Aircraft Fire Extinguishing Solutions

ADPA / NSIA

Naval Postgraduate School

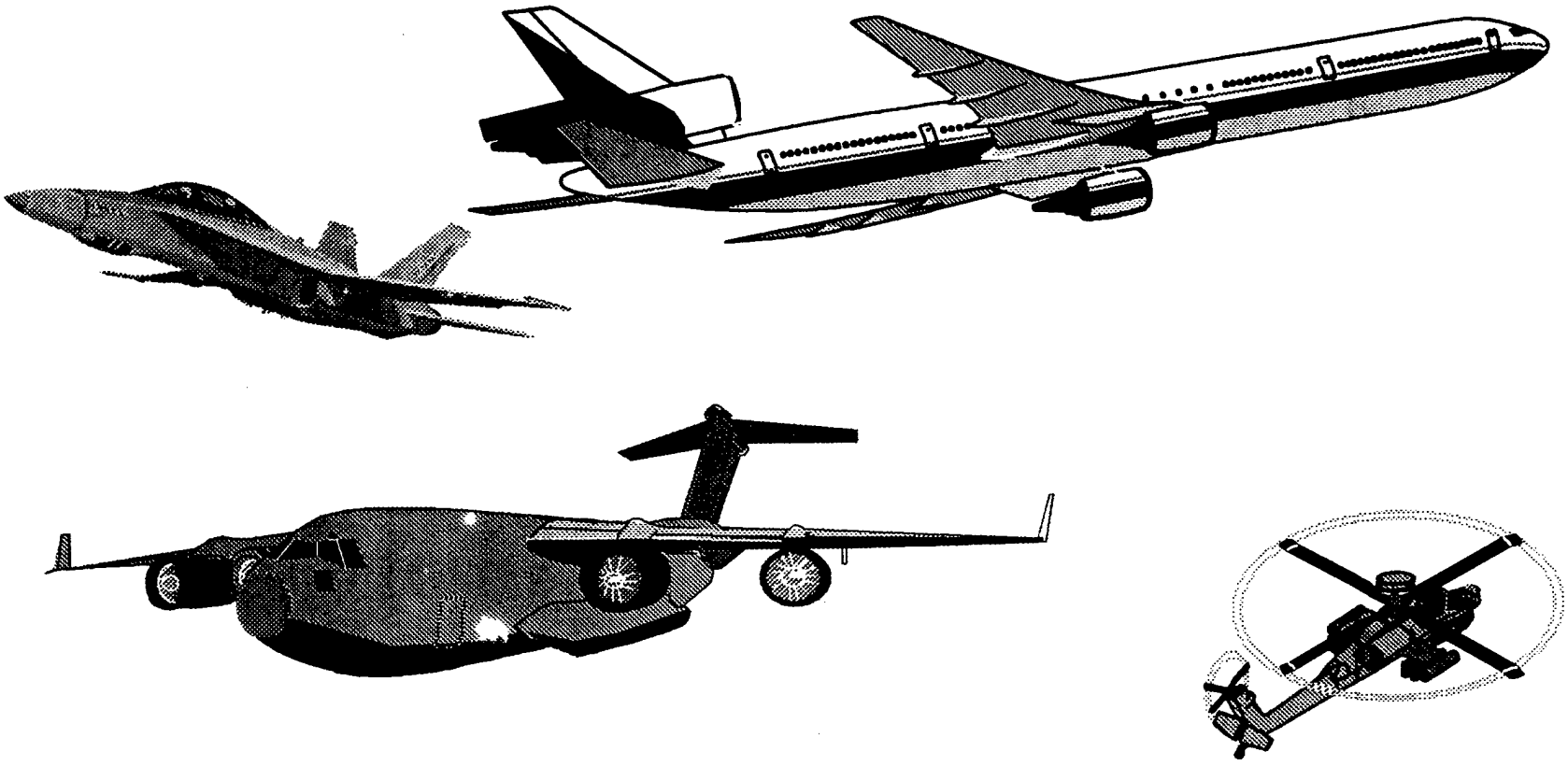
Monterey California

October 1997

BOEING®

Glenn Harper
(314) 233-6459

All Aircraft Types
Have Fire Protection Systems

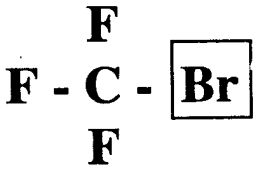


Applications

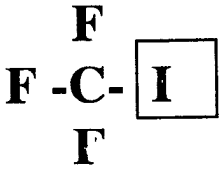
- Applications:
  - Engine Nacelles
  - Passenger / Crew
  - Lavatories
  - Cargo Bays
  - Dry Bays
  - Fuel Tanks

Leading Alternatives

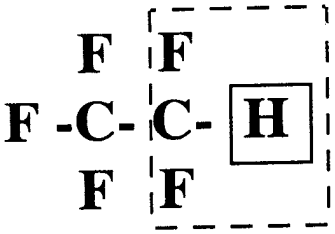
Baseline: HALON 1301 (CF_3Br)



Triodide: (CF_3I)

