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

Technical Center

Atlantic City Int'l Airport
New Jersey 08405

March 28, 1994

Dear Group Participant:

Enclosed please find a copy of the Minutes of the March 14-15, 1994, International Halon Replacement Working Group meeting held at the Fire Service College in Gloucestershire, England.

This package includes copies of the presentations made by the Task Group Leaders, presentations made by the FAA Technical Center Subgroup Leaders, individual organizations, and CAA information on Flight Attendant Training.

Task Group Reports are included in this package for your comment. Please forward your comments on the Task Group Reports to April Horner by Friday, April 29, 1994, so that she may distribute them to the Task Group leaders.

All those who agreed to participate in a Task Group should refer to the Task Group Assignments in Minutes to review their assignments. Please begin working on your assignments as soon as possible so that your group will have results to present at the July meeting.

The next meeting will be hosted by Boeing Commercial Airplane Group in Seattle, Washington, on July 26-27, 1994. Further details are provided in this package. Please return the enclosed Meeting Return Form to April Horner by Friday, June 10, 1994, if you plan to attend this meeting.

If you have any questions, please contact April at 609-485-4471, or by fax at 609-485-5796.

We look forward to seeing you in Seattle in July.

Sincerely,

Richard G. Hill

Richard G. Hill
Program Manager

Enclosures

INTERNATIONAL HALON REPLACEMENT WORKING GROUP MEETING

Held at

THE FIRE SERVICE COLLEGE, MORETON-IN-MARSH, ENGLAND

MARCH 14-15, 1994

MONDAY, MARCH 14, 1994

TASK GROUP REVIEW - D. Hill

D. Hill gave a brief overview of the Task Groups established at the October 1993 meeting. (See October 13-14, 1994, Minutes/Information Package for detailed descriptions). He was followed by presentations by each of the Task Group Leaders.

Copies of reports/presentations for each Task Group are included with this minutes package:

TASK GROUP #1 - RECYCLED HALON - R. Glaser (Walter-Kidde)

Main conclusion: Either of 3 available specs are adequate. This Task Group has completed its work.

TASK GROUP #2 - CARGO AREA (AGENT TOXICITY) - J. O'Sullivan (British Airways)

J. O'Sullivan: Reviewed results of survey sent out. 35 surveys sent out with 28 responses.

C. Lewis (Transport Canada): Have you looked at your results broken down based on who answered what questions--manufacturers or airlines?

J. O'Sullivan: I did not have time to analyze trends.

B. Glaser (Walter-Kidde): What was breakdown of groups surveyed?

J. O'Sullivan: 20 major airlines, 10 cargo airlines (non-passenger and military), 5 aircraft manufacturers.

L. Virr (CAA): Why would you limit this to cargo areas? Why not handheld?

J. O'Sullivan: Because this was the task assigned.

D. Blake: Was there enough comments that came back with these responses to resolve some of the discrepancies?

J. O'Sullivan: No, there were only about 5 that gave us thorough comments.

D. Hill: We selected the cargo area because it has the most variables to see what alternatives airlines would accept. For example: if they would accept water mist, then we would continue water mist work in R&D

TASK GROUP #3 - CARGO AREA (TEMPERATURE) - D. Hill

D. Hill: Reviewed results of group. Halon systems are not designed to extinguish a cargo fire. They are designed to suppress the fire and keep it suppressed. We would like more input on this task since only one company responses.

TASK GROUP #4 - FIRE LOAD - A. Gupta (Boeing)

A. Gupta: Reviewed group's findings. Stressed surface fires, however, improbable, would be most likely to occur.

L. Virr (CAA): You did not deal with Class B compartments?

A. Gupta: We were tasked only on Class C.

D. Hill: We will be getting together with some of the other authorities to define a realistic fire threat.

TASK GROUP #5 - ENGINES - M. Kolleck (Booz-Allen & Hamilton)

M. Kolleck: Gave background on Engine Survey (see October 13-14, 1994, Minutes/Information Package for description).

D. Hill: How are the results going to be distributed or published?

M. Kolleck: There will be a summary report that will be available to the respondees.

D. Hill: Maybe you can make the report available to us, and we will supply a copy to anyone who requests it from us.

TASK GROUP #6 - CURRENT ALTERNATIVE AGENTS - B. Tapscott (NMERI)

B. Tapscott: Proposed changing name of Task Group to "Current Agent Options" or "Agent Options".

B. Tapscott: Do we mention brand names in our report and in our Task Group?

W. Grosshandler (NIST): These Task Groups were to work together where potential replacement agents will be used in a specified application. For example: cargo area.

D. Hill: We wanted this Task Group to come up with the types of agents or systems that we should look at first in R&D. We are looking for a group of agents based on your group's knowledge and experience to test first as replacement agents. We need to know which possible agents will have a short commercial lifetime so that they will be eliminated because of environmental restrictions. This way we will not spend time and money in R&D to evaluate unlikely replacement agents.

B. Tapscott: Does anyone have a problem with using brand names?

Group Consensus: No, use brand names.

FAA TECHNICAL CENTER SUBGROUP LEADER PRESENTATIONS

Copies of Subgroup Leader presentations are included in this minutes package.

CARGO COMPARTMENTS - Dave Blake

D. Blake: Gave brief review of this project. Reviewed water mist tests that have been done so far at the FAA Technical Center. This is one concept we are testing. We are going to run halon as a baseline test to compare temperatures.

D. Blake's comments on Task Group presentations:

1. I agree with one group member's comment that all Task Groups will have to work together to draw conclusions for each task group.

2. There are many contradictions in Task Group #2's report.

ENGINE NACELLES - Larry Curran

L. Curran: Gave brief update on development of test article at FAA Technical Center. Your input is critical to ensure our test article design is accurate and a true representation as to what is out there. If any foreign authorities have data on engine fires, I would appreciate receiving it.

M. Bennett (WPAFB): When will the test article be up and running?

L. Curran: We hope to do some initial qualification testing by early this summer.

L. Virr (CAA): How are you going to create the fires?

L. Curran: Nozzle with downstream electric ignitors. Our plan is to create a nacelle environment that is simple and repeatable so that we can test the various agents without a lot of readjustment between tests.

Member Question: Will you be doing baseline testing with halon?

L. Curran: Yes, we will be doing baseline testing with halon and comparing it with some of Mike Bennett's data.

A. Gupta (Boeing): Do you plan to do any tests with water misting fog systems?

L. Curran: Yes, three groups will be coming to the FAA Technical Center to test their water mist fog systems.

WPAFB HALON 1301 REPLACEMENT PROGRAM UPDATE - Mike Bennett

M. Bennett: Gave update on some of the test that have been done at WPAFB. Gave detailed description of new test article at WPAFB.

HANDHELD EXTINGUISHERS - Dick Hill

D. Hill: Gave brief update on Halon 1211 replacement agents program at FAA Technical Center. Explained that hidden fires are very, very rare, but they are the ones that cause fatalities. As far as I know the FAA has no intention of allowing extinguishers into the aircraft that are not approved by other regulatory authorities. For a new agent we are going to have to establish an acceptable level of toxicity.

J. O'Sullivan (British Airways): If we went to a different agent what level of training is required for the attendants and what level of efficiency will we get? How much training will be required for attendants.

D. Hill: We realize that crew training is important in this area. The regulation actually states that Halon 1211 or equivalent must be used. The airline has to prove that the agent is equivalent.

Member Question: Has any aircraft certification office approved an equivalent agent?

D. Hill: Not as far as I know.

A. Gupta (Boeing): If two fire extinguishers have the same rating, are they "equivalent"?

D. Hill: No, extinguishers with the same rating are not necessarily"equivalent" for the types of fire scenarios of concern in aircraft.

B. Glaser (Walter-Kidde): There may be an urgent need this year to come up with an equivalent agent for Halon 1211 because many companies will stop production of Halon 1211 in the near future because their use is being discouraged in other (non-aviation) applications. Airlines may find it difficult to by Halon 1211 extinguishers in the near future.

P. Huston (Amarex): Alternative agents should be U.L. approved if they are going to be used as replacements for Halon 1211. Manufaturers should have to be able to demonstrate that they can pass U.L. tests if their agent is determined equivalent by the FAA.

D. Hill - Summary: This Working Group needs participation. If you do not provide us with your input, we are going to go ahead with the information we have, because we will consider the information we have as the best information available to us.

D. Collier (ATA): Doubted if an "equivalency" determination would be based on a hidden fire scenario since the FAA requirement for Halon 1211 extinguishers was based on a seat/gasoline fire scenario.

TUESDAY, MARCH 15, 1994

WORKING GROUP MEMBER PRESENTATIONS

1. Sam Carbough (WPAFB): Gave in-depth overview and explanation of Halon 1301 Replacement Testing Program at WPAFB.

2. Mike Bennett (WPAFB): Gave explanation on their down select to three agents for testing as replacements in nacelle and dry bays. There is a report that will be available through NIST in about two (2) months (this report will be unrestricted-anyone can request this information). Contact Mike Bennett at WPAFB or William Grosshandler at NIST to get on the mailing list for this report.

3. Esther Jacobson (Spectronix): Gave presentation on main areas of research at Spectronix/Spectrex. Gave some information on their agent, SFE.

4. Gerald Whitworth (North American Fire Guardian): Gave update on their "drop-in agent", NAFS III.

5. Bob Tapscott (NMERI): Gave update on iodides as second generation agents.

OPEN DISCUSSION

D. Hill: Keep in mind that the three applications are very specific. These applications are very dependent on fire scenario and particularly the configuration. Engine nacelles, cargo compartments, and handheld extinguishers are very different from one another. Dates on availability of agents or extinguishers--we have heard that the dates when these agents will no longer be available are moving closer and closer. What is the time frame that we need to develop a certification test or requirement for equivalent agent approval.

K. Ghaemmaghami (Federal Express): As of last year, we had a 5-year goal to have a replacement agent.

P. Huston (Amarex): We are looking to have a replacement within 4 years.

D. Collier (ATA): Reviewed results of a telephone survey he conducted with 11 member airlines in the U.S. (combination of Halon 1211 and 1301) to find out their Halon availability. There was great variation, but the average was 10.7 years for the combination.

H. Mehta (Boeing): Does it take into account aircraft fleet sizes over the years.

D. Collier: I think some of the airlines that have planned out what their supply will be in the future may also have put some thought into what their fleet size will be.

D. Hill: How much of the Halon 1211 is recycled?

P. Huston (Amarex): It is fairly easy to recycle. Halon has to be recycled on a 6-year cycle because after about 6 years, bottles may begin to experience leaks at the 'O' rings. 99.6% is the purity level of recovered recycled Halon 1211.

D. Hill: Would extinguisher manufacturers sell handheld extinguishers to airframe manufacturers wanting to purchase the extinguishers for use with recycled Halon?

K. Metchis (U.S. EPA): Is the problem getting recycled Halon or getting the bottles to put it in?

B. Glaser (Walter-Kidde): Is there an EPA rule on restricting the use of extinguishers with recycled Halon?

K. Metchis (U.S. EPA): No, there is no rule.

B. Tapscott (NMERI): In the Federal Register recently it was stated that the sale of Halon 1211 for domestic use was going to be restricted.

K. Metchis (U.S. EPA): I was not aware of such as statement. I will check on this.

D. Hill: It is important to know this.

G. Sarkos: Provide us with some information on EPA rules/guides on use/restrictions on Halon 1211 use so that we may distribute it to this Working Group.

Member Comment: Keep in mind what is happening in the U.S. is not necessarily the case in a lot of other countries, especially some of the smaller countries.

B. Glaser (Walter-Kidde): As I stated yesterday, Walter-Kidde advised its airline customers that they will stop production of aircraft Halon 1211 extinguishers after 1994, also Chubb and Amarex

K. Ghaemmaghami (Federal Express): We took a survey and came up with these results: Federal Express requires 2.5. pounds of Halon 1211 per aircraft per year and 5 pounds Halon 1301 per aircraft per year.

D. Hill: We are at the point that the industry has to get together and find a manufacturer to produce aircraft handheld extinguishers for use with recycled Halon 1211.

W. Grosshandler (NIST): This is a problem which would kind of go away if you (FAA) would come up with your test method for equivalent agents. Maybe the FAA could come up with a date for the test method for handheld extinguishers.

D. Hill: We are going to work with the other authorities to come up with a test method. I believe we should be able to set a deadline/time frame for establishing this test method. It seems there is a lot of misinformation and there are some companies who have recycled Halon but think they won't be able to get extinguishers for their recycled Halon.

TASK GROUP DISCUSSIONS

TASK GROUP #1 - RECYCLED HALON

D. Hill: Does anyone see a need to continue this Task Group?

Group Consensus: No need to continue.

D. Hill: Task Group #1 is dissolved.

TASK GROUP #2 - CARGO AREA (AGENT TOXICITY)

D. Hill to J. O'Sullivan: Do you see a need to do some carry-on work presently?

J. O'Sullivan: Does the group see any need to carry-on with this. Would there be any value in the chairpeople of each Task Group getting together to write a report?

D. Hill: Why don't we put off the discussion on the continuation of your Task Group until we ask the entire Working Group to comment on the reports of the Task Groups and return their responses by a certain date to see if they feel there are other questions that should be asked by Task Group #2.

TASK GROUP #3 - CARGO AREA (TEMPERATURE)

D. Hill: We would still like to see more data from manufacturers on this. Would anyone like to chair this group?

Group Comments: No one volunteered to chair this group.

D. Hill: The authorities will make the decision on maximum allowable temperature since no one has volunteered or has any additional comments.

TASK GROUP #4 - FIRE LOAD

D. Hill: Conclusion of group: Most likely fire was started by an exterior ignition source outside the cargo compartment. The authorities will factor this information into the development of a fire load(s). This group is dissolved.

TASK GROUP #5 - ENGINES

D. Hill: If you have a survey, complete it and send it in. This Task Group will be ongoing.

S. Carbough (WPAFB): We need more than technical background. We need to know information on use-where was Halon 1301 used historically. You can expect more surveys in the future.

D. Hill: You will have to put together a form or questionnaire to send out through the same people you did with the Engine Survey.

TASK GROUP #6 - CURRENT ALTERNATIVE AGENTS

B. Tapscott (NMERI): Bob Tetla and William Grosshandler have offered to help provide information to this group. Karen Metchis volunteered to be on the committee to review agents being considered.

D. Hill: We are looking for 3 agents or systems that your group has determined are the best recommendations to test as replacement agents for each area we are concerned with: cargo compartments, handheld extinguishers, and engine nacelles.

C. Lewis (Transport Canada): I think Bob needs information of the type that John O'Sullivan asked for in his Task Group.

D. Hill: Bob will have to get back to the group if there is other information he needs.

L. Virr (CAA): I would have thought that the alternative agent we select would have about the same level of toxicity as Halon.

D. Hill: We will have to have a discussion among the authorities as to is Halon now the standard in terms of allowable agent toxicity or is the standard something we have not defined?

NEW TASK GROUPS

TASK GROUP #7 - POTTY BOTTLES

D. Hill: One company has submitted a test method for potty bottles. It looks good except I have a little concern with the fire load. I would like a small group of people to review this test method and make any suggestions or changes on this method.

B. Glaser (Walter-Kidde) will chair this group. A. Gupta (Boeing), B. Tetla (USAF), S. Hariram (Douglas) will participate in this group.

K. Metchis (U.S. EPA): Verification on question of restriction on domestic use of Halon 1211: Per her office: There is no regulatory activity underway to control the use of Halon 1211 as far as domestic use is concerned.

TASK GROUP #8 - HALON RESTRICTIONS

D. Hill: I think we need a Task Group to prepare a one or two page paper on what the various restrictions are on recycled Halons are. For example, Transport from one country to another. We need a summation of what is and is not allowable for Halon 1211 and 1301.

The following Group members volunteered to participate:

John O'Sullivan (British Airways), Jack Caloras (Tec-Air Services), Gary Taylor, Karen Metchis (U.S. EPA), Sam Carbough (WPAFB), Ray Duggan (Australia Dept. of Defense).

N. Povey (CAA): First generation replacement agents such as: HFC's, HCFC's, etc., should also be covered as far as restrictions on agent usage and agent production for alternative agents.

D. Hill: Are there any countries that have restricted or banned use of Halon by a certain date?

Group Consensus: Yes, Australia and Germany are two.

D. Hill: Include this information in the Task Group report. Restrict this information to what is used on aircraft.

H. Mehta (Boeing): This morning we were talking about setting a date for a Halon 1211 replacement. Do we have a date for this?

D. Hill: The group consensus was that a date could not be determined because some people said they could not get Halon 1211, some said they had it, some have not planned for obtaining Halon in the future, etc.

What is international policy on the discharge of Halons in certification tests? Also, do we have to restrict ourselves to alternative methods of training where you don't discharge the agent? Should we have a Task Group to look at ways of training someone to fight fires with Halon extinguishers without using Halon?

K. Metchis (U.S. EPA): I think the U.S. Air Force developed a method of doing this.

D. Hill: We are referring to training of flight attendants.

H. Humfeldt (Lufthansa): In Germany, we use CO^2 in a modified bottle in training.

F. Stossel (Swissair): In Switzerland, we do the same thing.

J. Burnett (CAA): In the U.K., we use video training and simulators, and we use a modified bottle as well.

G. Taylor: Why don't you have a Task Group to put a case study together on how a specific airline is training without using Halon or other topics concerning Halon?

D. Hill: I think that is something more for the authorities to handle. It sounds like it is more an operational issue. We will not look into this at this time. Are there any other areas for a Task Group to handle?

Some discussion took place on how toxicity is measured.

L. Virr (CAA): If you look at the regulation, it says if you use a toxic agent in the cargo compartment, you have to prove that the smoke (and agent) will not enter the cabin.

K. Metchis (U.S. EPA): Are you going to design a test for this?

D. Hill: Dave is taking measurements in the cabin to see what concentrations of toxic gas are entering the cabin. He showed some results in his presentation yesterday.

NEXT MEETING

The next meeting will be hosted by Boeing Commercial Airplane Group on July 26-27, 1994, at the Red Lion Hotel in Seattle, Washington, USA. An information sheet is included in this package.

ADVANCED MEETING NOTICE

The International Halon Replacement Working Group

The International Halon Replacement Working Group will meet in Seattle on July 26 and 27, 1994.

