

Halon Replacement for Aircraft Portable Fire Extinguishers – Progress Report

PRESENTATION TO:

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Safety Research Conference

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Overview

- **Three halon 1211 alternatives are currently FAA and UL approved**
 - HCFC Blend B
 - HFC-236fa
 - HFC-227ea
- **2-Bromo-3,3,3-trifluoropropene (2-BTP or BTP) in development**
 - Boeing supporting research
 - SNAP application was expected earlier in the year
 - Just recently filed
 - Additional testing ongoing

Property Comparison

	HALON 1211	HCFC Blend B	HFC-236fa	HFC-227ea	BTP
Chemical Formula	CF ₂ ClBr	CF ₃ CHCl ₂ + gases (Ar, CF ₄)	CF ₃ CH ₂ CF ₃	CF ₃ CHF ₂ CF ₃	CF ₃ CBr=CH ₂
Molecular Weight	165.4	150.7	152.0	170.0	174.9
Boiling Point @ 1 Atm.	26 °F (-3 °C)	81 °F (27 °C)	30 °F (-1 °C)	2 °F (-16 °C)	93 °F (34 °C)
Specific Gravity, Liquid	1.83	1.48	1.36	1.40	1.65
Atmospheric Lifetime	16 years	1.3 years ⁽¹⁾	242 years	39 years	7 days
LC 50 (4 hr rat), ppm	31,000 – 100,000	30,000 – 35,000	>189,000	>800,000	> 20,000
Cardio-Tox LOAEL, %vol.	1%	2%	15.0%	10.5%	1%
Cardio-Tox NOAEL, %vol.	0.5%.	1%	10%	9%	0.5%
Cup Burner, heptane, %vol.	3.2%	6.5%	6.3%	6.5%	4.7%

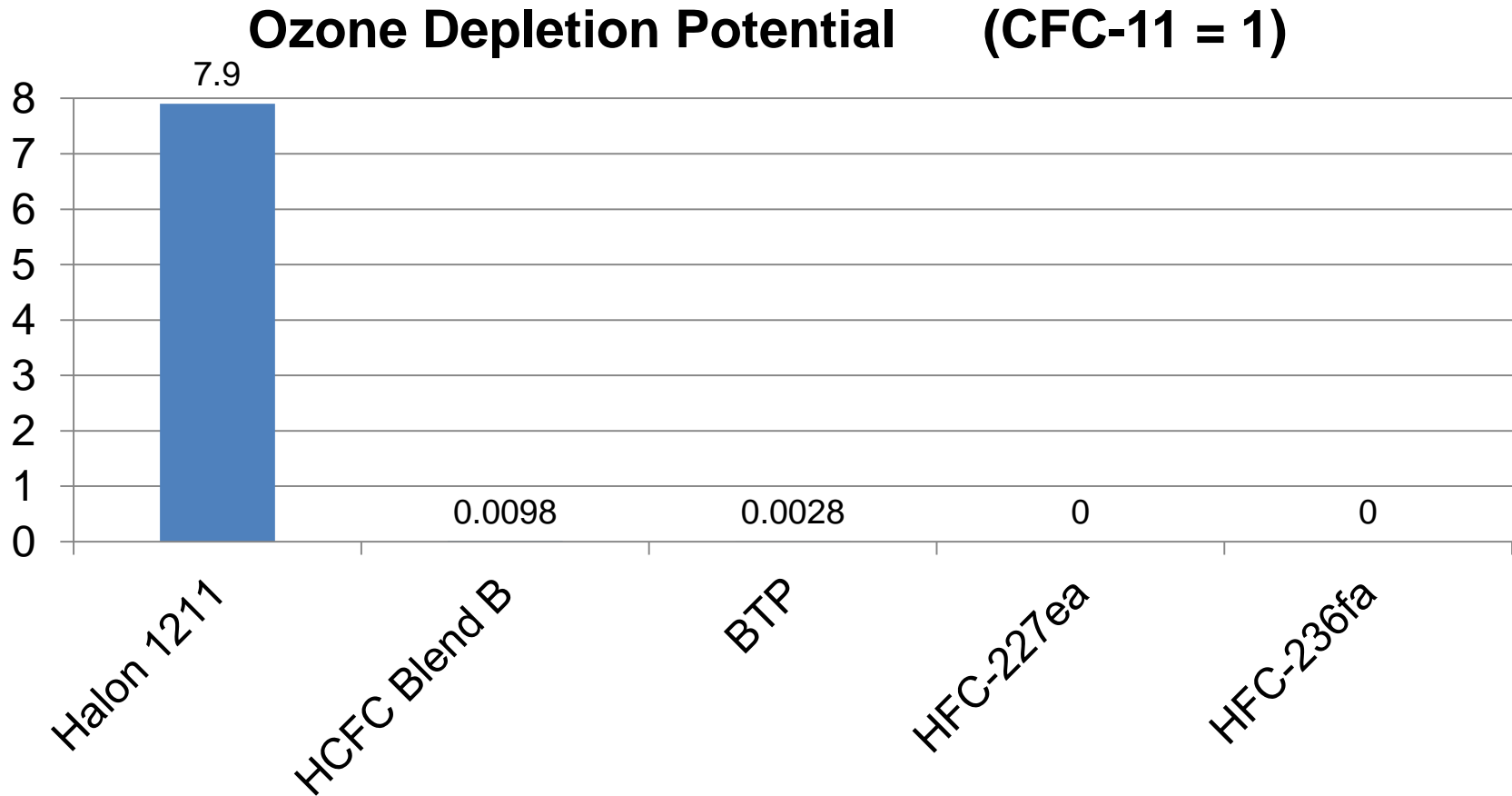
1. Value based on HCFC-123. Also contains one PFC in small proportion

