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## REPORT OF THE HFC EMISSIONS ESTIMATING PROGRAM (HEEP)

### 2002 – 2015 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 has been 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. Emissions of HFCs currently represent less than 2% of total greenhouse gas emissions. Emissions of HFCs from fire protection 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 U.S. climate protection and stratospheric ozone goals.

#### Fire Protection and Environmental Protection

The U.S. fire protection industry fully supports the goal of minimizing non-fire emissions of 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

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 must necessarily rely on a verifiable baseline of HFC emissions. 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 and submission of data from reporting parties in industry that are in a position 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 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 will collect industry reports of emissions by agent type, convert the values to equivalent emissions of carbon dioxide, and report only aggregate results annually back to industry.

### **Data Collection Effort**

In August 2002 a survey was distributed to a list of 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 all of the appropriate companies would be reached.

Based on the response 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 by about 5-10%.

Five installer-distributors reported direct recycle data in 2016 and HARC is working to increase distributor participation for 2017.

Each year 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<sub>2</sub>) equivalence for each agent are shown below.

<b>HFC / PFC Chemical ASHRAE Designation</b>	<b>Global Warming Potential (GWP)<sup>1</sup></b>
HFC 23	11,700
PFC 14	6,500
HFC 125	2,800
HFC 134a	1,300
HFC 227ea	2,900
HFC 236fa	6,300
PFC 3-1-10	7,000

## Results

Data were submitted by 14-16 reporting parties for the years 2002 to 2013 and 20 reporting parties for 2014 and 2015. 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 2009, 2014, and 2015, as data for past years were not available.

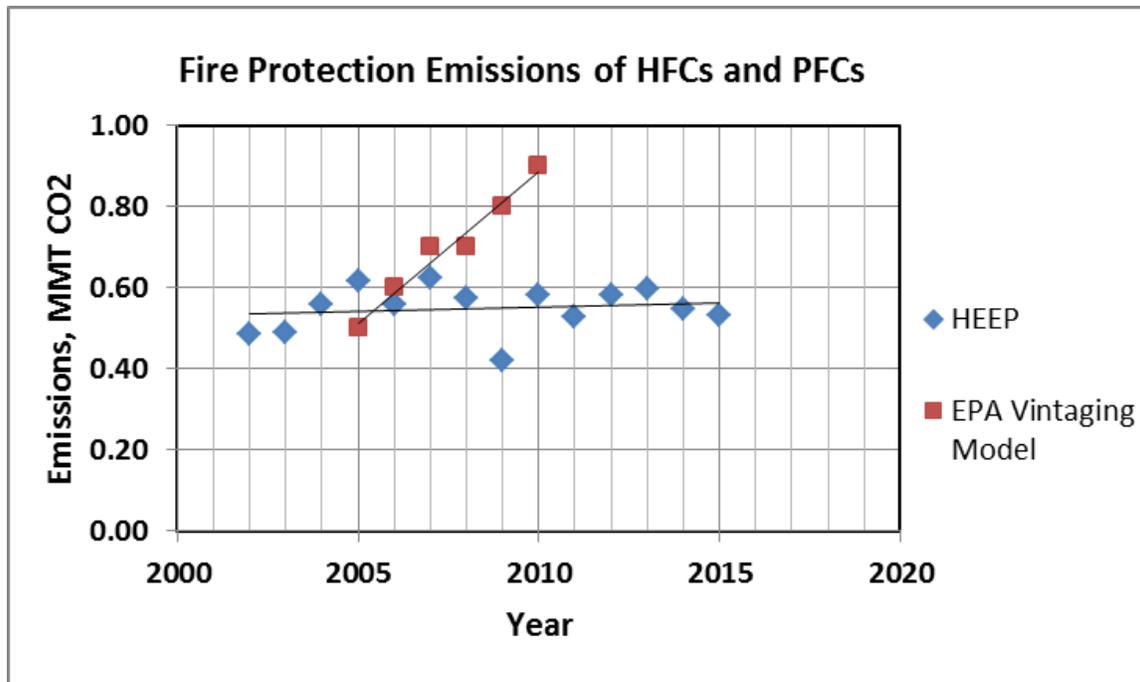
<sup>1</sup> 100-year GWP values from the IPCC Second Assessment Report (1995).

