INTERNATIONAL HALON REPLACEMENT WORKING GROUP

A Message From The Coordinator's Office

July 30, 1996

Dear International Halon Replacement Working Group Members:

Enclosed is the Minutes Package from the July 16-17, 1996, meeting held at the William J. Hughes Federal Aviation Administration (FAA) Technical Center.

This package includes a copy of the 'Lavatory Disposal Receptacle Built-In Extinguisher Halon Replacement Proposed Minimum Performance Standard'. Any comments on this proposed standard should be directed to Tim Marker at 609-485-6469 or by fax at 609-485-5580. The 'Proposed Minimum Performance Standards for Aircraft Engine and APU Compartment Fire Extinguishing Agents/Systems' is also included in this package. Any comments on this proposed standard should be directed to Doug Ingerson at 609-485-4945 or by fax at 609-646-5229.

The next meeting will be held on October 9-10, 1996, in the London area. A complete meeting details package will be mailed to all working group members as soon as it is available.

Thank you for another successful meeting.

Sincerely yours,

April Horner

April Horner

Enclosures

Sponsored by:
Federal Aviation
Administration
Technical Center

INTERNATIONAL HALON REPLACEMENT WORKING GROUP MEETING

Held at the Federal Aviation Administration (FAA) Technical Center

July 16-17, 1996

TUESDAY, JULY 16, 1996

R. Hill spoke about possible impact of ValuJet accident earlier this summer in Florida and the conversion of Class D cargo compartments to Class C cargo compartments on transport aircraft.

Review of Minutes of March 26-27, 1996 Meeting

No comments from group.

Schedule for Halon Replacement - R. Hill

Engine work is on schedule provided minimum performance standards are worked out. Cargo work is about 3-4 months behind schedule due to ValuJet accident investigation. Lavatory test method is progressing. There have been several meeting since the March WG meeting on the lavatory test method. We (at the FAATC) have set up the handheld test apparatus here and begun testing. B. Glaser: Will you include John Petrakis' Halon Replacement schedule in the minutes and will it include all of these areas? R. Hill: Yes, we will include it and we will include all of these areas in it.

CARGO - FULL SCALE TESTING - D. Blake

Presented results of Hydrogen Fluoride TC10 Cargo Test Cargo Compartment at 3'6". Discussed future tests planned. Dave showed a few photos from the ValuJet investigation. A. Gupta: Is there something we can learn from this accident? Heat seems to be a major factor. D. Blake: A lot of work could be done in this area and we have a project we would like to do, but at present, we are understaffed for all the tests we would like to conduct.

R. Hill

We have talked in the past about what threat you want to prevent against. There has been quite a bit of discussion about what material should and should not be carried in a cargo compartment recently.

Water Mist - R. Hill

We (FAATC) have done some tests with water mist systems with containerized loads. We are going to be doing some water mist testing after we finish with the gaseous agents probably late in the fall. We have recommended to the FAA Certification Personnel that we should do the additional water mist testing sooner than that. A. Gupta: Would it help the FAA if we reconvene the Task Group on cargo compartment tests? R. Hill: If you feel it would be useful to make additional comments/recommendations, we are open to additional comments. A. Gupta: Would the Task Group members like to reconvene? S. Hariram: Yes.

FIREDASS PROJECT - N. Povey

Gave brief presentation on the structure of the FIREDASS PROJECT and its intent.

ENGINE - FULL SCALE TESTING - D. Ingerson

Presented status of FAATC Nacelle Simulator. Discussed the progress of the group currently working on the he Minimum Performance Standard for Engines and the proposed testing at Wright Patterson Air Force Base for August 1996. Presented a list of reports he found with a number of agents on engine live fires from the 1940's through 1970. B. Grosshandler: How do you see your simulator interfacing with the WPAFB simulator eventually? Do you see using your facility early in the game and then shifting the more detailed work to WPAFB or doing all of the work here? D. Ingerson: Our intent is to be able to do the same work here with the simulator.

MPSE Member Comment: The first draft of the MPSE that we are working on with Doug does not address all issues.

R. Hill: With the Minimum Performance Standards we are not trying to change the requirement or the level of safety. We are trying to equate the agent or system to what is presently used.

The proposed Minimum Performance Standard for the Engine/APU compartment has been completed. The proposed standard has a generic approach to Halon replacement in the engine/APU compartment. The general test cycle involves:
1. developing a nacelle simulator of specified geometry and environment
2. producing a certification quality Halon distribution within the nacelle simulator
3. finding fire scenarios which demonstrate a statistical suppression behavior as a result of Halon 1301 fire suppression performance
4. challenging the fire scenarios found in (3) with an alternate suppression technology
5. finding the alternate suppression technology equivalent to Halon 1301 performance by the bench mark of the fire scenarios found in (3).

Representatives supporting individual suppression technologies would be expected to work out details with the parties of interest (e.g. manufacturer, test facility, and certification authority) for the testing to generate valuable information and see to the correct individuals receiving that information. D. Ingerson and H. Mehta respectfully acknowledged the effort of the group members, past and present.

HANDHELD - N. Povey

Gave brief update on Minimum Performance Standard for Handheld Extinguishers - In this Standard, we defined all the criteria an extinguisher must meet. We will be doing some toxicity work. D. Catchpole: Has the CAA done any tests with the alternative agents? N. Povey: J. O'Sullivan has been closely involved in one of the tests we did. One concern is extensive training for the flight attendants so that they know what to expect when they discharge the agent.

R. Hill: The FAA did a study a number of years ago on cabin fires/smoke. Some of the most common fires were small fires in lavatories, galley fires in various locations (microwave ovens, etc.). We specified Halon 1211 in the requirement because of the specific threat we indicated that 1211 (or the equivalent) must be used to extinguish a fire with a handheld extinguisher. A. Gupta: I received a brochure in the mail about an FAA approved fire extinguisher for ground applications. This could be misinterpreted. Is there some way to bring attention to this? J. Petrakis: We could put out a bulletin. R. Hill: We will take this up as an Action Item. B. Stacho: What about the Appendix 2 as indicated in the Handheld Minimum Performance Standard draft? R. Hill: We will discuss this later when we are out at the facility.

LAVATORY TRASH RECEPTACLE EXTINGUISHMENT TESTING - T. Maker

Gave a brief presentation on the testing at the FAATC to date. Traveled to Walter-Kidde facility in North Carolina to compare test procedures. Walter-Kidde reps and Pacific Scientific reps visited FAATC to work on Minimum Performance Standard. Presented update on Minimum Performance Standard revised at the June meeting at the FAATC with Walter-Kidde and Pacific Scientific. B. Grosshandler: Is the FAATC comfortable with 20°F? T. Marker: I'm leaving that open for discussion with this WG during this afternoon's discussions at the test facilities.

GENERAL DISCUSSION ON AVAILABILITY OF DETECTION SYSTEMS FOR PRESENT CLASS D CARGO COMPARTMENTS - R. Hill

R. Hill: What is the problem associated with requiring Halon 1301 systems for all Class D cargo compartments? Is there enough agent out there? We are talking about 3,500 airplanes in the U.S. fleet with Class D cargo compartments of 500 cubic feet or less. You would have to be able to get an initial discharge of 5% keeping the concentration above 3%. Most of these planes are used for shorter flights not for long over water flights -- 2 to 3 cargo compartments per plane. Does anybody see a problem for quantities of 1301 if a system was required now and 1301 was allowed. J. O'Sullivan: What is the quantity needed per hold? R. Hill: 15 pounds per compartment. Member comment: Would you legally be allowed under legislation to require 1301? R. Hill: The FAA will not require the use of 1301 specifically. We are looking at putting a requirement out to require a suppression system in the Class D compartments. This may also put pressure on industry develop a system/agent to replace Halon 1301 for cargo compartments. J. O'Sullivan: There are a number of areas that need to be looked at first. B. Grosshandler: How do you factor in the uncertainty of the availability of 1301? R. Hill: Right now we are assuming that there is no problem requiring for 1301 because it is available based on this WG's response. It will take some time to put out a rule (a year or two or more). By that time an alternative agent may be approved. It will take some time for this rule to be in place unless there is a Congressional directive. D. Catchpole: Why doesn't the FAA say they don't want to use 1301? R. Hill: We have no mandate by law to tell users they cannot use 1301 if it is still allowed to be used (if there is no law making it illegal to use 1301). B. Leach: There is already a push for alternative agents. R. Rubenstein: The aviation industry is not one of the critical areas where what little Halon that is left should be used. There are other applications where only Halon can be used at present. This is where our remaining Halon can be used. R. Hill: There is no mention of 1301 in the requirements. H. Mehta: I think that there are several issues being mixed up here. 1) Do Class D need a fire detection and suppression system. 2) Some of this is political and out of this WG's hands. 3) We are here to try to come up with minimum requirements for alternative agents. A. Gupta: There are better ways to make it safer--one is better training of baggage handlers and banning aerosol cans from checked baggage (allow it to be carry-on luggage only which remains in the cabin and is not stored in the cargo compartment).

WEDNESDAY, JULY 17, 1996

Report Publication Update

DOT/FAA/AR-96/8 "User Preferred Fire Suppression Agent for Lavatory Trash Container Fire Protection" - Published April 1996

Update to "Chemical Options to Halon for Aircraft Use" - to be published August 1996

"User Preferred Fire Extinguishing Agent for Aircraft Cargo Compartments" - to be published August 1996
"User Preferred Fir Extinguishing Agent for Engine and APU Compartments" - to be published August 1996

Task Group Leader Presentations/Updates

Cargo Detection False Alarm Survey - J. O'Sullivan

100 surveys sent out only 13 responses from airlines to date, 2 responses from manufacturers, and 1 from a regulatory authority. Responses were due to John O'Sullivan by June 30, 1996. Over a 5 year period there were 75 events reported by the 13 airline respondents. There were 2 real fires out of these 75. Member question: Why don't we try to find out how many alarms there were in Class C cargo compartments and how many were undetected? Also, how many fires there were in Class D cargo compartments? R. Hill: We can't even get the airlines to reply with the basic information how will we be able to get responses on more specific information from them? J. O'Sullivan: I think that is broadening the base on what we are asking for significantly. Member question: Do they all use the same detection system. B. Gibbs: There are number of different manufacturers but most systems operate under the same basic principles. A copy of the survey responses to ate is included in this package.

Halon Restrictions Update - J. O'Sullivan/D. Ball

Supplied information on September 11-12, 1996, Conference in England on Halon.

D. Ball gave presentation on Decision VII/12 and the Aerospace Industry and some details on the Halon provisions in the Montreal Protocol and some amendments to the Montreal Protocol. A copy of his presentation is included in this package.

It is important for us to publicize what we are doing in this Working Group to find alternative agents for Halon in the aviation industry. R. Rubenstein: An engineering effort may need to made to make the alternative agents/systems (for halon) available work in aviation applications.

DISCUSSION ON MINIMUM PERFORMANCE STANDARDS

Minimum Performance Standard for Handheld Extinguishers

R. Hill/N. Povey - Are there any questions or areas of concern on this Minimum Performance Standard? B. Grosshandler: How did you arrive at the volume in the Minimum Performance Standard? N. Povey: The volume we wanted to represent some of the aircraft structure. The volume with the airflow gets you to an extinguishing concentration in some areas absolutely. A volume which you could use as a benchmark which you could say better than or worse than this volume. D. Ball: Is there going to be something specific in the handheld minimum performance standard on toxicology? N. Povey: If it approved as a handheld extinguisher one assumes that the agent is not going to be toxic. Meaning it won't have too irritating an effect on the user so that the user cannot use it (more difficult to use). The agent in an approved extinguisher, we like to assume, will not be lethally toxic. D. Ball: We have to define the acceptable toxicity of the alternative agent. R. Hill: In doing that we may run the risk of comparing the toxicity of the by-products of two or more agents. B. Grosshandler: Have you tried your system with CO_2 or water-based systems? N. Povey: CO_2 did not perform as well as Halon 1211. I haven't been involved with any water-based testing. R. Hill: We are trying to replace 1211 with an agent that gives us an equivalent level of safety. C. Lewis: What confidence do we have in extinguishing fires in the test apparatus to a real fire? N. Povey: We are trying to come up with a benchmark for 1211 to compare the other agents to. We are confident that this will be an accurate comparison. Member Question: When will you develop pass/fail criteria? N. Povey: When we are confident that our test apparatus is reproducible in the U.S. (when the FAATC gets the same results with their test apparatus that we got with our apparatus). D. Ball: Who is developing the toxicity standard? N. Povey: Currently, we don't have any wording other than something along the lines of "the agent will not cause undo hazard". B. Grosshandler: Who will make the judgment as to what is acceptable? R. Hill: You have to get someone within the FAA to agree that what you put in the extinguisher is equivalent. You will have to convince that person. Concerning the toxicity, you will have to prove that the alternative agent is not more hazardous than Halon 1211. N. Povey: By the next meeting I think we will have enough information to see if we have a problem area. R. Rubenstein: Do you set the air exchange rate? R. Hill: Yes, we do set the air exchange rate. You can do certain things to increase the air exchange rate if it is absolutely positively needed (for example, if there is a lot of smoke). R. Rubenstein: What about if you had a small area fire on an aircraft? Would you change the air exchange rate? R. Hill: Not necessarily, unless there was a lot of smoke. R. Rubenstein: Is there a time limit you can set for the air exchange rate? R. Hill: Yes, that is what we do in the test. We set the airflow and take measurements. B. Grosshandler: I recommend that you handle the toxicity issue separately by running a toxicity tests. R. Hill: I would like to hold off until we have run a number of tests before we run toxicity tests, because we may find the that the fire produces more smoke than the agent extinguishing the fire as in the case of Halon 1211. N. Povey: By the time we meet in October the FAATC will have done some testing. We also have some testing work going on at CEAT. At the next meeting CEAT will give an update on their work.

