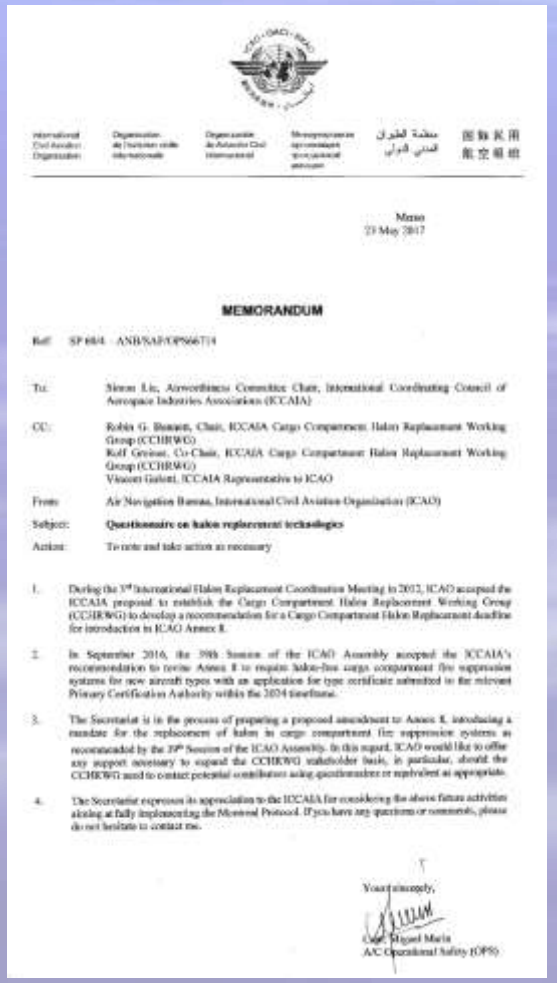
Cargo Compartment Halon Replacement Advisory Group - CCHRAG -

Update: Technical Assessment Overview

For
International Aircraft Systems Fire Protection Forum Meeting
May 14, 2019

Halon replacement solution requires collaboration

- ICCAIA Cargo Compartment Halon Replacement Advisory Group (CCHRAG)(2013)
  - Airbus, Boeing, Bombardier, Embraer, Mitsubishi
  - Recommended cargo halon replacement deadline for new TC applications after 2024 (2015)
- ICAO supported questionnaire on halon replacement technologies (2017)
- CCHRAG queried stakeholders for interest in participating in Technical Assessment



Memo
23 May 2017

MEMORANDUM

Ref: SP 88/4 – ANB/SAF/OPS66/14

To: Simon Lin, Airworthiness Committee Chair, International Coordinating Council of Aerospace Industries Associations (ICCAIA)

CC: Robin G. Bunyan, Chair, ICCAIA Cargo Compartment Halon Replacement Working Group (CCHRWG)
Rolf Greisse, Co-Chair, ICCAIA Cargo Compartment Halon Replacement Working Group (CCHRWG)
Vincent Galeni, ICCAIA Representative to ICAO

From: Air Navigation Bureau, International Civil Aviation Organization (ICAO)

Subject: **Questionnaire on halon replacement technologies**

Action: To note and take action as necessary

1. During the 3rd International Halon Replacement Coordination Meeting in 2012, ICAO accepted the ICCAIA proposal to establish the Cargo Compartment Halon Replacement Working Group (CCHRWG) to develop a recommendation for a Cargo Compartment Halon Replacement deadline for introduction to ICAO Annex 8.

2. In September 2016, the 39th Session of the ICAO Assembly accepted the ICCAIA's recommendation to revise Annex 8 to require halon-free cargo compartment fire suppression systems for new aircraft types with an application for type certificate submitted to the relevant Primary Certification Authority within the 2024 timeframe.

3. The Secretariat is in the process of preparing a proposed amendment to Annex 8, introducing a mandate for the replacement of halon in cargo compartment fire suppression systems as recommended by the 39th Session of the ICAO Assembly. In this regard, ICAO would like to offer any support necessary to expand the CCHRWG stakeholder basis, in particular, should the CCHRWG need to contact potential contributors using questionnaires or equivalent as appropriate.

