the refrigerant manufacturers.

2. Numerous industries have provided written testimony stating that there are no acceptable substitutes for HFCs they use. Please comment on these claims with respect to the aerospace, semiconductor, composites, foam, and defense sprays industries. Please list all HFCs for which such claims have been made and state whether or not you agree with the claim that no acceptable substitute exists. If you do not agree, please provide the name of the substitute and why you believe it to be acceptable.

   As a professional society focused on advancing human well-being through sustainable technology for the built environment, ASHRAE cannot comment on matters pertaining to industries outside of ASHRAE's areas of expertise and mission (e.g., aerospace, semiconductor, composites, defense sprays).

   For the purposes of HVAC&R equipment, there continues to be emerging refrigerant developments that provide equipment manufactures and end-users with multiple options for refrigerants across wide temperature ranges to serve the application needs. Because there are often multiple choices of candidate refrigerants to replace HFCs, there will; inherently, be trade-offs that need to be considered. This also applies to the use of these fluids as blowing agents for insulation materials that are used within the HVAC&R industry.

Additional information concerning refrigerant selection is available in ASHRAE's "Position Document on Refrigerants and Their Responsible Use[1]" and provided below for your reference:

> Throughout the history of air conditioning and refrigeration, numerous substances have been used as refrigerants[2], and for many years refrigerant choice was not of primary concern when selecting equipment. This changed over the last three decades as choosing a refrigerant became increasingly more complex due to the new environmental criteria applied to refrigerant selection that resulted in many new substances and blends being invented, tested, and commercialized. Earlier generations of commercial refrigerants were mostly fluorinated gases—chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). They contributed to the depletion of stratospheric ozone and are being phased out globally under The Montreal Protocol. CFCs and HCFCs have largely been replaced with hydrofluorocarbons (HFCs), some of which have high global warming potential (GWP) and are being restricted as the world deals with global climate change. More recently, fluorinated alternatives referred to as hydrofluoroolefins (HFOs) have been introduced. They have zero ozone-depleting potential (ODP) and very low GWP, but some of them are mildly flammable.
>
> Nonfluorinated refrigerants (frequently referred to as natural refrigerants) include ammonia, carbon dioxide (CO2), hydrocarbons, water, and air. Some of them have been used for many decades with varying degrees of adoption. Although their GWP is very low, natural refrigerants are not free of other concerns, such as corrosion, toxicity, high pressures, high flammability, or in some cases lower operating efficiencies. There are also other single components and blends (mixtures of different refrigerants from the same or different class/group) that are available as transitional or long-term solutions with different flammability and GWP value characteristics.

3. For HFCs where users claim that the current substitute is too expensive, based on the country's prior experience transitioning from CFCs to HFCs, what do you believe will occur with respect to the price of HFC substitutes?

   As a technical society focused on technological advancements, ASHRAE declines to comment on speculation concerning the cost of various HFC substitutes. However, ASHRAE does expect the candidate refrigerants being proposed for replacing HFCs will likely undergo a process of consolidation. In some applications, we expect there will initially be a larger list of refrigerants available but over time, that list will decline based on market acceptance.

[1] Approved by ASHRAE Board of Directors June 27, 2018. Expires June 27, 2021.
[2] Calm, J.M. 2008. The next generation of refrigerants—Historical review, considerations, and outlook. Int. J. Refrigeration 31:1123–33

FIRST CONTINENTAL INTERNATIONAL

11 Harristown Road
Glen Rock, NJ 07452
Tel: (201) 670-9848
Fax: (201) 670-9840
www.fci-nj.com

April 27th, 2020

Honorable John Barrasso, M.D.
Chairman, Senate Committee on
Environment and Public Works
United States Senate
Washington, D.C. 20510

Honorable Thomas R. Carper
Ranking Member, Senate Committee on
Environment and Public Works
United States Senate
Washington, D.C. 20510

Dear Chairman Barrasso and Ranking Member Carper:

We are grateful to have received your questions on our written testimony regarding, *"S. 2754, American Innovation and Manufacturing Act of 2019."*

First Continental International Inc. appreciates this opportunity to elaborate for you and the Senate Committee on Environment and Public Works the elements of this bill that raise serious concerns to impacted American consumers and industries.

We strongly support the reevaluation of this bill and have included our report below pertaining to the HFO replacement material's patent history, and surprisingly higher carbon footprint and vast price difference to HFCs.

Finally, we will voice support for language to be added that will protect consumers from huge price increases by allowing low-GWP, zero-ODP HFCs to remain in the market, in particular HFC-152a.

Additionally, language to push the baseline period for phase downs later, as other countries have, will accurately represent HFC usage and growth, and benefit those growing American industries.

Thank you for your leadership and attention to how the replacement of HFCs with HFOs will throttle American lives and industries, such as aerosol, blowing agent, and refrigeration, and more. We look forward to your continued feedback and are pleased to answer any further questions.

Very Best Regards,

Michael Valenti

Michael Valenti
Vice President
First Continental International
11 Harristown Road, Glen Rock, NJ 07403
mvalenti@fci-nj.com
+1 (201) 670-9848

Greg Heden

Greg Heden
Senior Sales and Marketing Manager
First Continental International
11 Harristown Road, Glen Rock, NJ 07403
gheden@fci-nj.com
+1 (201) 670-9848

Table of Contents:

Question 1. Can you explain who holds most of the patents for HFC replacement chemicals? When do these patents expire?

I. History and Distribution of Granted Patents

Most of the granted patents for the HFO technology (Opteon^{TM}), suggested as the HFC replacement by the patent owners, belong to the Honeywell-Chemours alliance. As shown in Table 1, 154 out of the 298 total are held by Honeywell and Dupont/Chemours, and these are the most important ones, because the technology was originally developed by these companies. Of course, Chemours is a spin off from DuPont, but the companies share similar interests and are linked through the patents.

These three major chemical companies make what one may call the "Big Three" of the HFO business.

Table 1. Patents issued to the main players in the HFO technology

Company name	Country	Patents total	Process	Usage	Pending
Honeywell	USA	88	77	11	42
DuPont/Chemours	USA	66	52	14	18
Arkema	France	62	50	12	22
Total:		**298**	**179**	**37**	**82**

Figure 1 gives a graphical view of how the Big Three of the HFO industry have acquired their patent portfolio since the beginning of the 2000s, the inception of HFO technology. The chart in Fig. 1 is based on US PTO (US Patent and Trademark Office) data and provides statistics separately for "process", or "production" patents and for "application", or "usage" patents.

