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User Preferred Fire Extinguishing Agents for Engine and Auxiliary Power Unit (APU) Compartments

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16. Abstract

The results of the "User Preferred Agent for Engine and Auxiliary Power Unit (APU) Compartment Fire Extinguishing System" survey sent to airlines and airframe manufacturers are compiled in this report.

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Halon, Halocarbons, Fire extinguishing system, Engine, Auxiliary Power Unit (APU)	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

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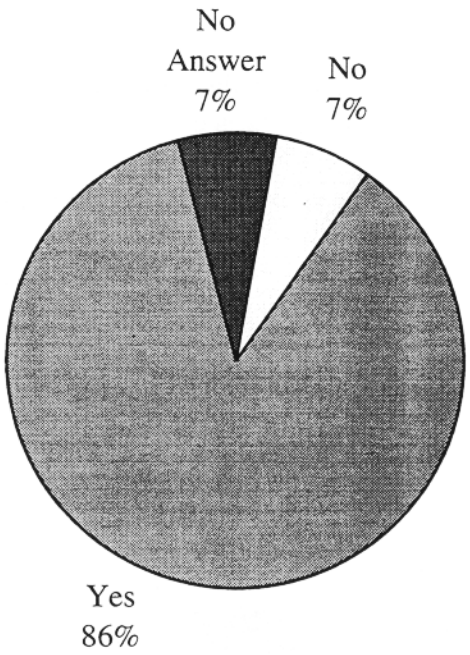
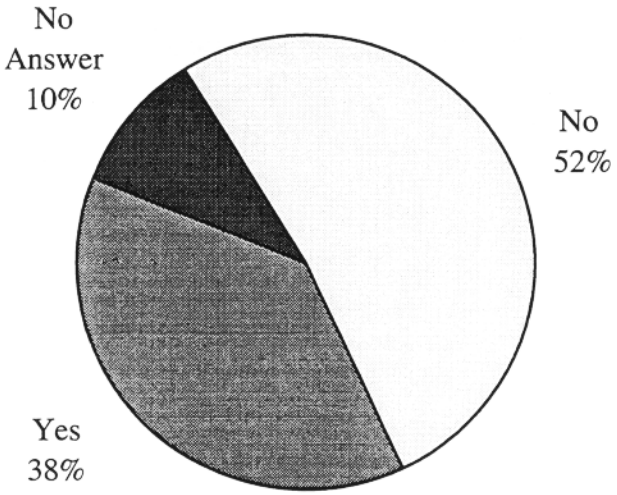
EXECUTIVE SUMMARY

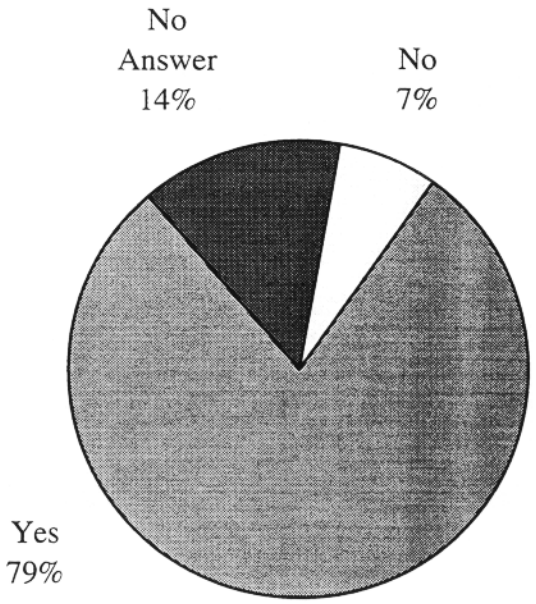
Results of a survey conducted to determine the user preferred halon replacement agents for aircraft engine and auxiliary power unit fire extinguishing systems are



Do you agree with the recommendation of halocarbon agents, specifically FIC-1311 and HFC-227ea, for engine and APU fire extinguishing systems?