Minimum Performance Standards for Lavatory Trash Receptacle Fire Extinguishers

T. Marker: Does anyone have any general comments on the Minimum Performance Standard? D. Dierdorf: I suggest that we change some of the wording about the requirement for the amount of agent in the first part of the Minimum Performance Standard. B. Grosshandler: Why have the amount of agent needlessly restrictive since it will be used in a trash container (an enclosed area)? A. Gupta: You can not count on the ventilation in the lavatory, because when the aircraft is on the ground the ventilation is different than when it is in flight. H. Humfeldt/A. Gupta: Maybe include some wording along the lines of "not to exceed a certain volume". H. Humfeldt: Didn't you say why implement restrictions, give the end users a chance? R. Hill: Yes, I did. D. Dierdorf: I'd like to propose some wording taken from the Handheld Minimum Performance Standard such as: "in confined spaces such as the lavatory at no time should the agent present an unacceptable health hazard....leakage". R. Hill: I have no problem with that statement as long as some numbers are included in that. G. Sarkos: How about a statement such as: "the quantity of agent should be limited by the lowest adverse...". B. Gibbs: I think maybe it is the definition of 'total flood' that we need to clarify. R. Hill: We'll draft something up and send it around for comment on this. T. Marker: How about the number of extinguishers? R. Hill: Does 4 out of 4 or 5 out of 5 mean 4 in a row or 5 in a row? R. Mazzone: I really haven't seen very much in the way of confidence level that will give us 4 out of 4 or 5 out of 5. B. Glaser: Aren't you guys going to run a series? Do you have data that shows 100%? We are going to run about 10 more tests to get the statistical data. T. Marker: What are we going to agree on as to the discharge temperature of the agent? What about 20°F? B. Glaser: Based on the bottle and our amount of testing, I would say 30°F not 20°F. C. Lewis: I'm not too sure that we have enough sampling to make that decision. T. Marker: We'll (FAATC) run some more tests and Walter-Kidde will run some more tests and see what we come up with. B. Bowen: Was the word 'functioning' used? R. Hill: Yes, the word 'functioning' was used. R. Mazzone: What is the temperature that all three test facilities have had success with? T. Marker: 30°F, based on the tests that we've (all three facilities) run so far. R. Hill: By the next meeting we should have a temperature that the three test facilities agree upon. R. Mazzone: Is there a way we can measure the moisture content in the towels? R. Hill: By weight would be the only way (weigh the a certain number of towels). The latest version of the Lavatory Minimum Performance Standard is included in this package.

Minimum Performance Standard for Engine Nacelle/APU

D. Ingerson gave update on results of this group's meetings. A copy of the Minimum Performance Standard for Engine Nacelle/APU is enclosed in this package. B. Grosshandler: Will pan and spray fires be lighted simultaneously? D. Ingerson: No, individually.

Minimum Performance Standard for Cargo Compartments

R. Hill: Does anyone have any comments on the copies that were distributed yesterday through Nick Povey? We can't get into the toxicity issue right now because the toxicity concentration in the cargo compartment depends on the design of the aircraft. B. Grosshandler: Who is responsible for the measurements on carbon dioxide concentration? R. Hill: Nick Povey. Take any questions specific to the numbers in that copy up with Nick Povey. N. Povey: Please get any comments you have on this document back to me or GEC Marconi. This document is written to cover all types of agents. R. Hill: It is a combination of the Minimum Performance Standard for Cargo Compartments that we initially wrote up and cargo compartment water mist testing that is being worked on at GEC Marconi. B. Grosshandler: Are you going to be doing the pressurized aerosol can test? R. Hill: Yes, we will develop something that we feel is representative.

B. Bowen: Should the minimum performance standard include a user impact statement (dealing with corrosiveness of substance, long term odors, what kind of servicing might be necessary, what kind of clean up is necessary, etc.). How will the airlines and airframe manufacturers get this information--from the agent/system manufacturers? R. Hill: The members of the Working Group as operators and users stated in previous meetings that this type of information should not be included in the minimum performance standards, but leave it up to the end users to get this information for themselves (this is similar to the health and safety concerns about the agent). B. Bowen: I'm talking about something in the Minimum Performance Standard that would require the supplier to provide an impact statement. R. Hill: Let's have the airlines make a list of some of these concerns such as clean up, etc., that they would like addressed for discussion at the next meeting. We'll talk to Bob Tapscott about maybe including information like this in the third version of the report. D. Moore: As a manufacturer, I'd be happy to answer any questions concerning the agents we manufacture. B. Bowen: I will go to the ATA and see what kind of list they can provide. R.Hill: Send it to April or bring it to the next meeting. We'll discuss it at the next meeting.

Fire Safety Section Internet Information

Information about the International Halon Replacement Working Group and the International Aircraft Materials Fire Test Working Group is now located on the Internet as well as other information about work being done by the Fire Safety Section at the FAATC. The home page address is: **http://www.asp.tc.faa.gov/FAATC/AAR422/index.html**

Working Group Member Presentations

A. Moussa

FAATC (G. Sarkos) will chair a Task Group to publicize what this Working Group has been doing (work, reports, etc.). He will coordinate with J. O'Sullivan. Contact G. Sarkos or A. Horner if you are interested in participating in this project.

CONVERSION OF CLASS D CARGO COMPARTMENTS TO CLASS C CARGO COMPARTMENTS - R. Hill

Are there any additional comments at this time? Is there any idea based on the fact that what we are talking about on D compartments are small compartments is that the agent is not accessible? We are not talking about a whole lot of extra weight since these are small compartments. Does anyone have any idea of the cost (maybe compared to that of Halon 1301 for this size area)? D. Dierdorf: You are going to have different costs for different technologies. A number of group members stated that the cost would be similar to that of Halon 1301 for most of the gaseous agents because the plumbing is the same for these as for Halon 1301, the cost of the other agents would be close to that of Halon 1301. The cost of the agent is trivial according to a number of WG members (agent manufacturers).

NEXT MEETING

October 9-10, 1996, in the London area. Further details will be sent out to all group members when available.

CARGO HOLD DETECTION STUDY

1.	**AIRLINES**	**NB OF ACT**	**NB OF EVENTS**	**DET/RES**
	(a)	21	NIl	YES
	(b)	N.I.	1	YES
	(c)	19	1	YES
	(d)	16	5	YES
	(e)	N.I.	5	YES
	(f)	N.I.	33	YES
	(g)	124	2	YES
	(h)	69	10	YES
	(i)	60	9	YES
	(j)	3	1	YES
	(k)	150	4	YES
	(l)	N.I.	4	YES
	(m)	24	NIL	YES
2.	**AUTHORITIES**			
	(a)	N/A	470 APPROX	
3.	**MANUFACTURERS**			
	(a)	N.I.	9	YES
	(b)	29	2	YES

AIRLINES	13 (75)	
AUTHORITIES	1 (470)	
MANUFACTURERS	2 (11)	2

TOTAL	RESPONSES	16
	EVENTS	556
	RESEARCH	15

AIRLINES:	SYSTEM ACTIVATED	25
	DIVERSIONS	18
	ACTUAL FIRES	2

* NOTE: This information not yet reviewed.

N.I. = No information.

jos-cgo

Decision VII/12 and the Aerospace Industry

- Montreal Protocol - History and Status
- Montreal Protocol - Effect to date
- Options at Vienna Meeting
- Vienna Decision VII/12
- Implications for Aerospace

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Montreal Protocol - Chronology

1985 - Vienna Convention on Protection of the Ozone Layer

1987 - Montreal Protocol on Substances that Deplete the Ozone Layer (Parties: 156)

1990 - London Amendments (II/) (109)

1992 - Copenhagen Amendments (IV/) (54)

1995 - Vienna Adjustments (VII/)

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Montreal Protocol - Organisation

- Parties to the Protocol
  - meet annually (preparation by OEWG)
- UNEP Ozone Secretariat
  - permanent
- Assessment Panels
  - including Science; Effects; Technology & Economics
- Technical Options Committees
  - including HTOC
  - meets 2-4 times annually

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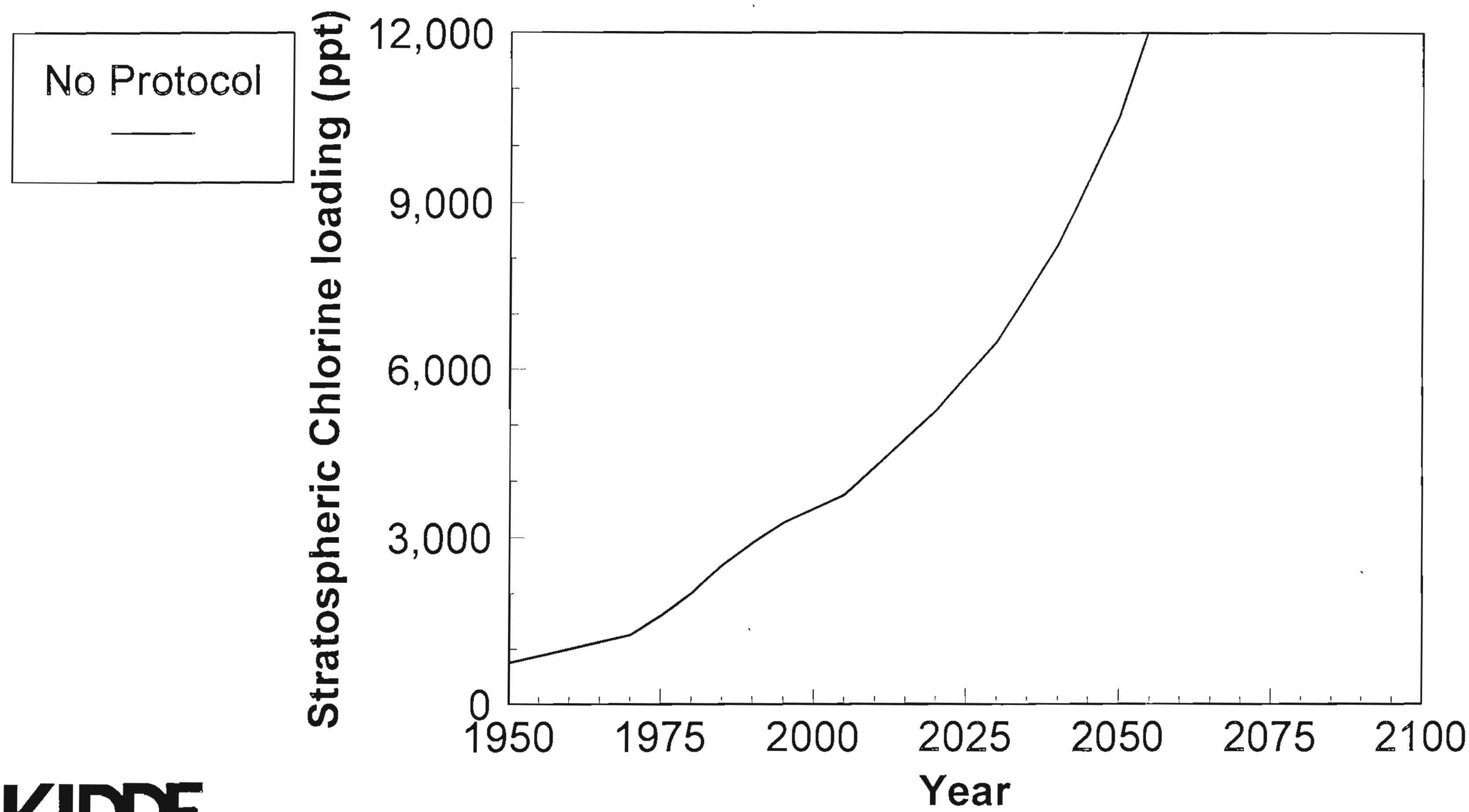
Montreal Protocol - Effect

- Predicted level of stratospheric chlorine loading
- Model and data presented in Report "Scientific Assessment of Ozone Depletion 1994" (Allbritton, Solomon *et al*)

Stratospheric Chlorine - Without the Protocol



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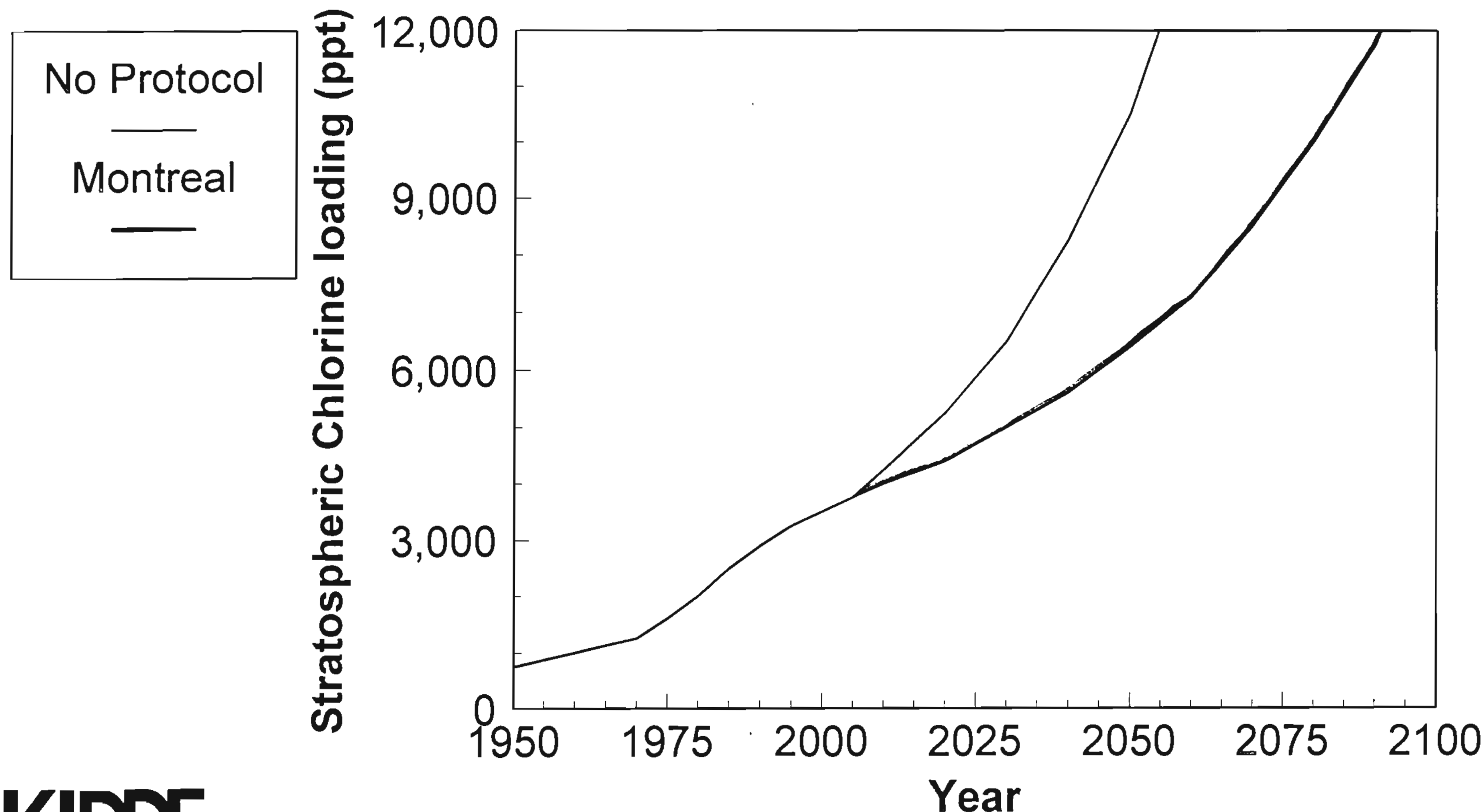
Montreal Protocol (1987) - Provisions on Halons