Essentially, there are three different aspects of the patents:

(i) manufacture, or process chemistry;

(ii) blending HFO with other refrigerants;

(iii) application, or use of HFO.

These patents will prevent any other company the opportunity to challenge their position in the HFO market.

Please see Figure 1 below, charting the number of patents issues by every type, every year since 2005:

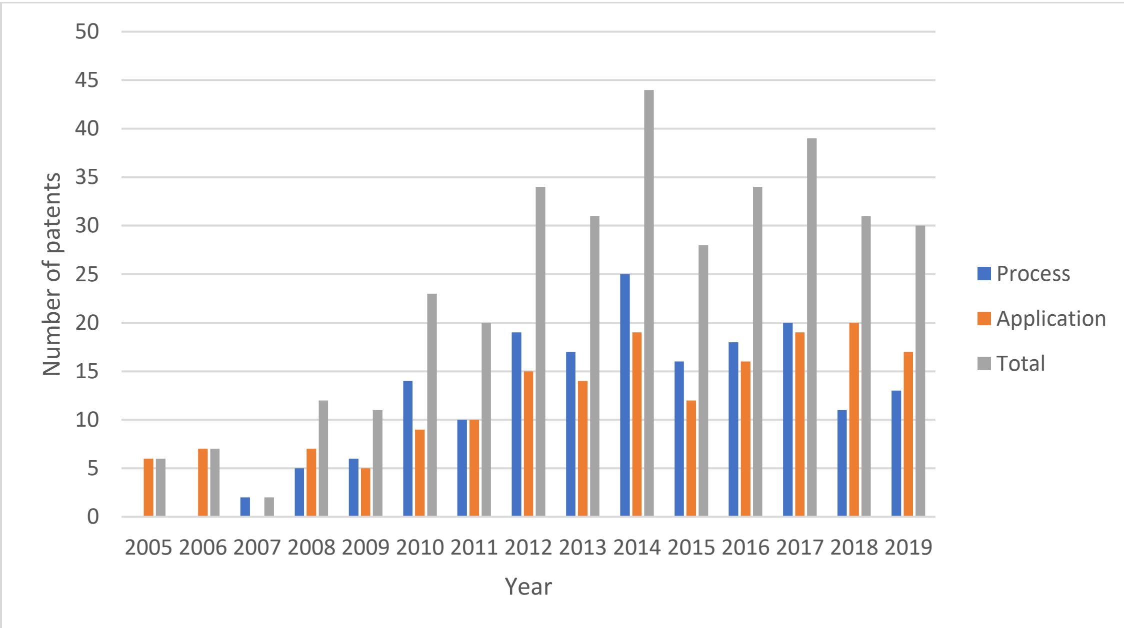


Fig. 1. HFO patents issued by US PTO to "the Big Three" since the HFO technology inception.

Every new patent added in each consecutive year to the market means an even longer extension to these few companies' ability to keep HFO usage under their control. These patents are growing in their efforts to do everything possible to extend their ability to unfairly dominate the market.

II. Patent Enforcement and Infringement

Honeywell and Chemours vigorously safeguard their HFO intellectual property, from production to blending to applications. For example, Chemours has recently filed a patent infringement lawsuit in Japan against Asahi Glass Company (AGC) over HFO-1234yf. They claim infringement of Chemours' patents covering HFO-1234yf compositions and use in automotive air conditioning and other refrigeration applications. Many companies such as AGC and Arkema do not agree. There are concerns "that patents on the HFO production process and application patents on their use in various sectors could adversely impact efforts to transition from HFCs." This simply gives the owners of the vast amount of HFO patents a chance to create a monopoly.

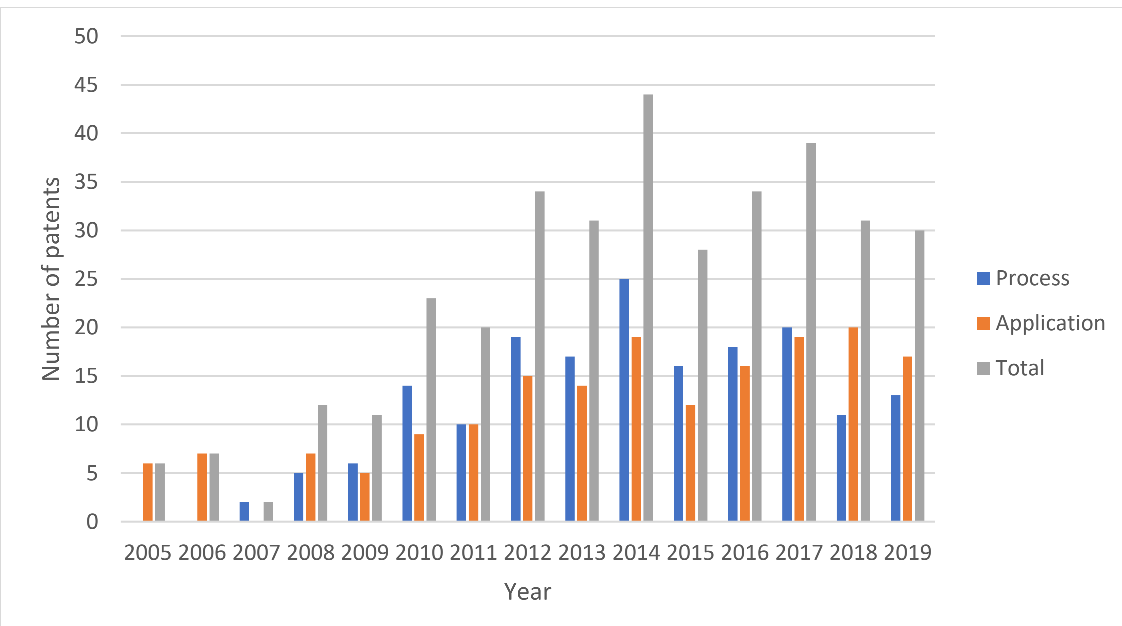
For example, Arkema requested a license from Honeywell to manufacture HFO, but the request was rejected. Arkema has filed a complaint with the European Commission that Honeywell is denying license to produce HFO-1234yf and stated that Honeywell is creating an unfair market dominance with their patents. If Arkema is given the license, it would build two plants, one in China and one in Europe.

