International Civil Aviation Organization

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**WORKING PAPER**

# ASSEMBLY — 42ND SESSION

## TECHNICAL COMMISSION

**Agenda Item 25: Other issues to be considered by the Technical Commission**

## THE CHALLENGE OF HALON REPLACEMENT: BALANCING FIRE SAFETY, ENVIRONMENTAL GOALS, AND INDUSTRY READINESS

(Presented by the International Coordinating Council of Aerospace Industries Associations (ICCAIA), the International Federation of Air Line Pilots' Associations (IFALPA) and the International Business Aviation Council (IBAC))

**EXECUTIVE SUMMARY**

The manufacturing industry is committed to replace Halon in aircraft applications.
The current lack of acceptable alternatives to Halon for use in cargo compartment fire suppression fixed systems have presented substantial challenges for industry to meet the existing deadline for replacing Halon. Modifying the deadline, advocating for allowances for regulatory exemptions and aligning international bodies like the UNEP (United Nations Environmental Programme) Ozone Secretariat would provide a balanced path forward, allowing continued progress toward sustainable fire suppression solutions while avoiding regrettable substitutions that could introduce new adverse environmental and health impacts.

**Action:** The Assembly is invited to:

a) acknowledge that, despite extensive efforts, no acceptable and certifiable Halon alternative for cargo fire suppression systems could be successfully developed by the November 28 2024 cutoff date due to complex technical, regulatory, safety and environmental requirements;
b) direct the Council to, in coordination with industry and the UNEP Ozone Secretariat, propose a revised sustainable cut-off date for Halon replacement in Annex 8 — *Airworthiness of Aircraft* for new aircraft type certificate, based on comprehensive data including Halon availability, alternative solution development progress, and safety considerations to inform a decision no later than the 43rd Session of the ICAO Assembly;
c) request ICAO Member States to initiate a comprehensive assessment of global Halon reserves for essential aviation fire suppression needs until an acceptable alternative solution is available, and explore options, including an application for an Essential Use Nomination under the Montreal Protocol to ensure aviation safety; and
d) adopt the amended Resolution to supersede Resolution A39-13, as contained in the appendix.

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| *Strategic Goals:* | This working paper relates to *Every flight is Safe and Secure, Aviation is Environmentally Sustainable* and the *International Civil Aviation Convention and other treaties, laws and regulations address all challenges.* |
| *Financial implications:* | The activities referred to in this paper will be undertaken with the resources available in the 2026-2028 Regular Programme Budget. |
| *References:* | Annex 8 — *Airworthiness of Aircraft*<br>Doc 10184, *Assembly Resolutions in Force* (Assembly Resolution A39-13)<br>A42-WP/395-TE/158, *Aircraft Fire Suppression - Halon Replacement*<br>A41-WP/96-TE/22, A*ircraft Halon Replacement* |

[1] English, Arabic, Chinese, French, Russian and Spanish versions provided by ICCAIA.

## 1. INTRODUCTION

1.1 The International Coordinating Council of Aerospace Industries Associations (ICCAIA) has previously alerted the ICAO Assembly to the need to find an acceptable[2] alternative to Halon gas for cargo compartment fire suppression. This need results from Halon being classified as a prohibited ozone depleting substance (ODS) under most local regulatory frameworks globally. These regulatory constraints have led the industry to investigate acceptable substitutes or alternatives.

1.2 The Assembly has previously acknowledged these challenges in Resolution A39-13, *Halon replacement*, and specifically:

> *Encourages* States to collaborate with the Industry Consortium for engine/APU (Auxiliary Power Unit) applications and the Cargo Compartment Halon Replacement Working Group established by the International Coordinating Council of Aerospace Industries Associations;
>
> *Encourages* ICAO to continue collaboration with the International Aircraft Systems Fire Protection Working Group and the United Nations Environment Programme's Ozone Secretariat through its Technology and Economic Assessment Panel's Halons Technical Options Committee on the topic of halon alternatives for civil aviation.

1.3 At the 41st General Assembly, ICCAIA presented A41-WP/96, *Aircraft Halon Replacement*, which highlighted the significant challenges in identifying acceptable candidate agents for Halon replacement. The industry has faced persistent hurdles, as the most technologically advanced fire suppression agents considered for Halon replacement have not met all regulatory and performance criteria while also delivering global environmental benefits. Developing a new system capable of satisfying the complex technical, regulatory, safety and environmental requirements is a complex undertaking. Based on previous experience, such development is estimated to take up to a decade, rendering the previously established 2024 deadline, which has already passed, unattainable. Given these ongoing challenges and the need for a comprehensive, fact-based assessment, the definitive replacement cut-off date requires further evaluation.

