November 3, 1993

Dear Group Participant:

Enclosed please find the minutes of the recent International Halon Replacement Working Group meeting held at the Federal Aviation Administration Technical Center on October 13-14, 1993. I believe the meeting was a success and look forward to the continued success of the Working Group.

As a result of the meeting several task groups were formed to research and present their findings in a number of areas. These task areas are outlined in the minutes. If you volunteered to participate in one of these task groups, please hold up your obligations. I would like the task group leaders to contact the Working Group Coordinator sometime before February 15, 1994, to let us know how much time each task group will need to present its findings at the meeting so that we can plan the agenda accordingly. The preliminary agenda will be mailed out in December.

The next meeting will be hosted by British Airways on Monday and Tuesday, March 14-15, 1994. The meeting will be held at:

The Fire Service College  
Moreton-in-Marsh  
Gloucestershire GL56 ORH  
England  
Telephone: 44-608-650831  
Fax: 44-608-651788

Rates:  
Double: 71 Pounds  
Single: 60 Pounds  
Includes: Full English Breakfast, Lunch, and Dinner

You are required to make your own accommodation reservations. British Airways has arranged significantly discounted airline rates for group members attending the meeting. You must make your airline reservations directly through British Airways at 800-635-6516. Give the representative the following code exactly as it reads: CIC star 115 stroke 34. A March Meeting Return Form is included in this package. Please complete and return this form to the Working Group Coordinator so that we may have an accurate count of those attending.

The Summer 1994 meeting will be hosted by Boeing Commercial Airplane Group in Seattle, Washington, U.S.A. The tentative meeting dates are sometime during the last week of July. As soon as the exact dates have been determined we will notify everyone.

If your organization would like to host a future meeting, please complete and return the enclosed Request to Host Meeting Form. This form also includes a space for your suggestions for future meeting discussions/topics.

If you need any additional information or have questions, please contact April Horner, Working Group Coordinator, at 609-485-4471 or by fax at 609-485-5796.

Thank you for your participation in the Working Group. I hope to see you at the March meeting.

Sincerely yours,

Richard G. Hill  
Program Manager
INTERNATIONAL HALON REPLACEMENT WORKING GROUP MEETING MINUTES

Held at

FEDERAL AVIATION ADMINISTRATION (FAA) TECHNICAL CENTER
ATLANTIC CITY INTERNATIONAL AIRPORT, NEW JERSEY 08405

OCTOBER 13-14, 1993

FAA Halon Replacement Program Overview

D. Hill: We are not looking specifically for a replacement agent or system. We are developing facilities to test and certify an agent/system to replace halon. This Group is designed to be an informal Working Group modeled after the International Aircraft Materials Fire Test Working Group. Main purpose of the group is to get industry input into our Research and Develop Program because our (Technical Center) experience is in research not designing aircraft, flying aircraft, running an airline, etc. This is why we need your input. There will be three subgroups--these subgroups will be set up to provide an exchange of information among all participants. The subgroups will cover the design of test methods in the following areas: Cargo (Subgroup Leader-Dave Blake), Engines (Subgroup Leader-Larry Curran), and Hand Held (Subgroup Leaders-Mike Barrientos, Tim Marker).

Brief Presentations by FAA Technical Center Subgroup Leaders

CARGO - DAVE BLAKE

A copy of Dave’s presentation is included in this package.

D. Blake: Reviewed various types of cargo compartments. Highlighted some of the test work done at the FAA Tech Center facility. Gave brief description of cargo set-up in FAA test article. Reviewed options to replace Halon 1301 in cargo compartments.

Subgroup purpose: Provide input to determine test conditions for cargo compartment test methods.

ENGINES - LARRY CURRAN

L. Curran: At this time we do not have any full-scale test apparatus in the engine nacelle area. We are currently working closely with Wright Patterson Air Force Base, since they have the test facilities. We are planning to build two nacelle test simulators at the FAA Tech Center. We will be looking at work done at Wright Patterson closely to see what parameters we need to model.

Subgroup purpose: Provide input to ensure FAA research efforts remain focused and are comprehensive. Provide design input.

Member Question: When will fire history information in engine nacelles by available.

L. Curran: By the next meeting.
HAND HELD - MIKE BARRIENTOS

**M. Barrientos:** Reviewed reasons for Halon 1211 requirement on aircraft. Described some of the hidden fire work done recently at the FAA Tech Center facility.

**D. Hill:** Hidden fires cause the destruction of aircraft. They are the ones that bring the aircraft down and are the cause of fatalities. Hand held extinguishers should be designed to give protection against hidden fires. Open fires in the cabin are not the cause of fatalities.

**CARGO**

**D. Hill** question to airlines: What would an acceptable replacement system be in a cargo compartment from the standpoint of toxicity? Would a CO\textsubscript{2} system be acceptable if it killed animals in the cargo area? What is the airline philosophy on dry chemicals or suspended aerosols which require massive clean-up after accidental discharge? We need your input on these questions so that time is not spent on a system/agent that will never be used.

**ENGINES**

**D. Hill:** Would you use a suppression system that is toxic in an engine nacelle area?

**D. Hill** question to manufacturers: Is volume a bigger problem than weight?

Other considerations: Recycling! Can we use specifications that are out there for recycled halon? Should we accept any specification?

Also, replacement agents for testing of Halon 1301 systems must be considered. Are there other agents that can be used so that we don’t have to discharge 1301 and not use it for demonstration purposes.

Training of Flight Attendants: Are training films like those used by the CAA to train flight attendants in use of Halon 1211 adequate?

**HALON WORK UPDATES**

The following government/industry/academia representatives gave brief presentations on their work/concerns in the area of halon replacement. Copies of some of these presentations are included in this package.

