FEWG beyond SF6: Managing Halocarbon Emissions

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Review of Progress to Date

- Industrial fugitive gases comprised 14% of the DOE Scope 1 and 2 GHG baseline 2008 inventory.
- 90% of baseline industrial fugitive GHG emissions were SF_6.
- Between 2008 and 2010, DOE sites reduced industrial fugitive emissions by 39%.
- This effort has prevented the release of more than 600,000 metric tons of CO2 equivalent since 2009!

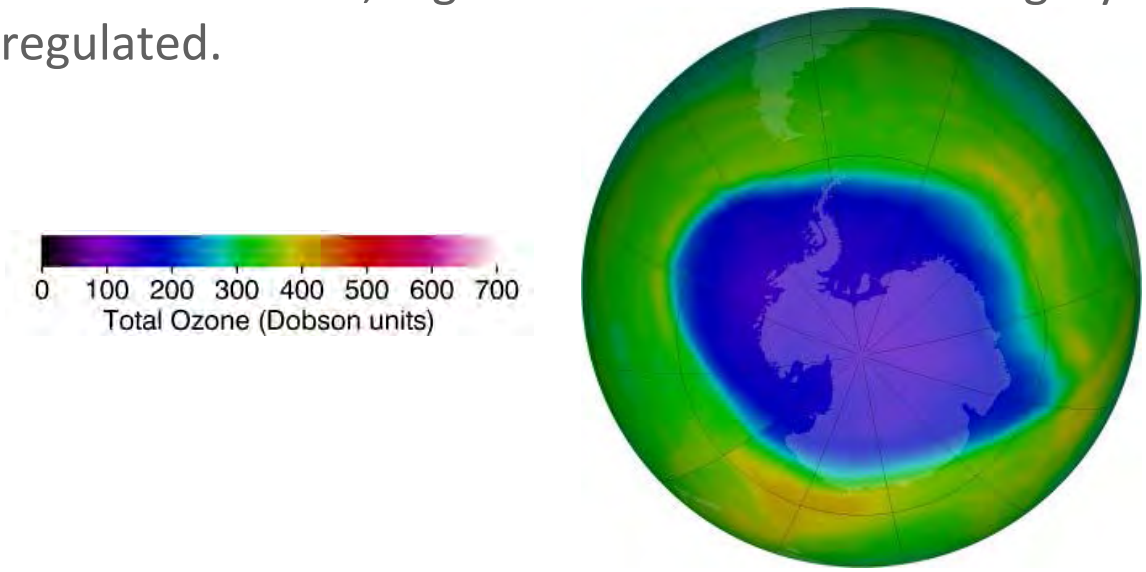
(Fugitive Emissions Working Group Secretarial Achievement Award, photo courtesy of ANL)

What are halocarbons?

- Halocarbon compounds are chemicals in which one or more carbon atoms are linked with one or more halogen atoms (fluorine, chlorine, bromine or iodine).
- Halocarbons are typically nonreactive and nonflammable although some may be ionized.
  - Ionization via UV radiation can lead to ozone depletion.
  - Ionization via high temperature or electrical discharge is used in experimental high energy and nuclear physics.

