U.S. Department
of Transportation
**Federal Aviation
Administration**

Technical Center

Atlantic City Int'l Airport
New Jersey 08405

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

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_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 Ghaemmaghami	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 withstanding. 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.

3. FIRE LOAD - Survey what is out there and what types of materials are internally carried in cargo compartments (ie: 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 palettes 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 <u>MONDAY, JANUARY 10, 1994,</u> TO:

APRIL HORNER
FAX: 609-485-5796

<u>OR CALL:</u>

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

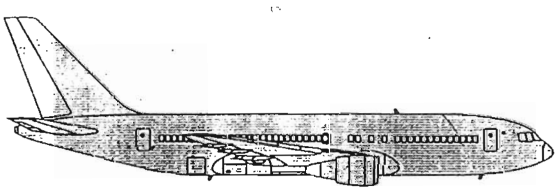
3. Mike Barrientos - HAND HELD EXTINGUISHERS

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.

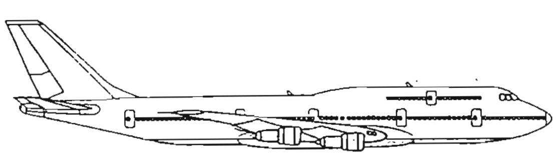
Options:
Replacement Agent (drop in)
'ater Spray System
Nitrogen (OBIGGS)
CO_2
Suspended Aerosols

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



Class C
735 cubic feet



Class B
17,000 cubic feet

Present Level of Safety Provided by Halon 1301:

Extinguishes Flaming Combustion and Prevents Reignition 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.

Engine Nacelle Test Facility
FAA Technical Center

On June 17, 1993 the FAA embarked on a research plan to develop performance test methodologies which would lead to recommended air worthiness 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 93-1. As detailed, the plan would concentrate in four main areas where halons are currently used in aircraft, namely, cargo, engine nacelles, handhelds 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 agents ability to extinguish the fire. A study currently being conducted at Wright Patterson Air Force Base is looking at identifying which parameters these are.At this time it appears that the following nacelle parameters will be modeled;

- Air Flow
- Air Pressure (small range ±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 is able to be very easily 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 not be 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.

The engine core will be constructed of a piece of 3/16ths inch thick carbon steel pipe and will act as the main structural support for the fixture. The outer nacelle skin will also be 3/16ths 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 distorted due to repeated fire tests. Provisions 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.

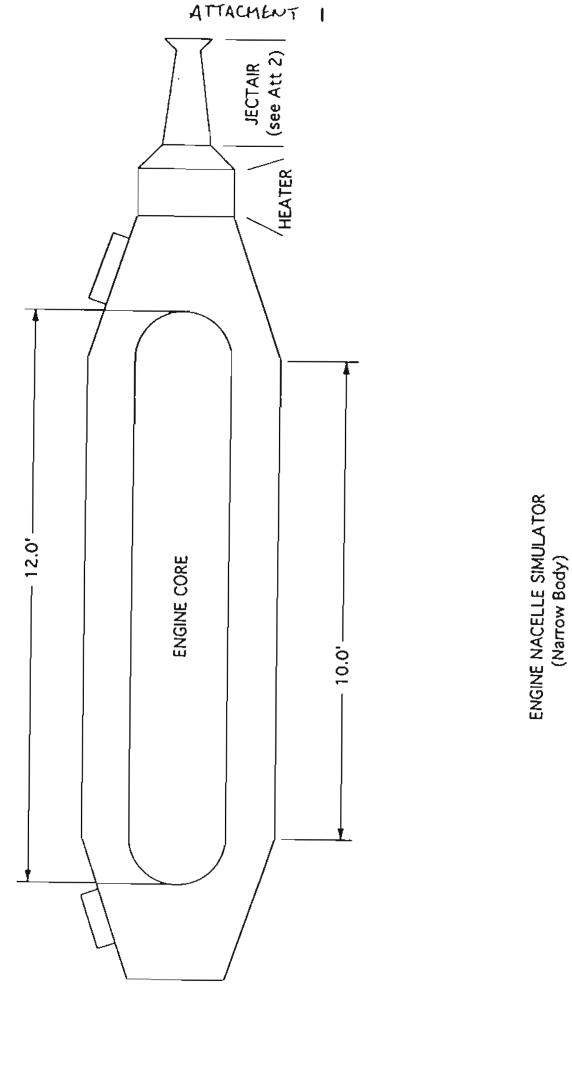
Working Group Input

The above describes in very general details 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

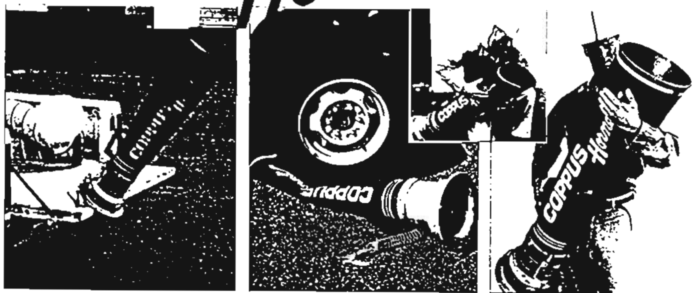
I look forward to your thoughts and working with you on this program.

ATTACHMENT 1



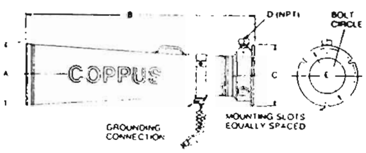
ATTACHMENT J

COPPUS Jectair Hornet



The Jectair Hornet can really take rough treatment! Unlike conventional steel diffuser air horns, the Hornet retains its original shape even after falling from a moving vehicle or after it is "run over" by a truck. The amazing engineered polymer diffuser can simply be flexed back to its original shape.

SPECIFICATIONS



Model	A	B	C	D	Mounting Slots E	Mounting Slots No.	Mounting Slots Width	Net Weight
3S-HP	6.0 152	16.5 419	7.5 190	½ 13	6.5 165	3	0.4 10	4 lbs 1.3 kg
3-HP	7.3 185	33.0 838	7.5 190	½ 13	6.5 165	3	0.4 10	5 lbs 2.3 kg
6-HP	12.0 305	44.2 1 123	11.5 292	1 25	10.8 274	3	0.4 10	14 lbs 6.4 kg

MATERIAL SPECIFICATIONS
Diffuser: Linear Low Density Polyethylene
Rated UL 94-V2
Maximum Operating Temp. 200°F
Inlet Housing: Cast Aluminum

ENGINEERING CORP
Box Number 15003
Worcester, MA 01615 0003
Tel 508-756-8391 Fax 508-756 8375

1992 Coppus Eng. Patented and Other Patents Pending

PRESSURE & FLOW CHARACTERISTICS cfm (m³/hr) AT VARIOUS STATIC PRESSURE

Inlet Pressure	Model	Imposed Static Pressure 0" (0 mm)	1" Wg (25.4 mm)	2" Wg (50.3 mm)	3" Wg (76.2 mm)	Inductor Ratio
60 PSIG 4.2 Kg/cm²	3S-HP	1370 2 371	1180 2 005	950 1 614	630 1 070	29.[illegible]
	3-HP	1520 2 583	1340 2 277	1120 1 903	870 1 47[illegible]	32.3
→	6-HP	3980 6 762	3340 5 675	2560 4 350	980 1 665	40.[illegible]
80 PSIG 5.6 Kg/cm²	3S-HP	1530 2 600	1470 2 498	1210 2 056	950 1 614	25.1
	3-HP	1700 2 888	1550 2 634	1410 2 396	1190 2 022	[illegible]
→	6-HP	4500 7 646	3980 6 762	3460 5 879	2620 4 451	35.[illegible]
100 PSIG 7 Kg/cm²	3S-HP	1660 2 82[illegible]	1540 2 61[illegible]	1390 2 362	1210 2 056	22.[illegible]
	3-HP	1860 3 160	1720 2 922	1540 2 616	1400 2 379	25.[illegible]
→	6-HP	[illegible]	4500 7 646	4000 6 796	3380 5 743	[illegible]

SAFETY PRECAUTION

FAA HALON REPLACEMENT PROGRAM

FOR

ENGINE NACELLES AND APU'S

Presented by:

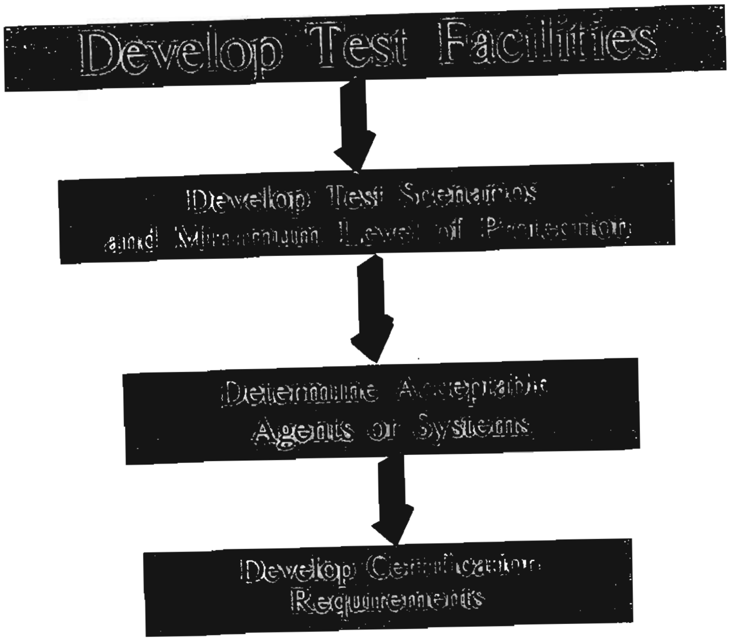
Larry Curran, Project Manager
Fire Safety Branch, ACD-240
FAA Technical Center
Atlantic City International Airport, NJ 08405

Background

- All FAA required fixed fire suppression systems in commercial airliners employ Halon 1301 ($CBrF_3$) extinguishing agent.
- The Montreal Protocol requires global production of Halons to cease by January of 1994.
- 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.

PROGRAM OBJECTIVE:

Develop test methodologies and certification criteria for the approval of non Halon fire suppression agents/systems to be used in engine nacelle and APU installations aboard commercial aircraft.



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 scenerio, or should it reflect a more typical situation which may have a greater probability of occurrence?
- Conduct parrallel 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 agents 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.

FAA HALON REPLACEMENT PROGRAM

FOR

HANDHELD EXTINGUISHERS

Presented by:

Michael Barrientos, Project Manager
Timothy R. Marker
FAA TECHNICAL CENTER
Aircraft Fire Safety Branch, ACD-240
Atlantic City International Airport, NJ 08405

Present requirement on board transport category aircraft:

minimum of 2 Halon 1211 hand fire extinguisher

MAIN PURPOSE: TO GET INPUT ON HOW WE SHOULD EVALUATE REPLACEMENT AGENTS THROUGH TESTS METHODS

What criteria should these agents meet?- equal to or better than Halon 1211

Handheld extinguisher:

1. must be able to extinguish hidden in-flight fire hazards
2. be capable of extinguishing seat fires
3. trash receptacles

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.): ______________

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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

U.S. Department of Transportation
Federal Aviation Administration

LIST OF ATTENDEES
INTERNATIONAL HALON REPLACEMENT WORKING GROUP MEETING
Held at FAA Technical Center, New Jersey, USA
October 13-14, 1993

