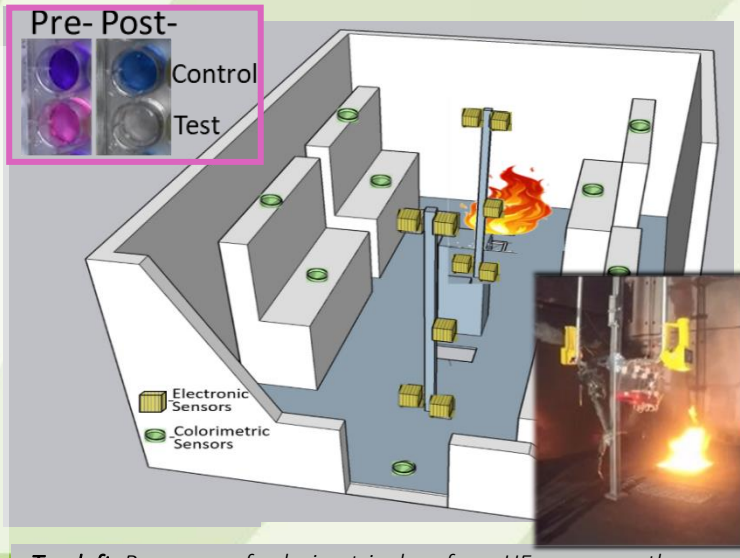
National Defense Center for Energy and Environment

Visual Indicator for Hydrogen Fluoride Produced from Extinguishing Fires with Hydrofluorocarbon Fire Suppression Technologies

PROJECT OVERVIEW

Hydrofluorocarbon (HFC) fire extinguishing agents provide exceptional, water-free, fire suppression chemistry. The technology is marketed as a "clean agent", use will limit damage to sensitive materials, disperse rapidly after use, and will not affect the atmospheric ozone layer. There is a significant drawback for the extinguishers, although the product itself has minimal safety or health issues, thermal decomposition of HFC produces hydrogen fluoride (HF) vapor, which poses an acute risk when inhaled, ingested, or absorbed through skin.

The project at AFCEC/CXAE included two thrusts. A series of live fire demonstrations were done in order to characterize and estimate the risk from use of HFC extinguishers for class-B (liquid fuel) fires. In addition, the work devised a materials solution for detection of HF vapor, and subsequently evaluated materials in the live-fire demonstrations. Live fire tests were primarily done using AFCEC/CXAE fixed facility test bed. A modest liquid fuel fire (1.5 L Jet A) was ignited and then extinguished using HFC. Electronic sensors, commercial indicator materials, and developmental materials were exposed to the test to determine HF concentrations and their duration as well as the responsiveness and sensitivity of indicator materials.



Top left: *Response of colorimetric dyes from HF exposure; the intense pink of Rose Bengal disappears after vapor contact.*
Center: *Sketch & layout of test bed used for demonstration. The materials and devices were arranged to provide a spatial & temporal map of HF concentrations during the demonstration.*
Bottom right: *Photo of live fire testing shortly after ignition.*

BENEFITS

The demonstrations revealed that the risk from HFC use was much greater than suggested by manufacturer's literature. Extinguishing the small liquid fuel fire produced peak HF vapor concentrations over 10,000 ppm, which is >300× the lethal exposure threshold. The concentrations in the test area remained above the IDLH (immediately dangerous to life or health) level for 2 h and above the PEL (permissible exposure limit) for nearly 4 h.

The quantitation of–and insight to–the risks from HFC extinguishers provides details to guide training and safety protocols for sites and equipment using the systems. Personnel must be informed of the production of HF from HFC-charged extinguisher; that in a fire emergency they must vacate area immediately and not return until area has been assessed by trained and protected personnel. Any emergency personnel entering an area must use appropriate PPE to block inhalation, ingestion, and adsorption.

Present monitoring and reporting insufficiently address the HF risk and fail to provide real-time information for personnel. The test indicator solutions tested were responsive to HF with sensitivity potentially greater than commercial products' detection capabilities. Effective packaging of the test indicator still must be done to confirm practical application.

The passive indicator material will provide continuous monitoring to protect personnel and first responders that could be exposed in an emergency.

PATH FORWARD

Inform stakeholders of the risks from HFC-extinguishers – Write and submit formal Memorandum for Record to Air Force that documents potential risk from deployed systems – Encourage transition to alternative fire suppression systems in subsequent modernization cycles.

Refine materials sensor concept – package reagents for 1) extended environmental monitoring 2) rapid point-of-use determination.

Explore and quantify HF output from lithium-ion battery fires – emerging risk with growing implementation of electric vehicles and other rechargeable equipment.

DoD Executive Agent

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FOR FURTHER INFORMATION

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