MAKING PROVEN HALON ALTERNATIVES EVEN BETTER

Presented to:

Halon Options Technical Working Committee (HOTWC)

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JOINT AIRCRAFT SURVIVABILITY PROGRAM OFFICE (JASPO)

On-going Project: ***Automatic Engine Fire Suppression***

Issues: Project promises enhanced system performance (quicker is better) with reduced weight/volume (better affords lighter) for expanded threats (safety & ballistic fires).

Objectives: This project will develop an automatic engine fire suppression system capable of providing immediate fire/explosion protection while allowing continued controlled operation of the affected engine.

Benefits: Single engine aircraft and UAV's get viable option for engine fire protection, where currently there is none. All aircraft get option for enhanced fire protection against ballistic threat, not currently designed for.

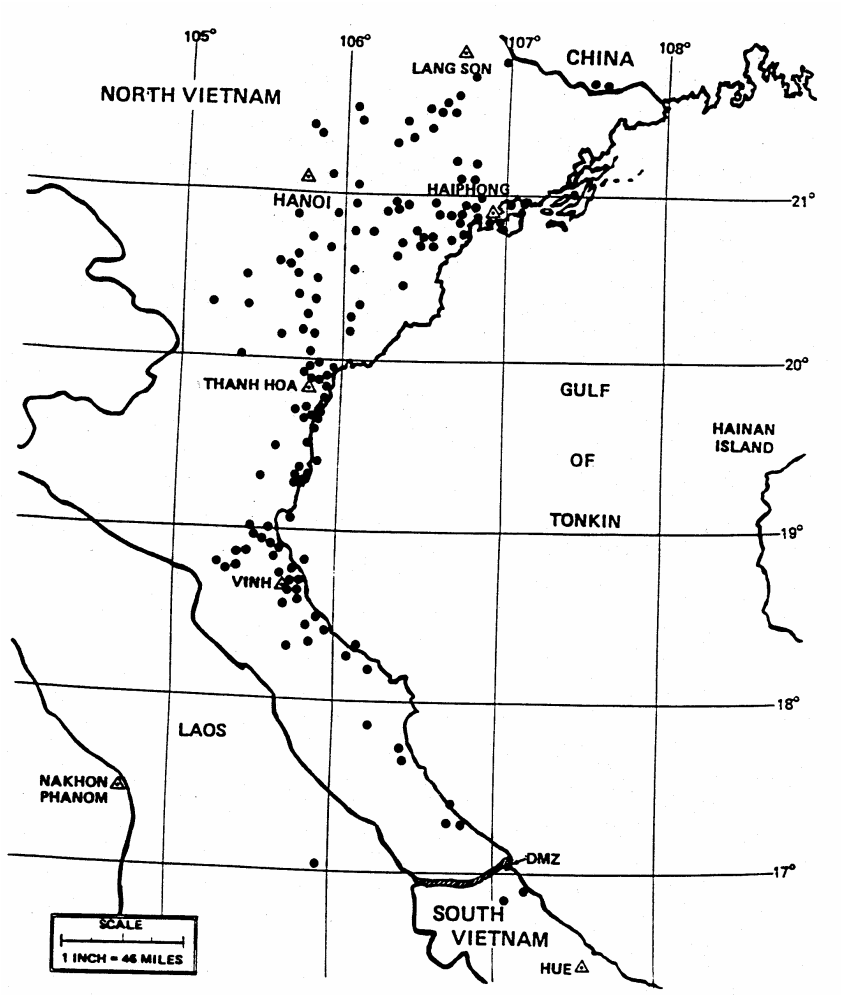
APPROACH

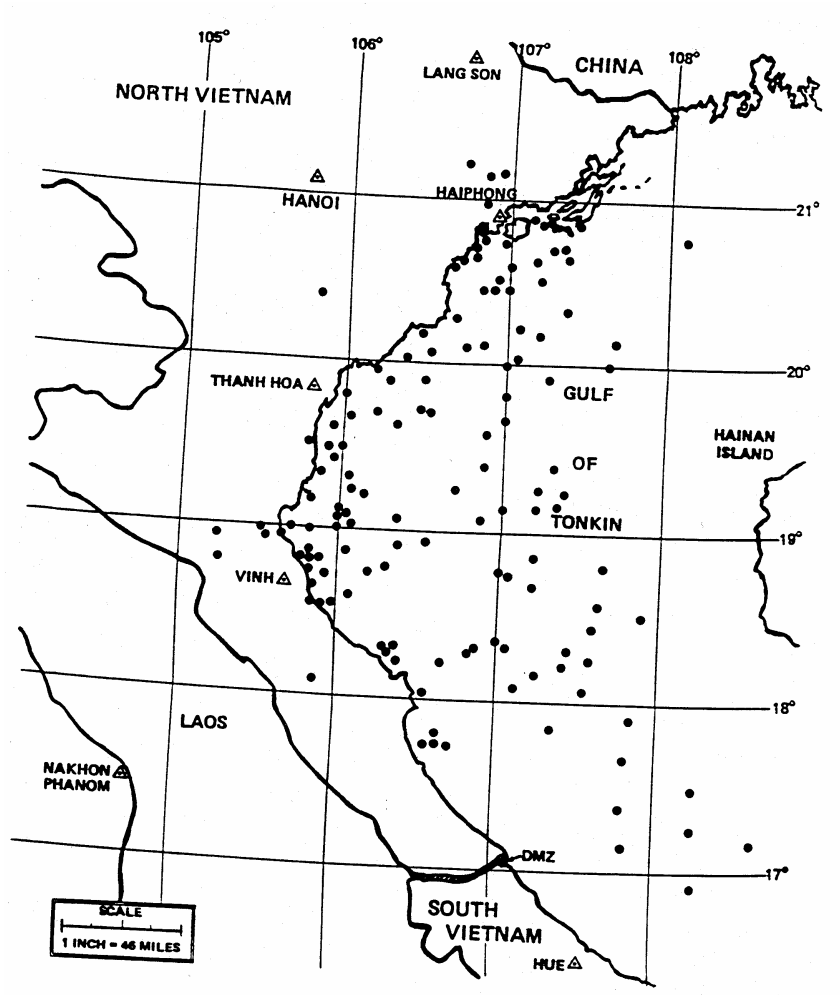
Phase I analysis (FY04) detailed merit of project.

Phase II (FY05) safety fire testing quantified system weight as a function of delay in system activation.