The meeting will be held at the Red Lion Hotel at the Seattle Tacoma airport. Attendees should make arrangements with:

Red Lion Hotel
Seattle Airport
18740 Pacific Highway South
Seattle, Washington 98188

(206) 246-8600
Fax: (206) 431-8687

The hotel is located on Pacific Highway South, just across from the southeast corner of the airport, at the intersection of Pacific Highway South and South 188th Street. It features free parking and complimentary 24 hour airport shuttle service.

We encourage attendees to use the Red Lion because the Boeing Company's costs for hosting the meeting are based partly on how many of the attendees stay at the Red Lion. Please mention that you are attending the International Halon Replacement Working Group Meeting when registering. Although normal room rates would begin at $124.00, the attendees will be offered a special rate:

$69.00 Single
$84.00 Double
$99.00 Triple
$104.00 Quad

If any questions arise, please contact Al Johnson at (206) 655-4138, Harry Mehta at (206) 234-3650 or Alan Gupta at (206) 237-7515.

JULY 26-27, 1994
MEETING RETURN FORM

INTERNATIONAL HALON REPLACEMENT WORKING GROUP

The next meeting will be hosted by Boeing Commercial Airplane Group at the Red Lion Hotel in Seattle, Washington, U.S.A., on Tuesday and Wednesday, July 26 and 27, 1994. (A detailed information sheet is attached).

PLEASE COMPLETE THE FOLLOWING INFORMATON IF YOU PLAN TO ATTEND:

NAME: ______________________________

COMPANY: ______________________________

PHONE: ______________ FAX: ______________

ADDRESS: ______________________________

CITY, STATE, ZIP: ______________________________

COUNTRY: ______________________________

BOEING EVERETT PLANT TOUR:

Please indicate if you will participate in a tour of the Boeing Everett Plant Tour on Thursday, July 28, 1994. Boeing will provide transportation from the Red Lion Hotel at 8:00 AM and return to Red Lion Hotel at approximately 12:00 (noon):

☐ Yes, I will participate. ☐ No, I will not participate.

SEATTLE AREA INFORMATION:

☐ I plan to bring my spouse. Please send me general areas of insterest and sightseeing information on the Seattle, Washington area.

RETURN THIS FORM BY FAX BY FRIDAY, JUNE 10, 1994, TO:

APRIL HORNER
FAX: 609-485-5796

OR CALL:

PHONE: 609-485-4471

U.S. Department
of Transportation
Federal Aviation Administration

'ORT OF TASK GROUP ONE

RECYCLED HALON MATERIAL SPECIFICATIONS

PARTICIPANTS:

DR. GEORGE C. HARRISON	WALTER KIDDE AEROSPACE
MAURICE KINDEL	AIR FRANCE
CLAUDE LEWIS	TRANSPORT CANADA AVIATION
WILLIAM TESTA	GRINNELL FIRE PROTECTION SYSTEMS

DOCUMENTS REFERRING TO THE MATERIAL SPECIFICATIONS

- BS6535, SECTION 2.1:

  BRITISH STANDARDS INSTITUTE MAKING ISO 7201-1 AN OFFICIAL BRITISH STANDARD.

  (OTHER COUNTRIES MAY HAVE A SIMILAR DOCUMENT)

- BFPSA:

  "CODE OF PRACTICE FOR RECOVERY AND RECYCLING OF HALONS"

  MAKES REFERENCE TO BS6535 AND ISO 7201.

- ULC/ORD-C1058.18-1993:

  "THE SERVICING OF HALON EXTINGUISHING SYSTEMS"

  UNDERWRITERS' LABORATORIES OF CANADA MAKES REFERENCE TO U.S. MIL-M-12218, ISO 7201 AND U.S. MIL-B-38741.

TABLE I

HALON 1301 SPECIFICATION COMPARISON

PROPERTY	REQUIREMENT MIL-M-12218C	ISO 7201-1	ASTM ES24-93	REMARKS
Purity, Mole %, min.	99.6	99.6	99.6	
Acidity, ppm by weight, max.	3.0	3.0	3.0	
Water, ppm by weight, max.	10	10	10	
Nonvolatile Residue, % by weight, maximum	-	0.01	0.01	.01% = 100 ppm
Halogen ION	Passes Test	Passes Test	Passes Test	
Suspended matter or sediment	None Visible	None Visible	None Visible	
Other Halocarbons, mole %, maximum	0.4	-	-	
Fixed Gases in Vapor Phase of Shipping Cylinder expressed as Air, % by Volume	1.5	Undefined-	Choose your own Concentration Consistent with Safe Bottle Pressure	See Table II
Boiling Point, °C at 760 mm/Hg	-57.75	-	-	
Boiling Range, °C, 5 to 85 percent distilled	0.3	-	-	
High Boiling Impurities, grams/100 ml, maximum	0.05	-	-	0.05 gm/100 ml = 320 ppm

GROUP ONE

TASK STATEMENT:

SUPPLY SPECIFICATIONS AND PRESENT DATA ON THE DIFFERENCES AND SIMILARITIES.

NOTE ANY PROBLEM AREAS

HALON 1301 MATERIAL SPECIFICATIONS

- U.S. MIL-M-12218C
- INTERNATIONAL STANDARD, ISO 7201-1: 1989(E).
- AMERICAN SOCIETY OF TESTING MATERIALS, ASTM ES24-93

OTHER DOCUMENTS OF INTEREST

- NFPA-12A:

  THE HALON 1301 FIRE EXTINGUISHING SYSTEM STANDARD. RECENTLY MODIFIED TO ACCEPT ASTM ES 24-93 AS A HALON 1301 SPECIFICATION.

- UL 2083:

  HALON 1301 RECOVERY/RECYCLING EQUIPMENT STANDARD.

  ISSUED BY UNDERWRITERS LABORATORIES, INC. (USA).

  NOT A MATERIAL SPECIFICATION.

  USES A CONTAMINANT REMOVAL TEST AS A

  MACHINE PERFORMANCE SPECIFICATION.

TABLE II

HALON 1301 / NITROGEN MIXTURES

HALON FILL DENSITY (LBS/CU FT)	HALON PRESSURE @ 70°F (PSIG)	DISSOLVED NITROGEN WEIGHT (LBS,CU FT)	NITROGEN PARTIAL PRESSURE @ 70°F (PSIA)	TOTAL CHARGE PRESSURE (PSIG) @ 70°F	@ 130°F	HALON PURITY (MOLE %)	REMARKS
75	199	0.06	19	218	455	99.6	PASS PURITY
• 75	199	0.19	66	265	507	98.6	FAIL
75	199	0.28	91	290	535	98.1	FAIL
70	199	0.056	19	218	455	99.6	PASS
• 70	199	0.56	196	395	652	95.9	FAIL
70	199	0.68	236	435	697	95.1	FAIL

• NOTE: THESE FILL CONDITIONS MEET THE U.S. D.O.T. LIQUID FULL REGULATIONS.

(Bottles not liquid full at or below 130°F)

JULY 26-27, 1994
MEETING RETURN FORM

INTERNATIONAL HALON REPLACEMENT WORKING GROUP

The next meeting will be hosted by Boeing Commercial Airplane Group at the Red Lion Hotel in Seattle, Washington, U.S.A., on Tuesday and Wednesday, July 26 and 27, 1994. (A detailed information sheet is attached).

PLEASE COMPLETE THE FOLLOWING INFORMATON IF YOU PLAN TO ATTEND:

NAME: ____________________

COMPANY: ____________________

PHONE: ____________________ FAX: ____________________

ADDRESS: ____________________

CITY, STATE, ZIP: ____________________

COUNTRY: ____________________

BOEING EVERETT PLANT TOUR:

Please indicate if you will participate in a tour of the Boeing Everett Plant Tour on Thursday, July 28, 1994. Boeing will provide transportation from the Red Lion Hotel at 8:00 AM and return to Red Lion Hotel at approximately 12:00 (noon):

☐ Yes, I will participate. ☐ No, I will not participate.

SEATTLE AREA INFORMATION:

☐ I plan to bring my spouse. Please send me general areas of insterest and sightseeing information on the Seattle, Washington area.

RETURN THIS FORM BY FAX BY <u>FRIDAY, JUNE 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

SHIPPING CONTAINERS

"Freon" FE 1301 is supplied in the following sizes and types of containers

"Freon" FE 1301 Capacity Lbs.	Container DOT Specification	Outside Diameter In.	Overall Length In.	Tare Weight Lbs.
6*	3AA 1800	4.14	16.75	9
10	3AA 1800	5.26	18.75	17
28	3AA 1800	6.75	23.56	28
150	4BA 400	10.7	47.75	65.5
2000	110A 800W	30	81.5	1400

*Occasionally the 10-lb size cylinder is substituted for the 6-lb size for shipment of 6-lbs FE 1301

The small shipping cylinders (6, 10, 28 and 150 pound) are closed with a Superior 1250X packless diaphragm valve, shown in Figure 3. The valves are presently equipped with a spring relief valve set to relieve at 600 psig, although some older cylinders in service have 450 psig relief valves. The relief valve setting is stamped on the valve body. All cylinders are shipped with caps to protect the valve assembly during shipment.

SMALL SHIPPING CONTAINERS FOR "FREON" FE 1301

SUPERIOR 1250X VALVE ON 28-LB. SHIPPING CYLINDER

The 2000 pound tank is fitted with two Superior 1031X valves (Figure 4). An internal view of the ton tank (Figure 5) shows the arrangement of siphon tubes and placement of fusible plugs on the rear heads and spring-loaded relief valves on the front head. The fusible plugs are designed to melt at 160°F to relieve excess pressure in the container. The spring-loaded relief valves are set to relieve at 500 psig

FIGURE 3
SUPERIOR 1250X
PACKLESS DIAPHRAGM VALVE

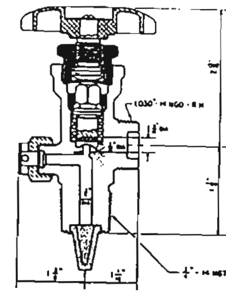


FIGURE 4
SUPERIOR 1031X
PACKLESS DIAPHRAGM VALVE

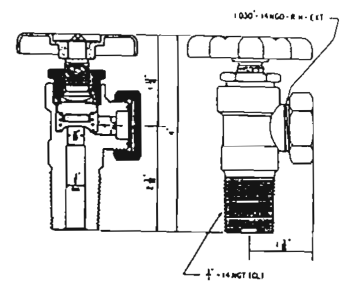
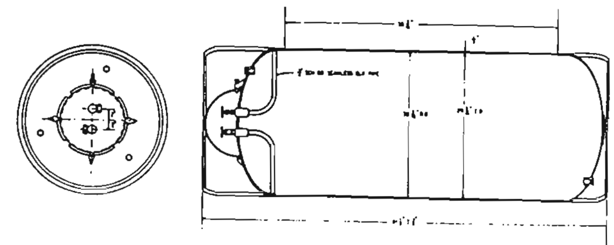


FIGURE 5
2000 LB. DOT 110A 800W SHIPPING CONTAINER
(Ton Tank)



WALTER KIDDE AEROSPACE

TYPICAL HALON

RELIEF VALVE SETTINGS

PRESSURE		STORAGE VESSEL TYPE
450 PSIG	-	6 → 150 LB. CYLINDERS
500 PSIG	-	1 TON
600 PSIG	-	6 → 150 LB. CYLINDERS

TABLE III

HALON 1211 SPECIFICATION COMPARISON

PROPERTY	MIL-B-38741	ISO 7201-1:1989(E)
Bromochlorodifluoromethane percent by volume, minimum	99.0	-
Purity, Mole percent, minimum	-	99.0
Boiling Point at 760 mm/Hg	-4 ± 1 °C (24.8 ± 1.8°F)	
Acid Halides and Free Halogens ppm (by weight), maximum	3.0	-
Nonvolatile Residue *	0.02 gm/100 ml	0.01% (m/m)
Suspended Matter of Sediment	None	None Visible
Color (Pt-Co Color Standard)	≤ #15	-
Moisture, percent by weight, maximum	0.002 ← SAME	-
Moisture, ppm by mass, maximum	-	→ 20
Acidity, ppm by mass, maximum	-	3.0
Halogen ION	-	Passes Test

* 0.02 gm/100 ml = 110 ppm; 0.01% = 100 ppm

INTERNATIONAL HALON REPLACEMENT WORKING GROUP

CARGO ALTERNATIVE AGENTS

SURVEY RESULTS

JOHN O'SULLIVAN

FIRE PROTECTION MANAGER

BRITISH AIRWAYS (14-15 MARCH 1994)

Halon Replacement Working Group

Assignment: Cargo alternative agents

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
Would you accept a Halon alternative ?	19	7	2	0	0

35 requests & 28 returns

Halon Replacement Working Group

Assignment: Cargo alternative agents

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
Would you use a gas agent ?	9	11	5	2	1

35 requests & 28 returns

Halon Replacement Working Group

Assignment: Cargo alternative agents

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
Would you use a water mist/fog agent ?	0	7	9	6	6

35 requests & 28 returns

Halon Replacement Working Group

Assignment: Cargo alternative agents

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
Would you use a Dry Chemical agent ?	1	5	8	7	7

35 requests & 28 returns

Halon Replacement Working Group

Assignment: Cargo alternative agents

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
Would you use suspended aerosols ?	1	7	9	10	1

35 requests & 28 returns

Halon Replacement Working Group

Assignment: Cargo alternative agents

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
Would you accept a weight penalty ?	0	1	14	8	5

35 requests & 28 returns

Halon Replacement Working Group

Assignment: Cargo alternative agents

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
Use agent with increased toxicity	0	3	5	5	15

35 requests & 28 returns

Halon Replacement Working Group

Assignment: Cargo alternative agents

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
Use agent that may kill animals & birds	0	0	10	3	15

35 requests & 28 returns

Halon Replacement Working Group

Assignment: Cargo alternative agents

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
Accept an agent with a higher toxicity factor, but requires less media	0	6	8	10	6

35 requests & 28 returns

Halon Replacement Working Group

Assignment: Cargo alternative agents

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
Increased corrosive properties when in contact with airframe	0	0	4	3	21

35 requests & 28 returns

Halon Replacement Working Group

Assignment: Cargo alternative agents

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
Increased time for clean-up	2	2	8	11	5

35 requests & 28 returns

Halon Replacement Working Group

Assignment: Cargo alternative agents

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
Agents that provide similar levels of fire protection but take longer to service and replace	3	9	9	3	4

35 requests & 28 returns

Halon Replacement Working Group

Assignment: Cargo alternative agents

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
Accept agents that are less efficient but have same weight factor	0	3	7	14	4

35 requests & 28 returns

Halon Replacement Working Group

Assignment: Cargo alternative agents

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
Accept an agent that may not deal with all hidden fires	1	0	7	4	16

35 requests & 28 returns

Halon Replacement Working Group

Assignment: Cargo alternative agents

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
Use agents that are more expensive	4	10	9	4	1

35 requests & 28 returns

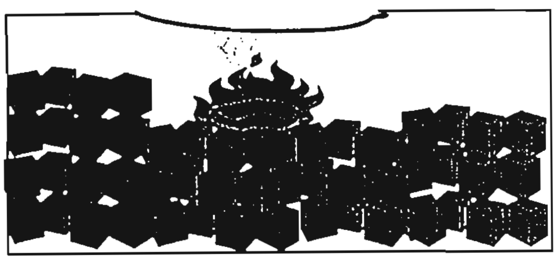
Halon Replacement Working Group

Assignment: Cargo alternative agents

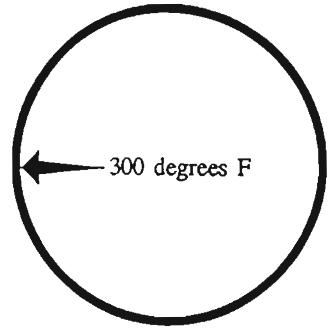
	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
Use Nitrogen as an alternative	0	2	17	8	1

35 requests & 28 returns

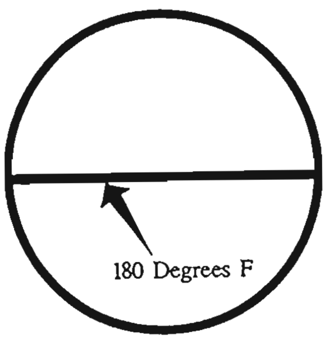
Cargo Area (Temperature Limits)



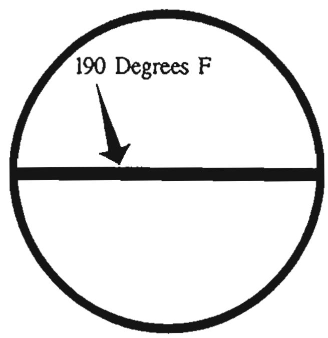
Primary Structure



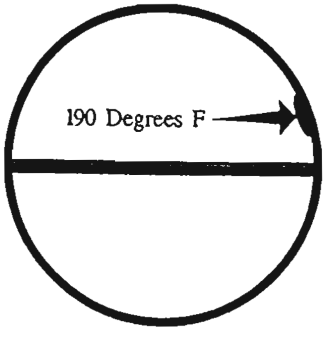
Main Deck Floor Beams



Main Deck Floor Panels

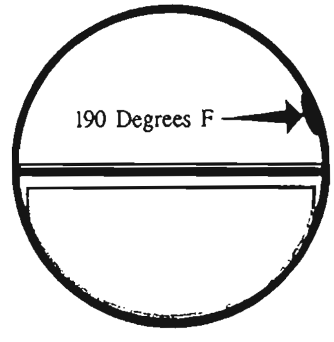


Main Deck Windows



Temperature Gradient:

Cargo Compartment to Structure



LIKELY FIRE THREATS IN CLASS C CARGO COMPARTMENTS

PREPARED BY

INTERNATIONAL HALON WORKING GROUP -TASK GROUP 4.