4. The Secretariat expresses its appreciation to the ICCAIA for considering the above future activities aiming at fully implementing the Montreal Protocol. If you have any questions or comments, please do not hesitate to contact me.

Yours sincerely,

Capt. Miguel Marín
A/C Operational Safety (OPS)

Technical Assessment identified potential solutions

- Technical Assessment supports CCHRAG Work Plan deliverable to report status of cargo halon replacement solutions to ICAO

- Responses received in June 2018
  - 8 Participants with 9 potential halon replacement solutions
  - Chemical manufacturers, fire protection suppliers, and aircraft system suppliers
  - Technologies include chemical agents, inerting systems and new/novel equipment
  - Varied stages of development

Technical Assessment Criteria Categories

Category	Criteria	Compliance	Value (whenever applicable)	Evidence of Value	Expected Completion Date	Notes
Fire Fighting Performance	**Cup burner fire extinction/suppression concentration established (ISO, NFPA)**					
	Other Industry Standards met (UL, ANSI, NFPA, etc.)					
	FAA MPS testing concentration determined					
	Test method determined to demonstrate compliance with paragraph 25.851(b)(2)					
Physical	**Agent & System Weight is less than or equal to Halon system**					
	Agent & Systems Size is less than or equal to Halon system					
	Long & short range applicability					
	Clean agent (gaseous) - no clean up required					
	Boiling Point					
	No damage to aircraft materials after agent discharge					
	Freezing point is less than normal operating conditions					
	Freezing point is less than minimum operating/storage conditions					
	Decomposition temperature is greater than fire conditions (or HF formation and thermal decomposition products are under the dangerous toxic level for humans)					
	Not thermally conductive					
	Not electrically conductive					
	No aircraft hydromechanical interfaces required (e.g. bleed air, fuel tank inert gas, etc)					
	Operational impacts have been identified & mitigated					
	System (knockdown & metered) available whenever airplane is powered					
Production	Currently used in other industries and/or applications					
	Supply chain established					
	Agent readily available					
	Agent modification not needed for aircraft application					
	Risks for system adaptation is mitigated or low					
Environmental, Health & Safety	Not a Montreal Protocol listed ODS					
	Not a Kyoto Protocol listed GHG					
	Not GHS-listed Hazardous material					
	US EPA SNAP approved					
	US EPA TSCA Inventory listed					
	EU REACH Registered, Authorised, and/or Restricted					
	Not a PBT, POP, or endocrine disrupter					
	Present on other regulatory lists					
	US OSHA Regulated					
	Not a Carcinogenic, mutagenic, repro-tox substance (CMR)					
	Cardiac sensitization: LOAEL, NOAEL is less than or equal to Halon 1301					
	Oral, inhalation, dermal toxicity is less than or equal to Halon 1301					
Schedule	**Current TRL is greater than 3**					
	Aviation Authority Certification experience					

***8 key criteria** identified in 5 categories to evaluate status and potential*

Technical Assessment Report

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Executive Summary

- CCHRAG is optimistic that a solution will be available to meet the ICAO deadline.
  - Assuming further development by the participants and timely government approvals
- If a candidate system has not been demonstrated to be application ready one year before the 41st Session of the ICAO Assembly, ICCAIA will indicate the potential consequences with respect to the 2024 deadline.

FIREFIGHTING PERFORMANCE

- **Key Criteria**
  - **Cup burner fire extinction/suppression concentration established**
    - Majority of participants stated compliance through cup burner testing or existing standards.
    - Three participants have not established system concentration due to non-gaseous agent.
    - CCHRAG concludes that interest has been demonstrated by conducting preliminary tests.
  - **FAA MPS testing concentration determined**
    - One participant states compliance w/FAA MPS testing, having performed the test at the FAA.
    - One participant has performed the exploding aerosol can test at their own facilities.
    - It is essential more agents successfully complete MPS testing by 2020 to reduce risk.
  - **Test method determined to demonstrate compliance w/ 14CFR paragraph 25.851(b)(2)**
    - Over half participants responded that their solution test method was not yet determined.
    - Regulatory agencies will need to confirm specific test methods well in advance of implementation
- **Summary**
  - Ensuring performance on an aircraft under extreme conditions may pose significant challenges to the system design and aircraft integration requirements.
  - Continued technology development is needed to guarantee successful certification.

