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REPORT OF THE HFC EMISSIONS ESTIMATING PROGRAM (HEEP) 2002 – 2020 DATA COLLECTION

Introduction

Hydrofluorocarbons (HFCs) have been commercialized as replacements for ozone-depleting substances such as chlorofluorocarbons (CFCs) and halons. The development of these chemicals for use in fire and explosion suppression applications was instrumental in achieving the accelerated halon production phaseout mandated by the Montreal Protocol on Substances that Deplete the Ozone Layer. At the same time, the use of this class of chemicals carries with it some environmental concern and, therefore, the need to minimize emissions.

While HFCs are not ozone-depleting substances, they have been identified by the Intergovernmental Panel on Climate Change as potent greenhouse gases with long atmospheric lifetimes and are part of the basket of six gases included in the United Nations Framework Convention on Climate Change. In 2016 HFCs were added to the Montreal Protocol and scheduled for a phase down of production that began in 2019. In 2020 emissions of HFCs represent about 3% of total greenhouse gas emissions.[1] Emissions of HFCs related to fire protection uses are estimated at about 3% of total HFC emissions from all sources. Nevertheless, because of their significant atmospheric impacts once released, careful management of these gases is an essential component of international climate protection and stratospheric ozone goals.

Fire Protection and Environmental Protection

The U.S. fire protection industry fully supports the goal of minimizing emissions of HFC and PFC fire protection agents, and is committed to continuing to contribute to both ozone layer and climate change protection. The overriding concern of the fire protection industry, however, is the reduction of risk to people and property from the threat of fire through the use of products and systems proven to be effective. With the aim of ensuring that both of these goals are achieved, the fire protection industry has developed a voluntary code of practice that is intended to focus the industry's efforts on minimizing emissions of HFC fire protection agents.

The Voluntary Code of Practice for the Reduction of Emissions of HFC & PFC Fire Protection Agents (VCOP) is a partnership of the U.S. Environmental Protection Agency (EPA), Fire Equipment Manufacturers Association (FEMA), Fire Suppression Systems Association (FSSA), Halon Alternatives Research Corporation (HARC) and National Association of Fire Equipment Distributors (NAFED). Since its was launched in March 2003, this program includes fifteen partner companies, representing fire equipment

1. See https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks

manufacturers and distributors throughout the U.S. that are working to meet the goals of the VCOP through training, education, and reporting on HFC and PFC uses. This innovative partnership serves as an important model for national and international voluntary industry efforts in other sectors, such as mobile air-conditioning and refrigeration, committed to achieving responsible use of HFC alternatives for ozone-depleting substances.

HFC Emissions Estimating Program (HEEP)

Accurate, credible recordkeeping and reporting is central to meeting the goals of the Voluntary Code of Practice (VCOP). Successful implementation of the elements of the VCOP has relied on a verifiable database of HFC emissions from fire extinguishing equipment. The HFC Emissions Estimating Program (HEEP) provides a format to help industry minimize emissions by setting benchmarks, by providing the incentives to make improvements to current standards and practices, by documenting the industry's commitment to safety and responsible use, and by providing data to support these substitutes for halon systems. The essential elements of the HEEP are as follows:

- Collection of HFC and PFC emissions data from reporting parties in industry that are able to make relevant measurements.

- Not all fire equipment companies need to be reporting parties in order for data collection to be substantially complete. Only the following need be reporting parties:

  - Equipment manufacturers or distributors that perform First Fill of original equipment and also recharge equipment.

  - Agent suppliers or equipment manufacturers that sell HFC and PFC agents to distributors that only perform recharge.

- "Emission" for the purposes of the HEEP is defined as the quantity of agent sold for the purpose of "recharge" of fire suppression containers. This approach is deemed reasonable as recharge is only required after agent has been discharged or emitted from equipment.

- Distributors who recharge cylinders but do not fill original equipment – most distributors – do not need to report as their agent use would be reported by their supplier.

- An independent Third Party collects industry reports of emissions by agent type, converts the values to equivalent emissions of carbon dioxide, and reports only aggregate results annually back to industry.

Data Collection Effort

In August 2002 a survey was distributed to companies previously identified as possible reporting parties and to the members of FEMA, FSSA, HARC, and NAFED. The purpose of the survey was to identify all of the companies in the U.S. that were likely to be HEEP reporting parties based on the criteria outlined above. By distributing the survey to the

members of the four major fire protection associations, it was felt that substantially all of the appropriate companies would be contacted.

Based on the responses to the survey and additional input from industry experts, a final list of 22 reporting parties was identified. Since that time the number of reporting parties has shrunk to 15 due to mergers/acquisitions, consolidated reporting, and a re-evaluation of the program in 2010 that found some overlap in the data. Although the number of reporting parties has gone down, the overall percentage of the clean agent market they represent should be relatively the same.