Phase III (FY06) ballistic fire testing seeks to expand threat coverage.

Suppression vs. Extinguishment





FY05 Accomplishments

- ***Safety Fire Testing Conducted, as Planned***
  - **Engine Nacelle Simulator**
    - **JP-8 Fuel Spray**
    - **Spark Ignition: NO HOT SURFACES**
    - **Flight Representative Airflow**
    - **Computer Controlled Bottle Activation**
  - **3 Delay Conditions (Detection ⇔ Suppression)**
    - **20.0 Second:** Typical of Engine Systems (Pilot-Activated**)**
    - **2.0 Second:** Convenient Middle Data Point
    - **.2 Second:** Typical of Dry Bay Systems (Automatic)

	20 Second	**2 Second**	**0.2 Second**
Fire Out	1.0 #	0.95 #	1.65#
Fire Not Out	0.9 #	0.75 #	1.55 #
Average	***0.95 #***	***0.85 #***	***1.60 #***

Nacelle Fire Test Facility (Patuxent River)

- Full-scale engine nacelle with in-flight airflow simulation capabilities
- Ability to develop new fire suppression technologies and tools
- Evaluate the effectiveness of existing/new systems and/or agents
- Laser Doppler Volicimetry (LDV), hot wire anemometry, 5 hole pitot probes
- 200+channel, 1000 samples/sec data acquisition system
- Color video recording capabilities: standard and high speed