Mr. Jelle Benedictus
KLM Royal Dutch Airlines,
Schipol-Oest
THE NETHERLANDS

Mr. Alankar Gupta
Boeing Airplane Co.
Seattle, WA
(USA)

Mr. K.Ghaemmaghami
Federal Express
Los Angeles, CA
(USA)

Mr. Claus Oster,
S.A.S Scandinavian Airlines
Copenhagen
DENMARK

Mr. Jean Paillet,
Aerospatiale
Toulouse
FRANCE

Mr. Felix Stossel,
Swissair
Zurich
SWITZERLAND

Presented
at
International Halon Working Group Meeting
The Fire Service College
Moreton-in Marsh, England
March 14, 1994

Regulations applicable to the design of Class C cargo compartments

• Classification

FAR25.857(c)* defines a Class C cargo compartment as follows:

A Class C cargo or baggage compartment is one not meeting the requirements for either a Class A or Class B compartment but in which-

(1) There is a separate approved smoke detector or fire detector system to give warning at the pilot or flight engineer station;

(2) There is an approved built-in fire extinguishing system controllable from the pilot or flight engineer stations;

(3) There are means to exclude hazardous quantities of smoke, flames, or extinguishing agent, from any compartment occupied by the crew or passengers;

(4) There are means to control ventilation and drafts within the compartment so that the extinguishing agent used can control any fire that may start within the compartment.

* Federal Aviation Regulations (FAR) and Joint Airworthiness Requirements (JAR) are identical.

Regulations applicable to the design of cargo compartment fire detection system

• FAR 25.858* requires:

(a) the detection system must provide a visual indication to the flight crew within one minute the start of a fire.

(b) the detection system must be capable of detecting a fire at temperature significantly below at which the structural integrity of the airplane is substantially decreased.

(c) There must be means to allow the crew to check in flight, the function of each detector circ

(d) The effectiveness of the detector system must be shown for all approved operating configurations and conditions.

* Federal Aviation Regulations (FAR) and Joint Airworthiness Requirements (JAR) are identical.

Regulations applicable to the design of cargo compartment fire suppression system

• FAR25.851(b) *requires:

(1) Each built-in fire extinguishing system must be installed so that-

(i) No extinguishing agent likely to enter personnel compartments will be hazardous to the occupants; and

(ii) No discharge of the extinguisher can cause structural damage.

(2) The capacity of each required built-in extinguishing system must be adequate for any fire likely to occur in the compartment where used, considering the volume of the compartment and the ventilation rate.

* Federal Aviation Regulations (FAR) and Joint Airworthiness Requirements (JAR) are identical.

Regulations applicable to cargo compartment construction and materials of construction

• FAR25.855* requires:

(a) Compartment must meet Class requirements of FAR25.857*.

(b) Class C cargo compartments must have a liner which is separate from (but may be attached to) the airplane structure.

(c) The ceiling and sidewall liner panels must meet test requirements.

[At least three samples, simulating the sidewall or ceiling liner panels and including design features such as joint, lamp assemblies, etc., whose failure can compromise liner capability, must be tested. Acceptance criteria : no flame penetration of any specimen within 5 minutes after application of the flame source (1700 °F ± 100°F ; 927 °C± 38 °C) and the peak temperature 4 inches above the upper surface of the of the horizontal test sample must not exceed 400 °F.]

(d) All other materials used in the construction must meet test criteria.

[Floor panels, insulation blankets, cargo covers and transparencies, molded and thermoformed parts, air ducting joints and trim strips, etc. are required to be self-extinguishing when tested vertically. The average burn length may not exceed 8 inches and the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the test specimen may not continue to flame for more than an average of 5 seconds after falling.]

* Federal Aviation Regulations (FAR) and Joint Airworthiness Requirements (JAR) are identical.

Regulations applicable to cargo compartment construction and materials of construction (contd)

• FAR25.855 *requires:

(e) No compartment may contain any controls, wiring, lines, equipment, or accessories whose damage or failure would affect safe operation, unless those items are protected so that-

(1) They cannot be damaged by the movement of cargo in the compartment, and

(2) Their breakage or failure will not create a fire hazard.

(f) There must be means to prevent cargo or baggage from interfering with the functioning of the fire protective features of the compartment.

(g) Sources of heat within the compartment must be shielded and insulated to prevent igniting the cargo or baggage.

* Federal Aviation Regulations (FAR) and Joint Airworthiness Requirements (JAR) are identical.

Airline Industry practices-cargo transportation

•Cargo transported

All items that fit in cargo compartment are transported. There is no "typical cargo". Generally it consists of:
- -Paper, fabrics, wood, plastics
- -Hardware such as machines, precision parts
- -Electrical goods such as computer, audio-visual equipment
- -Consumer goods such as cameras, watches, radios
- -Chemicals such as paint, adhesive, drugs, medicines
- -Foods such as meat, fish, fruits, vegetables (some packed with dry ice)
- -Live animals, plants, flowers
- -Passenger baggage which may contain aerosol cans, small quantities of flammable fluids (perfume, liquor, after shave lotion, gas or fluid lighters), flammable materials matches (safety and strike anywhere)
- -Mail and packages
- -Hazardous cargo as defined by IATA's document "Dangerous Goods Regulations." or US Department of Transport regulations contained in Code of Federal Regulations Title 49 Parts 172 and 175.

Airline Industry practices baggage, cargo and mail loading

•Passenger baggage
-Wide body airplanes : Normally loaded in IATA Unit Load Devices (ULD). Crew baggage and last minute passenger baggage transported as bulk cargo.

- Standard body airplanes : Normally loaded as bulk cargo

•Cargo
-Wide body airplanes: Normally loaded in containers or on pallets. Pallets are preloaded usually several hours before scheduled loading time. Pallets have a covering, typically plastic.

-Standard body airplanes: Normally loaded as bulk cargo.

•Mail and packages
-Carried both as container cargo and bulk cargo.

•Dangerous Cargo
Handling/loading per the rules defined in IATA's "Dangerous Goods Regulation" document, Code of Federal Regulations Title 49, Parts 171, 172, 173, and 175. or other applicable regulations Persons assigned duties and responsibilities for handling dangerous materials given training (14 CFR Part 121 in US or other applicable regulations).

Airline Industry practices-container inspection & loading

•Container inspection
-Are visually checked for damage and functionality prior to use.
-Damaged containers are not used. They are sent for repair.
-Closed containers allow little air infiltration into and leakage out of the container.

•Container loading
-Cargo containers are not segregated from the passenger baggage containers.
-A cargo container may be loaded adjacent to a baggage container.

Fire Threat

•Empty cargo compartment.
-A well maintained as originally designed empty cargo compartment neither has ignition sources nor fuel to support combustion.

•Cargo (including baggage and mail) outside the cargo compartment
-It contains combustible material and a small quantity flammable materials.
- °Most of it is inside bags, suitcases and boxes.
- °On wide body airplanes a major portion of the cargo is loaded inside IATA approved and frequently checked containers. Cargo on pallets is covered by a plastic sheet.
- °Air supply to support combustion inside containers and underneath plastic covers on pallets is severely restricted.
- °Dangerous goods are packaged and handled per regulations or generally accepted procedures.
- °Dangerous cargo can be part of the mail.

-Cargo can serve as fuel in the presence of an ignition source.

•Cargo inside the compartment.
-Fire inside a cargo compartment can occur if there is an ignition source.
-Cargo can provide combustible material (Class A or Class A and B) to sustain a fire.
--The probability of a fire is extremely low.

Likely ignition sources and likely fires

•Ignition sources

-Human supplied ignition source
- • improper repair of aircraft system - surface fire likely
- • improper disposal of burning material while loading cargo- surface fire likely
- • cargo damage (chemical spill)- surface or deep seated fire.

-Cargo supplied ignition source
- • planted incendiary device - fire can not be characterized.
- • high energy device (shorted battery) - fire can not be characterized.

- Aircraft systems supplied ignition
- • human error, multiple system failures - surface fire likely, in the vicinity of aircraft systems
- •

Conclusions

• Conclusions

- Probability of a fire in a cargo compartment is extremely remote due to (I) design features included in compartment design, (ii) airline industry practices, and (iii) commitment of aviation industry to safety.

-Service experience of nearly 400 million flight hours suggests the probability of a significant fire is of the order of 1 in 10^8 to 10^9 flight hours. Its probability in a Class C cargo compartment, based on exclusively Class C cargo compartment service experience is significantly less.

- Cargo compartment contains combustible materials and ignition sources can be human, cargo or airplane systems supplied.

- Likely fire by aircraft supplied ignition source is a surface fire. The fire will likely be fueled by Class A and/or Class B material.

- Fire by cargo supplied ignition can not be characterized.

- Fire by human supplied ignition source depends on saboteur's ingenuity and can not be characterized.

CF_3I Mat ials Compatibility

- Testing up to 170°F Shows no Agent Breakdown and Very Low Corrosion Rates
- One Excursion to 240°F in Presence of Air Showed Significant HF Formation
- Testing to 350°F is Planned (APU Agent Temperatures Can Go to 300°F to 350°F)

Halon 1301 Replacement Program for Aviation

Wright Laboratory, WL/FIVS
1901 Tenth Street, Building 63
Wright-Patterson AFB OH 45433-7506

Samuel G. Carbaugh
Program Manager
Major, United States Air Force

Systems Approach For Halon Replacement

Immediate

Bank
- AF & EPA Approved
- DLA Managed
- 15-30 yr Life

Prolong Bank
- Remove/Reserve/Recycle
- Limit Ops Use

Near Term

Alternate Agent
- Identify Oct 94
- Design Data Oct 96
- Development Aircraft
- Retrofit Were Possible

Alternate Technologies
- Zero False Alarm Sensor
- Solid Propellant Fire Extinguisher

Far Term

Next Generation System
- Clean Slate
- Program Study

More Affordable Systems
- Cost Payment Study

Fall Back Position
- Near Term Solutions
- Not Optimized But Will Work

Aviation Halon Replacement Team

- US Air Force
  - Wright Laboratory
  - Armstrong Laboratory
- US Navy
  - Navy Air Systems Command (NAVAIR)
- US Army
  - Army Aviation & Troop Command (ATCOM)
- Federal Aviation Administration (FAA)
  - Technical Center
- Department of Commerce
  - National Institute of Standards and Technology (NIST)
- Industry
  - Walter-Kidde
  - Systron Donner
  - Boeing
  - 3M
  - Dupont
  - Great Lakes
  - Pacific Scientific

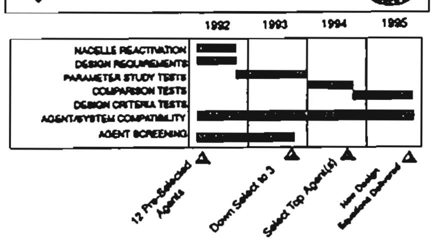
Aircraft Halon Problem

- Ozone Depleting Potential
  - Halon 1301 - ODP 16
  - Halon 1202 - ODP 1.25
- Military Standards Assumes Halon Use
  - Clutter - Airflow - Volume = Halon 1301
- Identified Replacements Have 3 X Weight, Volume
- $Billion USAF Impact
- Manufacturer/Military Phaseout

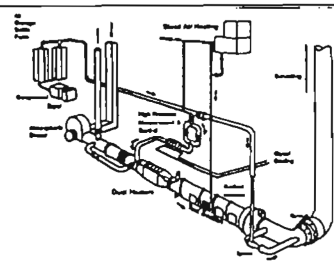
Program Objective

- Identify, Evaluate Halon Replacement(s)
  - In Flight, Remote System (Dry Bay, Engine Nacelle)
    - Unoccupied Area - Near Term Need
  - Minimal Weight, Volume Impact
  - Compatible With Aircraft Systems, Environment
- Satisfy Montreal Protocol, Environmental Protection Agency (EPA), Military Guidelines
- Provide Performance Data to Users
  - Preliminary Design Data to Users
  - Scheduled to Meet User's Design Milestones

Schedule



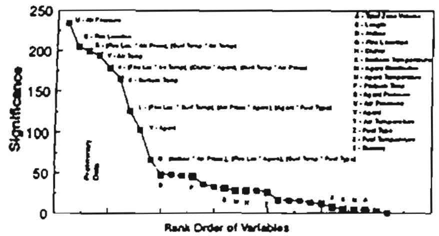
Aircraft Engine Nacelle Test Facility Schematic



Engine Nacelle Test Parameters and Levels

Internal Airflow	0.6 lb/sec	2.5 lb/sec
Total Zone Volume	82 cu ft	141 cubic ft
Pre-burn Time	5 sec	20 sec
Agent Dist System	bottle squib	piccolo tube
Clutter	Low	High
Vent Air Temp	100 Deg F	250 Deg F
Bottle Pressure	400 psig	800 psig
Compartment Configuration	10 ft length	15 ft length
Fire Location	Top	Bottom
Fuel Type	JP8	Hyd Fluid
Vent Air Pressure	14.5 psia	18 psia
Agent	Halon 1301	Perfluorohexane
Surface Temp	100 Deg F	1300 Deg F
Fuel Temp	100 Deg F	325 Deg F
Storage Bottle Temp	- 20 Deg F	160 Deg F

Design of Experiments Output
"Scree" Plot
Aircraft Engine Nacelle 120 Degree Test Fixture



Downselected Agents

Aircraft Engine Nacelle

Chemical	Trade Name	FSN *	System Wt Ratio
CF3I	"Halon 13001"	1.2	1.21
HFC 227	FM 200	1.9	1.54
HFC 125	FE 25	2.1	1.86

Preliminary estimate by Walter-Kidde Aerospace

Approximate change in system storage weight given FSN and usual container construction/design

Does not include change in plumbing if required.

Dry Bay

Chemical	Trade Name	FSN *
CF3I	"Halon 13001"	1.4
FC 218	n/a	1.5
HFC 125	FE 25	1.7

FSN = Flame Suppression Number (+/- 0.1)
Average experimental test flame suppression efficiency (by volume) normalized to halon from National Institute of Standards and Technology study

Aviation Halon Replacement Summary

- **Users Involved**
  - Technology Transition (T2) Team Formed
- **Industry Informed**
  - Extinguisher Manufacturers Contributing Expertise
- **On Schedule**
  - Down Select 3 Agents - Oct 93 *Done*
  - Select Best Agent(s) - Oct 94
  - Deliver Design Equations - Oct 95
- **Transitioning Information To Public**
  - Participating in FAA/CAA Working Group
  - Assisting Automotive Racing Application

Program Status

- **Technology Transition Team Meeting 5-7 Oct 93**
  - Customers Down Select To 3 Chemical Finalists
- **NIST Testing Continuing**
  - Materials - Corrosion, Shelf Life, etc.
  - Hardware Optimization - Nozzle Types, Time vs Concentration, etc.
- **Armstrong Laboratory Toxicology Testing**
  - Preliminary Evaluation Completed
  - Detailed Testing Started - Estimated Complete Oct 94
- **Phase I Parameter Engine Fire Tests Continuing**
  - Engine Nacelle 1/3 Annulus Complete, Full Annulus Jan-Feb 94
  - Dry Bay Non-airflow Complete, Airflow Dec 93-Jan 94

Aviation Halon Replacement Product

- **Agent Evaluated to Meet Operational Requirements**
  - Performance
  - System Compatibility (Extinguisher, Aircraft)
  - Toxicity
- **Design Equations to Size Systems**
- **Data Pertaining to Application of Agent**
  - Cost
  - Storage, Servicing, Handling
  - Performance & Physical Characteristics
- **Revised Understanding of Halon Effectiveness**

SAVE THE PEOPLE SAVE THE EARTH
HALON 1301 REPLACEMENT PROGRAM

Joseph Michael Bennett
Program Technical Director

Samuel G. Carbaugh
Program Manager
Major, United States Air Force

Updat… …n Iodides as Second-Generation Halon Replacements

Robert E. Tapscott
Center for Global Environmental Technologies
NMERI, University of New Mexico
Albuquerque, NM 87131-1376
USA

International Halon Replacement Working Group Meeting
The Fire Service College
Moreton-in-Marsh, England
14-15 March 1994

Selected Cup Burn… Test Data (n-Heptane)

$CBrF_3$	2.74
$CBrClF_2$	3.2
CF_3I	3.05
CF_3CF_2I	2.1
$CF_3CF_2CF_2I$	3.0
$CF_3CF_2CF_2CF_2I$	2.8
CF_3CFICF_3	3.2
$CF_3CF_2CF_2CF_2CF_2CF_2I$	2.5

Trifluoromethyl Iodide

- CF_3I
- Molecular Weight: 196
- Boiling Point: -22.5ºC (-8ºF)
- Two Manufacturers Identified Thus Far
- Expected Cost to Bulk Purchaser: $20 to $30 USD Per Pound

CF_3I Environmental Data

- Atmospheric Lifetime: 1.15 Days
- Estimated ODP: 0.01 or Lower (Very Conservative Estimate)
- GWP: Approximately Zero

CF_3I Cup Burner Test Update

Fuel	Halon 1301	CF_3I
Acetonitrile	1.51	1.70
1-Butanol	3.72	3.29
n-Butyl Acetate	2.53	2.52
Diesel #2	2.60	3.26
Ethane	3.08	3.37
Ethanol (Absolute)	2.97	2.99
Ethyl Acetate	1.92	2.99

CF_3I Cup Burner Update, Continued

Fuel	Halon 1301	CF_3I
Ethylene Glycol	1.88	2.37
Gasoline, Aviation	2.77	3.66
Gasoline, Unleaded	3.49	3.60
Heptane	2.74	3.05
Hydraulic Fluid #1	2.02	2.34
JP-4	2.84	3.29
JP-5	2.57	3.23

CF_3I Cup Burner Update, Continued

Fuel	Halon 1301	CF_3I
Methanol	5.86	3.75
Methyl Ethyl Ketone	2.63	4.36
Methyl Isobutyl Ketone	2.39	2.88
Nitromethane	2.77	2.22
Pyrrolidine	2.87	2.79
Turbo Hydraulic Oil 2380	2.22	2.07
Xylene	1.74	5.52

CF_3I Toxicity Testing

- 12.7% 15-Minute Modified Limit Test: No Effects
- 15-Minute LC_{50}: 27.4%
- Strongly Anesthetic at 13% to 15% During 4-Hour Exposure
- Cardiac Sensitization, Developmental Toxicity, Anesthetic Dose, to be Completed Summer, 1994
- Submittal for Listing Under EPA SNAP for Normally Uninhabited Areas in Progress

CF_3I Testing in NMERI 645 Cubic Foot Test Chamber

- Extinguishments Comparable to Halon 1301
- Discharge Characteristics Comparable to Halon 1301
- HF Concentrations (10 to 80 ppm) Equivalent to Halon 1301
- Carbonyl Fluoride at 0.2 to 1.5 ppm (None Detected for Halon 1301)
- Carbon Monoxide Concentrations (100 to 400 ppm) Equivalent to Halon 1301

REPORT OF TASK GROUP 1

RECYCLED HALON MATERIAL SPECIFICATIONS

INTERNATIONAL HALON REPLACEMENT WORKING GROUP MEETING

14, 15 MARCH 1994

THE FIRE SERVICE COLLEGE

MORETON - IN MARSH, GLOUCESTERSHIRE

UNITED KINGDOM

The first meeting of the International halon Replacement Working Group was at the FAA Technical Center on 13-14 October 1993. Several task group assignments were made. Task Group 1 was to supply Recycled Halon specifications and to comment on their differences and similarities.

