

# Handheld Extinguisher Draft Advisory Circular Update



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Aircraft Systems Fire Protection Working Group Meeting  
London, UK  
April 16-17, 2007



# OUTLINE OF TALK

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- Background
- Purpose of the handheld advisory circular (AC)
- FAR requirements for hand-held extinguishers
- Minimum performance standard (MPS) for transport category aircraft
- Fire fighting guidance
- Toxicity: decomposition products, agent, low oxygen hypoxia
- Safe use of hand extinguishers
  - Ventilated and unventilated compartments
  - Accessible Cargo Compartments in Passenger/Cargo & Cargo Aircraft
- AC language for halocarbon fire extinguishers
- Task group comments on March 2007 AC Draft



# BACKGROUND

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- Since **1994**, halon 1211 has no longer been produced in the US.
- By **2010**, Halon 1211 will no longer be produced anywhere in the world . Remaining users of halons are dependent on existing, potentially uncertain, supplies and their ability to gain access to these remaining stockpiles
- Based on evaluations of human health and environmental effects, safe, effective alternatives are commercially available to replace halon 1211 in handheld fire extinguishers on aircraft.
- For all new installations, FAA recommends users to transition to the alternatives which do not deplete the ozone layer and still provide safe, effective fire protection in handheld extinguishers on aircraft.
- For all existing installations, FAA is allowing continued use of halon extinguishers to be replaced with required halon equivalent extinguishers by attrition (Extinguishers already installed remain safe to use based on history of safe use of halon extinguishers on aircraft)



# BACKGROUND

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- Halon replacement hand extinguishers are available meeting UL, and MPS requirements and FAA safe-use guidelines: HCFC Blend B, HFC-236fa and HFC-227ea.
- Current A/C 20-42C for halons will be cancelled.
- A draft hand extinguisher advisory circular has been reviewed by The FAA Aircraft Certification Office, and then by the hand extinguisher task group. Discussion at Systems Meeting.
- A FAA Technical Report “Halocarbon Handheld Extinguisher Handbook” will include safe use guidance for agents introduced after the publication of this Advisory Circular.



# PURPOSE OF ADVISORY CIRCULAR

- Provides guidance for new installations of required hand extinguishers
- Provides a method of showing compliance with the applicable airworthiness requirements for new installations of hand extinguishers. *This AC is not mandatory.*
  - Provide safety guidance for hand extinguishers.
    - ❖ Effectiveness in fighting onboard fires.
    - ❖ Toxicity
    - ❖ Provides updated general information.
- Applies to aircraft and rotorcraft.
- Refers to outside documents:
  - ASTM specifications
  - UL Standards
  - MPS for hand fire extinguisher for transport category aircraft
  - Federal Aviation Regulations (FARS)
  - CFR Title 40: Protection of the Environment

# FEDERAL AVIATION REGULATION (FAR) REQUIREMENTS FOR HAND FIRE EXTINGUISHERS

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- Specifies the minimum number of Halon 1211 or equivalent extinguishers for various size aircraft.
- Specifies the location and distribution of extinguishers on an aircraft.
- Each extinguisher must be approved.
- Each extinguisher intended for use in a personnel compartment must be designed to minimize the hazard of toxic gas concentration.
- The type and quantity of extinguishing agent, if other than Halon 1211, must be appropriate for the kinds of fires likely to occur.
- The FAR does not give extinguisher ratings. This is done in the AC.

# THE MINIMUM PERFORMANCE STANDARD (MPS) FOR HAND-HELD EXTINGUISHERS

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- Provides specifications for equivalency to required Halon 1211 5 B:C extinguishers to satisfy FARS citing “Halon 1211 or equivalent”:
- UL rated 5 B:C Halocarbon extinguishers that will replace the required 2½ lb. Halon 1211 extinguishers in transport category aircraft **must pass 2** tests identified in DOT/FAA/AR-01/37 Development of a Minimum Performance Standard (MPS) for Hand-Held Fire Extinguishers as a Replacement for Halon 1211 on Civilian Transport Category Aircraft.
  - **Hidden Fire Test**
  - **Seat Fire/Toxicity Test** (The toxicity test is for decomposition products of the agent). Guidance for **agent** toxicity can be found in the advisory circular.