NAME	ORGANIZATION/ AFFILIATION	ADDRESS	PHONE/FAX
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LARRY CURRAN	"	ACD-240	PHONE: 609-485-4525 FAX: 609-485-5796
Michael Burrnicky	"	"	PHONE: 609-485-4597 FAX: 609-485-5796
TIM MARKER	"	"	PHONE: 609-485-6469 FAX: 609-485-5796
John Petrakis	FAA Aircraft Certification	AIR-120 800 Independence Av. Washington, DC 20591	PHONE: 202 267-9274 FAX: -5340
NICK POVEY	UK CAA	SAFETY REGULATION GROUP AVIATION HOUSE GATWICK RH6 0YR	PHONE: 44 (0)293 573347 FAX: 44 (0)293 573970
GUS SARKOS	FAA Fire Safety Br.	ACD-240	PHONE: (609) 485-5620 FAX: " " 4004
Nelson Miller	FAA Research Director Aircraft Safety	ACD-200	PHONE: 609-485-4465 FAX: " " 4004
BRUCE SINGER	FAA ACD	ACD-2	PHONE: 609 485 6085 FAX: " " 4401
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Bob GLASER	"	"	PHONE: FAX: "
Bob McCracken	FAA Transport Standards Staff	1601 Lind Ave S.W. Renton, WA 98055-4056	PHONE: 206 227 2118 FAX: 206 227 1320 or 1100
Maurice KINDER	AIR FRANCE Engineering Dr.UX	POB 124 ORLY-SUD 94396 ORLY AEROGARE CEDEX FRANCE	PHONE: (1) 41 75 5673 FAX: 33 (1) 41 75 5191
JEAN PAILLET	AEROSPATIAL	316 route de Bayonne 31060 Toulouse CEDEX 03 France	PHONE: 33 61937165 FAX: 33 6193 8874
EMIL DAVID CARA	BELL HELICOPTER TEXTRON CANADA	12,800, RUE DE L'AVENIR MIRABEL, P.Q. J7J1R4 CANADA	PHONE: (514) 437-2939 FAX: (514) 437-6382
JERRY A. BROWN	SPECTREX INC (ADI)	1487 CHAIN BRIDGE Rd Suite 304, MCLEAN, VA 22101	PHONE: (703) 734-9626 FAX: (703) 448-8591
MATHIAS L. KOLLECK	BOOZ-ALLEN & HAMILTON	4141 Col GLENN Hwy SUITE 131 DAYTON, OH 45431	PHONE: 513-429-4504 FAX: 513-429-9796
FELIX STÖSSEL	SWISSAIR ENGINEERING PROJECTS MANAG.	CH 8058 ZURICH AIRPORT TEPS SWITZERLAND	PHONE: (01) 8126950 FAX: (01) 8129098
Jelle Benedictus	KLM engineering dept.	P.O box 7700 1117ZL Schiphol-Oost the Netherlands	PHONE: +31-20-6490[illegible] FAX: +31-20-6498[illegible]

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PETER J. GIBBS	GEC MARCONI AVIONICS LTD.	AIRPORT WORKS ROCHESTER, KENT ME1 2XX ENGLAND	PHONE: 44-634-844400 EXT 4239 FAX: 44-634-816554
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JEFF GIBSON	AMERICAN PACIFIC CORP.	3770 HOWARD HUGHES PARKWAY #300 LAS VEGAS, NV 89109	PHONE: 702 735 2200 FAX: 702 735 4876
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DAN FILICICCHIA	SPRAYING SYSTEMS CO.	NORTH AVE. & SCHMALE RD WHEATON, IL. 60189-7900	PHONE: 708-665-5201 FAX: 708-260-0865
Daniel W. MOORE	DuPont Fluorochemicals	Barley Mill Plaza, 13-2150 PO BOX 80013 Wilmington, DE 19880-0013	PHONE: 302 992 2177 FAX: 302 992 2836
MARIA BOULDEN	DuPont Fluorochemicals	CHESTNUT RUN PLAZA BUILDING 711F WILMINGTON, DE 19880	PHONE: (302) 999-5214 FAX: (302) 999-2093
BILL MESERVE NEIL RICHARDSON	PACIFIC SCIENTIFIC	1800 HIGHLAND AV DUARTE, CA 91010	PHONE: 818 359 9317 FAX: 818 359 7013

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ALANKAR GUPTA	Boeing Commercial Airplane Co.	P.O. Box 3707, M/S 6H-TR Seattle, WA 98124	PHONE: (206) 237-7515 FAX: (206) 237-5444
JOHN E. CHORBA	3M	3M CENTER BLDG. 223-6S-04 ST. PAUL, MN 55144-1000	PHONE: (612) 736-7569 FAX: (612) 736-7542
JOHN A. PIGNATO, JR.	3M	3M CENTER BLDG 236-2B-01 ST. Paul, MN. 55144-1000	PHONE: 612-733-5720 FAX: 612-733-4835
RONN BLUNKE	MC DONNELL DOUGLAS FIRE PROTECTION	3855 LAKEWOOD BLVD. LONG BEACH, CA m/c 800-34	PHONE: 310 593 6949 FAX:
STEPHEN LEONG	McDonnell Douglas ~~[illegible]~~ Douglas Aircraft Propulsion Sys	3855 Lakewood Blvd m/c 36-50 Long Beach, CA. 90846	PHONE: (310) 496-6802 FAX: (310) 593-7352
Ron Fisher	Executive Director Defense Fire Protection Assoc.	3335 Duke Street Alexandria VA 22314	PHONE: 703 823 3372 FAX: 703 823 6945
Jean De Haai	Delavan Inc	811 - 4th St. West Des Moines IA 50265	PHONE: 515-274-1561 FAX: 515-27-7200
CLAUDE LEWIS	TRANSPORT CANADA AIRWORTHINESS (AARDH)	CENTENNIAL TOWERS 200 KENT ST (6TH FLOOR) OTTAWA, ONT CANADA K1A 0N8	PHONE: 613 990 5906 FAX: 613 996 9178
JAMES D. LAKE	National Fire Sprinkler Assoc.	~~[illegible]~~ 62 Lathrop Ave Binghamton NY 13905	PHONE: (607) 771-0238 FAX: (607) 878-4215
BRIAN T NOENING	GLOBE FIRE SPRINKLER CORP	4077 AIRPARK DRIVE STANDISH, MI 48658	PHONE: (517) 846-4583 FAX: (517) 846-9231

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Paul DeSipio	Naval Air Warfare Center	PO Box 5152 Code 6013 Warminster PA 18974-0591	PHONE: 215/441-1326 FAX: 215/956-4103
John J. O'Sullivan	British Airways	Trident House (S.583) P.O. Box 10 Heathrow Airport Hounslow Middlesex: TW6 2JA England	PHONE: 44-81-562-5460 FAX: 44-81-562-2988
Ian C Harris	Ministry of Defence (Procurement Exec.)	Rm 246 St Giles Ct London WC2H 8LD	PHONE: 44-71-632-6411 FAX: 44-71-632-6256
CAPT Bob Tetla	USAF	WL/FIVCF 139 Barnes Dr (suite 2) Tyndall AFB FL 32404	PHONE: 904 283 3745 FAX: 904 286 6763
Rehan Majid	TEC-AIR Services, Inc	2-10 Railroad Ave. East-Northport, N.Y. 11731	PHONE: 516-368-2200 FAX: 516-368-2218
W. Mark Cummings	U.S. Coast Guard R&D Center	Fire Research Branch 1082 Shennecossett Rd. Groton, CT. 06340-6096	PHONE: 203/441-2761 FAX: 203/441-2792
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Martin Goerl	Great Lakes Chemical Corp	20 Brookside Terrace North Haledon, NJ 07508	PHONE: (201) 423 5220 FAX: (201) 423 2589
John O'Rourke	AT&T	225 [illegible]	PHONE: 410-584-6139 FAX: 41[illegible]-584-6405

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Joel L. Krinsky	Naval Sea Systems Command	NC-4 Room 430 Wash D.C. 20362	PHONE: 703 602-0547 FAX: 703 602-8010
Kevin Faughnan	Aerosafe Intnat'l	3033 Richmond Pkwy Richmond, CA 94806	PHONE: 510 758 0122 FAX: 510 758 0119
John Harwood	Australian Defence (Air Force)	Code 108R Naval Air Warfare Center Warminster PA 18974	PHONE: 215 441 2185 FAX: 215 441 2092
Dave Catchpole	BP Exploration (Alaska)	P.O. Box 196612 Anchorage Alaska 99519-6612	PHONE: 907-564-5038 FAX: 907-564-5020
Tom Cortina	HARC	2000 L Street, N.W. Suite 730 Washington DC 20036	PHONE: 202-223-6166 FAX: 202-223-5979
James A. Cinelli	ASC/ENFA (USAF)	BLDG 125 2335 Seventh Street STE 6 Wright Patterson AFB OH 45433-7809	PHONE: 513-255-2680 FAX: 513-255-5877
Glenn E. Harper	McDonnell Douglas Aerospace - East	P.O. Box 516 St. Louis MO MC 106-6157	PHONE: 314-233-6455 FAX: 314-233-4433
Mike Bennett	U.S. Air Force Wright-Patt AFB	Attn: Mike Bennett WL/FIVS Bldg 63 1901 Tenth St. Wright-Patterson AFB OH 45433-7605	PHONE: (513) 255-6302 FAX: (513) 255-2237
Lt Gregg Caggianelli	U.S Air Force WPAFB	Attn: 1Lt Gregg Caggianelli WL/FIVS Bldg 63 1901 Tenth St. WPAFB, OH 45433-7605	PHONE: (513) 255-6179 FAX: (513) 255-2237

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David D. Thurston	Naval Air Warfare Center, Lakehurst	NAWCAD Code 5R11 Lakehurst, NJ 08733	PHONE: 908/323-2689 FAX: 908/323-1989
Donell V Schull	ANSER	Suite 800. 1215 Jeff Davis Hwy Arlington	PHONE: (703) 685-3135 FAX: (703) 685-3329
Lui Bender		FAA Tech Cntr	PHONE: 485 5779 FAX:
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John A.	Federal Express Corp.	PO Box 727-1870 Mpls, TN 38194	PHONE: 901-395-4849 FAX: 901-395-3715
Kamran Ghaemmaghami	Federal Express Corp.	7401 World Way West Los Angeles CA 90045-0050	PHONE: 310 649-8517 FAX: 641-9475
Jerry McOllian	Federal Express Corp.	3101 Tchulahoma Memphis TN 38118-5413	PHONE: 901-369-2462 FAX:

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Robert E. Tapscott	NMERI/CGET ~~[illegible]~~	University of New Mexico Albuquerque, NM 87131-1376	PHONE: 505-272-7252 FAX: 505-272-7203
Joseph L. Scheffey	Hughes Associates Inc	6770 Oak Hall Ln Suite 125 Columbia, MD 21045	PHONE: 301 596 2190 FAX: 301 596 2295
Olden J. Carr	Spectrex, Inc.	220 Little Falls Rd. Cedar Grove, NJ 07009	PHONE: (201) 239-8398 FAX: (201) 239-7614
			PHONE: FAX:
			PHONE: FAX:
Bob Hefty	NAWDC		PHONE: FAX:
APRIL HORNER (W.G. Coordinator)	c/o FAA Technical Ctr.	ACD-240/BLDG 287 Atlantic City Int'l Airport, NJ 08405	PHONE: 609-485-4471 FAX: 609-485-5796
			PHONE: FAX:
			PHONE: FAX:

1

Navy Aircraft Halon 1301 Alternatives

Presented by:
Mr. James M. Homan
NAVAIR 53031J

Dave Thurston / NAWC Lakehurst

2

HALON 1301

- Halon 1301 "Responsible Use" policy
  - Existing aircraft - Use Halon 1301 from reserve from life of aircraft or until drop-in becomes available
  - Make provisions for non-ODS in emerging designs
  - Modification to hydrostatic testing requirement

3

HALON 1301 (cont.)

- Program approach:
  - Replacement of Halon 1301 portables
  - Elimination of unnecessary releases
    - Inadvertent
    - False

4

HALON EMISSIONS
1992 ANNUAL USAGE - 49,129 (LBS/YR)
AIRCRAFT INSTALLED BASE - 72,400 (LBS)

5

AIRCRAFT HALON 1301 SYSTEMS

A/C	QUANTITY (#/AIRCRAFT)	ANNUAL USAGE (#/AIRCRAFT) TYPE)
P-3	55	12495
F-18	5.5	1400
A-6	15.75	2036
E-2C	18.5	1582
EA-6B	30	-
C-2	20.75	1365
S-3	3.89	785
E-6	82.38	221
C-130	62.25	4992
T-44A	6.5	285
F/A-18E/F	5.5	<10
F-16N	13	312
C-9	16.8	319
H-53E	20.75	2160
H-60	7.75	1432
H-53A/D	16.25	1995
H-46	4	2281
H-1	6.75	3290
H-2	7.75	2592
H-3	6.75	2530
	TOTAL USAGE	4XXXX

6

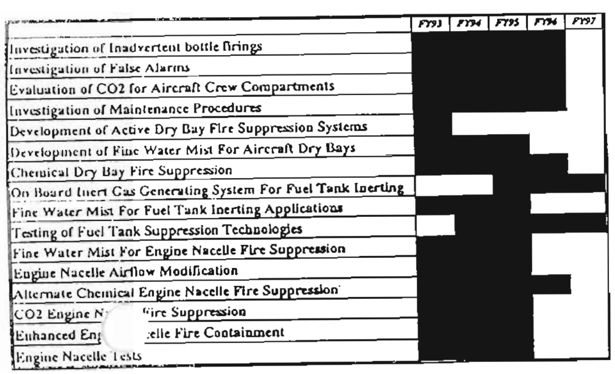
HALON 1301

Halon 1301 alternative R&D

- Co-sponsoring tri-service and FAA effort
  - Engine nacelle
  - Dry bays
- Fuel tank inerting
- Crew Compartment portables

7

Aircraft 1301Halon Alternatives Research and Development Efforts



8

"RESPONSIBLE USE"

Second-Generation Agents

High-Efficiency Halon Replacement Candidates

Robert E. Tapscott
Center for Global Environmental Technologies
NMERI, University of New Mexico

Halon Replacement Working Group Meeting
Fire Safety Branch, FAA
13-14 October 1993

Halon Options

- Replacements: Halon-Like Clean, Gaseous or Volatile Halocarbons
- Alternatives: Non-Halocarbon Agents (Misting Systems, Particulate Aerosols, Inert Gases, Etc.)

