



Engine/APU Halon-1301 Replacement Efforts for Commercial Aircraft



**FAA Technical Center Triennial Cabin and
Fire Safety Research Conference**

Robert S. Wright
Boeing Commercial Airplanes

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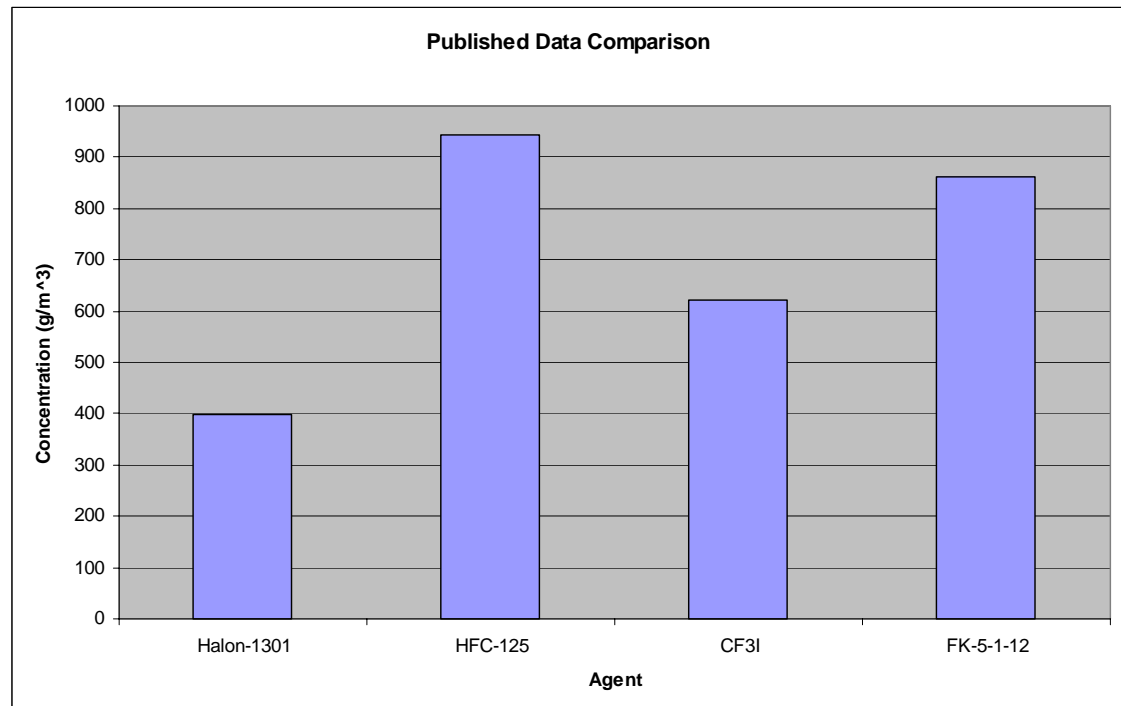
Robert S. Wright
BCA – Propulsion Fire Protection

Overview

- **Industry Work**
- **Requirements for Commercial Airplane Applications**
- **Design Impacts**
- **Boeing Activity**
- **Summary**

Engine/APU Halon Replacement – Industry Work

- **International Aircraft Systems Fire Protection Working Group (IASFPWG) established to develop standards for replacement agents**
 - **Six agents tested in Nacelle Fire Simulator – others eliminated earlier**
 - **Several test facilities in work or in use at this point**
- **Two airplanes announced with alternative systems**
 - **Eclipse 500 – didn't use MPSE protocol for PhostrEx testing; agent not feasible for large airplanes**
 - **Airbus A350 announced to use FK-5-1-12; not tested or in service yet**



Agents with currently published concentration values require significant increases in mass to maintain equivalent performance

Fielding an Alternate Agent – What's Required?