# FAA POLICY LETTER

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- UL listed 5B:C **and equivalent EN3 listed hand extinguishers** replacing required 2½ lb 5B:C halon 1211 extinguishers must meet the MPS for hand extinguishers.
  - Hidden Fire Test
  - Seat Fire/Toxicity Test
- A permanent label must be affixed to the extinguisher:
  - Label identifies FAA approval for UL listed 5B:C extinguishers for use onboard transport category aircraft based on meeting the MPS test requirements.
  - **Label also should also indicate: “For aircraft use: Refer to FAA Advisory Circular AC20-42D”.**



# EXTINGUISHER LISTINGS FOR HALON REPLACEMENT AGENTS

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## Aircraft Cabin:

- Recommends a minimum 5B:C UL or equivalent listing.
- Always provide the recommended number of hand held extinguishers with the proper UL listing, even in spaces where the toxicity guidelines are exceeded.
- If the safe-use guidelines are exceeded, select the safest extinguisher of the required UL listing and **use only the amount necessary to extinguish the fire.**
- Halon replacement extinguishers with a minimum listing of 5B:C can be used in place of required TSO'd water extinguishers if it can be shown that the replacement extinguisher has comparable or better class A extinguishing performance than the TSO'd water extinguisher **and an acceptable throw range for that installation.**
- Two required TSO'd water extinguishers in close proximity may be replaced by one halon replacement extinguisher if the extinguisher has been shown to have comparable or better class A fire extinguishing capability as both water extinguishers **and an acceptable throw range for that installation.**

# DRAFT ADVISORY CIRCULAR

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## Accessible Cargo Compartments: Passenger/Cargo & Cargo Aircraft:

- Recommends a minimum extinguisher listing of 2A:10B:C for compartments less than 200 ft<sup>3</sup>
- Compartments 200 ft<sup>3</sup> and larger should meet the requirements of the FAA Airworthiness Directive AD 93-07-15. This AD provides options to the use of hand extinguishers:
  - Conversion to meet Class C cargo compartment requirements
  - Use fire containment containers or covers.



# ACCESSIBLE CARGO COMPARTMENTS

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## Cabin Safety Guidance:

- Cargo extinguishers should be available to fight cabin fires
- Select a cargo extinguisher that meets the safe use guidance for the aircraft cabin.
- If no cargo extinguisher meets the safe use guidance for the aircraft cabin:
  - Consider installing a class C fire flooding suppression system in the cargo compartment or alternatives to handheld extinguishers that would provide effective fire protection.
  - Use the required UL listed extinguisher.
    - ❖ Select the least toxic agent of the required UL listing. Place a placard alongside the bottle stating: “Discharge of the entire contents of this size bottle into the occupied cabin area exceeds safe exposure limits. Use only the amount necessary to extinguish a fire”



## THROW RANGE

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- The MPS requires a minimum throw range of 6-8 feet
- A longer throw range of 10 feet or greater provides significant advantages in fighting fires in large aircraft cabins
- A shorter throw range with a lower velocity discharge is less likely to cause splashing &/ or splattering of the burning material. Consider a shorter throw range for very small aircraft
- Select a range that would allow the firefighter to effectively fight fires likely to occur.



## **FIXED NOZZLE/HOSE/ ADJUSTABLE WAND**

- For access to underseat, overhead and difficult to reach locations, it is recommended that extinguishers be equipped with a discharge hose or adjustable wand.
- An extinguisher with a discharge hose or adjustable wand is more likely to result in the extinguisher being properly held during use.
- Provides a means of directing a stream of agent to more inaccessible areas.
- Fixed nozzle and adjustable wand allows one-handed use.



# TOXICITY CONSIDERATIONS

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- **Toxicity of the halocarbon itself**
  - Cardiotoxicity
  - Anesthetic Effects
  - Guidelines in the proposed circular are stricter than UL 2129 “Halocarbon Clean Agent Fire Extinguishers”. Immediate egress is assumed in the UL 2129 standard.
- **Low oxygen hypoxia: Very small aircraft**
- **Toxicity of halocarbon decomposition products**
  - Guidelines set in the Minimum Performance Standard for Handheld Extinguishers



## **SAFE-USE GUIDANCE**

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- Use science-based safe-use approach published in peer-reviewed literature.
  - Conservative
  - More accurate than approach used for halons
- The safe-use guidance is based on an assessment of the relationship between halocarbons in the blood and any adverse toxicological or physiological effect.
- Separate guidance provided to avoid low oxygen hypoxia.
- Includes guidance for general aviation as well as transport category aircraft.
- Operators of non-transport category aircraft should become familiar with the information in this AC