Auto-Engine Fire Suppression Test

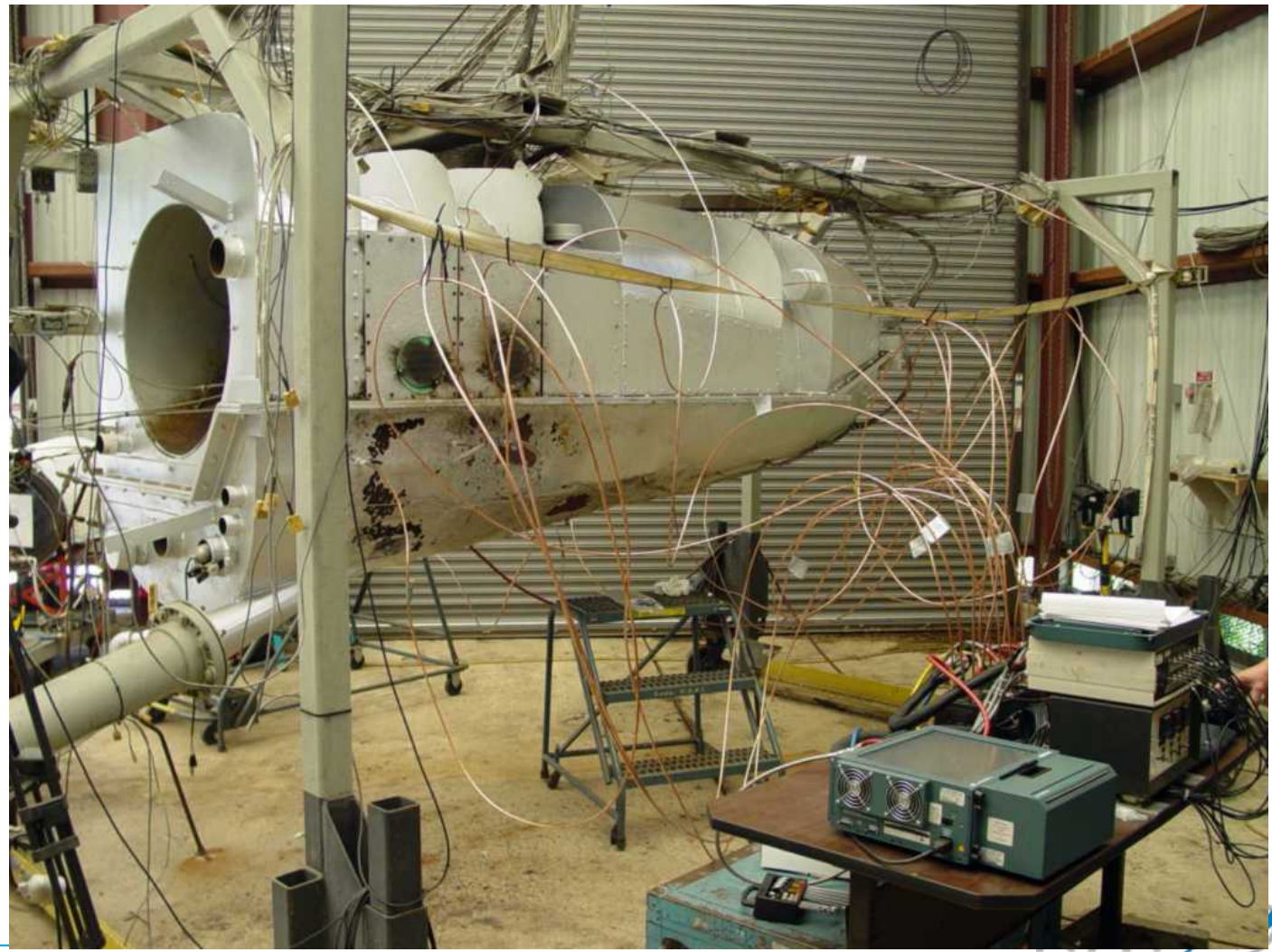
FY05 Accomplishments (cont'd)

- ***Positive and Meaningful Results***
  - **PROVEN: *Quicker Response Requires Less Agent***
    - **10% Less Agent from 20 to 2 Second Delay**
  - **LEARNED: *You Can Be Too Fast***
    - **100% More Agent from 2 to 0.2 Second Delay**
      - **"Fire Burst" as Fire Catches Up with Previously Liberated Fuel**
      - **Threat Still Growing as System Was Activated at 0.2 Seconds**
        - » **Spray Fire + "3-D Pool" Fire**
  - **LEARNED: *Hot Surface Reignition is the Predominant Agent Weight Driver***
    - **Reference: Comparison to F/A-18E/F Tests Run on Same Simulator**

FY05 Accomplishments (cont'd)

- ***Additional Testing Conducted (Within Established Budget)***
  - **Statham Testing to Quantify Agent Concentration**
  - **LEARNED:** ***Fire Out Accomplished Well Below HFC-125 Design Equation "Requirement"***

Simulator Rigged for Statham Tests



FY05 Accomplishments (cont'd)