- From 1.1.1992,
  Cap production
  at 1986 level

Stratospheric Chlorine Loading - with Montreal Protocol



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London Amendments (1990)

- From 1.1.1995, Production halved (II/1)
- From 1.1.2000, Production banned (II/1)
- Possibility of "Essential Use" Production (II/3)
- If ODP>0, "Transitional Substance" with phase out date 2020-2040 (London Resolution)

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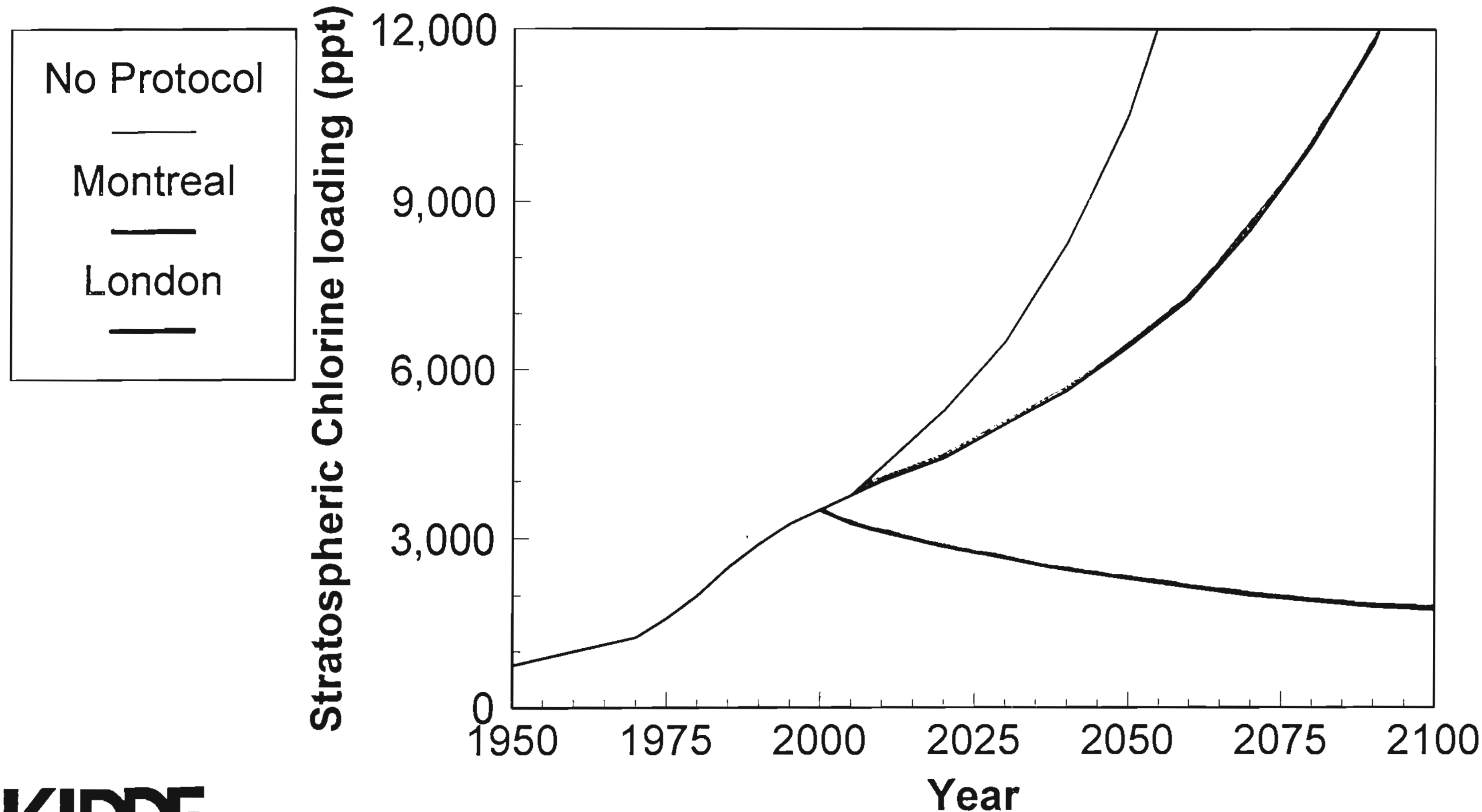
Stratospheric Chlorine Loading - with London Amendments



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Copenhagen Amendments (1992)

- From 1.1.1994, Production banned (IV/2)
- "Essential Use" Criteria defined (IV/25)

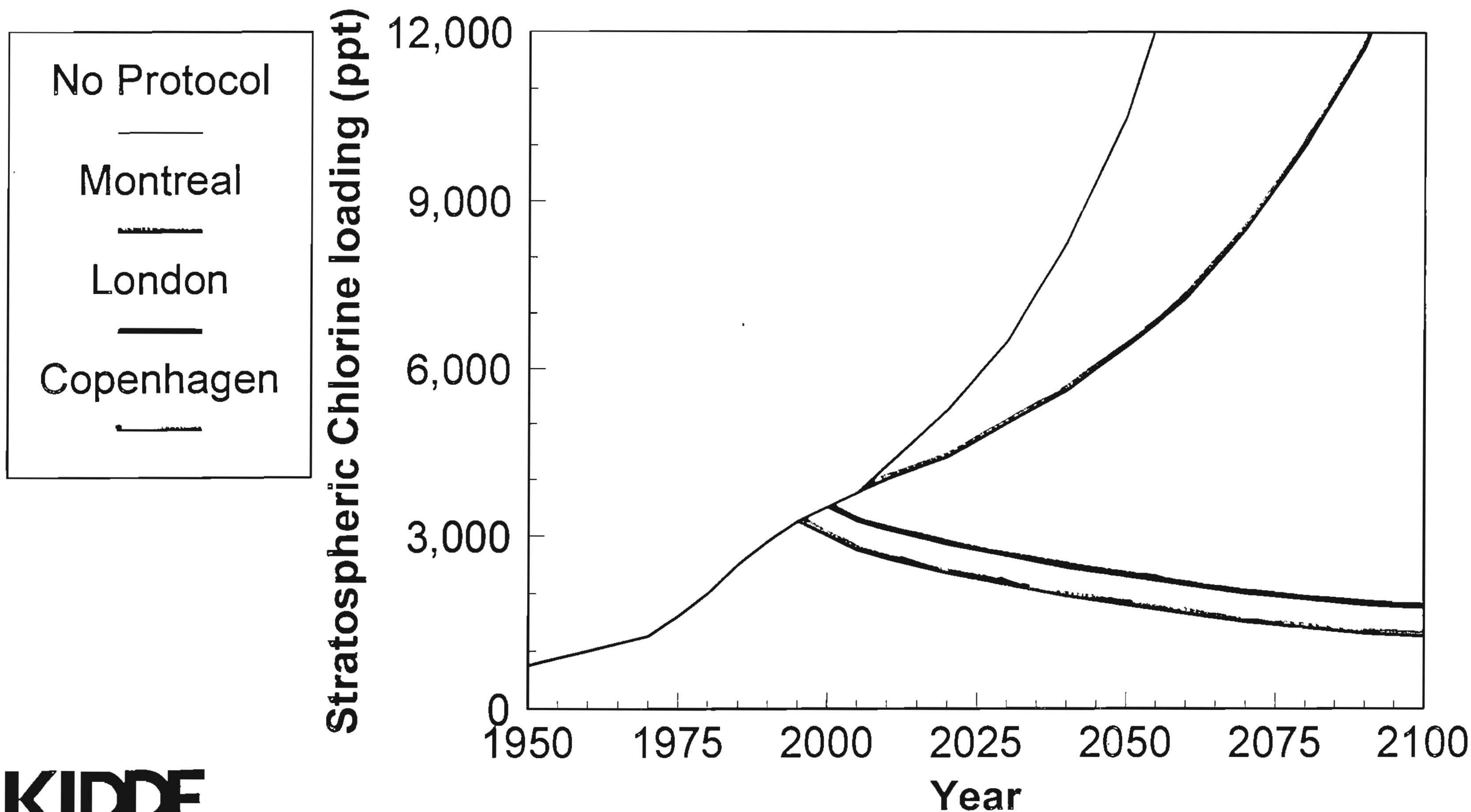
Necessary for the health, safety or critical for the function of society (including cultural/intellectual)

AND

No available technically and economically feasible alternatives acceptable for environment and health

- "Transitional Substance" phase out date advanced to 2015 (90% reduction) (IV/3)

Stratospheric Chlorine Loading - with Copenhagen Amendments



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Recent Findings on Tropospheric Chlorine Loading

- Montzka *et al* in SCIENCE, 31 May
- First observed decrease in <u>tropospheric</u> loading
- Stratospheric loading lags by 4-5 years
- Consistent with model

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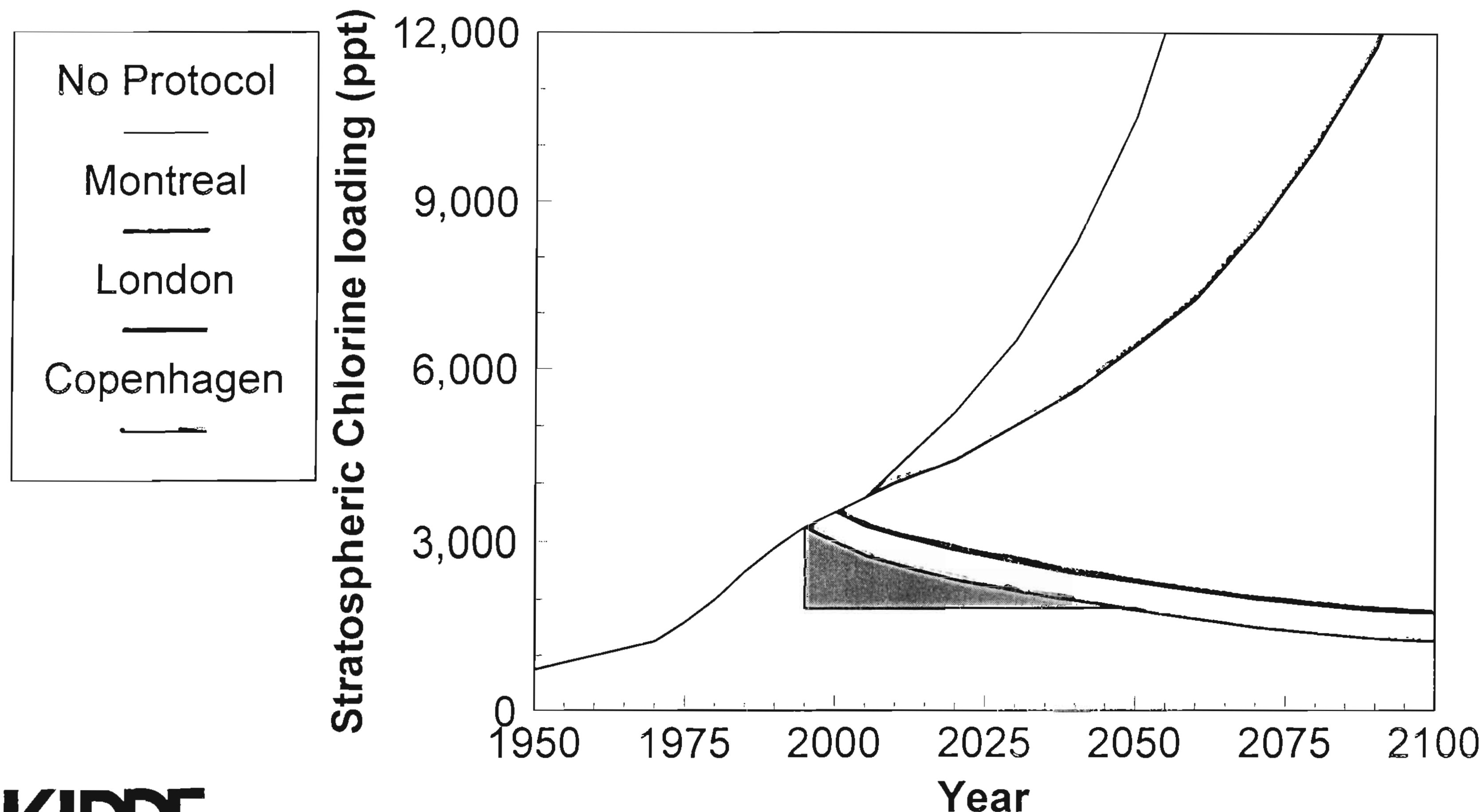
Stratospheric Chlorine - What's Left for Vienna?



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Options at Vienna

- Methyl Bromide
  - Elimination by 2001 reduces integrated ozone loss over next 50 years by 13%
- Halons
  - Destroying stored agent reduces integrated ozone loss over next 50 years by 10%
- HCFCs
  - Acceleration of phaseout to 2004 reduces integrated ozone loss over next 50 years by 5%

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Vienna Decision VII/12

To recommend that all non-Article 5 Parties should endeavour, on a voluntary basis, to limit the emissions of halon to a minimum by:

(a) Accepting as Critical those applications meeting the Essential Use criteria as defined in Decision IV/25, paragraph I (a);

(b) Limiting the use of halons in new installations to Critical Applications;

(c) Accepting that existing installations for Critical Applications may continue to use halon in the future;

(d) Considering the decommissioning of halon systems in existing installations, which are not Critical Applications, as quickly as technically and economically feasible;

(e) Ensuring that halons are effectively recovered;

(f) Preventing, whenever feasible, the use of halon in equipment testing and for training of personnel;

(g) Evaluating and taking into account only those substitutes and replacements of halon, for which no other more environmentally suitable ones are available;

(h) Promoting the environmentally safe destruction of halons, when they are not needed in halon banks (existing or to be created).

