Improvements in Aircraft Fire Detection

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Jim Milke, Selena Chin and Jennifer Wood
Dept of Fire Protection Engineering
University of Maryland

Motivation

- Need for timely fire detection in cargo compartments on board aircrafts
- Reduce proportion of nuisance alarms from fire detection systems
- Scope
  - Cargo compartments
  - Hidden spaces (wall cavities, ceiling spaces)

Overview

- **Previous progress**
  - **Background study completed of**
    - Requirements for detection in FAR
    - Nuisance:fire source ratios
  - **Initial experimental program conducted**
    - Small-scale tests at UMD
    - Full-scale tests at FAA Tech Center (FAA-TC)

Experimental Program

Source/Location	UMD	FAA-TC ULD	FAA-TC Cargo Compartment	FAA-TC ULD in Cargo Compartment
Heptane	X	X	X	X
PU foam (flaming)	X	X	X	
PU foam (smoldering)	X	X	X	
Suitcase (soft)	X	X	X	X
Shredded paper		X	X	X
Wood	X	X	X	
Baled Cotton		X		
Boiling Water	X			

Experiment Overview (FAA-TC)

Experimental Setup

Sensors and Instrumentation:

- Aspirating smoke detectors (ASD)
- Thermocouples
- Light obscuration meters
- Linear heat detector
- Photoelectric spot detector
- Smoke Generator Standardization Apparatus (SGSA)
- Gas sensors (CO, CO_2, O_2)

Materials and Protocols

- Heptane (UL268, EN54)
- Polyurethane (PU) foam (UL268, EN54)
- Suitcase (unique test)
- Shredded paper (UL268)
- Baled cotton (unique test)
- Wood chips (UL268, EN54)

Results - ASD

		Whittaker	ASD		
			VLF	VEA	VLC
Tests Responded to (%)	Flaming	0%	100%	66.7%	100%
	Smoldering	64.3%	100%	71.4%	100%
Tests where systems responded before or on par with the Whittaker (%)			88.9%	55.6%	100%