PHYSICAL PROPERTIES OF EXTINGUISHING AGENT

- **Key Criteria**
  - **Agent & System Weight is less than or equal to Halon system**
    - In order to minimize the CO2 emission caused by increased fuel burn due to increased system weight, this criterion has been rated of high importance by the CCHRAG. Also, this criterion is important because it will aid in system integration providing a quicker, less costly transition to clean fire suppression agents for the growing fleet.
    - Majority of participants indicated difficulty in compliance with weight criteria.
    - A couple participants who state compliance have not investigated the system layout in detail.
    - The CCHRAG concludes that a weight increase cannot be avoided for any of the halon replacement solutions presented. The development challenge is to find the lowest weight solution.
  - **System (knockdown & metered) available whenever airplane is powered**
    - About half of participants responded that their technology complies with this criteria.
    - Other participants were either To Be Determine or non-compliant.
    - The group recommendation is that a halon replacement system should be independent from other aircraft systems. Until more reliable inerting systems with improved availability (no warm-up time required) have been developed, these systems remain nonviable.
  - ***Continued . . .***

PHYSICAL PROPERTIES OF EXTINGUISHING AGENT (cont'd)

- **No damage to aircraft materials after agent discharge**
  - A few participants who are investigating non-gaseous agents have stated this is TBD.
  - One participant who uses a non-gaseous agent stated compliance without verification.
  - CCHRAG assesses that gaseous agents are preferable in the context of potential damage to aircraft materials.
- **Clean agent (gaseous) - no clean up required**
  - It is important that the aircraft stays clean after a fire extinguishing discharge.
  - Participants report that all gaseous agents are compliant.
  - Participants that proposed non-gaseous agents identified the need for further investigation. This especially holds true for agents other than pure water.

- **Summary**
  - CCHRAG anticipates that for most non-gaseous agents, there will be a need for additional maintenance efforts within the compartment after agent discharge.
  - System architectures and correlated operational impact might differ for different aircraft models.
    For example, some aircraft models already are equipped with fuel tank inerting systems; other models cannot benefit from this opportunity.
  - CCHRAG assesses that halon replacements will most likely require increase in weight.

PRODUCTION

- **Compliances**
  - All participants indicated that their solutions are currently in use in other, non-aviation, applications.
  - Seven participants stated that supply chain has been established for the agents and/or technology.
  - Two technologies are not readily available for aircraft cargo fire suppression.
  - Five participants stated that risk mitigation for system adaptation is yet to be defined.

- **Summary**
  - CCHRAG group concludes that the solutions assessed are in various states of production readiness.
  - No information was collected on timing to establish aerospace-specific production capability and/or a roadmap/plan to establish supply chain support and logistics is unknown at this time. Therefore, CCHRAG is unable to assess production schedule readiness.

ENVIRONMENTAL, HEALTH & SAFETY

- **Compliances**
  - Responses varied due to the differences in development status, agent properties, and current use.
  - Four are considered compliant with US EPA SNAP.

- **Summary**
  - CCHRAG's assessment was that full compliance will take time and resources.
  - Some of the technologies appear to meet human health and safety criteria, but appear to have environmental trade-offs.
  - Other solutions appear to meet most of these criteria, there are trade-offs with the other criteria described elsewhere in this assessment.
  - CCHRAG believes most of the solutions still have multiple environmental and health impacts that are yet to be evaluated.

SCHEDULE

- **Key Criteria**
  - **Current Technology Readiness Level is greater than Discovery Phase, TRL3**
    - All but one of the participants stated that their solutions have reached TRL3, confirming proof of concept.
    - Four participants are chemical manufacturers with limited experience in supplying the aerospace industry.
    - Technical solutions based on nitrogen inerting are stated to be beyond TRL3/4, which is proven by successfully passed minimum performance standard tests and use in other applications. However, the reliance on NGS or OBIGGS will present significant challenges with regard to technical maturity.
    - Other gaseous fire suppression systems are currently undergoing minimum performance standard testing.