In a different instance, Arkema and other companies tried to invalidate some of the Honeywell "use", or "applications" patents such as, for example, US Patents 8033120 and 8065882. While the EU has issued an invalidation ruling on these application patents, it is currently under appeal and remains in effect.

III. Patent Expiration: Extended Every Year

There is virtually no expiration on these patents, as they are adding a huge number of new patents every year, and they are continuously being extended as shown in our chart again:

Fig. 1. HFO patents issued by US PTO to "the Big Three" since the HFO technology inception



<u>Conclusion: Almost no expiration in sight for these patents.</u>

According to Chemours Company's investor presentation of November 2018, the very first HFO patents expire in 2023. Another suite of patents trademarked Opteon expire in 2026, while hundreds of recently filed and issued follow-up patents (see Fig. 1) "will remain in full force well into the 2030's." Based on the continued issuing of new patents to this day, especially to

Honeywell and Chemours, their patents will easily last over 30 years from now, and will continue to be extended through each newly issued patents. This control assures them lifelong patents, and a lifelong monopoly in the market, and the ability to sell their HFO products at the higher prices they'd like to sell at, which will be passed directly to the manufacturers who use these products, and then ultimately to the consumer.

Question 2. Can you provide any data you have comparing the carbon footprint of HFC production to HFO production?

According to the Intergovernmental Panel on Climate Change 2013 Report, the global warming potential (GWP) of HFO-1234yf is low, around 1. This is largely due to its short lifetime in the atmosphere, which is reported to be 10.5 days. But this estimate only gives us an idea of the HFO-1234yf's fate in the atmosphere, but it does not take into consideration any indirect, or associated green gas emissions whatsoever. The truth is that the apparently low GWP value of HFO-1234yf is hugely counter-balanced by the carbon footprint associated with its production.

There are several HFCs, however we have selected 3 for comparison. We can provide at least estimates of the carbon footprint of HFO production by comparing it to the following HFC productions:

i. Our in-house estimate of HFO-1234yf based on energy consumption and CO_2 emissions versus HFC-152a, HFC-134a, and HFC-32.

ii. Estimate of HFC-134a *vs.* HFO-1234yf by the International Council on Clean Transportation based on life cycle analysis and chemical engineering modeling

I. FCI's In-House Estimate of HFO Carbon Footprint

Our calculations based on available data on energy consumption and CO_2 emissions (see Table 2) attest that the carbon footprint of **HFO-1234yf** production both in the US[2] and China[3] is very high. For 1 metric ton, it is **20 times higher** than the carbon footprint of production of 1 metric ton of HFC-152a, a highly useful HFC with a low GWP value.

Table 2. Comparative analysis of carbon footprints of HFO and HFC manufacturing

Plant	Chemical	Production[1]	Assumptions[2, 3]	Carbon footprint
Arkema, Changshu[4]	HFO-1234yf	7,000 MT	2.46 tons of coal translates into 20 MWh	9 tons CO_2 per 1 ton of HFO-1234yf
Honeywell, Geismar, LA[5]	HFO-1234yf	12,000 MT	536 thousand tons of CO_2 emissions for all 5 plants within the facility	9 tons CO_2 per 1 ton of HFO-1234yf
Chemours, Corpus Christi, TX[6]	HFC-152a	20,000 MT	24 thousand tons of CO_2 emissions for whole plant	0.4 tons CO_2 per 1 ton of HFC-152a

Mexichem, St. Gabriel, LA[7]	HFC-134a	30,000 MT	53 thousand tons of CO_2 emissions for whole plant	1.8 tons CO_2 per 1 ton of HFC-134a
Arkema, Calvert City, KY[8]	HFC-32	20,000 MT	1,034 thousand tons of CO_2 emissions for all 6 plants within the facility	4.3 tons CO_2 per 1 ton of HFC-32

Footnotes:

[1]Production is in metric tons (MT) annually

[2]All tons in Table 1 are metric tons

[3]Assumptions for CO_2 emissions are from the EPA Greenhouse Gas Reporting Program available for public at https://www.epa.gov/ghgreporting/ghgrp-chemicals

[4]Assumptions for the energy consumption by the Arkema plant in China are from the City of Suzhou government, which approved construction of the Arkema Changshu plant: http://www.zfxxgk.suzhou.gov.cn/sjjg/szsfzhggwyh/201401/t20140103_346327.html, translated from Chinese

[5]Honeywell Specialty Chemicals facility has 5 plants, with one of them producing HFO. The nominal share of this plant is calculated from the total CO_2 emissions of 536 thousand metric tons divided by 5.

[6]Chemours Corpus Christi facility manufactures two more products in addition to HFC-152a, so the nominal share of HFC-152a manufacturing is calculated from the total CO_2 emission of 24 thousand metric tons divided by 3.

[7]Mexichem Fluor's plant in St. Gabriel is entirely dedicated to the production of HFC-134a.

[8]Arkema's facility in Calvert City, KY has 6 plants, with one of them producing HFC-32 and HFC-134a, so the nominal share of HFC-32 is calculated from the total CO_2 emissions of 1,034 thousand thousand metric tons divided by 6 (number of plants) and then by 2 (assuming that HFC-32 comprises one half of HFC production)

II. More Energy Needed and More Waste Created by HFO Production

Calculations based on chemical theory suggests the following result: to produce 1 mole, or weight equivalent of HFO-1234yf, one takes 1 equivalent of ethylene, 1 equivalent of carbon tetrachloride, 1 equivalent of chlorine gas, and 4 equivalents of anhydrous hydrofluoric acid (HF) in a six-step chemical process. In addition, 4 equivalents of hydrogen chloride HCl are generated as a by-product.

By contrast, production of 1 equivalent of HFC-152a takes 1 equivalent of acetylene and 2 equivalents of anhydrous HF in a one-step process.

It is clearly seen that HFO production is much more energy and material demanding.

But it also generates much more hazardous wastes. For example, the six-step process by which HFO-1234yf is produced, generates on the whole six times more fugitive emissions of HCl and organochlorine compounds compared to the one-step production of HFC-152a, a typical hydrofluorocarbon. Just to make it clear again, production of HFO-1234yf pollutes the air and water six times more so than production of HFC-152a. Additionally, one of the byproducts of production, HCl, or hydrogen chloride, is a harmful material that can easily sink into the ground, and into drinking water.