Bottle Details – UL/FAA Approved 5B:C

	HALON 1211	HCFC Blend B	HFC-236fa	HFC-227ea	BTP
Bottle Dimensions, in.	17 x 4.8 x 3.25	15 x 5 x 4.25	15.9 x 8 x 4.5	16.6 x 6.5 x 4.4	~17 x 5 x 3.25
Agent Weight, Lb.	2.5	5.5	4.75	5.75	3.75
Gross Weight, Lb.	3.93	9.3	9.5	9.8	5.6
Bottle Construction	Aluminum	Carbon Steel	Carbon Steel	Carbon Steel	Aluminum

- **Current approved alternatives gross weight based on carbon steel bottles**
 - Reductions possible
- **BTP bottle is a drop-in for current Boeing Halon 1211 unit**
 - May be different in size than other airframe manufacturers

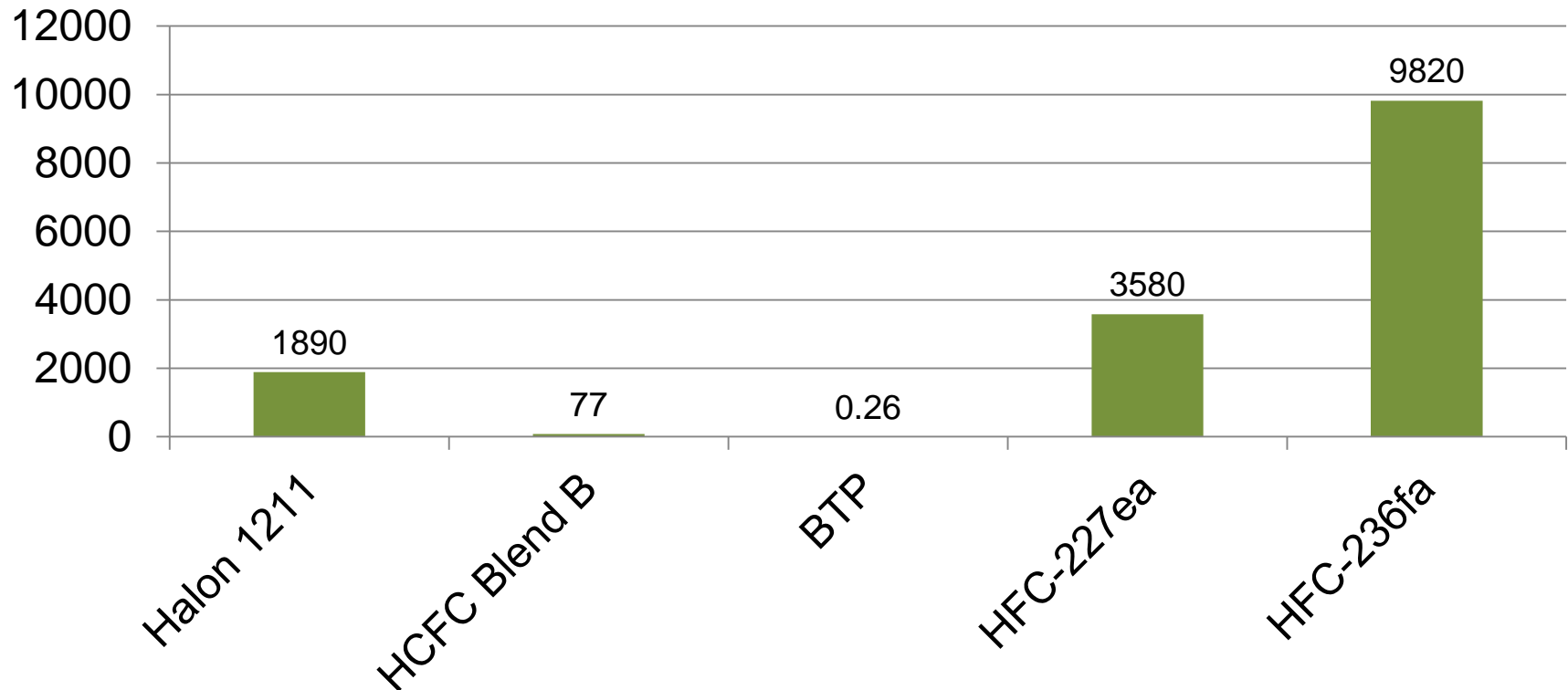
Environmental Profile - ODP



Source: Scientific Assessment of Ozone Depletion, 2010
For BTP: Journal of Geophysical Research, Vol. 117, 2012

Environmental Profile - GWP

Global Warming Potential (100yr CO₂ = 1)