- **Summary**
  - CCHRAG assesses that this criteria is achievable but further development is needed to meet the necessary timeframe.

SUMMARY

Key Criterion	Conclusion	Remarks
Cup burner fire extinction/suppression concentration established (ISO, NFPA)	Achievable	
FAA MPS testing concentration determined	Achievable with conditions	More agents must pass to reduce risk of not meeting 2024 deadline
Test method determined to demonstrate compliance with paragraph 25.851(b)(2)	Achievable with conditions	Specific test methods need to be confirmed
No damage to aircraft materials after discharge	Achievable	
System (knockdown & metered) available whenever airplane is powered	Achievable with conditions	In case that the system relies on other aircraft systems, the required amount of agent supply might not be available during certain flight phases.
Agent & System Weight is less than or equal to Halon system	Not Achievable	A weight increase cannot be avoided for any of the halon replacement solutions presented. A consequence is an increased CO2 emission caused by higher fuel burn.
Clean agent (gaseous) - no clean up required	Achievable	
Current TRL is greater than 3	Achievable	

SUMMARY (cont'd)

- All participants have either documented TRL3 or are promoting solutions that could potentially be adapted to aircraft cargo compartment fire protection.
- For most, much developmental work still remains and acceptance is dependent on performance and economic viability to justify strong business case.
- It is anticipated that other new agents are under development and may be available for assessment in the coming year.
  - The CCHRAG will consider whether this assessment should be expanded and/or updated after the 40th Session of the ICAO Assembly in 2019.
- CCHRAG is optimistic that a solution will be available to meet the ICAO deadline, assuming further development and timely government approvals.
- If a candidate system has not been demonstrated to be application ready (actively being worked at Technology Readiness Level 7) one year before the 41st Session of the ICAO Assembly, ICCAIA will indicate the potential consequences with respect to the 2024 deadline.
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FUTURE OUTLOOK

- The drive for improved safety and fire protection on aircraft is increasing.
- Aviation authorities are challenged to ensure all fire threats are addressed and seek opportunities to better understand the risks and investigate potential mitigations.
- The CCHRAG welcomes the FAA's new Cargo Fire Suppression MPS Task Group and will participate to ensure alignment as new technologies are actively undergoing research and testing to meet current cargo fire suppression requirements (equivalent level of performance to halon).
- The challenge for all will be to work cooperatively and efficiently such that progress remains on track to support the ICAO 2024 deadline.

ICCAIA CCHRAG Technical Assessment Timeline

January 9, 2019	**Core CCHRAG finalized draft Technical Assessment (TA)**
January 10, 2019	CCHRAG Chair distributed draft TA to Participants
January 25, 2019	Participants responded with comments on draft TA
February 8, 2019	CCHRAG Chair consolidated comments & distributes to Core CCHRAG
February 11, 2019	Core CCHRAG reviewed consolidated comments
February 18, 2019	CCHRAG Chair sent out Stakeholder Review meeting notice
February 26, 2019	CCHRAG Chair distributed revised draft TA to Participants
March 7, 2019	**CCHRAG conducted review with Stakeholders** *30+ participants from 13 organizations!*
March 12, 2019	Stakeholder feedback received
April 24, 2019	**ICCAIA begins review of Final draft TA & Information Paper (IP)**
May 15, 2019	CCHRAG Chair presents IP/TA summary at IASFPWF Meeting
June 28, 2019	ICCAIA review of IP/TA complete
July 1, 2019	**Core CCHRAG shares IP/TA with ICAO**
July 31, 2019	Core CCHRAG collects feedback from ICAO
Aug-Sept 2019	Core CCHRAG prepare for ICAO General Assembly
Sept-Oct 2019	**CCHRAG Chair present IP/TA @ ICAO General Assembly, if needed**

Questions & Answers

Thank you!

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