F-15 Halon Replacement Trade Study

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Baseline System

- One 6.6 pound Halon 1301 bottle mounted between engines
- System weighs 21 pounds
- Four bays protected (3 fire zones)
  - Right/Left Engine
  - JFS/AMAD bays
- Bottle and system design and qualification based on Mil-E-22285
- DoD Halon bank supporting **F-15** fleet

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Performance Requirements

- Two fundamental performance requirements
  - Minimum agent required defined by design equations (volume and ventilation)
  - Agent concentration must be 6% for 0.5 secs simultaneously throughout bay
- Concentration tests in engine nacelle verify system performance

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The Candidates

- Three candidate replacements down selected for study
  - HFC-125 (Fe-25, C_2HF_5)
  - CF_3I (Triodide, Iodoguard)
  - Gas Generators
- Baseline: Halon 1301 CF_3Br

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HFC-125

- Selected by DoD, FAA as agent for near term development
- Test effort at Wright Labs is determining amount of agent needed
  - Design equations
  - Concentration vs. time profile
  - DoD meeting in January to review results
- Selected by V-22 for engine nacelle fire protection

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HFC-125 Issues

- Total weight = 41 pounds (at 2.1 x Halon volume)
  - Cylindrical bottle needed
- Adequate dispersion at all operating temperatures
  - Additional discharge nozzle may be needed
- Maintenance similar to Halon
- Toxicity - Approved only for normally unoccupied areas
- Material compatibility acceptable
- Qualification similar to Halon

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CF_3I

- Advertised as drop-in replacement
  - Volume competitive with Halon
- Commercial aircraft most interested
- FAA plans on determining required concentration profile in early 1996
  - Fire tests, concentration measurements

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CF_3I Design Configuration

- Existing data suggests volume equal to Halon
  - System weight 26 pounds
- CF_3I probably not drop-in replacement for F-15
  - Additional discharge nozzle in upper forward portion of bay
- Material compatibility, stability acceptable
- Maintenance, qualification similar to Halon

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CF_3I Toxicity

- NOAEL an order of magnitude lower than Halon 1301, HFC-125
- Data based on exposure times of about 15 minutes
- Maintenance crew exposure likely to be seconds
  - Personnel can evacuate
  - CF_3I will concentrate at ground level
- No data on short times, high concentration levels
- MDA experts feel physical injury more likely than chemical injury
  - Common to all agents

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CF_3I Dispersion at Cold Temperatures

- Boiling point -8°F at sea level
- Test data shows adequate dispersion with cold bottle in ambient bay
- Dispersion, vaporization in cold bay questionable
- How critical is performance at -20°F on ground?
  - Ground crew often extinguish these fires
  - Extra agent may compensate

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Gas Generators

- Derived from automobile air bag technology
- Selected by F/A-18 E/F for engine nacelle protection
- USAF plans to flight certify KC-135 system
- Extinguishing mechanism not fully understood
  - Inerting vs. blow out

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Gas Generator Design Configuration

- Propellant burns for 6 seconds
  - Long burn time prevents relight
- System weight 29 pounds
  - Additional nozzle in forward, upper nacelle
- Engine cleanup may be required after use
  - Solids expelled
- 5.5 year service life
  - Same as electrical initiators

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Gas Generator Qualification

- F/A-18 €IF
  - Building and extinguishing fires to qualify
  - Nacelle simulator withstands many fires
  - Determined baseline fire location, strength
    - Limit of Halon system
  - Will attempt to measure concentration vs. time
- Assuming F-15 will need to build fires

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Summary

	Halon 1301	HFC-125	CF_3I	*Gas* Gen
Weight (lbs)	21	41	26	29
Dist Sys	-	(Add discharge nozzle for all options)		
Qualification	-	Conc test	Conc test	Fire test
LC Cost ($\$x10^{-6}$)	5	17	14	40
Risks				
Minor	Bank viability	Weight	Toxicity Material comp	-
Moderate			Low temp performance	Extinguishing mechanism

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Conclusions/Recommendations

- Gas generators too expensive
  - No strong advantages to overcome cost
- HFC-125 acceptable
  - Best knowledge base
  - Better low temperature performance than CF_3I
- CF_3I has marginal advantages over HFC-125
  - Easiest retrofit, Minimum cost/weight
  - Issues: Low temperature performance, toxicity
- Pending WPAFB test results may change conclusions
- There is no pressing need to change from Halon

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