In 2015 a change was made to the HEEP program to include reporting of direct recycling by installers, usually distributors of OEM equipment. Based on responses from a survey of installers and some anecdotal information from HARC members, it was determined that a significant amount of HFC fire protection agent is being recycled directly by installers (i.e. removed from decommissioned equipment and then used for recharge of systems and extinguishers). Under its previous structure, the emissions represented by these sales of HFCs for recharge were not captured by the HEEP program. As such it is possible that the HEEP data may have underestimated U.S. emissions of HFCs from fire protection. Four installer-distributors reported direct recycle data in 2021 and HARC is working to increase distributor participation for 2022.

Annually guidance letters and data collection forms are sent to the HEEP reporting parties asking for the quantity of HFC/PFC fire protection agents sold for recharge in the previous year. A list of the agents for which data is requested along with the global warming potentials (GWPs) used to calculate carbon dioxide (CO_2) equivalence for each agent are shown in Table 1.

Table 1. HFCs and PFCs used in fire protection systems and their GWP values.

HFC / PFC Chemical ASHRAE Designation	100-year Global Warming Potential (1995)[2]	100-year Global Warming Potential (2007)[3]
HFC 23	11,700	14,800
PFC 14	6,500	6,500
HFC 125	2,800	3,500
HFC 134a	1,300	1,430
HFC 227ea	2,900	3,220
HFC 236fa	6,300	9,810
PFC 3-1-10	7,000	7,000

Results

Data were submitted by 13-16 reporting parties for the years 2002 to 2014, 17 reporting parties for the years 2015 to 2018 and 16 reporting parties for the years 2019 and 2020. Results from 2002-2008 were adjusted by subtracting overlapping data from six reporting parties. No adjustment in previous results was made for the new reporting parties added in 2015, as data for past years were not available.

[2] IPCC Second Assessment Report (1995).
[3] Intergovernmental Panel on Climate Change (IPCC) fourth assessment report, 2007 (AR4)

In each year emissions data were reported for the agents HFC-23, HFC-125, HFC-236fa, HFC-227ea, and PFC 3-1-10. The total of the reported emissions for each agent was multiplied by its respective GWP to obtain an equivalent of carbon dioxide. The carbon dioxide equivalent emission amounts of the five agents were then added to obtain a total reported emission for each year, expressed in millions of metric tons of carbon dioxide ($MMTCO_2$) and million metric tons of carbon equivalent (MMTCE).

The combined results reported to date are given in the Table 2 and illustrated graphically in Figure 1.

Table 2. Number of reporting parties and total annual emissions of HFC and PFCs in CO_2 equivalent amounts.

Year	Companies Reporting	$MMTCO_2$	MMTCE	2007 GWP $MMTCO_2$
2002	16	0.484	0.132	
2003	16	0.490	0.134	
2004	15	0.559	0.152	
2005	15	0.618	0.169	
2006	15	0.559	0.152	
2007	15	0.622	0.170	
2008	15	0.573	0.156	
2009	15	0.421	0.115	
2010	14	0.580	0.158	
2011	14	0.527	0.144	
2012	14	0.582	0.159	
2013	15	0.598	0.163	0.751
2014	13	0.547	0.149	0.699
2015	17	0.533	0.145	0.643
2016	17	0.607	0.166	0.732
2017	17	0.645	0.176	0.771
2018	17	0.722	0.197	0.846
2019	16	0.729	0.199	0.860
2020	16	0.599	0.163	0.724
	Statistical Summary			
	Average	0.579	0.158	0.753
	St Dev	0.075	0.020	0.078
	St Dev %	12.9%	12.9%	10.4%