# SAFE-USE GUIDANCE

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- **Safe human exposure limits**, up to 5 minutes are derived using a Physiologically-based Pharmacokinetic (PBPK) modeling of measured agent levels in blood .
- Assume 70F (21.1C) cabin temperature, perfect mixing, and the maximum certified cabin P altitudes:
  - 8,000 ft- Pressurized Aircraft .
  - 12,500 ft- Nonpressurized aircraft with no supplemental oxygen.
  - 14,000 ft- Nonpressurized aircraft with no supplemental oxygen.
  - 18,000 ft- Nonpressurized aircraft with nasal cannula oxygen supply.
  - 25,000 ft- Nonpressurized aircraft with oxygen masks (diluter demand).
- **Non-ventilated aircraft:**
  - The allowed concentration would be based on the 5-minute PBPK safe human concentration if available. Otherwise, the “No Observable Adverse Effect Level” (NOAEL) may be used.
  - Table provides maximum safe weight/volume ratios for the aircraft cabin.
- **Ventilated aircraft:** Selector graphs will be included if PBPK data is available for that agent.



# AGENT TOXICITY : MAXIMUM SAFE CONCENTRATIONS

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Total agent available from all extinguishers should not be capable (assuming perfect mixing) of producing concentrations in the compartment by volume, at **70°F (21.1°C)** **when discharged at the maximum certificated altitude** that exceeds the agent's safe exposure guidelines.

*(Note: Designing for altitude provides a large safety factor for ground use. No need for 120°F correction)*

- **Nonventilated passenger or crew compartments:**

- PBPK derived 5 minute safe human exposure concentration, if known.
- If PBPK data is not available, the agent No Observable Adverse Effect Level (**NOAEL**) is to be used. *(Note: UL 2129 allows use of a (sometimes higher) LOAEL Concentration)*

- **Ventilated Compartments:**

- Use ventilation selector graphs to obtain the maximum agent weight per unit volume allowed in the cabin. Graphs are based on PBPK modeling of theoretical concentration decay curves & perfect mixing. If graphs are not available, follow concentration guidelines for nonventilated compartments.

# MAXIMUM SAFE WEIGHT OF AGENT WITH NO VENTILATION



*Perfect mixing assumed*

*Solve equation or use table:*

$$\left(\frac{W}{V}\right)_{Safe} = \frac{1}{(S \times A)} \times \frac{C_{Altitude}}{(100 - C_{Altitude})}$$

$(W/V)_{Safe}$  is based on **all** hand extinguishers in the compartment

(The cabin is a compartment)

S = Specific volume of the agent at sea level:  
At 70°F (21.1°C): S= \_\_\_\_\_ ft<sup>3</sup>/lb

A = Altitude correction factor for S:

8000 ft:	A= 760/ 564.59 = 1.346
12,500 ft:	A= 760/ 474.09 = 1.604
14,000 ft:	A= 760/ 446.63 = 1.702
18,000 ft:	A= 760/ 397.77 = 2.003
25,000 ft:	A= 760/ 282.40 = 2.695

*Air is half as dense at 18,000 ft. than at sea level*

$C_{Altitude}$  is the maximum safe clean agent concentration (%)

$C_{Altitude}$  *is not altitude dependent.*

# AGENT TOXICITY: MINIMUM SAFE COMPARTMENT WEIGHT/VOLUME (NO VENTILATION, 70°F, 21.1°C)



Total agent weight from all extinguishers in compartment, released at 70°F: (21.1°C)

Agent	Minimum Safe W/V (pounds/ft <sup>3</sup> ) <i>a,b,c</i>					
	Sea Level (For info only)	8,000 ft P Altitude (Pressurized Cabin) <sup>d</sup>	12,500 ft P Altitude <sup>d,e</sup>	14,000 ft P Altitude <sup>d,e,f</sup>	18,000 ft P Altitude <sup>d,e,f</sup> Nasal Cannula Oxygen Supply	25,000 ft P Altitude <sup>d,e,f</sup> Diluter-Demand Oxygen Mask
HCFC Blend B <sup>g</sup>	0.00389	0.00289	0.00245	0.00229	0.00194	0.00145
HFC-227ea	0.0551	0.0409	0.0344	0.0324	0.0275	0.0205
HFC-236fa	0.0595	0.0442	0.0371	0.0349	0.0297	0.0221
Halon 1211 <sup>h</sup>	0.00449	0.00334	0.00281	0.00264	0.00225	0.00167
Halon 1301 <sup>h</sup>	0.0260	0.0193	0.0162	0.0153	0.0130	0.00968