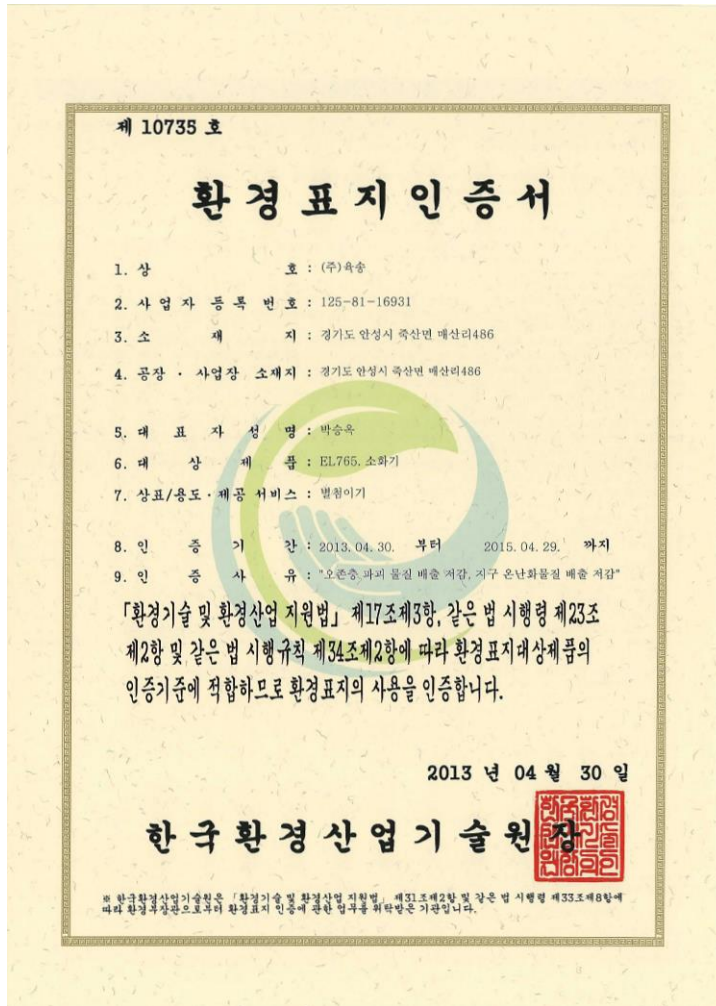


Source: Scientific Assessment of Ozone Depletion, 2010

For BTP: Journal of Geophysical Research, Vol. 117, 2012

HCFC Blend B value based on HCFC-123, also contains small proportion PFC