- John Petrakis, FAA Technical Analysis Branch, AIR-120
- Mike Bennett, Air Force
- Richard Gann, National Institute of Standards and Technology (NIST)
- Alan Gupta, Boeing Commercial Airplane Group
- Maurice Kindel, Air France
- Joseph Scheffey, National Fire Protection Association
- Dave Thurston, Navy
- Bob Tapscott, University of New Mexico
- Robert Glaser, Walter Kidde Aerospace
- Elio Guglielmi, North American Fire Guardian Technologies
- Jerry Brown, Spectrex, Inc.
- John Pignato, 3M
- Daniel Moore, DuPont Fluorochemicals
- Ian Harris, United Kingdom Ministry of Defense
- Bill Meserve, Pacific Scientific
- Kamran Ghaemmaghani, Federal Express
D. Hill: Present regulations for cargo and engine specify that you will supply a suppression system that will provide an adequate level of protection. Clarified regulations concerning Halon 1211 extinguishers.

Member Question: Has it ever been defined what adequate is?

D. Hill: No, Halon 1301 has been acceptable. We must define what we need protection against.

A. Gupta (Boeing): Boeing’s concerns regarding Halon Replacement: CARGO AREA: Passenger safety covers safety of people and animals. Animals make up a good portion of passengers on aircraft. We recommend Advisory Circular should be revised by committee made up of users and then submitted to public for public comment. Should we design for an empty cargo compartment or a half-full cargo compartment? HAND HELD: This group should look into test requirements, and are they really necessary? This Working Group should address the question: Do we really need potty bottles? He emphasized that Boeing is extremely concerned with animal cargo safety.

SUMMARY OF MEMBER PRESENTATIONS

D. Hill: Emphasized that program is in the development of test criteria that will be used in testing agents/systems not in developing of agents/systems. You must be able to combat fires in open areas and hidden areas with hand held extinguishers. That is where we need to design tests to prove alternative agents/systems are equivalent to Halon 1211. Are we willing to sacrifice animal life in cargo compartments? How important is clean-up to airlines? What are the parameters the end user can live within the design of alternative agents/systems? Maybe airlines could give us suggestions for crew training in use of alternative agents/systems. There is a lot of work going on in industry in developing new agents/systems, etc. There needs to be a better communication between the various organizations/corporations. There is some contact with Russian technologies and hopefully this will continue.

GROUP ORGANIZATION/STRUCTURE - D. HILL

Three Subgroups:

These subgroups will meet sequentially. One after the other so that group members may participate in more than one subgroup. If there are smaller task groups within a subgroup, they may want to work via fax, telephone, mail outs, etc.

D. Hill: Are there any questions on what we are trying to do at the Tech Center or on organization of the Working Group?

No questions received.
THURSDAY, OCTOBER 14, 1993

TASK ASSIGNMENTS

Task groups were assigned accordingly:

1. **RECYCLED HALON**: Supply specifications that you know exist and present data on the differences and similarities at the next meeting. Outline the following: specifications - similarities and differences, and the problem areas. **Participants**: George Harrison (Walter Kidde) will head up this group. Maurice Kindel (Air France) will give input on some of the problems such as water vapor, etc. William Testa (Grinnell Fire Protection Systems) will also participate. Claude Lewis (Transport Canada) suggested U.L. standards for U.S. and Canada. George Harrison has some information on this.

2. **CARGO** - What are your thoughts/concerns on clean-up of an agent, toxicity, carrying of animals? Opinion on powders, aerosols, and toxic gas and would airlines use these systems to save weight? **Participants**: Glynn Roundtree (AIA) will contact someone from ATA in an attempt to get participation from U.S. airlines. John O'Sullivan (British Airways) will participate. A representative from 3M will participate.

3. **CARGO** - We would like information on maximum allowable temperatures that the structure and control systems should be capable of withstand. What temperature can we allow? How much does it vary from one type design aircraft to another? **Participants**: Ron Blumke (Douglas Aircraft) will participate. Alan Gupta (Boeing) might participate. Emil Cara (Bell Helicopter) will try to put together some data.

4. **FIRE LOAD** - Survey what is out there and what types of materials are internally carried in cargo compartments (i.e.: aerosol cans, etc.). What else is carried on passenger aircraft other than passenger baggage? What types of containers are used? What percentage of cargo is mail and what percentage is baggage? Is cargo hazardous? **Participants**: Alan Gupta (Boeing) will participate. D. Hill: We will contact ATA to try to get U.S. airlines' participation.

4. **ENGINES** - We are going to redistribute survey Mike Bennett sent out on what types of engine nacelles are out there so that they know their testing represents what is out there? D. Hill: We should task a group such as AIA or air frame manufacturers and have them send it out. **Participants**: Claude Lewis (Transport Canada) and Nick Povey (CAA) will distribute a copy of the survey to the appropriate organizations in their countries. Glynn Roundtree (AIA) will distribute survey to airframe manufacturers.

5. **CURRENT ALTERNATIVE AGENTS** - Put together an updated list of what alternative agents are out there. Look at various agents and data that is available and determine what agents look the most promising based on what they already know on cargo fires, engine fires, and hand held (based on what problems they know exist in aircraft). What agent is best for each application (cargo, engine, hand held)? **Participants**: Bob Tapscott (NMERI) will chair the group. John Mossel, Larry Dvorak (Beech Aircraft), George Harrison (Walter Kidde), and Jerry Brown (Spectrex, Inc.) will participate. Alan Gupta (Boeing) will assist in providing information on cargo compartments. B. Tapscott: Will water misting systems be included? D. Hill: Yes. As chairman of this group you can include whatever you want to include. Please provide as much information as you possible on every agent/system looked at.
**Member Question:** What kind of research has been done on water spray in cargo compartments and aircraft in general?

**D. Hill:** Kidde-Gravner has done some work and produced a report. Talk to David Ball. Water spray in cabins: There has been some extensive work done on this. Is there anything anyone wants to bring up concerning cargo area fire protection?

**Member Question:** Has anyone looked at the use of systems such as machine vision in the detection of cargo fires?

**D. Hill:** Pacific Scientific has designed a system which we tested here at the Tech Center.

**D. Hill:** Is there anyone who is not comfortable with exactly how cargo compartments are set-up. Does everyone understand what the different classes mean? We are mainly concerned with Class B and C. Class B is a combi. Cargo compartments are limited in their leakage, but there is some. You generally have airflow around the compartment, usually coming from up top. The cargo compartment is pressurized. You can’t use a highly pressurized agent or you will blow the liners out. In cargo compartments we are talking about Class A fires and are dealing with fire suppression.