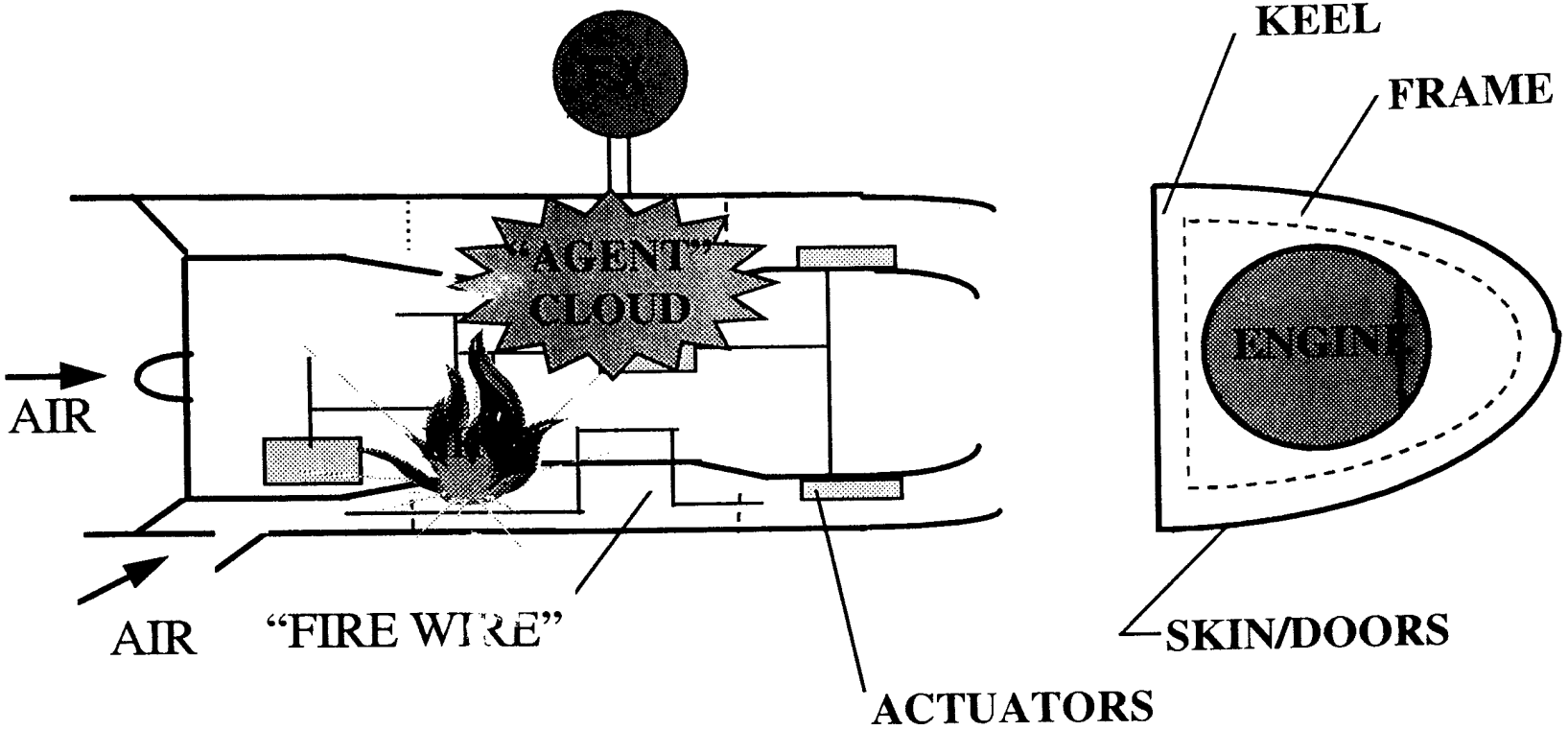


Fe-25: (C_2HF_5)

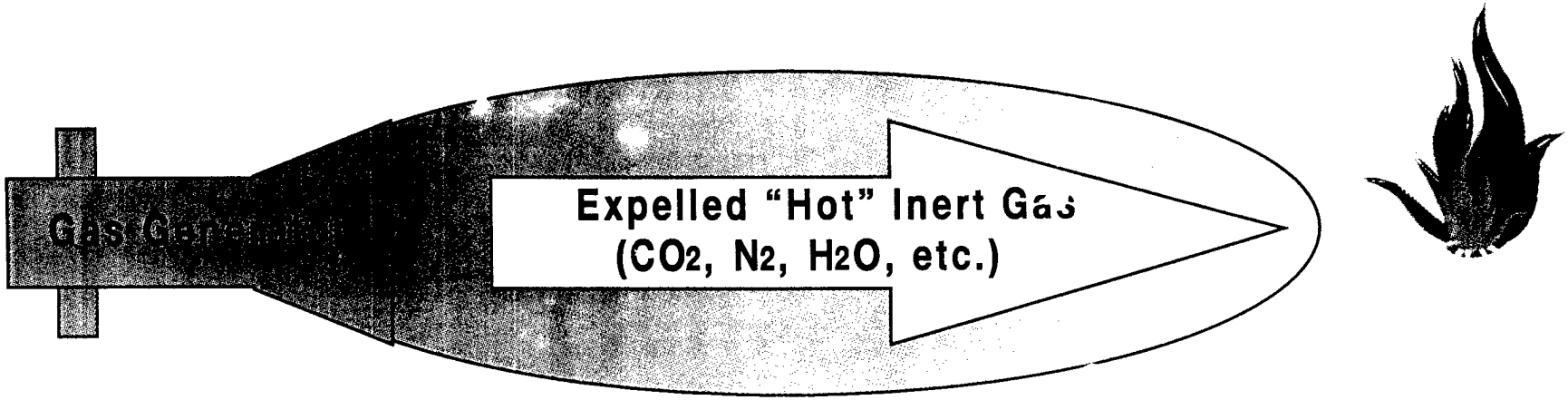


Solid Propellant Gas Generators: N_2, CO_2, H_2O, "Dust"