Desired for Replacements

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

First-Generation Replacements

- Physical Action Agents (PAAs)
- Decreased Efficiency Relative to Halons
- In Many Cases, Long Atmospheric Lifetimes, high GWPs
- In Some Cases, Non-Zero ODPs

Second-Generation Replacements

- Chemical Action Agents (CAAs)
- Contain Bromine and/or Iodine
- Low Atmospheric Lifetimes
- Low or Zero ODPs
- Low or Zero GWPs

Second-Generation Agent Families

- Iodides
- Unsaturated Halocarbons
- Polar-Substituent Halocarbons

Uncertainties

- Manufacturability
- Toxicity
- Emissions
- Material Compatibility
- Stability

Trifluoromethyl Iodide

- CF_3I
- Effectiveness Approximately Same as Halons
- Zero or Near-Zero Lifetime, ODP, GWP
- Modified Limit Test: No Effect at 12.7% (Four Times Cup Burner Value)
- Synthetic Routes From Halon 1301
- Manufacturer Identified

FIRE SUPPRESSION SCIENCE AT NIST 1

Richard G. Gann, Chief
Fire Science Division
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899

International Halon Replacement Working Group Meeting
FAA Technical Center
October 13, 1993

MISSIONS 2

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY:

HELP U.S. INDUSTRY IMPROVE THE QUALITY AND INTERNATIONAL COMPETITIVENESS OF ITS PRODUCTS

BUILDING AND FIRE RESEARCH LABORATORY (BFRL):

ENHANCE THE COMPETITIVENESS OF U.S. INDUSTRY AND PUBLIC SAFETY THROUGH PERFORMANCE PREDICTION, MEASUREMENT TECHNOLOGIES, AND TECHNICAL ADVANCES THAT IMPROVE THE LIFE CYCLE QUALITY OF CONSTRUCTED FACILITIES

NIST FIRE RESEARCH PROGRAM 3

CAPABILITIES IN HALON REPLACEMENT TECHNOLOGY

- BROAD STAFF EXPERTISE IN FIRE SCIENCE AND ENGINEERING
- STATE-OF-THE-ART BENCH-SCALE AND REAL-SCALE FACILITI[ES,] INSTRUMENTATION, AND COMPUTATION FACILITIES
- EXPERIENCE IN FIRE CONTROL TECHNOLOGIES:
  - FIRE DETECTION
  - FLAME EXTINCTION
  - FIRE SUPPRESSION SYSTEMS
  - COMPARTMENT FIRE DYNAMICS
  - SMOKE AND BY-PRODUCT ANALYSES

NIST/BFRL HALON REPLACEMENT TECHNOLOGY 4

- COMPLETED PROJECTS:

  "Preliminary Screening Procedures and Criteria for Replacements for Halons 1211 and 1301," R.G. Gann *et al.*, NIST Tech Note 1278, 1990.

  "Construction of an Exploratory List of Chemicals to Initiate the Search for Halon Alternatives," W.M. Pitts *et al.*, NIST Tech Note 1279, 1990.

  "Evaluation of Alternative In-Flight Fire Suppressants for Full-scale testing in Simulated Aircraft Engine Nacelles and Dry Bays," W.L. Grosshandler *et al.*, NIST Special Publication, in preparation, 1993-94.

CONTINUING WORK:

- Optimization of Agent Discharge
- Real-Time Agent Concentration Measurement During Fire Suppression
- Agent Compatibility with Aircraft Materials
- Prediction of Combustion By-Products from Fire Suppression

IN-FLIGHT FIRE SUPPRESSION PROGRAM 5

- SPONSORED BY USAF, NAVAIR, USA, FAA
- RECOMMEND CANDIDATES FOR FULL-SCALE TESTING AT WPAFB
- ELEMENTS:
  - FIRE SUPPRESSION EFFICIENCY
  - DISCHARGE SPEED AND DISPERSION
  - THERMODYNAMIC PROPERTIES
  - COMBUSTION BY-PRODUCT FORMATION
  - COMPATIBILITY WITH STORAGE AND AIRCRAFT MATERIALS
  - ENVIRONMENTAL AND AVAILABILITY ISSUES

CORE CANDIDATES 6

COMPOUND	FORMULA
HFC-32/HFC-125	CH_2F_2/CHF_2CF_3 (azeotrope)
[HFC-32	CH_2F_2]
HFC-125	C_2HF_5
HFC-227ea	C_3HF_7
HFC-236fa	$C_3H_2F_6$
HCFC-124	$CHFClCF_3$
HCFC-22	CHF_2Cl
HFC-134a	CH_2FCF_3
FC-116	C_2F_6
FC-218	C_3F_8
FC-31-10	C_4F_{10}
FC-318	cyclo-C_4F_8
Sodium bicarbonate	$NaHCO_3$

RECOMMENDATIONS 7

ENGINE NACELLE	DRY BAY
HFC-125 (C_2HF_5)	FC-218 (C_3F_8)
HCFC-124 (C_2HF_4Cl)	HFC-125 (C_2HF_5) [CHECK FOR PRESSURE RISE]
CF_3I [PARTIAL SERIES]	HCFC-124 (C_2HF_4Cl)
$NaHCO_3$ [PARTIAL SERIES]	HFC-134a ($C_2H_2F_4$) [IF HFC-125 FAILS]

~~CARGO COMPARTMENT~~ HALON WORK UPDATE

GOALS

CONCERNS

CURRENT WORK

Presented at

International Halon Replacement Working Group Meeting,
Federal Aviation Administration Technical Center,
Atlantic City International Airport, New Jersey.

October 13, 1993

Alankar Gupta,

(206) 237-7515, FAX 206-237-5444

Being Commercial Airplane Group
Seattle, WA.

GOALS

• Primary goal: Ensure current level of airplane and passenger safety during halon replacement.

• Secondary goal: Enhance safety and reduce overall fire protection system Life Cycle Cost.

• Essentials to achieve these goals:

• Cooperative effort between suppliers, users and regulators.

• Better fire detection systems

-Reliable and accurate (zero false alarm)
-Detect and annunciate fire before it becomes a hazard
-Require no scheduled maintenance
-Fail safe

• Fire suppression systems that are

-Environment, people and animal friendly
-Suitable for probable threat
-Require minimum maintenance
-Competitive with halon 1301

CONCERNS

1. **Fire detection and suppression treated as two independent systems.**

   • Suppression system performance requirements (agent concentration, duration, etc.) are defined without any consideration of the performance capabilities of the detection system. [No credit allowed for an innovative or high technology detection system.]

2. **Cargo compartment fire detection system certification criteria based on time from the start of a fire and use of aerosols as fire signature.**

   • Undefined performance requirement for non-aerosol detection systems.

   • Lack of consensus on the definition of a hazardous fire (heat release rate, compartment air or liner temperature, temperature rise rate, etc.).

   [Detection thresholds for signatures other than aerosols should be defined.]

3. **Lack of consensus on probable fire threat in cargo compartments.**

   • Probable fuel, fuel loading, ignition source, ignition energy, etc.

   • Fires in loaded standard containers and fires deep in the center of cargo.

   [Standard test fire, based on probable cargo, packaging, loading, other regulations, airline practices, probable ignition sources and their energy, should be developed.]

CONCERNS (contd)

4. **Inadequate Advisory material.**

   • AC 25-9 AND -9A do not provide the necessary guidance to further the fire protection technology.

   [Revision of AC by a committee consisting of users, suppliers, and regulators.]

5. **Requirements (FAR 25.851) for built-in fire extinguishers not clear**

   • Suppression - fire may persist below detection level.
   • Extinguishment- fire must go out (no heat or smoke release).
   • Inerting- fire must not start in presence of an ignition source (ignition energy?, fuel ?).

   [Scope of Advisory Circular should be expanded to include fire suppression.]

6. **Critical design conditions cargo compartments**

   • Design volume (empty cargo compartment)
   • Faster agent decay (chemical agents)
   • Higher initial agent concentration, lower oxygen partial pressure.

   [Scope of Advisory Circular should be expanded to include fire suppression.]

CONCERNS (contd)

7. **Critical fire for hand-held fire extinguisher**

   • Hidden fire (Delta L-1011 hidden fire scenario) and acceptable method of threat simulation.

8. **• Lavatory Trash Receptacles**

   • Need in view of FAR 25.854(a) and FAR 25.853(f) requirements.

9. **Testing**

   • Need of airplane tests for certification of detection and suppression systems.

CURRENT WORK

1. **Monitor and participate in activities of various agencies.**

   • National Fire Protection Association (NFPA) 2001 " Standard on Clean Agent Fire Extinguishing Systems.

   • Environmental Protection Agency (EPA) - Snap Program, Montreal Protocol

   • Federal Aviation Administration (FAA)- Halon Replacement Program

   • Airframe Industries Association (AIA)- International Symposium, Working Groups

   • United States Air Force (USAF)- Agent Evaluation (Mike Bennett)

   • Suppliers (chemical agents, detection and suppression equipment)

2. **Independent Research and Development (IR&D)**

   • Fire detection by signatures other than aerosol

   • Fire suppression by non-chemical agents

   • Evaluation of Sulphur hexafluoride for use in test of halon 1301 systems

AIR FRANCE HALON PROGRAM

International FAA HALON Replacement Working Group

ATLANTIC CITY, October 13th 1993

Paper presented by Maurice KINDEL,
AIR FRANCE Direction de la Maintenance,
Central Engineering

HISTORICAL

- Confirmation in March 1993 by the UNEP of the cessation of the manufacturing of the HALONS for 1/1/94 with a possible exception for essential users.
- Essential use definition :
  - Human safety directly involved,
  - No alternative, technically and economically.
- Notification to the potential essential users to be registered by the UNEP by the end of April 1993.

ACTIONS

Registration of all the ground uses of HALONS within the AIR FRANCE GROUP

- Computer rooms
- Flight simulators
- Electronics and Avionics workshops
- Building climatisation

File-in of the locations, quantities and type of containers (tanks, cylinders, bottles etc..)

ACTIONS

- Suppression of the discharge testing of A/C extinguishers
- Decreasing of the frequency of the pressure testing in accordance with the French airworthiness authorities, DGAC (Direction Générale de l'Aviation Civile).
- Suppression of the flight crew fire-fighting training with HALON 1211 equipped fire-extinguishers.

ACTIONS

Coordination with the C T F H E

Comité Technique Français des Halons d'Extinction)

- Registration of recyclable Halons
- Approval of the recyclers
- Tentative of definition of the minimum required quality of the recycled HALONS

AVRIL 1993

Cooperation with the French Ministry of the Environmental Affairs for the Declaration of essential uses.

MAY 5th, 1993

AF/ IT letters requesting officially to the UNEP the classification of AIR FRANCE GROUP as an essential user of HALONS 1301 and 1211.

ACTIONS

Determination of the whole airborne quantity,

HALON 1301 and HALON 1211

Evolution versus fleet growth up to Year 2000

Consumption estimation, servicing, fire alarms and B 747 Combi equipment

ACTIONS

Evaluation of new recycling HALON benches

Selection of

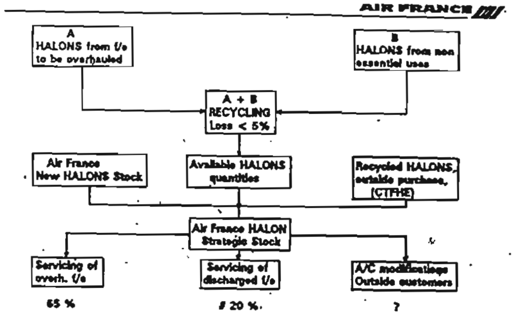
HAL TEAM AER LINGUS servicing and recycling bench for fire extinguishers equipped with HALON 1301

Modification of the existing bench for HALON 1211

ACTIONS

Setting-up a strategic stock of HALON 1301 & 1211 to assume Air France fleet servicing up to Year 2000 and more

Reimplementation of the strategic stock with recycled HALONS

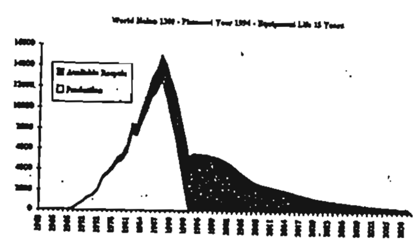


PROBLEMS

- ISO / ASTM standard may be too restrictive technically and economicaly for the recycled HALONS quality and availability.
- Recyclers will offer warranty based only on the ISO / ASTM parameters with exception for the water and the dissolved nitrogen content.

