



Halon Replacement for Airplane Portable Fire Extinguishers - Progress Report

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Objective

Provide a progress report on development of a new and environmentally acceptable Halon Replacement Portable Fire Extinguisher for use on large commercial passenger and freighter aircraft.

Agenda

- **Requirements**
- **Halon Replacement Background**
- **Agent Summary Chart**
- **Bromotriflouropene (BTP) Performance**
- **BTP Risks**
- **BTP Next Steps**
- **Summary**

Requirements

- **Zero or low ODP (not listed in Montreal Protocol)**
- **Low GWP**
- **Replacement fire extinguisher bottle fits in same envelope as Halon 1211 extinguisher.**
- **FAA Minimum Performance Standard for Hand-Held Fire Extinguishers as a Replacement for Halon 1211, MPS AR-01/37 (passenger cabin only)**
- **AC 20-42D – Draft (advisory material)**
- **14CFR25.851 plus installation regulations**
- **UL 711 5BC rated (passenger cabin)**
- **UL 2129, NFPA 10...**
- **Compatible with aircraft materials**
- **US EPA SNAP and EU REACH approvals**
- **Approximately 40 other requirements**

Halon Replacement Background

- Halotron 1, FE-36 , and FM200 are not drop-in replacements for halon 1211. They are all heavier and bigger.
- FAA approved halon 1211 replacements have known and unrealized environmental issues:
 - HFCs FE-36 and FM-200 have high GWPs, up to 5 times higher than Halon 1211 and 9800 times higher than BTP.
 - EU adopted regulation mandating requirements for HFCs, and two countries have use restrictions in place.
 - Kyoto Protocol requires reduction of greenhouse gases including HFCs.
 - Draft US House/Senate bills propose cap-and-trade requirements on HFCs.
 - EPA included HFCs under Section 202(a) of the Clean Air Act in the list of six greenhouse gases that "threaten the public health and welfare".
 - HCFC -123 (primary constituent of Halotron 1) is subject to US production phase-out in 2015. Supply will be limited to recycling after 2015, unless HCFC-123 is removed from Montreal Protocol.
 - HCFC Blend B (Halotron 1) is subject to EU use restrictions.
- Boeing has contracted with American Pacific Corporation on the initial development of BTP (2-bromo-3,3,3-trifluoropropene) as a halon alternative.
 - Low ODP, low GWP, cardiotox values same as Halon 1211, smaller extinguisher volume requirement

Boeing's goal is to replace portable fire extinguishers just one time, and with an environmentally acceptable agent.