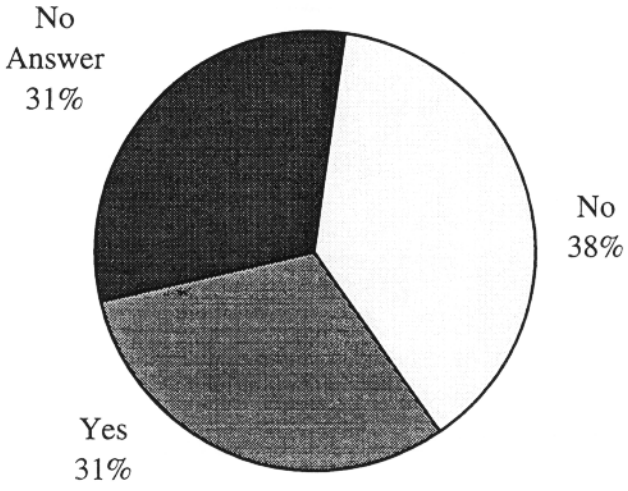
Do you have concerns if the agents approved for use only in unoccupied areas are used for engine and APU fire extinguishing systems?





Do you agree with the proposal to consider the gas generators as the next choice of agents to be evaluated?

Do you prefer different agents for existing aircraft systems and for new systems (future aircraft model)?



The survey confirmed halocarbons as user preferred agents. The performance criteria for these should be developed first. Also recommended was investigation of compatibility of these agents with engine and APU materials likely to be exposed to them.

1. INTRODUCTION.

This report discusses results of a survey to determine user preference for halon replacement agents in aircraft engine and auxiliary power unit (APU) fire extinguishing systems. It was conducted by a task group of the International Halon Replacement Working Group (IHRWG) for the aviation industry. The goal of the working group, established by the United States Federal Aviation Administration (FAA) in October 1993, is to provide industry inputs for the research program undertaken by the FAA in cooperation with the Joint Aviation Authorities (JAA) in Europe, the Civil Aviation Authority (CAA) in the United Kingdom, and Transport Canada Aviation (TCA) leading to performance criteria and certification methods for non-halon fire extinguishing/suppression systems. Participants in IHRWG include aviation regulatory authorities, other government agencies involved in R&D, airframe manufacturers, airlines, industry associations, fire protection equipment suppliers, and researchers. There are subgroups to address each of the three areas of fire protection, which are cargo compartment, engines and APU, and passenger cabin (lavatory and hand-held extinguishers).

In the April 1995 meeting of the IHRWG, the final report of the task group, "Chemical Options to Halons for Aircraft Use" was presented. The report (No. DOT/FAA/CT-95/9) reviews a variety of chemicals and other options. However, it was concluded by the task group that inputs from the users were essential to make recommendations about preferred agents or systems for aircraft use. Therefore, a new task group was formed with only airframe manufacturers and airlines as members. Participants in this task group are identified in appendix A. The task group decided to invite comments from manufacturers and users of aircraft.

In the July 1995 meeting of the IHRWG, results of a survey on preferred agents for cargo compartments and passenger cabins were presented. A survey for the engine and APU compartment fire extinguishing systems was conducted during August-October 1995, with a proposal to consider two specific agents for further evaluation by the FAA. The task group considered the best available technical information and identified three halocarbon agents (HFC-125, HFC-227ea and FIC-13I1) as being particularly promising. Of these, HFC-125 was being evaluated by the U.S. Air Force. Therefore, the proposal included the other two agents (HFC-227ea and FIC-13I1) for evaluation by the FAA.

2. SURVEY RESPONSE.

A survey package was distributed by the IHRWG Coordinator to airlines, engine and APU, and airframe manufacturers around the world. The package provided background information, summary data on potential halon replacements, factors important in agent selection, and a questionnaire. There were 29 responses which are included here as appendix B. Table B-1 shows the responses in a summarized form.

3. ANALYSIS.

It was mentioned in the survey that a written response was encouraged and that the lack of a response would imply agreement with the proposal. However, for the purpose of the following analysis only the 29 responses were considered.

3.1 AGREEMENT WITH THE PROPOSAL.

A. *The IHRWG task group proposes halocarbon agents (specifically HFC-227ea and FIC-13I1) for replacing halon 1301 in engine and APU compartment fire extinguishing systems. The group recommends these agents for tests and performance criteria development by the FAA.*

Do you agree with this proposed recommendation? *Yes*_____ *No*_____

The answers to this question were 25 positive, 2 negative, and 2 blank. One of the two respondents who did not answer yes or no gave a list of priorities for agent selection Japan Airlines (JAL); the other indicated their products were not affected by this issue (BFGoodrich Aerospace). These two respondents (JAL and BFGoodrich) did not answer any other questions. The Ministry of Defense, UK, answered with a negative, commenting that they would agree if other agents and water mist were included. Short Brothers Plc explained their negative answer citing concerns about toxicity, corrosiveness, and atmospheric life. They also suggested other agents including water.