PROBLEMS

- Classification of essential uses is withdrawn for the manufacturing of new HALONS.
- This concept must be reinstated by the International Authorities for the use of recycled HALONS, with legal barriers and penalties to discourage deceptions and unuseful destructions.



PROBLEMS

- There is no effective HALON bank available in France
- Recyclable HALONS from other CEE countries cannot be purchased for recycling. (In some states they are considered as wastes and must be destroyed).

PROBLEMS

- Recyclers will not offer any warranty on unsuspected pollution not covered by ISO / ASTM standard.
- There is no cheap method available to differenciate new HALONS from the recycled ones.

PROBLEMS

- FAA Airworthiness Directive on B747 "Combi A/C"
  - Inerting of the cargo compartment during 90 mn in an automatic sequence of fire-extinguishers percussion, i. e. 400 kg for each alert.
- Reequipment of A/C in outside stations after a fire extinguisher percussion for suspected fire.

PROBLEMS

- No HALONS substitutes will be probably available before Year 2000
- No A/C fire-extinguishing systems equipped with HALONS substitutes will be probably certified before Year 2005
- A/C, Engines and APUs designed before that date will be equipped with HALONS systems. These A/Cs and equipments will be oper--ive up to 2030

HALON ALTERNATIVES AS THEY AFFECT NFPA AVIATION STANDARDS

Joseph L. Scheffey, P.E.
Director of Fire Protection RDT & E
Hughes Associates, Inc.

NFPA Aviation Section

- Encourage understanding of life safety and property protection as applied to aircraft and airport facilities
- Enhance cooperation between professional disciplines

NFPA Technical Committee

Airport Facilities

- * 409 - Hangars
- 415 - Airport Fueling Ramp Drainage
- 416 - Airport Terminals
- 417 - Aircraft Loading Walkways
- 419 - Airport Water Supply Systems
- * 423 - Aircraft Engine Test Facilities

NFPA Technical Committee

Aircraft Rescue and Firefighting (ARFF)

- 402M - ARFF Operational Procedures
- * 403 - ARFF Services at Airports
- * 408 - Aircraft Hand Fire Extinguishers
- 412 - Evaluating Foam on ARFF Vehicles
- * 414 - ARFF Vehicles
- 422M - Aircraft Fire Investigator's Manual
- 424M - Airport Emergency Planning

NFPA 403

ARFF Services - 1993 Edition

Secondary Agent - PKP or Halon 1211

- Quantities and discharge rates specified

Recognizes Montreal Protocol

- Limit use to unwanted fires, do not use for training

NFPA 408

Aircraft Extinguishers - 1994 TRC

- 1211 Portable Extinguishers Specified for Flight Decks, Cabins, and Galleys
- Recognizes Montreal Protocol
- "Approved, Listed, and Labeled extinguishers containing clear evaportating type HCFC or HFC halogenated replacement agents may also be used to comply with requirements of this standard"

NFPA 10

(Portable Extinguishers) - 1994 TRC

- Recognizes Montreal Protocol
- As currently written, does not specifically recognize halon alternatives

Facilities

409 Hangars - Ref. NFPA 10 for portable extinguishers

403 Aircraft Engine Test Facilities

- Engine test cell - Halon 1301 or 1211 option Ref. NFPA 12A and NFPA 12B

NFPA 2001

Alternative Protection Options to Halon

Scope - Alternative protection options to Halon 1301 and 1211

Compare properties of suppression systems relative to occupancies being protected

Design and Installation Standard for Total Flooding System (analog to NFPA 12A)

Adoption proposed at NFPA Fall Meeting

NOTES FROM THE SUBGROUPS FORMED AT THE:

FIRST INTERNATIONAL SYMPOSIUM ON HALON REPLACEMENT IN AVIATION

HELD

FEBRUARY 9-10, 1993

IN

RESTON, VIRGINIA

Design Requirements & Objectives for Engine/APU Nacelle Fire Extinguishing Systems

General Discussion and Background

Federal Aviation Regulations in FAR 25.1181 defines power plant fire zones and specifies that these zones meet the requirements of FAR 25.1185 thru 25.1205. In general, the nacelle fire zones are isolated from other airplane structures, contain only fire resistant or fireproof components and are monitored by fire detection systems. The primary means of controlling fires is to shutoff the flow of combustible materials into the affected zone and to rely on the fire walls to contain the fire. The fire is extinguished by the discharge of fire 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 which are not meant to replace the FAR wording.

Design Requirements & Objectives

1) Per FAR 25.1195:
   a) the system agent quantity, discharge rate and discharge distribution must be adequate to extinguish fires.

2) Per FAR 25.1197, agents must:
   a) be able to extinguish fires from any burning combustible in the protected area. (Note: Typical materials are listed in the table below.)

Area	Typical Combustible Material
Engine/APU Nacelle	Hydraulic Fluid, Engine Fuel and Engine Oil

   b) be thermally stable under expected operating condition extremes of system. (Note: The FAR does not call out specific conditions, but system design criteria is generally as specified below.)

Variable Condition	Range
Temperature	-65°F to 250°F
Pressure Altitude	-2,000 ft to 50,000 ft
Humidity	0 to 100%

   c) provisions must be made to protect passengers and crew from harmful concentrations of toxic agents that may occur by leakage during normal operation of the aircraft or during discharge of the agent during flight or on the ground.

3) Per FAR 25.1199, extinguishing agent containers:
   a) must indicate that the container is discharged or that it pressure is below the minimum necessary for proper system operation.
   b) temperature must be maintained within the appropriate design range to provide for adequate discharge rate, prevent premature discharge from high temperatures and that if a pyrotechnic cartridge is used for discharge, that there is no hazardous deterioration of the pyrotechnic. (Note: This is written as an airplane requirement. The equivalent extinguishing system requirement is that the system operate within the temperature design criteria -65 °F to 250 °F.)

4) Per FAR 25.1201:
   a) the agent shall not react with any material in the system to create a hazard. (Note: Typical materials used in current system components are listed in the table below.)

Component	Typical Material
Extinguisher Bottle	CRES, Titanium
Bottle Discharge Heads	7075 AL
Hose Fittings	AL
Discharge Hoses	tetrafluoroethylene inner tubes covered with braided CRES reinforcement wire, Stainless Flexi-Metal Hose
Discharge Tubing	6061-T6 AL, CRES
Tubing Fittings	AL, CRES
Discharge Nozzles	CRES

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)

Component	Typical Material
Engine Nacelle Fire Zones	Titanium, CRES, AL, Magnesium, Plastics

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

7) Inadvertent discharge of the agent should not require immediate cleaning of the areas 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 check of electrical continuity without discharging bottle.

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AIA HALON REPLACEMENT SYMPOSIUM
ENGINE/APU SUB GROUP

4-02-93 TELECONFERENCE MINUTES

Participants:

Lt. Gregg Caggianelli	USAF Wright Labs
Gle Dubrucq	McDonnell Douglas
Te y	USAF F22 SPO
Gle Harper	McDonnell Douglas
Chris Hummell	Lockheed
Don Hodge	USAF
Dan Landan	Sikorsky
Mike Parsons	HTL
Neil Richardson	HTL
Dunell Schull	ANSER
Deborah Walker	GRAB
Tony Wickstead	Gulfstream Aerospace
Bill Worthey	Lockheed

Discussion outline:

I. Agreement on "Significant Issues" and "Priorities" lists.

II. Status of Dunell Schull's effort to obtain copies of preliminary "Technical Development Plan" from DOD.

III. Review "Comprehensive Test Plan", specifically, the lists of parameters controlled during the test and data collected shown on pages 23 and 27, and the materials tested for compatibility in appendix C.

IV. General Comments and Discussion

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 Airframe & Engine Manufacturers Working Group Chairman as is on April 9 barring further member comment.

Glenn Dubrucq questioned whether detection systems on aircraft would have to be changed as a result of new agent selection. The concensus was that better detection would aid in

prevention of faults and false alarms, conserving the halon that is now available, and is desirable in new systems that may have less effective extinguishing agent. Discussion about various fire detection methods touched on machine vision detection technology, current electrical and pressure based detection loops, and a new linear thermocouple (from HTL) that meets new FAA HIRF requirements.

II. DOD Report

Dunell Schull 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 5-9.

III. Review of Test Plan

Comments on "Test Parameters" on page 23:

Internal Airflow: McDonnell Douglas has some installations that exceed (6000 cfm) the 2530 cfm max listed. The 0 minimum level did not make sense. Caggianelli stated the range had been changed to .6 lb/sec min and 2.5 lb/sec max. This max was based on facility constraints, not by choice.

Agent Dist. Sys: Bottle squib is actually a solenoid.

Vent. Air Temp: Range changed from 100°F -> 400°F to 100°F -> 260°F, again because of facilities constraints. The minimum is hoped to be lowered with chillers to around 0°F, which would be more desirable.

Bottle Press: 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.

Compart. Config: Dan Landan questioned whether composite nacelle materials were to be simulated; Lt. Caggianelli answered no.

Vent. Air Press: This realistically should be 2.3 psia to 20 psia to cover most flight conditions. Again, facility constraints dictates the range. The maximum of 20 psia has been changed to 17 psia. Glenn Harper stated that any trends in the data of less effectiveness at lower pressures should be watched carefully.

Compart. Surf. Temp: The max of 1500°F looked a little high. Max temp encountered by committee members was around 1300°F.

Fuel Temp: Still TBD, probably will have max < 250°F

Storage Bottle Temp: Still TBD, but probably will be -20°F min.

Also, fuel rate into the nacelle was questioned. Caggianelli believed the rate would be something higher than 8 gal/hr. Glenn Harper stated that some cases that still might not be covered in these ranges are high speed civil transports and some military projects that we are not aware of.

Comments on "Output Response Variables", page 27

No specifics, just that the group would like to see a more detailed instrumentation plan with ranges, accuracies, locations, etc. to form a more educated opinion.

Comments on Materials Testing in Appendix C

Looks too limited. Harper stated that according to Mike Bennett, even though steel and titanium corrosion testing was being done, this would not necessarily disqualify an agent.

IV. General Comments

The group still feels that certification (FAA or otherwise) of whatever agent(s) are identified is a top priority to airframe/engine/equipment manufacturers. The test plan from Wright Pat does not address this, nor is it designed to. The group sees the testing at Wright Pat culminating in a best 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" designers of systems 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 researches should be reminded of this early and often.

2) Deliverables:

Minutes of 4/2 telecon to be sent out by Hummell to working group.

b) "Significant Issues" and "Priority" lists will be sent to Bob Glaser, Co-Chair of Airframe/Engine working group by Friday, 4/9/93.

c) Copies of DOD report/plan related to halon will be sent to the group by Dunell Schull during week of 4/9.

d) Teleconference minutes and members notes will be collected by Worthey/Hummell for condensation into a "paper" for distribution to Glaser and Mike Bennett.

3) Next meeting:

TBD. The subgroup's next step is supposed to be "Solicit industry solutions" per Bob Glaser/Al Gupta. Worthey will discuss this with Glaser and inform group of next meeting.

