From: Kristen Taddonio
To: Goetz, Kimberly (ECY)
Subject: Comments on Refrigerant Management
Date: Wednesday, July 21, 2021 2:20:31 PM
Attachments: image001.png
2021 ACC Refrigerant Calculator v1a.xlsx
FGas_Inventory_2020_CARB.xlsx

Dear Ms. Goetz,

Thank you for the opportunity to provide input on the State of Washington's pending program to address refrigerant management.

Going into the design, I urge you to carefully consider from the start how to design a program that is robust, and above all, enforceable. Too many HFC laws and rules have been plagued by non-compliance: Trying to manage individual consumer or technician behavior, as envisioned by the Clean Air Act's original prohibition on venting refrigerants, has proven to be rather difficult, to put it mildly. Monitoring and reporting is essential—especially for large sources of emissions—and penalties for non-compliance should be designed in a way that makes compliance the default path of least resistance. Programs that shift responsibility from end-users (numbering in the thousands to millions) to producers and vendors (numbering in the dozens to hundreds) could assist simplifying the program and increasing compliance.

Deposits paid by producers can help provide a financial incentive to reduce leaks and recover refrigerant at end-of-life, and can double as a source of revenue to enforce your refrigerant management program and/or accelerate replacement of large leaky equipment. Similarly, severe penalties for retailers and online vendors selling illegal products (i.e. automotive "service cans" of HFC-134a) should be established, with revenues helping assist with implementation of your refrigerant programs. If penalties are too small, non-compliance will continue, and businesses that do comply will be subject to unfair competition. In my many years of work with the automotive AC service industry, for example, common complaint is not the environmental rules themselves, but the injustice of inadequate enforcement benefitting the non-compliant over the law-abiding.

Please consider that for many types of equipment that use F-gases, end-of-life emissions are only a small portion of overall emissions. The attached chart, for instance, shows just how much refrigerant each major type of equipment emits annually, at end of life, and total.

I used the Refrigerant Calculator (attached) developed by E3 for the State of California's public utilities commission to generate these estimates. This calculator could easily be modified to help the State of Washington's utilities calculate avoided costs & avoided GHG emissions from helping their customers shift to low-GWP options. (Also attached for your reference is California's HFC inventory, covering 1990-2020, maintained by Glen Gallagher of the California Air Resources Board. Although Washington likely has differences (fewer ACs perhaps), it could help you get a good sense of where emissions may be coming from.)

The major take-away of this?: replacing existing stocks of large equipment (especially supermarket refrigeration systems) with lower-GWP options will result in far greater emissions reductions than focusing on end-of-life alone. When dealing with large equipment, the annual leakage usually dwarfs end-of-life emissions. For example, a large retail food facility (grocery store) could emit over 34,000 tonnes of CO2-eq using 20-year GWPs, but only 1,828 tonnes of that would be expected to occur at end-of life. Similarly, a large chiller might emit over 6,000 tonnes of CO_2-eq over its life, but less than 1/3 of that would be expected to occur at end-of-life. California's Refrigerant Management Program for facilities using over 50 lbs of refrigerants could be a nice template for Washington to start with, if only because it will give you a much clearer picture of where your major sources of emissions are, and which ones should be replaced ASAP (perhaps in partnership with their local utility, per the new authority in Washington's latest HFC law—the utility could benefit by claiming the GHG credit toward carbon compliance/neutrality targets, and it may also help improve efficiency and the cost-effectiveness of their efficiency programs).

SECTOR	**Sub-Sector** *refrigerant type used for baseline GWP*	**Refrigerant Emissions Per Unit** in metric tons CO_2-eq, 20-year GWPs *Annual | End-of-life |Total*	**Societal Cost Per Unit** at $50 per metric ton of CO_2-eq
STATIONARY REFRIGERATION	Large Retail Food / Commercial Refrig. *R-404A*	2,211 | 1,828 | 34,998	$110,550 | $91,400 |$1,749,900
	Medium Retail Food / Commercial Refrig. *R-404A*	427 | 373 | 6,778	$21,350 |$18,646 | $338,900
	Small Retail Food / Commercial Refrig. *R-404A*	44 | 56 | 932	$2,190 | $2,808 | $46,611
	Sub-Small Retail Food / Commercial	6 |14 |97	$300 | $679 | $4,875