**Member Question:** How effective is depressurization in fighting cargo fires.

**D. Blake:** It depends on how quickly you can get down from a high altitude.

**D. Hill:** Class A flaming combustion will be suppressed at 25,000 feet, but when you start to come back down, it will burn more rapidly.

**Member Question:** Is there an organized database of successful and unsuccessful events?

**Member Question:** Please give clarification on what Class A and Class B systems are.

**D. Hill:** *Class A compartment:* Easily accessible, usually in cockpit, such as a closet.

*Class B compartment:* Has to have a detection system and must be accessible in-flight. Can be any size. Class B compartments carry other items besides passenger baggage--things such as mail, overnight packages. Some are on pallets with nets over them. Some cargo containers are fiberglass, some are made of Plexiglas. They are made of different materials.

**Member Question:** What about Class E? Is the Class E compartment excluded from work done by this group?

**D. Hill:** The FAA has no requirement for halon in Class E compartments. The replacement agents that work for Class B compartments will probably also be good for Class E compartments. There is a different level of safety for freighters than there is for passenger aircraft.

**R. Gann (NIST):** We can put together some information on computer modeling.

**D. Hill:** Does anyone want to participate in looking into mathematical models for cargo compartments' fire protection agents/systems?

**Boeing and McDonnell Douglas representatives** will look into getting someone to contact Dick Gann on this.
**Member Question:** What is purpose of modeling?

**Member Question:** What is the time frame?

**D. Hill:** We would like to get this information back by next meeting. Some time around the beginning of March.

**ENGINES**

**D. Hill:** Are there any questions on what you have heard or seen on engine fire protection? The main difference between what we are doing and what the Air Force is doing: Our program includes work that other people are doing. The Air Force program: We are giving them some money so that they will keep in mind civil aviation. They are going to give us some data to develop simulators here based on some of their information. Air Force is looking for an agent, and it is not known what they plan to do with their facilities and program after that agent is found. This is why we want our own facilities, so we can have control of those facilities to be able to test new agents when industry comes up with them. It is not two competing programs, we are working together.

**Member Question:** Is there a common procedure for use of an extinguisher in the engine bay?

**D. Hill:** When the detection light goes on, you pull the fire handle to shut down the engine and shut off the fuel.

**D. Hill:** The FAA Tech Center engine test plan will be sent to those interested as soon as it is available.

**M. Bennett:** Suggested setting up a small group to discuss some military applications.

**D. Hill:** We can have a group that is primarily concerned with military to meet at some point at each meeting as a separate group.

**HAND HELD**

**D. Hill:** Does everyone realize that we have no doubt that an approved extinguisher will handle fires in the cabin out in the open? We are concerned about hidden fires and terroristic threats. We want to make sure that the toxic level in the cabin is acceptable and that it can handle a hidden fire as well as a Halon 1211 extinguisher.

**Alan Gupta (Boeing)** provided notes from subgroups formed at the First International Symposium on Halon Replacement in Aviation held February 9-10, 1993. A copy is included in this package.

**NEXT MEETING**

British Airways will host the next meeting which will be held on Monday and Tuesday, March 14-15, 1994, at the Fire Service College in Gloucestershire, England. Additional information is included in this package.
MARCH 14-15, 1994
MEETING RETURN FORM

INTERNATIONAL HALON REPLACEMENT
WORKING GROUP

The next meeting will be hosted by British Airways at the Fire Service College in Gloucestershire, England, on Monday and Tuesday, March 14-15, 1994. You must make your own room reservations with the college at telephone 44-608-650831 or fax 44-608-651788. The room rates are Double: 71 Pounds and Single: 60 Pounds. The room rates include a full English Breakfast, Lunch, and Dinner. British Airways is offering significantly discounted airfares for those attending the meeting. You must make your reservations directly with British Airways at 800-635-6516. Give the representative the following code exactly as it reads: CIC star 115 stroke 34.

PLEASE COMPLETE THE FOLLOWING INFORMATION IF YOU PLAN TO ATTEND:

NAME: __________________________________________
COMPANY: _______________________________________
PHONE: ______________________ FAX: ____________________
ADDRESS: _________________________________________
CITY, STATE, ZIP: ________________________________
COUNTRY: _______________________________________

RETURN THIS FORM BY FAX BY MONDAY, JANUARY 10, 1994, TO:

APRIL HORNER
FAX: 609-485-5796

OR CALL:

PHONE: 609-485-4471

U.S. Department of Transportation
Federal Aviation Administration
FAA TECHNICAL CENTER

INTERNATIONAL HALON REPLACEMENT WORKING GROUP

SUBGROUP LEADER PRESENTATIONS

1. Dave Blake - CARGO AREA
2. Larry Curran - ENGINE NACELLES
3. Mike Barrientos - HAND HELD EXTINGUISHERS

Copies of Presentations given by the FAA Subgroup Leaders and additional information provided by the Subgroup leaders is attached. This information is followed by copies of the Presentations given by other Group members.
Options:
Replacement Agent (drop in)  
Water Spray System  
Nitrogen (OBIGGS)  
CO2  
Suspended Aerosols

FAA Task: Develop certification criteria that is applicable to the suppression system that is selected.

Working Group Task: Provide input to determine a viable system.

Present Level of Safety Provided by Halon 1301:

Extinguishes Flaming Combustion and Prevents Re ignition of Smoldering Fires for as Long as Concentration Remains Above Three Percent.

Working Group Task: Provide input to determine the maximum conditions that the cargo compartment and surrounding structure can withstand.

Class C  
735 cubic feet

Class B  
17,000 cubic feet
On June 17, 1993 the FAA embarked on a research plan to develop performance test methodologies which would lead to recommended fireworthiness criteria for the evaluation of non Halon fire suppression agents/systems to be used aboard commercial transport airplanes and rotor craft. This plan was outlined in Public notice number 93-2. As detailed, the plan would concentrate in four main areas where halons are currently used in aircraft, namely, cargo, engine nacelles, handholds and lavatory trash receptacles. The major tasks of the program are as follows:

- Develop Test Articles
- Develop Test Scenarios and Minimum Levels of Protection
- Determine Acceptable Agents or Systems
- Develop Certification Requirements

The Engine Nacelle Program is in the process of developing full scale test articles which are described below.