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Decision VII/12 - Key Points

Voluntarily minimise halon emissions by:

- Limiting new halon use to *Critical* (meeting the Essential Use criteria) Applications;
- Considering *decommissioning* non-Critical installations, as quickly as feasible;
- Taking into account only replacements for which no other more *environmentally suitable* ones are available;
- Promoting the environmentally safe *destruction* of halons not needed in banks.

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Decision VIII/12 - Implications

Changes in Political Complexion:

- Criticality = <u>Use Control</u>
- Decommissoning
- Destruction
- Other Environmental Issues

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Criticality and Use Control

- <u>Only</u> basis for continued use?
- Who decides?
- How often?
- Who determines economic feasibility?
- Active search for alternatives likely to be a condition
- Implications for trade and international movement?

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Decommissioning and Destruction

- Without Critical needs (immediate or via bank) "surplus" liable to destruction
- 1211 perceived as in surplus ...
- Asset could become liability leading to venting
- Pressure to decommission non-Critical uses <u>now</u> will limit availability <u>long term</u>
- Banks need to be built <u>now</u> or never

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Environmental Suitability

- Search for alternatives needs to allow for other environmental issues
- Need to publicise existence of aerospace efforts on alternatives
- Need to publicise technical difficulty of aerospace applications
- Need to implement alternatives where available and publicise

Implications for Aerospace

- Banks need to be built <u>now</u>
- Need to pursue <u>and publicise</u> search for alternatives
- Need to <u>implement</u> alternatives
- Aerospace needs to <u>be involved</u>

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LAVATORY TRASH RECEPTACLE EXTINGUISHMENT TESTING

Background

10/95-3/96 INITIAL TESTING OF AGENTS

- HALON 1301
- FM-200
- HFC-125
- WATER
- ENVIROGEL

3/96 WG MEETING IN ROME REVEALS LARGE DIFFERENCES IN TEST RESULTS

run additional tests..

5/96 FAATC TO WKA

- TYPE OF TOWEL USED
- METHOD OF CRUMPLING
- COMPRESSION OF CRUMPLED TOWELS IN RECEPTACLE

run additional tests..

6/96 WKA & PAC SCI to FAATC

- REFINEMENT OF MINIMUM PERFORMANCE STANDARD
- NEW PHILOSOPHY ON CONTROLLING CRUMPLING
- 0°F AGENT DISCHARGE TEMP TOO LOW

run additional tests..

LAVATORY TRASH RECEPTACLE EXTINGUISHMENT TESTING

UPDATED MINIMUM PERFORMANCE STANDARD

AMBIENT TEST CONDITIONS: 80°F +/- 20°F

CRUMPLING METHOD STANDARD: 18" X 18" X 18" FILLED WITH 340 TOWELS (+/- 10 TOWELS)

COMPRESSION OF TOWELS TO HALF VOLUME: REMOVED

AGENT DISCHARGE TEMPERATURE: 20°F OR BELOW (WHEN RELEASED)

STANDARDIZATION OF TOWEL

C-FOLD, 2-PLY BLEACHED HANDIFOLD

10.25" x 13.25"

TIME LIMIT ON EXTINGUISHER DISCHARGE AFTER IGNITION (4 MINUTES)

STANDARDIZATION OF TEST RECEPTACLE VIEWING WINDOW

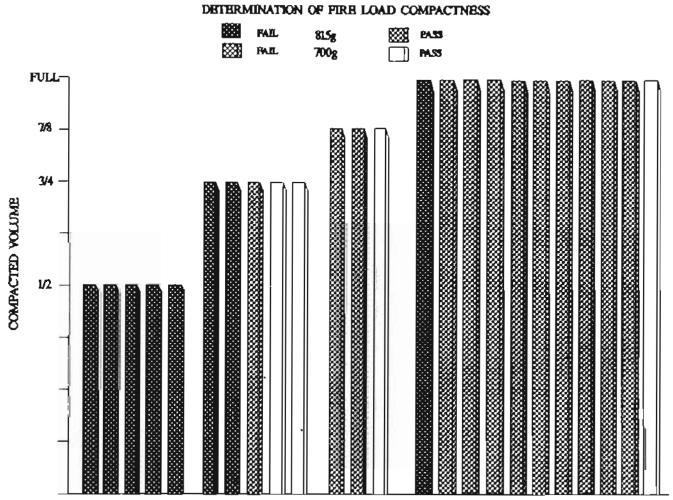
9.5" +/- 0.5" W X 8.5" +/- 0.5" H

6" +/- 0.5" from base

MAX AIR VELOCITY : 50 FPM ADJACENT TO TEST RECEPTACLE

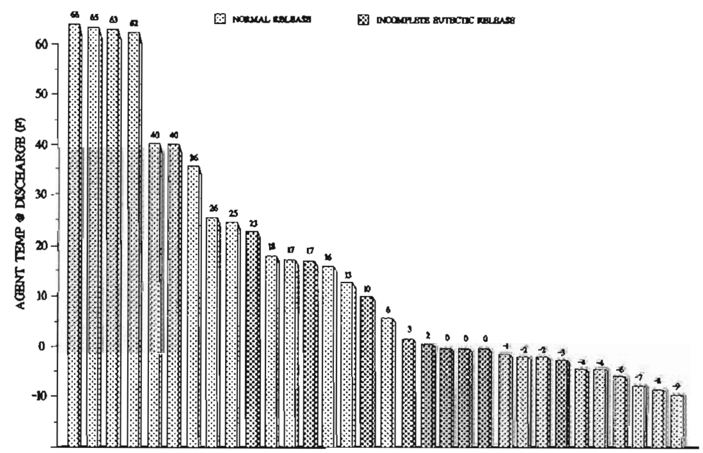
LAVATORY TRASH RECEPTACLE EXTINGUISHMENT TESTING

DETERMINATION OF FIRE LOAD COMPACTNESS



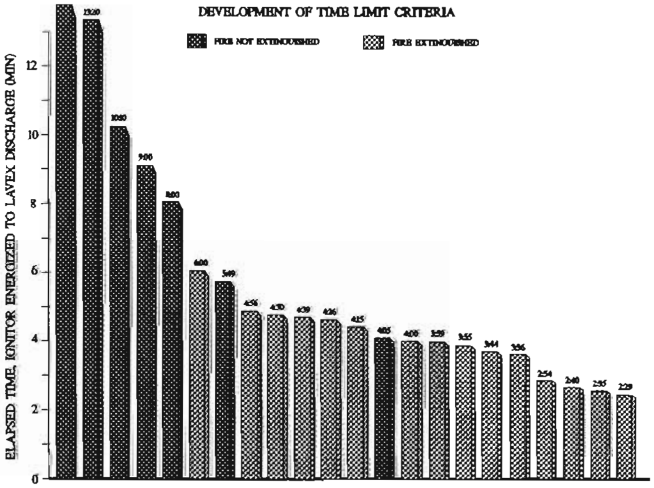
LAVATORY TRASH RECEPTACLE EXTINGUISHMENT TESTING

EFFECT OF TEMPERATURE ON EUTECTIC OPERATION



LAVATORY TRASH RECEPTACLE EXTINGUISHMENT TESTING

DEVELOPMENT OF TIME LIMIT CRITERIA



LAVATORY TRASH RECEPTACLE EXTINGUISHMENT TESTING

SUMMARY OF UNRESOLVED ITEMS (assignments in parenthesis)

section (a) NOAEL wording (IHAWG)

section (b), SNAP wording (IHAWG)

section (d), Largest Trash Receptacle volume in use (IHAWG)

section (e)(1), # of successful extinguisher tests for a pass (IHAWG)

section (f)(3), agent temperature at discharge (IHAWG)

section (g)(1), re-draw figure 1 (PAC SCI)

section (g)(2), temperature of ignitor, method of measurement (WKA)

section (h)(i), towel specification; wet strength, absorption (FAATC)

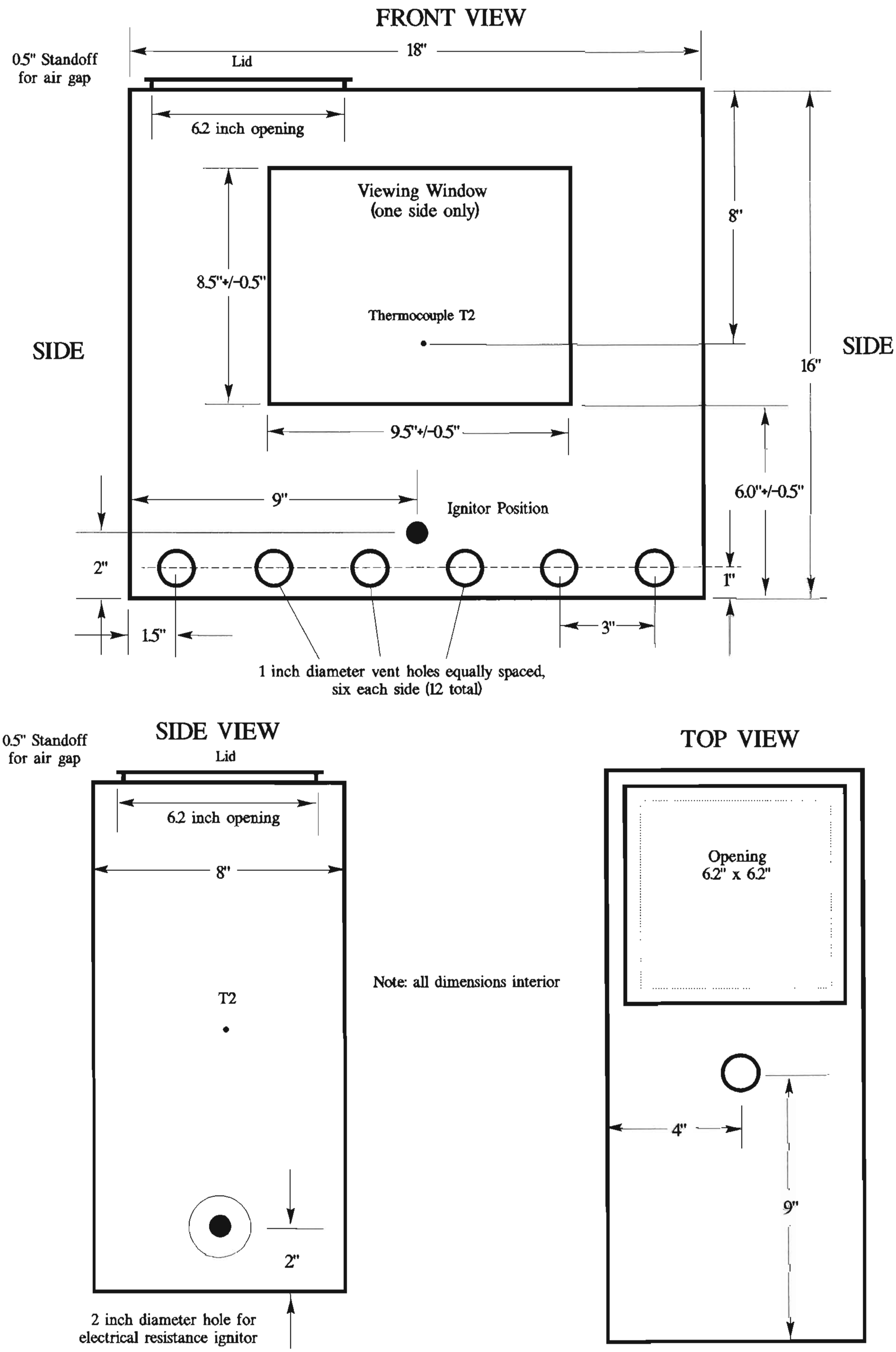


Figure 1. Standard Lavatory Disposal Receptacle For Evaluating Fire Extinguishing Agents

FAA Technical Center Nacelle Simulator Status:

I. Working on the following systems (percentage indicates completion):
   A. Inlet air flow conditioning, measurement, and control. 0%
   B. Fuel delivery and fire scenario systems. 55%
   C. Agent conditioning and delivery system. 35%

II. Scenarios will be in compliance with Minimum Performance Standard for the Engines (MPSE).

III. Timeline => ??

Wright-Patterson Air Force Base (WPAFB) Testing, August 1996:

I. Scheduled for 9-30 August 1996.

II. Tests will meet intent of MPSE.

III. Four agents examined will include:
   A. Halon 1301.
   B. CF_3I.
   C. HFC125.
   D. HFC227ea.

IV. Fire and concentration testing will be performed.

V. Report will be issued after completion of test sequence.

Historical Record of Agent Concentration Recorder Development and the Half Second, Volumetric 6% Halon 1301 Rule

I. Several FAA reports spanning the 1940's through 1970 chronicle engine live fire testing on era aircraft and development of agent concentration measurement equipment. This is not an all-inclusive listing.

A. Agent Concentration measurement equipment:

1. Aircraft Fire Extinguishment, Part III - An Instrument for Evaluating Extinguishing Systems, Technical Development Report **No. 206**, June, 1953.
2. Aircraft Installation and Operation of an Extinguishing Agent Recorder, Technical Development Report **No. 403**, September, 1959.
3. Criteria for Aircraft Installation and Utilization of an Extinguishing Agent Recorder, Report No. **FAA-DS-70-3**, March, 1970.