III. HFO Carbon Footprint Estimate by International Council on Clean Transportation

The International Council on Clean Transportation, a nonprofit think tank based in Washington, DC in 2013 commissioned a research group of the Ohio State University to evaluate upstream climate impacts from production of HFO-1234yf compared to production of HFC-134a, both used in automotive air conditioning systems.

This research group was the first one to bring attention to a missing element in the US and European regulations: "consideration of the upstream climate impacts of refrigerant production".

In their white paper titled "Upstream Climate Impacts from Production of R-134a and R-1234yf refrigerants used in Mobile Air Conditioning Systems", the group studied indirect global warming contributions from production of refrigerants.

They applied life cycle analysis, chemical theory, and carried out numerical simulations with ChemCAD software to evaluate the following contributions: (i) material consumption; (ii) energy consumption; and (iii) fugitive emissions.

The results are as follows:

- Production of 1 metric ton of **HFC-134a** causes indirect emissions of **5 metric tons** of CO_2
- Production of 1 metric ton of **HFO-1234yf** causes indirect emissions of **13.7 metric tons** of CO_2

The authors of this study concluded that upstream CO_2 emissions of HFO-1234yf are about three times those of HFC-134a, indicating that higher upstream greenhouse gas emissions may offset a fraction of the climate mitigation benefits offered by the low GWP value of HFO-1234yf.

Question 3: Can you provide any data highlighting the cost difference between HFCs and HFOs?

Although the price of HFOs vary based on small or bulk volumes purchased, even the lowest prices are still significantly higher than HFC alternatives across the board.

HFO’s higher cost is firstly due to the extremely high margins built into the products based on the monopoly the producers have as discussed in the patent section. The extremely tight control is kept from 3 types of patents and is perpetuated by the continuous extension of control from new patents, making it lifelong without expiration.

The smaller portion of the cost comes from the complexity of its multi-step production process, and again its limited number of producers.

Coupled with vastly growing industries and lobbied regulations to restrict HFCs, HFOs remain a seller’s market.

Alternatively, HFCs are no longer under patent and allow for a highly competitive market that benefits all consumers and American industries at a much lower cost.

Most pricing data available for HFOs is for HFO-1234yf because it is the most prominent due to car refrigerant regulations. However, the cost of HFO-1234yf is reflective of the other HFOs as well, because they all use similar complicated production techniques and are under tight patent constraints with limited producers.

Here we will analyze the cost of production of HFO-1234y and compare it to the cost to the market price of HFO-1234yf and its HFC alternatives.

I. Cost of HFO Production

Extensive cost analysis has been performed by Nolan Sherry & Associates, which is cited at the end of this response:

The costs of producing HFO-1234yf using two different, prominent processes was estimated to be between $7,800 to $15,610/metric ton (MT). This is based only on capital recovery costs and variable costs (raw materials and feedstocks, and energy) and a 3.2 per cent annual cost for maintenance of fixed capital assets.

Other cost factors such as operating labor and supplies, maintenance labor and materials, plant overhead, taxes and insurance, sales and marketing, interest paid on capital, and general and administrative costs could add anywhere from 75-150 percent to the variable and capital costs of production.

The Total costs for the two HFO-1234yf production processes were therefore estimated to be $13,650-39,025/MT (as shown in Table 3), which is significantly lower than the current market price of the HFO's.

Table 3. HFO-1234yf Production Cost Chart

	Production Costs	Other Costs	Total Cost
Low End	$7,800/MT	+ 75%	$13,650/MT
		+ 150%	$19,500/MT
High End	$15,610/MT	+ 75%	$27,317/MT
		+ 150%	$39,025/MT

II. HFO Price Difference: Inflated Market Price of HFOs in the Auto Industry

International regulations have pushed the automobile industry to utilize HFO-1234yf as its primary refrigerant.

Research done by Nolan Sherry & Associates estimates that HFO-1234yf is selling for approximately $75-80/kg ($75,000-80,000/MT) in bulk quantities purchased by vehicle manufacturers, while smaller quantities sold to vehicle service companies are estimated at $250 to $350/kg.

Source: http://www.nolansherry.com/assets/hfo-1234-yf.pdf

Even at the bulk volume, this price is 10 times higher than HFC-134a which is currently priced at $6-8/kg. The bulk quantity market price for HFO-1234yf is approximately 10 times or more the current price of bulk HFC-134a.

Table 4. Price Comparison Chart: HFCs and HFOs

Item	**Cost**	**Source**
HFC-134a	$6-8/kg	Nolan Sherry & Associates
HFO-1234yf (Bulk)	$75-80/kg	Nolan Sherry & Associates
HFO-1234yf (Small)	$250-$350/kg	Nolan Sherry & Associates
HFO-1234yf (Recharge)	$71/lb ($157/kg)	Patrick J. Michaels, CATO Institute
HFO-1234yf – 10lb Recharge Cylinder	$70/lb ($154/kg)	Refrigerant HQ
HFO's	Up to 8x Cost of HFC's	Clean Energy Manufacturing Analysis Center

Additionally, as shown above, Patrick Michaels of the Cato Institute cites the cost of HFO's for HVAC units at $71/lb – while the out-of-patent HFCs are closer to $7/lb. This is only the raw material costs and does not include the labor and or installer markup costs.

HFO-1234yf is not a drop in product for HFC refrigerants either, so consumers will have to pay thousands of dollars to install a new system for the HFO products.

Consumers will likely see cost increases to fill a new residential HVAC system of more than $1000!