Full Scale Test Article Design Considerations

The goal of our test article development phase is to develop an engine nacelle simulator that is simple in concept and design but will still realistically simulate the environment found in engine nacelles aboard operating aircraft. To simplify the design and to provide more flexibility and availability of test articles, two nacelle simulators are envisioned at this time. One will model the smaller power plant installations found on narrow body aircraft and the other will model the larger nacelle volumes found on current wide body aircraft. The nacelle parameters that will be simulated will be limited to those that have a significant impact on an engine's ability to extinguish the fire. A study currently being conducted at Wright

The engine core will be constructed of a piece of 3/16th inch thick carbon steel pipe and will act as the main structural support for the fixture. The outer nacelle skin will also be 3/16th carbon steel. It will be constructed in two foot sections that will be bolted together and hinged at the top. This construction technique will allow for the replacement of skin sections should they become significantly damaged due to repeated fire tests. Provision will also be made to allow for the nacelle to be easily cleaned to ensure test results are not being changed due to residue from previous tests. The fixture will be provided with two pressure relief devices (rupture disks) to prevent damage in the event of explosive reignitions.

The outlet of the fixture will be provided with a simple scrubbing tower and dump tank to minimize effluent releases to the atmosphere.

Working Group Input

The above describes in very general terms the current status of the design of the first engine nacelle test fixture to be constructed here at the FAA Technical Center. I would request that you all take a few minutes to review this with your people and comment as to the design philosophy and actual design. Comments may be addressed to me as follows:

Larry Curran
ACD-240 BLDG 287
FAA Technical Center
Atlantic City International Airport, NJ 08405

I look forward to your thoughts and working with you on this program.

Patterson Air Force Base is looking at identifying which parameters base are.At this time it appears that the following nacelle parameters will be modeled:

- Air Flow
- Air Pressure (small range \pm ambient)
- Fire Location
- Clutter
- Hot Surfaces
- Fuel Type and Flow Rate

Unless testing at Wright Patterson shows otherwise it is not expected that inlet air temperature is a significant variable. To better provide for test repeatability, however, we plan to heat the inlet air to approximately 100 Deg F for each test to negate the effect of external environmental conditions.

Nacelle Simulator Design (Proposed)

Attachment 1 is a simplified schematic of the test fixture for small power plant installations. The simulated engine core is 12 feet in length and has a diameter of 2 feet. The active length of the nacelle is 10 feet in length and has a diameter of 4 feet. This provides a nacelle volume of approximately 100 cubic feet.

The air flow will be provided with the device depicted on attachment 2. This device provides several advantages over conventional blowers in that it has no moving parts, provides uniform airflow within a very short distance and the output can be readily controlled by throttling the inlet compressed air flow (removing the need for mechanical dampers).

The type and size of the heater has not been determined as yet. Should the inlet air temperature be determined to be not a significant variable then an electric duct heater will be employed to raise the temperature to 100 Deg F. Should it be determined that we must simulate higher inlet air temperatures then it is probable that we will have to go to some type of higher capacity heater, possibly a gas fired version.
FAA HALON REPLACEMENT PROGRAM

ENGINE NACELLES AND APU'S

Background

- All FAA required fixed fire suppression systems in commercial airliners employ Halon 1301 (CBrF3) extinguishing agent.


- Uncertainty of future regulations and availability concerning recycled Halons provide great risk for those relying on the bank.

- Most currently identified replacement agents carry a weight and volume penalty of a factor of two to three.
Role of the Working Group in Nacelle Testing

- Provide input to ensure FAA R&D efforts remain focused and are comprehensive.

- Provide input to design philosophies such as: should replacement systems maintain the same safety factors presently afforded by the Halon systems?

- Provide input to test philosophies such as: should certification testing be under a worst case type scenario, or should it reflect a more typical situation which may have a greater probability of occurrence?

- Conduct parallel R&D efforts and input data to the group and test program.

Full Scale Test Articles

- Two nacelle simulators are envisioned at this time. One modeling the smaller power plant installations found on narrow body aircraft and one modeling the larger installations found on typical wide body aircraft.

- Nacelle parameters to be simulated will include those identified by the current parameter study underway at Wright Patterson Air Force Base (WPAFB) as having a significant impact on an agent's ability to extinguish the fire.

- Early validation tests will be conducted and compared to results obtained on simulator at WPAFB.

- Working group input to the design is critical to the success of the program.
3. Trash receptacles

2. Be capable of extinguishing seat fires

I. Must be able to extinguish hidden in-cabin fires

Handheld extinguisher:

minimum of 2 Halon 1211 hand fire extinguisher

transport category aircraft:

Present requirement on board

Halon 1211 better than

What criteria should these agents meet? Equal to or

THROUGH TESTS METHODS

REPLACEMENT AGENTS

SHOULD EVALUATE

MAIN PURPOSE: TO GET INPUT ON HOW WE

Presented by:

HANDHELD EXTINGUISHERS

FOR

FAA HALON REPLACEMENT PROGRAM
Proposal: develop test article such as symmetrical half of a fuselage barrel section

Testing criteria suggestions:

1. Toxicity level monitoring

2. The amount of time the fire can be put out

3. What type of fire the agent can handle (chemical, electrical, lav. receptacles, hidden, etc.)

4. Max. distance the agent can put out fire

5. How often should extinguishers be checked
REQUEST TO HOST MEETING

INTERNATIONAL HALON REPLACEMENT WORKING GROUP

We have been asked to set up a schedule for future meetings so that group members may plan travel/budgeting in advance. Therefore, we are interested in determining which companies/organizations would like to host meetings in North America and outside the United States. The time frame we have established for the next four meetings is listed below. Please select which date would be most convenient for your company/organization. All requests should be returned to April Horner via fax at 609-485-5796, by MONDAY, JANUARY 10, 1994. Thank you for your support. The following meeting times have been established:

- Fall 1994
- Winter/Spring 1995
- Summer 1995
- Winter/Spring 1996

PLEASE COMPLETE THE FOLLOWING INFORMATION FOR THE CONTACT PERSON:

- NAME: ________________________________
- COMPANY: ________________________________
- PHONE: _______________ FAX: _______________
- DATE REQUESTED: ________________________________
- MEETING LOCATION (CITY, COUNTRY, ETC.): ________________________________

SUGGESTIONS FOR DISCUSSION AT FUTURE MEETINGS: ________________________________

RETURN THIS FORM BY FAX BY MONDAY, JANUARY 10, 1994 TO:

APRIL HORNER
FAX: 609-485-5796

OR MAIL:

Federal Aviation Administration (FAA) Technical Center
Fire Safety Branch, ACD-240, Building 287
Atlantic City International Airport, NJ 08405
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*Held at FAA Technical Center, New Jersey, USA*
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<td>Robert T. Trensell</td>
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<td>University of Maine, Orono, ME</td>
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Crew compartment potential
Fuel tank inerting
Dry days
Engine nacelle
tieri of effort
Co-responding in-service and FAA
Halon 1301 alternative R&D

HALON 1301

HALON 1301 SYSTEMS

Requirement
Modifications to hydrostatic testing
Emerging economies
Make provisions for non-ODS in
until drop-in becomes available
Replacement of Halon 1301
Program approach

HALON 1301 (cont)
Second-Generation Agents

- Manufactured Intended
- Synergistic Potentiate from Halon 1301
- Time to Burner Yield
- Minimal Limit Test: No Effect at 12.7% (Four)
- Zero or Near-Zero Limit: OD-P, GWP
- Effectiveness Approximately Same as Halons
- CF2

Second-Generation Agent

- Toluene
- Methanol
- Emissions
- Toxicity
- Manufacturability

Uncertainties

- In Some Cases, Non-Zero OD-Ps
- High GWP
- In Many Cases, Long Atmospheric Lifetimes
- Decreased Efficiency Relative to Halons
- Physical Action Agents (FAA)

First-Generation Replacements

- Law, OD, CFC-11

Second-Generation Replacements

- OD, CFC-12

Desired for Replacements

- Effectiveness
- Cleanliness
- Volatility
- Acceptable Toxicity
- Low OD, GWP, Atmospheric Lifetime

High-Efficiency Halon Replacement Candidates

- Acetonitrile: Non-Fluorohalon Agents (Altining)
- Replacement: Halon-Like Clean, Gaseous or

Second-Generation Agents
FIRST INTERNATIONAL SYMPOSIUM ON HALON REPLACEMENT IN AVIATION

HELD
FEBRUARY 9-10, 1993
IN
RESTON, VIRGINIA

NOTES FROM THE SUBGROUPS FORMED AT THE:


design Requirements & Objectives for engine/APU Nacelle

Fire Extinguishing Systems

General Discussion and Requirement

Federal Aviation Regulations in FAR 25.1281 defines power plant fire zones and specifies that these
zones must meet the requirements of FAR 25.1185 thru 25.1200. In general, the nacelle fire zones are
limited from other airplane structures, contain only the resistant of fireproof components and are
monitored by fire detection systems. The primary means of controlling fires is by shutting the flow of
combustible materials into the affected area, and to rely on the fire system to contain the fire. The fire is
extinguished by the discharge of an extinguishing agent into the zone after the flow of combustible
materials into the fire zone has been shut-off. Listed below are the requirements and objectives for
engine/APU fire extinguishing systems, including brief descriptions of the applicable FAR requirements
exempted to replace the FAR wording.

Design Requirements & Objectives

1) Per FAR 25.1185: a) the system agent quantity, discharge rate and discharge distribution must be adequate to

2) Per FAR 25.1187, agents must:

(c) be able to extinguish fires from any burning combustible in the protected area.

Variable Conditions Range

| Temperature | 400°F to 2500°F |
| Pressure Altitude | 0 to 60,000 ft |
| Humidity | 0 to 100% |

3) Per FAR 25.1199, extinguishing agent containers:

must indicate that the container is charged or that its pressure is below the minimum
necessary for proper system operation.

Discharge Hoses

4) Per FAR 25.1201:

must be maintained within the appropriate design range to provide for adequate discharge rates, prevent premature discharge from high temperature or that a
pyrotechnic cartridge be used for discharge, that there is no hazardous deterioration of the
pyrotechnic. (Note: This is written as an airplane requirement. The equivalent
extinguishing system requirements is that the system operate within the temperature
design criteria 45°F to 250°F.)

5) The agent and its decomposition of combustion products during and after the fire shall be compatible with airplane materials that have the potential for being exposed. (see table below)

6) The fire extinguishing agent shall be FAA approved. Its Ozone Depleting Potential (ODP), Global
Warning Potential (GWP), atmospheric life and other environmental characteristics shall comply with
all US laws and international agreements to which US is a signatory.

7) Inadvertent discharge of the agent shall not require immediate cleaning of the area to which it is
discharged.

8) The agent electrical conductivity should not pose a hazard to the system during normal airplane
operation or use of the system.

9) Bottle discharge cartridges, if used, shall be made of CRES and hermetically sealed.

10) System design shall allow for the quick of electrical continuity without discharging bottle.
AIA HALON REPLACEMENT SYMPOSIUM
ENGINE/APU SUB GROUP

4-28-91 TELECONFERENCE MINUTES

Participants:
- Lt. Greg Caggilani
- Mr. "Dino"
- Mr. Peter
- Mr. Richard
- Ms. holland
- Mr. Schmitt
- Mr. Walter
- Mr. Wyckoff
- Mr. Workley

Discussion Points:
1. Agreement on "Significant Issues" and "Priority" List.
2. Status of Denny Schmitt's effort to obtain copies of preliminary "Technical Development Plan" from DOD.
3. Review of "Comprehensive Test Plan". Specifically, the list of parameters established during the test and data collected and the materials tested for compatibility in Appendix C.
4. General Comments and Discussions.

V. Conclusions, deliverables, next meeting.

I. "Significant Issues":
The comprehensive list (Rev. B) and the short prioritized list were agreed upon and will be sent to the Airframes/Engine Manufacturers Working Group Chairman as is on April 9 testing further member comments.