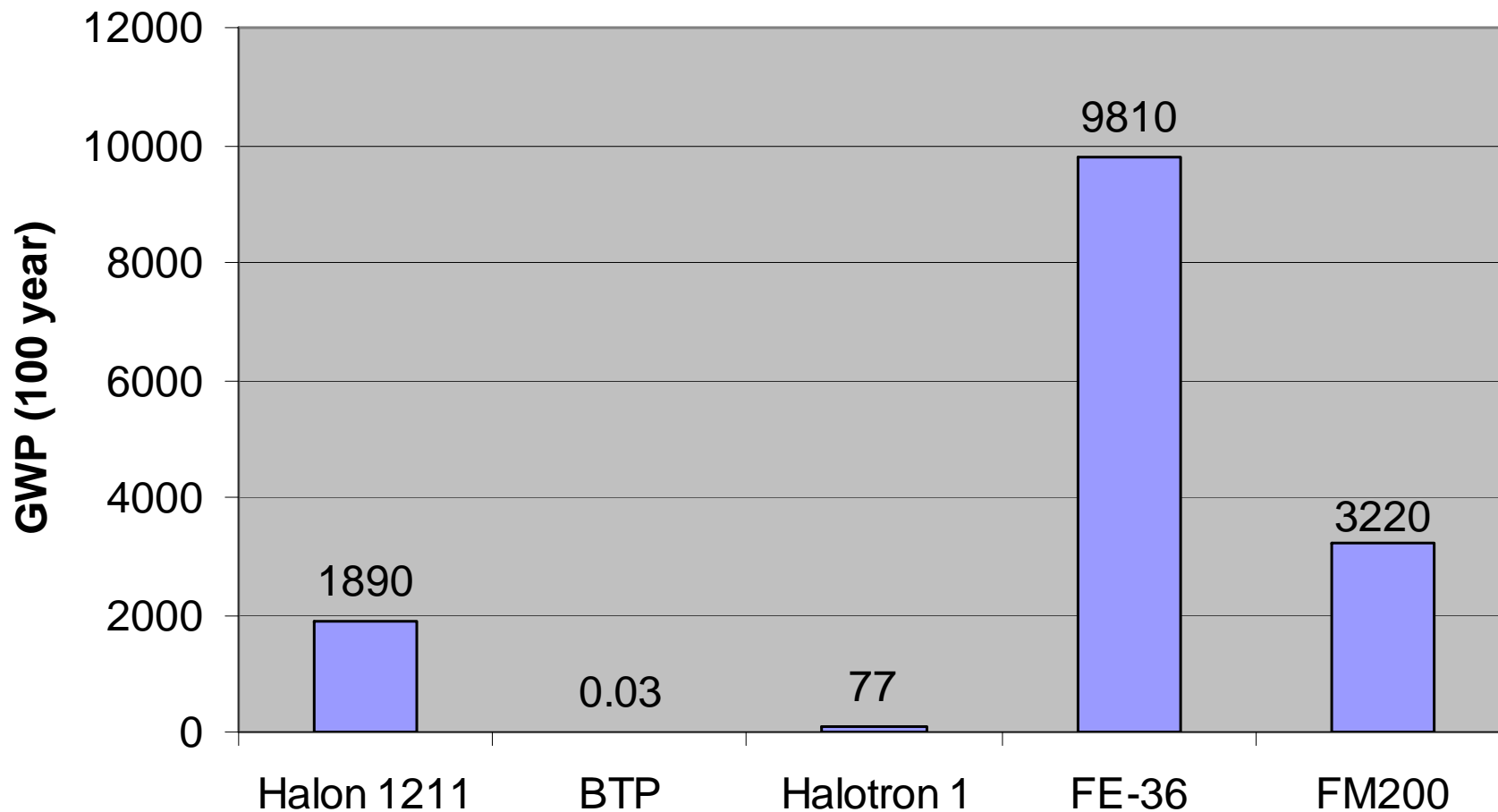
Agent Summary

| Agent | UL 711 Rating | Agent Weight (#) | Total Weight (#) | Dimensions (H x W x D) | ODP | GWP (100 year) |
|--------------------------------------|---------------|--------------------------------|--|-------------------------|---|---|
| Halon 1211 | 5 BC | 2.5 | 3.93 | 17 x 4.8 x 3.25 | 7.1¹ | 1890¹ |
| BTP | 5 BC | 3.75 | 5.6 | 15.75 x 5 x 3.5 | <0.0005² (2D -model) | 0.007-0.03² |
| Halotron 1 (HCFC Blend B) | 5 BC | 5.5 (tentative 5.0) | 9.3 (tentative UL listing for 7.3 Lb model) | 15 x 5 x 4.25 | .0098¹ | 77¹ (Based on HCFC-123) |
| FE-36 (HFC-236fa) | 5 BC | 4.75 | 9.5 | 15.9 x 8 x 4.5 | 0¹ | 9810¹ |
| FM-200 (HFC-227ea) | 5 BC | 5.75 | 9.8 | 18.5 x 6.5 x 5.5 | 0¹ | 3220¹ |

1. World Meteorological Organization Report No. 50 – “Scientific Assessment of Ozone Depletion: 2006.”
2. NIST Report “Photochemical Properties of 2-BROMO-3,3,3-TRIFLUOROPROPENE and Semi-Empirical Kinetic Estimations of its Global Impacts on the Atmosphere” dated July 20, 2004, Author Vadimir Orkin. (Note that ODP/GWP values vary by latitude, and values presented are valid for the latitudes encompassing the U.S. and EU).