SIGNIFICANT ISSUES TO BE ADDRESSED
(Engine and APU Bay Applications)

REV:B
03/17/93

5

1) Effectiveness:
- a) Required Concentration/Mass — A
- b) 3D Dispersion Characteristics
  - Effect of "Clutter"
  - Manifold Required, Flow Characteristics in Manifold, etc.
  - "Throw Distance"
- c) Required Duration
- d) System Weight and Volume
- e) Altitude Effects
- f) Detection — B

2) Operating Conditions:
- a) Max/Min Temperatures
- b) Max/Min Airflow
- c) Discharge Time Delay (Pre-Burn) — A
- e) Fuel Type (Hyd, lube, etc.)
- f) Engine/Bay materials
- g) Fuel Temperature — A
- h) Fuel Flow (Leak) Rate — A
- i) Fuel Flow Duration — A
- j) Fuel Pressure — A
- k) Agent/Pressure Characteristics — B
- l) Discharge Line Length — B

3) Health/Toxicity:
- a) Agent
- b) Combustion Products
- c) Post Fire Cleanup
- d) Post Discharge Cleanup (False Alarm)
- e) Human/Animals
- f) Manufacturing & Handling

4) Environmental Impact:
- a) Ozone Depletion Potential (ODP)
- b) Global Warming Potential (GPW)
- c) (deleted) — B
- d) Post Use Cleanup
- e) Manufacturing — A
- f) Regulatory Conformation/Approval — B

5) Certification/Qualification:
- a) New Sensors /Test Equipment/Procedures Required? — B
- b) [combined with a)] — B
- c) Required Concentration, Dispersion, Duration
- d) (deleted) — B
- e) Bottle Modifications (Press, Matl, Orifice, Propellant, etc) — A
- f) Multi Agency Concurrence — B

6

6) Material Compatibility/Corrosion:
- a) Agent
- b) Combustion Products
- c) Ambient Temperature
- d) Elevated Temperature/Pressure — A
- e) Cleanup/Neutralization Materials
- f) Consider Engine/APU, Bay, and Agent Container & Distr. Sys. — B
- g) Composite Material and Special A/C Coatings Compatibility — B

7) Miscellaneous
- a) Retrofitability
- b) On-line/International Availability — B
- c) Shelf Life
- d) Installed Life (on A/C) — B
- e) Cost
- f) Politically Correct?
- g) New Handling/Storage Procedures (Logistics) — B

SHORT LIST OF ISSUES

1) Agent effectiveness
- a) System Volume and Weight
- b) Detection System Changes
- c) Distribution Characteristics

2) Environmental/Toxicity
- a) Must be Zero ODP and GPW
- b) Agent Toxicity to Humans/Cleanliness

3) Compatibility
- a) Ease of Retrofit
- b) Logistics of New Substances

4) Corrosion
- a) Container/Supply System
- b) Clean-up After Release

5) Certification
- Functions for Sizing System

1

Design requirements and Objectives
Cargo compartment fire extinguishing systems

The following are the recommended requirements and objectives.

1 equirements.

1.1 The fire extinguishing system shall provide FAA mandated fire extinguishing capability.

[Note: The FAA will mandate the acceptable fire extinguishing capability. An Appendix to Part. 25 (similar to Appendix C or F) will provide information necessary to determine the required capability. The "required" capability will be based on analysis of probable fuel and ignition sources in the cargo compartment. Aviation industry and fire protection experts will help FAA, as required, to prepare this Appendix so that fire extinguishing capability for "any fire likely to occur in the cargo compartment", see FAR 25.851(b)(2), is ensured.]

1.2. The design fire extinguishing capability shall be provided when the cargo occupies no more than TBD% of the compartment useful internal volume.

[Note: The FAA will define TBD in the Appendix to Part 25 based on analysis of probable cargo load. The airline industry will help FAA define TBD. Typically, cargo compartments do not fly empty and in an empty cargo compartment there is nothing to burn.]

1.3. The fire extinguishing system shall quickly reduce heat release from a probable fire so that
(a) structural integrity of the airplane is not decreased [FAR 28.858(b)] and
(b) the continued safe flight and landing of the airplane is not compromised [FAR 125.1309(b)(1)]

[Note: The FAA will define means to show compliance with the above requirement in the Advisory Circular. The agent manufacturers and the airframe manufacturers will help FAA define the acceptable means: temperatures and temperature decay rate.]

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

[Note: 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 requirement.]

2

1. 5. The fire extinguishing system shall perform its intended function in ambient conditions probable in the cargo compartment.

[Note: Typical cargo compartment conditions: Temperature -40 °F to 130°F, Pressure 15.0 to 10.0 psia, Relative humidity 0-100%.]

1.6. The fire extinguishing system and its components shall not be adversely effected by temperature and pressure extremes which may occur during storage, test or in the event of on board system malfunctions or structural failure.

[Note: The probable extremes are Temperature -65 °F to 160 °F, Pressure 24.0 psia to 2.0 psia.]

1.7. The agent and its products of decomposition or combustion shall not be toxic in concentrations that may probably occur in service. In demonstrating compliance with this requirement the following shall be considered.
(i) Agent leak in the compartment that may occur during maintenance. [
(ii) Inadvertent agent release.

[Note: 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 requirement.]

1.8. The agent and its products of decomposition or combustion shall be compatible with materials of aircraft construction which may get exposed during service. Material mechanical properties shall not degrade following 24 hours of continuous exposure to probable concentrations.

1.9. The agent shall not damage the probable contents of a cargo compartment (packaged baggage, paper and paper products, unpowered and packaged electrical/electronic equipment, etc.) in the event of inadvertent agent discharge.

1.10. Inadvertent agent discharge shall not require immediate cleaning of the cargo compartment to prevent damage to the compartment or its contents. No special cleaning procedures and/or special chemicals shall be required to remove residue, if any.

1.11. The agent electrical conductivity shall not pose a hazard when used in the cargo compartment.

3

2.0 Objectives

2.1. The system shall have low life cycle cost.

2.2. The agent characteristics shall be such that existing halon 1301 fire extinguishing system equipment can be used to the maximum 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.The agent's fire extinguishing effectiveness shall be such that FAA mandated fire extinguishing capability can be provided using existing halon 1301 systems' hardware with minimum change.

Design Requirements and Objectives
Cabin Interior Fire Extinguishing Systems

1

ref a) FAR 25.851 Fire Extinguishers
b) D6-36097, Transport Airplane Certification Handbook - Everett Payloads Systems (section 28.0, page 95 - Fire Extinguishers)
c) FAA Advisory Circular AC 20-42, "Hand Fire Extinguishers For Use in Aircraft"
d) National Fire Protection Association, "Standards for Portable Fire Extinguishers", NFPA 10

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.iii applies.

iii) No discharge of the extinguisher can cause structural damage.

Test Protocol
Cargo compartment fire extinguishing systems

1

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. T test fuel and its packaging shall be defined by FAA.

[...estion: The fuel should be determined after a study of cargo compartment fires and the materials that have previously burned. This together with a study of materials that can be legally transported by air should facilitate determination of the probable fuel. A standard cardboard box, filled with a known weight of combustibles (paper, wood chips, cloth, etc.) soaked with a known volume of ethyl alcohol (simulate a suitcase with a broken bottle of Scotch) may form a probable fuel. This would require a consensus.]

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

[Suggestion: An electrical arching device with input power representative of a typical electrical circuit (15-30 amp, 110 volt) to represent a shorted electrical circuit or an electrical resistance heater of known heat flux simulating a compartment heating device (electrical blanket) or several packages of matches.]

1.3. Probable compartment ventilation The ventilation rate in the compartment should 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.

[Suggestion: Class C cargo compartments may be normally ventilated. The design ventilation rate is selected based on animal hauling requirements. For test purpose, the highest rate that is currently used in commercial fleet, in terms of cfm/ft^3 of compartment volume, during fuel burn, should be used. Also, the highest current rate of infiltration/leakage, in terms of cfm/ft^3 of compartment volume, during fire extinguishment should be used. If these rates are not exceeded, the data will be applicable to all compartments.]

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

[Suggestion: FAR 25.858(a) requires that the detection system must provide an indication to the flight crew within one minute after the start of the fire. Recognizing that after the indication additional time will elapse, before the fire extinguishing system procedures are implemented, 3 minutes after the start of the fire (or TBD minutes after warning threshold) may be a probable time for detection/crew reaction.]

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

[tion: Airplanes seldom fly with empty cargo compartments and when they do, the... is nothing to burn in the cargo compartment. A maximum ratio of 0.5 based on typical passenger load factors may be considered a probable factor.]

1.6 Probable fire location. The fire should be exposed to the ambient air.

[Suggestion: The probable ignition source for fire in a cargo compartment is a shorted electrical circuit or a heating blanket. These ignition sources will in all probability cause the ignition of the fuel that is exposed to the ambient air.]

1.7 Probable ambient conditions The tests should be conducted at

2.0 Design Objectives

2

2.1) Weight

a) The unit's gross weight should be kept to a minimum.

i) Consideration should be given to the agent's ratio of extinguishing ability to the quantity required to knock down the kinds of fires likely to occur.

2.2) Cleanability

a) The agent and its products of decomposition shall be cleanable with an aircraft approved cleaning agent.

2.3) Corrosive Properties

a) The agent and its products of decomposition should not be compatible with materials of aircraft construction which may get exposed during service.

b) The mechanical properties of materials of aircraft construction shall not degrade following 24 hours of continuous exposure to probable concentrations.

c) Inadvertent discharge shall not require immediate cleaning of interior components likely to be exposed.

d) The agent or its products of decomposition should not adversely affect electrical components nor be electrically conductive.

2.4) Temperature

a) The agent shall perform its intended function in ambient conditions probable in the passenger compartment and flight deck.

b) The agent and fire extinguisher shall not be adversely affected by temperature and pressure extremes which may occur during shipping, storage, or in-service.
(note: Temperature extremes in the passenger cabin and flight deck are considered to be -40 °F to 130 °F)

2.5) Fire Extinguisher Size

a) The unit's size should be as nearly the same as the existing halon extinguishers to facilitate exchangeability.

4.0 Test Procedure

2

With the compartment ventilated, and the instrumentation system recording temperatures, the ignition source should be exposed to the probable fuel. The fire should be considered started when a temperature greater than TBD is detected by a temperature sensor. The ignition source should be turned off after the probable detection/crew reaction time and the fire extinguishing procedure (ventilation shut off, fire extinguishing agent discharge) should be initiated.

[Suggestion: A temperature of 400 °F is suggested as an indication of the start of fire. Temperature is a good indicator of fire and its severity.]

5.0 Test conditions

The test described above should be conducted for several amounts of fire extinguishing agent discharges to determine the effect of agent weight on fire suppression.

6.0 Evaluation criteria.

The temperature data should be used for performance evaluation. The evaluation should be based on temperatures and temperature decay characteristics. The acceptable agent concentration should reduce temperature readings in the vicinity of the fuel below TBD °F, in less than TBD minutes after initiation of agent discharge and the temperatures should be decreasing. The agent concentration that meets the above criteria shall be tested three additional times to confirm its performance.

[Suggestion: Continued combustion requires that the combustion process generate thermal energy to sustain thermal decomposition of combustible material (pyrolysis) and provide energy for ignition of the combustible aerosols. A 350 °F temperature is suggested based on thermal particulate temperatures of 500°F for paper and 360°F for wool products. Five minutes is recommended for the agent to reduce the temperature.]

7.0 Fire extinguishing agent design concentration

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

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

[Suggestion Fire is probable during all flight conditions. At ground level, the oxygen partial pressure is the highest and the fire would have the greatest burn rate. It is suggested that all tests be conducted at laboratory conditions.]

2.0 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 70.0 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 cargo to the desired ratio of cargo to test chamber volume. The probable fuel load shall be located midway between two adjacent agent discharge nozzles.

[Note: Typically cargo compartments smaller than 1000 cubic feet are Class D. An exact configuration of the cargo compartment is not essential for tests. For end effects 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 to

…eneral Offices
…enter
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…33 1110

3M

…ar Fire and Safety Professional:

…hank you for your interest in 3M's new Clean Extinguishing Agents.

…M Brand Clean Extinguishing Agents (CEA's) are fluorocarbon compounds …at offer you an effective replacement to halon for use in occupied areas …nd applications requiring a clean, non-conducting agent.

…M now has two CEA products – one for total flood applications and a …econd for portable streaming devices. Both have an Ozone Depletion …otential (ODP) of zero.

…hope the attached information will help you in evaluating 3M CEA's as a …placement for halon in your critical fire suppression applications.

…you would like to discuss your Clean Extinguishing Agent needs today, …lease call me at 612/733-7937. I look forward to hearing from you.

…incerely,

Joan M. Leedy

…oan M. Leedy
…arket Development Supervisor
…ire Protection Systems
…12/733-7937

3M Brand PFC-410 Clean Extinguishing Agent

Description
PFC-410 is a fully fluorinated organic compound which has been tested and shown to effectively extinguish fires when used in a manner similar to Halon 1301.