Balancing ODP and GWP

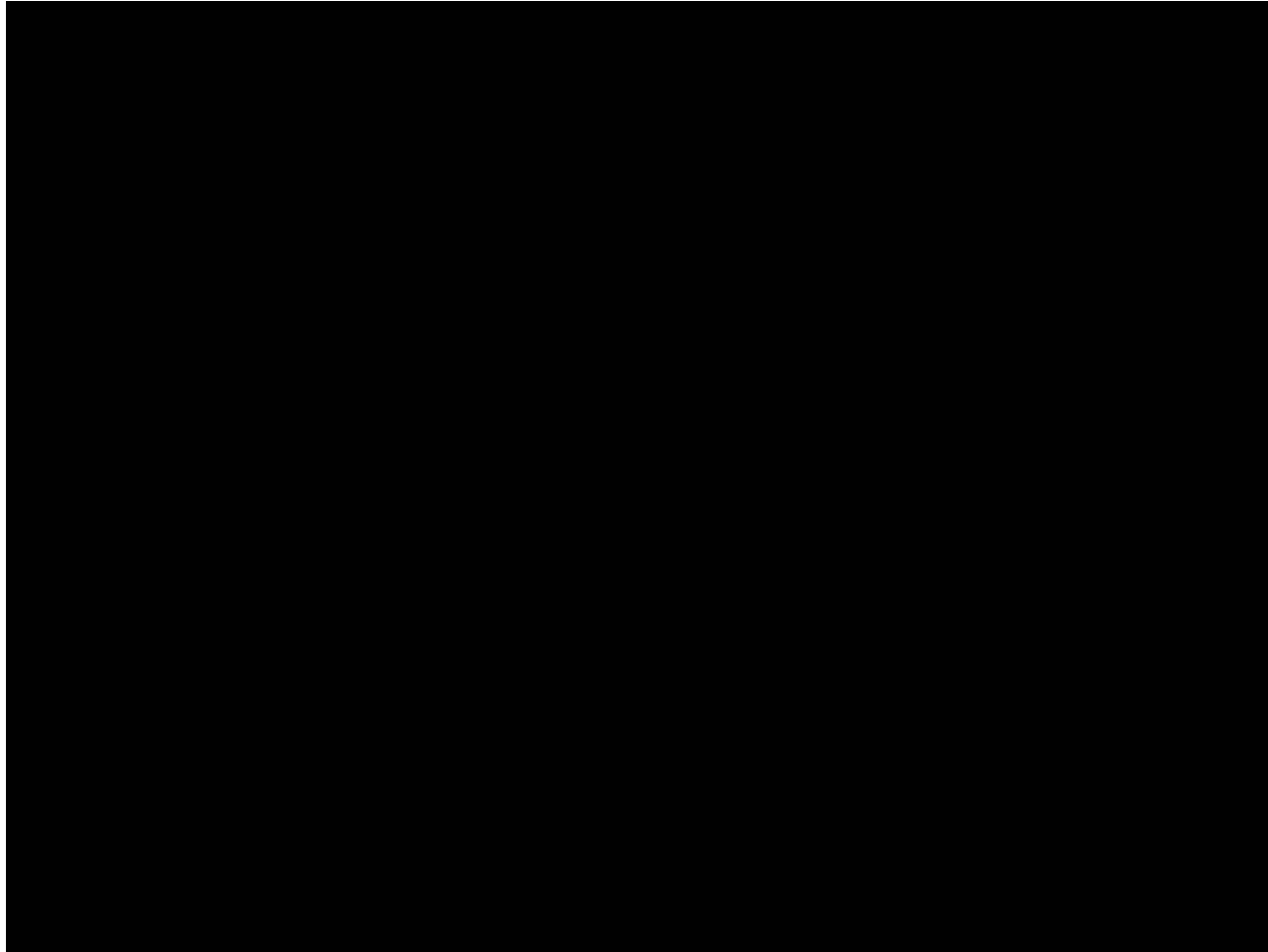


- **Korean Green Mark**
 - Criteria
 - ODP less than 0.055
 - GWP less than 3000
- BTP meets criteria
- Mark has been issued for HCFC Blend B
- HFCs do not meet criteria