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 reported emission amounts of all five agents were then added to obtain a total reported emission for each year, expressed in millions of metric tons of carbon dioxide, or MMTCO. This number can be multiplied by 12/44 to obtain the emission amount in terms of carbon alone expressed as million metric tons of carbon equivalent, or MMTCE.

The combined results reported to date are given in the table and illustrated graphically below.

Year	Companies Reporting	MMTCO <sub>2</sub>	MMTCE
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
2014	20	0.547	0.149
2015	20	0.533	0.145
Statistical Summary			
	Average	0.550	0.150
	St Dev	0.056	0.015
	St Dev, %	10.1 %	10.1 %

<sup>1</sup> Carbon dioxide consists of 12 parts carbon and 32 parts oxygen on a mass basis. Thus, 12/44 is the mass fraction of carbon dioxide that is elemental carbon.



In order to put these numbers in perspective, it is useful to compare the estimates of emissions from other applications and to estimates of emissions of HFC/PFC fire protection agents based on modeling. The EPA vintaging model is a source of estimated emissions of greenhouse gases used as substitutes for ozone depleting substances. It tracks chemical consumption and emissions by making detailed calculations in over 40 end-uses of the quantity of equipment or products sold, serviced, and retired each year, what chemical(s) are being used, and the amount of chemical required to manufacture and/or maintain the equipment.

Estimates of emissions of HFCs/PFCs for fire protection from the EPA vintaging model are 0.5 MMTCO<sub>2</sub> in 2005, 0.7 MMTCO<sub>2</sub> in 2007, 0.8 MMTCO<sub>2</sub> in 2009, and 0.92 MMTCO<sub>2</sub> in 2011. EPA estimates of 2011 emissions for other applications are as follows: 103.9 MMTCO<sub>2</sub> from refrigeration and air conditioning, 9.7 MMTCO<sub>2</sub> from aerosols, and 5.9 MMTCO<sub>2</sub> from foams.

### Discussion

Emissions of HFC and PFC fire protection agents were about 3% lower in 2015 than the previous year and about 11% lower than 2013, although they are consistent with emission levels seen in 2004 through 2008 and 2010 through 2014.

Between 2002 and 2015 emissions of HFC and PFC fire protection agents averaged 0.550 MMTCO<sub>2</sub>, with a high of 0.622 MMTCO<sub>2</sub> in 2007 and a low of 0.421 MMTCO<sub>2</sub> in 2009. However, the reported emission value for 2009 is inconsistent with the other twelve years of data and appears to be aberrant, possibly reflecting an effect of the economic downturn of the period. Overall the thirteen-year trend line suggests a slight increase in

reported emissions of 0.0038 MMTCO<sub>2</sub>/year, a value that is only 0.69% of the 14-year average emission rate, and only 6.8 % of the standard deviation in the data. Thus, the better conclusion may be that variations in the annual emissions rate are too small to have statistical significance and that the reported emissions have been stable over the measurement period.

When the HEEP program began in 2002, the expectation was that emissions of HFCs from fire protection would continue to increase each year as the size of the installed base grew. This expectation is reflected in the EPA vintaging model, which predicted a 45% increase in HFC emissions from fire protection between 2005 and 2011. Instead what HEEP data show are essentially invariant emissions of GHGs over the 2002 through 2015 period of about 0.55 MMTCO<sub>2</sub> equivalent.

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 more probable that reason (2) is dominant, that is, in spite what is believed to be a growing installed base, the probability of release of GHG agents is decreasing owing to improved stewardship, by whatever means, by fire protection system owners.

### **Impact of Recycling**

When the HEEP program began in 2002 about 13% of the reported HFCs sold for recharge came from recyclers. In 2015 that number had increased to 84%. 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 thirteen years.
- Adjustments were made in 2010 and 2014 to HEEP reporting parties to reflect changes in how these agents are sold for re-charge and for new installations.
- 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.
- The HEEP data collected annually from 2002 through 2015 show an essentially invariant rate of emissions of GHG agents over that period of about 0.55 MMTCO<sub>2</sub> equivalent.

- The invariance of fire industry emissions of GHG agents, in light of continues sales of new systems, may be credibly attributable to steadily improved stewardship of installed systems by their owners.
- Overall, the VCOP and HEEP programs appear to be serving their intended purposes.