Physical Properties (Not for specification purposes)

Chemical Formula	C_4F_{10}
Molecular Weight	238.03
Boiling Point at 1 ATM	28.4°F (-2.0°C)
Freezing Point	-198.0°F (-128.2°C)
Critical Temperature	235.8°F (113.2°C)
Critical Pressure	337 psia (23.23 bar)
Critical Volume	.025 ft³/lbm (.000159 m³/kg)
Critical Density	38.3 lbm/ft³ (630 kg/m³)
Critical Compressibility Factor	.273
Density, Sat. Liquid, 25°C	94 lbm/ft³ (1.517 g/ml)
Density, Gas, 1 ATM, 25°C	.62 lbm/ft³ (9.835 kg/m³)
Specific Volume, 1 ATM, 20°C	1.62 ft³/lbm (.101 m³/kg)
Specific Heat, Liquid, 25°C	0.25 BTU/lbm-°F (1045 J/kg·°C)
Specific Heat, Vapor, 1 ATM, 25°C	0.192 BTU/lbm-°F (805 J/kg·°C)
Heat of Vaporization at b.p.	41.4 BTU/lbm (96.3 J/g)
Thermal Conductivity, Liquid, 25°C	.031 BTU/hr-ft-°F (0.053 W/m·°C)
Viscosity, Liquid, 25°C	4.08 x 10⁻⁴ lbm/ft-sec (6.42 x 10⁻⁴ Poiseuille)
Relative Dielectric Strength, 1 ATM, 25°C (N_2=1.0)	5.25
Solubility of water in PFC-410, 25°C	0.001% by wt.
Vapor Pressure, 25°C	42 psia (2.9 bar)

Applications
PFC-410 is best suited for total flood fire protection, explosion suppression and inerting applications which demand a fire extinguishing agent that is clean, gaseous, electrically non-conductive and low in toxicity.

Fire Extinguishing Performance

Extinguishment Concentration Using Cup Burner Method

Fuel	Concentration (Vol. %) PFC-410	Halon 1301	Fuel	Concentration (Vol. %) PFC-410	Halon 1301
Heptane	5.9	3.9	Methyl Ethyl Ketone	5.9	4.0
Methanol	9.4	7.8	Methyl Isobutyl Ketone	5.5	3.5
Ethanol	6.8	4.7	Hexane	5.8	3.9
Isopropanol	6.2	3.9	Cyclohexane	5.5	3.9
N-Butyl Alcohol	6.7	4.9	Isooctane	5.5	3.5
Benzyl Alcohol	5.5	4.7	Jet Fuel (JP-4)	5.0	4.0
Acetone	5.5	3.5	Toluene	4.2	2.7

This data was obtained by using the "cup burner" test method. Concentrations vary depending on the particular apparatus used. Data is most useful when compared to a standard, such as the Halon 1301 data which was tested on the same cup burner apparatus.

Total Flood Applications
PFC-410 has been tested in total flood applications using standard Halon 1301 equipment pressurized to 360 psi with nitrogen. When tested on class A and B fires, the fire extinguishing performance of PFC-410 at a concentration of 6.6 volume percent was comparable to Halon 1301 at a concentration of 5.0 volume percent. On a weight basis, PFC-410 requires approximately twice the quantity of agent as Halon 1301 for the extinguishment of similar fire scenarios.

Inerting Effectiveness

Fuel	Concentration (Vol. %) PFC-410	Halon 1301
Methane	7.8	6.9
Propane	9.0	6.0

Environmental
PFC-410 does not contain chlorine nor bromine and does not contribute to the destruction of stratospheric ozone. PFC-410 has an ozone depletion potential of zero. Due to its chemical stability, PFC-410 does have a long atmospheric lifetime. However, calculations based on maximum anticipated usage levels of PFC-410 and related perfluorocarbon products conclude that their combined usage will have an insignificant effect on global warming.[1] Additionally, the atmospheric release of PFC-410 will be much less than the maximum usage levels described above by 1) limiting use to critical applications 2) limiting atmospheric release to fire emergencies and 3) recycling agent from decommissioned systems.

Toxicity
Perfluoroalkanes, like PFC-410, are essentially chemically inert. They have been produced in commercial quantities by 3M for over 30 years and have proven to be very low in toxicity. Acute toxicity of PFC-410 is greater than 800,000 ppm (LC_{50} Rats; 4 hours). Additional toxicity tests now under way are expected to show that PFC-410 has the same very low toxicity seen with other perfluoroalkanes. Toxicity information for PFC-410 is available from Material Safety Data Sheets and Product Toxicity Summary Sheets.

Regulatory Approvals
Documentation on PFC-410 has been submitted to the following agencies in order to obtain an approval or listing:
Underwriters Laboratory (UL)
Factory Mutual Research Corporation (FMRC)
National Fire Protection Association (NFPA) Document 2001 – Clean Agent Standard
Environmental Protection Agency (EPA) – Significant New Alternatives Policy (SNAP)

Electronic Equipment Compatibility
PFC-410 is electrically nonconductive. It will not damage electronic equipment or leave a residue.

Materials Compatibility and Storage
PFC-410 exhibits excellent materials compatibility with common metals, plastics and elastomers. PFC-410 will not degrade during long term storage.

Additional Information
For additional information on 3M Brand PFC-410 Clean Extinguishing Agent, please call 612/733 7937.

Important Notice to Purchaser: All statements, technical information and recommendations contained herein are based on tests conducted with 3M approved equipment, and are believed to be reliable, but the accuracy or completeness thereof is not guaranteed, and the following is made in lieu of all warranties, expressed or implied, including the implied warranties of merchantability and fitness for purpose:

Seller's and manufacturer's only obligation shall be to replace such quantity of the product proved to be defective. Before using, user shall determine the suitability of the product for its intended use, and user assumes all risk and liability whatsoever in connection therewith. NEITHER SELLER NOR MANUFACTURER SHALL BE LIABLE EITHER IN TORT OR IN CONTRACT FOR ANY LOSS OR DAMAGE, DIRECT, INCIDENTAL, OR CONSEQUENTIAL, ARISING OUT OF THE USE OF OR THE INABILITY TO USE THE PRODUCT. No statement or recommendation not contained herein shall have any force or effect unless in an agreement signed by officers of seller and manufacturer.

[1] Calculations show that the maximum anticipated use levels of perfluorocarbon products would have a potential effect on global warming of <0.005°C, assuming a typical product lifecycle of 30 years.

…M Brand PFC-614 …lean Extinguishing Agent

…escription
…C-614 is a fully fluorinated organic compound which has been tested and shown to effectively …inguish fires when used in a manner similar to Halon 1211.

…ysical Properties (Not for specification purposes)

Chemical Formula	C_6F_{14}
Molecular Weight	338
Physical State at 25°C	Liquid
Pour Point	-130°F (-90°C)
Boiling Point	132°F (56°C)
Liquid Density	105 lbm/ft³ (1.68 g/ml)
Liquid Viscosity	0.00045 lbm/ft. sec. (0.00068 Poiseuille)
Vapor Pressure at 25°C	4.5 psia (0.31 bar)
Heat of Vaporization at b.p.	38 BTU/lbm (88.4 J/g)
Liquid Thermal Conductivity at 25°C	0.033 BTU/hr.ft. °F (0.0571W/m°C)
Critical Temperature	352.4°F (178.0°C)
Critical Pressure	266.1 psia (18.3 Bar)
Solubility of Water in PFC-614 at 25°C	0.001% by wt.

…plications
…-614 is best suited for streaming fire protection applications which demand a fire extinguishing agent …is clean, electrically non-conductive and low in toxicity.

…Extinguishing Performance

USAF Flammable Liquid Fire Extinguishing Tests
Typical Extinguishment Data

…nt	Fire Size (Sq. Ft.)	Extinguishment Time (Seconds)	Agent Used (Pounds)	Flow Rate (lbs./sec.)
…-614	4.0	2.5	2.3	0.9
…-614	32.0	5.5	15.0	2.7
…-614	75.0	12.5	60.0	4.8
…-614	75 – 30	13.0	67.0	4.9
…-614	150.0	15.6	84.0	5.4
… Halon 1211	75 – 30	32.0	65.0	2.1)

…se fires were run with 1/4" of JP-4 fuel with 30 to 60 seconds preburn time. The USAF Halon 1211 …ighting Agent Replacement Program selected PFC-614 as the clean agent replacement chemical …wing over 5 years of research and after the detailed cataloging and analysis of over 800 candidate …micals. PFC-614 is comparable to Halon 1211 in typical USAF flightline fire scenarios. The suitability of …-614 as a general Halon 1211 replacement agent has not yet been verified.

Fire Extinguishing Performance (continued)

Extinguishment Concentration Using Cup Burner Method

Fuel	Concentration (Vol. %)
Heptane	4.0
Butane	3.7

Thermal Decomposition Products
Using various extinguishing agents, the USAF evaluated thermal decomposition products generated during flightline fire extinguishing scenarios. PFC-614 generated a lower level of acid gases than Halon 1211.

Thermal Decomposition Product Generation Rates

Combustion Products	Halon 1211	PFC-614
HCl/HBr/HF (PPM)	265.0	120.0

Environmental
PFC-614 does not contain chlorine nor bromine and does not contribute to the destruction of stratospheric ozone. PFC-614 has an ozone depletion potential of zero. Due to its chemical stability, PFC-614 does have a long atmospheric lifetime. However, calculations based on maximum anticipated usage levels of PFC-614 and related perfluorocarbon products conclude that their combined usage will have an insignificant effect on global warming.[1] Additionally, the atmospheric release of PFC-614 will be much less than the maximum usage levels described above by 1) limiting use to critical applications 2) limiting atmospheric release to fire emergencies and critical training exercises and 3) recycling agent from decommissioned systems.

Toxicity
Perfluoroalkanes, including PFC-614, are essentially chemically inert. They have been produced in commercial quantities by 3M for over 30 years and have proven to be very low in toxicity. Acute toxicity of PFC-614 is greater than 300,000 ppm (LC_{50} Rats; 4 hours). Toxicity information for PFC-614 is available from Material Safety Data Sheets and Product Toxicity Summary Sheets.

Electronic Equipment Compatibility
PFC-614 is electrically nonconductive. It will not damage electronic equipment or leave a residue.

Materials Compatibility and Storage
PFC-614 exhibits excellent materials compatibility with common metals, plastics and elastomers. PFC-614 will not degrade during long term storage.

Additional Information
For additional information on 3M Brand PFC-614 Clean Extinguishing Agent, please call 612/733 7937.

Important Notice to Purchaser: All statements, technical information and recommendations contained herein are based on tests conducted with 3M approved equipment, and are believed to be reliable, but the accuracy or completeness thereof is not guaranteed, and the following is made in lieu of all warranties, expressed or implied, including the implied warranties of merchantability and fitness for purpose:

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[1] Calculations show that the maximum anticipated use levels of perfluorocarbon products would have an effect on global warming of <0.005°C, assuming a typical product lifecycle of 30 years.

Chemical and Physical Properties

	PFC-410	Halon 1301
Chemical Formula	C_4F_{10}	$CBrF_3$
Molecular Weight	238	148.9
Heat of Vaporization KJ/kg and (BTU/lbm, mol)	22.8 at -2°C (9801 at 28°F)	12.3 at 21°C (5292 at 70°F)
Normal Boiling Point	-2.2°C (28°F)	-57.8°C (-72°F)
Vapor Pressure MPa (psia)	0.330 at 32°C (47.9 at 90°F)	1.47 at 21°C (213.7 at 70°F)
Critical Temperature	113.2°C (235.8°F)	67°C (152.6°F)
Critical Pressure	2.32 MPA (337 psia)	3.97 MPa (575 psia)
Liquid Density kg/m³ (lbm/ft³)	1517 at 20°C (94.6 at 68°F)	1567 at 21°C (97.8 at 70°F)

3M Clean Extinguishing Agents offer you a realistic alternative to ozone-depleting halon extinguishants. They are available now in commercial quantities for use in both fixed and portable systems.

Chemical and Physical Properties

	PFC-614	Halon 1211
Chemical Formula	C_6F_{14}	$CBrF_2Cl$
Molecular Weight	338	165.4
Heat of Vaporization (BTU/lbm.)	38	58
Normal Boiling Point (°C)	56	-4
Vapor Pressure @ 25°C (psia)	4.5	40.8
Critical Temperature (°C)	178	154
Critical Pressure (psia)	266	610
Liquid Density (kg/m³)	1680 @ 25°C	1815 @ 20°C

For more information:
Fire Protection Systems
3M Center
Bldg. 223-6S-04
St. Paul MN 55144-1000
612/736-6055
(Product Information)
612/733-0444
(Ordering Product)

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DU PONT ALTERNATIVE

FIRE EXTINGUISHANTS

FE-13 for Total Flooding Agent Applications

TABLE 1

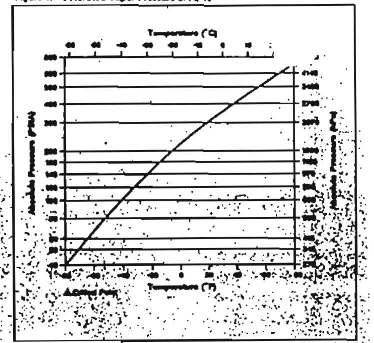
Properties of Du Pont Alternative Fire Extinguishant

Comparison of CO_2 and FE-13

Comparison of CO_2 and FE-13

Toxicity

Figure 1. Saturated Vapor Pressure of FE-13



Specification

Availability

Cost

Additional Information

Compatibility

DU PONT ALTERNATIVE

FIRE EXTINGUISHANTS

FE-241 Fire Extinguishing Agent

Comparison of Du Pont FE-241 to Halon 1211

Property	Halon 1211	FE-241
Chemical Formula	CF_2ClBr	CF_3CHClF
Ozone Depletion Potential	4	0.02
Molecular Weight	164.5	136.5
Boiling Point °F/°C	24.8/ -4.0	12.2/ -11.0
Critical Temperature °F/°C	308.8/153.8	252.0/122.2
Liquid Density at 77°F/25°C lbs/ft³ / kg/m³	112.2 / 1797	85.15 / 1364
Vapor Pressure at 77°F/25°C psia / kPa	40.0 / 275.8	61.0 / 420.6
Heat of Vaporization at 77°F/25°C BTU/lb / cal/gm	52.6 / 29.2	64.8 / 36.0
Extinguishing Concentration, n-heptane, cup burner, % by volume	3.8	7.0
Acute Toxicity ALC (rats, 4 hrs., ppm)	85,000-100,000*	>230,000 <295,000
Relative Dielectric Strength at 1 Atm and 77°F/25°C Nitrogen = 1	–	1.5

*Estimated value

Description

FE-241 is a residue-free, colorless, nearly odorless, electrically nonconductive gas which is an effective medium for extinguishing fires. Du Pont believes that this agent should be evaluated as a replacement for high ozone-depleting fire extinguishing materials such as Halon 1211. Chemically FE-241 is chlorotetrafluoroethane ($CHClFCF_3$). At ambient conditions it is a gas, but is normally stored under pressure as a liquified compressed gas.