	Refrig. *R-134a*		
	Large Cold Storage *R-404A*	2,926 |3,954 |62,472	$146,295 | $197,696 | $3,123,601
	Medium Cold Storage *R-404A*	155 | 301 |3,401	$7750 | $15,048 | $170,043
	Small Cold Storage *R-404A*	12 |62 |308	$616 | $3,080 | $15,402
	Large industrial process cooling 2,000 lbs.+ *R-404A*	1,969 |3,202 |42,588	$98,464 | $160,103 | $2,129,379
	Medium industrial process cooling 200-2,000 lbs. *R-404A*	225 |360 |4,858	$11,245 | $17,992 | $242,895
	Small industrial process cooling 50-200 lbs. *R-404A*	26 |57 |573	$1,290 | $2,835 | $28,635
	Stand alone (self-contained) refrigeration *R-404A*	0.03 |2.47 |3.03	$1.40 | $123.60 | $152
	Refrigerated Food Processing and Dispensing Equipment *R-134a*	0.05 |4.83 |5.45	$2.60 | $241.30 | $273
	Commercial Ice Machines *R-134a*	0.03 |5.52 |5.67	$1.40 | $276.10 | $283
	Water Coolers - Drinking Fountains *R-134a*	0.004 |0.37 | 0.43	$0.20 | $18.40 | $21
	Refrigerated vending machines *R-134a*	0.01 |0.92 |1.08	$0.50 | $45.80 | $54
	Heat Pump Water Heaters *R-134a*	0.04| 3.59 | 4.17	$2.10 | $179.30 | $209
	Heat Pump Clothes Dryers *R-134a*	0.02 |1.32 |1.53	$0.80 | $65.90 | $77
	Household refrigerator/freezer *R-134a*	0.01 |0.39 |0.48	$0.30 | $19.70 | $24
STATIONARY AC AND HEAT PUMPS	Large Chiller 2,000 lbs. + *HCFC-22*	214 | 1,862 |6,145	$10,707| $93,107 | $307,252
	Medium Chiller 200-2,000 lbs. *HCFC-22*	37 |246 |985	$1,848 | $12,311 | $49,245
	Commercial Unitary AC 50-200 lbs., > 135,000 BTUh size *R-410A*	10 |28 |220	$482 | $1,378 | $11,024
	Commercial Unitary AC, < 50-lbs., < 135,000 BTUh size (includes smaller "residential-type" central AC and heat pumps) *R-410A*	1.7 |20 |45	$84 | $1,003 | $2,266
	Window/Room AC and PTAC Units, commercial *R-410A*	0.06 |2.3 | 3	$3 | $114 | $150
	Residential Unitary AC *R-410A*	0.74 |10 |21	$37 | $502 | $1,056
	Residential Heat Pumps *R-410A*	0.86 |11 | 24	$43 | $543 | $1,185
	Window/Room/Wall AC and Packaged Terminal AC (PTAC) Units, residential *R-410A*	0.06 |2.3 |3	$3 | $114 | $150
	Portable AC *R-410A*	0.03 |2.7 |3	$1.50 | $134 | $150
	Dehumidifiers *R-410A*	0.02 |1.8 |1.9	$1 | $92 | $97
MOBILE SOURCES	Mobile Vehicle AC (MVAC) Light Duty *R-134a*	0.2 |1 | 3.5	$11 | $47 | $174
	MVAC Heavy Duty (non-bus) *R-134a*	1.7 |1.7 |19	$86 | $86 | $943
	MVAC Off-Road *R-134a*	1.4 |1.4 |16	$71 | $71 | $785
	MVAC Bus *R-134a*	4.4 |16 |69	$222 | $819 | $3,478
	Transport Refrigerated Units (TRUs) *R-404A*	6.5 |18 |64	$327 | $908 | $3,198
	Refrigerated Shipping Containers *R-404A*	4.5 |16 |39	$226 | $819 | $1,947
	Ships *HCFC-22*	234 | - |3,510	$11,702 | - | $175,525

In the remainder of my comments, I address the Department of Ecology's questions point by point.

How to encourage proper recycling and disposal of household equipment that contains refrigerants.

- Mandate (or weaker, incentivize) appliance retailers to participate in the US EPA's Responsible Appliance Disposal program and penalize those that don't.
    - That way, refrigerant recycling is automatic without putting the burden on the consumer: most major retailers will "take away" your old appliance when they deliver your new one. If retailers are participating in RAD, they should make sure those units are recycled.
    - Note that it is much more cost-effective to recycle refrigerant and HFC blowing agent contained in household appliances when they are aggregated. See EPA's 2018 study on the costs of ODS destruction, figure 5 on page 31 for instance. The costs of HFC collection and destruction are essentially the same. https://www.epa.gov/sites/default/files/2018-03/documents/ods-destruction-in-the-us-and-abroad_feb2018.pdf
- Allow utilities to get credit toward their GHG reduction goals by facilitating appliance HFC recycling.
    - Many utilities in the past have had appliance recycling programs, and they too can be partners with RAD.
    - Update the CA "refrigerant calculator" with Washington-specific inputs (your state's estimate of the social cost of carbon, for instance) to help utilities estimate the additional financial benefit "avoided cost" they can claim by incorporating refrigerant into their efficiency programs.
- Extended producer responsibility.