Engine Nacelle Protection



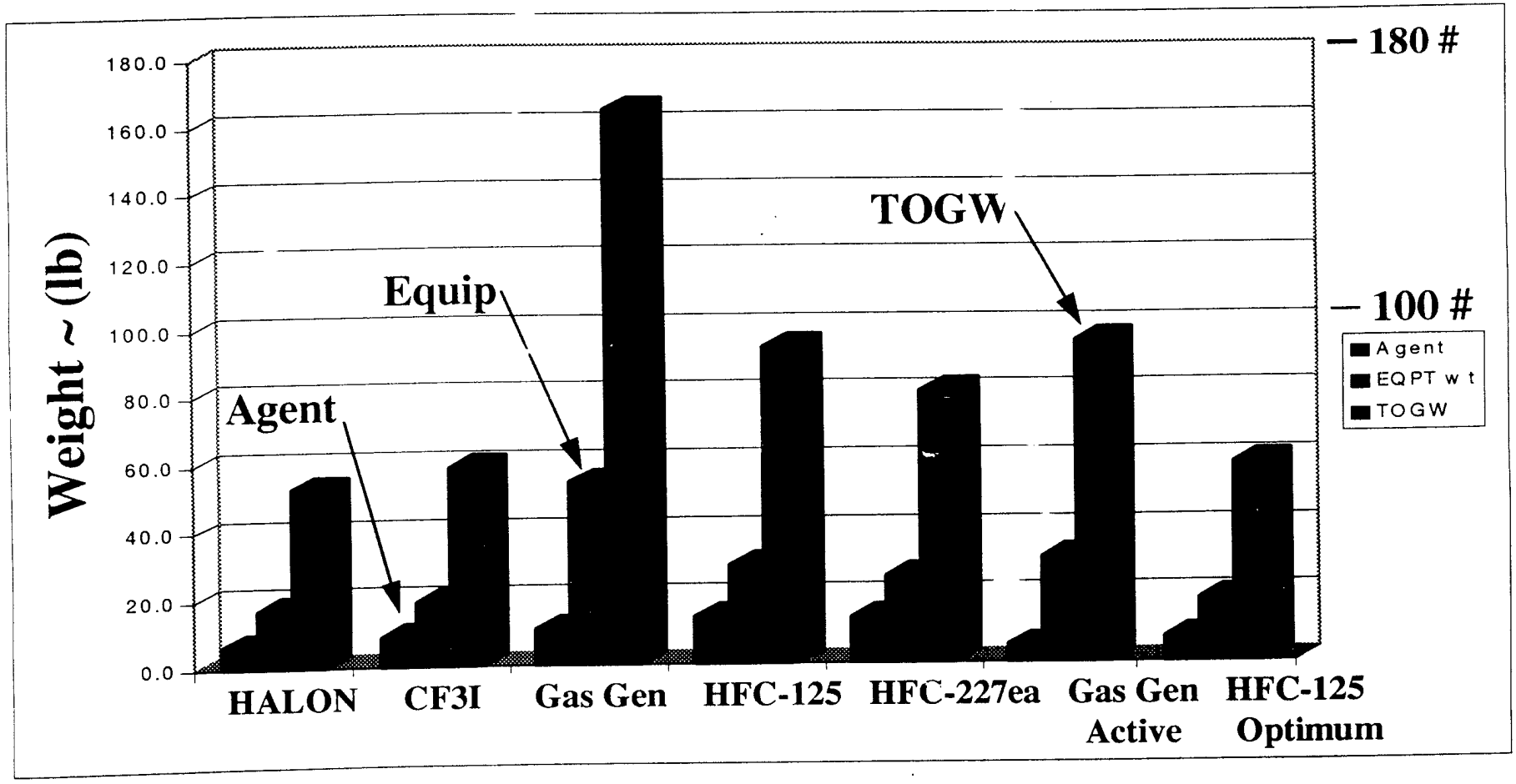
Solid Propellant Gas Generators



Other Alternatives

- "Water" Mist
- Hybrids (GG + FM-200 or "Active" Compounds)
- Advanced Agents
- Electric Field
- Several Candidates Have Had Little Aerospace Acceptance
  - Powders, Aerosols, Gels, etc.
  - Being Reconsidered
- PBr3

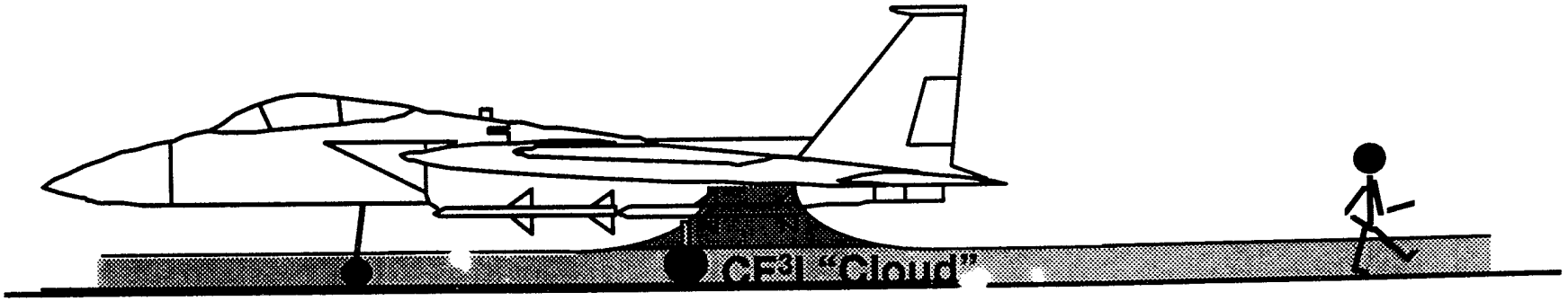
Updated Penalties



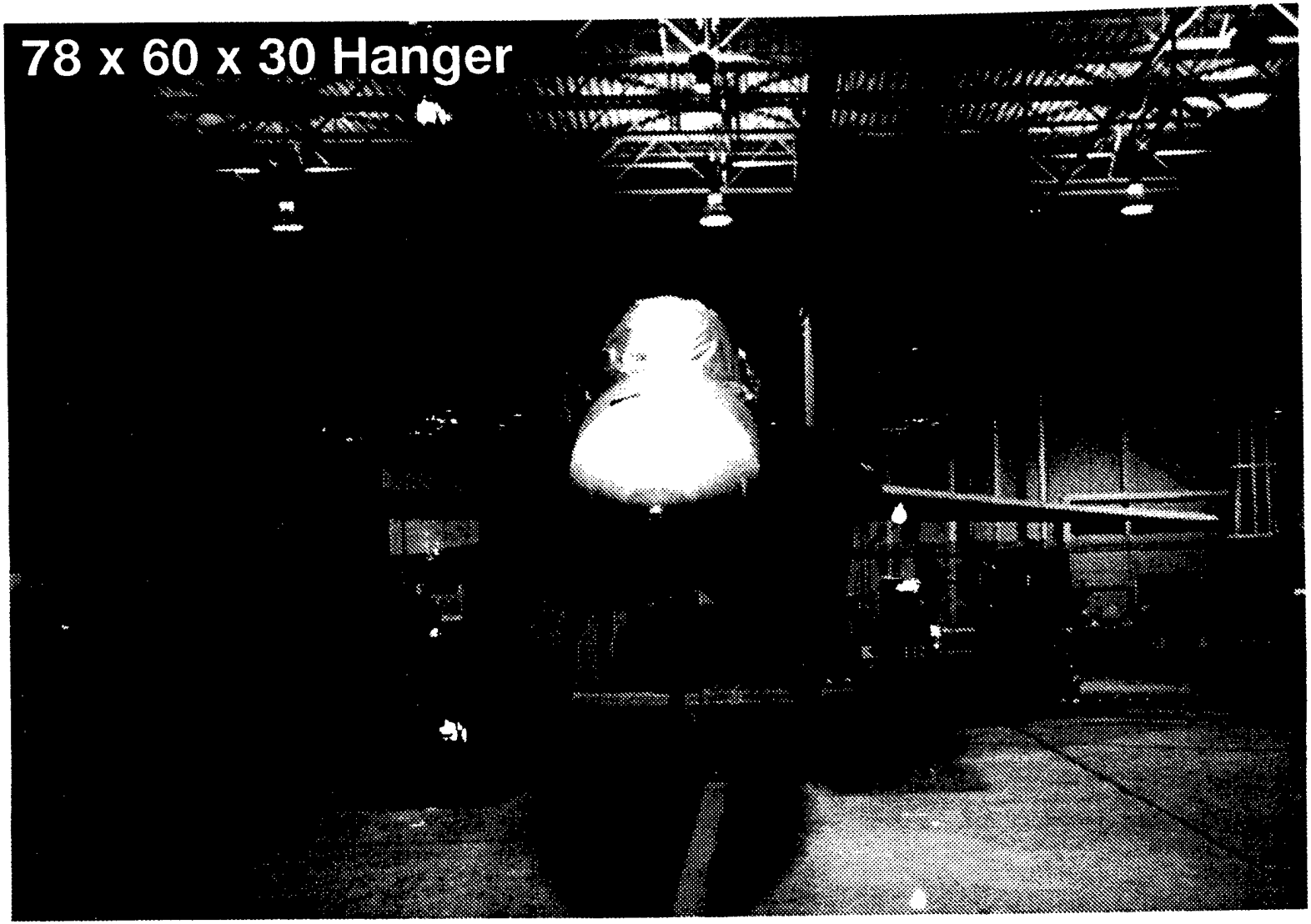
- Gas Generator: High Temp
- Active Gas Generator: High Temp, High Cost
- HFC-125: Full Scale Test Shows Promise

