HALON PRESSURE

Environmental deadlines signal impatience with civil aviation's inability to replace legacy aircraft fire-suppression agents.

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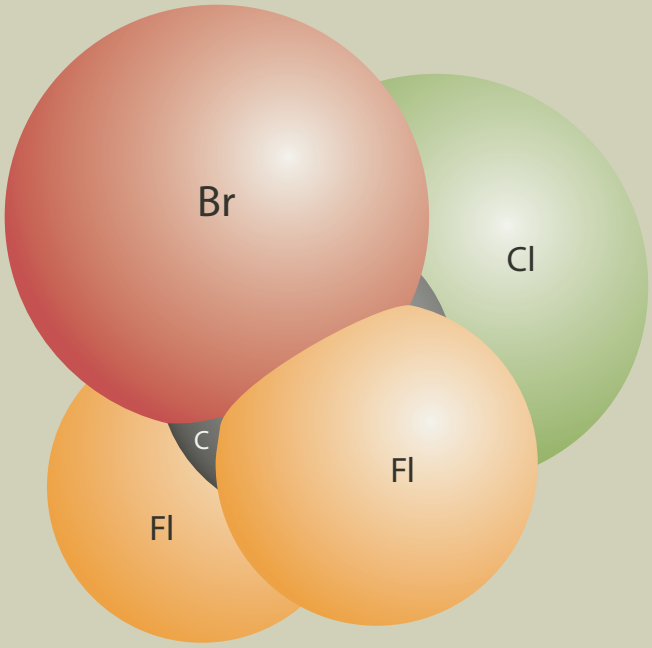

The European Union, International Civil Aviation Organization (ICAO) and Underwriters Laboratories recently have taken steps toward withdrawing within a few years the regulatory exemptions allowing commercial transport aircraft to carry halon 1211 and halon 1301. These two halons[1] — clean fire-extinguishing agents for scenarios requiring a streaming or total flooding attack, respectively[2] — have been the only agents universally accepted for fighting in-flight fires on these aircraft for more than 45 years. Many aviation safety specialists regard them as unmatched in overall performance, worth what they consider negligible risk of serious environmental harm,[3] and still indispensable.

For a sense of the quantity of halon carried on current widebody passenger jets, a Boeing 777 typically has 377 lb (171 kg) to protect cargo compartments, 57 lb (26 kg) to protect engines and auxiliary power units (APUs), 10–18 lb (4.5–8 kg) in hand-held extinguishers, and 1.5–3 lb (0.7–1.4 kg) in lavatory trash receptacles.

An analysis for the International Aircraft Systems Fire Protection Working Group (IASFPWG) — which includes specialists from Australia, Brazil, Canada, France, the United Kingdom and the United States — said that proposed European regulations would apply new limits to exemptions for critical use of halons aboard commercial transport aircraft. The IASFPWG as of mid-2009 was studying the proposal, especially the following mandatory halon-replacement deadlines: The cut-off dates for halon in all new aircraft would be January 2012 for lavatory trash receptacles, hand-held fire extinguishers and engine nacelle/APU compartments, and January 2017 for cargo compartments. The end dates for carrying halons in all existing aircraft would be 2017 for lavatory trash receptacles, 2021 for hand-held fire extinguishers and 2031 for engine nacelle/APU compartments and cargo compartments.

The European rationale for this proposal said in part, "In its 2007 report, the [Scientific Assessment Panel established under the Montreal Protocol on stratospheric ozone-depleting substances] warned the parties that, despite the successes, continued vigilance was required to keep to the newly projected timetable for recovery of the ozone layer, also taking account of the remaining uncertainties, notably about the impact of climate change.

Halon gas molecules.

