HALON 1211/1301 REPLACEMENT PROGRAM
STATUS: U.S. AIR FORCE GROUND BASED
FIRE SUPPRESSION APPLICATIONS

Charles J. Kibert
Wright Laboratories, WL/FIVCF
OBJECTIVE

- Identify or develop replacement agents for Halon 1211 and Halon 1301 that are non-toxic and that have low to zero ozone depletion and global warming potentials

TECHNICAL APPROACH

- Conduct laboratory and small scale tests of available candidate chemicals

  Down select to most promising candidates and conduct medium to large scale tests to validate one or more chemicals

- Down select to most promising candidates to qualify chemical for USAF use

PAYOFF

- Provide USAF firefighter with environmentally safe, non-toxic, clean fire suppression agents

- Meet AFR 19-15 requirement to cease use of halons by 1 Jan 2000
HALON 1211 REPLACEMENT
AGENT RESEARCH &
VALIDATION PROGRAM

AGENT DEVELOPMENT
MATERIAL & CHEMICAL PROPERTIES
TOXICITY SCREENING
FIRE EXTINGUISHMENT PERFORMANCE
LAB SCALE TESTING
PRODUCTION & COST OUTLOOK


ZERO ODP AGENT: PERFLUOROHXANE (C_6 F_{14})

AGENT VALIDATION
COMBUSTION PRODUCTS
OPERATIONAL EXPOSURES
MATERIALS COMPATIBILITY
OPERATIONAL TOXICITY
OPERATIONAL FULL SCALE TESTING
ENVIRONMENTAL IMPACT ASSESSMENT
LOGISTICS/SUPPORTABILITY
PRODUCTION TECHNICAL DATA

FULLY OPERATIONAL
& ENVIRONMENTALLY COMPLIANT

PART
WR-ALG ACQUISITION
PROGRAM MANAGER

CONTRACT
BASE FIRE DEPARTMENT
CHANGEOVER TO
REPLACEMENT AGENT

LEADTIME

TIME NOW

AFR 19-15 TOTAL
USE PHASEOUT DATE:
1 JAN 2000
## 6.2 R&D RESULTS

### LIVE FIRE TESTS
- CUP BURNER APPARATUS
- LAB SMALL PANS
  - 4 SF
  - 32 SF
- 75 & 150 SF POOL FIRES
- 3-D ENGINE NACELLE
  - W/FLOWING FUEL COLUMN
  - INTO 75 SF POOL FIRE

### PERFLUOROHEXANE PROPERTIES
- HEAVY MOLECULE CHEMICAL, HIGH ENERGY ABSORBER
- CHEMICALLY INERT - VERY LOW TOXICITY
- STABLE, NON-REACTIONAL, ELECTRICALLY NON-CONDUCTIVE
- LEAVES NO RESIDUE AFTER FIRE EXTINGUISHMENT
- LIQUID DENSITY = 1.69, LONG STREAM RANGE
- TRANSPORTABLE - NO SPECIAL CONTAINMENT VESSEL REQ'D
- COMPATIBLE WITH ALL CURRENT EXTINGUISHER MATERIALS
- LONG ATMOSPHERIC LIFE

### HALON 1211
- TOXICITY: 12.8%
- EXTINGUISHMENT: 3.2%
- ODP: 3.0
- PRODUCTION: FULLY AVAILABLE
- COST: $10.96/LB

### HCFC-124
- TOXICITY: 21%
- EXTINGUISHMENT: 8.2%
- ODP: 0.02
- PRODUCTION: AVAILABLE 1992-93
- EST: $4.80/LB

### HCFC-123
- TOXICITY: 3%
- EXTINGUISHMENT: 6.3%
- ODP: 0.02
- PRODUCTION: AVAILABLE LATE 1991
- EST: $4.80/LB

### PERFLUOROHEXANE 15-50%
- TOXICITY: > 30%
- EXTINGUISHMENT: 4.4%
- ODP: 0.00
- PRODUCTION: N/A
- COST: N/A

* - $3.00 COST + $7.95 TAX PENALTY STARTING 1994
### HALON 1211 - PFC-614
#### FIRE EXTINGUISHMENT PERFORMANCE COMPARISON

**USN - 800 SF/250-GAL FIRE ON WATER W/150LB AMEREX**

<table>
<thead>
<tr>
<th></th>
<th>HALON 1211</th>
<th>PFC-614</th>
<th>TME/VOLUME EQUIVALENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXTINGUISHMENT TIME (SEC)</td>
<td>13.2</td>
<td>27.7</td>
<td>2.1</td>
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<tr>
<td>AGENT USED (LB)</td>
<td>58.0</td>
<td>124.3</td>
<td>2.1</td>
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<td>FLOW RATE (LB/SEC)</td>
<td>4.47</td>
<td>4.54</td>
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**USAF - 250 SF/6-GALLON FIRE ON CONCRETE W/150 LB AMEREX**

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<thead>
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<th>HALON 1211</th>
<th>PFC-614</th>
<th>TME/VOLUME EQUIVALENCY</th>
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</thead>
<tbody>
<tr>
<td>EXTINGUISHMENT TIME (SEC)</td>
<td>6.0</td>
<td>6.0</td>
<td>1.0</td>
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<tr>
<td>AGENT USED (LB)</td>
<td>30.5</td>
<td>38.5</td>
<td>1.3</td>
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<tr>
<td>FLOW RATE (LB/SEC)</td>
<td>5.1</td>
<td>6.4</td>
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**USAF - 3-D NACELLE FLOWING FUEL W/150LB AMEREX**