Participants in the group were:

George C. Harrison, Chairman
Walter Kidde Aerospace
4200 Airport Drive N.W.
Wilson, NC 27896-9643
Telephone: (919) 237-3787 ext. 296
Fax: (919) 237-4717

Maurice Kindel
Air France
Direction de la Maintenance, E'tudes Centrales,
P.O.B. Orly-Sud 124, 2 Avenue de Fontainbleau
Orly, F-94396 Orly A'erogare Cedex
France
Telephone: 33(1) 41-75-56-73
Fax: 33(1) 41-75-51-91

Claude Lewis
Transport Canada Aviation
Ottawa, Ontario
Canada
Telephone: (613) 990-5906
Fax: (613) 996-9178

William Testa
Grinnell Fire Protection Systems
675 Woodward Road
North Providence, R.I. 02904
Telephone: (401) 727-2479
Fax: (401) 727-2487

INTERNATIONAL HALON REPLACEMENT WORKING GROUP/FAA

.k Group #1: Recycled Halon:

Task Statement: Supply specifications and present data on the differences and similarities. Note any problem areas.

A. Halon 1301 Specifications:

There are three known basic documents which refer to the material specifications for halon 1301 as a fire fighting medium.

1. U.S.A. military specification, MIL-M-12218C

2. International standard, ISO 7201-1: 1989(E).

3. American Society of Testing Materials, ASTM ES24-93.

Other documents make use of these specifications or include them by reference, but are not themselves material specifications. For example, the British Standards Institution issues BS 6535, section 2.1 which incorporates ISO 7201-1 into the official British Standards system. I expect that many countries make use of the ISO specification in a similar way.

When recycling of halon 1301 became a consideration, we understood that the removal of fixed gases, mostly nitrogen, was not always necessary. Certainly, removal to the level required by the military specification MIL-M-12218C was not needed. An effort began to change the military specification and ended in the generation of ASTM emergency standard ES24-93. The ASTM ES24-93 has issued. A new revision to make it a standard specification was prepared in January 1994 and should be available to issue in July or August of 1994. The National Fire Protection Association has modified its NFPA-12A standard on Halon 1301 Fire Extinguishing Systems to accept the ASTM ES24-93 material specification.

The British Fire Protection System Association has issued a "Code of Practice for Recovery and Recycling of Halons". This BFPSA code is applicable to both halons 1301 and 1211. It makes reference to the relevant BS 6535 specification, ISO 7201.

The Underwriters Laboratories, Inc. has issued Halon 1301 Recovery/Recycling Equipment Standard, UL 2083. This is not a halon 1301 material specification, it is a machine specification which contains a Contaminant Removal Test in section 42.

The Underwriters' Laboratories of Canada have issued document ULC/ORD-C1058.18-1993, entitled, "The Servicing of Halon Extinguishing Systems". The first edition was published in August, 1993. It establishes requirements for servicing Halon 1301 and Halon 1211 systems excluding portable fire extinguishers which are covered in a separate regulation. This document is not a material specification, but references the ISO-7201 Standard, US MIL-M-12218C or US MIL-B-38741 for specifications as required.

The only material specifications for recycled halon 1301 are:

1. MIL-M-12218C
2. ISO 7201-1
3. ASTM ES 24-93

The specifications in each of these documents are compared in Table I.

MIL-M-12218C stands out from the other two halon 1301 specifications in two major ways. It permits a maximum of about 320 ppm by weight of "High Boiling Impurities", while the other two specifications allow a maximum of 100 ppm by weight of "Nonvolatile Residue". Secondly, the military specification permits a very low amount of fixed gas impurity. The ISO 7201-1 specification ignores fixed gases entirely. The ASTM emergency specification at least cautions that the nitrogen partial pressure shall be such that "the safe working pressure of the receiving vessel is not exceeded". The recent revision of this emergency specification redefines the 99.6 mole percent purity minimum in terms that exclude the effect on purity of any nitrogen present. See Table II. In the recent revision of the ASTM emergency specification, this has been accomplished by definition of the mole percent purity of halon 1301 specifically excluding nitrogen present. A separate analysis for nitrogen, including air, is advised as a precaution in judging a safe fill density when the material is confined in a bottle.

This same change needs to be made to the ISO 7201-1 specification. Merely ignoring the presence of fixed gases or nitrogen is not a safe practice.

TABLE I HALON 1301 SPECIFICATION COMPARISON				
	REQUIREMENT			
PROPERTY	MIL-M-12218C	ISO 7201-1	ASTM ES24-93	REMARKS
Purity, Mole %, min.	99.6	99.6	99.6	
Acidity, ppm by weight, max.	3.0	3.0	3.0	
Water, ppm by weight, max.	10	10	10	
Nonvolatile Residue, % by weight, maximum	-	0.01	0.01	.01% = 100 ppm
Halogen ION	Passes Test	Passes Test	Passes Test	
Suspended matter or sediment	None Visible	None Visible	None Visible	
Other Halocarbons, mole %, maximum	0.4	-	-	
Fixed Gases in Vapor Phase of Shipping Cylinder expressed as Air, % by Volume	1.5	Undefined-	Choose your own Concentration Consistent with Safe Bottle Pressure	See Table II
Boiling Point, °C at 760 mm/Hg	-57.75	-	-	
Boiling Range, °C, 5 to 85 percent distilled	0.3	-	-	
High Boiling Impurities, grams/100 ml, maximum	0.05	-	-	0.05 grm/100 ml = 320 ppm

TABLE II HALON 1301 / NITROGEN MIXTURES						
HALON FILL DENSITY (LBS/CU FT)	HALON PRESSURE @ 70°F (PSIG)	DISSOLVED NITROGEN WEIGHT (LBS,CU FT)	NITROGEN PARTIAL PRESSURE @ 70°F (PSIA)	TOTAL CHARGE PRESSURE @ 70°F (PSIG)	HALON PURITY (MOLE %)	REMARKS
75	199	0.06	19	218	99.6	Meets ASTM & ISO Spec.
* 75	199	0.19	66	265	98.6	
75	199	0.28	91	290	98.1	
70	199	0.056	19	218	99.6	Meets ASTM & ISO Spec.
* 70	199	0.56	196	395	95.9	
70	199	0.68	236	435	95.1	

* Note: These fill conditions meet the U.S. D.O.T. LIQUID FULL REGULATIONS.

(Bottles not liquid full at or below 130°F)

The fixed gas, nitrogen and air, acts as an impurity. Thus it affects the Halon Mole Purity Test results. At a fill density of 75 pounds per cubic foot, only 0.06 pounds per cubic foot of nitrogen is sufficient to reduce the halon purity to its limit of 99.6%. Only 19 psia of nitrogen partial pressure will cause enough nitrogen to dissolve in halon 1301 to reduce to the purity limit. At higher partial pressures of nitrogen, enough nitrogen dissolves to cause the liquid mixture to fail the 99.6% mole purity test. Clearly, a material specification must define recycled halon purity exclusive of the nitrogen or fixed gas concentration. This has been done in the pending revision of ASTM ES 24-93. It needs to be done for the ISO 7201-1 specification, also.

B. Halon 1211 Specifications:

There are two material specification documents which refer to halon 1211 for use as a fire extinguishing agent:

1. U.S.A. Military Specification, MIL-B-38741

2. International standard, ISO 7201-1: 1989(E).

Since 1211 is a streaming agent, it is used onboard aircraft only in hand held portable units. There has been no need expressed for a recycled halon 1211 specification. The current specifications are compared in Table III.

Neither of the halon 1211 specifications make any mention of fixed gases. Acidity is handled differently, but this is only a minor variation. In 1984, the allowable moisture in the military specification was changed to make it equivalent to that in the ISO standard.

Fixed gas concentration issues are not as critical with Halon 1211. Under most conditions of use in aircraft hand held portable units, most of the bottle pressure is due to nitrogen added as a propellant gas. Separation of this gas occurs easily because of the much higher boiling point of halon 1211.

TABLE III HALON 1211 SPECIFICATION COMPARISON		
PROPERTY	MIL-B-38741	ISO 7201-1:1989(E)
Bromochlorodifluoromethane percent by volume, minimum	99.0	-
Purity, Mole percent, minimum	-	99.0
Boiling Point at 760 mm/Hg	-4 ± 1 °C (24.8 ± 1.8°F)	-
Acid Halides and Free Halogens ppm (by weight), maximum	3.0	-
Nonvolatile Residue *	0.02 gm/100 ml	0.01% (m/m)
Suspended Matter of Sediment	None	None Visible
Color (Pt-Co Color Standard)	≤ #15	-
Moisture, percent by weight, maximum	0.002	-
Moisture, ppm by mass, maximum	-	20
Acidity, ppm by mass, maximum	-	3.0
Halogen ION	-	Passes Test

* 0.02 gm/100 ml ≈ 110 ppm; 0.01% = 100 ppm

For a copy of the Appendices refer to U.S. MIL-M-12218C, ISO 7201-1: 1989(E) [ASTM ES24-93], and U.S. MIL-B-38741 or contact April Horner at 609-485-4471 for a copy.

International Halon Working Group

Task Group 4 Report Number 1

Likely Fire Threats in Class C cargo Compartments

Presented
at
Halon Replacement Working Group Meeting
The Fire Service College
Moreton-in Marsh, England (UK)
March 14, 1993

Preface

This report has been prepared by Task Group 4 of the International Halon Working Group. Task Group 4 was assigned the task to evaluate likely fire threat(s) in Class C cargo compartments, and to define threat simulation method(s).

This report deals with the first assigned task; likely fire threats in Class C cargo compartments. The second task; threat simulation method, will be undertaken after industry consensus on the threat. This report was presented at the meeting of the International Halon Working Group at the Fire Service College in Moreton-in Marsh, England, (UK) for review and comments.

This report resulted from collaborative efforts between the airframe manufacturers and airplane operators. The Task Group 4 members, listed below gratefully acknowledge the help of their peers.

NOTE:
All members of Task Group 4 have not had the opportunity to review this final report due to lack of time. There was substantial agreement among the members on the previous draft. This report should not be considered as a Task Group 4 consensus report until all members have affixed their signatures.

Mr. Jelle Benedictus,
Engineer Aircraft Systems
KLM Royal Dutch Airlines,
THE NETHERLANDS

Mr. Alankar Gupta,
Principal Engineer,
Boeing Commercial Airplane Group
Seattle, (USA)

Mr. Claus Oster,
Engineering Department
S.A.S Scandinavian Airlines
DENMARK

Mr. Jean Paillet,
Aerospatiale
Toulouse
FRANCE

Mr. Kamran Ghaemmaghami
Project Eng., Avionics/Systems Engg.
Federal Express
Los Angeles, (USA)

Mr. Felix Stossel,
Swissair Engg Projects Manager
Zurich Airport
SWITZERLAND

1.0 Introduction

Halon 1301 has been the agent of choice for fire suppression since the certification of the first Class C cargo compartment. It is extremely effective in suppressing fires on a weight basis. It is non-toxic, compatible with aircraft materials of construction and a clean agent. However, the scientific community believes that it may be linked to ozone depletion in the stratosphere, when released. Under the terms of the Montreal Protocol, an international agreement, halon production, except for essential uses, ceased on January 1, 1994.

In October 1993, the Federal Aviation Administration (FAA) sponsored an I ational Halon Working Group, at the FAA Technical Center, Atlantic City, I jersey, to facilitate the search for alternate agents or systems for aviation use. Three sub-groups were formed: engine and auxiliary power unit; Class C cargo compartment; and hand held fire extinguishers.

The sub-groups formed several teams, called Task Groups, to work on specific tasks. Task Group 4 was assigned the tasks: (i) determine likely fire threat(s) in Class C cargo compartments and (ii) define threat simulation method(s). The Task Group membership was open to all; mostly people representing airframe manufacturers and airplane operators volunteered to work on this assigned tasks.

This report deals with likely fire threats in Class C cargo compartments. Task Group 4 studied regulations applicable to the design of Class C cargo compartments (Federal Aviation Administration, Joint Airworthiness Requirements), airline cargo handling procedures, and International Air Transport Association (IATA) and International Civil Aviation Organization dangerous goods regulations. The Task Group also evaluated in-service experience of operators and fire incidents reported in all types of cargo compartments.

This report was presented at the meeting of the International Halon Working Group, on March 14 at the Fire Service College in Moreton-in Marsh, England, (UK).

The second task; threat simulation methods; will be undertaken after industry/FAA consensus on likely fire threats. The simulation methods will be documented in Task Group 4, Report 2.

2.0 Cargo Compartments

The compartments in the pressurized shell, on a commercial transport, are classified according to FAR25.857* into five classes, A through E, see appendix I. According to the current regulations, Class B, C and E compartments are required to have approved smoke or fire detectors. Compartment Class C is required to have a built-in fire extinguisher system. Class C and D cargo compartments are not accessible in flight. They are generally located below the passenger cabin and are designed to comply with the requirements of FAR25.855*. The lower lobe cargo compartments are Class D on the B707, B727, B737, DC-8, DC-9, L1011 model airplanes. The lower lobe cargo compartments are Class C on the B747, B757, B767, B777, DC-10 Series 30 and 40, MD-11, A321, A330 and A340 model airplanes. The A320 compartments are either Class C or D cargo compartments based on customer option. Some L1011 have a fire detection system in their Class D cargo compartment. DC-10 Series 10 has one class C and one Class D cargo compartment.

2.1 Current regulations applicable to the design of Class C cargo compartments

2.1.1 Classification

The current FAR25.857(c)* defines a Class C cargo compartment as follows:

A Class C cargo or baggage compartment is one not meeting the requirements for either a Class A or Class B compartment but in which-

(1) There is a separate approved smoke detector or fire detector system to give warning at the pilot or flight engineer station;

(2) There is an approved built-in fire extinguishing system controllable from the pilot or flight engineer stations;

(3) There are means to exclude hazardous quantities of smoke, flames, or extinguishing agent, from any compartment occupied by the crew or passengers;

(4) There are means to control ventilation and drafts within the compartment so that the extinguishing agent used can control any fire that may start within the compartment

2.1.2. Cargo compartment fire detection system

The fire detection system required by FAR25.857(c)(1)* is required to comply with the regulations contained in FAR 25.858* which are currently as follows:

* Federal Aviation Regulations (FAR) and Joint Airworthiness Requirements (JAR) are identical.

(a) The detection system must provide a visual indication to the flight crew within one minute after the start of a fire.

(b) The detection system must be capable of detecting a fire at a temperature significantly below that at which the structural integrity of the airplane is substantially decreased.

(c) There must be means to allow the crew to check in flight, the function of each fire detector circuit.

(d) The effectiveness of the detector system must be shown for all approved operating configurations and conditions.

2.1.3. Built-in fire extinguishers

The fire extinguishing system, required by FAR25.857(c)(2)*, is required to comply with the regulations contained in FAR25.851(b)* which are currently as follows:

(1) Each built-in fire extinguishing system must be installed so that-
(i) No extinguishing agent likely to enter personnel compartments will be hazardous to the occupants; and
(ii) No discharge of the extinguisher can cause structural damage.

(2) The capacity of each required built-in fire extinguishing system must be adequate for any fire likely to occur in the compartment where used, considering the volume of the compartment and the ventilation rate.

2.1.4. Cargo compartment construction

The cargo compartment must meet one of the class requirements of FAR25.857*. Materials of construction used and its construction must comply with the regulations contained in FAR25.855*. Significant applicable current regulations are as follows:

FAR25.855(b)* requires Class C cargo compartments, as defined in FAR25.857*, must have a liner, and the liner must be separate from (but may be attached to) the airplane structure.

FAR25.855(c)* requires that the ceiling and sidewall liner panels of Class C compartments must meet the test requirements of Part III of Appendix F of this part or approved equivalent methods (see paragraph 2.1.5 of this report).

F 5.855(d)* requires that all other materials used in the construction of the cargo c .rtment must meet the applicable test criteria prescribed in part I of Appendix

* Federal Aviation Regulations (FAR) and Joint Airworthiness Requirements (JAR) are identical.

F of this part or other approved equivalent methods (see paragraph 2.1.5 of this report).

FAR25.855(e)* requires that no compartment may contain any controls, wiring, lines, equipment, or accessories whose damage or failure would affect safe operation, unless those items are protected so that-

(1) They cannot be damaged by the movement of cargo in the compartment, and

(2) Their breakage or failure will not create a fire hazard.

FAR25.855(f)* requires that there must be means to prevent cargo or baggage from interfering with the functioning of the fire protective features of the compartment.

FAR25.855(g)* requires that sources of heat within the compartment must be shielded and insulated to prevent igniting the cargo or baggage.

2.1.5. Materials used in the construction of cargo compartment

The test criteria and procedures for showing compliance with the requirements of FAR25.855* are contained in Parts I and III of Appendix F to Part 25.

Part III dealing with the ceiling and sidewall liner requires that at least three samples of cargo compartment sidewall or ceiling liner panels must be tested. The defined criteria for acceptance is that there must be no flame penetration of any specimen within 5 minutes after application of the flame source (1700 °F ±100 °F ; 927 °C± 38 °C) and the peak temperature measured 4 inches above the upper surface of the horizontal test sample must not exceed 400 °F. In this test each specimen is required to simulate the liner panel and include design features such as, joints, lamp assemblies, and all other attachments, the failure of which would affect the capability of the liner to contain a fire.

Part I deals with all other materials of construction, floor panels, insulation blankets, cargo covers and transparencies, molded and thermoformed parts, air ducting joints and trim strips, etc. They are required to be self-extinguishing when tested vertically. The average burn length may not exceed 8 inches and the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the test specimen may not continue to flame for more than an average of 5 seconds after falling.

* Federal Aviation Regulations (FAR) and Joint Airworthiness Requirements (JAR) are identical.