Susan Reed

Key remaining challenges relate to the release of 'banked' ozone-depleting substances [such as halons]/greenhouse gas emissions into the atmosphere, exempted uses of ozone-depleting substances [such as critical uses in aviation] and new ozone-depleting substances. … As alternatives are now available to replace halons in fire-protection applications, end dates for existing applications can now be set. … However, in individual cases it will be possible to grant derogations from these end dates if no technically and economically feasible alternatives are available."[4]

In March 2008, ICAO asked all states to consider Assembly Resolution A36-12 — Halon Replacement, urging them to "advise their aircraft manufacturers, airlines, chemical suppliers and fire-extinguishing companies to move forward at a faster rate in implementing halon alternatives in engine and [APUs], hand-held extinguishers and lavatories; and investigating additional halon replacements for engines/[APUs], and cargo compartments." The resolution noted that "much more needs to be done because the available halon supplies are dwindling and the environmental community is becoming more concerned with the lack of substantive progress in aviation [and] no real progress has been made in cargo compartment halon replacement, which is by far the largest application of extinguishing agent."

The resolution asked the ICAO Council to consider mandatory replacement of halons in 2011 for lavatories of new production aircraft; and also for lavatories, hand-held extinguishers, engines and APUs when aircraft manufacturers apply for a new aircraft type certificate. It also called for mandatory replacement of halon in 2014 for hand-held extinguishers on new production aircraft.

In June 2009, the International Coordinating Council of Aerospace Industries Associations (ICCAIA) asked ICAO to reconsider its "unrealistic timeline" for halon replacement. "After the U.S. Federal Aviation Administration (FAA) and ICCAIA briefing, ICAO's Air Navigation Commission decided to establish a task force to consider the various halon issues in greater depth," the council said. "ICCAIA maintains that the ICAO Assembly acted without full consideration of all the ramifications. Appropriate replacement agents are not available … and some alternatives produce a weight penalty that causes greater fuel burn and more release of carbon dioxide and other emissions more damaging to the environment than the small amount of halon emitted on rare occasions."

Also responding in June, the IASFPWG said that although there was no foreseeable problem replacing halon 1301 in lavatory trash receptacles, the date for replacing halon 1301 engine nacelle/APU compartment extinguishers would not be feasible, and the date for replacing halon 1211 hand-held portable extinguishers probably could be met only with significant aircraft structural redesign. Drop-in replacements would not be available in that time frame.

Underwriters Laboratories a year earlier had announced plans to withdraw, and not replace, its "Standard for Halogenated Agent Fire Extinguishers, UL 1093" on the basis of imminent phase-out of halons and in response to mounting environmental concerns about preserving a standards infrastructure allowing indefinite further use of halons. After the organization consulted with representatives of the U.S. commercial airline industry, however, it changed the effective date of this decision from Oct. 1, 2009, to Oct. 1, 2014.[5]

Boeing Commercial Airplanes had told the IASFPWG in November 2008 that UL 1093 was vital to keep as the only standard available to meet FAA regulatory requirements, that related FAA guidance to industry was not expected until 2010 and that significant installation issues would require a minimum of three years before non-halon systems could be installed in airplanes. "Boeing's goal is to replace fire extinguishers just one time, and with an environmentally acceptable agent," Boeing representatives said in a May presentation to the working group. "Industry resources are better spent working to develop a drop-in replacement to reduce the overall impact of the change."[6]

Halon can be used in many ways, including in some of these hand-held extinguishers.

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Boeing representatives also said that, contrary to common misconception, FAA approval of an extinguishing agent does not constitute approval for use aboard a specific aircraft. "There are FAA-approved 5BC extinguishers [a capacity and type suitable for hand-held use on flammable liquids and gases and energized electrical equipment], but they are not FAA-approved for installation on Boeing airplanes," they said. "Boeing must show compliance to multiple FAA regulations related to structure; design and construction; and installation." They said that issues of performance, such as increased size and weight of non-halon hand-held extinguishers; uncertain future environmental considerations; and economic concerns if old and new technologies are not interchangeable, complicate the process.

Increased size and weight of replacement fire fighting equipment may require "relocation and/or extensive configuration/structural changes to the airplane … a revised/new installation drawing for each location" and testing to ensure that cabin crewmembers can reach, maneuver and retrieve the new fire extinguishers, they said.