B. Engine Fire Testing:

1. Aircraft Fire Extinguishment, Part I - A Study of Factors Influencing Extinguishing System Design, Technical Development Report **No. 184**, October, 1952.
2. Aircraft Fire Extinguishment, Part II - The Effect of Air Flow on Extinguishing Requirements of a Jet Power-Plant Fire Zone, Technical Development Report **No. 205**, June, 1953.
3. Aircraft Fire Extinguishment, Part IV - Evaluation of a Bromochloromethane Fire Extinguishing System for the XB-45 Airplane, Technical Development Report **No. 240**, June, 1954.
4. Aircraft Fire Extinguishment, Part V - Preliminary Report on High-Rate-Discharge Fire Extinguishing Systems for Aircraft Power Plants, Technical Development Report **No. 260**, February, 1956.
5. An Investigation of In-Flight Fire Protection with a Turbofan Powerplant Installation, **Report No. NA-69-26**, April 1969.

II. There is evidence of another series of reports titled "Determination of Means to Safeguard Aircraft from Power Plant Fires In-FLight". I have not had the opportunity to locate any of these reports.

Lavatory Disposal Receptacle Built-In Extinguisher Halon Replacement Proposed Minimum Performance Standard

As required by 14 CFR 121.308(b), since April 29, 1987, each lavatory in every passenger carrying transport category airplane is equipped with a built-in automatic discharge fire extinguisher for each disposal receptacle for towels, paper, or waste located within the lavatory. Fire extinguishers, to be evaluated as a replacement for the currently used Halon lavatory extinguisher, must meet the performance regulations specified in BCA SCD 10-61909 and comply with the following proposed minimum performance standards:

(a) The agent, for use in areas occupied by humans, must be demonstrated to meet or exceed recognized national or international standards. The quantity of agent shall not exceed the LOAEL when distributed homogenously within the lavatory.

(b) The agent must be approved under the Environmental Protection Agency (EPA) Clean Air Act, Significant New Alternatives Policy (SNAP) program. Approved agents on the SNAP list must not exceed the established criteria for Ozone Depletion Potential (ODP) and toxicity.

(c) The fire extinguisher must successfully extinguish a test fire contained in the test receptacle after automatically discharging into the test receptacle in accordance with the test procedures specified below.

(d) Additional testing may be required to substantiate agent/system effectiveness in trash receptacles larger than the 1.333 cu ft volume test article. If an extinguishing system is to be used on receptacles of with internal volume larger than 1.333 cu ft, it is the responsibility of the manufacturer to demonstrate the effectiveness of a particular agent amount.

(e) Acceptance Criteria. Each lavatory receptacle automatic discharge extinguisher must meet the following criteria:

(1) Four extinguishers must be tested (the extinguisher must extinguish the fire during four successive tests).

(2) The discharge performance of the extinguisher must meet the requirements of BCA SCD 10-61909, which specifies maximum allowable design discharge temperature (usually $170^{\circ}F \pm 10^{\circ}F$).

(3) The test fire must be extinguished and must not re-ignite or flare-up after the access panel to the test receptacle has been opened.

(4) An extinguisher that meets the requirements for use in trash receptacles up to 1.333 cu ft (based on volume and cross-section) is acceptable for use in a smaller receptacle, with a similar installation, without additional testing.

(f) Test Conditions. Each test must be performed under the following conditions:

(1) The ambient temperature must be $80^{\circ}F \pm 20^{\circ}F$

(2) The fire load materials described in (h) must be conditioned to 70°F ± 5°F and a maximum of 55% relative humidity until moisture equilibrium is reached for 24 hours. Note: the test must be initiated within 30 minutes of removal of fire load materials from the conditioning chamber if the atmospheric conditions within the test area are different.

(3) Agent Temperature. Temperature of extinguishant must be at or below 30°F at the time the agent is discharged into the receptacle. This can be accomplished several ways, all of which can be left at the discretion of the testing facility or the appropriate certification authority (in a TSO, the FAA would typically use the standards of RTCA DO-160C, Environmental Conditions and Test Procedures for Airborne Equipment, 12/89, which in this case calls for a low temperature of 5°F. However, the original halon fire extinguising bottles with eutectic devices do not function properly below temperatures of 25°F, therefore all replacement agents must only be tested/discharged at or below 30°F).

Example 1. Keep agent in a separate cold chamber during the test, ensuring that the temperature will be at or below 30°F. The chamber should allow the agent bottle to be as close to the discharge point as possible, to allow for the shortest possible transfer plumbing.

Example 2. Overcooling of agent. This method could be used when an accurate estimate of the elapsed time can be determined for the eutectic device to open (i.e. temperature in the receptacle to reach 170°F at the top) after initiation of the ignitor. This would allow the tester to back calculate the maximum amount of time available to ensure that the agent is at or below 30°F, once it is removed from the cold chamber.

(g) Test Apparatus. The test receptacle and extinguisher bottle installation is described below:

(1) Trash Receptacle Test Article. The test receptacle must be constructed of either aluminum or steel. The test receptacle apparatus for trash containers up to 1.333 cubic feet (.038 m^3) volume is shown in figure 1. All receptacle dimensions are internal measurements.

(i) The front of the test receptacle must contain a clear access panel constructed of fire resistant polycarbonate or glass to facilitate the visual observation. The access panel must be 9.5 inches wide ± .5 inches by 8.5 inches high ± .5 inches with the lower edge of the panel positioned 6 inches ± .5 inches from the bottom surface.

(ii) A 2.0 inch (5.08 cm) diameter hole must be centered 2 inches up the side of the test receptacle for ignitor insertion and must be sealed after insertion of the ignitor.

(iii) The front and back face of the test receptacle must have six 1.00 inch (2.54 cm) diameter holes (12 holes total) equally spaced for ventilation which are equipped with a mechanism for quick opening or closing.

(iv) A waste flap opening must be provided at the top of the test receptacle. The opening must be 6.20 inches (15.75 cm) by 6.20 (15.75 cm). A plate which is no more than .50 inches (1.27 cm) larger than the opening must be mounted .50 inches (1.27 cm) above the opening.

(v) The agent discharge tube should be centered in the top of the test receptacle, pointing straight down.

(2) Ignition Source. A standard electrical resistance ignitor must be used. The ignitor shall consist of a nichrome wire (nominal 0.025 inch diameter) with 15 loops of 0.25 inch diameter. THE VOLTAGE THROUGH THE IGNITOR SHALL BE ADJUSTED TO

PROVIDE X^{O}F TEMPERATURE WHEN MEASURED AT THE CENTER OF THE IGNITOR.

note: a clipping device or other non-intrusive means to prevent the ignition source from skewing left or right when the paper is being loaded is helpful.

(3) Thermocouples. The three thermocouples to be used for testing must be type K grounded with a nominal 30 American Wire Gauge (AWG) size conductor.

(i) One thermocouple must be installed on the fire extinguisher to measure surface temperature.

Note: in order to obtain the most accurate reading of the agent temperature, it is reccommended that the thermocouple be placed over a non-painted area on the agent vessel and covered using adhesive tape (this may necessitate light sanding of the painted exterior of the agent vessel).

(ii) One thermocouple must be installed at the centerline of the test receptacle.

(iii) One thermocouple must be placed to measure ambient temperature.

(4) Instrumentation. A data acquisition system or other suitable instrument with an appropriate range must be used to measure and record the output of the thermocouples.

(5) Timing Device. A stopwatch or other device must be used to measure the time of ignition energizing, smoke generation, open flaming, agent discharge, and extinguishment.

(h) Test Fire Load.

(i) Towel specification. The fuel source used in the tests must be C-fold, 2-ply bleached handifold towels having dimensions of 10.25 inches by 13.25 inches. The weight of each towel shall be 4.5 $\pm$ 0.1 g.

Towels manufactured by:
Fort Howard Corporation
Green Bay, WI 54307
1-800-558-7325
part number 244-00

Towels distributed by:
W.W. Grainger Inc.
(713) 748-8280
part number 2U215

WET STRENGTH SPECIFICATION: TO BE DETERMINED BY MANUFACTURER
ABSORPTION SPECIFICATION: TO BE DETERMINED BY MANUFACTURER

(ii) Paper crumpling specification. Prior to loading the paper towels into the test receptacle, they must be opened and crumpled to simulate used hand towels. This can be accomplished by performing a free fill density procedure in which 340 paper towels, $\pm$ 10 towels are crumpled to fill an 18 X 18 X 18 inch container to the top level to ensure similarity of crumpling between the various testing facilities (note: this procedure may require several attempts in order to achieve the proper crumpling tightness). A total of 815 g $\pm$ 5 g of the crumpled paper towels will then be used in each test.

(i) Test Booth or Chamber. The test receptacle should be located in a booth or room containing adequate ventilation capabilities. The maximum air velocity directly adjacent to the test receptacle should not exceed 50 feet per minute.

(j) Test Procedure.

(1)Condition the fire load

(2) Weigh the extinguisher and record the value

(3) Set up data acquisition system

(4) Install and clamp the ignitor in the test receptacle 1 inch above the ventilation holes at the approximate centerline of the receptacle.

(5) Installation of fire load. Ensure that the entire bottom of the test receptacle is fully covered with a layer of pre-crumpled towels (also pack one or two pre-crumpled hand towels under the ignitor to prevent damage during subsequent loading). Finish loading remainder of 815 g $\pm$ 5 g of crumpled towels into the receptacle through the bin flap, making certain that the observation window is closed. If there is difficulty in fitting the entire 815 g of crumpled towels into the test receptacle, it can be shaken lightly to provide adequate space.
Note: the test must be initiated within 30 minutes of removal of fire load materials from the conditioning chamber if the atmospheric conditions within the test area or booth are different.

(6) Mount the conditioned fire extinguisher per manufacturers installation drawing.
Note: ensure that the agent temperature will be at or below 30°F at the time of discharge, as described above.

(7) Record initial ambient, extinguisher surface, and test receptacle temperatures.

(8) Start data acqusition system

(9) Energize the ignitor (time =0) and begin to record the times to relevant events as described in k2.

(10) Upon extinguisher discharge:
(i) Remove power from the ignitor
(ii) Close all ventilation holes in the test receptacle
Note: if extinguisher does not discharge within 5 minutes of ignitor energizing, the test should be aborted and considered a non-test.

(11) After 5 minutes:
(i) if the temperature and visual observations indicate that combustion has ceased, open the access panel and secure it open.

(12) If after a further 2 minutes re-ignition does not occur:

(i) empty the compartment and spread the waste into a single layer.

(ii) observe and note any residual smoldering. Record the extent of fire load consumption, presence or lack of smoldering, etc. If residual smoldering is present, the test is a failure.

(13) if re-ignition does occur, the test is a failure:

(i) Extinguish the fire using water or other environmentally friendly method

(14) Weigh the discharged extinguisher to determine and record weight of agent discharged.

(k) Test Report. The test report must include the following:

(1) A complete description of the test receptacle and the fire extinguisher, including photographs, if appropriate.

(2) Details of the test results should include the temperature of the extinguisher surface, temperature of the receptacle, and the times from ignition energizing to generation of: smoke, open flaming, agent discharge, and end of test.

SUMMARY OF ITEMS STILL UNRESOLVED/WORK ASSIGNMENTS:

(g)(2) temperature of ignitor? How is this measured? (WKA)
(h)(i) towel specification; wet strength? Absorption? (FAATC)

International Halon Replacement Working Group

Minimum Performance Standards for Aircraft Engine and APU Compartment Fire Extinguishing Agents/Systems

Introduction

Engine and APU (Auxiliary Power Unit) compartment fire extinguishing systems are required by FAR/JAR 23.1195, 25.1195 including JAR 25A.1195, 27.1195 and 29.1195. The current fire extinguishing systems using Halon 1301 as the extinguishing agent are deemed to satisfy these requirements if the system can produce concentrations of Halon 1301 specified in FAA AC 20–100 (FAA Advisory Circular). This AC was based on the performance of Halon 1301 in developmental testing including large scale fire tests. The standards described herein are intended for use in large scale fire testing for the purpose of developing performance criteria for systems using alternative agents. These standards are also applicable to other FAR/JAR pertaining to fire suppression in aircraft.

These standards are not necessarily the same as for Halon based systems nor are they a complete listing of techniques which may be required for certifying an aircraft engine and APU fire extinguishing system.

There are two major parts to these standards. Section 1 addresses the requirements for alternative agents/systems. Section 2 addresses test apparatus and methods necessary for evaluating agents/systems.

Background

Historically, Halon 1301 has proven to be an extremely effective total flooding agent for extinguishing fires. A comparison of the performance of candidate replacement agents to date, in terms of either the agent concentration or the total mass of an agent required to extinguish fires, has shown that they are not as effective as Halon 1301. The goal of these minimum performance standards is to identify criteria for alternative agents/systems to ensure that the current level of fire safety will be maintained for the engine and APU compartment.

The current level of safety, as recognized by the FAA, is that provided by a volumetric concentration of 6 % Halon 1301 throughout a protected fire zone for a duration of 0.5 second for a given agent discharge scenario. In evaluating the performance of alternative agents using this standard, the test apparatus must have the agent distribution system to demonstrate the current level of fire safety with Halon 1301. A successful application of the standards described herein, including the comparison of performance of Halon 1301 with that of the alternative agent, will allow the definition of an equivalent level of safety in terms of the performance of the alternative agent. At that point, it will be possible to define or evaluate the equivalent level of safety without using Halon 1301 as the standard.

References

The following references form the basis of current Halon 1301 performance criteria for aircraft engine and APU fire extinguishing systems.

1. Advisory Circular FAA AC 20–100

2. Aircraft Fire Extinguishment, Part I – A Study of Factors Influencing Extinguishing System Design, Technical Development Report No. 184, October, 1952.

3. Aircraft Fire Extinguishment, Part II – The Effect of Air Flow on Extinguishing Requirements of a Jet Power–Plant Fire Zone, Technical Development Report No. 205, June, 1953.

4. Aircraft Fire Extinguishment, Part III – An Instrument for Evaluating Extinguishing Systems, Technical Development Report No. 206, June, 1953.

5. Aircraft Fire Extinguishment, Part IV – Evaluation of a Bromochloromethane Fire Extinguishing System for the XB–45 Airplane, Technical Development Report No. 240, June, 1954.

6. Aircraft Fire Extinguishment, Part V – Preliminary Report on High–Rate Discharge Fire Extinguishing Systems for Aircraft Power Plants, Technical Development Report No. 260, February, 1956.

7. An Investigation of In–Flight Fire Protection with a Turbofan Powerplant Installation, Report No. NA–69–26, April, 1969.

1.0 Requirements for Agents/Systems

The agent and the fire extinguishing system must comply with the following minimum performance standards.