1997 Study

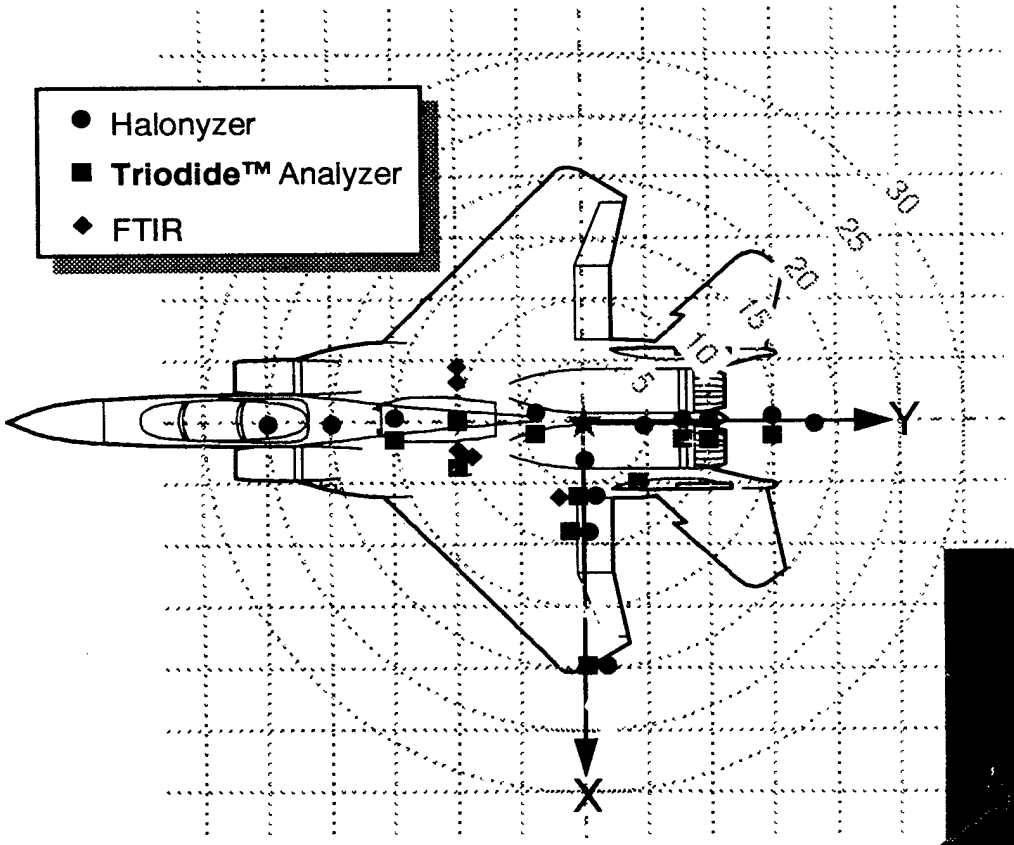
CF3I "Cloud" Shape / Height ?