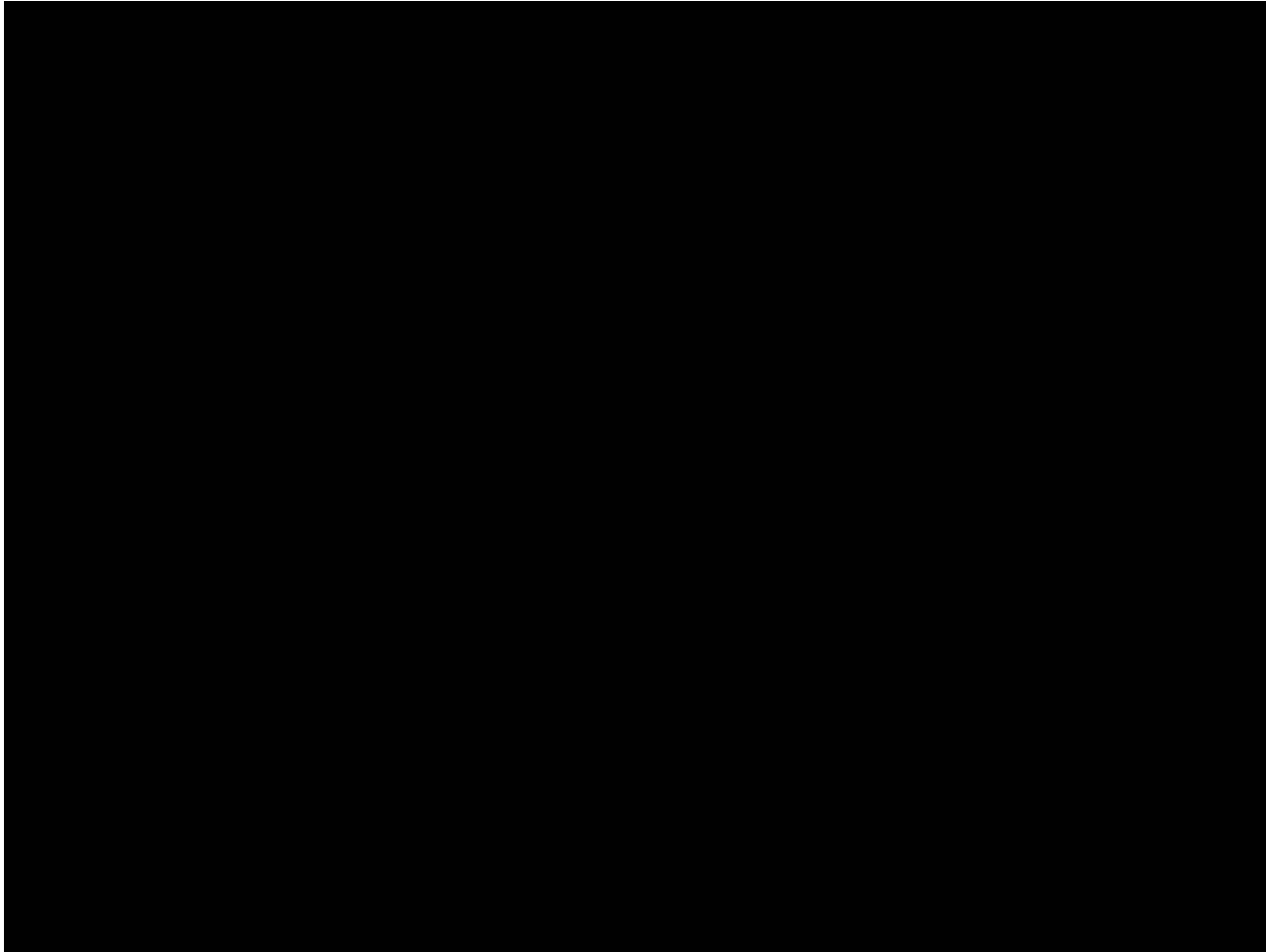
BTP Development – FAA/UL

- **AC20-42D, Hand Fire Extinguishers for Use In Aircraft**
 - Requires
 - UL listing for 5B:C
 - FAA Hidden Fire Test
 - Conducted at UL
 - FAA Seat Fire / Toxicity Test

