F/A-18E/F ENGINE BAY FIRE PROTECTION RISK REDUCTION TEST PROGRAM

Marco Tedeschi and William Leach
Naval Air Warfare Center Aircraft Division
Code 43520AB562-3, Highway 547
Lakehurst, NJ 08733-SO49 USA
and
Lawrence Ash
Naval Air Warfare Center Aircraft Division
Code 43520, Building 2187
Patuxent River, MD 20670 USA

As a risk reduction measure, the F/A-18E/F aircraft fire protection program has conducted a series of engine bay fire tests using a high fidelity full-scale F/A-I 8E/F engine nacelle simulator. These tests are intended to verify the performance capabilities of several alternate agents against Halon 1301 as an extinguishing agent. The comparison is conducted against **a** baseline fire using Halon 1301 as the threshold performance indicator. Concentration tests are subsequently conducted for each of the alternate agents and Halon 1301. The results for the tests are reviewed and analyzed for performance comparison.

OBJECTIVE

- DEVELOP AND IMPLEMENT A NOS ODS-BASED ENGINE BAY/AMAD/APU FIRE EXTINGUISHING SYSTEM

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BACKGROUND

- REQUIREMENT CALLS FOR NON-ODS BASED FIRE EXTINGUISHING AGENT
- SEVERAL KLSK REDUCTION EFFORTS CONDUCTED WITH CONTRACTOR SUPPORT
  - BOEING
  - NORTHROP GRUMMAN
- EVALUATION OF ALTEHNATE AGENTS CONDUCTED
- MINIMIZE RISK OF MEETING EXTINGUISHING REQUIREMENTS PRIOR TO FORMAL QUALIFICATION

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REQUIREMENTS

- FIRE EXTINGUISHING SYSTEM PERFORMANCE COMPARABLE TO HALON 1301 IN F/A-18 E/F EMD CONFIGURATION
  - INITIAL EXTINGUISHMENT
  - HOT SURFACE RE-IGNITION
- FUEL SOURCE : 0.15 GPM ATOMIZED JP-8
- AIR SOURCE : AIR INLET - 2.11 LB/SEC

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ENGINE NACELLE SIMULATOR

- HIGH FIDELITY F/A-18 E/F ENGINE NACELLE SIMULATOR INCLUDING:
  - F404 TURBOFAN ENGINE CASE
  - ALL MAJOR ENGINE SUBSYSTEMS
  - AIR INLET GEOMETRY
  - AFT EXHAUST VENTS
  - COMMUNICATION PORTS
    - -BALANCE PISTON VENT
    - •AMAD BAY

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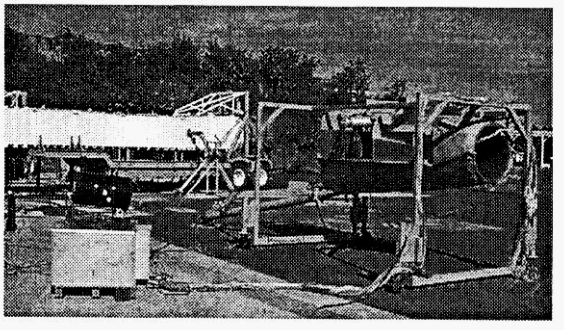

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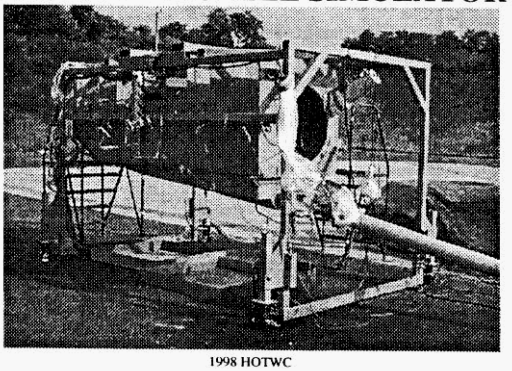

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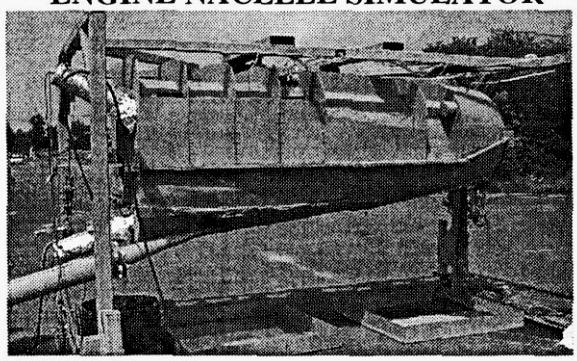