CF_3I Discharge Test 12/96

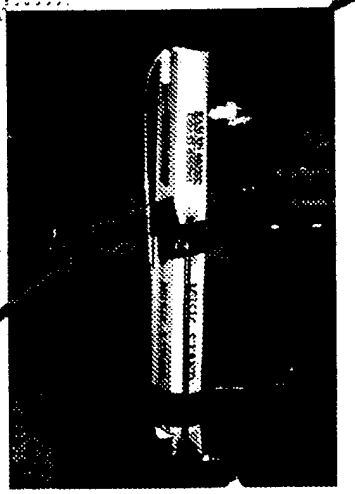


Open Nacelle - Sensor Coverage

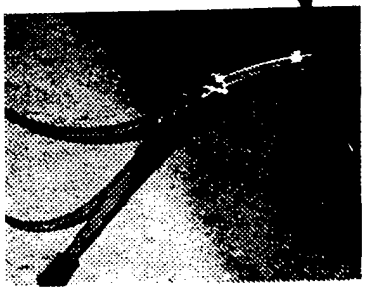


Aircraft in 78x60x30 ft. Paint Hanger

Tygon Tubes Transport Sample Gas To Analyzer

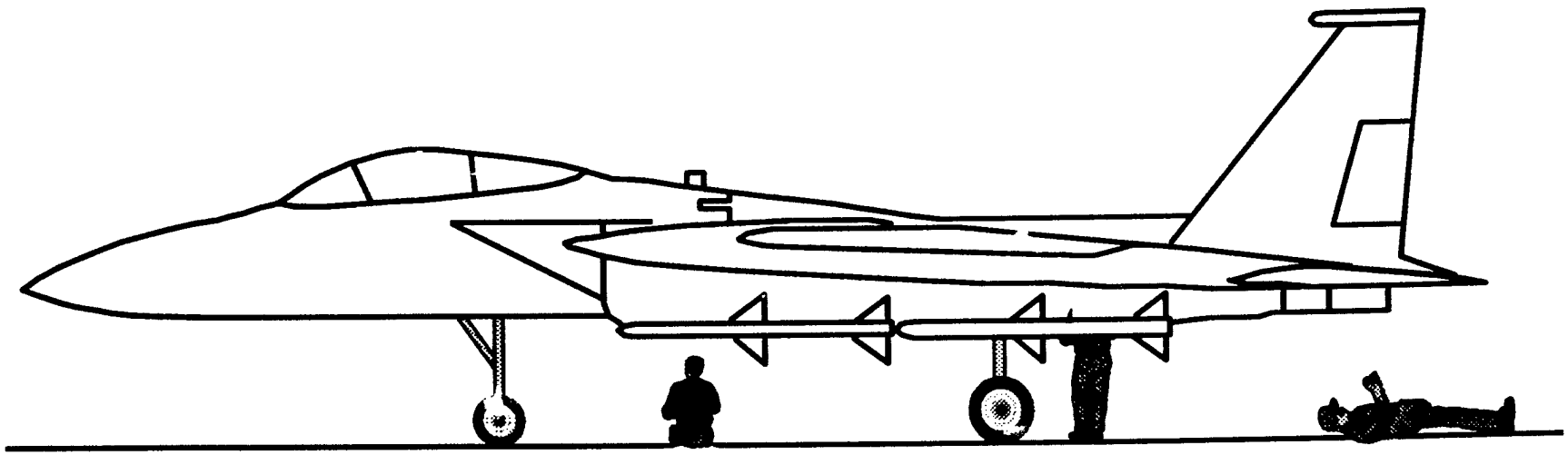


3 ft. & 5 ft. Sensors



1/2 ft. Sensors

Crew Locations Considered

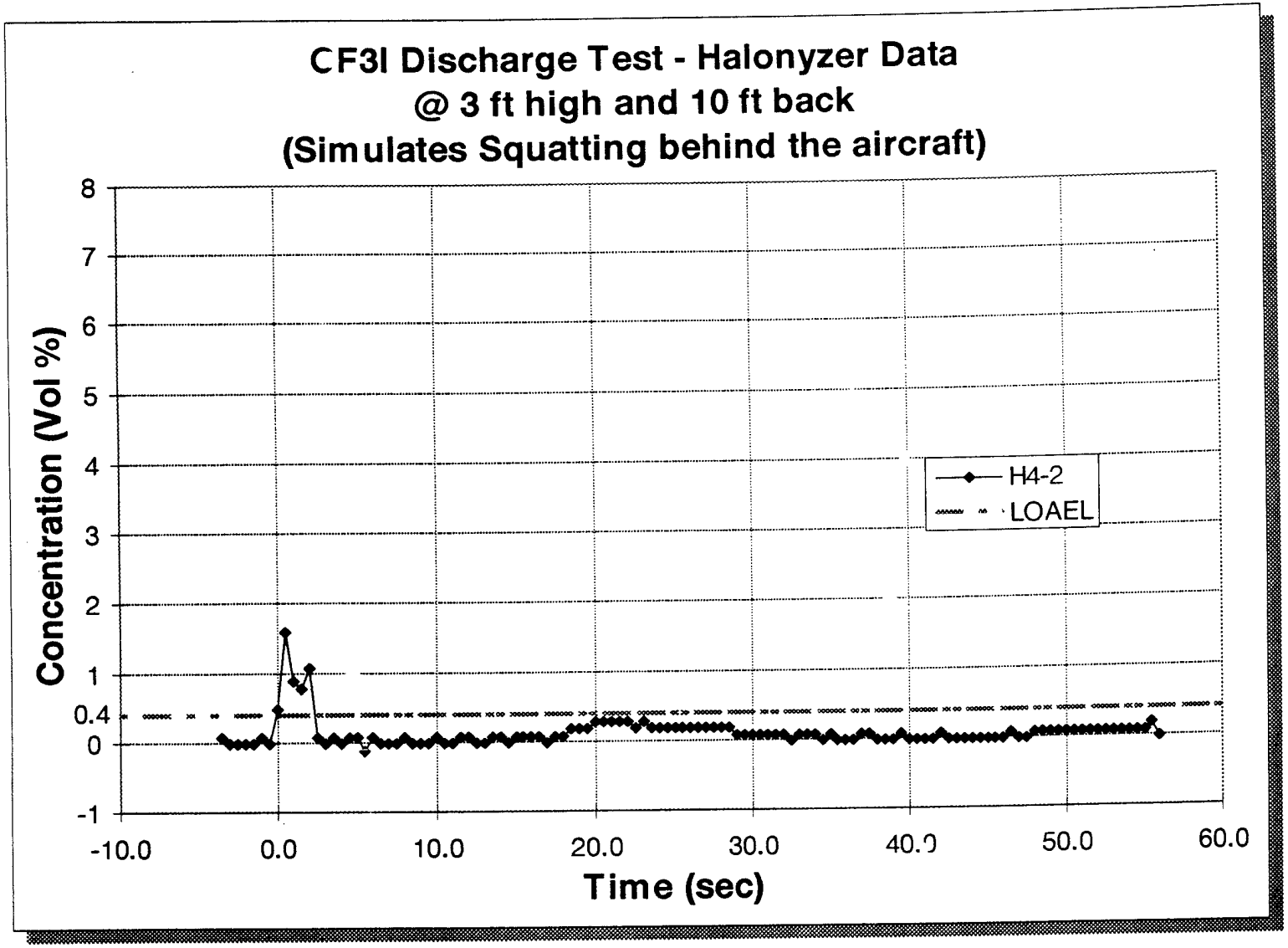


Kneeling or Standing Near Engine Bay

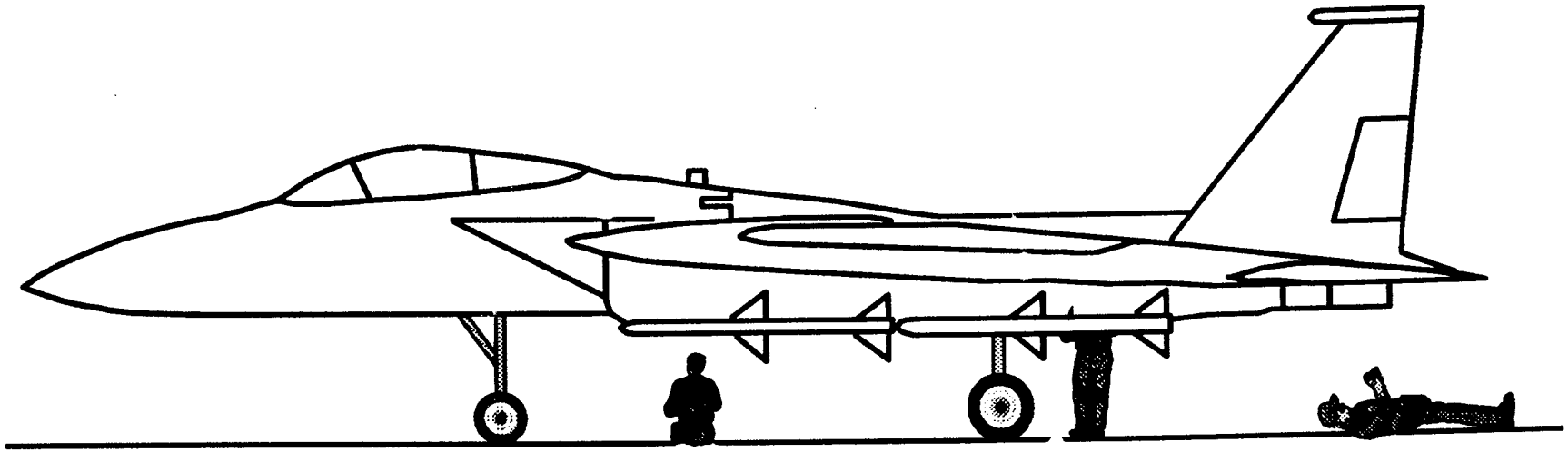
Working in or Under Engine Bay

Laying Near Engine Bay

Highest Concentration Location (Kneeling *Outside* the Nacelle)