BTP – 5B Fire Video



BTP – Hidden Fire Test Video



BTP – Seat Fire Test



BTP Development

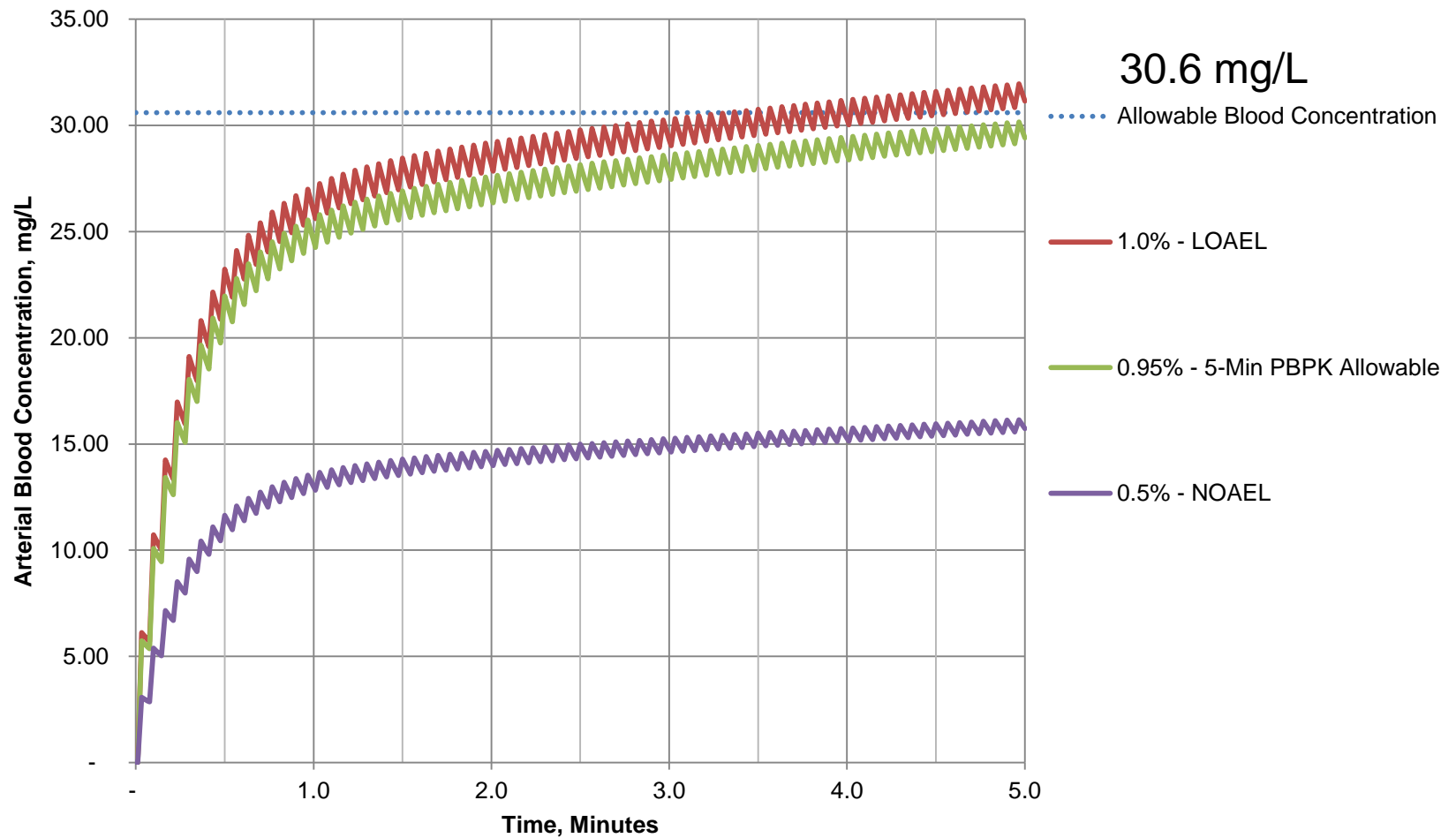
- **Extensive Toxicity Test Program Required for SNAP/TSCA, REACH, and FAA**
 - Rat Micronucleus
 - Eye Irritation
 - Skin irritation
 - Acute Dermal
 - 90-day Sub-Chronic Inhalation
 - Reproductive and Development Screen
 - Acute Fish Toxicity
 - Activated Sludge Respiration Inhibition
 - Biodegradation
 - Partition Coefficients
 - Physiologically Based Pharmacokinetic (PBPK) Modeling
- **All testing in this series complete**