1.1 Environmental Characteristics

The environmental characteristics of the fire extinguishing agent must comply with international laws and agreements. Agents approved by the regulatory agencies for use in areas not normally occupied by humans are acceptable if they also satisfy the requirements defined in Section 1.3.

1.2 Fire Extinguishing Performance

1.2.1 Fire Threat

The agent (which satisfies requirement 1.1 above) when deployed through a suitable system must be capable of extinguishing any probable fires in the aircraft engine designated fire zone or in the Auxiliary Power Unit (APU) compartment for which the system is intended.

Here a probable fire implies a fire likely to occur in modern aircraft engine installations. Since precise definition of a likely fire in terms of measurable quantities has not been previously developed, the likely fire will be defined for the purpose of these standards by using test parameters such as the fuel type and flow rate. Combined with the simulation of hot engine environment, the simulated fire will adequately represent a real engine fire threat.

A real fire could be large, engulfing most of the protected fire zone in flames or it could be small, localized fire depending on the source and quantity of fuel and other conditions such as the air flow. The requirement for the fire extinguishing system is to defeat the fire anywhere in the zone including the entire zone. For the purpose of evaluating the agents, it is necessary to create a representative fire in a representative fire zone and show that the candidate agent can be distributed effectively in that zone to extinguish the fire; then determine the condition (concentration of the agent in the fire zone) at the location of the fire that resulted in successful extinguishment. It is not necessary to have a fire everywhere in the zone because if it can be shown that a specific real system can produce the required agent distribution throughout the zone which satisfies the condition determined in the fire test then it ensures that a fire will be defeated throughout the zone.

1.2.1.1 Physical Parameters

A fire in an engine or an APU compartment is probable when a fuel and air mixture comes in contact with an ignition source. Airflow through an engine or APU compartment is normal and a fuel (combustible fluid) source is possible due to leakage of aviation engine fuel, hydraulic fluid or engine oil or due to a failure expelling these fuels. The ignition source could be any surface at a temperature above the hot surface ignition temperature for the fuel in the compartment. Ignition can also occur if the fuel enters an environment in which rapid heating causes it to exceed its autoignition temperature. Three typical combustible fluids for the fire must be considered: aviation engine fuel, hydraulic fluid and engine oil. The consideration of probable fires must cover the range of physical parameters in the fire zone for the operational envelope of the engine or of the APU. These physical parameters include: the zone volume, cross sectional area and shape, the zone air temperature and flow rate, the surface temperatures, the fuel type and flow rate, the amount of clutter within the zone and the temperature of the agent/system (inservice temperatures before a discharge).

For the purpose of this standard, the current level of safety will be determined by tests using 6 % volumetric concentration of Halon 1301 for 0.5 second in the fire zone with probable fires that cover the range of the physical parameters.

To describe simulated fires corresponding to near maximum challenge for Halon 1301 in extinguishing fires at the current level of safety, the term Robust Fire will be used in these standards. This is defined in more detail in Section 2.4.

It is possible that fires in some locations in the fire zone may be more difficult to extinguish than in other locations. The alternative agent/system must be able to extinguish probable fires anywhere in the fire zone. When comparing the performance of the alternative agent with that of Halon 1301, equivalent level of safety implies the same probability of extinguishment with both agents. That is, in five fire tests under similar conditions if Halon 1301 is successful four times, equivalent level of safety would require the alternative agent to be successful in at least four tests.

1.2.1.2 Fire Extinguishment

A fire will be considered extinguished if there are no visible signs of a flame for eight seconds. In aircraft engine nacelles, fuel (combustible fluid) may still be available after the initial extinguishment of fire. The presence of surfaces which might be cooling down but still hot enough to act as an ignition source could result in a re-ignited fire. To distinguish the original fire from the re-ignited fire, an eight second time interval should be adequate. This is based on test experience and a consensus opinion of fire safety experts.

1.3 Health and Safety

The fire extinguishing agent/system for an engine compartment or an APU configuration must satisfy the following safety and health requirements.

1.3.1 Health and Safety in Handling

The agent/system should be designed to minimize exposure of workers to unsafe conditions during installation and normal maintenance of the system. Safety features incorporated in the equipment and handling procedures for the agent/system which mitigate this hazard should be taken into account while assessing compliance with this provision.

1.3.2 Flight Safety

The use and operation of the agent/system in the aircraft should not result in any additional hazard such as:

(a) Malfunction of components critical for flight control necessary for continued safety of flight.

(b) Damage to other critical components and areas within the compartment being protected, which would create a hazard either immediately or remain undetected and be a hazard after a passage of time.

(c) Corrosion of the aircraft structure.

(d) Ignition sources in any area of the aircraft not designed for accommodating ignition sources.

2.0 Test Methods for Agent/System Evaluation

Tests will be necessary to evaluate the fire extinguishing performance of an agent/system and to determine if it will satisfy the requirements stated in 1.2. There are two types of these tests.

The first type of tests will evaluate the effectiveness of candidate agents in extinguishing an actual fire in terms of the "quantity" of the agent required to extinguish the fire within the zone.

It has become the normal practice to specify the performance of a gaseous agent (such as Halon 1301 after a discharge) in terms of the volumetric concentration required to extinguish the fire. A particular replacement agent could be in a solid, liquid or gaseous phase when interacting with the fire and its effectiveness might be dependent on both the state and the quantity of the agent. For example, the particle size of a solid agent or the droplet size of a liquid agent could influence its performance. The standards herein are meant to apply to any type of agent including liquid and solid. However, acceptable methods to specify concentration of solid or liquid agents have not been identified for aircraft applications. Therefore, the generic term "quantity" is used here. For halocarbon agents, which are in gaseous form as they interact with the fire, the practice of specifying extinguishing concentration is acceptable. In the following sections, whenever the term concentration is used for this purpose, it is not meant to exclude the applicability of these standards to other type of agents. It will be necessary to develop suitable methods for specifying the performance of solid or liquid agents prior to their evaluation tests. Any parameters critical to these new methods such as line sizes, line temperatures, nozzle configurations etc. must be controlled during tests. If the effectiveness of the agent is highly dependent upon a certain parameter, it should be investigated through additional testing and documented.

Volumetric concentration of the agent and the time required to extinguish the fire should be recorded. If it is not practical to record the agent concentration in a fire test, back to back tests must be conducted. That is, tests must be conducted with and without the fire with the same fire simulation parameters. The agent would be discharged in both tests in identical manners. The concentration measurement in the test without the fire would correspond to the extinguishing performance in the test with the fire.

As stated in 1.2.1.2, in aircraft engine nacelles, fuel and ignition sources may still be available after the initial extinguishment of fire and a re–ignition of fire is possible. Surface temperature of a strategic location in the vicinity of the fire should be monitored to gain further understanding of the extinguishment process.

The second type of tests are system validation tests. They will apply to aircraft specific designs in a manner similar to Halon 1301 systems. They will verify the effectiveness of the specific delivery system in transporting the required quantity of the agent at the potential location of the fire. Thus, the agent evaluation tests will provide the basis for: (1) the design and engineering of the system and (2) the system validation tests.

The test methods proposed here address the first type of tests. These tests should be planned and conducted so as to provide complete data for stating the performance criteria for successful fire extinguishing agents/systems.

2.1 Test Apparatus

2.1.1 Aircraft Engine Compartment Simulator

For the purpose of these tests, the engine compartment (nacelle) simulator should have an annular fire zone having a minimum volume of 65 cubic feet and a minimum cross sectional area of the annulus of 5.5 square feet, both before reductions due to clutter simulation. It should be equipped to simulate test parameters described in 2.2.1. The inner cylinder in this configuration will represent the engine case. The test section must be equipped to allow a real time visual indication of fire. A schematic diagram of a simulator is shown in Figure 1. The agent distribution system must be capable of extinguishing fires within the overall zone or in any isolated location within the fire zone. It must be possible to demonstrate the currently acceptable level of safety with Halon 1301. That is, it should be possible to achieve 6 % volumetric concentration of Halon 1301 for 0.5 second in the entire zone. The facility must provide simulation of a flaring fire (leaking fuel stream on fire, also called spray fire) and a residual fire (baffle stabilized pan fire due to ignition of accumulated fuel in some part of the fire zone).

The size of the zone was selected on the basis of the range of fire zone sizes of actual aircraft installations and considerations for a practical simulator where physical parameters can be properly simulated and controlled. If an agent/system is successful with a fire zone of this size, it is highly likely to be successful in both larger and smaller zones with appropriate agent quantities and system designs. The purpose here is to define the minimum performance standards with probable fire scenarios in a typical fire zone. As stated in 1.2.1, it is not necessary to have a fire everywhere in the zone. However, there may be specific applications which may benefit from these test data but may require additional considerations which are not a part of these minimum performance standards.

A separate simulator for APU compartments is not necessary because experience in recent testing by the U. S. Air Force has shown that the requirements developed for the engine compartment provide equal or higher level of safety for the APU compartment.

2.2 Test Conditions

2.2.1 Engine Compartment Test Parameters

A number of tests will be necessary to cover the range of conditions. Depending on these conditions, different amounts of agent might be required to establish the extinguishing concentration.

2.2.1.1 Airflow Rate

At least two internal (ventilation) airflow rates should be selected, one each from the following two ranges.

(a) High 2.5 -- 3.0 lbm/sec.

(b) Low 0.2 – 0.9 lbm/sec.

Section 2.2.1.1 (a) corresponds to about 57 air changes per minute for the fire zone having 65 cubic feet volume and 5.5 square feet cross sectional area. For significantly different volume and cross section, the airflow rates should be adjusted appropriately. These flow rates cover the significant range of air flows in modern engine installations. This information is based on a US Air Force survey. Note that ventilation airflow is a commonly used term for airflow through the engine compartment.

2.2.1.2 Air Temperatures

At least two (ventilation) air temperatures of 100 °F and 400 °F.

The above temperatures cover a significant range of air temperatures in engine compartments.

Ventilation air temperature as low as –40 °F could exist in some cases under extremely cold atmospheric conditions at high altitudes. However, under these conditions an engine fire threat is extremely unlikely due to low power demand from the engine, cold fuel and relatively cooler surfaces in the fire zone. In addition, these conditions could delay the detection of a small fire which could result in an increase in air temperature. These are adequate reasons to conclude that this fire threat could be easily overcome by a system designed for larger fire threats which are likely when the air and surface temperatures are higher. Therefore, it is not necessary to simulate air temperatures below the ambient conditions in the test facility. However, for consistency between tests conducted during different ambient conditions, a controlled air temperature is preferred. Therefore 100 °F is selected to represent the lower end of the temperature range.

2.2.1.3 Surface Temperature

At least a portion, about 2 feet long and encompassing a 90° arc, of the surface of the test article simulating the engine core (inner cylindrical surface) must attain temperature in the range 900 – 1300 °F. The tests to establish robust fires (Section 2.4) should begin with the highest surface temperature in this range. Lower temperatures should be used as a last resort parameter to adjust in trying to get successful extinguishment with Halon 1301. The surface temperature must be monitored during the test. After initiating the discharge of the agent, heating of the surface should be discontinued.

In a test, since the fire location would be close to this surface, it could attain higher temperature than the control temperature. As the fire begins to be extinguished, this temperature may decrease. To represent an actual situation in which the engine is shut down prior to the agent discharge and to be able to observe the effect of the agent on the fire, it is appropriate to turn the surface heating off as the agent is discharged in the test.

2.2.1.4 Clutter

The simulated blockage or clutter should have up to 50 % reduction in the local cross sectional area and the resultant volume reduction.

The above estimate is based on visual inspection of clutter in actual engine installations. It is possible that some installations have very high clutter factors. The purpose here is to simulate clutter in a practical manner. For installations with high clutter, the system validation tests will be more important where agent distribution even in such highly cluttered zone must be proven. If the extinguishing concentration can be achieved, the system would have the required level of safety.

2.2.1.5 Fuel Parameters

A fuel (combustible fluid) flow rate of 0.1 to 1 gpm (gallon per minute) at a controlled temperature of 150 ^{o}F should be provided. The fuel flow rate should be adjusted to attain a fire threat which is just barely extinguished by Halon 1301. The tests should begin with a high fuel flow rate in the above range to establish robust fires (Section 2.4). Lower fuel flow rates should be successively used if at higher flow rates Halon 1301 cannot extinguish fires.

This method would create a realistic fire threat to evaluate the agents. It is possible that in some aircraft fire scenarios, the flow rate could be higher than 1 gpm which could result in a spread of fire to a larger portion of the zone. However, as it has been stated earlier in this standard, if the extinguishing concentration is present in the entire zone, the fire should be extinguished everywhere.