Aircraft cargo compartment design and airline operating practices have made fire in a cargo compartment an extremely rare occurrence. Based on the service experience of nearly 400 million flight hours of jet transport fleet operation, the probability of a significant fire on an airplane is of the order of one in 10^8 to 10^9 flight hours. Its probability in a Class C cargo compartment, based on exclusively Class C cargo compartment service experience, is significantly less.

Cargo compartment contains combustible material and ignition source can be human, cargo or aircraft supplied. Likely fire by an aircraft supplied ignition source is a surface fire. Human and cargo supplied ignition sources can cause a variety of fires (surface, · seated, flaming, smoldering, explosive, metallic, fires with their own oxidizer, .nical, etc.). These fires can not be characterized.

For aircraft supplied ignition, simultaneous multiple fires are not likely based on service experience. Likely locations for these fires, if they occur due to multiple failures or human errors, will be in the vicinity of powered equipment within the cargo compartment. The fires will most likely be fueled by Class A material or Class A and B material.

For human supplied ignition, everything is possible based on saboteur's ingenuity.

Appendix I : FAR25.857* Cargo compartment classification

(a) Class A. A Class A cargo or baggage compartment is one in which-
(1) The presence of a fire would be easily discovered by a crewmember while at his station; and
(2) Each part of the compartment is easily accessible in flight.

(b) Class B. A Class B cargo or baggage compartment is one in which-
(1) There is sufficient access in flight to enable a crewmember to effectively reach any part of the compartment with the contents of a hand fire extinguisher;
(2) When the access provisions are being used, no hazardous quantity of smoke, flames, or extinguishing agent, will enter any compartment occupied by the crew or passengers;
(3) There is a separate approved smoke detector or fire detector system to give warning at the pilot or flight engineer station.

(c) Class C. A Class C cargo or baggage compartment is one not meeting the requirements for either a Class A or Class B compartment but in which-
(1) There is a separate approved smoke detector or fire detector system to give warning at the pilot or flight engineer station;
(2) There is an approved built-in fire extinguishing system controllable from the pilot or flight engineer stations;
(3) There are means to exclude hazardous quantities of smoke, flames, or extinguishing agent, from any compartment occupied by the crew or passengers;
(4) There are means to control ventilation and drafts within the compartment so that the extinguishing agent used can control any fire that may start within the compartment.

(d) Class D. A Class D cargo or baggage compartment is one in which-
(1) A fire occurring in it will be completely confined without endangering the safety of the airplane or the occupants.;
(2) There are means to exclude hazardous quantities of smoke, flames, or noxious gases, from any compartment occupied by the crew or passengers;
(3) Ventilation and drafts are controlled within each compartment so that any fire likely to occur in the compartment will not progress beyond safe limits;
(4) [Reserved]
(5) Consideration is given to the effect of heat within the compartment on adjacent critical parts of the airplane.
(6) The compartment volume does not exceed 1,000 cubic feet.
For compartments of 500 cubic feet or less, an airflow of 1500 cu. ft. per hour is acceptable.

(e) A Class E cargo compartment is one on airplanes used only for the carriage of cargo and in which-

* Federal Aviation Regulations (FAR) and Joint Airworthiness Requirements (JAR) are identical.

Appendix I : FAR25.857* Cargo compartment classification (contd)

(1) [Reserved]
(2) There is a separate approved smoke detector or fire detector system to give warning at the pilot or flight engineer station;
(3) There are means to shut off the ventilating airflow to, or within, the compartment, and the controls for these means are accessible to the flight crew in the crew compartment;
(4) There are means to exclude hazardous quantities of smoke, flames, or extinguishing agent, from any compartment occupied by the crew or passengers; and
(5) The required crew emergency exits are accessible under any loading condition.

* Federal Aviation Regulations (FAR) and Joint Airworthiness Requirements (JAR) are identical.

Appendix II: Fire Classifications

North American Classification

Class A fire A fire that involves ordinary solid combustible materials such as wood, cloth, paper, rubber and many plastics.

Class B fire A fire that involves a flammable or combustible liquid such as oil, fat, alcohol, gasoline, and hydraulic fluid. Some plastics behave like Class A combustibles up to a point, but then have many attributes of a Class B fire.

Class C fire A fire that involves energized electrical equipment or wiring.

Class D fire A fire that involves combustible metals such as magnesium, titanium, zirconium, sodium, lithium, and potassium.

European Classification

Class A	Wood, paper, cloth, etc.
Class B	Flammable liquids
Class C	Flammable gases
Class D	Metal fires
Class E	Electrical fires

British Classification

Class A	Carbon compounds that form glowing embers.
Class B	Liquids or liquefiable solids
Class B1	Class B materials miscible with water
Class B2	Class B materials immiscible with water
Class C	Flammable gases or vapors
Class D	Metals
Class E	Electrical fire in energized equipment

3.0. Airline practices baggage, cargo and mail loading, and containers maintenance

Operators haul passenger baggage, cargo and mail in Class C cargo compartments. The following discusses industry practices.

3.1 Description baggage, cargo and mail

The cargo transported on every flight varies and it is difficult to define a "typical cargo load". In general, the cargo load consists of the following:

- Paper, fabrics, wood, plastics
- Hardware such as machines, precision parts,
- Electrical goods such as computer, audio-visual equipment,
- Consumer goods such as cameras, watches, radios,
- Chemicals such as paint, adhesive, drugs, medicines
- Foods such as meat, fish, fruits, vegetables (some packed with dry ice),
- Live animals, plants, flowers.
- Passenger baggage which may contain aerosol cans, small quantities of flammable fluids (perfume, liquor, after shave lotion, gas or fluid cigarette lighters) or flammable materials like matches (safety and strike anywhere)
- Mail
- Hazardous cargo as defined by the blue section of IATA's document "Dangerous Goods Regulations." or US DOT regulations contained in 49CFR Parts 172 and 175.

In summary, every type of imaginable cargo that will fit into the compartment is carried. A high percentage of the cargo (paper, fabric, plastics, wood, packing material) is combustible.

3.2. Loading

The industry loading practices are as follows.

3.2. 1. Passenger baggage

On wide body airplanes, passenger baggage is normally loaded in containers. The containers, referred to as Unit Load Devices (ULD), are defined in IATA's "ULD Technical Manual" Crew baggage and last minute passenger baggage may be carried as bulk cargo. Cargo and passenger baggage is not loaded in the same container.

On standard body airplanes, passenger baggage is normally loaded as bulk cargo.

* Federal Aviation Regulations (FAR) and Joint Airworthiness Requirements (JAR) are identical.

3.2.2 Cargo

On wide body airplanes, cargo is typically loaded in containers or on pallets. The cargo containers are not segregated from the passenger baggage containers. Pallets are preferred for cargo transport due to easier handling. Pallets are pre-loaded usually several hours before scheduled loading time. The loaded pallets have a covering, typically plastic, to safeguard the cargo from weather environment.

On standard body airplanes, cargo is normally loaded as bulk cargo.

3.2.3 Mail

Mail is carried both as container cargo and as bulk cargo.

3.2.4 Dangerous Cargo

All precautions are taken to reduce hazards (fire and other) which may originate from the presence of hazardous cargo in the cargo compartment. This is achieved by handling/loading dangerous goods per the rules defined in IATA's "Dangerous Goods Regulation" document. This document describes, amongst other things, classification, identification, packing, and handling of dangerous goods. In the US carriage of hazardous materials is regulated by Department of Transport regulations contained in Code of Federal Regulations title 49 Parts 171, 172, 173, and 175. Training requirements for persons assigned duties and responsibilities for the handling or carriage of dangerous materials is governed by Code of Federal Regulations Title 14, Part 121.

3.3 Container inspection

The containers used for cargo and baggage transport are defined in IATA's "ULD Technical Manual" They are visually checked for damage and function prior to use. Damaged containers are not used for loading of cargo and baggage. They are sent for repair. Closed containers allow little air infiltration into and leakage out of the container.

ᐧ Fire Threat

The fire threat was evaluated for an empty cargo compartment, for cargo outside the compartment (before loading) and cargo inside the compartment (after loading). Such an evaluation provides an insight of the fires that may likely occur and also how they would initiate.

4.1 Empty Cargo compartment

A well maintained as originally designed cargo compartment has neither ignition sources nor fuel to support combustion.

The cargo compartment is designed to comply with the requirements of FAR25.855(g)* which requires that sources of heat within the compartment must be shielded and insulated to prevent their serving as ignition sources.

FAR25.855(e)* specifies that controls, wiring, lines, equipment or accessories, installed in the cargo compartment will be protected so their breakage or failure would not create a fire hazard.

Materials used in the construction of cargo compartments must to comply with the requirements contained in FAR25.855* and Appendix F to Part 25. These materials do not to support combustion.

In summary, there is no fire threat in a maintained as originally designed empty cargo compartment.

4.2 Cargo (including baggage and mail) outside the compartment

Every type of imaginable cargo that will fit in the compartment is carried. Typically, the cargo contains combustible material. Most of the cargo intended for transport on wide body airplanes is typically packaged in containers. The containers are checked prior to filling.

It is likely that a few pieces of passenger baggage may contain flammable material (fluids containing alcohol, matches). But, these substances are inside a bag or case, which itself may be inside a container or buried deep under other bags. Air supply to the flammable material as packaged is highly restricted.

Dangerous goods are handled per the guidelines contained in IATA/ICAO document, ...gerous Goods Regulation" or according to applicable government regulations ...e of Federal Regulations, Title 49, Parts 172 and 175, Part 121) Incorrect declaration, marking and/or packing is probable. Dangerous cargo can also be part of the mail.

* Federal Aviation Regulations (FAR) and Joint Airworthiness Requirements (JAR) are identical

In summary, cargo contains combustible material with some flammable material.

4.3 Cargo inside the cargo compartment

Initiation and propagation of a fire requires fuel, ignition source, and oxygen (or air). Inside the cargo compartment, the source of fuel is limited to the cargo introduced into the aircraft. The cargo contains combustible materials, flammable materials and dangerous goods, see paragraph 4.2.

The possible ignition sources of cargo inside the cargo compartment are those provided by human errors, by cargo itself, and provided by the systems

Human error promoted ignition may result from improper disposal of an unextinguished cigarette butt, improper repair or mishandling of cargo. Surface fire is likely in the event of improper repair of aircraft system. Chemical spill and improper disposal of burning material can cause either a surface or a deep seated fire.

The cargo may contain planted incendiary devices. It is difficult to characterize the fire caused by such devices. Mislabelled and/or mispackaged chemicals (e.g., sulfuric acid, nitric acid), can start a fire in the event of a spill during loading. The resultant fire can either be a surface fire or a deep seated fire. High energy device such as shorted battery can start a fire in its container, the fire propagation will depend on the container, its location, and the availability of fuel and air inside the container. The fire produced by a high energy device can not be characterized.

Aircraft initiated ignition is minimized by design (shielding and insulating ignition sources in compliance with FAR25.855(e)*. In addition, aircraft electrical systems within the cargo compartment are de-energized when air/ground switch is in the air mode. Aircraft initiated ignition is probable only when there are multiple failures or human errors. The likely fire from an aircraft initiated ignition source will probably be a surface fire. The cargo consists of Class A materials (wood, cloth, paper, rubber, plastic) and some Class B material (flammable or combustible fluid). If a fire occurs, it will be fueled by Class A material or a combination of Class A and Class B materials (see Appendix II for classification of fires).

* Federal Aviation Regulations (FAR) and Joint Airworthiness Requirements (JAR) are identical.

REPORT OF TASK GROUP 6
CURRENT ALTERNATIVE AGENTS

International Halon Replacement Working Group Meeting
14, 15 March 1994
The Fire Service College
Moreton-in-Marsh, Gloucestershire
United Kingdom

PREFACE

Report of Task Group 6
Current Alternative Agents

International Halon Replacement Working Group Meeting
14, 15 March 1994
The Fire Service College
Moreton-in-Marsh, Gloucestershire
United Kingdom

Slide 1

The first meeting of the International Halon Replacement Working Group was held on 13-14 October 1993 at the Federal Aviation Administration (FAA) Technical Center, Atlantic City International Airport, New Jersey, USA. At that meeting, a number of task groups were established. Task Group 6 was assigned a review of "Current Alternative Agents." The membership of Task Group 6 is shown below (Slide 2).

Jerry A. Brown
Allied Defense Industries
1487 Chain Bridge Road
Suite 304/305
McLean, VA 22101
Telephone: 1-703-734-9626
Fax: 1-703-448-8591

Larry E. Dvorak
Beech Aircraft Corporation
9709 E. Central Avenue
PO Box 85
Wichita, KS 67201-0085
Telephone: 1-316-733-0001, X497
Fax: 1-316-733-5574

Alankar Gupta
Boeing Commercial Airplane Company
P.O. Box 3707, MS 6H-TR
Seattle, WA 98124-2207
Telephone: 1-206-237-7515
Fax: 1-206-237-5444

George C. Harrison
Walter Kidde Aerospace, Inc.
4200 Airport Drive N.W.
Wilson, NC 27896
Telephone: 1-919-237-7004
Fax: 1-919-237-4717

John W. Mossel
J. W. Mossel & Associates
"14 Westover Place NW
shington, DC 20016
ephone: 1-202-362-3764
Fax: 1-202-416-7857

Robert E. Tapscott, Chair
Center for Global Environmental Technologies
University of New Mexico
Albuquerque, NM 87131-1376
Telephone: 1-505-272-7252
Fax: 1-505-272-7203

Task Group 6

Jerry A. Brown
  Allied Defense Industries

Larry E. Dvorak
  Beech Aircraft Corporation

Alankar Gupta
  Boeing Commercial Airplane Company

George C. Harrison
  Walter Kidde Aerospace, Inc.

John W. Mossel
  J. W. Mossel & Associates

Robert E. Tapscott, Chair
  Center for Global Environmental Technologies

Slide 2

The following draft report has been prepared for presentation at the International Halon Replacement Working Group Meeting scheduled for 14, 15 March 1994 at The Fire Service College, Moreton-in-Marsh, Gloucestershire, United Kingdom. The report has been circulated among all members of the Task Group for review and comments; however, not all comments received have been incorporated. In addition, physical properties for clean agents are still being prepared. Thus, this report should be treated as a draft at this time.

INTRODUCTION

On December 31, 1993, halon production effectively ended throughout most of the world, and, as yet, most users are uncertain about what to put in their place. The following is a brief review of the agent (chemical) options — what is available, what the drawbacks and advantages are, and what is likely to be the outcome.

Before discussing chemical options to halons, we need some definitions to ensure that we are all talking about the same thing (Slide 3). The term "options" is used for anything that could be used in place of halons. "Replacements" denote fire extinguishants that are chemically similar to the present halons; "alternatives," are everything else. Moreover, replacements are divided into two types — first-generation and second-generation. "Chemical alternatives" are materials such as carbon dioxide, foam, water, and dry chemical whose chemistries differ from those of the halons. "Engineering alternatives" (not covered in this report) involve such approaches as rapid response and fire resistant structures.

Definitions

- Options — Anything That Could be Used in Place of Halons
- Replacements — Halocarbon Substitutes
  - ✓ First-Generation
  - ✓ Second-Generation
- Alternatives — Non-Halocarbon Substitutes
  - ✓ Chemical Alternatives
  - ✓ Engineering Alternatives

Slide 3

Discussions among members of Task Group 6 Indicated that the Group should cover not only halocarbon replacement agents, but chemical alternatives as well, excluding "classical" agents such as standard foams, dry chemicals, and water sprays.

REPLACEMENTS

There are a number of desirable characteristics for replacement (e.g., halocarbon) agents (Slide 4). That they must have acceptable global environmental characteristics (e.g., low ozone depletion potentials, ODPs, and low global warming potentials (GWPs) is obvious. The toxicity must also be acceptable, though there may be some debate about what is an acceptable level. The primary reason for using halocarbons, rather than such alternatives as foams and dry chemicals, is that halocarbons are clean and volatile. Finally, the agent must be effective. Note, however, that effectiveness does not necessarily mean as effective as the present halons, though this is desirable.

Desirable Characteristics For Replacements

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

Slide 4

The terms "first-generation" and "second-generation" were introduced at the first Halon Alternatives Technical Working Conference held in Albuquerque in 1991. The refrigeration industry has now adopted these terms for refrigerant replacements, though that sector uses three categories: first-generation refrigerant replacements (primarily HCFCs), second-generation (HFCs), and third-generation ("natural" refrigerants — carbon dioxide, air, sulfur dioxide, ammonia, etc.).

Before defining first- and second-generation halon replacements, we need to consider two different types of agents (Slide 5). Physical action agents (PAAs) are those that operate primarily by heat absorption. Chemical action agents (CAAs) are those that operate primarily by chemical means — removal of flame free radicals. In general, CAAs are much more effective extinguishants than are PAAs, but PAAs are more environmentally benign. CAAs often have high ODPs.

Agent Types

- Physical Action Agents (PAAs)
- Chemical Action Agents (CAAs)

Slide 5

First-generation replacements refer to halocarbon candidates that we have today — those candidates that have global environmental, toxicological, or effectiveness drawbacks. They are either (1) CAAs that have high or relatively high ODPs (HBFC-22B1 being the only example) or (2) PAAs. Second-generation agents are candidate agents that equal the halons in effectiveness, but have low tropospheric half lives giving them low global environmental impacts. Thus, second-generation halon replacements are CAAs with low ODPs and GWPs.

FIRST-GENERATION HALOCARBON REPLACEMENTS

Most of the first-generation agents are PAAs — chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), or perfluorocarbons (FCs or PFCs) (Slide 6). The only CAAs that have been announced are hydrobromofluorocarbons (HBFCs), which have high or relatively high ODPs, and which will be phased out by 1 January 1996 under the Copenhagen amendment to the Montreal Protocol.

First-Generation Replacements

- Chlorofluorocarbons (CFCs)
- Hydrochlorofluorocarbons (HCFCs)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (FCs or PFCs)
- Hydrobromofluorocarbons (HBFCs)

Slide 6

A large number of candidate replacement agents have been announced for commercialization, and even more chemicals are under serious consideration. A number of first-generation replacements have been announced for total-flooding applications (Slide 7). All of these agents are contained in

Announced First-Generation Total-Flooding Agents

FC-3-1-10	Perfluorobutane	$CF_3CF_2CF_2CF_3$
HBFC-22B1	Bromodifluoromethane	CHF_2Br
HCFC-124	Chlorotetrafluoroethane	$CHClFCF_3$
HFC-125	Pentafluoroethane	CHF_2CF_3
HFC-227ea	Heptafluoropropane	CF_3CHFCF_3
HFC-23	Trifluoromethane	CHF_3
HCFC Blend A	Blend including	HCFC-123, HCFC-22 HCFC-124

Slide 7

Until recently, the number of agents announced for streaming applications was small. Recently, however, the number has increased markedly (Slide 8).