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<tr>
<td>EXTINGUISHMENT TIME (SEC)</td>
<td>2.4</td>
<td>2.8</td>
<td>1.2</td>
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<tr>
<td>AGENT USED (LB)</td>
<td>20.3</td>
<td>28.0</td>
<td>1.4</td>
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<td>FLOW RATE (LB/SEC)</td>
<td>8.4</td>
<td>9.7</td>
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**USN - 72SF PAN FIRE ON WATER W/20 LB AMEREX**

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<th>TME/VOLUME EQUIVALENCY</th>
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<tbody>
<tr>
<td>EXTINGUISHMENT TIME (SEC)</td>
<td>5.0</td>
<td>12.2</td>
<td>2.4</td>
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<tr>
<td>AGENT USED (LB)</td>
<td>6.3</td>
<td>13.8</td>
<td>2.2</td>
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<tr>
<td>FLOW RATE (LB/SEC)</td>
<td>1.3</td>
<td>1.2</td>
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**USN - DUAL NACELLE 3D FIRE W/20LB AMEREX**

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<th>TME/VOLUME EQUIVALENCY</th>
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<tr>
<td>EXTINGUISHMENT TIME (SEC)</td>
<td>1.8</td>
<td>2.8</td>
<td>1.6</td>
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<td>AGENT USED (LB)</td>
<td>2.2</td>
<td>4.4</td>
<td>2.0</td>
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<tr>
<td>FLOW RATE (LB/SEC)</td>
<td>1.3</td>
<td>1.6</td>
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- NEAR TERM PROGRAM (<3 YRS)

- 2ND GENERATION AGENT DEVELOPMENT (10+ YRS)

- AEROSOL FIRE SUPPRESSION (ALTERNATE)
<table>
<thead>
<tr>
<th>AREA OF CONCERN</th>
<th>TOTAL-FLOOD</th>
<th>AIRCRAFT</th>
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<tbody>
<tr>
<td>TOXICITY</td>
<td>CRITICAL</td>
<td>NOT CRITICAL</td>
</tr>
<tr>
<td>SPACE/WEIGHT</td>
<td>NOT CRITICAL</td>
<td>CRITICAL</td>
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<tr>
<td>GASEOUS</td>
<td>CRITICAL</td>
<td>CRITICAL</td>
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<tr>
<td>CLEAN/NON-CONDUCTIVE</td>
<td>CRITICAL</td>
<td>NOT CRITICAL</td>
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<tr>
<td>EXPLOSION SUPPRESSION</td>
<td>NOT CRITICAL</td>
<td>CRITICAL</td>
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<tr>
<td>COST</td>
<td>CRITICAL</td>
<td>NOT CRITICAL</td>
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# HALON 1301 REPLACEMENT AGENT PROGRAM

## FACILITY TOTAL FLOOD

<table>
<thead>
<tr>
<th>FY 92</th>
<th>FY 93</th>
<th>FY 94</th>
<th>FY 95</th>
<th>FY 96 - 99</th>
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<tbody>
<tr>
<td>6.2</td>
<td>110</td>
<td>600</td>
<td>800</td>
<td>400</td>
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<tr>
<td>6.3A</td>
<td></td>
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### AGENT DEVELOPMENT
- Material & Chemical Properties
- Toxicity Screening
- Fire Extinguishment Performance
- Lab Scale Testing
- Production & Cost Outlook

(Candidate Halon 1301 Replacement Agents)

### AGENT VALIDATION
- Combustion Products
- Operational Exposures
- Materials Compatibility
- Operational Toxicity
- Full Scale Extinguishment Testing
- Facility System Flow Compatibility
- Environmental Impact Assessment
- Logistics/Supportability
- Purchase Description
- Facility System Specifications

### MCP/O&M
- Facility System
- Modifications & Changeover to Replacement Agent

- Program Management: CEF Fire Research, Tyndall AFB
- Program Risk:
  - Technical: Moderate
  - Schedule: Moderate
  - SAT Cost: Low
- Tech Transfer: Agent Purchase Spec & Facility Mod Criteria to AFCE
# CANDIDATE TOTAL-FLOOD AGENTS

Based on Halon 1211 Replacement Database Screens

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Formula</th>
<th>Ext Conc</th>
<th>LC50</th>
<th>ODP</th>
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<tbody>
<tr>
<td>Halon 1301</td>
<td>CF₃ Br</td>
<td>3-4 %</td>
<td>&gt; 40 %</td>
<td>10</td>
</tr>
<tr>
<td>FC-218</td>
<td>CF₃ CF₂ CF₃</td>
<td>6 %</td>
<td>Very low toxicity</td>
<td>0</td>
</tr>
<tr>
<td>FC-116</td>
<td>CF₃ CF₃</td>
<td>7.8 %</td>
<td>Very low toxicity</td>
<td>0</td>
</tr>
<tr>
<td>C-318</td>
<td>(CF₂)₄</td>
<td>7 %</td>
<td>Very low toxicity</td>
<td>0</td>
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<tr>
<td>HFC-23</td>
<td>CHF₃</td>
<td>13 %</td>
<td>&gt; 65 %</td>
<td>0</td>
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<tr>
<td>HFC-125</td>
<td>CF₃ CHF₂</td>
<td>9 %</td>
<td>&gt; 70 %</td>
<td>0</td>
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<tr>
<td>FC-3-1-10</td>
<td>C₄ F₁₀</td>
<td>5-6 %</td>
<td>&gt; 80 %</td>
<td>0</td>
</tr>
<tr>
<td>HFC-227ea</td>
<td>CF₃ CHFCF₃</td>
<td>6 %</td>
<td>&gt; 80 %</td>
<td>0</td>
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<tr>
<td>HCFC-123</td>
<td>Blend</td>
<td>8 %</td>
<td>29 %</td>
<td>0.02</td>
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</tbody>
</table>

**No Industry PropONENTS Yet**

**Industry Candidates**