See footnotes on next slide

# AGENT TOXICITY: MINIMUM SAFE COMPARTMENT WEIGHT/VOLUME (NO VENTILATION, FOOTNOTES)



- a. **Use this table if air change time is unknown or exceeds 6 minutes.**
- b. **Maximum safe W/V ratios represent total weight of agent from all extinguishers in the aircraft compartment.**
- c. **W/V multiplication factors can be applied to the data in this table for unventilated compartments if an egress analysis is performed and approved and escape time < 30 seconds:**
  - $MF_{HFC-227ea, 30sec} = 11.6/10.84 = 1.07$
  - $MF_{HFC-236fa, 30sec} = 14.84/12.75 = 1.16$
  - $MF_{Halon\ 1211, 30sec} = 1.73/1.0 = 1.73,$
  - $MF_{Halon\ 1301, 30sec} = 7.13/6.25 = 1.14$
- d. **If the maximum safe W/V is exceeded, use the safest extinguisher of the required rating.**
- e. **If possible, ventilate immediately, preferably overboard after successfully extinguishing the fire. Increase ventilation to the highest possible rate, and turn off any air recirculation systems, if equipped.**
- f. **Descend immediately at the maximum safe rate to an altitude of 8,000 feet or an altitude that is as low as practicable.**
- g. **At pressure altitudes above 12,500 feet follow precautions to prevent hypoxia. See paragraph 12h of this AC.**
- h. **Values are based on the NOAEL. All other agents are based on PBPK safe use concentrations for a 5 minute exposure. HCFC Blend B values will be made available in the FAA's "Halocarbon Handheld Extinguisher Handbook" when PBPK data is provided to the FAA.**
- i. **The maximum safe Weight/ Volume for blends of Halon 1211 and Halon 1301 can be found by assuming the total weight of the blend is Halon 1211**

# MINIMUM SAFE COMPARTMENT VOLUME



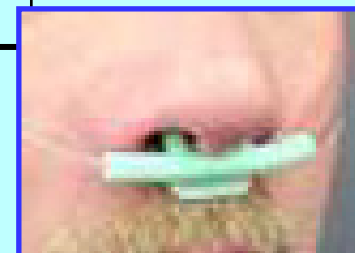
## Appendix

### NO VENTILATION

For the following 5 B:C extinguishers, released at 70°F: (21.1°C)

Agent	Agent Weight <sup>1</sup> (lbs)	Minimum Safe Volume (ft <sup>3</sup> ) <sup>2,3</sup>				
		Sea Level (For info only)	8,000 ft P Altitude (Pressurized Cabin)	14,000 ft P Altitude	18,000 ft <sup>4</sup> P Altitude Nasal Cannula Oxygen Supply	25,000 P Altitude Diluter- Demand Oxygen Mask
HCFC Blend B	5.2	1337	1799	2276	2678	3586
HFC-227ea	5.5	99	135	170	200	269
HFC-236fa	4.75	80	107	128	159	214
Halon 1211	2.5	556	749	947	1111	1497
Halon 1301	5.0	192	259	327	385	517

1. The agent weight for a 5 B:C extinguisher is extinguisher dependent.
2. Use this table if air change time is unknown or exceeds 6 minutes
3. Multiply this number by the number of extinguishers in the aircraft
4. If nasal cannula oxygen on-board



nasal cannula

# AGENT TOXICITY: MAXIMUM SAFE COMPARTMENT WEIGHT/VOLUME (NO VENTILATION, 70°F, 21.1°C)



Total agent from all extinguishers in compartment, released at 70°F: (21.1°C)

1. *Use this table if air change time is unknown, or exceeds 6 minutes.*
2. *Multiply W/V by the compartment volume to get the maximum safe weight.*
3. *Divide total agent weight from all ext. in compartment by W/V to get the min. safe volume. Safety improves as min. safe volume decreases for a given number of extinguishers of same UL rating.*
4. *If the proposed halocarbon extinguisher AC was applied to Halon 1211.*
5. *W/V multiplication factors if egress analysis is preformed and approved and escape time < 30 seconds.*  
 $MF_{HFC236fa,30sec} = 14.84/12.75 = 1.16$   
 $MF_{HFC227ea,30sec} = 11.6/10.84 = 1.07$   
 $MF_{Halon1211,30sec} = 1.73/1.0 = 1.73$   
 $MF_{Halon 1301,30sec} = 17.13/6.25 = 1.14$
6. *PBPK data is not available yet for HCFC Blend B. PBPK data is needed to determine multiplication factor.*