Glenn Dubrovic questioned whether detection systems on aircraft would have to be changed as a result of new agent injection. The consensus was that better detection would add in prevention of false and false alarm, conserving the halon that is now available, and is desirable in new systems that many have less effective extinguishing agent. Discussion about various fire-susceptibility methods concerned on machine vision detection technology, current electrical and pressure-based detection loops, and a new linear thermo-couple (from HTI) that meets new FAA/HS requirements.

II. DOD Report:
Dennell Schmitt stated that there were some sections of the "Technical Development Plan" that pertained to halons. He has gotten permission to release copies of these to the working group, and should have them in the mail during the week of April 5th.

III. Review of Test Plan

Comments on "Test Parameters":

- Internal Airflow: McDonnell Douglas has some installations that exceed 1000 cfm. The 1000 cfm max. The minimum level did not make sense. Caggilani stated the range had been changed to 1000 cfm min and 2500 cfm max. The test was based on facility constraints, not by choice.
- Agent Dist. Sys.: hydrochloric acid is actually a solvent.
- Vent. Air Temp.: Range changed from 10°F to 100°F to 20°F to 20°F, again because of facility constraints. The minimum is kept to be lowered with chillers to around 0°F, which would be more desirable.
- Bottle Pres.: Same, except it was commented that a system using a pyrotechnic propellant rather than a nitrogen gas precharge was being considered for test later in the program.
- Compartment: Door question whether complete materials would be to be simulated; Lt. Caggilani answered yes.
- Vent. Air Pres.: This normally should be 2.5 psia to 20 psia to cover most flight conditions. Again, facility constraints dictate the range. The maximum of 20 psia has been changed to 17 psia. Glenn Harper noted that any trends in the data showing efficiencies at lower pressures should be measured carefully.
- Compartment Temp.: The max of 100°F locked a little high. Max temp encountered by containment members was around 130°F.
- Fuel Temp.: Still TBD, probably will have max < 250°F
- Storage Bottle Temp.: Still TBD, but probably will be < 20°F.

IV. Comments on "Response Variables":

- Response Variables:
- No specific data was noted for the group to use a more detailed instrumentation plan with ranges, accuracies, locations, etc. to form a more educated opinion.

Comments on Materials Testing in Appendix C:

- Materials Testing:
- Looks too limited. Harper stated that according to Mike Hines, even though steel and stainless corrosion testing was being done, this would not necessarily disqualify an agent.

V. General Comments:

The group still feels that certification (FAA or otherwise) of whatever agent(s) are identified is a very critical issue for airframe/engine/aviation manufacturers. The test plan from Wright Pat does not address this, nor is it designed to. The group notes the testing at Wright Pat is not an agent selection, but this testing does not quantify the concentration needed throughout the protected volume or how the agent disperses. The program intends to deliver design equations, but without knowing concentrations, we feel these equations are not the "final answer" for designs need.

A follow-on program to this initial testing is needed to address the issue.

V. Conclusions, deliverables, next meeting:

1. Conclusions:
   a) The "Significant Issues" and Priority List was agreed upon, will be sent to Bob Glaser.
   b) Changes were suggested to list of parameters in Wright Pat test plan. A more detailed instrumentation list is requested.
   c) Certification/Qualification is a major issue among system manufacturers, and the test organizations and researchers should be involved of this early and often.

2. Deliverables:
   - Minutes of 4/12 teleconference to be sent out by Hennell to working group.
   - "Significant Issues" and "Priority" List will be sent to Bob Glaser, Co-Chair of Airframes/Engine working group by Friday, 4/19/91.
Design requirements and Objectives
Cargo compartment fire extinguishing systems

The following are the recommended requirements and objectives.

1. **Objectives**

1.1 **Fire extinguishing capability**

   - **Fire extinguishing capability** shall provide FAA mandated fire extinguishing capability. 

   - **Fire Extinguishing Capability** shall be performed in accordance with the limits of the applicable volume of the compartment concerned with the system.

1.2 **Design fire extinguishing capability**

   - **Design fire extinguishing capability** shall be provided when the cargo occupies no more than TBD% of the compartment's useful internal volume.

1.3 **Fire extinguishing system**

   - **Fire extinguishing system** quickly reduce heat release from a probable fire so that (a) the structural integrity of the airplane is not degraded (FAR 25.858(b)) and (b) the contained smoke and carbon dioxide of the compartment is not exposed (FAR 125.1309(b)(1)).

1.4 **Ozone Depleting Potential (ODP), Global Warming Potential (GWP)**, and other environmental characteristics of the fire extinguishing agent shall comply with all US laws, and with agreements to which US is a signatory.

   - **Agents that are approved by the US Environmental Protection Agency (US EPA) in Code of Federal Regulations (CFR) 40, Part 82, Stratospheric Ozone Protection: Significant New Alternatives Policy Program (SNAP) comply with the above requirements.**

**2. Objectives**

2.1. The system shall have low life cycle costs.

2.2. **Fire Extinguishing System** shall be such that existing balloon 1301 fire extinguishing system equipment can be used to maximize the extent possible.

2.3. The vapor pressure and the required superpressurization of the agent shall be such that the container pressure does not exceed 1000 psig at sea level in an ambient of 160 °F when the containers are filled with the required fill density.

2.4. **Agent's Fire Extinguishing Effectiveness** shall be such that FAA mandated fire extinguishing capability can be provided using existing balloon 1301 systems' hardware with minimum change.
Design Requirements and Objectives
Cabin Interior Fire Extinguishing Systems

1.0 Design Requirements

1.1 The fire extinguishing agent shall comply with all U.S. laws and agreements regarding the Ozone Depleting Potential (ODP), Global Warming Potential (GWP), and Atmospheric Life to which the U.S. is a signatory.

1.2 The fire extinguisher shall provide FAA mandated fire extinguishing capability. (See ref a)

a) Hand fire extinguishers
i) Each fire extinguisher must be approved.
ii) The types and quantities of the each extinguishing agent must be appropriate to extinguish the kinds of fires likely to occur where used. (See ref c for additional guidance).
iii) Each extinguisher for use where exposure of the agent to humans is possible, must be designed to minimize the hazard of toxic gas concentrations.

b) Built-in Fire Extinguishers
i) The capacity of the system must be adequate for the volume, ventilation, and type of fire likely to occur.
ii) Item a) ii applies.
iii) No discharge of the extinguisher can cause structural damage.