Agent Summary

Global Warming Potential (GWP) of Agents



Agent Summary

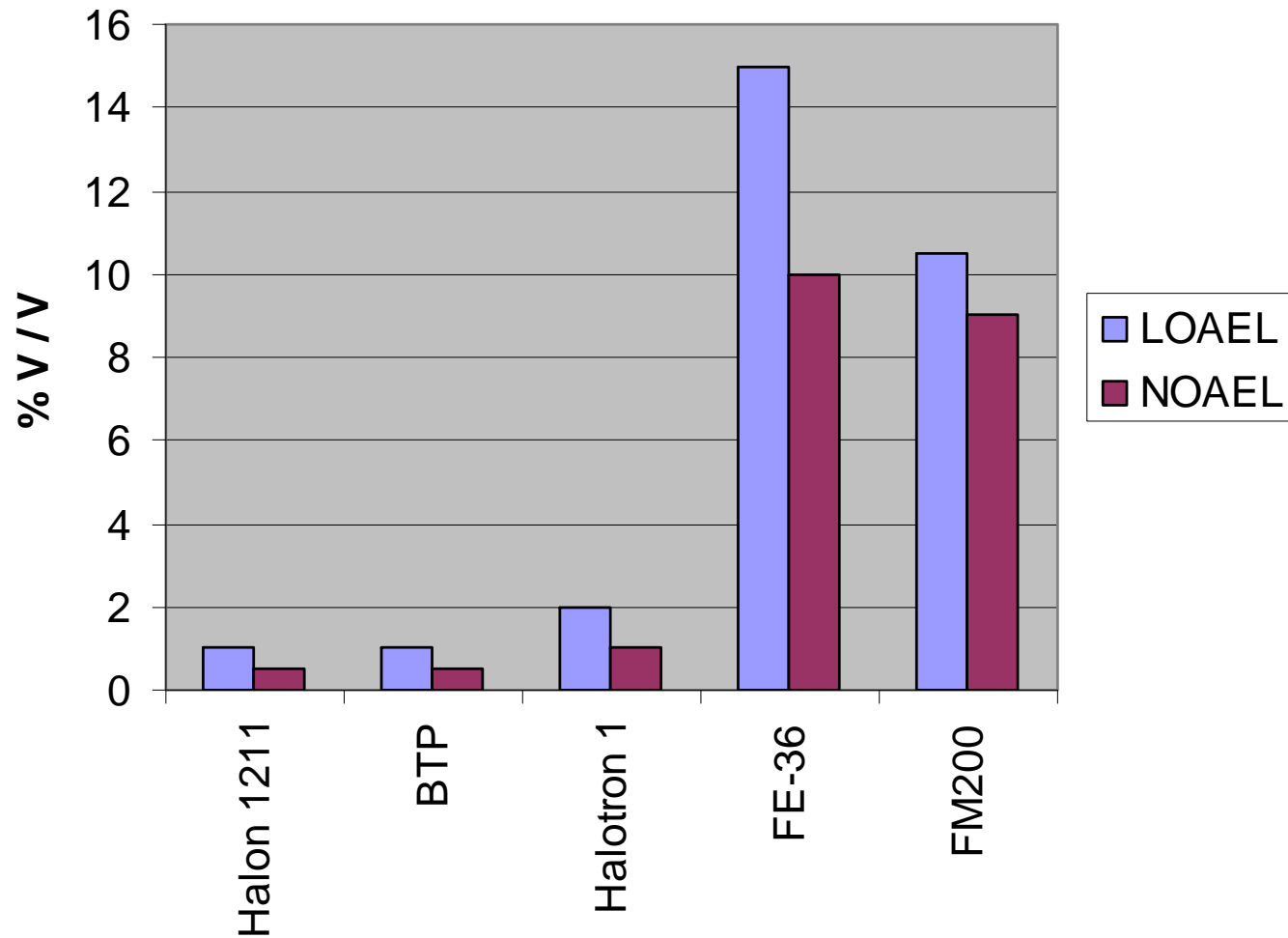
Previous BTP Toxicity Test Results

| Item | Comments |
|---|--|
| AMES (mutagenic test) | No effects noted |
| Human Lymphocyte (chromosomal aberration) | No effects noted |
| Cardiotoxic Dog Inhalation | NOAEL .5% LOAEL 1.0% |
| Preliminary Limit Test (5% for 30 minutes) | Some potential anesthetic effects noted |

Data from J Grigg & A Chattaway, "The Evaluation of Bromotrifluoropropene as a Halon 1211 Replacement", NIST SP 984, June 2002
<http://www.fire.nist.gov/bfrlpubs/fire02/PDF/f02114.pdf>