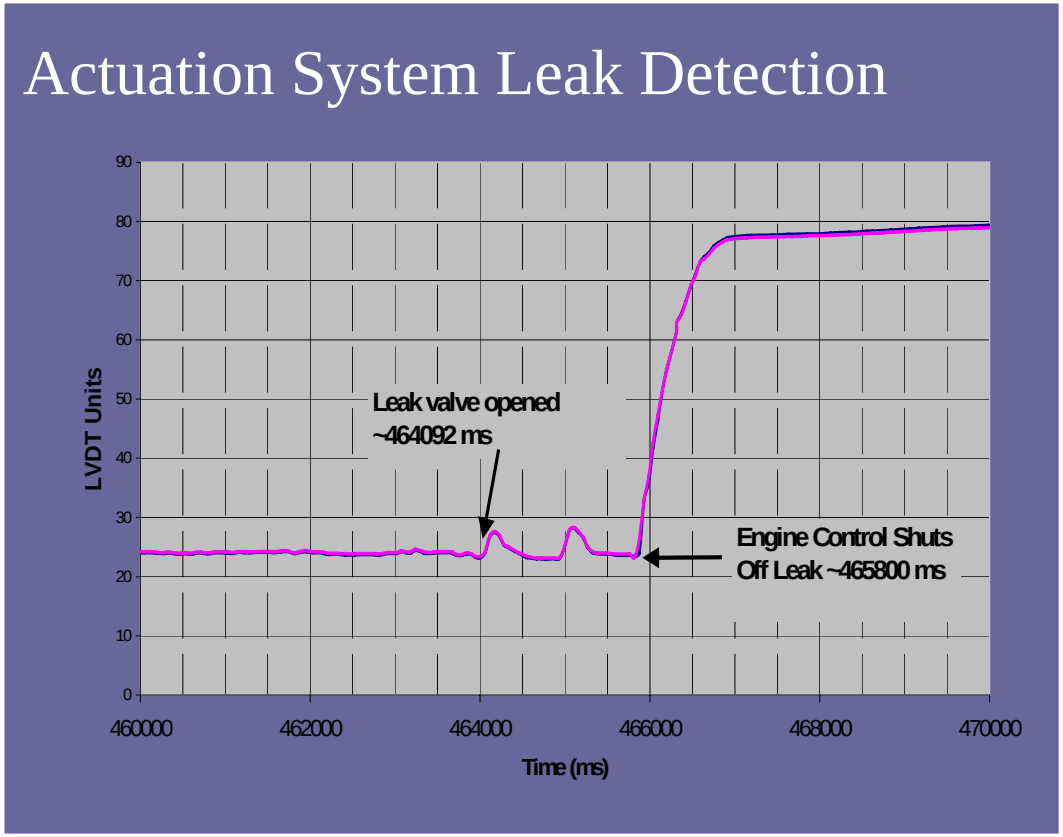
- ***Two Additional Concurrent Analyses***

  - **Optical Fire Detectors (OFD)**
    - **Catalogue Existing Uses**
    - **Categorize By Speed (Response Time)**
    - **Envision Coupling to SECAD**

  - **SECAD**
    - **Scrutinize & Exploit Fuel System Monitor & Control Capabilities**
      - **Which Lines Could/Should Lessen Fire Threat?**
      - **Fuel Line/Valve Closure Speed**
      - **Pressure Return Upon OFD-Out Signal**
    - **Assess OFD Input Potential**
      - **NOW: Purposeful Delay, to Minimize False Alarms**
      - **LATER: Not-in-kind OFD Offers "Immediate" Redundancy**