- **Fire-Fighting Performance**
 - Multiple testing protocols must be completed
- **Material Compatibility**
- **Safety, Health & Environment**
- **Weight/Volume**
 - Not a regulatory requirement, but a practical one
- **Measurability**
 - Without analysis capability, certification testing can't happen
- **Predictability**
- **Stability (Installed/Stored Shelf Life)**
- **Operational Envelope**
 - Commercial jetliners operate in a harsh world, so do their fire extinguishing systems

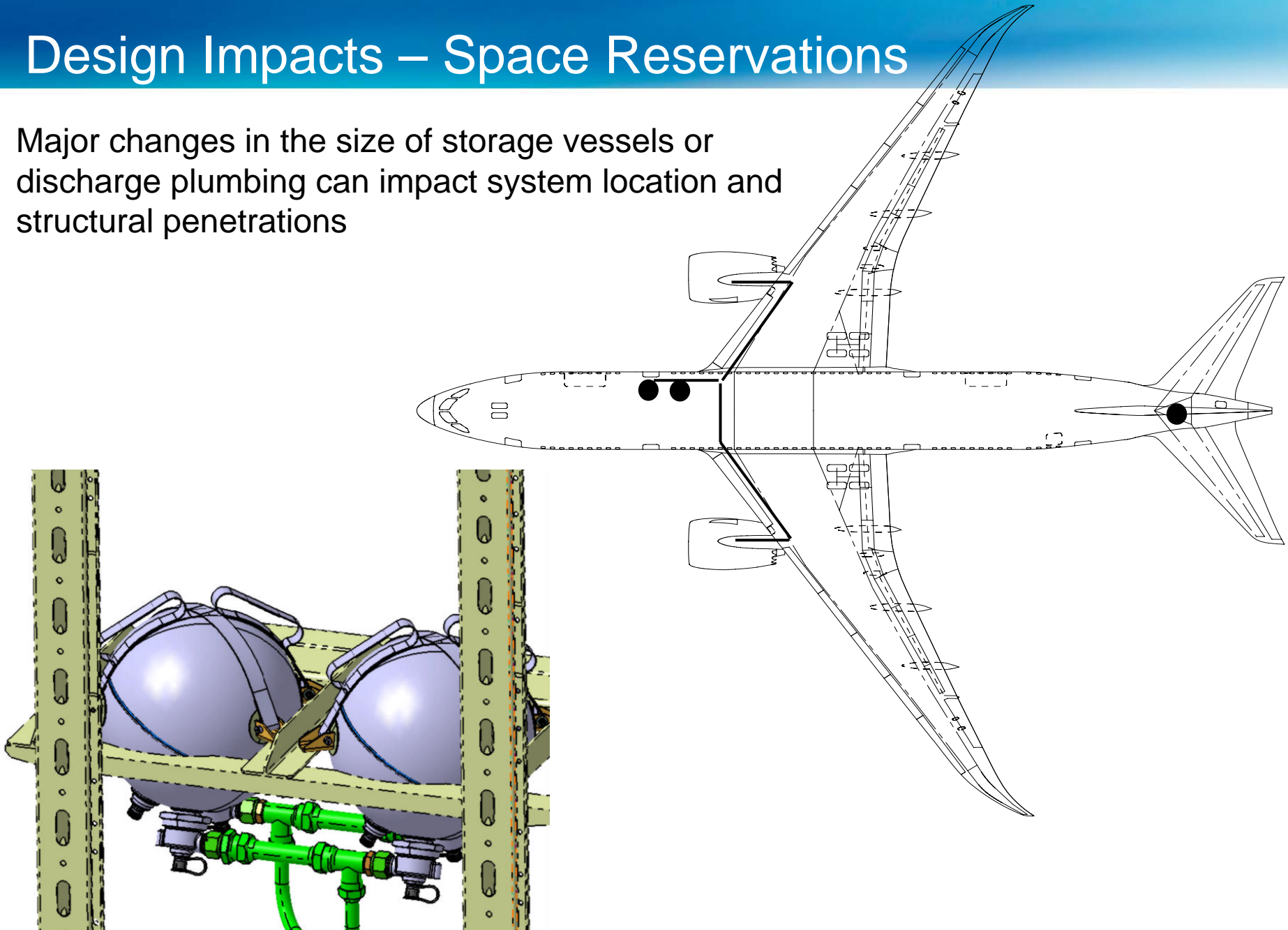
Any agent selected must be viable in an airline environment

What Needs to be Done to Implement a New Agent?