Performance

FE-241 extinguishes fire by both physical and chemical means. Primarily, it raises the total heat capacity of the environment to the point that the atmosphere will not support combustion. In practice, however, extinguishment occurs at concentrations less than the theoretical heat capacity value. This is explained by assuming that the agent also removes free radicals which serve to maintain the combustion process.

The cup burner test is a method which evaluates the extinguishing ability of a substance apart from the delivery system. By this test, the extinguishing concentration of FE-241 is 7.0% by volume on a n-heptane fire. n-Heptane is considered similar to gasoline. Of the common liquid fuels, methanol is generally the most difficult to extinguish, and in this case, the extinguishing concentration for FE-241 is 14% by volume. For total flooding applications the minimum design concentration should be the cup burner value plus a 20% safety factor.

Applications

The lower boiling point (12.2°F) of FE-241 means that at ambient conditions it will be in the gaseous state and therefore suitable as a total flooding agent. Suggested applications are total flooding of cabinets and modules containing electrical and electronic boards, under floor volumes, engine compartments, and other unoccupied volumes. Toxicity considerations preclude using FE-241 for total flooding of normally occupied spaces.

FE-241 should also be evaluated for use in portable fire extinguishers as a replacement for Halon 1211. However, because of differences in efficiency and physical properties from that of Halon 1211, hardware modifications may be required.

Where it is desired to increase the pressurization level of FE-241 or enhance its volatility, consideration should be given to blending it with FE-13, a higher pressure Du Pont fire extinguishing agent. By using FE-13 in place of nitrogen for pressurization, higher fill densities may be possible.

Toxicity

Testing to date indicates that FE-241 has a low order of acute, subacute and subchronic toxicity. In addition, FE-241 has not been shown to be a mutagen or a teratogen.

Du Pont has established an Acceptable Exposure Limit (AEL) for FE-241 of 500 ppm by volume. This is a time-weighted average concentration which is set to prevent health effects on workers during shifts of eight or twelve hours. However, it is anticipated that under fire fighting conditions, exposures will be brief, but at higher levels. A safe exposure limit for fire fighting situations is yet to be established by Du Pont.

Further toxicological testing of FE-241 is being done under the auspices of the Program for Alternative Fluorocarbon Toxicity Testing (PAFT). Members of this cooperative research effort are the leading producers of chlorofluorocarbons from around the world. PAFT intends to publish all studies in peer-reviewed scientific journals.

When exposed to open flames, FE-241 will decompose and produce hydrofluoric acid (HF) and hydrochloric acid (HCl). The amount of HF and HCl will depend upon the size of the fire and the speed of extinguishment. Even at low levels, these decomposition products have a very acrid odor and are easily detected by the human senses. The natural tendency to escape exposure should be heeded.

Environmental

FE-241 is in the class of substances known as hydrochlorofluorocarbons (HCFCs) which have a much reduced, but measurable Ozone Depletion Potential (ODP). The ODP of FE-241 is 0.02 which is very low, even in the HCFC category. It is a short-lived HCFC with an atmospheric lifetime of seven years. By comparison, Halon 1211 has an ODP of 4, so replacing it with FE-241 offers a 200-fold advantage.

Compatibility

Du Pont's experience with FE-241 and like substances indicates no compatibility problems with common metals during storage as long as moisture is excluded. Controlled testing is limited, but in one case, FE-241 was stored for 259 days at 100°F (37.8°C) in a tin-plated steel container without any sign of corrosion.

Elastomeric materials vary from source to source and should be evaluated before selection as sealants for long-term storage. Limited testing indicates that Neoprene W and butyl rubber are acceptable, but Buna N may not be.

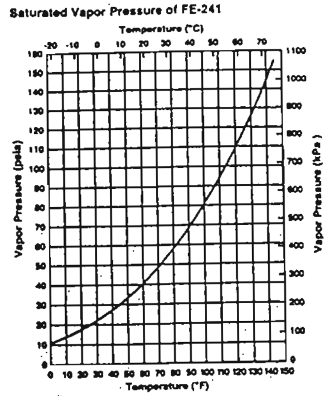
Plastic materials have not been tested with FE-241, but experience indicates that substances like FE-241 are suitable for use with nylon, polypropylene, and polyethylene. However, compatibility tests should be made for specific applications.

Specification

Du Pont's quality specifications for FE-241 guarantee a very pure and essentially residue-free product.

Purity, % by weight minimum	99.7
Moisture, ppm by weight, maximum	10
Acidity, ppm by weight, expressed as HCl, max.	0.1
Residue, % by volume, maximum	0.01

Saturated Vapor Pressure of FE-241



Availability

FE-241 is currently in production, but in limited quantities. During 1992, another facility will come on stream and enhance Du Pont's ability to supply developmental and commercial quantities of this product.

Du Pont reserves the right to limit or withhold commercial sales for any particular end-use.

Cost

At full commercial production, the price of FE-241 is expected to be between 2 and 2½ times the traditional (pre-tax and regulation) price of Halon 1211.

Additional Information

Further inquiry regarding FE-241 and other Du Pont alternative fire extinguishants can be made by phone to (800) 441-9442 or by mail to Du Pont Chemicals, Barley Mill Plaza 13-2150, P.O. Box 80013, Wilmington, Delaware 19880-0013.

If you are inquiring from Europe, Middle East or Africa, contact:
Christophe Dardel
Du Pont de Nemours International S.A.
Chemicals Department
P.O. Box 50
CH 1218 Geneva, Switzerland
Tel: +41 22 717 5111
Fax: +41 22 717 5109

DU PONT

Properties of DuPont Alternative Fire Extinguishants

STREAMING AGENTS				TOTAL FLOODING AGENTS		
Halon 1211	FE-232	FE-241		HALON 1301	FE-13	FE-25
CF_2ClBr	CF_3CHCl_2	CF_3CHClF	Chemical Formula	CF_3Br	CHF_3	CF_3CHF_2
4	0.02	0.02	Ozone Depletion Potential	16	0	0
24.8	82.2	12.2	Boiling Point (°F)	-72.0	-116.7	-55.3
4.0	13	61.0	Vapor Pressure at 77°F (psia)	234.8	665	190
3.8	7.5	7.0	Extinguishing Concentration heptane, cup burner (% by volume)	3.5	12.0	8.1
85,000 100,000•	32,000	>230,000 <295,000	Acute Toxicity (ALC or LC_{50} RATS; 4hrs. ppm.)	400,000- 800,000•	>650,000	>700,000
N/A	Yes	Yes	Commercially Available	Yes	Yes	Yes

•Estimated Values

EFFECTIVENESS OF REPLACEMENT AGENTS

AT DESIGN CONCENTRATIONS VS. HALON 1301

AGENT	DESIGN CONCENTRATION	POUNDS PER 1000 FT³	RATIO TO 1301
Halon 1301	5%	20.6	1.00
FE-13	16%	34.7	1.68
FE-241	8.5%	33.8	1.64
FE-25	10%	35.1	1.70
Heptafluoropropane	7%	34.1	1.66
Perfluorobutane	7%	46.3	2.25

NOTE: Design concentrations for Halon 1301, FE-13 and FE-241 exceed cup burner +20%.

WALTER KIDDE Aerospace October 13, 1993

AIRCRAFT FIRE EXTINGUISHER AGENT ACTIVITIES

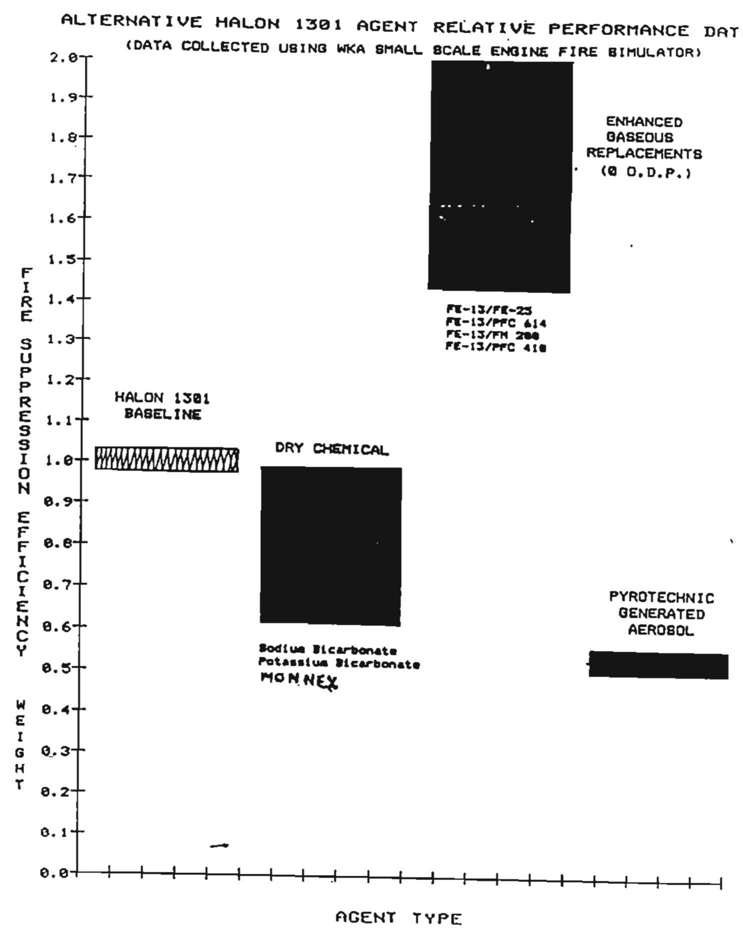
- RECYCLING/BANKING HALON 1301
  - ♦ REACH SYSTEM
  - ♦ 100,000 LB. BANK @ WKA
  - ♦ ACTIVELY CONVERTING HALON 1301 COMMERCIAL → CRITICAL USE
- EVALUATING NEW AGENT PERFORMANCE
  - ♦ ENGINES & APU'S
  - ♦ CARGO BAYS
  - ♦ LAVATORY WASTE BINS

WALTER KIDDE Aerospace October 13, 1993

SYSTEM WEIGHT IMPACT ESTIMATES

AGENT	N.I.S.T. FSN (VOLUME)	SYSTEM WEIGHT RATIO ESTIMATES	COMMENT
HFC-134A ($C_2H_2F_4$)	2.2	2.14	• SNAP APPROVED • COMBUSTIBILITY CONCERNS
HFC-125 (C_2HF_5)	2.1	2.08	• SNAP APPROVED • UNOCCUPIED SPACES ONLY
HFC-227 (C_3HF_7)	1.9	1.72	• SNAP APPROVED
CF_3I	1.2	1.35	• NEW CANDIDATE • NOT IN PRODUCTION • TOXICITY & CORROSION ISSUES UNCERTAIN
HALON 1301 (CF_3Br)	1.0	1.0	• BASELINE
$NaHCO_3$	0.5	0.58	• DRY CHEMICAL CLEAN UP & CORROSION CONCERNS

KIDDE Technologies, Inc.



WALTER KIDDE Aerospace October 13, 1993

- 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

SPECTREX, INC.