1.4 This paper urges ICAO to ensure continued safety by initiating a process for establishing a sustainable Halon replacement deadline. This approach would allow for a comprehensive assessment of available Halon reserves and the progress of alternative solution development, leading to a fact-based decision on whether to revise the cut-off date. Initial industry assessments show that revising the effective cut-off date in Annex 8 — *Airworthiness of Aircraft* for Halon replacement for cargo fire suppression systems would need to be delayed from 28 November 2024 to 31 December 2035 for new aircraft type certificate applications.

1.5 Cargo compartment fire suppression alternatives to Halon increase aircraft weight, leading to higher CO2 emissions. This environmental impact should be considered as part of a holistic approach when Halon replacement agents are developed and assessed.

1.6 Given all of these parameters, the industry believes that ICAO should initiate and support a comprehensive assessment of global Halon reserves and consumption rates to determine the projected availability of Halon until an acceptable alternative is available.

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[2] *A decision by the parties to the Montreal Protocol provided further guidance on what constitutes an acceptable alternative or substitute – namely - it must pass all the following criteria: Commercially available, Technically proven, Environmentally sound, Economically viable and cost effective, Safe to use, Easy to service*

1.7 Further information on the subject is contained in A42-WP/395, *Aircraft Fire Suppression - Halon Replacement.*

## 2. DISCUSSION

2.1 ICAO Resolution A39-13, *Halon replacement*, dating back to 2016, already highlighted challenges facing the sector in replacing Halon, most notably for use in cargo compartment fire suppression. The Resolution, and subsequent discussions, identified that new aircraft with a type certificate application on 28 November 2024 or later must be delivered with a Halon alternative. For decades, ICCAIA manufacturers have been working to find acceptable alternatives to Halon.

2.2 Following extensive evaluations, the fire suppression agent with the highest technology readiness level for Halon replacement in aircraft cargo compartment fire suppression systems contains 2-BTP, which is a fluorinated hydrocarbon. 2-BTP would be considered as Poly- and perFluoroAlkyl Substances (PFAS) per the 2021 Organisation for Economic Co-operation and Development (OECD) definition[3].

2.3 A number of States have also begun considering PFAS regulations, that could potentially restrict their use. In this context, its supply chain and availability could also be affected.

2.4 No acceptable 'drop-in' alternative has been identified, so other alternatives would require extensive retrofit and redesign solutions.

2.5 Manufacturers have explored some other potential Cargo Compartment Halon replacement agents, but none have been sufficiently developed to support the ICAO November 2024 deadline. One (CF3I) has not passed the Minimum Performance Standard (MPS) Test. One (water mist/nitrogen inerting) has been discontinued due to system complexity and even higher weight impact. Based on industry experience, development of a new cargo Halon replacement system may take up to an additional 10 years.

2.6 The investigated alternative fire suppression agents demonstrate lower mass efficiency compared to Halon, resulting in increased system weight and volume. Specifically, fire suppression system replacements contribute to an estimated increase in aircraft weight ranging from 100 kg to 400 kg per aircraft, dependent on aircraft type and configuration. While the substitution for Halon achieves benefits in stratospheric ozone layer protection, consistent with obligations under the Montreal Protocol (2014), it introduces a measurable increase in greenhouse gas emissions. Regulatory frameworks should systematically consider overall impacts, evaluating relevant factors such as stratospheric ozone protection, climate effects (including greenhouse gas emissions), operational safety, and technological feasibility to the extent practical, based on available data and recognized best practices.

2.7 Potential Cargo Compartment Halon replacement agents (2-BTP blend and inert gases) pose serious health risks due to high asphyxiation risk and higher cardiac sensitization potential compared to Halon 1301. To ensure safe use, additional safety measures are required. Industry and airworthiness authorities are currently working to develop an aligned approach for risk mitigations.

2.8 Based on these substantial risks and the ongoing lack of viable or uncertain alternatives, ICCAIA urges ICAO to initiate a process to establish a sustainable revised deadline for Halon

[3] OECD (2021), *Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance*, OECD Series on Risk Management of Chemicals, OECD Publishing, Paris, https://doi.org/10.1787/e458e796-en.

replacement in cargo compartment fire suppression systems. This process shall include a thorough assessment of all relevant data.