The fuel flow must remain on before and after the discharge of the agent to ensure that the extinguishment is the result of the action of the agent and not due to lack of fuel. As the surfaces might still be hot, this procedure (rather than fuel shut off at the beginning of agent discharge) would increase the chance of a re-ignited fire. Therefore, to address these two concerns in a practical way, criteria for fire extinguishment is that

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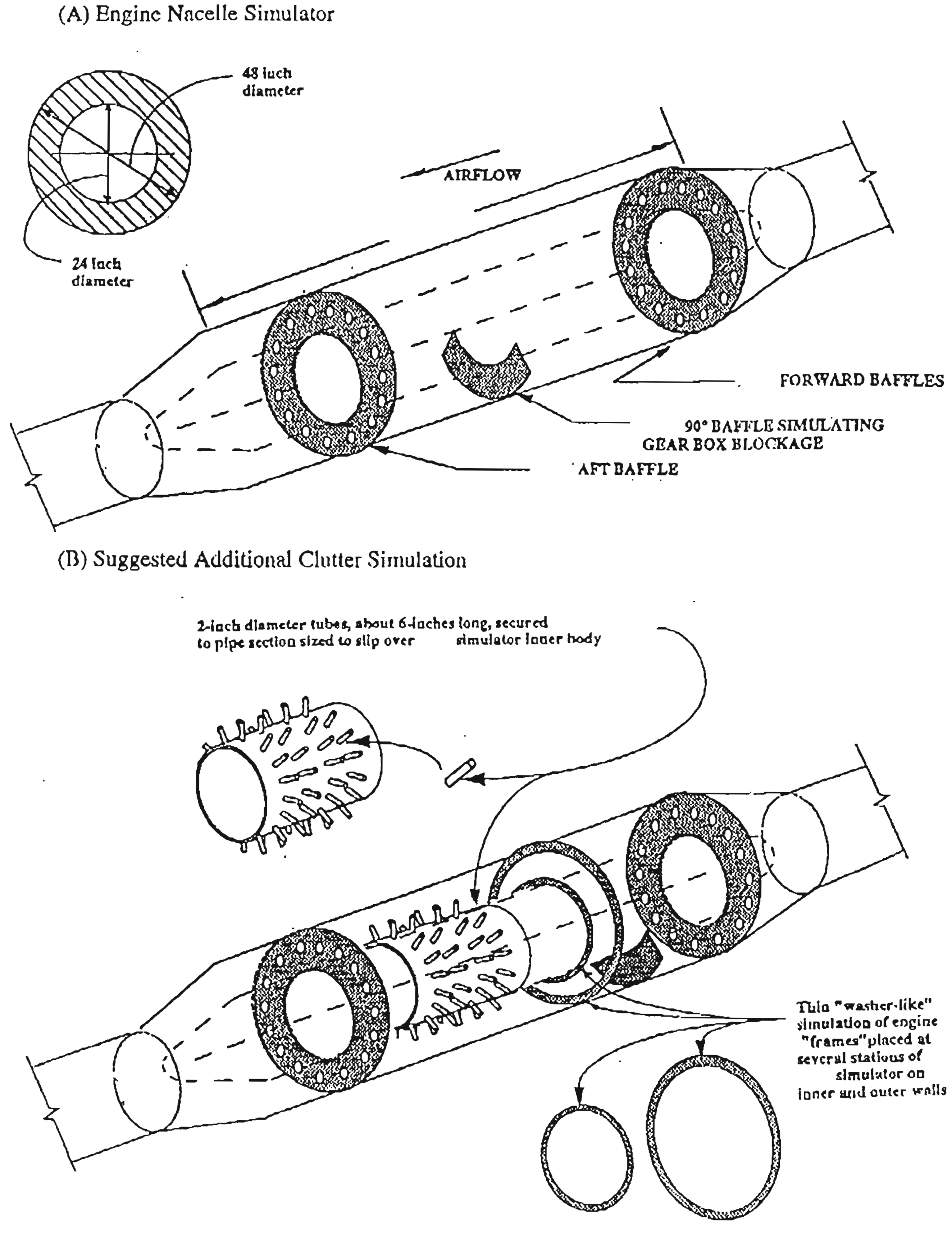

Figure 1. Schematic of the Proposed Aircraft Engine Nacelle Simulator for Fire Tests

mentioned in Section 1.2.1.2, viz. no visible signs of fire for eight seconds.

Proper operation of the fuel delivery system, including nozzles, should be checked to assure that the fire size and intensity are roughly reproducible in tests with similar conditions. A measurement of heat flux density to characterize the fire is not necessary. Undue importance could be attached to this parameter as a means to determine reproducibility of fires while the measurement itself could depend on a variety of different factors.

A baffle stabilized pan fire (residual fuel fire) simulation should be provided with an initial 0.25 gallon of fuel at a controlled temperature of 150 °F at the beginning of the test. The fuel level should be controlled at 1.5 in. below the top of the baffle to ensure repeatable fire conditions. Fuel quantity in the pan should be adjusted if necessary in tests to define robust fires (Section 2.4).

2.2.1.6 Fire Location

Axial location of the flaring fire must be over the surface which is at the controlled, high temperature (900 °F – 1300 °F) and downstream of the simulated clutter (some clutter could be in the fire). Circumferential location of this fire should be in the upper half of the zone.

Location of the simulated residual fire (baffle stabilized pan fire) can be chosen in the zone where convenient. Locations where the extinguishing agent can directly impinge on for the given distribution system must be avoided.

2.2.1.7 Preburn

A preburn time is the time elapsed between the initiation of fire (ignition) and the initiation of agent discharge. A minimum preburn time of 5 seconds is required for the spraying fire simulation.

The baffle stabilized pan fire should have a minimum preburn time of 15 seconds.

In an aircraft installation, when the fire alarm is received an action is initiated resulting in a sequence of events. The engine fuel supply is shut off first. Hot air and electrical sources may also be shut off before activation of the fire extinguishing system. If the alarm occurs during the climb phase of the flight, more than a minute may elapse between the alarm and the discharge of the agent. In other cases, this elapsed time may be shorter than a minute. For the purpose of these standards, a shorter preburn is selected to protect test equipment from exposure to repeated intense fires.

2.2.1.8 Agent Storage Temperature

Three agent storage temperatures will be used in different tests to cover the range of possible operational temperatures. Details of how these temperatures should be used are given in 2.4

(a) 100 °F.

A controlled bottle temperature is necessary to ensure consistent results from the tests. The variation in ambient temperatures would not provide a uniform basis for comparison. This temperature (100 °F) will be easy to attain for bulk of the testing.

(b) -65 °F.

This condition is based on the fact that Halon 1301 bottles in some current aircraft models could experience temperatures this low. Halon 1301does not solidify at this temperature. Actual aircraft installations will be designed for addressing the requirements based on the operational envelope of the aircraft. This may translate into a different low temperature requirement. The alternative agent in an operating aircraft system must not be stored at temperatures lower than the lowest tested temperature which resulted in a satisfactory fire extinguishing performance.

(c) 200 °F.

This condition is based on some installations for the APU fire extinguishing systems where such high temperatures are possible.

2.3 Fuels

Perform tests with all the appropriate test conditions specified in 2.2 using the following fuels:

(a) aviation engine fuel (turbine fuel, Avgas)
(b) engine lubricating oil
(c) hydraulic fluid

2.4 Tests

The agent evaluation tests for any given test apparatus will have two parts. In the first part, the current level of safety will be defined in terms of Robust Fires. The second part of tests will be agent evaluation using the robust fires defined in the first part.

A Robust Fire is a diagnostic test fire which establishes the current level of safety provided by Halon 1301 as follows:
(a) The standard Halon 1301 distribution conditions are 6 % volumetric concentration in all parts of the fire zone for 0.5 seconds.
(b) The standard distribution conditions must be achieved with the bottle temperature at -65 °F.
(c) A robust fire will be extinguished in 70–90 % of repeated fire tests with standard distribution of Halon 1301, (a).
(d) Robust fires will be determined with the agent stored at 100 °F.
(e) At least five tests with identical conditions must be performed to determine the probability of successful fire extinguishment.

A success rate of 70–90 % is chosen to define the robust fire because it assures that the fire threat is sufficiently large for even Halon 1301 to be unsuccessful in some case.

2.4.1 Robust Fire Characterization

This series of tests will establish physical test parameters to characterize robust fires with Halon 1301 as the extinguishing agent.

2.4.1.1 Halon 1301 Standard Distribution

Develop and implement an agent distribution system for halocarbon agents which will assure Halon 1301 volume concentration of 6 % for a minimum of 0.5 second and a maximum of 1 second throughout the fire zone of the test apparatus. The maximum concentration of Halon 1301 should not exceed 8 % in any location and the minimum concentration should not be greater than 6.6%. Replicate the distribution performance in three consecutive tests. This distribution should be achievable with the Halon 1301 bottle temperature of -65 °F.

After achieving successful distribution with agent bottle at −65 °F, keep the agent mass the same and repeat the concentration measurement tests with the bottle temperature at: (a) 100 °F and (b) 200 °F.

2.4.1.2 Halon 1301 Fire Tests

Select test conditions as specified in Section 2.3 and conduct fire tests to achieve at least two combinations of test conditions resulting in robust fires. Perform these tests with the Halon 1301 bottle at 100 °F. While covering the range of test conditions, begin with the values likely to provide more difficult fires to extinguish. For example, begin with fuel flow rate of 1 gpm, surface temperature of 1300 °F and airflow rate of 2.5 lbm/sec. Modify the values appropriately, if Halon 1301 fails to achieve the required success rate. Lower the surface temperature only as a last resort, after changes in other physical parameters fail to produce required success rate with Halon 1301. Where the prescribed range specifies at least two selections one each from a sub–range, selections from each sub–range should be made. These tests could provide more than just two combinations of test conditions defining robust fires. Identify at least two robust fires with test fuel from two different categories indicated in Section 2.3.

There should be at least one baffle stabilized pan fire which can be defined as a robust fire.

Procedure:

The tests should be performed using the following general procedure.

1. Select the test conditions and prepare the test equipment.
2. After attaining the desired level of steadiness with the test conditions, initiate the fuel (combustible fluid) flow and ignite the fire.
3. While observing the fire, let the preburn time elapse.
4. Initiate the agent discharge, observing its effect on the fire. Record the time for discharge of the system and extinguishment of the fire.
5. If the fire is extinguished and remains so for eight seconds continuously, the agent is successful in extinguishing the fire.
6. If the fire is not extinguished, the agent has failed.

Perform tests with different conditions until at least the required number of robust fires have been defined.

2.4.1.3 Additional Halon 1301 Fire Tests

Repeat the test conditions for robust fires identified in 2.4.1.2 with bottle temperatures: (a) –65 °F and (b) 200 °F. If the success rate is less than 40 %, repeat tests with different test conditions which satisfy the robust fire definition until a success rate of 40 % or better is achieved with bottle temperatures: (a) –65 °F and (b) 200 °F.

2.4.2 Alternative Agents Evaluation

These tests will be performed in a manner similar to tests described in 2.4.1 but with well defined test conditions (that is the conditions defining robust fires). They will differ in that the quantity of agent required in different tests would be subject to estimates and trials.

2.4.2.1 Alternative Agents Fire Tests

Alternative agents shall be evaluated against the robust fires defined in Section 2.4.1.2. Estimated quantities of the agent for different test conditions will be used initially and adjusted subsequently based on the performance of the agent.. Test procedure will be similar to 2.4.1.2. Agents must be tested using at least two robust fires in the spray fire category and a robust baffle stabilized pan fire.

The alternative agent evaluated in this manner will be considered to have an equivalent level of safety as Halon 1301 if its probability of success in extinguishing fires is equal or superior to that of Halon 1301.

In addition, fuels not covered by the robust fires can be qualified if a successful extinguishment of a baffle stabilized pan fire with those fuels is demonstrated.

If the alternative agent cannot perform with storage temperatures of –65 °F or 200 °F, the range of temperature in which it can perform should be established. The agent will then be qualified to be effective within that storage temperature range only.

2.4.2.2 Alternative Agents Distribution

Tests to determine the agent concentration will be necessary to provide a basis for specific system design and the performance criteria for system validation tests. In these tests, determine the agent concentration profiles and histories while duplicating conditions corresponding to the successful extinguishments of robust fires. These concentration measurements should encompass all conditions necessary to establish the operational range of storage temperatures.

Enough tests should be conducted and results evaluated to develop a consistent correlation between the agent quantity, agent concentration and agent distribution.

Conclusion

The Minimum Performance Standards described herein should lead to an accurate definition of fires likely to occur in aircraft engine installations which can be currently extinguished with Halon 1301 providing the currently acceptable level of safety. Evaluation of alternative agents against these standards is expected to lead to the development of performance criteria for aircraft engine and APU fire extinguishing systems based on these agents. Subsequently, advisory material for the alternative agents should be developed. This will ensure that the current level of fire safety will continue to be maintained in future for aircraft engine and APU installations.

LIST OF ATTENDEES

INTERNATIONAL HALON REPLACEMENT WORKING GROUP MEETING

July 16-17, 1996

NAME	ORGANIZATION/ AFFILIATION	ADDRESS	PHONE/FAX
TIM MARKER	FAA TECH CTR Fire Safety Section	AAR-422 BLDG 275	PHONE: 609 485 6469 FAX: 609 485-5580
Dave Blake	〃	〃	PHONE: 609-485-4525 FAX: 609-485-4810
GUS SARKOS	〃	AAR-422, Bldg 201A FAA, Wm. J. Hughes Tech Ctr Atlantic City, NJ 08405	PHONE: 609-485-5620 FAX: -4004
DOUG INGERSON	〃	AAR 422, BLDG 287 FAA, HUGHES TECH CENTER ATLANTIC CITY, INT'L, NJ 08405	PHONE: 609-485-4945 FAX: 609-646-5229
Louise Speitel	〃	AAR 422, Bldg 277 FAA, Wm. J. Hughes Tech Ctr. Atlantic City, NJ 08405	PHONE: 609-485-4528 FAX: 609-646-5229
Bob GLASER	Walter Kidde Aerospace	4200 Airport Dr Wilson, NC. 27896-9643	PHONE: 919 237-7004 FAX: 919 237-4717
Hans Humfeldt	Lufthansa Technik	P.O. Box 630 300 22313 Hamburg Germany	PHONE: 49-40-50702406 FAX: 49-40-50702385
Volker THEISS	Daimler-Benz Aerospace Airbus	P.O. Box 950109 D-2111 Hamburg Germany	PHONE: 49 4074373916 FAX: 49 40 7437 4727
Marco Potschkat	Airbus Industrie	1 Rond Point Maurice Bellonte, 31707 Blagnac, France	PHONE: (33) 61933759 FAX: (33) 61934908
NICK POVEY	CIVIL AVIATION AUTHORITY (UK)	SAFETY REGULATION GROUP AVIATION HOUSE W-SUSSEX RH6 0YR	PHONE: 44 1293 573347 FAX: 44 1293 573981
CLAUDE LEWIS	TRANSPORT CANADA - CIVIL AVIATION AIRCRAFT CERTIFICATION - STANDARDS	TOWER C PLACE DE VILLE 330 SPARKS ST. OTTAWA, ONT CANADA K1A 0N8	PHONE: (613) 990-5906 FAX: (613) 996-9178

