

Status of Research & Testing to Replace Halon Extinguishing Agents in Civil Aviation

Fire Safety Team

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Federal Aviation
Administration



Current Usage of Halon 1301/1211



Halon Replacement in Civil Aviation

- **Halon Used in Civil Aviation for Over 45 Years**
- **Halon Production Banned (*Not Use*) Montreal Protocol on January 1, 1994**
- **FAA Mandate to Develop Certification Criteria, i.e Minimum Performance Standards (MPS) for Each Application, Not Find Replacement Agents**
- **Established International Halon Replacement Working Group (Now the International Systems Fire Protection Working Group) to Develop MPS**
- **MPS Defines Full-Scale Fire Tests (Developed at FAATC) to Demonstrate Replacement Agent Equivalency to Halon**
- **Example of Relative Agent Weights (B777): Lavs (1.5 to 3.0 lbs), Hand-Held (10 to 17.5 lbs), Engine/APU (58 lbs), Cargo (377 lbs)**



Lavatory Trash Receptacle Summary

- **Lavatory MPS Developed in 1997
(DOT/FAA/AR-96/122)**
- **Approved Halon Replacement Agents
FM-200 and FE-36 Passed MPS Test**
- **Airbus and Boeing Offer These Lavatory
Extinguishers**

Lavatory Trash Receptacle Extinguishers



Hand-Held Extinguishers Summary

- **Hand-Held MPS Developed 2002 (DOT/FAA/AR-01/37)**
 - **Hidden Fire Test (Effectiveness)**
 - U.S. - U.L. Offers Test Approval
 - **Seat Fire Extinguishing Test (Toxicity)**
 - Full-Scale Tests at FAATC
 - Measures Agent Decomposition Products
- **Approved Halon 1211 Replacement Agents Listed by U.L. (Hidden Fire Test)**
 - HCFC Blend B (Halotron 1)
 - HFC-227ea (FM-200)
 - HFC-236fa (FE-26)
- **Draft AC 20-42D: “Hand Fire Extinguishers for Use in Aircraft”**
 - **Safe Agent Discharge for Wide Range Aircraft/Compartment Volumes**

Hand-Held Extinguishers Agent Summary

Agent	Weight Equivalent	ODP	GWP
Halon 1211	1.0	5.1	390
HFC-227ea (FM200)	2.2	0	3800
HFC-236fa (FE36)	1.9	0	9400
HCFC Blend B (Halotron 1)	2.2	.02	120

FAA HAND HELD FIRE EXTINGUISHER HIDDEN FIRE TEST

Hidden Fire Test Apparatus



Seat Fire Extinguishing Test (Toxicity)

FAA Advisory Circular AC 20-42D

- Guidance for New Installations of Required Hand-Held Extinguishers
- Lists FAA-Approved Replacement Agents
 - HCFC Blend B
 - HFC-227ea
 - HFC-236fa
- Would Replace AC 20-42C
- Developed with Experts in IASFPWG
- Publish in Federal Register in 2009 for Public Comment

Hand-Held Extinguishers Summary

- **FAATC to Begin Testing Other Promising Halon Replacement Agent Extinguishers.**
 - **Powders**
 - **Powder May Be Drop-in Replacement for Cabin.**
 - **ODP - 0 GWP - 0**
 - **Clean Up Needed After Discharge.**
 - **Since Rarely Used, is Clean Up a Big Issue?**
 - **Novec 1230 (FK-5-1-12)**
 - **2BTP**

Engine Nacelle/APU Summary

- **Engine/APU MPS (Report Draft)** - Available on FAATC Website
 - **Engine Nacelle Fire Simulator (ENFS) at FAATC**
 - Spray and Residual (Pan) Fires/Jet Fuel, Hydraulic Fluid, Engine Oil
 - Two Mass Flow Rates/Two Temperatures
 - **Equivalency Determinations (Halon 1301 = 6%)**
 - HCF-125 = 17.6%
 - CF_3I = 7.1%
 - FK-5-1-12 = 6.1%
- **FAA/Airbus ENFS Testing**
 - Proprietary Agent Equivalency/Certification Criteria Determined
 - Agent/System Will be Made Available for Production Airplanes
- **FAA/Walter Kidde/Boeing ENFS Testing**
 - New Agent Testing started in 2007