Results - ASD

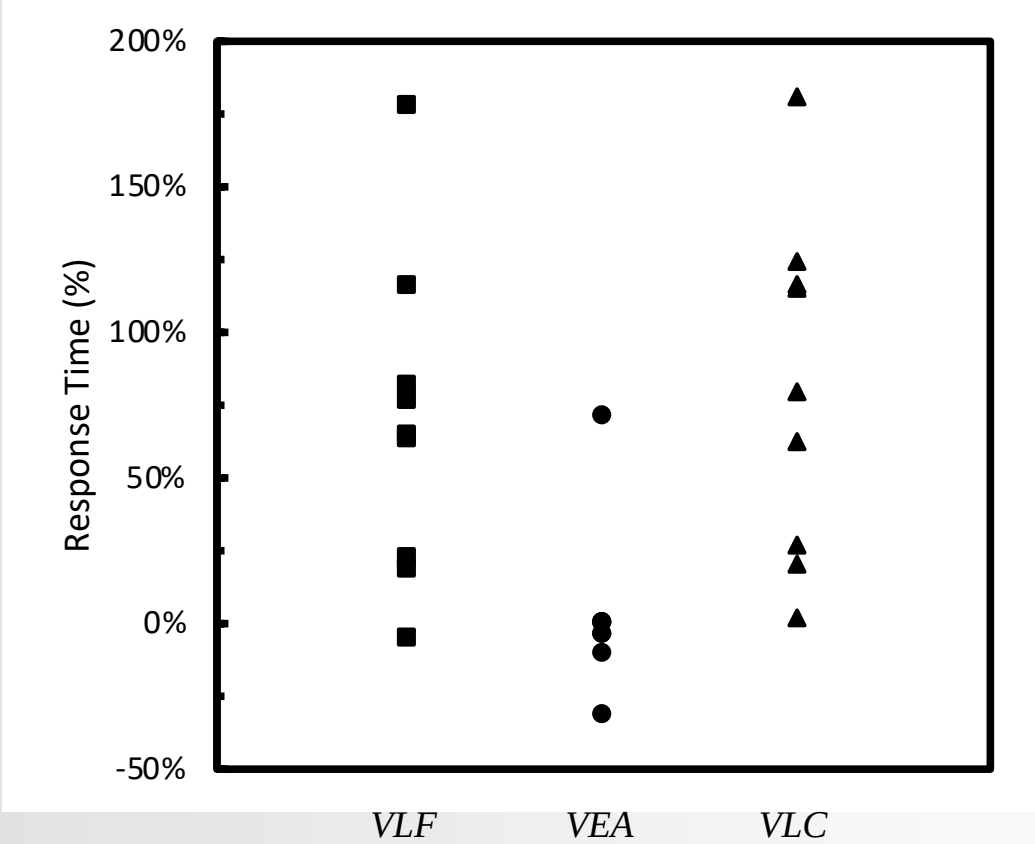
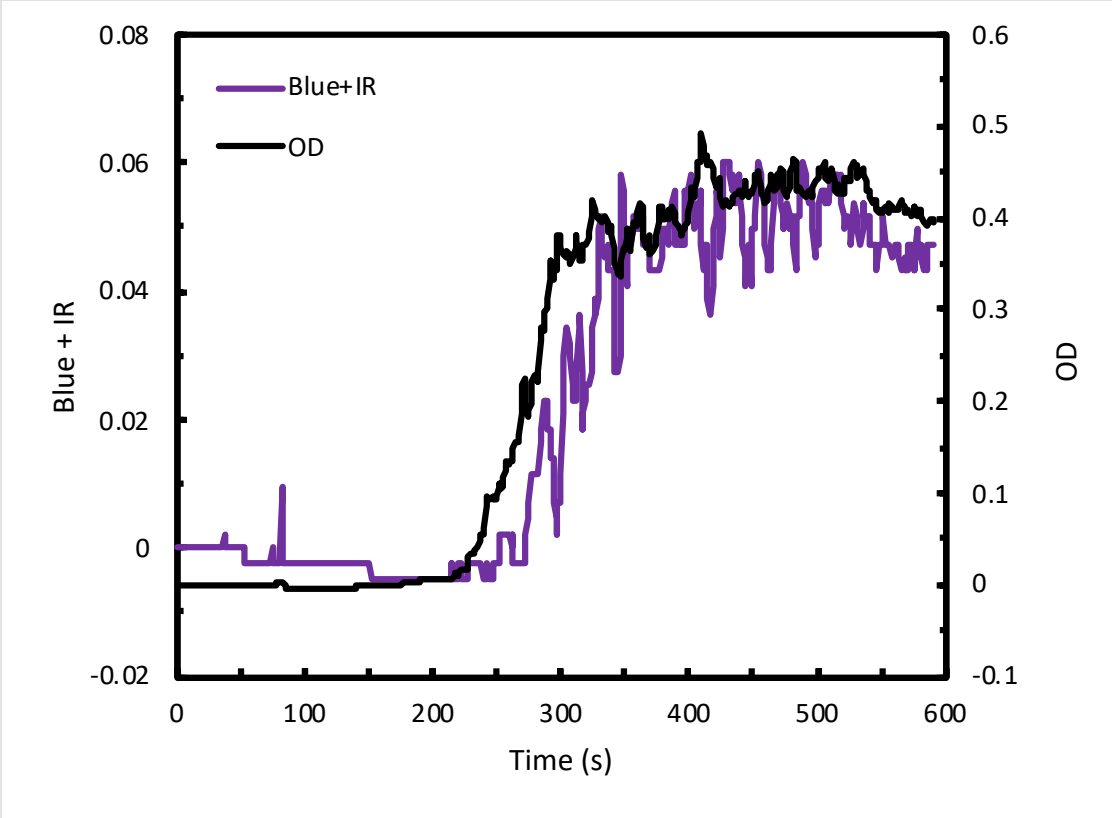