Source: "Ratifying Kigali Amendment Is All Pain, No Gain" - Patrick J. Michaels, CATO Institute

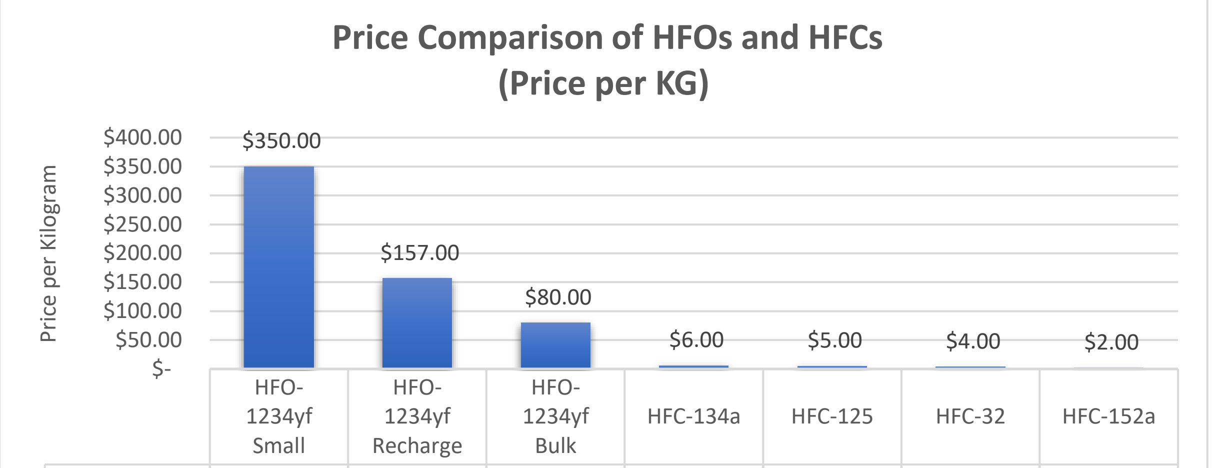
III. Future Prices of HFO are Still Extremely High, and Likely to Go Higher

Previous refrigerant transitions have shown that upfront costs for new equipment tend to increase, but that life cycle cost increases may be offset by improved product efficiency, production process improvements, and economies of scale.

However, projections for the HFOs due to its complication in production and potential market show that the costs will in no way reach the price of HFCs, and in fact will result in a permanently inflated price of refrigerants and propellants.

Not to mention, the lack of competition amongst producers will keep the price high!

This pricing is still significantly higher than the $2.70-3.63/lb price of HFC-134, as well as HFC-125, 32, and 152a. These will be passed on to consumers, and for your reference have created a comparison graph below to better illustrate these price differences, in kilograms:



	HFO-1234yf Small	HFO-1234yf Recharge	HFO-1234yf Bulk	HFC-134a	HFC-125	HFC-32	HFC-152a
Price per KG	$350.00	$157.00	$80.00	$6.00	$5.00	$4.00	$2.00

Conclusion: We believe it will hurt end users in the USA greatly. Most importantly, HFCs have zero ozone-depleting potential (ODP), although some have higher GWP. HFC-152a, for example has zero ODP and low GWP.

This is all the more reason why HFCs should not be phased down, and force users to buy HFOs. American industries and consumers deserve the right to make this choice themselves, especially when the current option (HFCs) are still zero ODP and low GWP!

Question 4. Do you believe language should be added to ensure the bill appropriately considers potential increases in consumer costs when setting regulations under the AIM Act?

I. Considering the Costs to American Consumers by Removing Zero ODP HFCs

Continuing our discussion on Question 3, we believe that the market should not be forced to use HFOs with the passing of this bill. However, in the case that the passing of this bill is considered, we do believe protective language should be added.

The AIM Act must have language that appropriately considers the increased costs consumers will face and provides a clear solution to it as well.

The previous question highlights the severity of the price difference between HFCs and their alternatives HFOs, for even simple everyday items such as hairspray, deodorant, household cleaners just to name a few. To reiterate, if HFCs were to be phased out, the only alternative options are Hydrofluoroolefins (HFOs) which are 10 times higher in price.

Only two HFO manufacturing companies in the USA have patents to produce this next generation technology, and this bill is a lopsided, targeted attempt to entrap then force a market to use their products – by limiting the materials they intend to replace. This is done at a dire cost to consumers, rather than create economic prosperity or encourage exports as the bill suggests.

Additionally, this bill does not in actuality reduce CO_2 emissions, if we consider the production of HFOs we have mentioned in our response to Question 2.

As the Competitive Enterprise Institute said on April 6, 2020; "In truth, the AIM Act has nothing to do with encouraging exports and everything to do with creating a captive domestic market from which to gouge American consumers," by way of restricting their use of HFCs, and forcing the use of HFOs.

II. Remove Low GWP HFC's from this Bill

In order to protect American consumers, additional protective language must be added to allow American industries to continue using low GWP HFCs, such as HFC-152a. By removing this group of HFC's from the phase down, the total impact of costs on consumers will be mitigated. As we have also mentioned in Question 2, the carbon footprint of these HFCs are much less than HFOs as well – so it is the correct choice for both a healthy competitive landscape, as well as the environment.

This will retain American jobs and not unfairly force lopsided changes. Additionally, the group of low-global warming potential HFC's have already been clearly defined by the California Air

Resources Board (CARB), making the guidelines of the additional language very clear and easy to introduce.

To be exact, the California Air Resources Board (CARB) (a government agency tasked with protecting air quality and established in California by then-governor Ronald Reagan) has categorized "high-global warming potential (high-GWP) refrigerants [to] include all ozone-depleting substances and any refrigerant with a GWP of 150 or higher."

There are several HFCs, but not all have a high GWP. HFC-152a, for example, should be considered unique and separate for several reasons, and be removed from the phase down list.

HFC-152a is a relatively smaller, yet widely used HFC that only has a GWP of 124 and is a major component of many direct to consumer products like hair spray, keyboard air dusters, home aerosols, and spray foam insulation.

HFC-152a not only has a GWP less than 150 but is a non-ozone depleting substance (ODP = 0) and non-volatile organic compound (non-VOC) as well!

In fact, industries have been using HFC-152a to replace many other HFC's that are significantly more destructive to our ozone. The table below compares the GWP for many common HFC's to show how different HFC-152a is:

Table 5. HFC Global Warming Potential Chart

Chemical Name	Common Name	Global Warming Potential (GWP)	CARB GWP Limits
CH_2FCH_2F	HFC–152	53	GWP < 150
CH_3F	HFC–41	92	
CH_3CHF_2	**HFC–152a**	**124**	
CH_2FCHF_2	HFC–143	353	GWP > 150
CH_2F_2	HFC–32	675	
$CH_2FCF_2CHF_2$	HFC–245ca	693	
$CF_3CH_2CF_2CH_3$	HFC–365mfc	794	
$CHF_2CH_2CF_3$	HFC–245fa	1030	
CHF_2CHF_2	HFC–134	1100	
$CH_2FCF_2CF_3$	HFC–236cb	1340	
CHF_2CHFCF_3	HFC–236ea	1370	
CH_2FCF_3	HFC–134a	1430	
$CF_3CHFCHFCF_2CF_3$	HFC–43–10mee	1640	
CF_3CHFCF_3	HFC–227ea	3220	
CHF_2CF_3	HFC–125	3500	
CH_3CF_3	HFC–143a	4470	
$CF_3CH_2CF_3$	HFC–236fa	9810	
CHF_3	HFC–23	14800	

III. Removing Low GWP HFC-152a in Particular – No Suitable Offsets

HFC-152a is mainly used to produce affordable aerosols for home and personal care products and blowing agents for foam insulation that directly help improve people's daily lives.