Crew Locations Considered

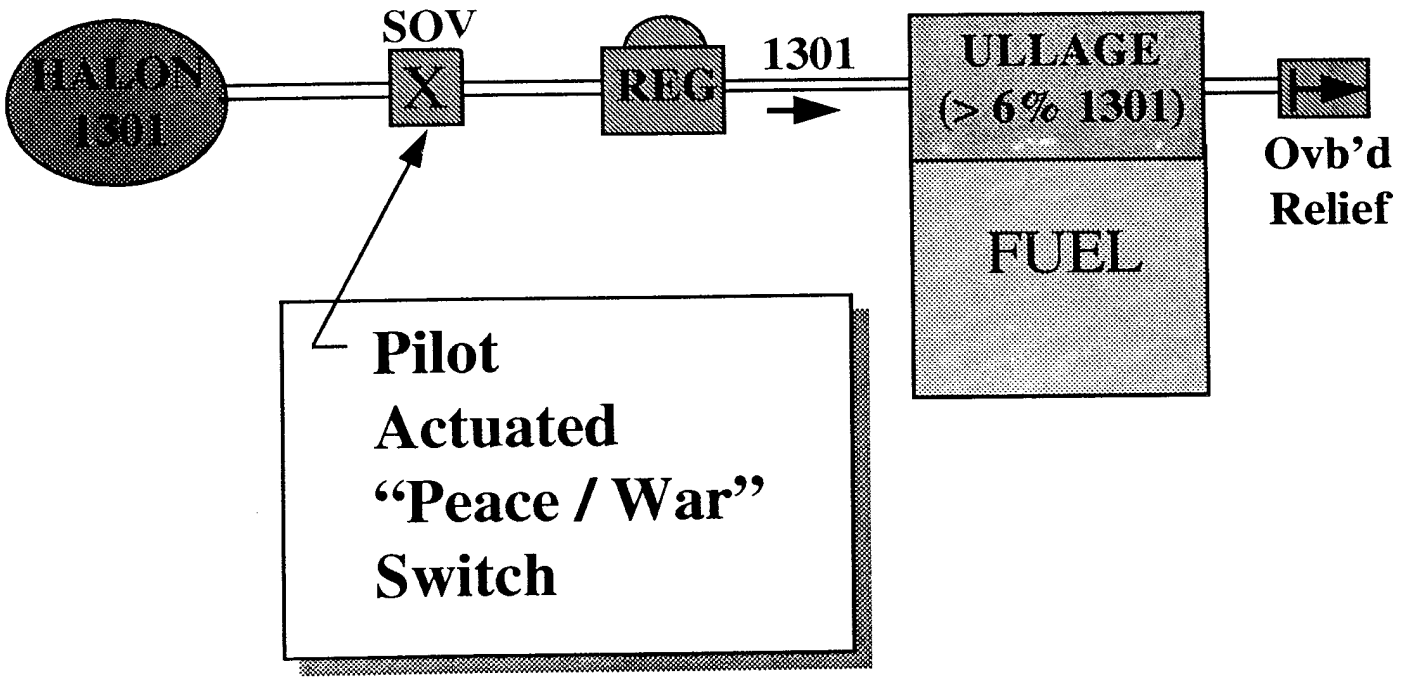


Kneeling or Standing Near Engine Bay

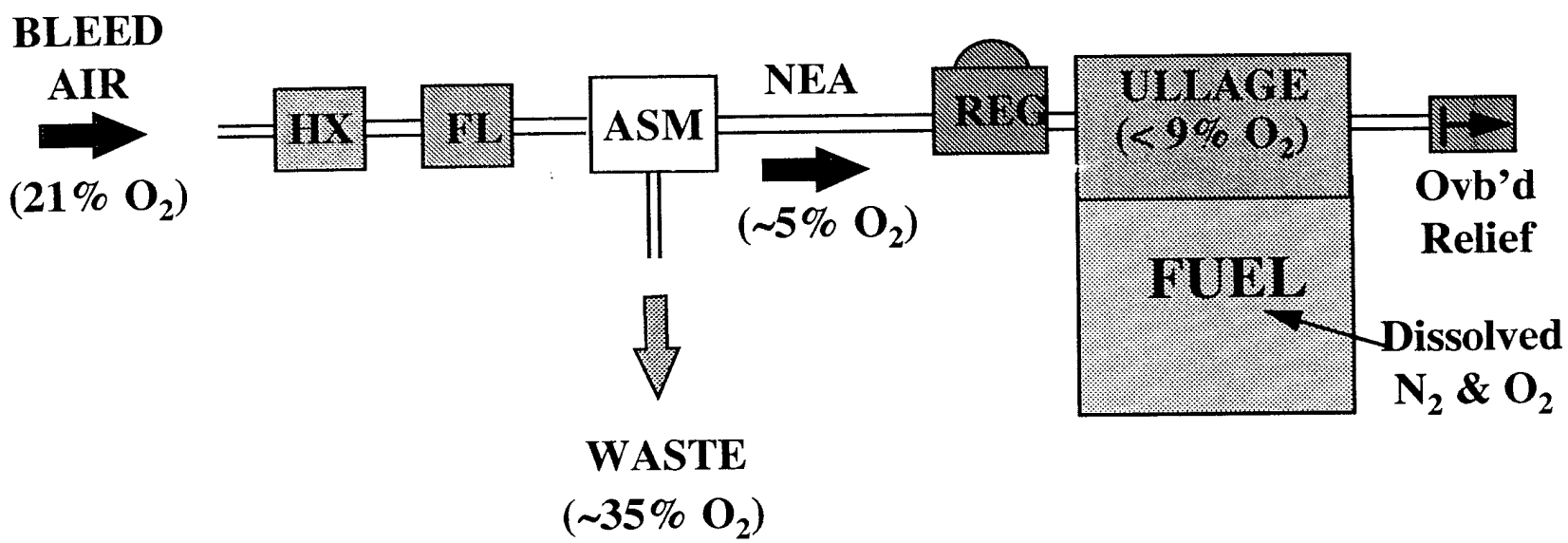
Working in or Under Engine Bay

Laying Near Engine Bay

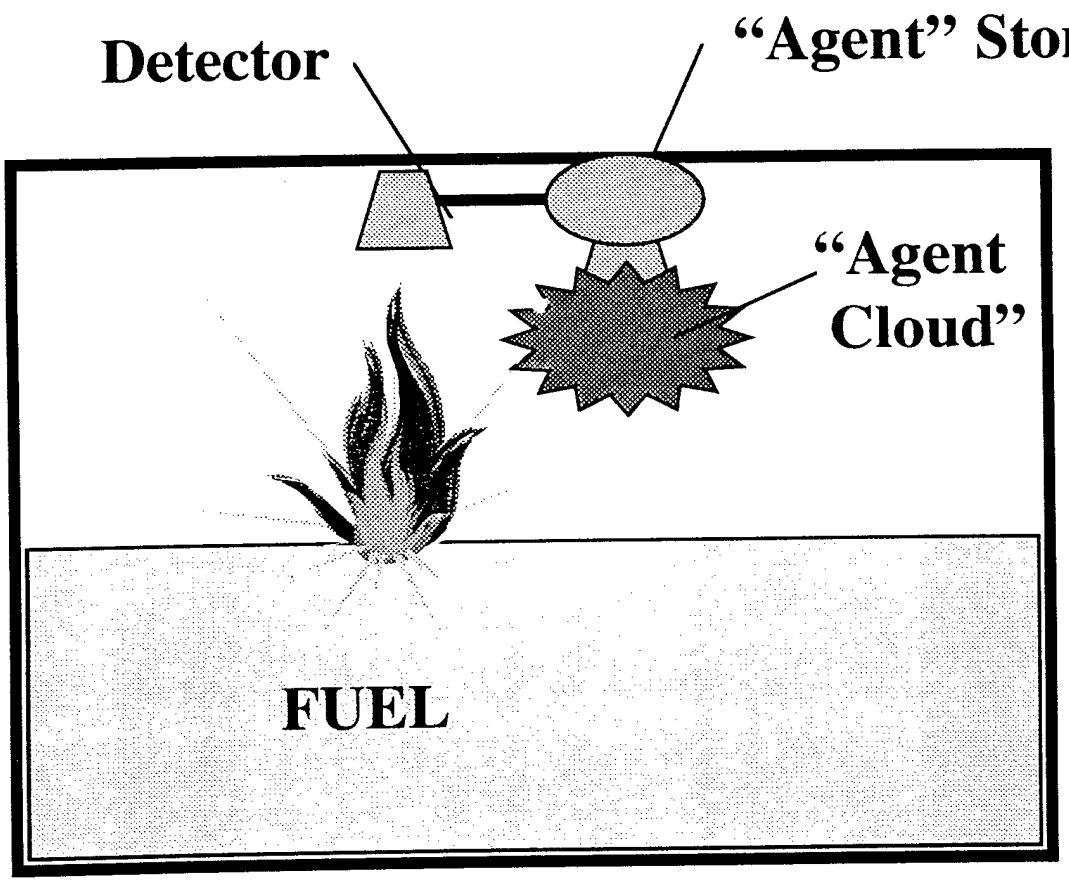