Announced First-Generation Streaming Agents

FC-5-1-14	Perfluorohexane	$CF_3(CF_2)_4CF_3$
HBFC-22B1	Bromodifluoromethane	$CHBrF_2$
HCFC-123	Dichlorotrifluoroethane	$CHCl_2CF_3$
HCFC-124	Chlorotetrafluoroethane	CF_3CHClF
HFC-227ea	Heptafluoroethane	CF_3CHFCF_3)
HCFC Blend B		Primarily HCFC-123
CFC Blend		

Slide 8

All of these first-generation agents have tradeoffs in one way or another. As noted earlier, halon replacements have four desirable characteristics: a low global environmental impact, acceptable toxicity, cleanliness/volatility, and effectiveness. Though it is very easy to find candidate replacements that meet any three of these criteria, it has been difficult to find agents that meet all four. For most (but not all) applications, at least two to three times as much of any first-generation replacement (except HBFC-22B1, which will be phased out starting 1 January 1996) is needed to provide the same degree of protection as provided by the present halons.

SECOND-GENERATION REPLACEMENTS

Researchers are looking increasingly at "second-generation" agents — materials that are highly effective, yet have low global environmental impacts (Slide 9). These materials are all CAAs, and they all contain bromine or iodine, one or both of which appear to be necessary to have a chemically active halocarbon fire extinguishant. The important thing about second-generation agents is that despite the presence of bromine and/or iodine, they have chemical features that promote very low atmospheric lifetimes, a property that reduces the ODPs and GWPs to near zero.

Second-Generation Replacements

- CAAs
- Contain Bromine and/or Iodine
- Low Atmospheric Lifetimes

Slide 9

Second-generation candidates contain bromine and/or iodine. However, once in the stratosphere, bromine (and probably iodine) compounds can cause serious depletion of ozone. One way to achieve low ODPs and GWPs is through agents that are destroyed or removed rapidly in the troposphere. Such compounds would not reach the stratosphere, or would reach it only in very small amounts. Such compounds are referred to as "tropodegradable."

The three major mechanisms for destruction of halocarbons in the troposphere are photolysis, attack by hydroxyl (OH) radicals, and attack by oxygen atoms (O). The sunlight reaching the troposphere has a longer wavelength (and a correspondingly lower energy) than that reaching the stratosphere. If molecules are to be photolyzed in the troposphere they must contain chromophoric (light absorbing) groups, weak bonds, or both Chromophoric groups include carbon-to-carbon multiple bonds (giving compounds that include the alkenes) and carbon-to-iodine single bonds ("iodides"). The latter type of chemical bonds are also weak compared to other carbon-halogen bonds. Carbon-to-carbon multiple bonds also react rapidly with naturally-occurring OH radicals found in the troposphere.

Thus, the following two groups of compounds having short tropospheric lifetimes and correspondingly low ODPs and GWPs, but also having chemical features that promote effectiveness (bromine and/or iodine) were arrived at: (1) bromine-containing alkenes and (2) iodocarbons including iodine-containing alkanes and alkenes. In general, these compounds are clean (they are gases or they evaporate without leaving a residue). Some examples of second-generation replacement candidates are shown in Slide 10.

Selected Second-Generation Candidates

Name	Formula	Halon No	Extinguishment Concentration, % by volume
Bromotrifluoromethane	$CBrF_3$	1301	2.9
Bromochlorodifluoromethane	$CBrClF_2$	1211	3.2
Trifluoroiodomethane	CF_3I	13001	3.0
Pentafluoroiodoethane	CF_3CF_2I	25001	2.1
1,1,2,2,3,3,3-Heptafluoro-1-iodopropane	$CF_3CF_2CF_2I$	37001	3.0
1,1,2,2,3,3,4,4,4-Nonafluoro-1-iodobutane	$CF_3CF_2CF_2CF_2I$	49001	2.8
1,1,1,2,3,3,3-Heptafluoro-2-iodopropane	CF_3CFICF_3	37001	3.2
1,1,2,2,3,3,4,4,5,5,6,6,6-Tridecafluoro-1-iodohexane	$CF_3CF_2CF_2CF_2CF_2CF_2I$	6-13-001	2.5
4-Bromo-3,3,4,4-tetrafluoro-1-butene	$CH_2{=}CH\text{-}CF_2CF_2Br$		3.5
4-Bromo-3-chloro-3,4,4-trifluoro-1-butene	$CH_2{=}CH\text{-}CClF\text{-}CF_2Br$		4.5

Slide 10

The problem is that we know little about manufacturability, toxicity, emissions, materials compatibility, and stability, and the market may not be sufficiently large to justify the cost of determining these unknowns (Slide 11).

Unknowns About Many Second-Generation Candidates

- Manufacturability
- Toxicity
- Emissions
- Materials Compatibility
- Long-Term Stability

Slide 11

ALTERNATIVES

More and more, non-halocarbon substitutes are being considered for replacement of halons. Already, water sprinklers are replacing halon systems in many applications. Dry chemical extinguishants and carbon dioxide are also receiving increased use.

A number of new alternatives are now under investigation (Slide 12). Among these are misting systems, particulate aerosols, and inert gas blends. Misting and particulate aerosols require decreased amounts of agents that can lead to secondary fire damage. Thus, these technologies may allow protection while minimizing the problems normally associated with water and solids. Recent advances in inert gases may allow the use of inert gas blends in new applications, particularly in occupied areas.

New Alternatives Under Investigation

- Misting
- Particulate Aerosols
- Inert Gases

Slide 12

WATER MISTING

Water misting systems allow the use of fine water sprays to provide fire protection with reduced water requirements and reduced secondary damage. Calculations indicate that on a weight basis, water could provide fire extinguishment capabilities better than those of halons provided that complete or near-complete evaporation of water is achieved. Since small droplets evaporate significantly faster than large droplets, the small droplets achievable through misting systems could provide this capability. No criteria have yet been established on the dividing line between mists and sprays; however, droplet sizes of 100 microns or less are often used as a criterion. A large part of the recent 1st International Conference on Fire Suppression (Stockholm Sweden, 5-8 May, 1992), sponsored by BRANDFORSK, the Swedish Fire Protection Board) dealt with the problem of water droplet size and fire protection. Two types of systems have been considered—one using high pressure to force water through small openings (high-pressure, single-fluid nozzles) and the second using a pressurized gas (usually nitrogen) to disperse the water (dual-fluid nozzles). Work on misting systems in the U.S. has been scattered. The need for such work and some concepts have been described at the Water Mist Fire Suppression Workshop, at the National Institute of Standards and Technology on 1-2 March 1993. Some work has been performed by the Fire Research Station in England on non-total-flood applications, primarily

aircraft crash/rescue, the Channel Tunnel, and streaming. Water misting has been found to be effective in suppressing flammable liquid fires (Reference 1), and it has been considered for use in spacecraft (Reference 2). The Naval Research Laboratory is examining water misting nozzles to simulate Halon 1211 for firefighter training (Reference 3).

Although misting systems have only recently begun to receive the attention that they deserve, considerable (but scattered) literature references and contacts are available. The use of relatively small (10-100 µm) diameter water droplets as a gas-phase extinguishing agent has been established for at least 40 years (References 4, 5, 6). Recent advances in nozzle design and improved theoretical understanding of fire suppression processes has led to the development of at least five water mist fire suppression systems.

Theoretical analysis of water droplet suppression efficiencies has indicated that water liquid volume concentrations on the order of 0.1 liter (water) /m^3 (air) is sufficient to extinguish fires in the gas phase. Similar results have been shown by Beyler (Reference 7) and Williams (Reference 8). This represents a potential two-order of magnitude efficiency improvement over applicable rates typically used in conventional sprinklers. The most important aspect of water mist technology is the extent to which the mist spray can be mixed and distributed throughout a compartment and the loss rate to surfaces and by gravitational dropout. The suppression mechanisms of water mist is primarily gas-phase cooling of the flame reaction zone below the adiabatic flame temperature limit. Other mechanisms are important in certain applications. For example, steam expansion/oxygen deletion has been shown to be important for suppression of enclosed 3-D flammable liquid spray fires.

The efficacy of a particular water mist system is strongly dependent on the ability to not only generate sufficiently small droplet sizes but to distribute critical concentration of droplets throughout the compartment (Reference 9, 10, 11). This depends on the droplet size, velocity, distribution, the spray pattern geometry and as well as the momentum and mixing characteristics of the spray jet.

The potential efficacy of water mist fire suppression systems has been demonstrated in a wide range of applications and by numerous experimental programs. These applications have included Class B spray and pool fires (References 12, 13, 14, 15, 16), aircraft cabins (References 17, 18, 19), shipboard machinery and engine room spaces (References 20, 21, 22, 23, 24, 25) shipboard accommodation spaces (Reference 26), and computer and electronics applications (Reference 27, 28).

An increased theoretical understanding of important processes has been developed by Jackman and coworkers (Reference 29). The ability of water mist systems to suppress fires much more dependent in the nozzle design, flow rate operating pressure, and resultant spray characteristics than total flooding gases. Hence, water mist must be evaluated in the content of a system not just an extinguishing agent.

There is no current theoretical basis for designing the optimum drop size and velocity distribution, spray momentum, distribution pattern, and other important system parameters. This is of course quite analogous to the lack of theoretical basis for nozzle design for total flooding.

gaseous systems, or even conventional sprinkler and water spray systems. Hence, much of the experimental effort conducted to date is full scale fire testing of particular water mist hardware systems which are designed empirically.

There are two basic types of water mist suppression systems: single and dual fluid systems. Single fluid systems utilize water stored at high pressure (40-200 bar) and spray nozzles which deliver drop sizes in the 10 to 100 μm diameter range. Dual systems use air, nitrous oxide, or other gas to atomize water at a nozzle. Both types of systems have been shown to be promising fire suppression systems. It is more difficult to develop single phase systems with the proper drop size distribution, spray geometry, and momentum characteristics. This difficulty is offset by the advantage of requiring only high pressure water storage versus water and atomizer gas storage.

Water mist systems are reasonably weight efficient. The use of small diameter distribution tubing and the possible use of composite, lightweight, high-pressure storage cylinders would increase this efficiency. It may also be possible to integrate a "central storage" of agent for use in several potential fire locations (for example, cargo and passenger cabin locations). This would further increase the benefit.

The major difficulties with water mist systems are those associated with design and engineering. These problems arise from the need to distribute the mist throughout the space while gravity and agent deposition loss on surfaces deplete the concentration. The need to generate, distribute, and maintain an adequate concentration of the proper size drops. Engineering analysis and evaluation if droplet loss and fallout as well as optimum drop size ranges and concentrations can be used effectively to minimize the uncertainty and direct the experimental program.

Although the concept of water misting is not new, significant work is needed to determine the potential of water misting. The ability of water mists to stay suspended and to reduce explosion overpressures in explosion protection must be assessed. Research and development must include evaluations of ability to extinguish fires with assessments of the damage to powered equipment, paper records, and electronic data storage media. It is likely that water misting could replace Halon 1301 in many fixed installations, though this remains to be demonstrated.

PARTICULATE AEROSOLS

Dry chemicals agents are at least as effective as halons in suppressing fires and explosions in many applications; however, such agents are exceedingly damaging to electronic equipment. Moreover, dry chemical agents, as now used, do not provide the extended inertion (explosion or fire) provided by halon systems. The discharge of dry chemicals also obscures vision. In Geneva Switzerland at the 2nd Conference on the Fire Protecting Halons and the Environment, 1-3 October 1990, representatives of the Soviet Union provided information on a solid agent that they claimed provides relatively long-term (20 minutes or more) inertion of an enclosed volume and excellent fire extinguishment (Reference 30). They have continued to keep the agent and the generation system secret; however, the small amount of information provided indicates that the Soviet material was a very fine particulate generated by combustion. Some have termed this type of technology "pyrotechnically generated aerosols," PGAs.

At the recent International Symposium on Halon Replacement in Aviation held in Reston, Virginia on 9-10 February 1993, extreme interest in the new pyrotechnically generated aerosol (PGA) technology was expressed. This Technology was also discussed at the 1993 NMERI Halon Alternatives Technical Working Conference, 11-13 May 1993 in Albuquerque, where three papers on particulate aerosols are scheduled for presentation (References 31, 32, 33).

One of the problems encountered with particulate aerosols is that the technologies are often proprietary or ill-defined. Thus, it is not at all obvious that, for example, the term PGA applies to all of the agents. The following presents some information on these materials.

S.F.E. Extinguishing Agents

The S.F.E. family of extinguishing agents is produced by Spectrex. Their system was recently tested (Reference 34).This new class of fire extinguishing agents known as SFE or EMAA (Encapsulated Micron Aerosol Agents) offer an air suspended dry chemical aerosol with micron size particles, that provide total flood capabilities. Some studies indicate that on a weight basis, the agents are three times more efficient than regular dry powders and five times more efficient than halocarbon extinguishing agents.

The S.F.E. compound in its various forms, upon activation ignites and creates an aerosol that contains about 40 percent solid particles (size of particle less than 1μ) of salts like KCl, K_2CO_3, etc. The remaining 60 percent of the emissions are gaseous combustion products such as CO_2, N_2, H_2O, O_2, and traces (ppm) of hydrocarbons.

The Aerosol solid particles, as a result of the high temperature of combustion, create a large surface area for capturing active species of the fire chain, such as hydroxyl free radicals (OH), which are considered to be the fire chain carriers. The smaller particle size provides for better dispersion and more effective aerosol. As the particle size decreases, the extinguishing surface of the aerosol on which heterogeneous recombination of the chain propagators takes place, increases. Moreover, as the size of the particles diminishes, rate of sublimation increases and the extinguishing effect is augmented by homogenous gas phase inhibition of the fire/flame through the interference of gaseous products forming from the condensed part of the Aerosol. It can be summarized that both heterogeneous inhibition (on the surface of the solid particles) as well as homogenous inhibition (in the gaseous phase) take place in the extinguishing process.

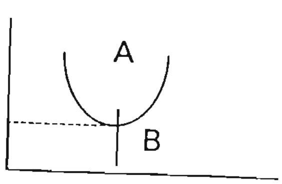
Physical characteristics of the solid compound include:

Specific density	1.6 - 1.8 x 10^3 Kg/m^3
Combustion Temp (°K)	1500 - 2400 °K
Combustion Velocity (mm/sec)	0.3 - 1.5 mm/sec
Shelf Life	15 years
Texture	Solid fine powdered mixture or gelled paste.

The amount of the extinguishing agent required for effective fast action is described by the following relation:

$$V \times 0.05 = Q$$

where V = volume to be protected (m^3) and Q is the amount of material (Kg).



A is the area of extinguishing effectiveness, and B is the optimal application rate and extinguishing concentration.

The build-up of this optimal condition depends on the fire scenario configuration, and could be applied from various equipment (apparatus) such as:

1. Hand held extinguishers
2. Local application aerosol generators
3. Total flood aerosol generators
4. Specific destructive (combustible) containers
5. Solid compound encased in specific coatings (line charges, shaped charges, etc.)
6. Deployable (throwable) units.

According to the volume to be protected, the specific configuration of the solid compound could be selected, as well as its generation discharge means. When compared to existing fire extinguishing agents as well as new gaseous replacements,S.F E. shows great promise, as can be seen from the following table.

Extinguishant Comparisons

		Halon 1301	Gaseous Replacement	CO_2	EMMA
1.	ODP	High	Low/Zero	Zero	Zero
2.	GWP	Moderate	Low	Low	Nil
3.	Toxicity	Low	Low	High	Low
4.	Conductivity	Low	Low	Low	Low
5.	Corrosivity	Moderate	Mod-Low	Mod-Low	Unknown
6.	Vol. Efficiency	Good	Moderate	Low	Excellent
7.	Ext. Concentration	5%	10-15%	45%	---
8.	Ext. Density	300 g/m^3	600-900 g/m^3	700 g/m^3	50 g/m^3
9.	Cost[a]	$150/$m^2$	>$250/$m^2$	$150/$m^2$	$50/$m^2$
10.	Life Cycle Cost[b]	High	High	High	Low

[a]Includes piping, cylinders, installation; no detection.

[b]Includes initial cost, maintenance, agent replacement.

Slide 13

S.F.E. offers an entire family of novel extinguishing agents, some of which have been tested. The lowest required concentration that was observed during testing was 0.03 kg/m^3, which is approximately 10 times more effective than Halon 1301.

S.F.E. needs no pressure cylinders. In fact it could be stored as tablets in the open air, on the self, and employed immediately on demand. When activated the tablet extinguishes the fire, depending on the application, between 5 to 30 seconds.

Several evaluation programs are in progress, performed by the various armed forces, research institutes and leading industries. A Cooperative Research and Development Agreement (CRDA) between the U.S Air Force and Spectrex Inc. has been signed on March 93, starting a two-year term of evaluation and specific product development of the EMAA/SFE technology for the Air Force specific needs. As a part of this program, recently the Air Force has been awarded a Strategic Environmental Research and Development (SERDP) grant for the EMAA program that will fund work on the three basic formulations developed by Spectrex Inc. at New Mexico Engineering Research Institute (NMERI), Armstrong Lab (Wright-Patterson AFB), Wright Laboratory (Tyndall AFB) and the University of Florida.

The tasks to be funded include:

a. Thermal output characteristics during solid material combustion.
b. Investigation of various heat absorption strategies for use in devices containing MAA.
c. Particle size characterization.
d. Materials compatibility/corrosion studies.
e. Extinguishment capability with various Class A, B, C and D fires.
f. Toxicity assessment of aerosols generated by EMAA combustion.

A request for follow-on SERDP funding to continue the program has been submitted for FY95. Future work will focus on the design and testing of fire suppression delivery systems and devices that use EMAA.

Among these systems, the EMAA/SFE deployable units held much promise for various applications. The Naval Research Laboratory (NRL) Navy Technology Center for Safety and Survivability, is studying pyrotechnic generated aerosol fire suppressants as part of its Halon Replacement Program for NAVSEA Code 03V2.