BTP REPRODUCTIVE AND DEVELOPMENTAL

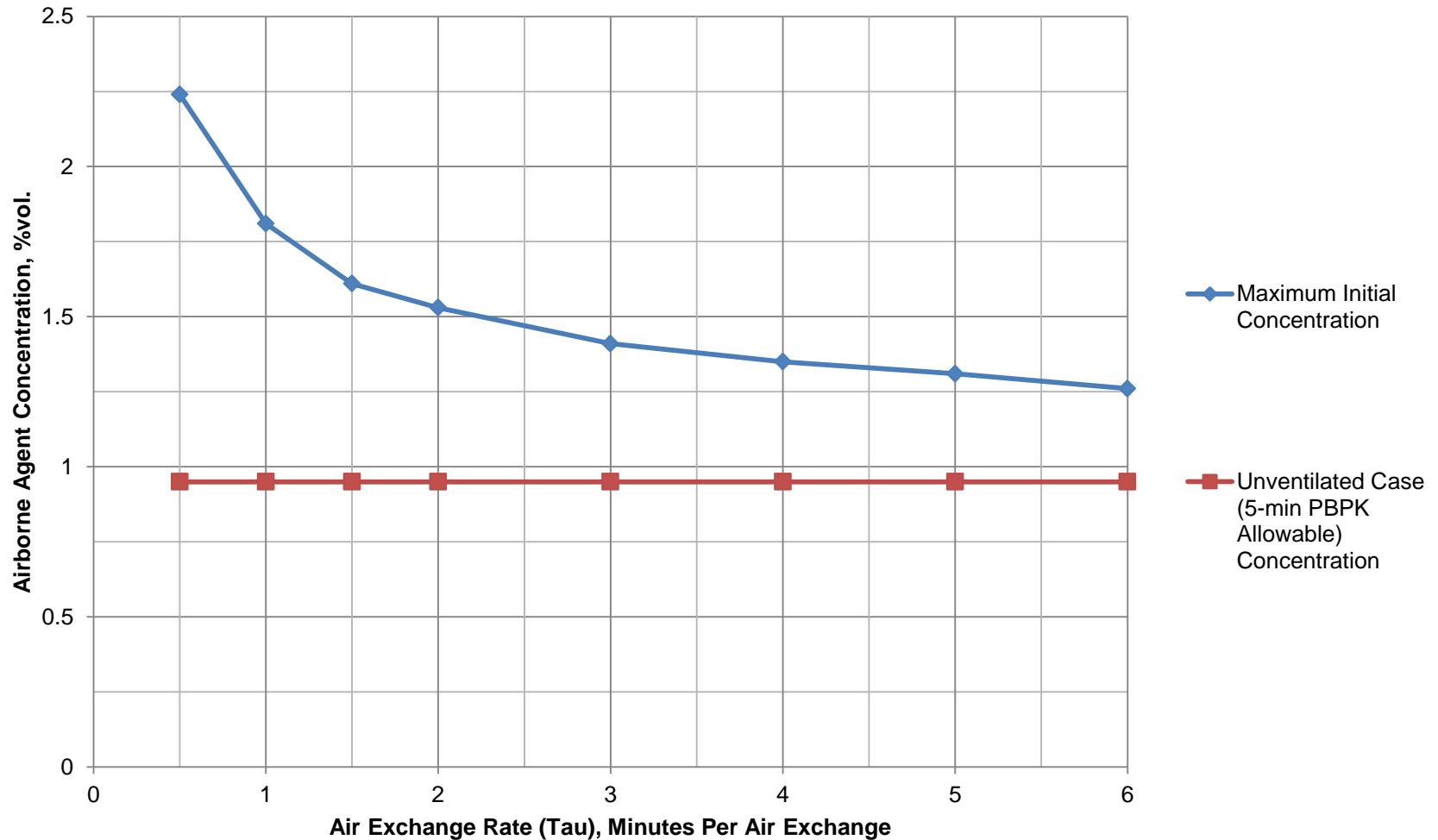
- **Initial Reproductive and Developmental Screen (COMPLETE)**
 - 6 hours/day, 7 days/week exposure
 - Not mutagenic and no birth defects noted
 - Effects to reproductive cycle observed
 - NOAEL not determined

- **Second Reproductive and Developmental Screen (ONGOING)**
 - Testing underway
 - Desire to find NOAEL and evaluate short term effects, if any, from exposure to discharge
 - 6 hours/day, 7 days/week exposure
 - Lower exposure levels than initial test
 - 5 minutes/day, 7 days/week exposure
 - Discharge exposure (1% for 5-minutes)
 - Report Tentative Completion - 1Q2014

BTP PBPK Model Results



BTP - PBPK - Concentration Vs Air Exchange



BTP Schedule

- **US EPA SNAP and EU ECHA REACH submittals should have been made**
 - Additional reproductive test report will be filed toward end of 1Q2014
- **UL fire performance complete**
- **UL hardware tests ongoing**
 - 1 year leak
 - Misc. hardware tests
- **Regulatory review anticipated to be complete by end of 2014**
 - US Federal Register notice may take longer
- **Commercialization to support airplane manufacture's implementation dates to meet ICAO's December 31, 2016 date**