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TEST SUPPORT EQUIPMENT

*AIRFLOW SOURCE
- JT3D TURBOFAN ENGINE PROVIDING 2.11 LBS/SEC AIRFLOW (CONDITIONED)

• FUEL SYSTEM
- 0.15 GPM ATOMIZED JP-8 FUEL IN FUEL CONTROL UNIT AREA

• VARIABLE DISTRIBUTION SYSTEMS
- SOLENIOD VALVES ACT AS SQUIBS

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INSTRUMENTATION

• LABVIEW-BASED DATA ACQUISITION SYSTEM
-VIRTUAL CONTROL PANEL
- 18 PRESSURE TRANSDUCERS
- 155 AIR/SURFACE THERMOCOUPLES
- 2 FLOW METERS (AIRFLOW/FUEL FLOW)
- 18 CO2/02 CONCENTRATION SENSORS
- SAMPLE RATE: in-50 Hz

• REMOTE DATA ACCESS VIA FTP SERVER
• FAA HALONVZER

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DISTRIBUTION

- SEVERAL "BLOWDOWN" DISTRIBUTION LAYOUTS TESTED
  - EMD CONFIGURATION
  - LRIP CONFIGURATION
  - THREE NOZZLE CONFIGURATION
  - FOUR NOZZLE CONFIGURATION

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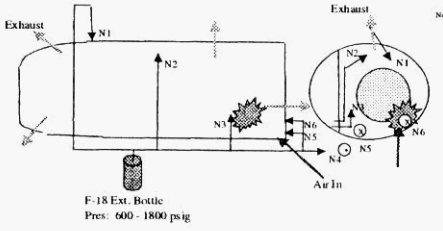
DISTRIBUTION



Nozzle Configuration Definition

Configuration	N1	N2	N3	N4	N5	N6
EMD	Open (0.19")	n/a	n/a	Open (0.25")	Open (3/8")	n/a
LRIP	Open (0.19")	n/a	n/a	Open (0.25")	n/a	Open (3/8")
3 Nozzle	Open (0.19")	Open (1/2")	Open (3/8)	Open (0.25")	n/a	n/a
4 Nozzle	Open (0.19")	Open (1/2")	Open (3/8)	Open (0.25")	n/a	Open (3/8")
LRIP +	Open	n/a	Open (3/8)	Open	n/a	Open (3/8")

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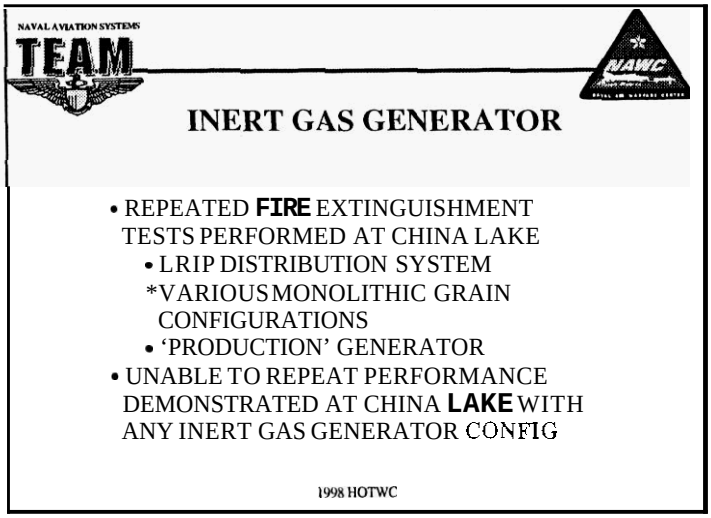
TEST RESULTS