3.2 ALTERNATIVE TO THE PROPOSAL.

A. *Which group of agents is preferred by you? Please list in the order of preference (halocarbons other than above, particulate aerosols, water mist). You may also identify specific agents in each group.*

Since only two respondents (7%) disagreed with the proposed two agents, most respondents skipped this question. Halocarbons, which were not included in the proposal, and water were mentioned as preferred alternatives by two respondents as noted in 3.1.

3.3 CONCERN ABOUT HUMAN EXPOSURE.

A. *Some agents are approved for use only in areas normally not occupied by humans.*

Do you have concerns about their use in engine and APU compartments?

*Yes*_____ *No*_____

A majority (52%) expressed no concern. Most who answered yes to this question did not elaborate. The main concern is for accidental/inadvertent discharge of the agent which could expose humans to toxic chemicals. Human exposure is not likely in normal operation of the system. However, a small concern exists regarding the ingestion of the agent into the engine bleed system and thereby into the passenger cabin.

3.4 GAS GENERATORS AS SECOND CHOICE.

A. *The IHRWG task group also proposed that the gas generators should be added to the list of agents to be tested when the technology for this purpose is more developed. Do you agree?*

*Yes*_____ *No*_____

A large majority (79%) agreed with the proposal. Reasons were not provided by a few respondents who disagreed or did not answer.

3.5 CHOICE OF DIFFERENT AGENTS FOR EXISTING MODELS AND NEW SYSTEMS.

A. *Do you prefer different agents for existing aircraft systems and for new systems (future aircraft models)?*

*Yes*_____ *No*_____

This is the only question where no clear preference emerged. There was only a small difference between yes and no answers with a significant number of blanks. If an ideal agent, one having zero ozone depletion potential (0 ODP), negligible atmospheric life, negligible or no toxicity, drop-in or no penalty in terms of weight or volume, could be identified, the choice would be easier—one agent for all that would simplify logistics, require minimum inventories, and would be acceptable everywhere in the world. Lacking an ideal agent, the aircraft operator's decision would be guided by many factors such as the cost of having different agents and local environmental regulations. These factors are likely to have varying impact on different operators. However, for the purpose of this survey, an indecisive preference in this matter has little significance.

3.6 COMMENTS.

A. *Provide any other comments and suggestions on additional sheets.*

A few respondents provided detailed comments which are included in appendix B. Several engine manufacturers commented on the need to assess corrosiveness and compatibility of these agents with respect to engine materials likely to be exposed to them. This issue will have to be addressed separately because the focus of the current FAA test program is primarily the fire extinguishing performance of the agents.

4. CONCLUSIONS.

The users prefer halocarbons for aircraft engine and APU fire extinguishing systems. This preference is almost unanimous. Since every agent in this category has some drawback, gas generators should be considered as the second choice. There is significant concern regarding potential of human exposure to agents and safety. The issue of material compatibility, which has not been fully investigated, must also be addressed.

5. RECOMMENDATIONS.

Based on the favorable response for the proposed two agents, the task group recommends that the performance of FIC-13I1 and HFC-227ea should be evaluated first. The task group did not propose HFC-125 in the July 1995 proposal because it was already being tested by the US Air Force. For the purpose of making the evaluation procedure uniform for all agents, the task group recommends inclusion of HFC-125 in the first priority tests by the FAA. It is also recommended that a request to investigate material compatibility be forwarded by the International Halon Replacement Working Group to the engine and APU manufacturers.

APPENDIX A—TASK GROUP "USER PREFERRED AGENTS FOR ENGINE AND APU COMPARTMENTS"

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TABLE B-1. RESULTS OF THE "USER PREFERRED AGENT FOR ENGINE AND APU COMPARTMENT FIRE EXTINGUISHING SYSTEMS" SURVEY

AIRLINES						
Respondent	Agree?	Concern?	Gas Generators?	Different?	Name & Phone	Comment
Air France	Yes	Yes	Yes	No	Maurice Kindel 33-1-48649977	W,V<W,V 1301
Aloha Airlines	Yes	No	No	No	Scott Fung 808-836-4235	
American Airlines	Yes	Yes	Yes		Michael Bucke 918-292-2388	Evaluate more agents, goal: common agent
American Trans Air	Yes	No	Yes		Luis A. Camacho 317-240-7663	
British Airways	Yes	Yes	Yes	Yes	John J O'Sullivan 44-181-502-5460	Include other agents, water mist
Canadian Airlines	Yes	No	Yes	No	Stephen J. Mulford 604-270-5529	
Delta Airlines	Yes	No	Yes	Yes	Steve Pitner 404-714-0701	Different agents OK if retrofit costs are high
Empresa Nacional De Aeronautica	Yes	No	Yes	No	Miguel Soto Aravena 56 2 528-3007	Favor FIC-13I1, standardization very important
Hawaiian Airlines	Yes	No	Yes	No	Richard Bonnardel 808-835-3378	Cost effectiveness
Hawaiian Airlines				Yes*	Richard Hosokawa 808-835-3457	

* Two responses from the same company were received. There was a difference in the last answer only. One (yes) answer was considered for the analysis.