Application	Consumption
Aerosols	54%
Blowing Agent	20%
Feedstock	17%
Refrigerant	8%
Other	1%

Source: Clean Energy Manufacturing Analysis Center

There are no reasonable alternatives to HFC-152a that can continue to make these products affordable for people. Keeping your house warm should not be a luxury, but a basic human right. The only alternative products cost astronomical amounts that will expand the gap between upper and lower classes in the United States. Home and personal care aerosol products should not only be for the wealthy.

What makes HFC-152a an efficient and favorable blowing agent is its excellent gas expansion performance, which is defined as the volume of fully expanded gas generated by 100 cubic centimeters of compressed liquid refrigerant.

Current HFOs have less than half the performance of HFC-152a.

When performing the calculations, every 1 pound of HFC-152a would have to be replaced by 2.1 pounds of HFOs.

Therefore, replacing HFC-152a with alternative HFOs will require:

- Doubling the volume of HFO production which yields a 36 times higher carbon footprint than producing HFC-152a (see Exhibit 1 at end)
- Denser, larger aerosol cans (packaging) resulting in more production and waste
- Double the amount of on-road transportation to deliver additional volumes of HFOs doubling the related CO2 and Nitrogen Dioxide (GWP=265) emissions.
- Longer run times at aerosol filling facilities requires more energy to fill the products with twice as much propellant.

The current cost of HFC-152a is around $1.80 to $2.00 per pound, whereas HFO's range from $20 to $71 per pound.

Since we learned that 2.1 pounds of HFOs are required to replace 1 pound of HFC-152a, the cost difference is up to $140 per pound!

Fig. 3 Consumer Cost: Hair Spray Example

We can calculate the real effect this will have on consumers looking at hair spray, one of those most popular applications for HFC-152a. A 10 oz can of hair spray ranges between $5 to $35 per can depending on brand and retailer.

The composition of HFC-152a in hair-spray averages to 30%, so a 10 oz can will contain 3 ounces of HFC-152a.

At $140 per pound additional cost, HFOs will add more than $28 to a 10 oz can that requires 3 ounces of propellant:

Propellant	**Low-end Hair Spray**	**High-end Hair Spray**
HFC-152a	$5 per can	$35 per can
HFO alternatives	$33 per can	$63 per can

All demographics in the United States use some form of hairspray. This price change will have a negative effect on everyone.

It is possible these prices will be even higher if HFC-152a is phased out. Currently there are only 2 manufacturers in the world that hold patents to produce HFO alternatives. With even less options and limited competition, it is very possible the price of HFOs will even increase when HFC-152a is regulated out of the market.

IV. Baseline Period of 2011-2013 should be updated to 2018-2019 – Current Baseline Neglects Large HFC Growth

Currently, the Bill defines the Baseline Period (the timeframe in which phase out quantities are determined) as between 2011 and 2013. However, this period neglects the 28% increase in HFC usage between 2014 and 2019.

The immediate phase out schedule of 10% reduction using 2011 to 2013 numbers, is actually a 30% immediate phase out reduction because usage of HFCs in recent years are not considered!

To provide background, the 2011 and 2013 years in this bill were introduced in the Kigali Amendment of the Montreal Protocol (2016). However, the Canadian government updated the baseline timeframe to 2014-2015 – because the previous 2 years best reflected the real market growth of HFCs.

Since this Bill is being introduced 4 years after the Kigali Amendment in 2020, then this timeframe should be updated to 2018-2019 to reflect the real market as well.

The Canadian government was adamant about keeping the phase down tightly as the previous 2 years' average, after having close discussions with the markets.

Josiane Vachon, a member of the The Halocarbons Management Team in Canada, states that the original option to use 2011 and 2013 was discussed at length, but it was subsequently decided that the final Regulations Amending the Ozone-depleting Substances and Halocarbon Alternatives Regulations would include provisions for the distribution of allowances based on companies' consumption during 2014 and 2015. This approach favored the stabilization of HFC consumption prior to the coming into force of the Regulations.

Also, if we consider how Canada's population of 37 million is much less than USA's 330 million, Canada was still willing to take the steps necessary to protect their consumers and industries with much less at stake than what America has to lose.

Furthermore, US HFC Consumption in 2010 was about 300 million tonnes of CO_2e (or carbon dioxide equivalent). Around the same time, the Canadian government calculated the total amount of HFCs consumed between 2011 and 2013 as only 18 million tonnes, which is almost 16 times less consumption.

If even Canada was careful to correct their baseline to the previous 2 years with only 18 million tonnes of usage, the US should definitely correct their baseline to 2018-2019 – because there is so much more industry and so many more American citizens' jobs at stake.

Therefore, it is without a doubt we should follow in this mindset and make a baseline movement as well to keep our countries industries well supplied and prevent large cost increases.

Once again, adding language that will update the Baseline Period will honor the reasonable phase down schedule accurately, and provide stakeholders enough time to control cost increases through innovation and alternative sourcing opportunities.

Chairman Barrasso and Ranking Member Carper, we wish to thank you sincerely for your leadership and consideration of the American industries and consumers severely impacted by this bill.

We appreciate your attention to our report, which aims to achieve the shared goal of helping so many of our fellow American industries and end users.

If you have any further questions, comments, or require any clarification, please let us know. For anything you would like us to do, we are indeed very happy to work for you. We look forward to and are grateful for your continued feedback.