Environmental Impact

Tension between environmental interests and aviation interests on this issue is not new, but has intensified. On one hand, all concerned want to protect the lives of aircraft occupants with the best technology at hand; on the other hand, all concerned want to rapidly halt and reverse life-threatening risks to millions of people and to ecosystems from damage to the Earth's ozone layer and global warming. The planet's ozone layer provides a protective barrier to ultraviolet (UV) solar radiation, mostly UVB, which in excessive amounts has been linked to fatal and non-fatal skin cancer, cataracts and a weakened immune system in humans, and measurable harm to plant and aquatic ecosystems. Global warming similarly affects many aspects of human life on a macro scale, from agriculture and weather to flooding and continued habitability of population centers, according to the U.S. Environmental Protection Agency.[7]

"Ninety percent of the ozone in the Earth's atmosphere is found in the stratosphere," the agency explains. "The characteristics of halon and other human-made chemicals that can deplete ozone … enable them to reach the stratosphere, where they break down, and the chlorine and bromine from them can destroy ozone. Halons are a major source of bromine in the stratosphere."[8]

When global authorities became aware of the severe stratospheric ozone layer–depleting properties of halons and their lesser global-warming properties, they banned any further production under an the Montreal Protocol in 1994 (Table 1, p. 32). Cessation of halon production alone was expected to lead to cessation of all halon uses as replacements were invented, tested and approved. Nearly all uses of halons were phased out, but aircraft in-flight fire fighting was exempted indefinitely pending aviation industry acceptance of fully equivalent solutions for aircraft. So far, only non-halon systems for protecting lavatory trash receptacles on new airplanes have been accepted.

The IASFPWG, like the FAA, has focused on minimum performance standards (MPS) for replacement agents in each aircraft application. Aircraft manufacturers notably are still calling for basic and applied scientific research leading to "drop-in" replacement agents wherever possible but also have pursued other alternatives.[9] Other avenues of halon replacement — for some of the four aircraft fire-suppression applications — include engine and APU fire research on applications of 3M Novec 1230 fire protection fluid since 2002.

So far, halon-replacement agents that have passed MPS tests and other FAA tests are larger, heavier, leaving the aviation industry unsatisfied and unconvinced that these solutions will have a long and predictable service life. Subject specialists are now considering advocating the retention of halon 1211 and halon 1301 aboard aircraft until the industry is convinced that comparable or better alternatives meet the whole range of requirements.

Underwriters Laboratories has listed three commercially available hand-held extinguishers as having MPS-compliant replacement agents — HCFC Blend B (Halotron I), HFC-227ea and HFC-236fa — and they have passed full-scale fire tests by the FAA. A new advisory circular about to be released for comment will cover these halon-replacement extinguishers and discuss their safe discharge inside aircraft.

Most halon-replacement products that have passed aviation MPS testing also come from a group of chemical compounds known as hydrochlorofluorocarbons (HCFCs). They do not have the high ozone-depletion potential of halons, but some environmental scientists see their global warming potential as significant. One concern of the IASFPWG is that proposed regulations seeking to accelerate halon replacement shortly afterward will be amended with deadlines for banning aircraft fire-extinguishing agents containing HCFCs, or perhaps requiring discharged-gas