TABLE B-1. RESULTS OF THE "USER PREFERRED AGENT FOR ENGINE AND APU COMPARTMENT FIRE EXTINGUISHING SYSTEMS" SURVEY (CONTINUED)

AIRLINES						
Respondent	Agree?	Concern?	Gas Generators?	Different?	Name & Phone	Comment
Japan Airlines					Toru Kawano 81-3-3747-3721	No answers, general priorities: safe, easy cleanup, availability
KLM	Yes	No	Yes	No	Theo Bloemendal 31-20-6499128	If cost effective, same agent desirable
Lufthansa Technik AG	Yes	No	Yes	Yes	Hans Humfeldt 49-40-5070-2406	ODP=GWP=0 for new aircraft
NWT Air	Yes	No	Yes		Peter Lewko 403-890-7707	Compatibility with existing systems
Philippine Airlines	Yes	Yes	Yes	Yes	Francisco R. Ramiro 632-832-3351	Include FC 3110, safe to environment, humans
Quantas Airways	Yes	Yes	Yes	No	R. W. Alcorn 61-2-691-7658	Drop in, not toxic
Singapore Airlines	Yes	No	Yes	Yes	Chiam Toon Jien 65 5415382	Drop-in replacement required

Note: ODP stands for Ozone Depletion Potential, and GWP stands for Global Warming Potential

TABLE B-1. RESULTS OF THE "USER PREFERRED AGENT FOR ENGINE AND APU COMPARTMENT FIRE EXTINGUISHING SYSTEMS" SURVEY (CONTINUED)

ENGINE/APU MANUFACTURERS						
Respondent	Agree?	Concern?	Gas Generators?	Different?	Name & Phone	Comment
Allied Signal Engines	Yes	Yes	No		Jim Laird 602-231-1613	Concern due to cabin bleed air
BFGoodrich Aerospace					Lamont F. Jones 607-335-5475	Products not affected
G. E. Aircraft Engines	Yes	No	Yes		Wallace M. Schulze 513-552-5671	Evaluate corrosiveness on materials
International Aero Engines	Yes		Yes		William A. Raabe 203-652-1674	
Mitsubishi Heavy Industries	Yes	Yes	Yes	No	Masaji Mita 81 568 79 0324	
Pratt & Whitney	Yes	Yes		No	John Zavodjancik 203-565-5030	Must perform material compatibility tests, 2-3 months needed

TABLE B-1. RESULTS OF THE "USER PREFERRED AGENT FOR ENGINE AND APU COMPARTMENT FIRE EXTINGUISHING SYSTEMS" SURVEY (CONTINUED)

AIRFRAME MANUFACTURERS						
Respondent	Agree?	Concern?	Gas Generator?	Different?	Name & Phone	Comment
Aerospatiale	Yes	No	Yes	No	Jean Paillet 33 61 93 71 65	Potential use of FIC-13I1 in cargo compartment; favor same as it could be drop in
Airbus Industrie	Yes	No	Yes	No	Marco Potschkat 33 61 93 33 33	Why is HFC-125 not on the list?
Boeing Commercial	Yes	No	Yes	Yes	Harry Mehta 206 655 5069	
Daimler Benz Aerospace	Yes	Yes*	Yes	No	Bernd Dunker 49 40 7437 5309	Include HFC-125, *if toxic effects are not negligible
McDonnell Douglas/ Douglas Aircraft Co.	Yes	No	Yes	Yes	Sham Hariram 310-593 4305	
Short Brothers Plc	No	Yes		Yes	John H. Miller & D. Riordan 44 1232 733604	Atmospheric life, toxicity, corrosive evaluation, other halocarbons, water
OTHER ORGANIZATION						
Respondent	Agree?	Concern?	Gas Generator?	Different?	Name & Phone	Comment
Ministry of Defense, UK	No**	Yes	Yes		A. J. Killingray 0171 3050 360	**Agree if other agents included; water mist