Very Best Regards,

Michael Valenti
Michael Valenti
Vice President
First Continental International
11 Harristown Road, Glen Rock, NJ 07403
mvalenti@fci-nj.com
+1 (201) 670-9848

Greg Heden
Greg Heden
Senior Sales and Marketing Manager
First Continental International
11 Harristown Road, Glen Rock, NJ 07403
gheden@fci-nj.com
+1 (201) 670-9848

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for the National Automobile Dealers Association

Chairman Barrasso

1. How much would you expect motor vehicle air-conditioning repair costs to go up if the Environmental Protection Agency mandates that Motor Vehicle Air-Conditioning (MVAC) service facilities must purchase equipment for refrigerants that have little to no global warming potential (GWP)?

Response: If dealers are required by the Environmental Protection Agency to purchase new recovery and storage equipment, we conservatively estimate that the aggregate regulatory cost to franchised dealers would be at least $56 million. This cost would either be passed along to the consumer or paid for by the business, meaning the business would have less capital to hire new employees or invest in new equipment. Another increased cost to the customer would be that of the new refrigerant (which some of our service customers have already been paying due to EPA's fuel economy regulation), which is six times the cost of the old refrigerant (HFC-134a). The Committee should also consider the expected increase in price for refrigerants that are being phased out under this legislation – especially for America's aging heavy-duty fleet which still uses these refrigerants.

Additionally, the Committee may want to consider whether enacting a new mandate on American business is appropriate at this time due to the current global pandemic. Many franchised new light- and heavy-duty dealers have dramatically scaled-back operations due to government-ordered closures and commensurate plummeting sales. With tens of thousands of dealership employees laid off in the last thirty days and the economy officially shrinking, it is an inopportune time for Congress to impose any new regulatory costs on business.

2. Can you elaborate further on the concerns raised in your testimony regarding the AIM Act's relationship with the Clean Air Act?

Response: Section 609 of the Clean Air Act (CAA), 42 USC §7671(h), was enacted in 1990 to help address health and environmental concerns associated with depletion of the ozone layer. It is NADA's position that Congress did not authorize EPA pursuant to Section 609 to regulate MVAC refrigerants that have no ozone depleting potential – let alone refrigerants that have little or no other environmental impacts. NADA is seeking an amendment to the AIM Act that would both clarify the limited nature of CAA Section 609 and ensure that the AIM Act will not impose inappropriate mandates on MVAC service facilities.

3. The Alliance of Automobile Innovation submitted testimony calling for an exemption for light-duty vehicle exports to countries that do not have an HFC phasedown in place. Would you also support this exemption?

Response: A strong domestic auto manufacturing sector with export capabilities benefits America's economy. We support this exemption for the same reasons that the Alliance for Automobile Innovation had articulated.

4. Can you explain why it is important to have sufficient lead time to implement a phasedown of HFCs?

Response: MVACs in the existing fleet primarily use HFC-134a and, to a lesser extent, CFC 12. These refrigerants are highly regulated under Section 609 of the CAA due to their significant ozone depleting potential. The reasonable availability of these refrigerants over time is appropriate given that the vast majority of motorists throughout the country view MVAC as a necessity, and that converting MVAC systems to use alternative refrigerants can be cost prohibitive – especially for older, lower value vehicles.

5. Do you have concerns that the broad language of the AIM Act's phasedown provisions, including the technology transitions provision, do not adequately figure in cost considerations?

Response: Yes. In addition to NADA's concern regarding the unnecessary and inappropriately high cost of MVAC recycling equipment for substitute refrigerants, NADA concurs that, in general, the costs associated with the AIM Act generally have not been adequately accounted for.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Robert Nance, Security Equipment Corporation

Chairman Barrasso

1. Can you further describe the petition process you have initiated with different states and Canada?

   Answer: For each individual state, I reached out personally to the state agency responsible and explained the situation. I would then also forward the testimony I provided to the Senate Committee. In some cases, the state required us to submit a report concerning our use of HFC 134a. Others did not need a report. The letter I sent them was sufficient. The use of HFC 134a in pepper sprays and bear sprays was then given an exemption.

   For Canada, I had to track down the agency managing the HFC 134a ban. I then presented them a letter that was similar to the testimony provided to the Senate. They then required a letter from each of our customers that were importing the HFC 134a into Canada. The importer was responsible for getting the HFC exemption and reporting their annual usage to the Canadian government. This is a difficult process because we, as the manufacturer, have to manage the process on behalf of the customer. It would be much easier to manage our imported amounts as a whole, rather than by each customer.

2. Does a jurisdiction-by-jurisdiction approach to HFC regulations pose burdens to your business?

   Answer: Yes, asking for 50 state exemptions is a burden. We have only completed the process for WA, CO and Canada. We would have to complete the process, which would likely have different requirements, another 48 times as each state moved to ban HFCs. One process from the Federal Government would simplify the process and make it manageable for small businesses.

3. Why is the essential use exemption of the AIM Act insufficient for your business as currently worded?

   Answer: Exemptions are not available until 2034. There are some allowance for use between now and 2034, but those quantities are reduced every year. As the quantities are reduced, so are the number of products we manufacture with HFC's. This would drive us stop making these products. We would have to use HFOs would reduce the effectiveness of the products by reducing the spray distance and making the products flammable. Flammability is a great concern to law enforcement officers that use a Taser. The combination of the defense spray and the Taser could cause a subject to ignite in flames.

4. Can you explain why it is dangerous for consumers to use HFOs in defense spray applications?

   Answer: It is dangerous for consumers to use HFOs for two reasons.

   1. HFO does not perform as well as HFCs. The distance of the spray is diminished due to lower vapor pressure. The vapor pressure is also more severely impacted at temperatures near freezing or below. The reduced distance is a large concern for bear spray products and law enforcement products that give 30 feet or more of distance to the spray pattern. We are working on alternative formulations and aerosol components to improve the distance, but this has not yet been achieved.

   2. The second reason HFO does not perform as well as HFC's is flammability. HFC 134a masks the flammability properties of most aerosols. It prevents the aerosol from catching fire when tested for flammability. HFO does not mask the flammable properties of aerosols. It is non-flammable by itself, but when mixed with non-flammable chemicals or formulas, the products do not pass standard flammability tests. They are flammable.