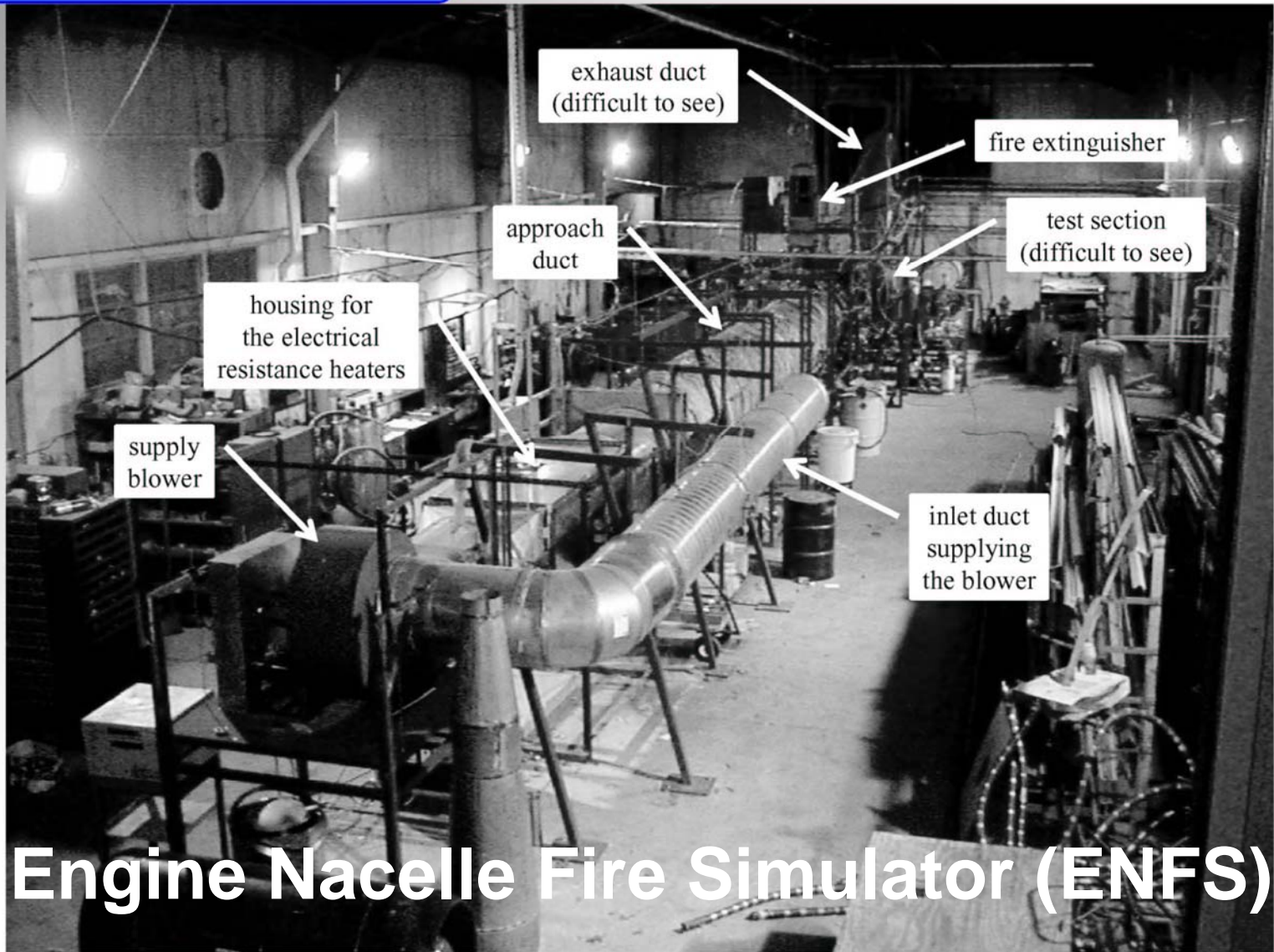
Engine Nacelle/APU Agent Summary

Agent	Weight Equivalent	ODP	GWP
Halon 1301	1	12	6900
HFC-125	2.36	0	3800
CF₃I	1.55	<.008	<1
FK-5-1-12 (Novec 1230)	2.16	0	<1