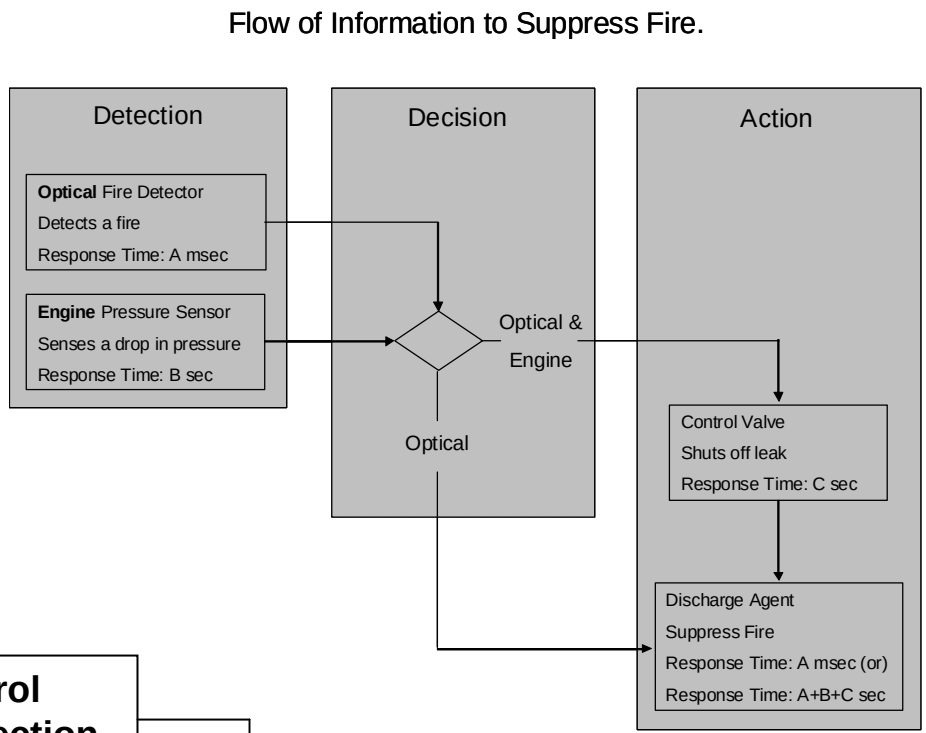
Engine Control Damage Detection

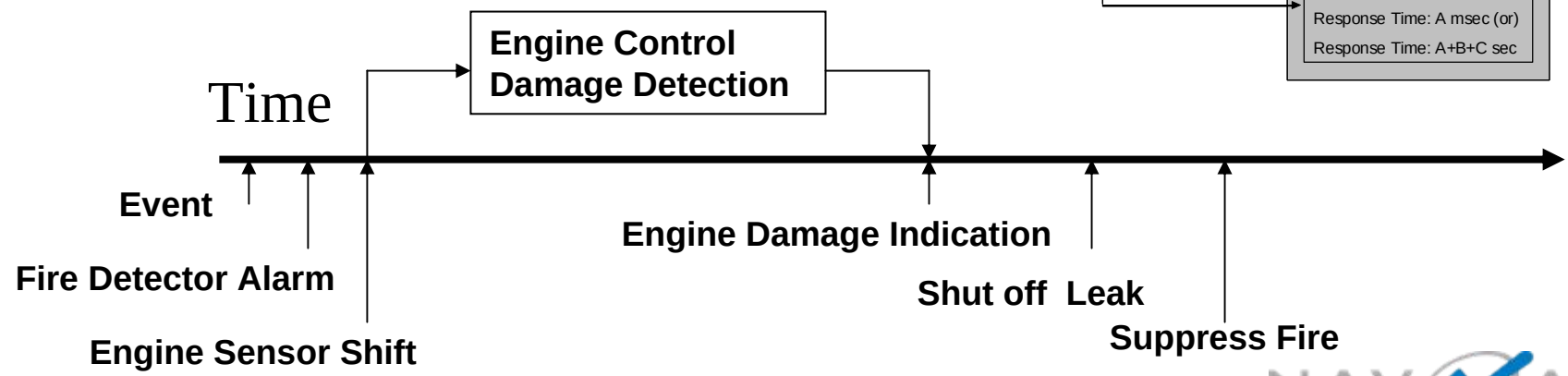
- **Modern engine controls are capable of detecting damage to actuation systems**
- **Indication of damage is nearly immediate**
- **Detection typically takes 2 seconds to improve detection reliability**