# AGENT TOXICITY: NO. OF 5BC BOTTLES ALLOWED

## Appendix

(NO VENTILATION, 8000 FT ALTITUDE, 70°F)



Aircraft/ Helicopter	Vol (ft <sup>3</sup> )	Max No. Seats	AC20- 42C & UL1093	AC40-22D				
			Halon 1211	Halon 1211	Halon 1301	HCFC Blend B	HFC- 227ea	HFC- 236fa
Cessna 152	77	2	0.3	0.1	0.3	0.04	0.5	0.7
Cessna 210C	140	6	0.5	0.2	0.5	0.08	1.0	1.3
Cessna C421B	217	10	0.7	0.3	0.8	0.1	1.5	2.0
Sikorsky S76	204	14	0.7	0.3	0.8	0.1	1.5	1.9
B727-100	5,333	131	17	7.1	21	3.0	38	50
B767-200	11,265	255	36	15	43	6.3	80	105
B 747	27,899	500	90	37	108	16	198	260

Less than one 5 B:C extinguisher allowed



# VENTILATION

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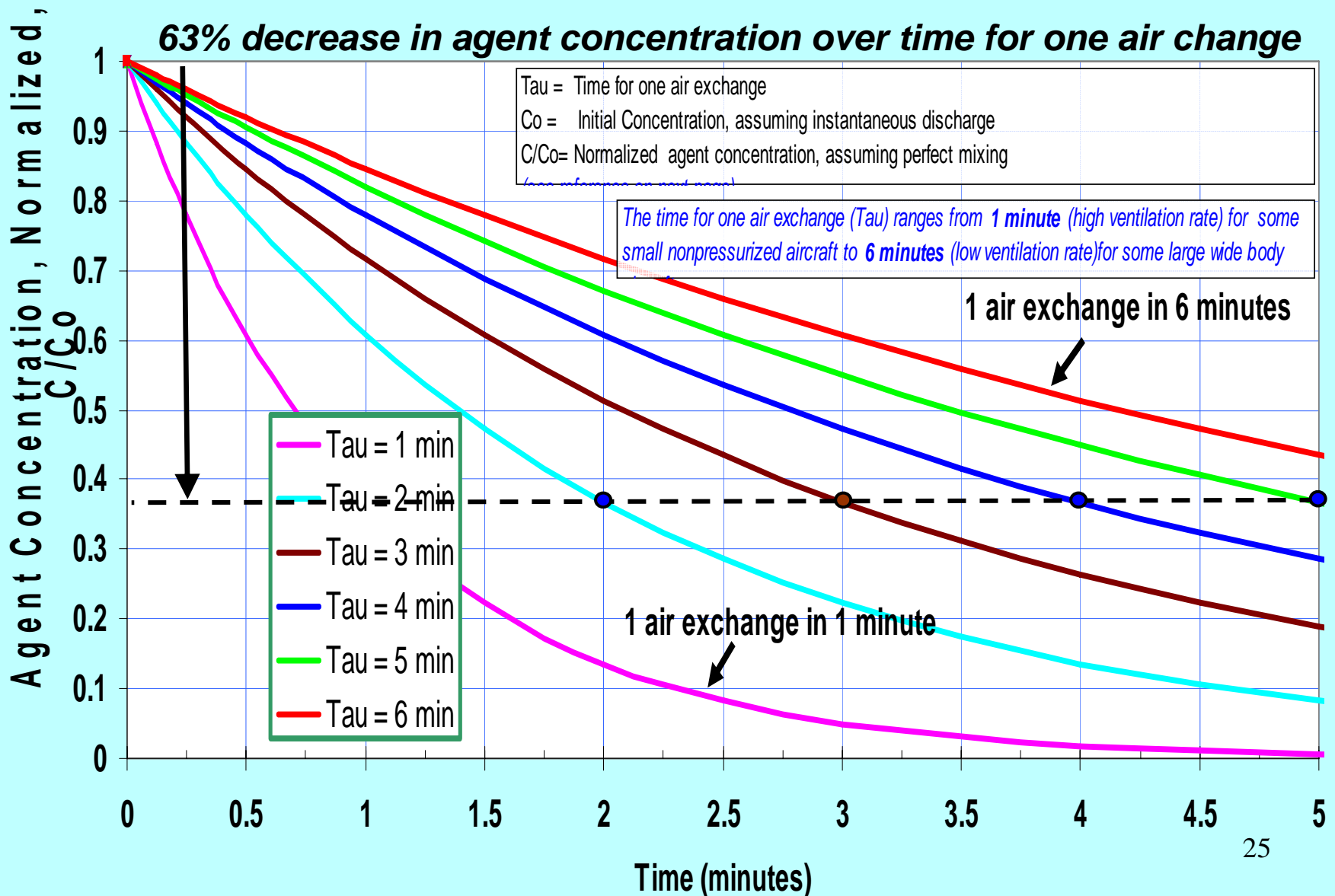
- **WARNING:** A small increase in concentration above the Maximum Safe 5 Minute Exposure Concentration results in a much shorter time to effect:  
Safe human exposure to constant concentration:
  - HFC 236fa : 12.75% for 5 min, 14.84% for 30 sec.
  - HFC 227ea: 10.84% for 5 min, 11.6% for 30 sec.,
- Development of Ventilation Tables:
  - Based on total weight of agent for **all** extinguishers in compartment.
  - Stratification of agents is a realistic expectation. It can be a safety benefit or disbenefit. Perfect mixing is assumed.
  - Agent manufacturers apply pharmacokinetic modeling of blood concentration data to perfect mixing agent decay concentration curves.
  - Selector graphs for ventilated aircraft can be developed from that data.
  - Selector graphs provide the maximum agent weight per unit cabin volume allowed in a compartment for any known air change time.