Engine Nacelle/APU Summary

- **PBR3 Certified Halon 1301 Replacement on Eclipse VLJ Aircraft**
 - Not Tested to MPS
 - Tested for Specific Application to the Intent of the MPS
 - Can only be Used in Configurations Tested
 - Very Toxic and Corrosive
 - No Other Airframe Manufacturers have Considered Using PBR3

IMAGERY - TEST FIXTURE



Engine Nacelle Fire Simulator (ENFS)

IMAGERY - TEST SECTION

TEST SECTION DIMENSIONS

48 INCH (1.22 m) OD SHELL

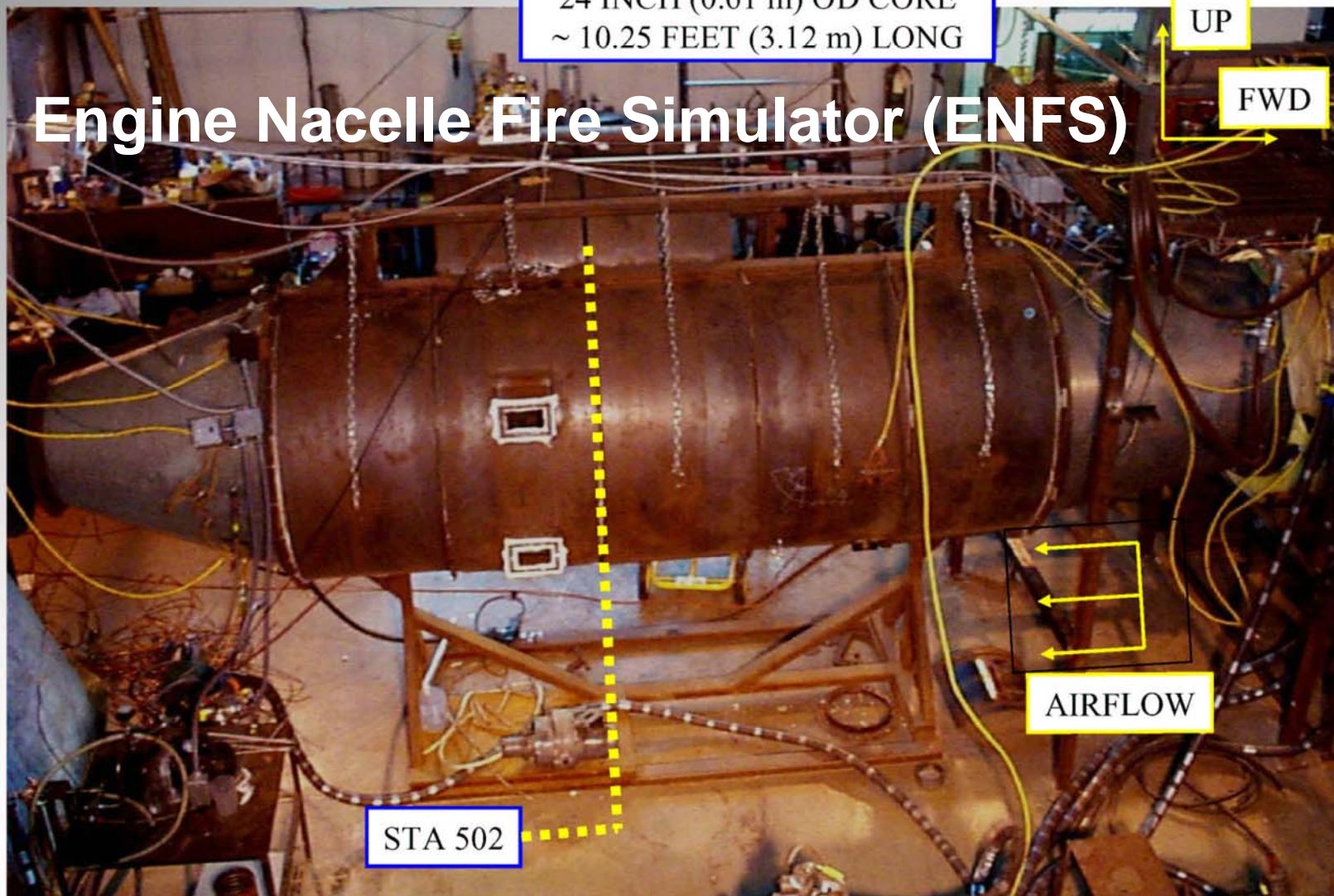
24 INCH (0.61 m) OD CORE

~ 10.25 FEET (3.12 m) LONG

Engine Nacelle Fire Simulator (ENFS)