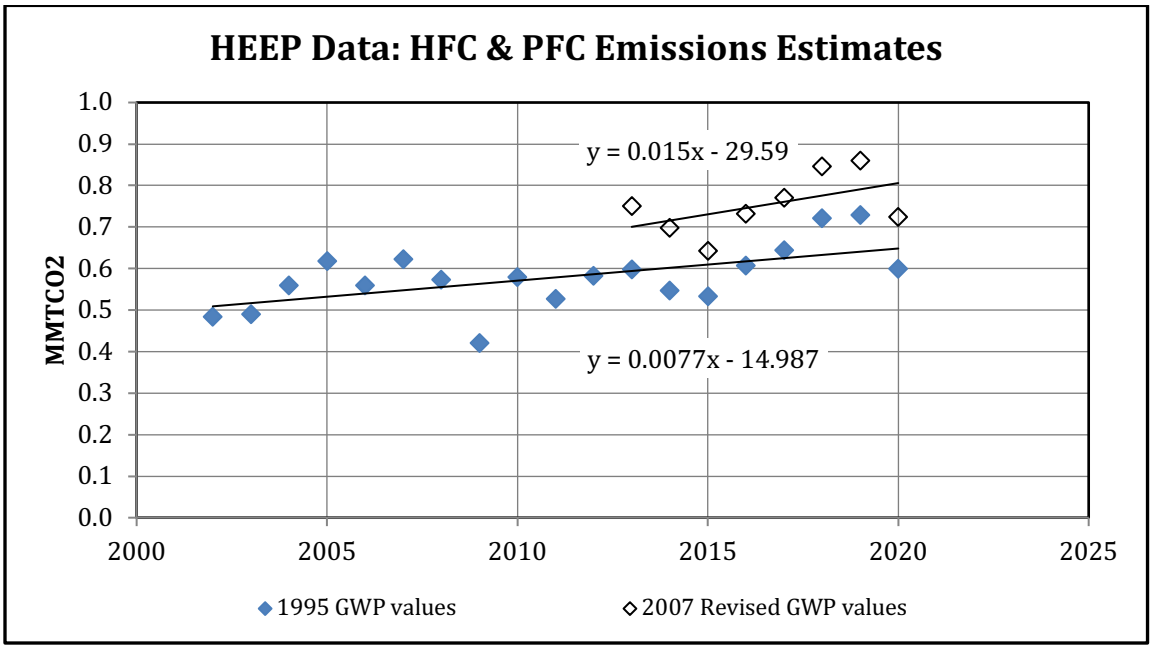

Figure 1. Annual reported CO_2-equivalent emissions of HFC and PFC agents.

Discussion

During the 19-year HEEP sampling period, 2002 to 2020, the year-to-year variations in reported emissions of HFC and PFC fire protection agents do not support a conclusion as to a definite long-term trend, either positive or negative. Thus, the only conclusion that can be thus far reached is that between 2002 and 2020 average annual rate of emissions of HFC and PFC fire protection agents has increased at only about 1.2 % annually.

When the HEEP program began in 2002, the expectation was that emissions of HFCs from fire protection would increase each year as the size of the installed base grew. This expectation is reflected in the EPA vintaging model, which is a source of estimated emissions of greenhouse gases used as substitutes for ozone depleting substances. The EPA model predicts steadily increasing emissions of HFCs between 2002 and 2018 at levels significantly higher than seen in the HEEP data. What HEEP data show are essentially invariant emissions of GHGs over the 2002 through 2020 period of about 0.579 $MMTCO_2$ equivalent.

EPA is currently reviewing their latest vintaging model estimates in conjunction with atmospheric data on emissions of HFC-227ea to account for emissions from other use sectors. Once EPA has completed this review HARC will work with EPA to better understand the differences between the HEEP data and the vintaging model estimates.

The foregoing observations regarding GHG fire systems emissions suggest some combination of the following:

1. The size of the installed base of HFC systems is stable and the normalized discharge frequency of HFC systems is stable;

2. The size of the installed base is increasing and the normalized discharge frequency of HFC systems is decreasing.

Since sales of new OEM HFC-agent fire protection systems continue, it seems likely that despite what is believed to be a growing installed base, the probability of release of high-GWP agents is decreasing owing to improved stewardship by fire protection system owners. At the same time, the ample, and in some cases oversupply, of recycled HFCs seen in the market in recent years likely reflects an increasing number of legacy systems being decommissioned, which would limit growth of the installed base.

Impact of Recycling

When the HEEP program began in 2002 about 13% of the reported HFCs sold for recharge came from recyclers. In recent years that number has increased to an average of about 75% (80% in 2020). This is a very positive trend for the industry as every pound of recycled HFC used for recharge is a pound of new HFC that is not manufactured.

Conclusions

- The HFC Emissions Estimating Program (HEEP), which was devised to develop fire industry emissions data, has been operating successfully for seventeen years.

- In 2015 HEEP began to include heretofore unreported emissions data due to direct HFC agent recycle from decommission of fully charged equipment by installer-distributors reporting. HARC estimates that the HEEP data may be underestimating US emissions of HFCs from fire protection by as much as 10% due to unreported direct HFC recycling by installer-distributors.

- The HEEP data collected annually from 2002 through 2020 show an essentially invariant rate of emissions of high-GWP agents over that period of about 0.579 $MMTCO_2$ equivalent.

- The invariance of fire industry emissions of high-GWP agents, in light of continues sales of new systems, may be credibly attributable, at least in part, to steadily improved stewardship of installed systems by their owners.

- Overall, the VCOP and HEEP programs appear to be serving their intended purposes.