- OVER 500 FIRE TESTS COMPLETED THUS FAR
  - AUGUST 97 - APRIL 1998
- INERT GAS GENERATOR (IGG)
  - MONOLITHIC GRAIN
  - SINGLE 'PRODUCTION-LIKE' GENERATOR
- HALON 1301
- HFC-125
- DRY CHEMICAL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INERT GAS GENERATOR
• REPEATED FIRE EXTINGUISHMENT TESTS PERFORMED AT CHINA LAKE
• LRIP DISTRIBUTION SYSTEM
*VARIOUS MONOLITHIC GRAIN CONFIGURATIONS
• 'PRODUCTION' GENERATOR
• UNABLE TO REPEAT PERFORMANCE DEMONSTRATED AT CHINA LAKE WITH ANY INERT GAS GENERATOR CONFIG
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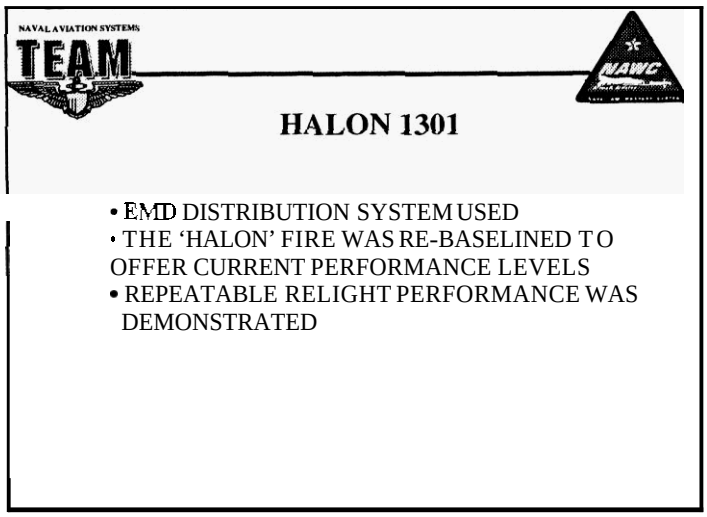
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HALON 1301
• EMD DISTRIBUTION SYSTEM USED
• THE 'HALON' FIRE WAS RE-BASELINED TO OFFER CURRENT PERFORMANCE LEVELS
• REPEATABLE RELIGHT PERFORMANCE WAS DEMONSTRATED


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DRY CHEMICAL
• CONDUCTED AS IRAD TESTS IN COOPERATION WITH WALTER KIDDE AEROSPACE (WKA)
• CONSECTUTIVE EXTINGUISHMENTS DEMONSTRATED
• WKA-DESIGNED DISCHARGE NOZZLES USED
• EXTENSIVE POST TEST CLEAN-UP TIME
• CORROSION REMAINS A MAJOR ISSUE

HFC-125

- PRIOR TO HFC-125 BASED DESIGN EQUATIONS, THREE TIMES THE VOLUME ASSUMED
  - VOLUME RESTRICTIONS IN ENGINE BAY/KEEL PREVENTED HFC-125 FROM INITIAL CONSIDERATION
- ENGINE BAY DESIGN EQUATION PREDICTIONS UNDER EVALUATION

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HFC-125

	Volumetric Concentration	Agent Mass (pounds)
Design Equation Prediction	18.51 %	4.87
Fire Test Data	8 - Y %	5.5

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HFC-125

- MAXIMUM AMOUNT OF HFC-125 IN EXISTING FIRE BOTTLE LOCATION TESTED AT ARL
- HFC-125 DEMONSTRATED EQUIVALENT PERFORMANCE TO HALON 1301
  - CONCENTRATION LEVELS FAR BELOW PREDICTED VALUES
  - HALON 1301 USED *EMD* DISTRIBUTION SYSTEM
  - HFC-125 USED SEVERAL *OPTIMIZED* DISTRIBUTION SYSTEMS

HFC-125

- HFC-125 TESTED AT TEMPERATURE EXTREMES
  - LOW TEMP (-40 F)
  - *AMBIENT TEMP (70 F)
  - HIGH TEMP (220 F) - SIMULATED BY RAISING BOTTLE PRESSURE TO EQUIVALENT TEMPERATURE STATE
- FIRE EXTINGUISHED AT ALL TEMPERATURE EXTREMES - REIGNITION STILL BEING EVALUATED

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HFC-125

- HFC-125 PERFORMANCE EVALUATION AGAINST HOT SURFACE RE-IGNITION CONTINUES
  - REIGNITION SURFACE REPRESENTED BY A SERIES OF TUBES LOCATED IN VICINITY OF THE ENGINE FUEL CONTROL UNIT AND ENGINE BAY AIR INLET

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SUMMARY

-ENTERING LATEST HFC-125 TEST SERIES
- MOST PROMISING DISTRIBUTION SYSTEMS
- BETTER SYSTEMS REQUIREMENTS DEFINITION

- HFC-125 OFFERS "NEW" OPPORTUNITY TO UTILIZE EFFECTIVE, LOW COST SYSTEM

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