UP

FWD



STA 502

AIRFLOW

Engine Nacelle/APU Summary

- **Non-Gaseous Replacement Agent**
 - Testing of Promising Non-Gaseous Agent is promising
 - Drop-in or Weight Saver
 - Current Version of Engine/APU MPS Requires Revision for This Type Agent
- **Revision to Engine/APU MPS Being Developed**
 - Eliminate Need For Halon 1301 Baseline Tests
 - Add Criteria for Non-Gaseous Agents

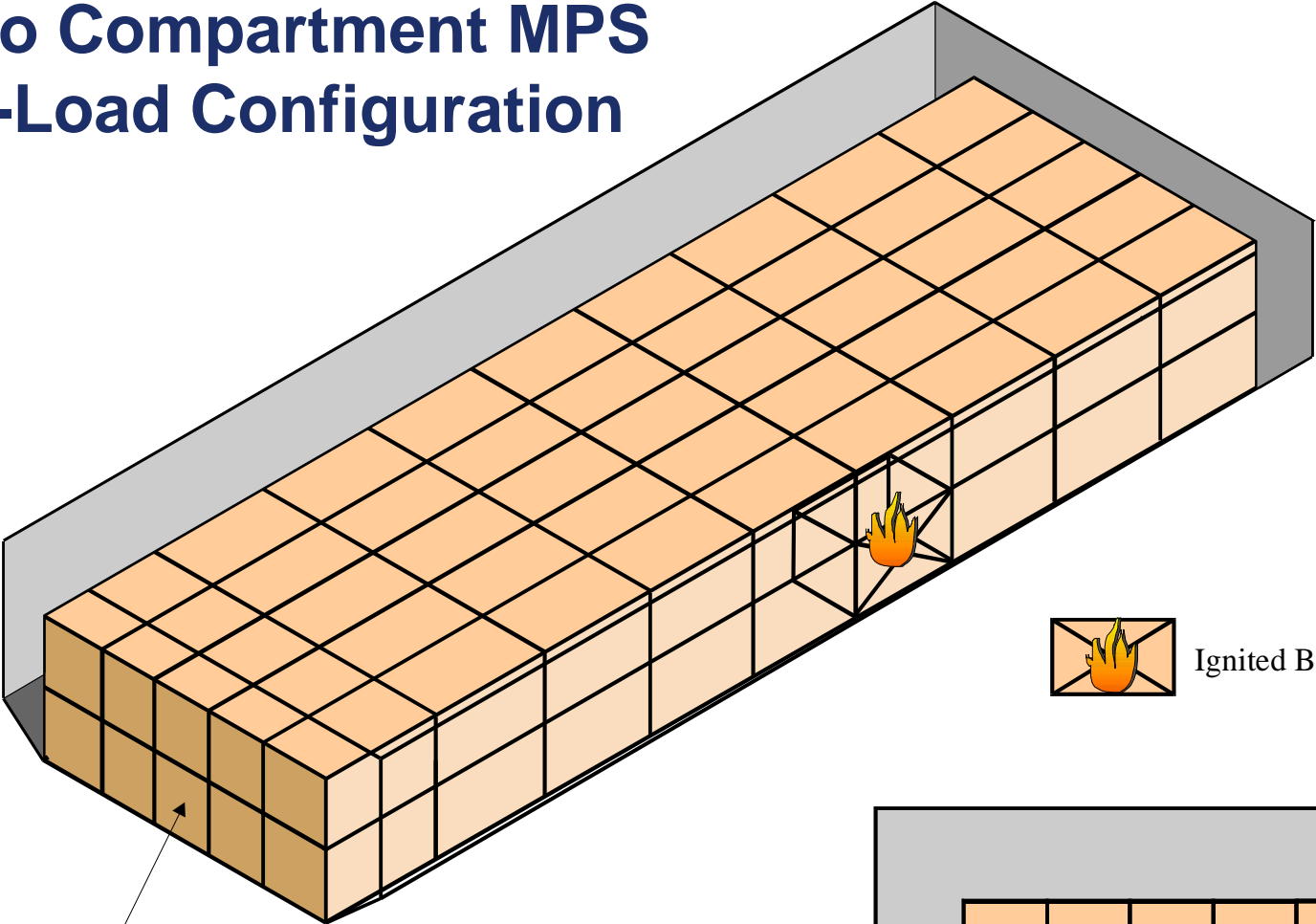
Cargo Compartment Summary

- **Cargo Compartment MPS Developed in 2005 (DOT/FAA/AR-TN05/20)**
 - **Full-Scale 2000 ft³ Test Article**
 - **Four Fire Scenarios**
 - Bulk-Loaded Cargo
 - Containerized Cargo
 - Surface Burning Fire
 - Exploding Aerosol Can
- **Replacement Agent Testing Each has Shortcomings**
 - HFC-125/FM-200: High Weight Penalty, High HF Concentrations, Ignition of Smoke Layer
 - CF₃I: Toxicity Concerns
 - 2-BTP/Novec 1230: Overpressures at Below Inerting Concentrations During Aerosol Can Scenario
- **Water Mist/Nitrogen System**
 - Promising Concept but Requires Significant Development and Acceptance

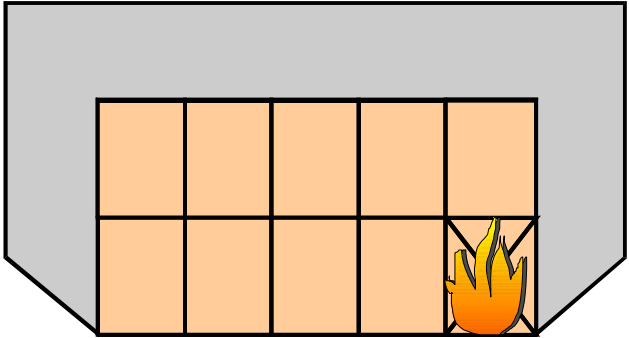
Cargo Compartment Summary

- **Integrated Fire Protection System (IFP)**
 - The use of the on-board inert gas generation system, installed on aircraft as part of a new fuel tank flammability reduction rule, to supply nitrogen for fire protection in other areas (such as cargo compartments) in aircraft.
 - IASFPWG Task Group studying the feasibility
 - Major impediment is MEL relief.