Halocarbon Emission Regulation

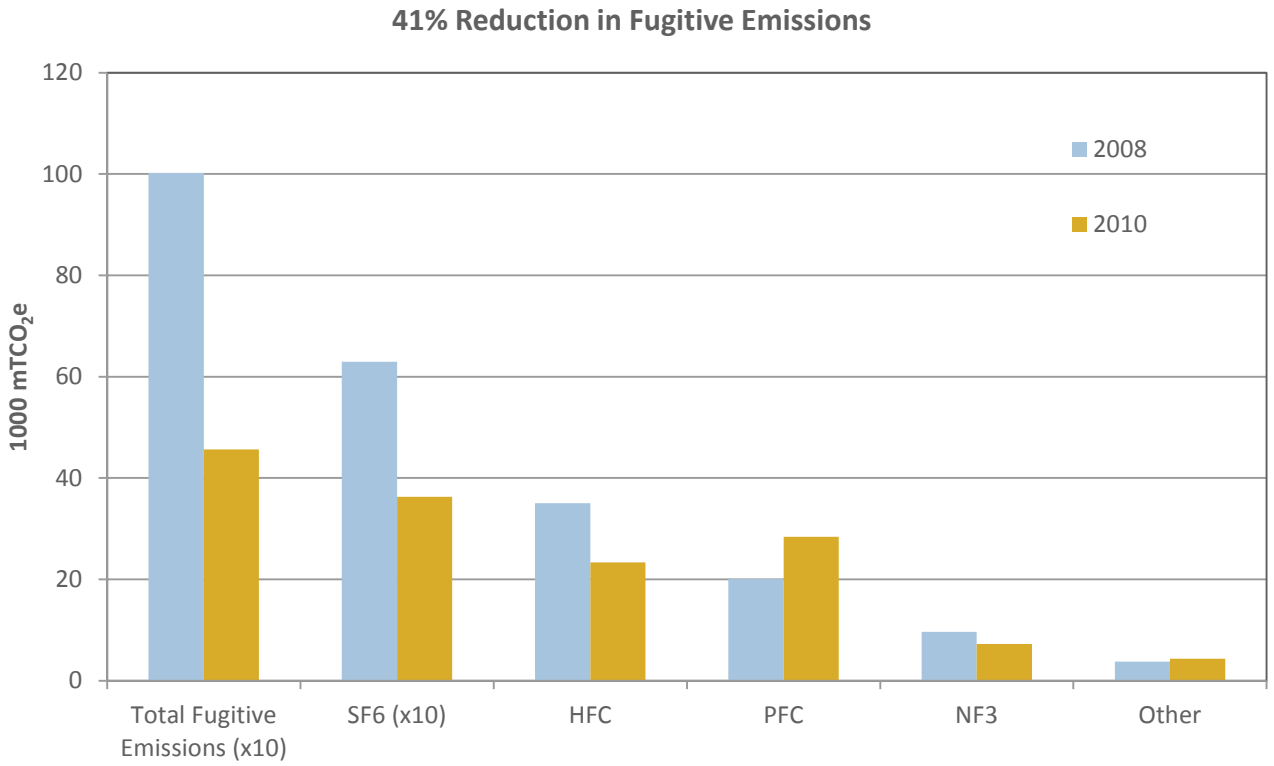
- Halocarbons (halogenated hydrocarbons) are covered under the Montreal Protocol.
  - The treaty is structured around several groups of halocarbons that have been shown to play a role in ozone depletion.
  - All of these ozone depleting substances (ODSs) contain either chlorine or bromine.
  - Fluorinate halocarbons are not covered (substances containing only fluorine do not contribute to ozone depletion).
- Aside from ODSs, fugitive emissions in this category are not otherwise regulated.



(Antarctic ozone hole, 2 Nov 2011, courtesy of NASA)