Fuel Tank Protection - HALON (or Similar "Agent")



Fuel Tank Protection - OBIGGS



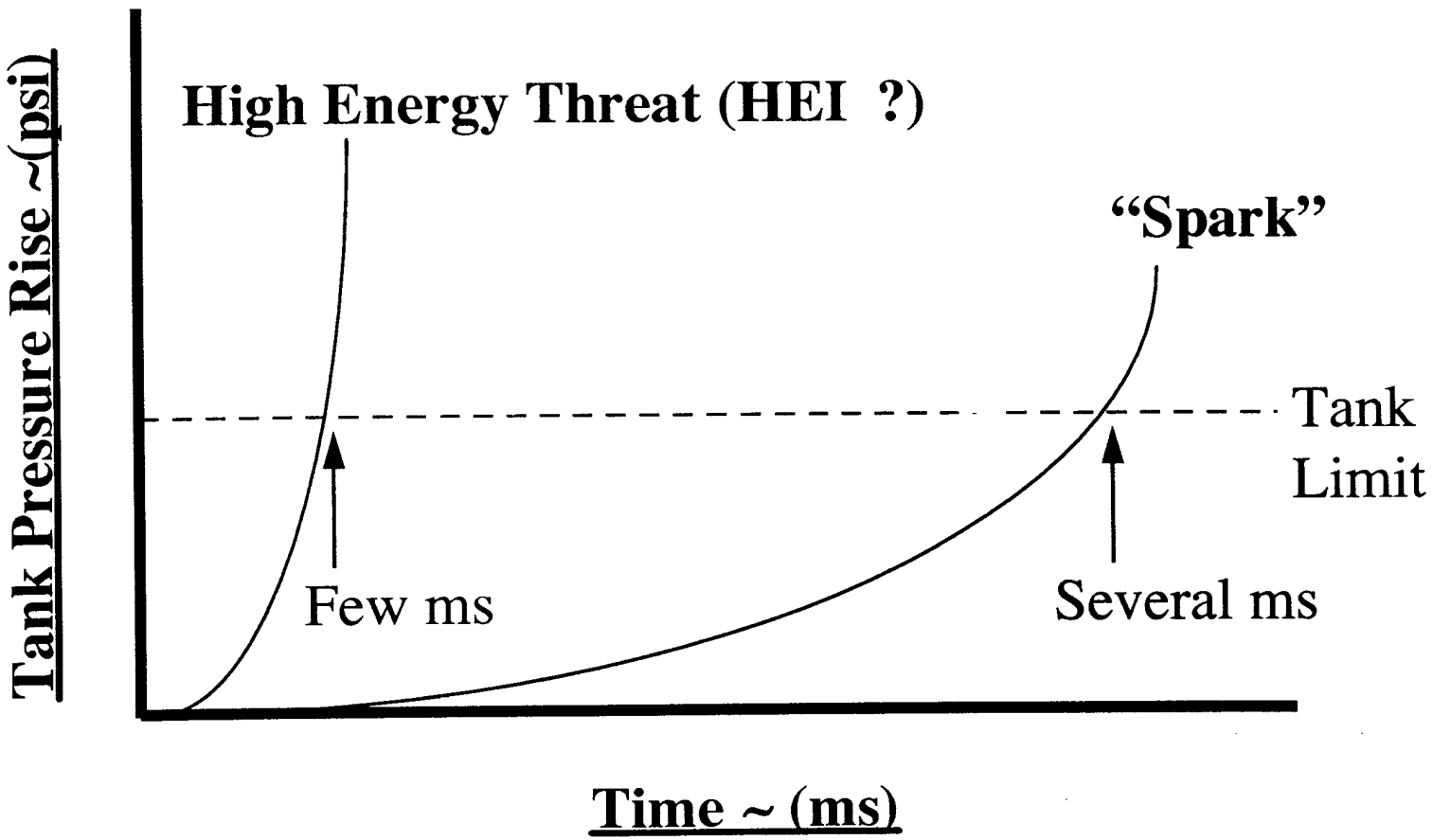
Detect / Suppress Tank Protection



Issues:

- Size of Threat
- Response Time
- Viewing Area
- "Full" Tank
- "Throw" Distance
- Geometry Limits
- "Clutter"