Cargo Compartment MPS Bulk-Load Configuration



178 Cardboard Boxes



Summary on Status Halon Replacements in Civil Aviation

- **Lavatory:**
 - Replacement Agents (2) Identified and are Being Installed in Newly Manufactured Aircraft
- **Hand-Held Extinguishers:**
 - Replacement Agents/Extinguishers (3) Identified But are not Being Installed Because of Increased Weight and Volume
 - New Agents are Being Evaluated
- **Engines:**
 - Significant and Promising Activity Last Several Years
 - Replacement Agent for New Aircraft Design and Possibly Current Manufactured Aircraft
 - New Agent Tests at FAATC for Another Manufacturer
 - New Version MPS for Non-Gaseous Agents Being Developed
- **Cargo Compartments:**
 - No Substantive Activity in Recent Years
 - Agents Tested Unsuitable or Require Significant Development
 - Most Challenging and Most Important (Largest Halon Usage) Application
 - FAATC will Conduct Tests in Cooperation with the Aircraft Manufacturers

Agents Tested

Agent	Chemical Formula	Name
Halon 1301	CBrF_3	
Halon 1211	CBrClF_2	
HFC-227ea	$\text{CF}_3\text{CHF}_2\text{CF}_3$	FM-200
HFC-125	CHF_2CF_3	FE-25
FIC-1311	CF_3I	Trodide
2-BTP	$\text{CH}_2\text{CBrCF}_3$	
HCFC Blend B	$\text{CF}_4/\text{CHCl}_2\text{CF}_3$	Halotron I
HFC-236fa	$\text{CF}_3\text{CH}_2\text{CF}_3$	FE-36
FK-5-1-12	$\text{CF}_3\text{CF}_3\text{COCF}(\text{CF}_3)_2$	Novec 1230
Water Mist	H_2O	
Water Mist/Nitrogen	$\text{H}_2\text{O}/\text{N}_2$	