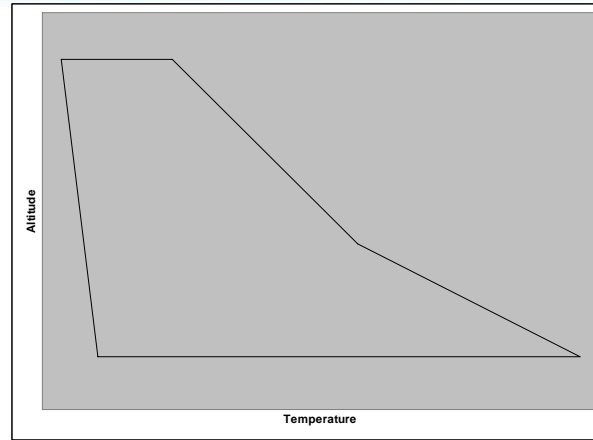
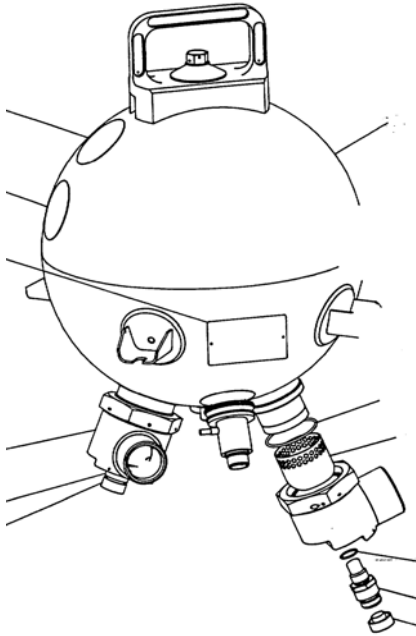
Discovery and Feasibility	Concept Development and Validation	System Development	Detailed Design and Testing	Delivery and Support
Information Request	Analyzer Tool Testing & Evaluation	Specific Airplane Requirements Definition	Certification Plan Submittal	Delivery of Airplane
Initial Evaluation of Candidates	Initial Distribution Testing & Evaluation	Detailed System Layout	Approval of Certification plan and any Side documents (e.g., Issue Papers)	Spares Provisioning
Material Compatibility Testing	Agent Production Testing & Demonstration	Hardware Sizing and Selection of Supplier	Definition of Maintenance Documents and Requirements	System Troubleshooting
Toxicity Testing	MPSE Testing at FAA Tech Center NFS	Communication with Airplane Operators	Agent Qualification Testing and Analyses	In-Service Events
Basic Cup Burner Testing of Agent	Trade Studies to Determine System Configuration	Fleet Support Planning	Hardware Qualification Testing and Analyses	Improvements
Lab Scale Testing & Evaluation	SNAP Approval		Certification Concentration Demonstration Test	

Design Impacts – Space Reservations

Major changes in the size of storage vessels or discharge plumbing can impact system location and structural penetrations