2. Test Protocol

Cargo compartment fire extinguishing systems

The following is the recommended test protocol for evaluation of fire extinguishing agents and/or systems.

1.0 Fire hazard: The test shall use a FAA defined fire hazard.

1.1 Probable fuel The "test fuel" shall represent materials that can be legally transported in the cargo compartments of commercial transports. The fuel and its packaging shall be defined by FAA.

1.2 Ignition source The "ignition source" used for the fire shall represent a probable ignition source and its characteristic (energy). It shall be defined by FAA.

2.0 Probable compartment ventilation The ventilation rate in the compartment shall be the maximum ventilation rate (cubic feet per minute per unit of compartment volume) during fuel burn and the maximum normal infiltration/leakage during fire extinguishment.

3.0 Probable detection/crew reaction time The probable fire detection and crew reaction times shall be allowed to elapse prior to the activation of the fire extinguishing system. These times should be defined by the FAA.

4.0 Probable clear air volume The cargo compartment loading, defined as the ratio of cargo volume to useful compartment volume, defined by the FAA, should be used.

5.0 Probable fire location The fire shall be exposed to the ambient air.

6.0 Probable ambient conditions The tests should be conducted at

7.0 Fire extinguishing agent design concentration

The fire extinguishing agent design concentration shall be 120% of the concentration determined by test for the probable fuel.

[Suggestions: 120% of the test concentration based on recommendations of National Fire Protection Association, NFPA.]

8.0 Fire extinguishing agent discharge The test chamber shall be loaded with simulated fire extinguishing agent discharge.

[Suggestions: Fire extinguishing agent discharge should be initiated at a temperature of 210°F.]

9.0 Test apparatus

All tests shall be conducted in a compartment whose volume is greater than 1000 cubic feet. The test volume height and width at floor level should not be greater than 700 and 130 inches respectively. The test compartment should incorporate at least two agent discharge nozzles. The compartment should be ventilated during fire burn and compartment infiltration/leakage should be simulated during fire extinguishment. The test chamber should be loaded with simulated fire extinguishing agent discharge.

[Nightly: Typically cargo compartments smaller than 1000 cubic feet are Class D. An agent configuration of the cargo compartment is not essential for tests. Further additional tests may be performed.

3.0 Instrumentation

Temperature sensors should be located in the vicinity of the fuel to monitor ambient temperature. A minimum of ten temperature sensors, located at various (defined) distances from the fuel load should be used in addition to.
Fire Protection Systems

3M Brand PFC-410 Cleaning Extinguishing Agent

**Description**

PFC-410 is a highly fluorinated organic compound which has been tested and shown to effectively suppress fire when used in a manner similar to Halon 1211.

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**Applications**

PFC-410 is best suited for use in pressurized extinguishing equipment and inerting applications which demand a non-toxic agent, such as in electronic and electrical equipment. It is also suitable for manual use and can be used in a variety of industries, including automotive, electronics, and telecommunications.

**Fire Extinguishing Performance**

**Extinguishing Concentration Using Cup Burner Method**

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**Environmental**

PFC-410 does not affect our ozone and does not participate in the destruction of stratospheric ozone. Due to its high boiling point, PFC-410 is non-flammable and non-toxic. Its low toxicity and high boiling point make it an excellent agent for use in a variety of industries.

**Additional Information**

For additional information on 3M Brand PFC-410 Cleaning Extinguishing Agent, please call 877-732-0909.

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3M Industrial Chemical Products Division
3M Center, St. Paul, MN 55144-1000

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<td>Methane</td>
<td>5.0%</td>
<td>4.5%</td>
</tr>
<tr>
<td>Xylene</td>
<td>4.7%</td>
<td>4.2%</td>
</tr>
<tr>
<td>Benzyl Alcohol</td>
<td>4.7%</td>
<td>4.2%</td>
</tr>
<tr>
<td>Aniline</td>
<td>4.7%</td>
<td>4.2%</td>
</tr>
</tbody>
</table>

**Thermal Decomposition Products**

Using various extinguishing agents, the GaF₇ formed thermal decomposition products generated during application. The following table shows the concentration of PFC-410 and Xylene for each agent:

<table>
<thead>
<tr>
<th>Concentration (%)</th>
<th>PFC-410</th>
<th>Xylene</th>
</tr>
</thead>
<tbody>
<tr>
<td>20%</td>
<td>10%</td>
<td>20%</td>
</tr>
</tbody>
</table>

**Environmental**

PFC-410 does not affect our ozone and does not participate in the destruction of stratospheric ozone. Due to its high boiling point, PFC-410 is non-flammable and non-toxic. Its low toxicity and high boiling point make it an excellent agent for use in a variety of industries.

**Additional Information**

For additional information on 3M Brand PFC-410 Cleaning Extinguishing Agent, please call 877-732-0909.
AIRCRAFT
FIRE EXTINGUISHER AGENT ACTIVITIES

- RECYCLING/BANKING HALON 1301
  - REACH SYSTEM
  - 100,000 LB. BANK @ WKA
  - ACTIVELY CONVERTING HALON 1301 COMMERCIAL → CRITICAL USE