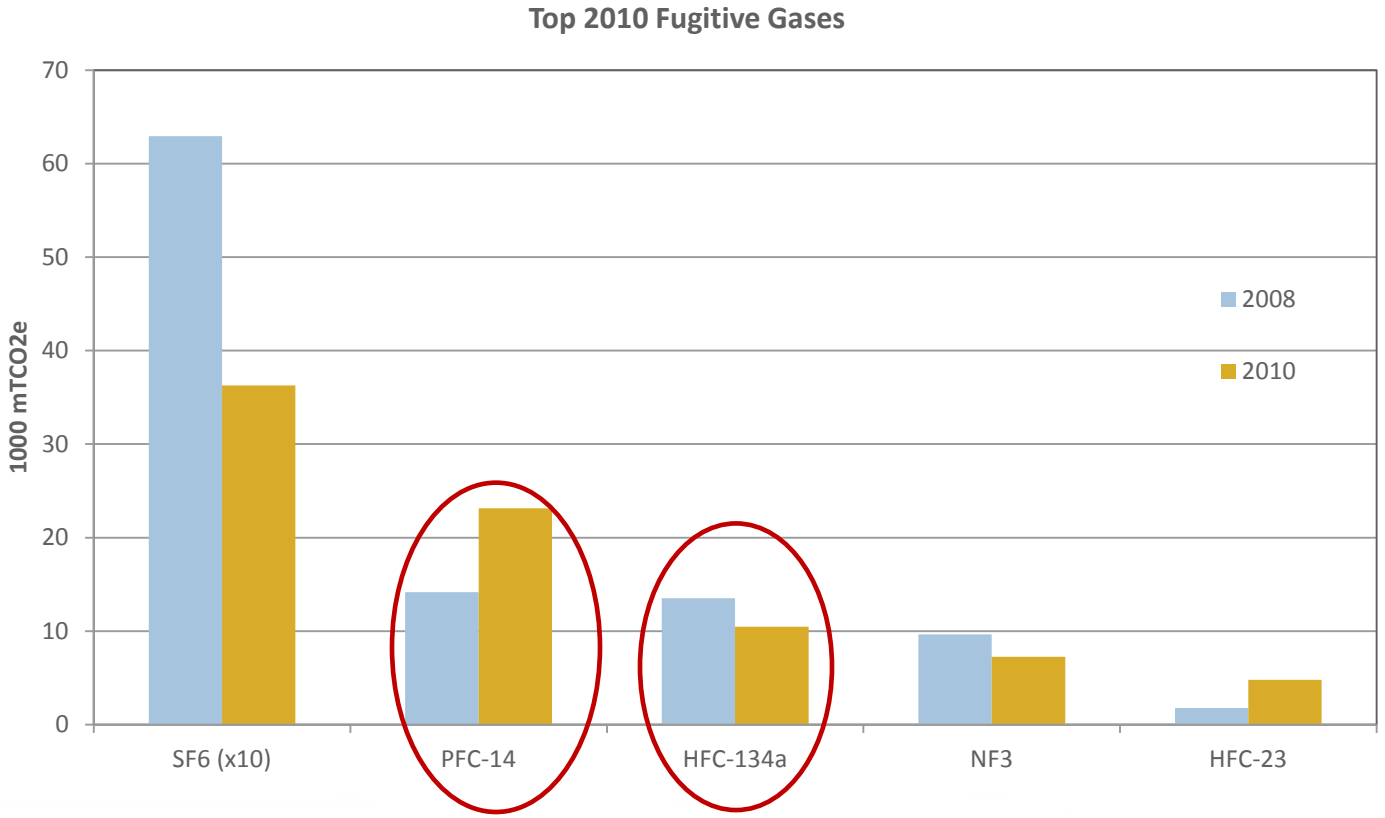
DOE Emission Inventory for Fugitive Gases

- In 2008, fluorinated GHGs (HFCs and PFCs) comprised 7.2% of the fugitive inventory.
- In 2010:
  - HFCs decreased 33%
  - PFCs increased 42%



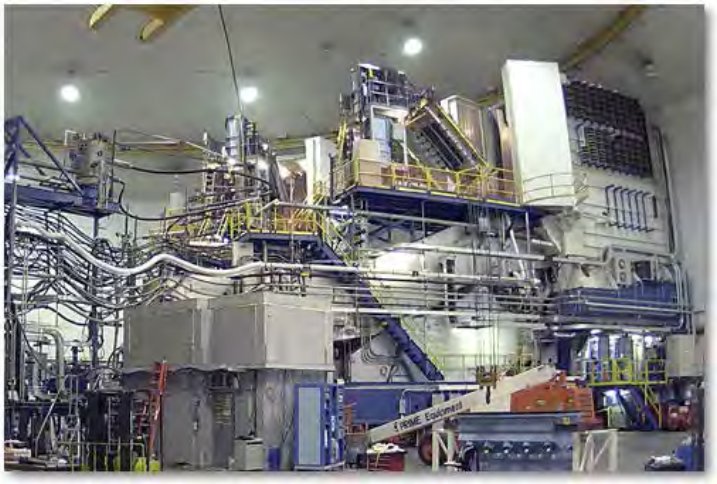
DOE Emission Inventory for Halocarbons

- While SF_6 is clearly the fugitive gas with the largest impact to the DOE GHG inventory, 2 halocarbons used in high energy physics are among the top 5 fugitive gases.
  - CF_4 (PFC-14), and
  - R-134a (HFC-134a).