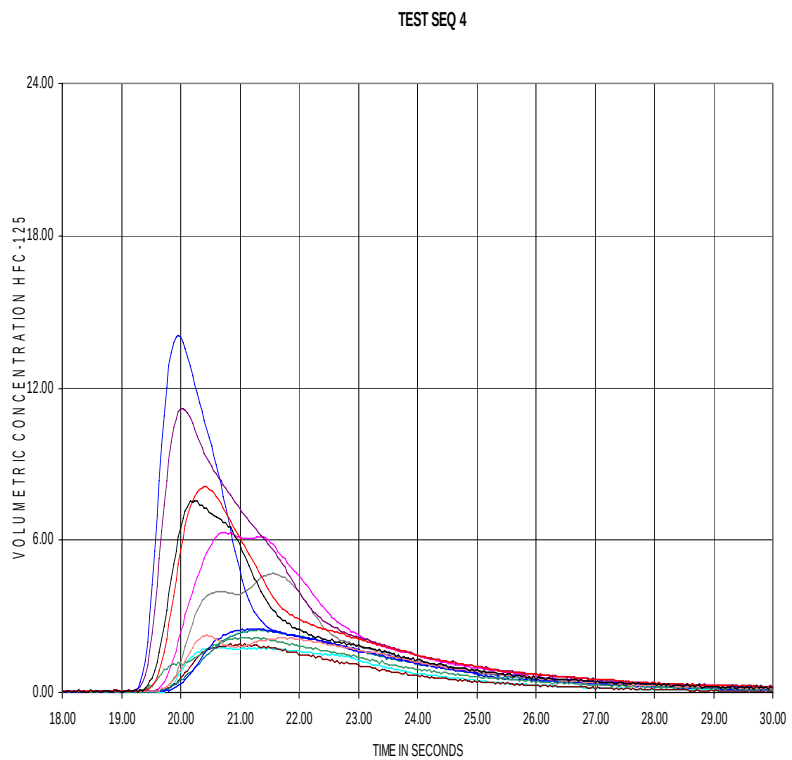
Integration

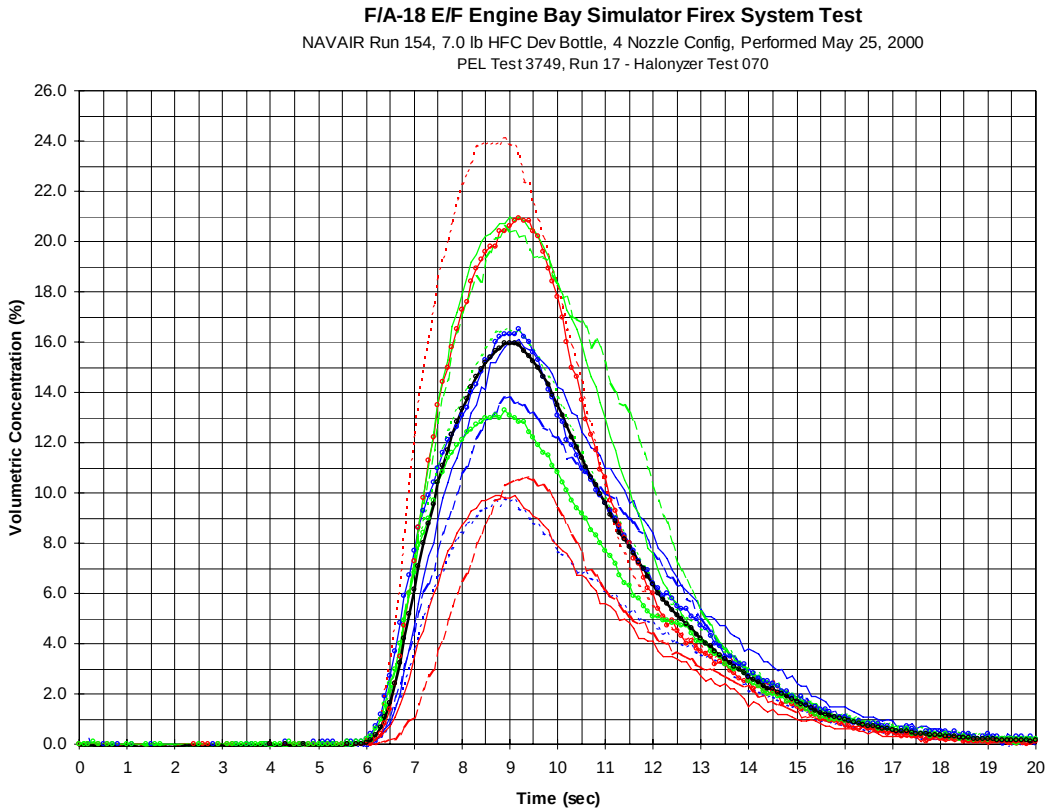
- Use of Fire Detection Signal could improve reliability and speed of engine damage detection





Effect of Hot Surface Reignition





Plan For FY06

- **Ballistically-Driven Fires (Vice Safety Fires of FY05)**
  - **Automated Approach to Safety Fires, So Now Can Entertain Ballistic Threat**
    - **ala Dry Bay Protection**
  - **Quantify Need for "Adding Agent Back", if any**
  - **Baselined to Safety Fire Agent Weights**

Industry Changing Potential