Timeline of Aircraft-Related Halon Replacement Issues

Date	Event/Development	Significance
1959–1977	Halon 1211 marketed as clean fire extinguishing agent in 1973. Scientists and FAA also recognize aircraft firefighting capability of halon 1301.	The new agents begin to displace problematic carbon dioxide and dry powders, but they remain in service as an extinguishing agent aboard aircraft.
Early 1980s	Significant decrease noticed in concentration of ozone in stratosphere over Antarctica.	Harmful ultraviolet solar radiation (primarily UVB) not blocked by ozone layer has increased at Earth's surface in affected areas.
1987	United Nations drafts the Montreal Protocol on Substances that Deplete the Ozone Layer.	Global debate begins on phase-out of ozone-depleting substances.
1990	Ozone-depleting substances account for about 50 percent of global carbon-dioxide emissions.	Carbon-dioxide equivalent (greenhouse gas) emissions in the atmosphere cause global warming.
1993	FAA forms International Halon Replacement Working Group to produce new MPS.	Work has focused on lavatory trash receptacles, cargo holds, hand-held extinguishers and engine nacelle/APU compartments.
1994	States sign Montreal Protocol.	Production of halons ceases but there is no prohibition on continued use of a finite recycled supply of halons.
Late 1990s	Decreased ozone layer considered severe over North Pole and South Pole; threats measured elsewhere.	Scientists link excessive UV radiation to human health (such as millions of fatal and non-fatal skin cancers, cataracts and immune system suppression) and harm to plant and aquatic ecosystems.
2000	First two halon 1301 replacement agents pass MPS tests.	Boeing and Airbus install lavatory trash receptacle fire systems with these agents on new aircraft.
2003	Renamed International Aircraft Systems Fire Protection Working Group surveys users of hand-held extinguishers.	Research continues on alternative agents focusing on customers and markets for them.
Mid-2000s	First halon 1211 replacement agents pass MPS tests for hand-held fire extinguishers.	Agent volume, weight and dimensions of equivalent extinguishers exceed halon-based solutions by a significant amount.
Late 2000s	Airbus, Boeing and research partners test separate proprietary systems for engine nacelle/APU fire protection.	Manufacturers of halon-replacement agents market them for many applications unrelated to commercial transport aircraft.
2007	ICAO letter urged faster action by states and industry to replace halon, and announced monitoring of progress toward this goal.	For its 2008-2010 work program, ICAO later agreed to continued working group discussion on feasibility of dates in 2011-2014.
2007	Montreal Protocol's Scientific Assessment Panel says the ozone layer is slowly returning to normal concentration.	Scientists push for more tools to accelerate full recovery of the ozone layers, such as by removing exemptions for halon systems aboard aircraft.
2009	U.S. Environmental Protection Agency issues a proposed endangerment finding.	Some substances used as halon replacements may come under further scrutiny as pollutants.
2009	FAA says it will issue for comment an advisory circular on latest options for replacing halon 1211 hand-held extinguishers.	Scientific research behind the draft advisory circular greatly expanded knowledge of human effects of discharging new agents in the cabin.
2009	FAA shows that three halon 1301 alternative agents met MPS for engine nacelle/APU protection.	Research showed that agent and system weight will be greater than halon-based systems, requiring new design approvals.
2009	Industry testing of cargo compartment agent alternatives to halon 1301 do not identify any agent that meets all MPS requirements.	Research continued on a water mist/nitrogen gas hybrid system as an alternative fire suppression technology in place on one agent.
2010	An update of the Kyoto Protocol to the United Nations Framework Convention on Climate Change is expected. Ozone-depleting substances will account for about 5 percent of global carbon-dioxide emissions.	Scientists push for elimination of remaining ozone-depleting substances and non-ozone-depleting substances that have significant global warming potential, including some of the halon alternatives for aircraft use.
2014	Underwriters Laboratories plans to drop support for its Standard for Halogenated Agent Fire Extinguishers.	FAA regulations have required that aircraft systems meet this standard, so a new basis of continuing use of halon agents would be required.
2015-2040	Targets set for phaseout of hydrocholorofluorocarbons in developed countries.	Some halon alternatives in aviation, especially airports, likely would have to be replaced.
2050	Projected recovery of Arctic and average ozone layers to pre-1980 level.	No ozone-depleting substances released into the atmosphere for any reason.
2060-2075	Projected recovery of Antarctic ozone layer	No ozone-depleting substances released into atmosphere.

APU = auxiliary power unit; FAA = U.S. Federal Aviation Administration; MPS = minimum performance standards

Sources: European Community Regulations; International Civil Aviation Organization; U.S. Federal Aviation Administration; Hughes Associates

Table 1

recovery systems, making costly changes at best only an interim solution.