2.9 Industry requests that ICAO Member States, together with the Committee on Aviation Environmental Protection (CAEP), who have existing links to UNEP, work in accordance with amended Resolution A39-13 to support a comprehensive assessment of global Halon reserves and consumption rates to determine the projected availability of Halon until an acceptable alternative is available.

2.10 In addition, global reserves of Halon are limited. According to the Fire Safety Technical Options Committee (FSTOC) 2022 Assessment Report[4], Halon reserves are expected to be depleted, with an indication that the quantity and quality of Halon available to satisfy the demand in aviation fire extinguishing for cargo compartments, depending on worldwide supply, annual emission and reclaim rates, may no longer be available starting in 2030. In the absence of acceptable alternatives, it is crucial to explore means to secure Halon supply via an Essential Use Nomination under the Montreal Protocol until an acceptable Halon replacement is available for use in aircraft cargo compartments.

## 3. CONCLUSION

3.1 The actions are contained in the Executive Summary of this working paper.

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[4] https://ozone.unep.org/system/files/documents/FSTOC-2022-Assessment.pdf

# APPENDIX A

# DRAFT RESOLUTION FOR ADOPTION BY THE 42ND SESSION OF THE ASSEMBLY

## Resolution ~~39/13~~ 42/xx: Halon replacement

*Recognizing* the importance of aircraft fire extinguishing systems to the safety of flight;

*Recognizing* that halogenated hydrocarbons (halon) have been the main fire extinguishing agent used in civil aircraft fire extinguishing systems for over fifty years;

*Whereas* halons are no longer being produced by international agreement because their release contributes to ozone depletion and climate change;

*Recognizing* that more needs to be done because the available halon supplies are decreasing and unsure and that the environmental community continues to be concerned that halon alternatives have not been developed for all fire extinguishing systems in civil aircraft;

*Recognizing* that the Minimum Performance Standard for each application of halon has been developed already by the International Aircraft Systems Fire Protection Working Group with participation by industry and regulatory authorities;

*Recognizing* that there are stringent aircraft-specific requirements for each application of halon that must be met before a replacement can be implemented;

*Recognizing* that the aircraft manufacturing industry has established mechanisms for stakeholder engagement in the development of common solutions for halon replacement in a realistic timeframe for cargo compartment applications;

*Recognizing* that the production is prohibited by international agreement, halon is now exclusively obtained from recovery, reclaiming and recycling. Therefore, recycling of halon gas needs to be rigorously controlled to prevent the possibility of contaminated halon being supplied to the civil aviation industry; and

*Recognizing* that any strategy must depend on alternatives that do not pose an unacceptable environmental or health risk as compared to the halons they are replacing;

*The Assembly*:

1. *Urges* States and their aviation industries to intensify development and implementation of acceptable halon alternatives for fire extinguishing and suppression systems in aircraft cargo compartments;

2. *Urges* States to determine and monitor their halon reserve and quality of halon;

3. *Encourages* ICAO to continue collaboration with the International Aircraft Systems Fire Protection Working Group and the United Nations Environment Programme's Ozone Secretariat through its Technology and Economic Assessment Panel's Halons Technical Options Committee on the topic of halon alternatives for civil aviation;

4. *Encourages* States to collaborate with the Industry Consortium for engine/APU applications and the Cargo Compartment Halon Replacement Working Group established by the International Coordinating Council of Aerospace Industries Associations;

5. *Encourages* States to support measures to minimize unnecessary halon emissions that occur when there is an absence of any safety threatening fire event and to ensure the better management and preservation of existing halon reserves;

*6. Encourages States to engage, with the assistance of the ICAO Committee on Aviation Environmental Protection, the United Nations Environment Program (UNEP) Ozone Secretariat to assess global Halon reserves and, if necessary, explore options, including an Essential Use Nomination for Halon in aircraft cargo compartment applications under the Montreal Protocol to maintain aviation safety;*

7. Directs the Council, in coordination with industry and the UNEP Ozone Secretariat, to develop a proposal for a revised sustainable effective cut-off date for Halon replacement in Annex 8 for new aircraft type certificate applications. This proposal shall be based on comprehensive data including Halon availability, progress in alternative solution development, and take account of safety considerations.

8~~6~~. *Directs* the Council to mandate the replacement of halon in cargo compartment fire suppression systems used in aircraft for which application for type certification will be submitted after a specified date in the 2024 timeframe; and

9~~7~~. *Declares* that this resolution supersedes Resolution A39-13.

— END —