      While HFO flammability might not be a large concern to typical consumers, it is a major issue for law enforcement and correction officers. Pepper sprays are used in conjunction with Electronic Immobilization Devices or Tasers®. When a flammable pepper spray comes in contact with the electrical current of a Taser®, there is significant chance for ignition. Law enforcement and corrections officers would need to be retrained so they do not use both products on a subject. This is a very serious human health issue as the ignition could cause sever bodily harm to a subject and the officers trying to control the subject.

Ranking Member Carper:

Please provide a response to each question, ***including each sub-part.***

5. In your testimony you expressed concern that the AIM Act would ban the HFCs used in defense sprays. The AIM Act would affect a phase down of the production and consumption of HFCs over a 15-year period, with 15 percent of the baseline period allowed to be produced and imported from 2036 onward. The AIM Act also contains provisions intended to increase to a significant degree the recovery and reclaim of HFCs. The purpose of these provisions, and other provisions in the Act, is to ensure the continued use of HFCs for decades to come, particularly in small or niche applications

for which no substitute is available. In light of this, why do you believe the AIM Act represents a hard "ban" on HFCs that would prohibit their use upon enactment?

Answer: Nothing in the bill out laws the use of HFC in defense sprays. However, if there a phase down period and there is no substitute available, it would prevent us from manufacturing the amounts we currently manufacture.

6. Of the HFC compounds that are being used by your company today, on average how much does the industry use on an annual basis (in tons and GWP-weighted tons) now?

   Answer: I estimate our industry usage is 125 metric tons and 28,560 GWP weighted tons of HFC 134a.

7. Assuming an annual total of 230,000 tons of HFCs produced and imported into the United States each year, what percentage of this figure is used by your company on an annual basis?

   Answer: I estimate the defense spray industry uses 0.0006% of the annual tons total used in the US.

8. Do you project HFC usage will grow or shrink over the next 15 years?

   Answer: We hope to reduce our usage of HFC over the next 15 years. We expect competitors to create alternative products that are non-flammable and have a greater vapor pressure. This would solve our issues and allow us to switch to HFOs. We expect the market for consumer pepper sprays to grow slightly over the next 15 years. We do not expect a great increase in the law enforcement market. There will likely be small increases in the bear spray market. However, that market will be severely impacted this year as most national parks are closed due to COVID 19.

9. If the AIM Act were implemented as introduced, do you believe the HFCs used by your company will be eligible for essential use exceptions? If not, why not?

   Answer: I do believe our product would be eligible for the essential use exception, but the exceptions are not put into place until 2034. We would be without an exception to manufacture with HFC's until then.

10. In the 1990s, the United States transitioned out of ozone-depleting substances used as propellants in the types of applications referenced by your testimony. Are you aware of any instance where an application using an ozone-depleting substance as a propellant was "forced" to transition by Title VI of the Clean Air Act before substitutes were properly tested and available?

Answer: We are a second-generation family business. I know my father was involved in the switch from CFC's to HFC's, however, that was before I joined the company. To my knowledge, HFC 134a was truly a drop in replacement for CFC's. It did not have a lower vapor pressure or flammability concerns. It was much easier to switch from CFC's to HFC's. The switch from HFC to HFO is much more complex due to the limited spray distance and flammability concerns. The flammability concerns have not been overcome by Honeywell, the manufacturer of HFC 1234ze.

Senator Whitehouse:

11. What is the total volume of HFCs for which there is no acceptable substitute used by the defense sprays industry? Please list each such HFC and the volume used. Please state the reasons why potential substitutes (if they exist) are unacceptable.

Answer: I estimate the industry uses 125 metric tons and 28,560 GWP weighted tons of HFC 134a per year.

It is dangerous for consumers to use HFOs for two reasons.

1. HFO does not perform as well as HFCs. The distance of the spray is diminished due to lower vapor pressure. The vapor pressure is also more severely impacted at temperatures near freezing or below. The reduced distance is a large concern for bear spray products and law enforcement products that give 30 feet or more of distance to the spray pattern. We are working on alternative formulations and aerosol components to improve the distance, but this has not yet been achieved.
2. The second reason HFO does not perform as well as HFC's is flammability. HFC 134a masks the flammability properties of most aerosols. It prevents the aerosol from catching fire when tested for flammability. HFO does not mask the flammable properties of aerosols. It is non-flammable by itself, but when mixed with non-flammable chemicals or formulas, the products do not pass standard flammability tests. They are flammable.

   While HFO flammability might not be a large concern to typical consumers, it is a major issue for law enforcement and correction officers. Pepper sprays are used in conjunction with Electronic Immobilization Devices or Tasers®. When a flammable pepper spray comes in contact with the electrical current of a Taser®, there is significant chance for ignition. Law enforcement and corrections officers would need to be retrained so they do not use both products on a subject. This is a very serious human health issue as the ignition could cause sever bodily harm to a subject and the officers trying to control the subject.

12. By what percentage has use of such HFCs been growing over the last five years? Please list each such HFC and its growth rate over the last five years.

    Answer: The only HFC used in the defense spray industry is HFC 134a. I would estimate the growth rate is around 5% per year over the last 5 years.

Senate Committee on Environment and Public Works
Information-Gathering Process entitled, *"S. 2754, American Innovation and Manufacturing Act of 2019: Written Testimony and Questions for the Record"*
March 25, 2020
Questions for the Record for Karen Meyers, Rheem

Chairman Barrasso

1. In comments to the Significant New Alternative Policy (SNAP) Rule 20 Docket, Rheem highlighted many examples where HFC regulations are closely related to energy efficiency standards promulgated by the Department of Energy (DOE):

   > *Any proposed changes to SNAP listing status should ensure that the alternatives whose use is being encouraged by the changes meet the requirements of stringent new DOE efficiency standards being promulgated simultaneously to this SNAP rulemaking.*

   Why is it important to ensure that Environmental Protection Agency and DOE requirements regarding equipment are not inconsistent?

Answer:

Rheem supports a predictable, cost-effective and orderly federal transition from high-GWP hydrofluorocarbons (HFCs) to next generation refrigerant technologies. U.S. Heating Ventilation Air Conditioning and Refrigeration manufacturers have, and will continue to invest significant resources to this effort, as many changes require extensive equipment redesign and qualification testing for low-GWP refrigerants (EPA) as well as new efficiency standards and testing procedures to comply with DOE energy efficiency rules. Therefore, it is important that effective dates for any requirements issued by both agencies be strategically sequenced, with notice well in advance of implementation, to minimize the frequency and impact of requirement changes.