Ideas for incentives to encourage homeowners and businesses to safely dispose of unwanted refrigerants and refrigerated equipment.

- Don't make it the end-user's responsibility. That has consistently been a recipe for failure. See suggestions above.
- But if you do go this route, you've got to make it easy AND cost-effective for them to find a recycle center that will take appliances and properly dispose of the refrigerants. Right now it's a burden and expensive. Hence old equipment winds up on craigslist of the side of the road or by a dumpster.

Ideas for incentives to encourage businesses to reuse or recycle refrigerants in their equipment.

- Provide credit toward GHG goals for using certified reclaim, if done per agreed protocols like this one from the American Carbon Registry: https://americancarbonregistry.org/carbon-accounting/standards-methodologies/certified-reclaimed-hfc-refrigerants
- Mandate, as CA did, that new equipment sold must contain a certain percentage of recycled/reclaimed HFC until they switch to low-GWP alternatives. (Note that the CA standard of 10% reclaim is weak. I've talked to refrigerant reclaimers and folks in industry who think it's laughably low.)

Challenges that businesses and equipment manufacturers may face in transitioning to safer refrigerants in existing equipment.

- The state really needs to pass a law like Texas did saying that ***refrigerants listed as acceptable under section 7671k of the federal Clean Air Act (42 U.S.Code 7671k) are acceptable, as long as equipment is listed and installed in accordance with the use conditions imposed within section 7671k.***
- This means that any refrigerant that has been reviewed and found acceptable for use in a specified piece of equipment by the EPA's Significant New Alternatives Policy Program can be used in your state, as long as it's used in accordance with the safety restrictions that EPA specified (such as the latest UL, ASHRAE, and SAE standards)
- Otherwise you're going to run into problems where the new refrigerants can't be used because the state or some city hasn't updated their codes in time, essentially forcing businesses and consumers to keep using the high-GWP refrigerants.

Examples from other states or jurisdictions with incentives encouraging reuse or recycling of refrigerants, as well as users' experience with those programs.

- See examples above

Costs associated with proper recycling and disposal of refrigeration equipment and other items containing refrigerants or other hydrofluorocarbons (HFCs).

- This EPA study is the best I know of; I believe it was recently updated too but I haven't found the latest version. Disposal costs for ozone depleting refrigerants (CFCs and HCFCs) are very similar to the costs for HFC refrigerants.
- https://www.epa.gov/sites/default/files/2018-03/documents/ods-destruction-in-the-us-and-abroad_feb2018.pdf
- See for example this excerpt:

Table 9: Range of Costs[a] for Recovery, Transport, and Processing of ODS in Products and Equipment

End-Use	Segregation/ Collection Costs[b] (US$/kg)	Transport Costs (Recovery) (US$/kg)	Recovery Processing Costs (US$/kg)
Domestic Refrigeration (refrigerant & foam blowing agent)	$6-10	$6-40	$10-20 for refrigerant; $20-30 for blowing agent
Commercial Refrigeration (refrigerant & foam blowing agent)	$8-20	$8-50	$8-15 for refrigerant; $25-35 for blowing agent
Transport Refrigeration (refrigerant)	NA	NA	$15-20
Industrial Refrigeration (refrigerant)			$4-6
Air Conditioning (refrigerant)	$1-2[c]	NA	$4-35
Fire Protection (halon)			
Steel-faced Panels (foam blowing agent)	$75-90	$5-10	$30-40
Block – Pipe (foam blowing agent)	$10-15	$15-20	
Block – Slab (foam blowing agent)	$80-100	$5-10	

Source: TEAP (2009).
NA = Not Available.
[a] Note that the range of costs for each sector reflects the estimated costs for collection, recovery, and transport of ODS from sources in densely and sparsely populated areas, requiring low or medium effort. In general, ODS recovery in sparsely populated areas involves medium effort and higher costs, while recovery from densely populated areas involves low effort and lower costs. Thus, the costs associated with low effort recovery is reflected in the lower bound of the cost range and medium effort recovery in the upper bound of the cost range.
[b] Costs are generally higher for equipment with smaller charge sizes because it requires the same amount of effort to collect smaller volumes of refrigerant or blowing agent.
[c] Awareness raising for recovery schemes.

Who should be responsible for costs associated with recycling or reclamation of refrigerants.
Where at all possible, the producer or manufacturer and not the end consumer.

- **For example, what are some possible funding sources for incentive programs?**
  - Recent legislation authorized utilities to spend EE program funds to help with refrigerant emissions reductions
  - Penalties for non-compliance can and should be a source of funding
  - Deposits on refrigerant contained in equipment can be an incentive to reduce leaks and collect at end of life

Thank you for the opportunity to share my thoughts.

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