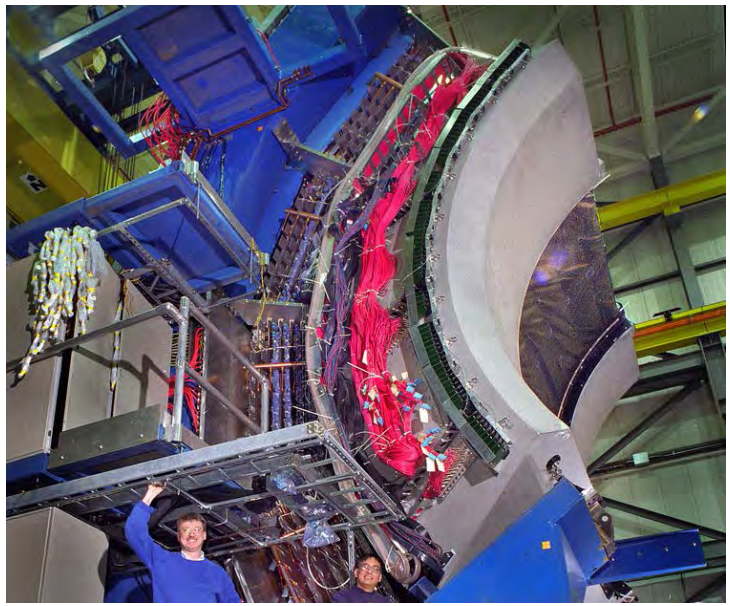


Halocarbons on DOE Sites

- CF_4 (PFC-14) and R-134a (HFC-134a) are often used in ionization chamber detectors.
- Cherenkov (Čerenkov) detectors rely on "heavier" gases such as C_4F_{10} (PFC-3-1-10) or C_4F_8O.
  - C_4F_{10} is currently tracked by the annual GHG inventory.
  - C_4F_8O is currently not tracked by the GHG inventory although estimated GWP is 8,700.
- Hydrocarbons that are often mixed with halocarbons in ionization chambers include methane, ethane, and iosbutane.
  - Aside from methane, these have very low GWPs.



(Hall A at JLab with Cherenkov detectors courtesy of JLab)



(Ring Imaging Cherenkov Detector at BNL courtesy of BNL)

Challenges of Halocarbon Management

- Halocarbons have unique spectral and electronegative properties that are ideal for detectors.
- Generally these gases are used in equipment as mixtures.
  - As a result, there are significant challenges to safe and reliable processing of the spent gas.
  - Typical management practice is to vent gas after use.
- It is unclear from current inventory methods what percent is used as refrigerants, what percent is used in experiments, and what percent is for other uses.
  - Management of halocarbon refrigerants may focus more on leak detection and repair.
  - Management of halocarbons for experimental use may focus on reuse and recirculation.
- Successful recirculation projects exist.
  - FermiLab recirculates CF_4 at a collider experiment.
  - CERN successfully recirculates R-134a.
  - Any other success stories?

For FEWG Discussion

- Some sites are already actively managing halocarbons to minimize emissions.
  - Are there opportunities to address this issue at other sites?
  - Could managing halocarbons limit ongoing efforts to manage SF_6?
- Most halocarbons are covered in the GHG inventory.
  - Should C_4F_{10} be added to the inventory?
- Are hydrocarbons (ethane, isobutane) associated with ionization detection significant enough to be added to the inventory?
- Are there other gases that are not currently tracked that should be tracked?

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