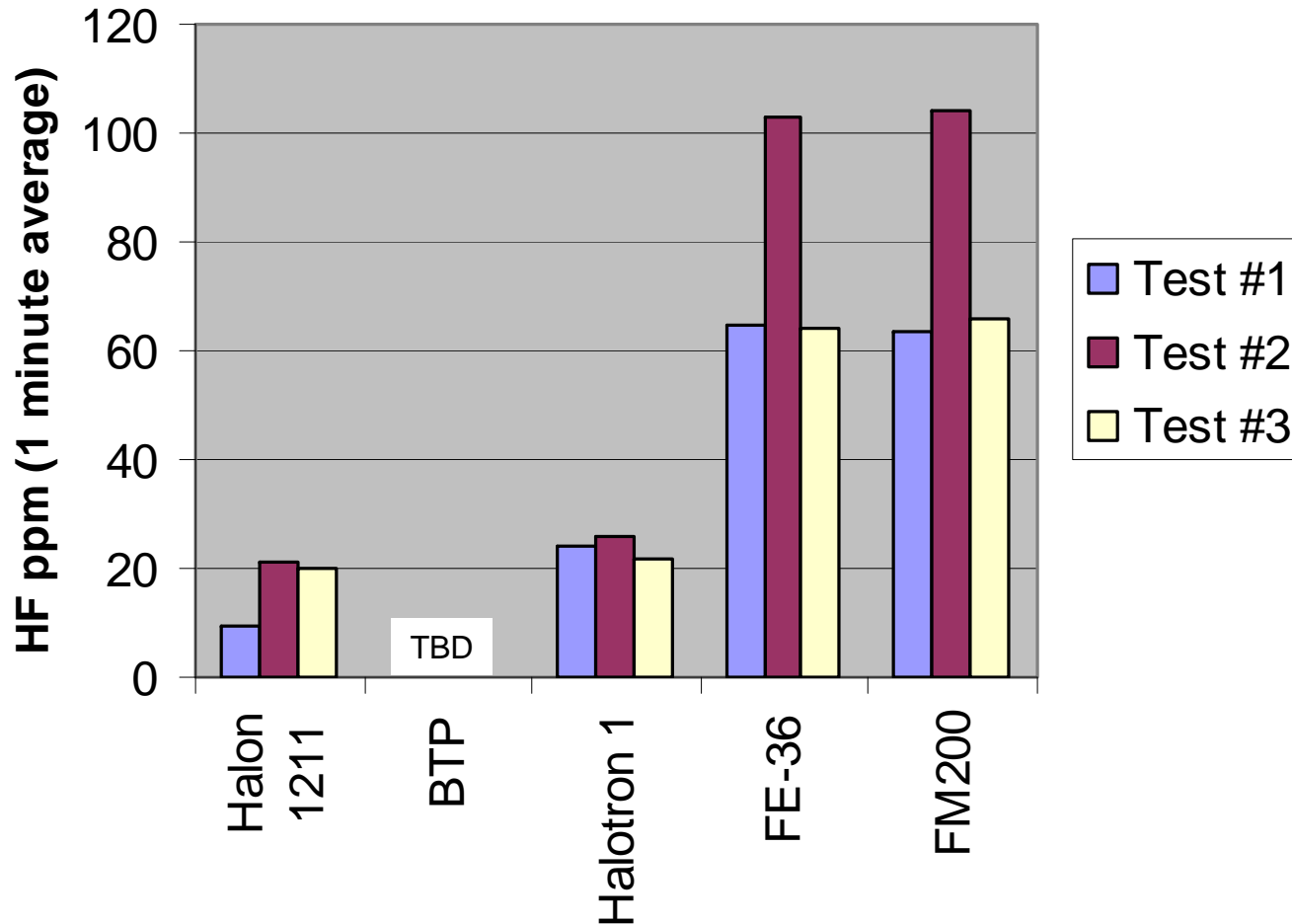
Agent Summary

LOAEL & NOAEL of Agents



Agent Summary

Seat Fire Toxicology Test Results



BTP Performance

- Passed UL 711 5B and UL 5B cold temperature fire tests, December 2009



MaddenBTP5B Wide(2).mmv

BTP Performance

- Passed FAA MPS AR-01/37 hidden fire tests at UL, December 2009



BTP Performance

- **Phase 1 Aircraft materials compatibility testing was successfully completed at Boeing Laboratories.**
 - **Non-corrosive to standard aircraft metals**
 - **No effect on standard aircraft plastics**
 - **No effect on standard seals or sealants**

BTP Next Steps

- **Phase 2 Aircraft materials compatibility testing at Boeing Laboratory (ECD 4Q10)**
- **FAA MPS seat fire toxicity test at the FAA Technical Center (ECD ~~2Q10~~ 4Q10?)**
- **3D atmospheric modeling - ODP (ECD 4Q10)**
- **Toxicology testing – approximately a two year program (ECD 4Q13)**
 - Primarily subchronic and chronic exposures
- **US EPA SNAP and EU REACH Approvals (ECD 1Q14)**
- **BTP market analysis/development (ongoing)**

BTP Risks

- **ODP is not zero.**
- **Must pass all toxicity tests prior to SNAP approval.**
- **AC 20-42D “Safe-Use Guidelines” currently show Halon 1211, Halotron 1, and BTP as unsafe for all Boeing airplane flight decks and other small volume spaces.**
 - Minimum volume requirements for BTP will be higher than Halon 1211 or Halotron I
- **Low volume production cost of BTP is high compared to Halon and alternatives. Need to expand market beyond airplane use.**
 - European market
 - Military
 - Airports
 - Other transportation (trains, buses, ships)
 - Other vehicles (racing, recreational, automotive)

Summary

- Existing FAA approved halon replacement fire extinguishers/agents have performance and environmental impacts which make them less than ideal.
- BTP is a promising drop-in replacement.
 - Passed official UL 711 5B, 2B cold temperature and FAA MPS hidden fire tests
 - Validated as a potential drop-in replacement for halon 1211 on Boeing airplanes
 - Near zero GWP and ODP (3D modeling forthcoming)
 - Proceeding with development as a halon replacement
- Boeing is continuing with development of BTP.
- Need FAA to reconsider AC 20-42D “Safe-Use Guidelines” as requested in NPRM comments.
- Would Companies in the room consider using BTP if commercialized?
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