This program includes two stages. The first one, an SFE/EMAA evaluation process was performed at the NRL 2000 cubic feet test chamber and it's preliminary results were presented by Dr. R. Sheinson in a paper entitled "Fire Extinguishment by Fire Aerosols Generation" at the CFC & Halon Alternative Conference (10-22 October 93, Washington, DC.)

The second stage will include evaluation of several SFE/EMAA aerosol generating devices and their application to large engine rooms. The test will be performed as part of the alternative evaluation study on the U.S. Shadwell.

The Naval Medical Research Institute Toxicology Detachment (NMRI/TD) is examining the physical characteristics of the aerosol created after the combustion of SFE Formulations A, B and C; and the individual chemical components for each formulation.

NMRI/TD also has conducted a pilot animal study to examine the mortality produced by SFE/EMAA on Fisher rats, via clinical observations, specific blood chemistry and physiological study. A preliminary report on the toxicity data appears to be very favorable and indicates that there are no apparent toxicology problems with the material tested. No immediate lethality was observed for as long as 60 minutes after exposure to 50-80 gr/m^3 SFE agent formulation A. Additional formulations are now being evaluated as well for their toxicity.

The FAA has conducted a preliminary evaluation of the inertization capabilities of SFE/EMAA on Class A deep-seated fires at the FAA Technical Center. The first test program included tests on shredded papers fires (in cardboard boxes). The fires were successfully suppressed and the inertization was continued for a period of 15 minutes.

... has been developed and is programmed for inertization tests in the near future. This new formulation has the unique capability to extinguish deep seated fires, class A, and sustain inertization for 1 hour and more, without lowering the oxygen concentration in the protected volume.

An SFE bulletin issued by the NAVY CFC & Halon Clearing-house will encompass the various evaluation programs, NAVY-NRL, NMRI, TOXLAB, USAF-CRDA progress, development programs, projects in industry and regulations/approval status. The NAVY CFC & Halon Clearing-house will edit and publish SFE bulletin periodically as new developments arise.

The SFE/EMAA technology will be included in the EPA/SNAP list to be published between February - March 94.

INERT GASES

Inergen

Argonite

Argon

REFERENCES

1. Papavergos, P. G., "Fine Water Sprays for Fire Protection—A Halon Replacement Option," Proceedings of the Halon Alternatives Technical Working Conference 1991, Albuquerque, NM, 30 April - 1 May 1991, pp. 206-217.

2. Reuther, J. J., "Design of Low Gravity Fire Suppression Experiments: Applications to Space and Earth-Based Agent Development," Proceedings of the Halon Alternatives Technical Working Conference 1991, Albuquerque, New Mexico, 30 April - 1 May 1991, pp. 142-152.

3. Personal communication, Dr. Joseph T. Leonard, Code 6180, Chemistry Division, Naval research Laboratory, Washington, DC, April 1992.

4. National Board of Fire Underwriters, *The Mechanisms of Extinguishment of Fire by Finely Divided Water*, N.B.F.U Research Report 10, the National Board of Fire Underwriters, 85 John Street, New York, 1955.

5. Rasbash, D. J., Rogowski, Z. W., and Stark, G. W. V.," Mechanisms of Extinction of Liquid Fires with Water Sptray," *Combustion and Flame*, Vol. 4, p. 223, 1960.

6. Carhart, H. W., "Suppression - Why Not Water?," *NRL Memorandum Report 3435*, Naval Research Laboratory, D. C., 1977.

7. Beyler, C. L., "A Unified Model of Fire Suppression," *Journal of Fire Protection Engineering*, Vol. 4, No. 1, pp. 5-16, 1992.

8. Williams, F. A., "A Univied View of Fire Suppression," *Journal of Fire and Flammability*, Vol. 5, No. 1, pp. 54-63, 1974.

9. Mawhinney, J. R., "Engineering Criteria for Water Mist Fire Suppression Systems," *Water Mist Fire Suppression Workshop*, National Institutes of Standards and Technologies, Gaithersburg, Maryland, 1 March 1993.

10. Cousin, C. S., "Resent Work on Fire Control Using Fine Water Sprays at the Fire Research Station," *Proceedings of the First International Conference on Fire Suppression Research*, Stockholm and Boras, Sweden, 5-8 May 1992.

11. Jackman, L. A., "Mathematical Model of the Interaction of Sprinkler Spray Drops with Fire Gases," *Proceedings of the First International Conference on Fire Suppression Research*, Stockholm and Boras, Sweden, 5-8 May 1992.

12. Papavergos, P. G., "Fine Water Sprays for Fire Protection," *Proceedings of the Halon Alternatives Technical Working Conference*, Albuquerque, New Mexico, 1991.

13. Butz, J. R., and Carey, R., "Application of Fine Water Mists to Fire Suppression," *Proceedings of the Halon Alternatives Technical Working Conference*, Albuquerque, New Mexico, 1992.

14. Wighus, R., *Active Fire Protection - Extinguishment of Enclosed Gas Fires with Water Sprays*, SINTEF Report STF25 A91028, Trondheim, 1991.

15. Wighus, R., "Extinguishment of Enclosed Gas Fires With Water Sprays," *Fire Safety Science - Proceedings of the Third International Symposium*, Edinburgh, 1991.

16. Wighus, R., "Fire Suppression Research in Norway," *Proceedings of the First International Conference on Fire Suppression Research*, Stockholm and Boras, Sweden, 5-8 May 1992.

17. Hill, R. G., Marker, T. R., and Savkos, C. P., "Evaluation of an On-Board Water Spray Fire Suppression System in Aircraft," Water Mist Fire Suppression Workshop, National Institute of Standards and Technology, Gaithersburg, Maryland, 1 March 1993.

18. Hill, R. G., Marker, T R., and Savkos, C. P., "Evaluation of an On-Board Water Spray Fire Suppression System in Aircraft," SAE Technical Paper 912224, Aerospace Technology Conference and Exposition, Long Beach California 23-26 September 1991

19. Whitfield, R. T., Whitfield, Q. A., and Steel, J., "Aircraft Cabin Fire Suppression by Means of an Interior Water Spray System," Civil Aviation Authority, CAA Paper 88014, July 1988.

20. Mawhinney, J. R., "Fine Water Spray Fire SUppression Project," *Proceedings of the First International Conference on Fire Suppression Research*, Stockholm and Boras, Sweden, 5-8 May 1992.

21. Turner, A. R. F., "Water Mist in Marine Applications," Water Mist Fire Suppression Workshop, National Institute of Standards and Technology, Gaithersvurg, Maryland, 1 March 1993.

22. Arvindson, M., and Ryderman, A., "Cabin and Public Space Fire Tests with Marioff's Hi-fog Fire Protection System," Swedish National Testing and Research Institute, Boras, Sweden, 91 R30141, 19 February 1992.

23. Tuomissari, M., "Fire Suppression Tests in Simulated Ship's Engine Room with a Hi-fog Fire Protection System," VTT Fire Technology Laboratory, Helsinki, Finland, PAL 2210/92, 16 November 1992.

24. Soja, E., "DGME Waterfog Trials," British Ministry of Defense, Navy, YARD Report No. 4175-NM0609, Bath, England, 1990.

25. Gamiero, V., "Fine Water Spray Technology Mist Fire Suppression Systems," Halon Alternatives Technical Working Conference, Albuquerque, New Mexico, 11-13 May 1993.

26. Arvindson, M., "Tests with Marioff Hi-fog Fire Protection System in a Simulated Cable Duct," 1992.

27. Hill, R. G., Marker, T. R., and Savkos, C. P., "Evaluation of an On-Board Water Spray Fire Suppression System in Aircraft," Water Mist Fire Suppression Workshop, National Institute of Standards and Technology, Gaithersburg, Maryland, 1 March 1993.

28. Tuomissari, M., "Withstand Voltage of Switch Gears in the Presence of Operating Hi-fog Fire Protection System," ABE Strömberg Research Centre, Vassa, Finland, 9 AFX92-98, 3 August 1992.

29. Jackman, L. SA., "Water Sprays: Characteristics and Effectiveness," Halon Alternatives Technical Working Conference, Albuquerque, New Mexico, 11-13 May 1993.

30. Kopylov, N, untitled informal presentation, 2nd Conference on the Fire Protecting Halons and the Environment, Geneva, Switzerland, 1-3 October, 1990.

31. Spring, D. J., "Alkali Metal Aerosols as Fire Extinguishants," Halon Alternatives Technical Working Conference 1993, 11-13 May 1993, Albuquerque, New Mexico.

32. Kibert, C. J., "Encapsulated Micron Aerosol Agents (EMAA)," Halon Alternatives Technical Working Conference 1993, 11-13 May 1993, Albuquerque, New Mexico.

33. Harrison, G. C., "Solid Particle Fire Extinguishants for Aircraft Applications," Halon Alternatives Technical Working Conference 1993, 11-13 May 1993, Albuquerque, New Mexico.

34. Tapscott, R. E., Dierdorf, D. S., and Moore, T. A., *Preliminary Testing of Encapsulated Micron Aerosol Agents*, Letter Report, Wright Laboratories (WL/FIVCF), Tyndall Air Force Base, Florida, March 1993.

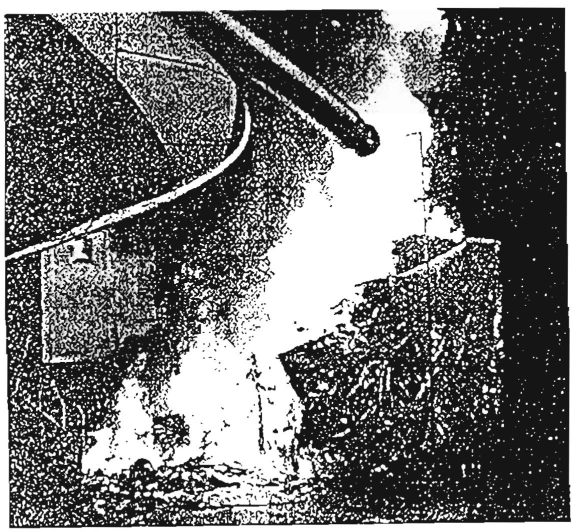
5 TESTS CONDUCTED:

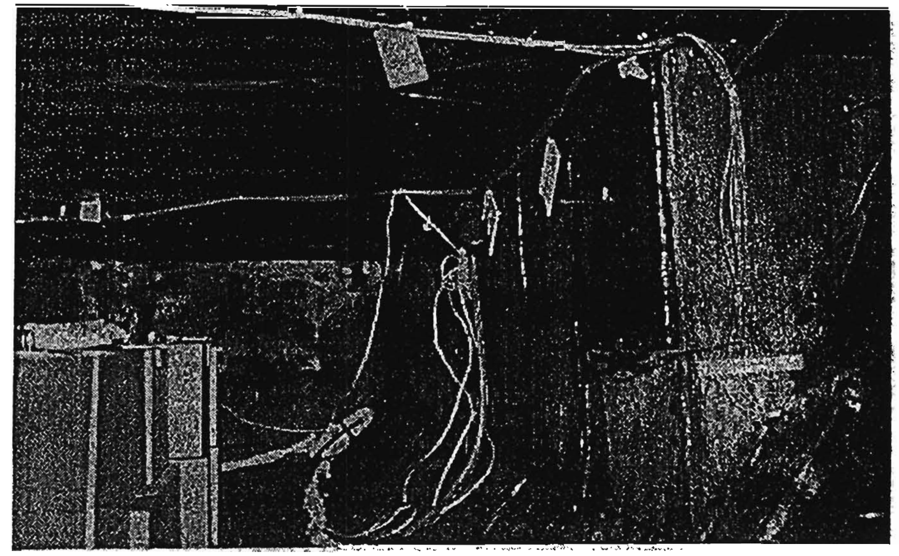
- TEST DURATION BETWEEN 50 AND 80 MINUTES
- WATER USAGE BETWEEN 80 AND 110 U.S. GALLONS
- AVERAGE CEILING TEMPERATURE 200 - 250 F (short periods elevated temps, but generally for less than 1 minute
- MINIMUM OXYGEN CONCENTRATION 13%

FUTURE TESTS:

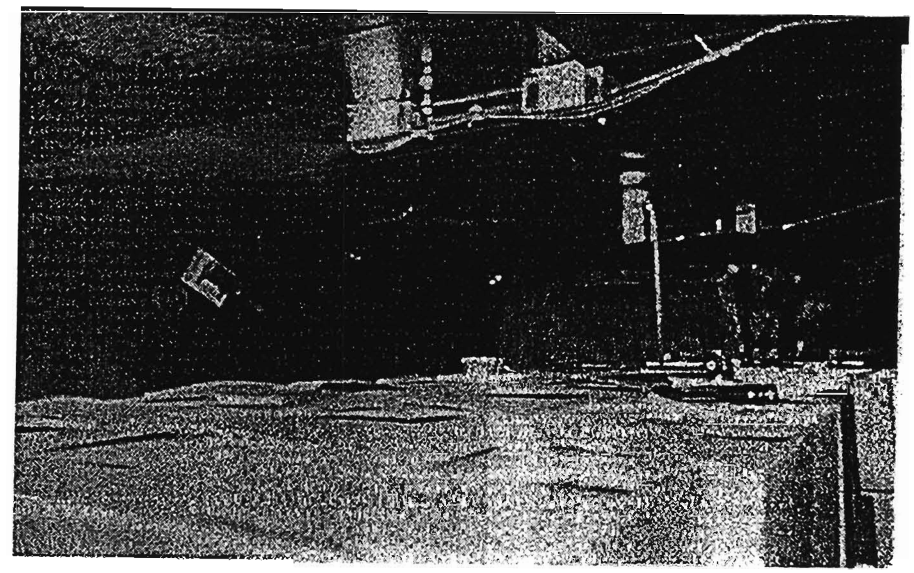
- DIFFERENT ZONE CONFIGURATION
- 360 DEGREE NOZZLE
- HIGH PRESSURE HYDRAULIC NOZZLES
- WATER COLLECTION/RECYLING SYSTEM

Cargo Compartment Subgroup Report





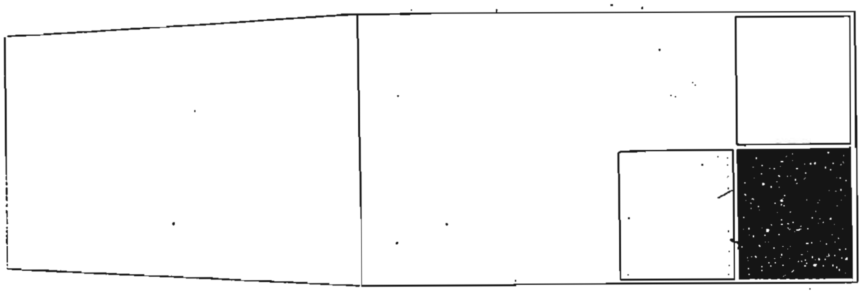
TC-10 Cargo Compartment Test Article

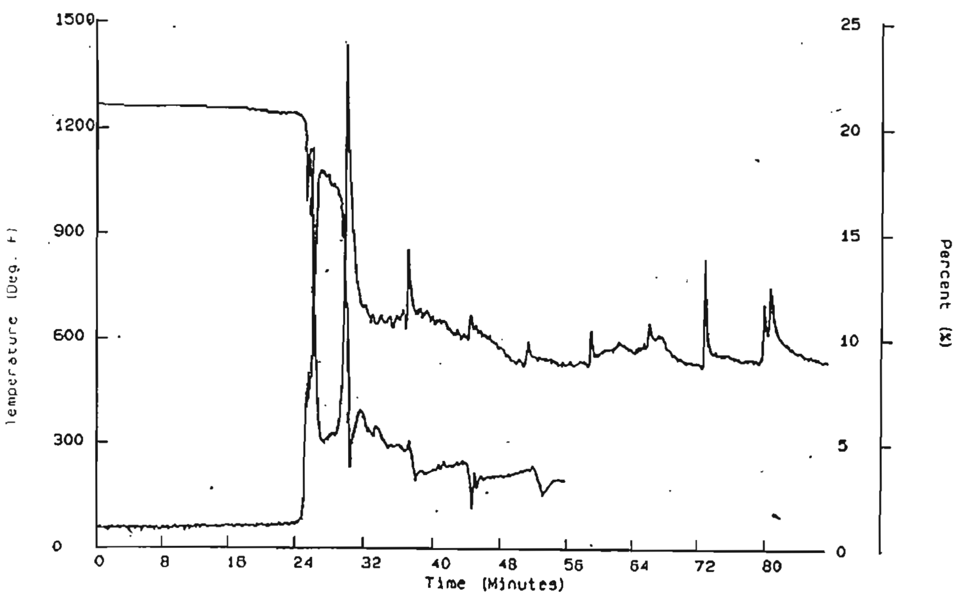


TC-10 Cargo Compartment Test Article

CARGO COMPARTMENT FIRE LOAD

- CONTAINERIZED TESTS (LD-3 W/PAPER FILLED CARDBOARD BOXES)
- BOX FILLED LD-3 NESTED BETWEEN 2 EMPTY LD-3 CONTAINERS
- LEXAN WALLED LD-3 ALLOWS FIRE TO BURN INTO COMPARTMENT



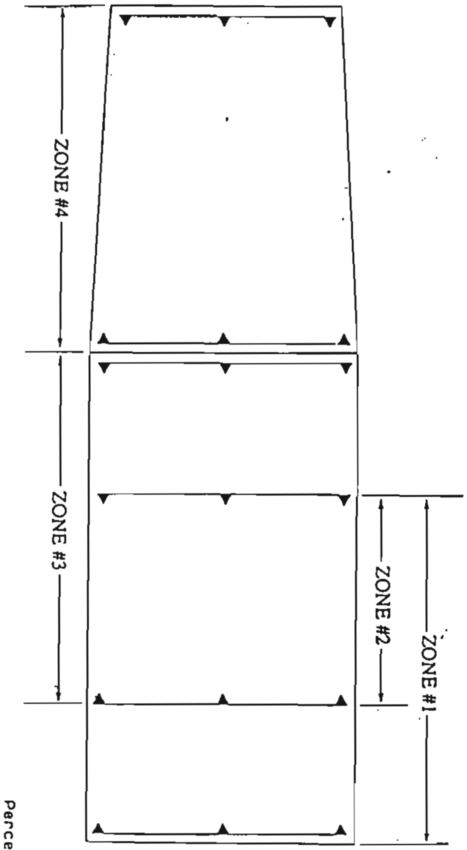


CARGO COMPARTMENTS

- Test Articles Available
- Critical Considerations
  - ✓ Fire Scenarios
  - ✓ Test Setup
  - ✓ Minimum Performance Level