LIST OF ATTENDEES

INTERNATIONAL HALON REPLACEMENT WORKING GROUP MEETING

July 16-17, 1996

NAME	ORGANIZATION/ AFFILIATION	ADDRESS	PHONE/FAX
Bill Bowen-SFOEG	United Airlines Maint. Operations Center	San Francisco Int. Arpt. San Francisco, CA 94128	PHONE: 415 634-4783 FAX: 415 634-4215
JOHN BLACKBURN	AVRO INTERNATIONAL AEROSPACE	POST STN 23A AVRO HOUSE CHESTER ROAD, WOODFORD STOCKPORT, SK7 1QR, ENGLAND	PHONE: (44) 161 955 4028 FAX: (44) 161 955 4035
SHAM HARIRAM	MCDONNELL DOUGLAS DOUGLAS AIRCRAFT	MAIL CODE 800-32 3855 LAKEWOOD BL. LONG BEACH, CA. 90846	PHONE: (310) 593-4305 FAX: (310) 593-7104
RICH MAZZONE	BOEING COMMERCIAL AIRPLANE GROUP - PAYLOADS SYSTEMS	P.O. BOX 3707 M/S 0R-01 SEATTLE. WA 98124	PHONE: (206) 266-9994 FAX: 206-717-0433
Robert Stacho	FAA Los Angeles Aircraft Certification Office	FAA - LAACO 3960 Paramount Blvd Lakewood, CA 90712	PHONE: 310 627 5334 FAX: 310 627 5210
John Petrakis	FAA Aircraft Certification Service, Hdqt.	800 Independence Ave Washington, DC 20591	PHONE: 202 267-9274 FAX: 202 267-5340
DUNG DO	FAA TECHNICAL CENTER	AAR 422 BUILDING 275 FIRE SAFETY SECTION	PHONE: 609 485 4530 FAX: 609 485 5580
JEROEN VAN DAM	K.L.M. Royal Dutch Airl's	P.O. BOX 7700 1117 ZL SCHIPHOL AIRPORT THE NETHERLANDS	PHONE: +31 20 6499128 FAX: +31 20 6488162
ALANKAR GUPTA	BOEING COMMERCIAL AIRPLANE Group	M/S 02-WF P.O.Box 3707, SEATTLE, WA 98124	PHONE: 206-294-3179 FAX: 206-294-7434.
Russell Stark	Autronics Corp	325 E. Live Oak Ave Arcadia, Ca 91006	PHONE: 818-445-5470 FAX: 818-446-0014
JOHN O'SULLIVAN	BRITISH AIRWAYS	TRIDENT HOUSE (S. 583) P.O. BOX 10 HEATHROW AIRPORT HOUNSLOW MIDDX - TW6 2JA UK	PHONE: 44-181-562-5660 FAX: 44-181-562-2026 EMAIL: JOHN J. O'SULLIVAN @ BRITISH AIRWAYS. COM

LIST OF ATTENDEES
INTERNATIONAL HALON REPLACEMENT WORKING GROUP MEETING
July 16-17, 1996

NAME	ORGANIZATION/ AFFILIATION	ADDRESS	PHONE/FAX
BRIAN GIBBS	BRITISH AIRWAYS ENGINEERING	BG TBA QUALITY STANDARDS GROUP PO BOX 10 HOUNSLOW MIDDX TW6 2JA UK	PHONE: 41 181 562 3805 FAX: 41 181 562 2773
DAVE CATCHPOLE	BP EXPLORATION (ALASKA) INC.	P.O. Box 196612 ANCHORAGE AK 99519-6612	PHONE: 907-564-5038 FAX: 907-564-5020
DAN VERDONIK	Hughes Associates, Inc.	3610 COMMERCE DRIVE SUITE 817 Baltimore MD 21227	PHONE: 410 737-8677 FAX: 410 737-8688
DAVID BALL	KIDDE INTERNATIONAL	MATHISEN WAY, COLNBROOK, SLOUGH, BERKSHIRE SL3 0HB UK	PHONE: +44 1753 766189 FAX: +44 1753 683032
William Grosshandler	NIST/BFRL	B356, Bldg 224 Gaithersburg, MD 20899	PHONE: (301) 975-2310 FAX: (301) 975-4052
MARCO TEDESCHI	NAVAL AIR WARFARE CENTER	CODE: 4352ØAB562-3 LAKEHURST, NJ Ø8733-51ØØ	PHONE: (9Ø8) 323-1167 FAX: (9Ø8) 323-1989
BILL LEACH	NAVAL AIR WARFARE CENTER	CODE: 4352ØAB562-3 LAKEHURST, NJ Ø8733-51ØØ	PHONE: (9Ø8) 323-1184 FAX: (9Ø8) 323-1989
GREG GMURCZYK	SAIC	555 Quince Orchard Rd, #500 Gaithersburg MD 20878	PHONE: 301-924-6119 FAX: 301-924-4594
JEFF JANUSZ	FAA (ACE-115W) WICHITA AIRCRAFT CERTIFICATION OFFICE PROPULSION BRANCH	1807 AIRPORT Rd. RM 100, WICHITA KS. 67201	PHONE: 316 946 4148 FAX: 316 946 4407
Mark Flora	FAA (ASW-170) South West Region Rotorcraft Cert.	2601 Meacham Blvd. Fort Worth, TX 76193-0170	PHONE: 817-222-5172 FAX: 817-222-5960
HARRY MEHTA	BOEING	49-53 P.O. Box 3707 SEATTLE, WA 98124	PHONE: 206-655-5069 FAX: 206-655-4955

LIST OF ATTENDEES

INTERNATIONAL HALON REPLACEMENT WORKING GROUP MEETING

July 16-17, 1996

NAME	ORGANIZATION/ AFFILIATION	ADDRESS	PHONE/FAX
Yudaya Sivathanu	Purdue University	School of Mech. Engg. TSPC. West Lafayette, IN 47907-1003	PHONE: 317-494-9364 FAX: 317-494-0530 sivathan@ecn.purdue.edu
TERRY SIMPSON	WALTER KIDDE AEROSPACE	4200 AIRPORT DRIVE WILSON NC 27896 USA	PHONE: 919-237-7004 FAX: 919-237-4717 SIMPSNE@WKAI-LAN.MHS.COMPUSERVE.COM
JIM LONERGAN	AMERICAN-PACIFIC CORP.	3770 HOWARD HUGHES PKY #300 LAS VEGAS, NV 89109	PHONE: 702 735 2200 FAX: 702 735 4876
JEFF GIBSON	AMERICAN PACIFIC CORP.	3770 HOWARD HUGHES PARKWAY #300 LAS VEGAS, NV 89109	PHONE: 702 735 2200 FAX: 702 735-4876
Laurent GRUZ	DGAC (France) STPA	26, boulevard Victor 75015 PARIS FRANCE	PHONE: 33 1 45 52 41 43 FAX: 33 1 45 52 61 76
Regis GAUTREAU	DGAC/STPA (FRANCE)	26, boulevard Victor 00460 ARMEES FRANCE	PHONE: 33 1 45 52 43 39 FAX: 33 1 45 52 59 60
Bill McCutcheon	GEC MARCONI AVIONICS LTD (UK)	ROCHESTER AIRPORT WORKS ROCHESTER KENT ENGLAND	PHONE: 44.1634 816515 FAX: 44-1634-816554
SQN LDR TONY KILLINGRAY	MOD (PE) FS (AIR) 42	MAPLE 02 MOD(PE) ABBEYWOOD PO BOX 702 BRISTOL BS12 7DU	PHONE: 0044 117 913410 FAX: 441179134933
Stephanie Skaggs	Pacific Scientific	3916 Juan Tabo NE Albuquerque, NM 87111	PHONE: 505-291-1109 FAX: 505-291-1141
Reva Rubenstein	U.S. Environmental Protection Agency	6205J 401 M ST SW WASH, DC 20007	PHONE: 202-233-9155 FAX: 202-233-9665
DOUG DIERDORF	PACIFIC SCIENTIFIC	3916 JUAN TABO NE ALBUQUERQUE, NM 87111 EMAIL: 72040.3223@COMPUSERVE.COM	PHONE: 505-291-1109 FAX: 505-291-1141

LIST OF ATTENDEES

INTERNATIONAL HALON REPLACEMENT WORKING GROUP MEETING

July 16-17, 1996

NAME	ORGANIZATION/ AFFILIATION	ADDRESS	PHONE/FAX
BILL MESERVE	PACIFIC SCIENTIFIC	1800 HIGHLAND AV DUARTE CA 91010	PHONE: 818 359 9317 FAX: 818 359 7013 EMAIL 102532, 2207.COMPUSERVE.COM
MARK KAY	McDONNELL DOUGLAS, St. Louis	P.O. BOX 516 St. Louis Mo. 63166 MAIL CODE 106 7075	PHONE: (314) 234-0218 FAX: (314) 233-3181
TERESA MONSERRATE	McDONNELL DOUGLAS LONG BEACH C-17 FIRE PROTECTION	2401 E. WARDLOW ROAD LONG BEACH, CA 90807-5309 M/C 52-225	PHONE: (310) 982-5918 FAX: (310) 982-5758 EMAIL: tmonserrate@c17m.mdc.c
JOHN R. OBERST	LIFETECH SYSTEMS INC	11350 RANDOM HILLS RD SUITE 800 FAIRFAX, VA 22030	PHONE: 703 273 2009 FAX: 703 273 9516 E-JROBERST@AOL.COM
Larry Stewart	Powsus Inc	1178 Wisteria Drive Malvern, PA 19355	PHONE: 610 647-2267 FAX: 610 648 0793
DAN MOORE	DU PONT FLUOROPRODUCTS	BMP 13-1114 PO BOX 80013 WILMINGTON, DE 19880-0013	PHONE: 302 992 2177 FAX: 302 992 4163
christian HAURE	CERBERUS GUINARD	Z.I. 617 Rue Fourny BP 20 78531 Buc. Cedex - FRANCE	PHONE: 33(1) 30 84 66 48 FAX: 33(1) 39 56 13 64
SIMON CHAER	CERBERUS GUINARD	"	PHONE: 33(1) 30846634 FAX: 33(1) 3956 1364
ERIC LESJARS	CERBERUS GUINARD	"	PHONE: 33(1) 30846651 FAX: 33(1) 39561364
Mike Bonnett	US Air Force Wright Labs	WL/FIVS Bldg 63 190 Tenth St. 45433-7605 Wright-Patterson AFB OH	PHONE: (513) 255-6052 FAX: (513) 255-2237
Lt Jim Tucker	"	"	PHONE: (513) 255-6052 FAX: (513) 255-2237

LIST OF ATTENDEES

INTERNATIONAL HALON REPLACEMENT WORKING GROUP MEETING

July 16-17, 1996

NAME	ORGANIZATION/ AFFILIATION	ADDRESS	PHONE/FAX
CHARLES MAY	MASS SYSTEMS, INC.	4601 LITTLE JOHN ST BALDWIN PARK CA 91706	PHONE: 818-3374640 FAX: 818-3371641
DONALD B. MACELWEE	Powsus Inc	14 WOODSTREAM DR WAYNE, PA 19087	PHONE: 610-296-2237 FAX: 610-695-0230
STEVE HAPPENNY	FAA/TRANSPORT AIRPLANE DIRECTORATE PROPULSION BRANCH ANM-112	1601 LIND AVE SW RENTON, WA. 98155	PHONE: 206-227-2147 FAX: 206-227-1320
CHARLES VAUGHAN	OLIN AEROSPACE	P.O. BOX 97009 REDMOND, WA 98073	PHONE: 206 885-5010 x 5538 FAX: 206 882-5744
Glynn Rountree	Aerospace Industries Assoc.	1250 Eye St., NW Washington, DC 20005	PHONE: 202-371-8401 FAX: -8471
Tom Cortina	HARC	2111 Wilson Blvd Suite 850 Arlington, VA 22201	PHONE: 703-524-6636 FAX: 703-243-2874
Dale Kent	3M	3296 Rice Cr. Terr. New Brighton, MN 55112	PHONE: 612-733-4931 FAX: 612-636-1977
Dale Atkinson	DBA	7703 Carrleigh Pkwy Springfield, VA 22152	PHONE: 703-451-3014 FAX: 703-451-4278
Bob Filipczak			PHONE: FAX:
			PHONE: FAX:
			PHONE: FAX:

AGENDA

INTERNATIONAL HALON REPLACEMENT WORKING GROUP MEETING

July 16-17, 1996

Held at the FAA Technical Center, Atlantic City Airport, New Jersey

<u>TUESDAY, JULY 16, 1996</u>

8:30-8:45 Introduction/Background/General Information
8:45-9:00 Review of Minutes of March 26-27, 1996 Meeting
9:00-9:15 Schedule for Halon Replacement Program
9:15-12:00 Subgroup Leader Reviews/Presentations

9:15-9:45 Cargo - Full Scale Testing
Water Mist
9:45-10:15 Engine - Full Scale Testing

10:15-10:30 Break

10:30-11:00 Handheld
11:00-11:30 Lavatory

11:30-12:00 Discussion on Handheld Minimum Performance Standard

12:00-1:30 Lunch

1:30-2:00 General Tour and Walkthrough of Test Facilities in Bldg. #287 & #275
2:00-3:00 Opportunity for Specific Questions at Each of the Test Areas
3:00-3:30 Final Discussion on Cargo
3:30-4:00 Final Discussion on Lavatory
4:00-4:30 Final Discussion on Handheld
4:30-5:00 Final Discussion on Engine
5:00 Adjourn for Day

<u>WEDNESDAY, JULY 17, 1996</u>

8:30-9:00 Comments on Published Reports/Status of Unpublished Reports

- <u>Published April 1996</u> - "User Preferred Fire Suppression Agent for Lavatory Trash Container Fire Protection", Report # DOT/FAA/AR-96/8

- Pending Reports:

Update to "Chemical Options to Halon For Aircraft Use" - B. Tapscott
At Editor "User Preferred Fire Extinguishing Agent for Cargo Compartments" — going to print
At Editor "User Preferred Fire Extinguishing Agent for Engine and APU Compartments"

9:00-10:30 Task Group Leader Presentations/Updates

Cargo Detection False Alarm Survey - J. O'Sullivan
Halon Restrictions Update - J. O'Sullivan
Agent Concentration - D. Dierdorf

10:30-10:45	Break
10:45-12:00	Discussion on Engine Minimum Performance Standard
12:00-1:00	Lunch
1:00-1:30	Continue Discussion on Minimum Performance Standards
1:30-2:00	Additional Discussion
2:00-4:00	Working Group Member Presentations - Albert Moussa (Blaze Tech) 20 minutes on "The Simulation of Clutter in Fire Suppression Tests in Aircraft Bays"
4:00-4:30	Next Meeting/Closing