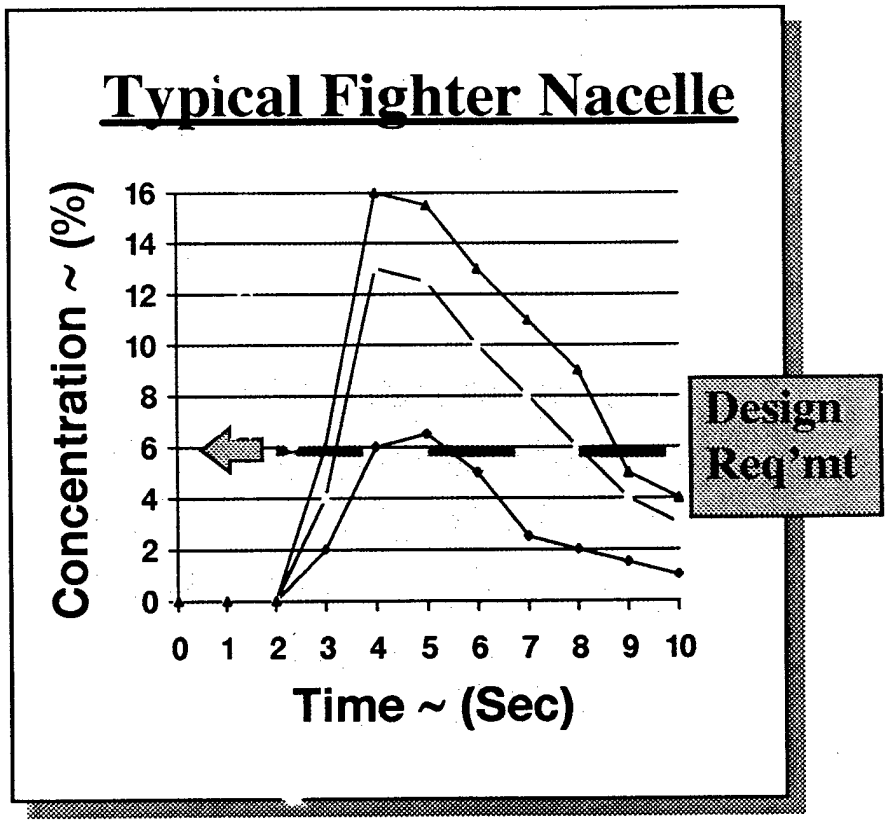
Fuel Tank Threat Effects



What Threat is "Best" Selected for Commercial Transports ??

Improved "Agent" Efficiency

- HALON 1301 Std:
  - Fixed Quantity & Test %
  - Concentration Usually OK
    - Simple Distribution
    - No Optimization Incentive
- Streaming Installations
  - "Old" USA More Complex
  - USSR 2402 More Complex
- USSR Fe-25 Test Data
- Unconventional Approaches



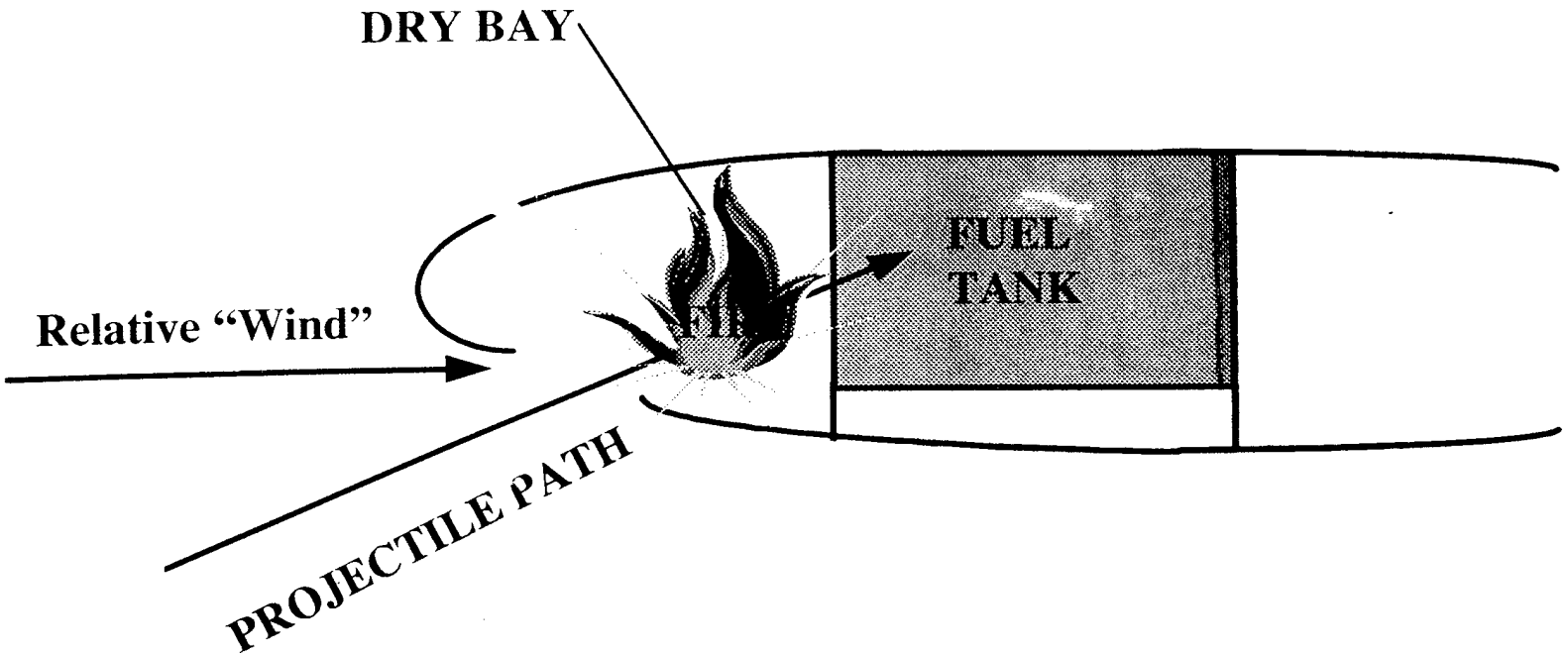
Can We Approach HALON Impacts by Optimizing Fe-25 ??

"Balanced" Hazards Evaluation

All Technologies Impose Some Human Hazard

	HALON 1301	Fe-25	Gas Gen	CF3I
"Surprise" Response	X	X	X	X
"Frostbite"	X	X		X
HF Effects		X		
"Hot" Exhaust			X	
"Dust" Impact			X	
Toxicity				X
Cardiac Sensitization				X
????				

Effect of "Equivalent Angle of Attack"



Should We Test @ Various Wind "Angles of Attack" ??

Material Compatibility

- Data on "Exotic" Eng/Airframe Mat'ls @ High Temperatures
  - Corrosion
  - Stress Corrosion, Hydrogen Embridelment, etc.
  - Salt Atmosphere, Salt Spray, SF, etc
- "Agents"
  - Fe-25, CF3I, 1301, etc.
  - Gas Generators (Std, Active)
  - Powders
- Exhaust Products
  - HF, HBr, etc.

Recommendations

Engine Nacelle

- More Efficient Dispersion of "Agents"
- Material Studies / Testing @ High Temperatures

Fuel Tank

- Commercial Threat Selection

Dry Bay

- Effect of "Angle of Attack"

General

- "Balanced" Evaluation of Alternatives & Associated Hazards
- Predictive Modeling
- Joint Military / Commercial Applications
- Continue "Next-Generation" Program