CARGO COMPARTMENT WATER SPRAY SYSTEM

- DUAL FLUID NOZZLE USED (WATER/AIR)
- NOZZLES ARRANGED IN "ZONED" CONFIG (18 NOZZLES, 4 ZONES)
- INDIVIDUAL ZONE ACTIVATION BASED ON TEMPERATURE



PARAMETERS MEASURED

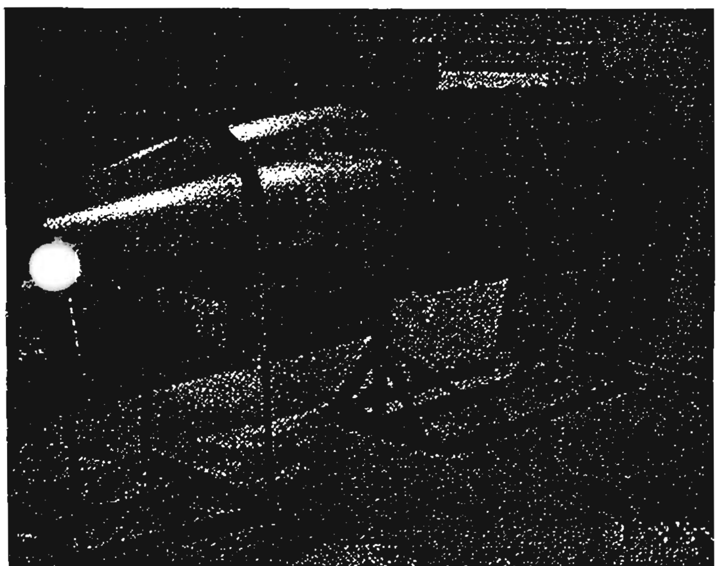
- TEMP @ CEILING LEVEL (31 LOCATIONS)
- TEMP @ CEILING FOR EACH ZONE (10 LOCATIONS)
- TEMP @ SIDEWALL (10 LOCATIONS)
- SMOKE DETECTION VIA 10 INTAKE PORTS ALONG CEILING C/L
- SMOKE LEVEL IN COMPARTMENT (3 HEIGHTS)
- SMOKE LEVEL IN CABIN (3 HEIGHTS)
- CONTINUOUS GAS CONCENTRATION IN COMPARTMENT (CO,CO2,O2)
- CONTINUOUS GAS CONCENTRATION ABOVE COMPARTMENT
- PRESSURE IN CARGO COMPARTMENT

* FAA Test Article Status
L. Curran - FAA

* Halon Replacement Program for Aviation Updat
S. Carbaugh, Major, USAF & M. Bennett, USAF

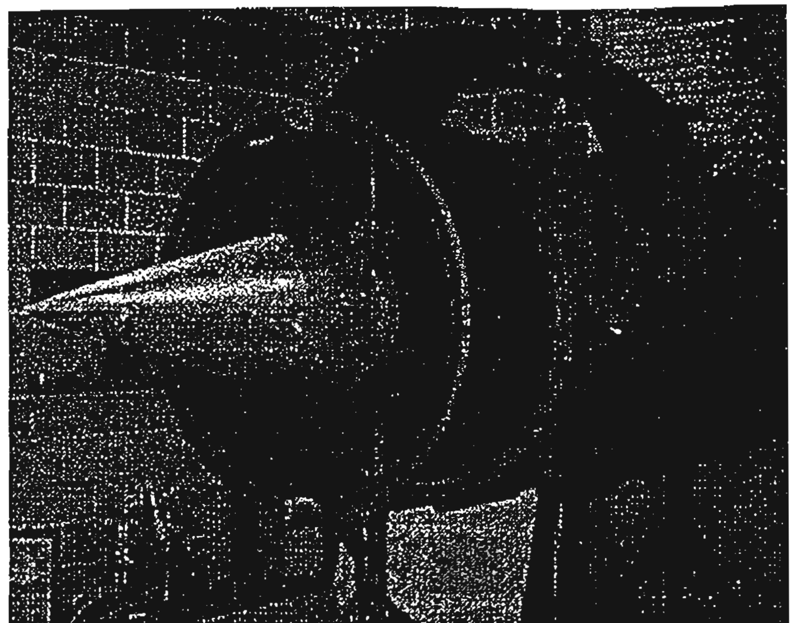
PROGRAM OBJECTIVE:

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.

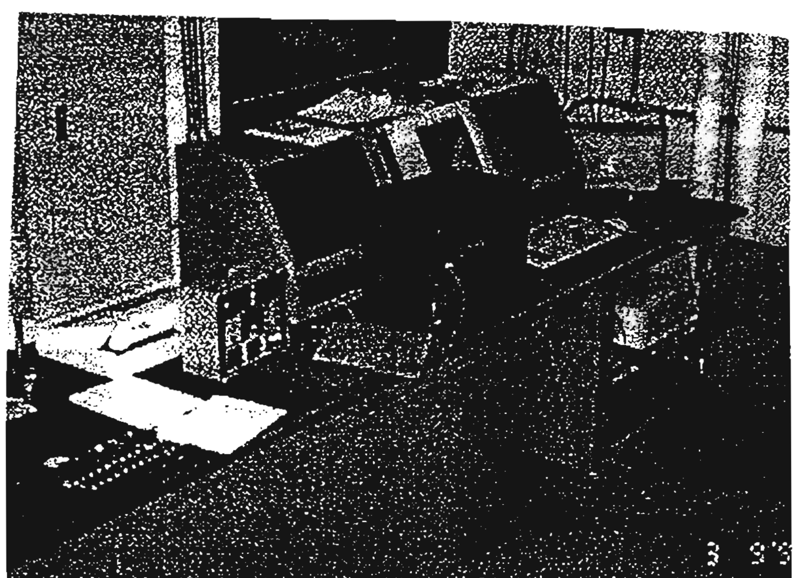


Engine Nacelle Test Fixture

- Construct Engine Nacelle Simulato
- Determine Critical Design Feature
  - ✓ Operating Conditions
  - ✓ Fire Source
- Safety Factor?



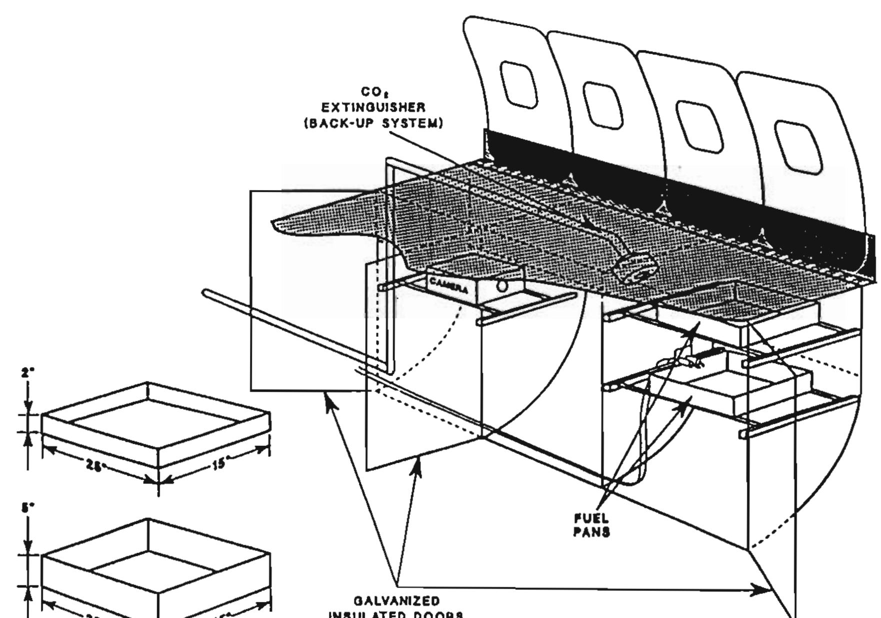
Engine Nacelle Test Fixture



Nacelle Control Room

Handheld Subgroup Report

Hand Held Replacements For Halon 1211



HIDDEN FIRE TESTING FOR REPLACEMENT AGENTS FOR HAND-HELD EXTINGUISHERS

UNITED KINGDOM
CIVIL AVIATION AUTHORITY

CAA

NOTICE TO AOC HOLDERS

Flight Operations Department, Aviation House, Gatwick Airport South, West Sussex RH6 0YR

8/92

FIRE FIGHTING TRAINING – THE USE OF HALONS

1 INTRODUCTION – THE MONTREAL PROTOCOL

1.1 The 1990 review by the Montreal Protocol on substances that deplete the ozone layer introduced a requirement for progressive cutbacks in the production and consumption of the Group II substances known as halons. The current requirement is that a 50% phase-out of production and consumption based on 1988 levels must be achieved by 1995 with a complete phase-out of production and consumption by the year 2000. Parties to the Protocol are due to review their position in November this year and an earlier compliance date seems likely. The Environmental Council (on which the UK is represented) has proposed an 85% phase out by 1 January 1994 and a total phase out by 1 January 1996. Other countries have already introduced more stringent measures and earlier phase-out dates should be anticipated.

1.2 Although halons form a small fraction of the world's consumption of Chlorofluorocarbons (CFCs) – 3%, they possess the highest Ozone Depletion Potential (ODP). Environmental regulations require any replacement substances to have a low ODP and some manufacturers have already developed such products. However, lowering of the ODP often causes fire fighting qualities to be reduced to unacceptable levels, particularly where success of the media is critical to survival factors such as dealing with an in-flight fire situation. One major manufacturer has ceased research into replacements as it firmly believes that none can reach this particular criterion. Research continues into possible replacements but as yet none would appear to be able to meet all essential criteria including fire fighting qualities, break down products, or toxicity levels.

1.3 Several of the world's producers of halon 1211 (which is used in hand held fire extinguishers) have already ceased production due to environmental pressure and it now seems likely that frugal management of existing halon stocks will be necessary in order to ensure that essential uses are protected. If the use of halon 1211 for training can be reduced, whilst ensuring that safety principles are maintained, it has been estimated that existing stocks will be sufficient to last until the year 2005. It is hoped that a replacement or alternative agent would be available by that time.

1.4 During the last three years the Authority has been closely involved with the relevant government departments who are driving this issue; meetings have been frequently attended, at the Department of Transport's request, in order to ensure that aviation's needs are highlighted and, where necessary, protected.

2 CHANGES TO CAP 360, PART ONE FIRE TRAINING REQUIREMENTS

Taking the above factors into consideration the Authority has agreed an easement to the CAP 360 Part One fire fighting training requirements until a suitable alternative agent becomes available.

2.1 With Immediate Effect

Where halon extinguishers are carried on board an aircraft, the operator may carry out the three yearly periodic practice in the form of a drill using an extinguisher fully representative of the size and operational characteristics as that provided on the aircraft, but charged with an alternative gas to normal operating pressures (subject to approval of the extinguisher manufacturer). Operators must provide a practical demonstration of the fire fighting qualities of halon on a fire representative of an interior aircraft fire, and must additionally provide practical fire training as required by CAP 360 Part One, Chapter 4, using an alternative extinguishing agent such as water.

2.2 Effective 1 January 1993

Where halon extinguishers are carried on board aircraft, initial and three-yearly training may be achieved by using an extinguisher fully representative of size, weight and operating characteristics but charged with an alternative gas to normal operating pressures (subject to approval of the extinguisher manufacturer). Operators must also provide practical fire training as required by CAP 360 Part One, Chapter 4, using an alternative extinguishing agent such as water on a fire representative of an aircraft interior fire. Additionally, operators will be required to show a film approved by the Authority demonstrating the fire fighting characteristics of halon on a fire representative of an aircraft interior fire (see Note). The film is to include the use of halon extinguishers on fires related to typical aircraft situations including galley fires, and fires in toilets, upholstery and electrical installations.

NOTE: It is anticipated that a suitable training video, currently under production by a commercial company, will be available by the end of the year. AOC Holders will be sent further details in the near future.

3 December 1992

UNITED KINGDOM
CIVIL AVIATION AUTHORITY

CAA

NOTICE TO AOC HOLDERS

Flight Operations Department, Aviation House, Gatwick Airport South, West Sussex RH6 0YR

ADDENDUM TO NOTICE TO AOC HOLDERS (NTAOCH) 8/92

FIRE FIGHTING TRAINING – THE USE OF HALONS

Notice to AOC Holders 8/92 identified the difficulties associated with the continued use and discharge of halon extinguishing agents during the practical fire fighting training for both flight crew and cabin attendants, as required by CAP 360 Part One.

A recent fire training video produced by Austin Charles Associates in conjunction with the Civil Aviation Authority and Caledonian Airways, demonstrates the extinguishing capabilities of halon agents. The Authority is satisfied that the content of this video adequately meets the requirements of NTAOCH 8/92.

Once this CAA approved video is incorporated into aircraft crew training, the easement referred to in paragraph 2.2 of NTAOCH 8/92 can be applied, negating the need to discharge halon whilst conducting the fire training required by CAP 360 Part One.

The producers have agreed to market this video at the lowest possible cost to United Kingdom AOC Holders.

United Kingdom AOC Holders:	£195.00	Including post and packaging.
Overseas Operators:	£595.00	Including post and packaging.

from:

Mr John Ellis
Austin Charles Associates Limited
Charwell House
Chestnut Avenue
Haslemere
Surrey
GU27 2AT

Phone: 0428-654044

Fax: 0428-656881

18 December 1992

The "Drop-In" Replacement for Halon 1301

By

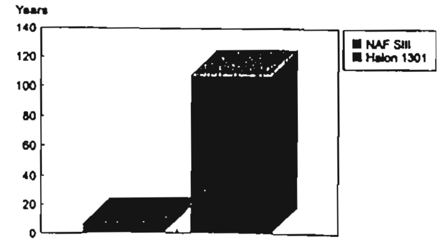
International Marketing Department

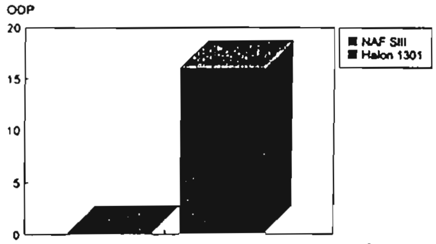
North American Fire Guardian Technology Inc.

- Environmental Considerations
- Toxicological Considerations
- Performance Considerations
- "Drop-In" Replacement

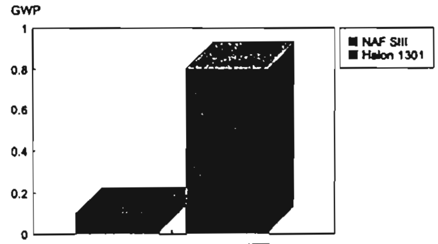
)zone Depletion Potential

	NAF SIII	Halon 1301
Ozone Depletion Potential	0.04	16
Global Warming Potential	0.1	0.8
Atmospheric Lifetime	7 years	107 years





Global Warming Potential



Toxicological Considerations

	NAF SIII	Halon1301
LC 50	700,000ppm	800,000ppm
NOAEL	10%	5%
LOAEL	>10%	>7.5%

Performance Considerations

	NAF SIII	Halon 1301
Design Concentration	8.6%	5.0%
Weight (metric)	360gr/cu.m	331gr/cu.m
(imperial)	0.0226lb/cu.ft	0.0205lb/cu.ft

Physical Properties

		NAF SIII	Halon 1301
Vapour Pressure @25*c	kPa	948	1468
Density of Liquid @21*c	g/ml	1.20	1.57
Heat of Vapourisation at Boiling Point	kJ/kg	225.6	118.8

Boiling Point

	NAF SIII	Halon 1301
Sea Level	-38.3*c	-57.75*c
36,100 ft	-68*c	
65,600 ft	-87*c	
82,000 ft	-102*c	

Container Size

Cargo Compartment Siz	NAF SIII	Halon 1301
1,[illegible] cu.ft	3.960 kg	3.641 kg
4,000 cu.ft	14.400 kg	13.240 kg

Materials Compatibility

- No reaction on metals used in aerospace engines and compartments
- No reaction with commonly used polymeric materials used for gaskets and seals

Electrical Conductivity

- Non-Conductive
- Safe for use on all Electrical & Electronic Equipment

Approvals

- ULC Listed
- ULC Recognition
- SASO Listed
- NFPA 2001 Standard
- Listed in Federal Register under EPA SNAP program
- Listed by Australian EPA
- Listed by Environment Canada

NAF PIII

The "Drop-In" Replacement for Halon 1211

Environmental Considerations

	NAF PIII	Halon 1211
Ozone Depletion Potential	0.017	4
Global Warming Potential	0.068	Not Quoted
Atmospheric Lifetime	4 years	25 years

Toxicological Considerations

	NAF PIII	Halon 1211
LC50	204,000ppm	100,000ppm

PRELIMINARY AGENDA

INTERNATIONAL HALON REPLACEMENT WORKING GROUP MEETING

MONDAY AND TUESDAY, MARCH 14-15, 1994

Held at

Fire Service College, Gloucestershire, England

MONDAY, MARCH 14, 1994

10:00-10:20	Opening/Introduction/Background
10:20-10:30	Task Group Review
10:30-11:00	Task Group Presentation - #1 Recycled Halon
11:00-11:30	Task Group Presentation - #2 Cargo Area (Agent Toxicity)
11:30-12:00	Task Group Presentation - #3 Cargo Area (Temperature)
12:00-13:30	Lunch
13:30-14:00	Task Group Presentation - #4 Fire Load
14:00-14:30	Task Group Presentation - #5 Engines
14:30-15:00	Task Group Presentation - #6 Current Alternative Agents
15:00-15:15	Break
15:15-16:45	FAA Subgroup Leader Reviews

15:15-15:45	Cargo
15:45-16:15	Engines
16:15-16:45	Handheld

16:45-17:15	Summary
17:15-17:30	Closing

TUESDAY, MARCH 15, 1994

09:00-10:00	Open Discussion
10:00-12:00	Working Group Member Presentations
12:00-13:00	Lunch
13:00-14:30	Task Group Discussions
14:30-14:45	Break
14:45-15:45	Task Group Assignments
15:45-16:30	Final Discussion/Next Meeting/Closing