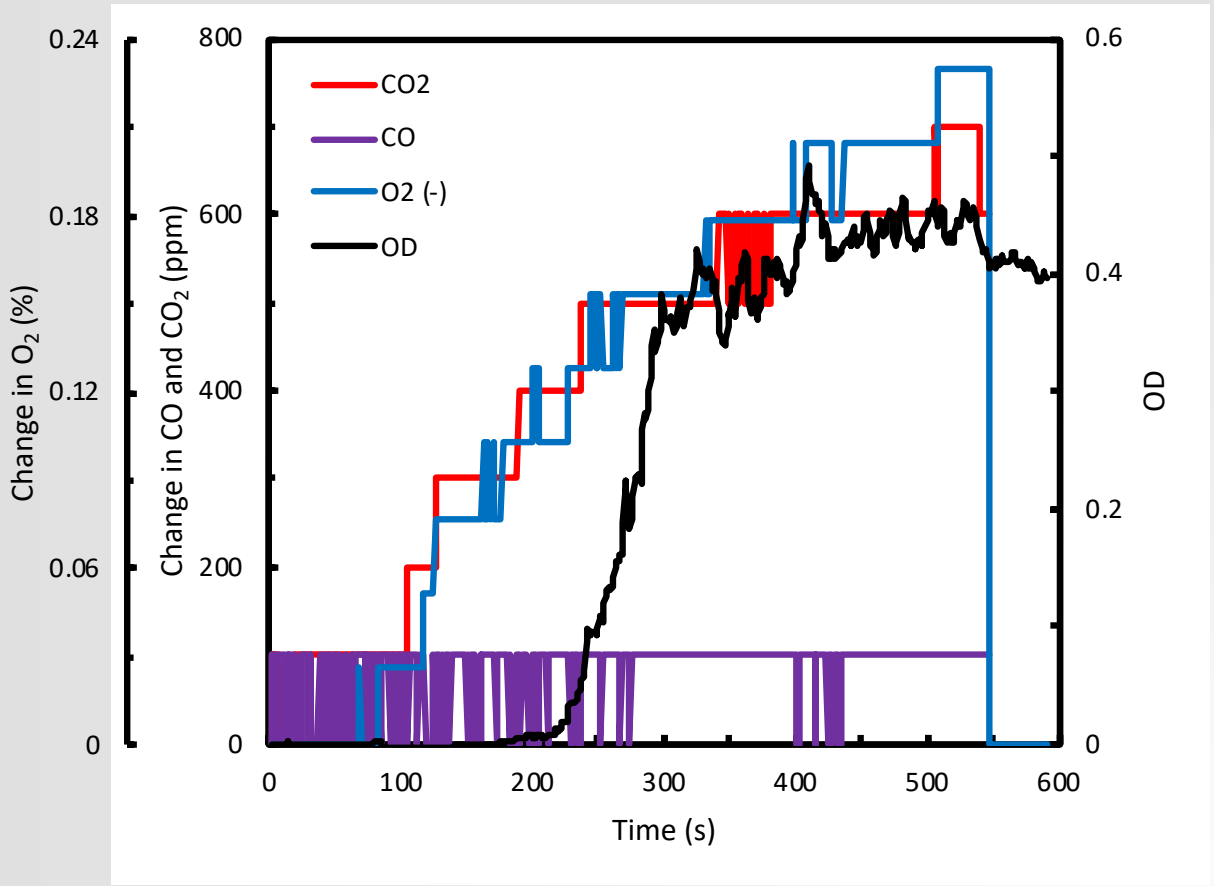
Figure 4.3: Total comparison of response times between ASDs and Whittaker photoelectric detector. Comparison in response time is presented as a percent difference to the Whittaker detector. Positive percentages indicate the VESDA system alarmed before the Whittaker while negative percentages indicate the VESDA system alarmed after the Whittaker.

Results - SGSA



Smoldering PU

Results – Gas Sensors



Smoldering PU Foam

Documentation of Results

- **Publication of research as FAA Technical Thesis currently underway**

THE SCALABILITY OF SMOKE DENSITY AND THE VIABILITY OF NEW DETECTION METHODS IN AIRCRAFTS

by

Selena K. Chin

Thesis submitted to the Faculty of the Graduate School of the University of Maryland, College Park, in partial fulfillment of the requirements for the degree of Master of Science 2018

Advisory Committee:
Professor James A. Milke, Ph.D., Committee Chair
Professor Peter B. Sunderland, Ph.D.
Robert I. Ochs, Ph.D.

Upcoming Research

Objective: Improve fire detection response times to fires in airplane cargo compartments.

- **Utilization of photoelectric detectors, dual wavelength detectors, & gas sensors for testing**
- **Detectors and sensors placed on the inside and outside of ULDs to find delta time between alarms**
- **Pressure flow measurements will be taken for each individual fuel type**

Proposed Test Matrix

Heptane (for calibration)	100 mm diameter pool fires, 4” above ground 15 mL of heptane
PU Foam (performing flaming and smoldering tests)	76 by 76 by 51 mm, 100 mm above ground Bottom and sides wrapped in aluminum foil
Suitcase (whole)	Position suitcase standing up, filled with ordinary combustibles Smoldering induced via electric charcoal starter at 550 W
Lithium Ion Battery	Using multiple Lithium Ion Batteries, create short in 1 battery OR heat batteries until thermal runaway
Aviator 440 SDT Smoke Generator	Corona Smoke Fluid 135 and CO_2 is supplied 4 chimney heaters, Position: 68” from rear doors and 48” from side wall

Thank you