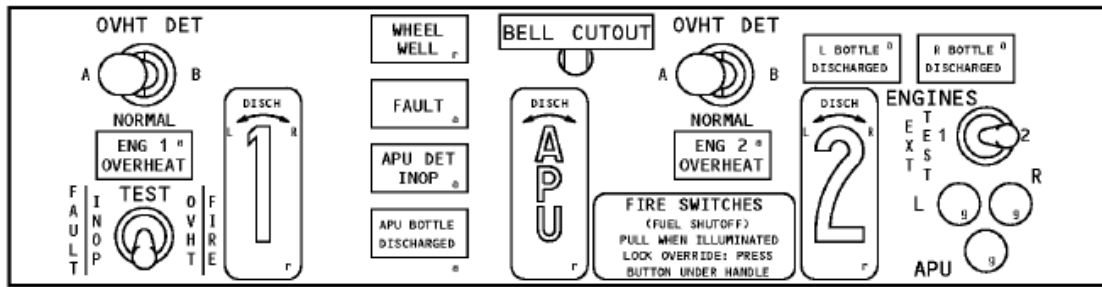


Design Impacts – Operations



Can the new agent operate across the full flight envelope of the airplane?

Will a new agent require more frequent replacements or special storage conditions?



ENGINE AND APU FIRE CONTROL PANEL (P8)

Will flight crew or maintenance procedures or training be impacted?

What Makes This So Challenging?

Characteristic	Conditions	Test Protocols	Test Facilities
Fire Fighting Performance	Cup Burner, High and Low Ventilation Spray, High and Low Ventilation Pool, Various Fuel Sources, Live Engine (as Required)	NFPA 2001 Cup Burner, MPSE Rev04, Custom Test Plans	Cup Burners Available - NIST, NFPA, Nacelle fire Simulator at Tech Center, also some private facilities
Material Compatibility	Aluminum, Titanium, Steel, Elastomers, Wiring, Insulation, Composite Materials, Electronic Components	Various ASTM and ASME tests, individual test protocols developed by OEMs	Widely available for hire - most OEMs have internal labs
Safety, Health and Environmental	Inhalation Toxicity, Irritation, Ozone Depletion Potential, Global Warming Potential	Variety, depending on agent specifics	Determined based on test needs
Weight and Volume	New Design Airplanes, In-Production Airplanes, In-Service (Out of Production) Airplanes	N/A	Highly specific to application
Measurability	Cup Burner Testing, MPSE Testing, Certification Testing	Specific to agent and measurement technology	Generally custom-built
Predictability	Test Cases, Cup Burner, MPSE, Certification	Specific design for each application	Various
Stability	Storage, Installed on Airplane	Specific design for each application	Various
Operational Envelope	Low Temperature Discharge, High Temperature Discharge, High Altitude, Low Altitude, High Speed, Low Speed	Specific design for each application	Various

Engine/APU Halon Replacement – Boeing Activity

- **Multi-year effort to define characteristics of successful Halon replacement agent for propulsion application**
 - **Multiple industry surveys to identify new agents**
 - Several agents evaluated, one unsuccessfully tested in 2002-3
 - Propulsion and Cargo applications pursued separately starting in 2004
 - Several new agents selected for further evaluation for propulsion only
 - Several agents currently in initial feasibility testing
 - One agent started MPSE testing in 2008; led to MPSE Rev04, work ongoing
- **Ongoing evaluation of opportunities and requirements**
 - **Future airplanes**
 - **Current production – does this create a mixed-fleet situation?**
 - **Out-of-production – Is there an incentive to retrofit airplanes?**

Much of this work is proprietary, and is not widely shared during the early stages.

Halon Replacement – Summary

- Halon-1301 has been used for decades as a fire extinguishing agent
 - Highly effective set of properties
 - As the “original” agent, Halon defined the standard
- Maintaining safety is paramount to industry and regulatory bodies
 - Very difficult to quantify all aspects of performance
 - Very complex test programs
- The end users – airlines – rely on all of us to maintain operations
 - Agents that are too heavy, corrosive, dirty, toxic or unstable can't be made to work in an airline environment
 - Operators have 50+ years of experience with Halon, including all aspects of use, from purchasing and storing to discharge

Airframers, agent manufacturers, system suppliers and regulators must work together to ensure that a viable solution is made available to the airplane operators.