- EVALUATING NEW AGENT PERFORMANCE
  - ENGINES & APU'S
  - CARGO BAYS
  - LAVATORY WASTE BINS

SYSTEM WEIGHT IMPACT ESTIMATES

<table>
<thead>
<tr>
<th>AGENT</th>
<th>N.L.S.T. FSN (VOLUME)</th>
<th>SYSTEM WEIGHT RATIO ESTIMATES</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>HFC-134A (C₂H₂F₂)</td>
<td>2.2</td>
<td>2.14</td>
<td>SNAP APPROVED</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>COMBUSTIBILITY CONCERNS</td>
</tr>
<tr>
<td>HFC-125 (C₂HF₅)</td>
<td>2.1</td>
<td>2.08</td>
<td>SNAP APPROVED</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>UNOCCUPIED SPACES ONLY</td>
</tr>
<tr>
<td>HFC-227 (C₂HF₇)</td>
<td>1.9</td>
<td>1.72</td>
<td>SNAP APPROVED</td>
</tr>
<tr>
<td>CF₃I</td>
<td>1.2</td>
<td>1.35</td>
<td>NEW CANDIDATE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NOT IN PRODUCTION</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TOXICITY &amp; CORROSION ISSUES UNCERTAIN</td>
</tr>
<tr>
<td>HALON 1301 (CF₂Br)</td>
<td>1.0</td>
<td>1.0</td>
<td>BASELINE</td>
</tr>
<tr>
<td>NaHCO₃</td>
<td>0.5</td>
<td>0.58</td>
<td>DRY CHEMICAL CLEAN UP &amp; CORROSION CONCERNS</td>
</tr>
</tbody>
</table>

CARGO BAY TEST RESULTS

- PYROTECHNICALLY GENERATED AEROSOL (PXA) DEMONSTRATED GOOD FLAME SUPPRESSION ON
  CLASS "A" AND CLASS "B" MATERIALS.

- LAVATORY WASTE BIN

- FM-200 (HFC-227) - APPEARS TO WORK IN EXISTING POTTY BOTTLES
EXTINGUISHING MATERIAL

A family of Extinguishing Agents that are originally in Solid, Powder or Gel Form

When Activated, an Oxidation-Reduction Reaction Takes Place, Forming an Aerosol Cloud Which Has powerful Extinguishing Capabilities

Various Chemical Formulations

Various Shapes and Sizes

Application - Tailored Design

DVANTAGES OF SFE/EMAA
- Simple
- No Piping
- No Pressurized Containers
- Low Cost
- Low/No Toxicity
- Low/No Maintenance
- Zero ODP
- Nil GWP
- Highly Efficient Extinguishing Agent

SPECTREX R&D EFFORT
- Three Promising HALON Related Technologies
  - Extinguishing by Electric Field
  - Extinguishing by Micron Size Dry Powder
  - Neutralizing HALONS/CFCs

AGENT EFFECTIVENESS COMPARISON

<table>
<thead>
<tr>
<th>Agent</th>
<th>Replacement</th>
<th>CO₂</th>
<th>HALON</th>
<th>Dry Powder</th>
<th>SFE/EMAA</th>
</tr>
</thead>
<tbody>
<tr>
<td>ODP</td>
<td>High</td>
<td>low</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>GWP</td>
<td>Moderate</td>
<td>low</td>
<td>high</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Toxicity</td>
<td>Low</td>
<td>high</td>
<td>high</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Conductivity</td>
<td>Low</td>
<td>low</td>
<td>low</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Corrosivity</td>
<td>Moderate</td>
<td>low</td>
<td>low</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Vol. Efficiency</td>
<td>Good</td>
<td>moderate</td>
<td>low</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Est. Concentration</td>
<td>6%</td>
<td>10-75%</td>
<td>nil</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Est. Density</td>
<td>300 g/m³</td>
<td>600-600 g/m³</td>
<td>700 g/m³</td>
<td>50 g/m³</td>
<td>0</td>
</tr>
<tr>
<td>Cost</td>
<td>$1000/lm³</td>
<td>&gt;$250/lm³</td>
<td>$150/lm³</td>
<td>$50/lm³</td>
<td>0</td>
</tr>
<tr>
<td>Life Cycle Cost</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>
KEY FACTORS AEROSPACE INDUSTRY

- Environmental Impact
- Toxicity
- Material Compatibility
- Fire Suppression Efficacy
- Boiling Point/Heat of Vaporization
- Density and Fill Density
- Vapour pressure/Supersaturation and Viscosity
- Electrical Conductivity

### Table

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiling Point/Heat of Vaporization</td>
<td>NAF S-III</td>
</tr>
<tr>
<td>Sea level</td>
<td>-38.9°C (-35°F)</td>
</tr>
<tr>
<td>1,000 ft</td>
<td>-60°C (-76°F)</td>
</tr>
<tr>
<td>2,000 ft</td>
<td>-70°C (-94°F)</td>
</tr>
</tbody>
</table>

### Table

<table>
<thead>
<tr>
<th>Material Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAF agents have shown no negative reactions on metals usually used in aerospace engine components.</td>
</tr>
</tbody>
</table>

### Table

<table>
<thead>
<tr>
<th>ELECTRICAL CONDUCTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-conductive</td>
</tr>
</tbody>
</table>

### Table

<table>
<thead>
<tr>
<th>NAF S-III</th>
<th>Halon 1201</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduction &amp; by volume</td>
<td>2.6%</td>
</tr>
<tr>
<td>Conduction &amp; by weight</td>
<td>500 gram/m²</td>
</tr>
</tbody>
</table>

### Table

<table>
<thead>
<tr>
<th>NAF S-III</th>
<th>Halon 1201</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>1,100 ft²</td>
</tr>
<tr>
<td>Compartment Size</td>
<td>4,000 ft²</td>
</tr>
</tbody>
</table>

WORLDWIDE DISTRIBUTORS

**NORTH AMERICA**

**SOUTH AMERICA**

**EUROPE**

**ASIA**

<table>
<thead>
<tr>
<th>Name &amp; Address</th>
<th>Phone</th>
<th>Fax</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>etc.</td>
<td>etc.</td>
<td>etc.</td>
<td>etc.</td>
</tr>
</tbody>
</table>

---

For discharge times for NAF S-III, see the attached paper by Factory Mutual Research Corp., which covers other data and factors influencing discharge times of Halon 1201 and substitutes. There are three physical properties involved in determining the most suitable type of discharge for NAF S-III. They are: vapor pressure, gas density, and rate of extinguishment. Discharge times go down as vapor pressure and gas density go down and increase as the rate of extinguishment increases. NAF S-III has a lower vapor pressure and gas density than Halon 1201 and a much higher rate of extinguishment. All three factors influence discharge times with NAF S-III. These factors should be considered when determining the discharge time of NAF S-III relative to Halon 1201 and thus should allow NAF S-III to act as a drop-in replacement for Halon 1201 piping systems.