HALON ALTERNATIVES

"Fighting Fire With Fire"

Presenters

Jerry A. Brown

SFE - NOVEL 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

ADVANTAGES 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 LIMITED

- One of the Original Pioneers in High Speed Detection and Fire Suppression for Combat Vehicles
- Flame and Explosion Detectors
- Optical Gas and Vapor Detectors
- Ship Damage Control Systems
- Fire Extinguishing Novel Technologies

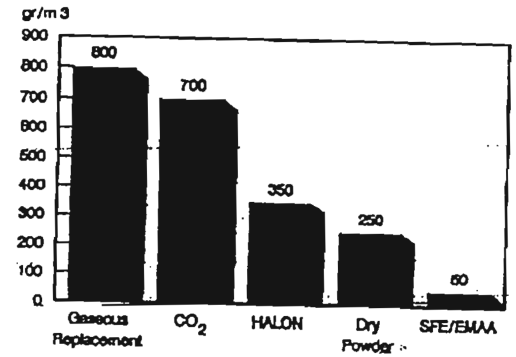
EXTINGUISHANT COMPARISONS

	HALON 1301	Gaseous Replace	CO_2	SFE/EMAA
1. ODP	High	Low/Zero	Zero	Zero
2. GWP	Moderate	Low/High	Zero	Nil
3. Toxicity	Low	Low	High	Low
4. Conductivity	Low	Low	Low	Low
5. Corrosivity	Moderate	Mod-Low	Mod-Low	Unk
6. Vol. Efficiency	Good	Moderate	Low	Excellent
7. Ext. Concentration	5%	10-15%	45%	-----
8. Ext. Density	300 g/m³	600-800 g/m³	700 g/m³	50 g/m³
9. Cost	$150/m³	>$250/m³	$150/m³	$50/m³
10. Life Cycle Cost	High	High	High	Low

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



MOD PRESENTATION TO THE HALON ALTERNATIVE WORKING GROUP AT FAA ATLANTIC CITY 13 & 14 OCTOBER 1993.

INTRODUCTION

My name is Ian Harris I work in Future Systems (Air)53 within the Directorate of Future Systems (Air) (DFS(Air)) in Controller Aircraft (CA) in the Ministry of Defence (Procurement Executive) (MOD(PE)). My main responsibility is that of the Specification Authority for Aviation Fuels and Engine Lubricants but I also cover the Montreal Protocol aspects for CA. The MOD(PE) specifies and procures equipment for the UK armed forces with CA responsible for the aircraft of all three services.

UK is a party to the Montreal Protocol and complies with consequent European Community legislation. MOD has been active in the meetings of the Parties to the Montreal Protocol supporting the UK Dept of the Environment. In addition we have participated in the United Nations Environment Programme (UNEP) Halons Technical Options Committee.

MOD MONTREAL PROTOCOL TASK FORCE

Within the MOD a small group of scientists and support staff has been set up to identify necessary changes within MOD to allow compliance with the Montreal Protocol. From this was set up the Montreal Protocol Task Force which brings together representatives from across the complete spectrum of MOD and acts as a focus for work in this area. One of the tasks has been to evaluate and list the applications of controlled substances which MOD considers to be essential. Subsequently to initiate procurement and management of recycling and banking facilities. The Halons Alternative Working Group has been set up by the Task Force to allow exchange of information. I will be feeding back the major points from this meeting.

AIRCRAFT SYSTEMS - ESSENTIAL USE STATUS

All fire suppression systems on the existing aircraft fleet, mainly using BCF (UK design), but some BTM (US design), have been designated as essential. Supplies from non essential applications have been located and will be recycled and banked.

HALON REPLACEMENT ACTIVITIES

The MOD UK Air Systems activities on Halon replacement are in three main areas. Firstly, alternatives to Halons for hand held extinguishers are being actively pursued with industry. Secondly MOD is monitoring the ongoing work on alternatives and proposals for future work both nationally and internationally, and is considering where it is necessary to make an input. Thirdly, Defence Standard 00-970 'Design & Airworthiness Requirements for Service Aircraft' is being updated to take account of developments and incorporate appropriate CAA and FAA regulations.

CONCERNS

The MOD UK Air System concerns are as follows. Firstly how to adequately specify alternative systems, have we sufficient data to be able to specify the required performance? Secondly, how can we be confident that the alternative systems will perform adequately. Should the performance of Halon systems be used as a measure of what is acceptable? Is a new set of test standards necessary? Thirdly, how can we be confident that the alternative materials are safe? Are we able to agree a definition of the minimal or acceptable effects of contact with the material or with the material decomposition products? This applies to living creatures - humans and live cargo and to the aircraft itself.

IDEAL SOLUTIONS

Ideally any alternatives to Halons should be drop in replacements. In addition from the logistic point of view we require the minimum number of alternatives.

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Presentation to

INTERNATIONAL HALON REPLACEMENT WORKING GROUP MEETING

at

FAA TECHNICAL CENTER
[illegible]ANTIC CITY INTERNATIONAL AIRPORT, NJ
October 13-14, 1993

by

Elio Guglielmi
[illegible]orth American Fire Guardian Technology Inc.

KEY FACTORS AEROSPACE INDUSTRY

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

	NAF S-III	HALON 1301
ENVIRONMENTAL IMPACT		
Ozone Depletion	0.044	16
Global Warming Potential	0.1	0.80
Atmospheric Lifetime	7 years	107 years

2. TOXICITY

Independent testing by British Columbia Research Corporation has concluded that due to the NAF XX component, when exposed to high temperature flames, NAF S-III reduces acid toxic fumes. The reason for this is that the detoxifying agent in NAF S-III scavenges the more toxic halogenated compounds from the atmosphere (British Columbia Research Corporation Report, September 16, 1991).

NAF S-III's acute toxicity of 640,000 ppm (LC_{50}) is well above the level that would be encountered in an emergency situation.

NAF S-III itself introduces no risk, although as with Halon 1301 the decomposition products might. NAF S-III gives off an easily detected odour which clearly signals the need to evacuate or ventilate long before reaching a hazardous level.

Personnel may be exposed to NAF S-III vapours in low concentrations for short periods of time without risk to their health or safety. As with Halon 1301, exposure to high concentrations for prolonged periods may produce dizziness, impaired coordination and disturbances in cardiac rhythm.

3. CARDIAC SENSITIZATION

The design concentration for NAF S-III is 8.6%, however, it has been tested to a 10% concentration. The tests were conducted by an independent laboratory under the supervision of ABA Bio-Research Laboratory of Montreal, Quebec, following accepted pharmacological principles and methods published by Reinhardt et al 1971 (Arch.Env.Hlth 22 265-279), as required by the EPA. Based on these tests, it is considered that the NOAEL and LOAEL for NAF S-III is, in fact, greater than 10%. Regardless, as with most synthetic chemicals, unnecessary exposure is not recommended.

Concentrations - NAF S-III

TYPE OF ENCLOSURES	CONCENTRATION % BY VOLUME IN AIR	MAXIMUM TIME FOR EXPOSURE
Normally Occupied Area	up to 10% 10% to 15% 16% to 20%	2 minutes 1 minute 30 seconds

Table 4
Toxicity - Comparison Chart (ALC or LC_{50})

NAF S-III	Halon 1301
320-640,000 ppm	400-800,000 ppm

Table 5
Lethal Concentrations

Component	LC_{50} (%)
NAF S-III	64*

* The lethal concentration for 50% of the population was calculated from the LC50s of the individual components.

[illegible] Elemental Mole Ratio

$$\frac{1}{LC_{50}(mixture)} = \frac{mole\%(F123)}{LC_{50}(F123)} + \frac{mole\%(F124)}{LC_{50}(F124)} + \frac{mole\%(F22)}{LC_{50}(F22)} =$$

$$\frac{mole\%}{LC_{50}\%} \quad \frac{2.09\%}{6.3\%} + \frac{6.47\%}{57\%} + \frac{88.01\%}{79\%} = 1.57$$

$$LC_{50} = \frac{1}{1.57} = 64\% = 640{,}000 \text{ ppm for 15 minutes}$$

Safety Factor of 10:

$$\frac{64\%}{10} = 6.4\%$$

$$\frac{15 \text{ MINUTES}}{\left(\frac{8.6\%}{6.4\%}\right)^2} = 8.3 \text{ MINUTES}$$

CRITERIA	NAF S-III PERFORMANCE
MATERIAL COMPATIBILITY	NAF agents have shown no negative reaction on metals commonly used in aerospace engines and compartments.
ELECTRICAL CONDUCTIVITY	Non-conductive

CRITERIA	PERFORMANCE NAF S-III	HALON 1301
EFFICIENCY		
By Volume: Design concentration	8.6%	5%
By Weight: Metric	360 grams/m³	331 grams/m³
Imperial	0.0226 lb./ft.³	0.0206 lb./ft.³

CRITERIA	NAF S-III PERFORMANCE
EFFICACY	• Proven Fire Suppressant • Approvals: ULC listed, ULC recognized, SASO listed • Listed in proposed Federal Registry under EPA's SNAP Program • Listed in tentative NFPA 2001 standard for halon alternatives

NAF S-III is virtual drop-in replacement for Halon 1301.

NAF S-III has proven to extinguish fires consistently at concentrations of 7.2% (300 g/m³ or 0.0187 lb./ft.³ at sea level).

CARGO COMPARTMENT SIZE	CONTAINER SIZE NAF S-III	HALON 1301
1,100 ft.³	3.960 kg.	3.641 kg.
4,000 ft.³	14.400 kg.	13.240 kg.

D.O.S. [illegible] -0-0.5 (Workplace Hazardous Materials Information System) legislation clearly sets out the test methods and classification list for use when deciding whether or not a product is a controlled product within the meaning of classes A, B, D, E and F. (see Class D - Poisonous and Infectious Material, Part IV of the "Controlled Product Regulations" (CPR), Section 1 - Acute Lethal Effect - OECD Test Guideline No. 403).

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PORTUGAL
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Re: Discharge times for NAF S-III.

Dear Mr. Guglielmi:

I recently came across a paper by Factory Mutual Research Corp. which among other things dealt with factors influencing discharge times of halon 1301 and alternatives. There are three physical properties identified as exerting the most influence on discharge times. They are vapour pressure, gas density, and heat of vapourization. Discharge times go down as vapour pressure and gas density go down and decrease as the heat of vapourization increases. NAF S-III has a lower vapour pressure and gas density than halon 1301 and a much higher heat of vapourization. All factors favour reduced discharge times with NAF S-III. These other factor should more than outweigh the additional quantities of NAF S-III required relative to halon 1301 and thus should allow NAF S-III to act as a drop-in replacement in any halon 1301 piping system.

CRITERIA	PERFORMANCE NAF S-III	HALON 1301
BOILING POINT/HEAT VAPORIZATION		
Sea level	-38.3°C (-36.9°F)	-57.75°C (-55.6°F)
36,100 feet	-68°C	
65,600 feet	-87°C	
82,000 feet	-102°C	

Table 1
Physical Properties

Property	NAF S-III*	Halon 1301**
Ozone Depletion Potential	0.044	16
Global Warming Potential	0.1	0.80
Lifetime in Atmosphere (years)	7	107
Molecular Weight	92.9	148.93
Boiling Point at 1 atm °C	-38.3	-57.75
Critical Temperature °C	125	67
Critical Pressure (bar)	66.5	67.0
Critical Density (kg/m³)	580	745
Density of Liquid at 25°C (g/ml)	1.20	1.57
Specific Heat of Liquid at 25°C [J/(kg.°C)]	1250	870
Heat of vaporization at boiling point (kJ/kg)	227	118.8
Viscosity of liquid at 25°C (centipoise)	0.21	0.159
Acute Toxicity (LC_{50}) (ppm)	320-640,000	400-800,000
Solubility in water at 25°C (weight %)	0.06	0.03
Physical State	Liquid Vapour	Liquid Vapour
Melting (Freezing) Pt. °C	< -107	-168

[illegible]

Table 2
Decomposition Byproducts

		NAF S-III with XX	NAF S-III without XX	WCB* 8 hr limit
HCl	ppm	1.6	5.4	5
	mg/m³	2.5	8.2	7
F_2	ppm	2.6	13.4	3
	mg/m³	4.1	21.1	2
Cl_2	ppm	0.2	0.8	1
	mg/m³	0.5	2.2	3
COX_2	ppm	< 0.02	0.15	0.1
as $COCl_2$	mg/m³	< 0.09	0.6	0.4

*Workers' Compensation Board (Canada)

Table 3
Concentrations - NAF S-III

TYPE OF ENCLOSURES	CONCENTRATION % BY VOLUME IN AIR	MAXIMUM TIME FOR EXPOSURE
Normally Occupied Area	up to 10% 10% to 15% 16% to 20%	2 minutes 1 minute 30 seconds