Elusive 'Magic Bullet'

"After more than 20 years … a 'magic bullet,' i.e., a one-to-one, drop-in replacement, has yet to be developed," said a 2009 analytical report by Hughes Associates for American Pacific Corp., which makes Halotron I, one of the HCFC products. "All alternatives are either less efficient, have undesirable environmental qualities or cause collateral damage. With supplies of halon 1211 dwindling, the need for an acceptable alternative is becoming more acute. The United Nations Environment Programme (UNEP) Panel has stated that, due to the lengthy process of testing, approval and market acceptance of new fire protection equipment and agents, no additional options are likely to be available in time to have an appreciable impact by the year 2015."[10]

In September 2007, the U.S. government and the UNEP Ozone Secretariat had addressed these issues in a working paper to the ICAO Dangerous Goods Panel and the ICAO Assembly on halon replacement in civil aviation aircraft.[11] The paper said. "Although the [MPS] are available, there has been little success in developing and installing alternatives to halon in civil transport aircraft. Halon has been the fire-extinguishing agent of choice in civil aviation because it is extremely effective on a per unit-weight basis over a wide range of aircraft environmental conditions; a clean agent (no residue); electrically non-conducting; and of relatively low toxicity.

"It is likely that any known alternative agents for engines/APUs will require more agent and system weight and will require significant design approval activity prior to incorporation into existing designs. Additionally, the existing alternative extinguishers for hand-helds are larger and heavier than the current halon extinguishers, which will trigger additional requirements for airframe manufacturers (i.e., design change approvals) and airlines (e.g., crew training) prior to incorporation into existing designs."

The MPS to replace halons in cargo compartment protection requires passing test scenarios involving simulations of bulk-loaded cargo, containerized cargo, a surface burning fire and an exploding aerosol container. "Generally, each approach [with alternative agents] had one or more shortcomings compared to halon 1301," the working paper said. "With two of the agents, tests have produced excessively high levels of hydrogen fluoride and a significant weight penalty. During the fire-suppression phase, the smoke layer ignited unexpectedly, producing a 'rollover' and temperature spikes, phenomena never seen with halon 1301. … Other agents caused toxicity concerns or over-pressurization of aerosol cans or sudden flare-ups."

Some participants in the debate have mentioned another unexpected source of halon-replacement pressure. Banked supplies of recycled halons — while dwindling — currently are adequate and sold at acceptable cost to replenish systems aboard commercial transport aircraft. One specialist told a 2008 FAA meeting, however, that civil aviation now competes directly for this resource with organizations seeking higher profits from the destruction of halons for greenhouse gas emission credits than they receive supplying halons to aircraft operators. "The cost of recycled halon in the United States is currently in the range of $15 per pound or $33,000 a ton ... if greenhouse gas credits are priced at $20 a ton of carbon-dioxide gas equivalent, a ton of halon 1301 would be worth $142,800 to destroy," according to a representative of Halon Alternatives Research Corp., the FAA said.

Notes

1. The term is a short form of halogenated hydrocarbon.
2. Halon 1211 is used in aircraft hand-held fire extinguishers. Halon 1301 is used in fixed extinguishing systems. Ideal clean agents quickly evaporate, do not obscure vision, are not electrically conductive and leave no residue.
3. Some aviation safety specialists have argued that the quantities of halons actually discharged during flight operations are too small to justify a near-term ban on them.
4. European Parliament and the Council of the European Union. "Regulation of the European Parliament and of the Council on Substances that Deplete the Ozone Layer (Recast)." No. 2008/0165 (COD). July 7, 2009.
5. Hughes Associates. "The Case for New Production of HCFC-123 Beyond 2020 for use in Production of Halotron I and in Other Niche Fire Protection Applications." July 1, 2009.
6. Carlo, Al; Madden, Mike. "Halon Replacement for Airplane Hand-Held Fire Extinguishers: The Challenges." Presentation to the International Aircraft Systems Fire Protection Working Group, Cologne, Germany. May 20, 2009.
7. EPA. "Guidance for the EPA Halon Emission Reduction Rule: Background for Halon Technicians." United States Air and Radiation EPA430-B-01-001, Environmental Protection (6205J). February 2001.
8. EPA.
9. Carlo; Madden.
10. Hughes Associates.
11. United States and United Nations. "Halon Replacement in Civil Aviation Aircraft." Working paper A36-WP/207 TE/64 presented at the 36th Session of the ICAO Assembly. Nov. 5–16, 2007.