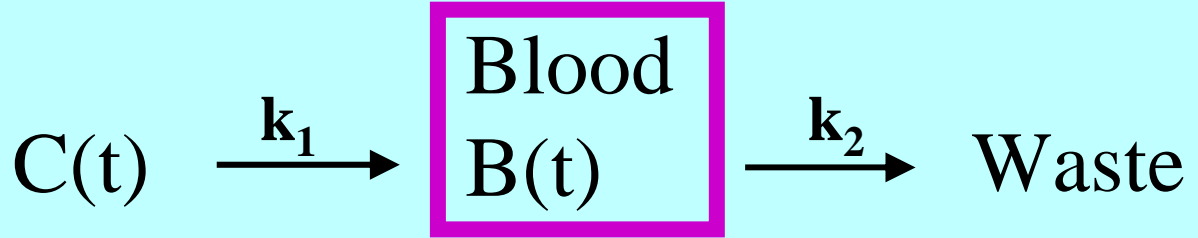
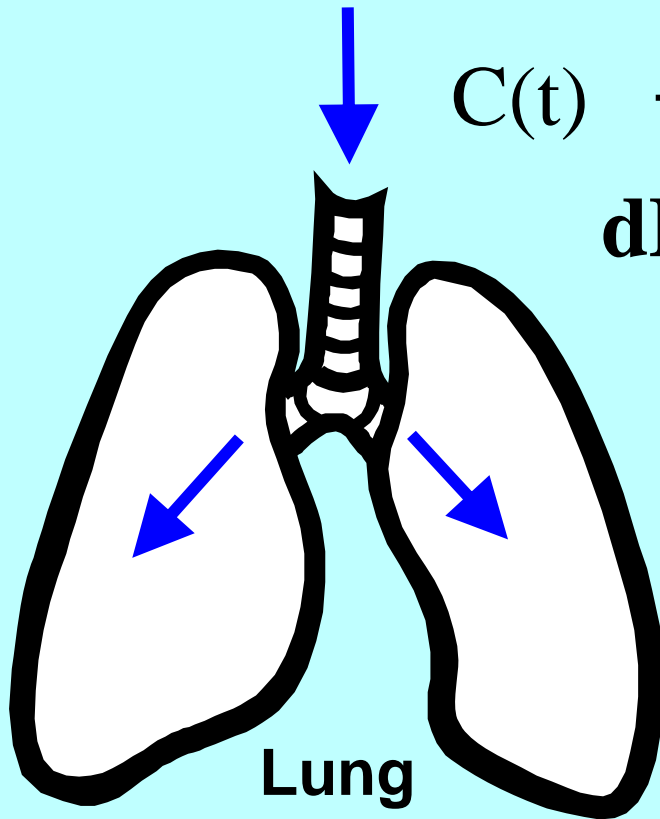
# Effect of Air Exchange Time (Tau) on Normalized Agent Concentration-Time Profiles



$$C/Co = \exp(-t / \text{Tau}) \quad (\text{assuming perfect mixing})$$



# MODELING ARTERIAL BLOOD CONCENTRATIONS OF HALOCARBONS USING 1<sup>st</sup> ORDER KINETICS



$$dB/dt = k_1 C(t) - k_2 B(t)$$

## Ventilated Cabin

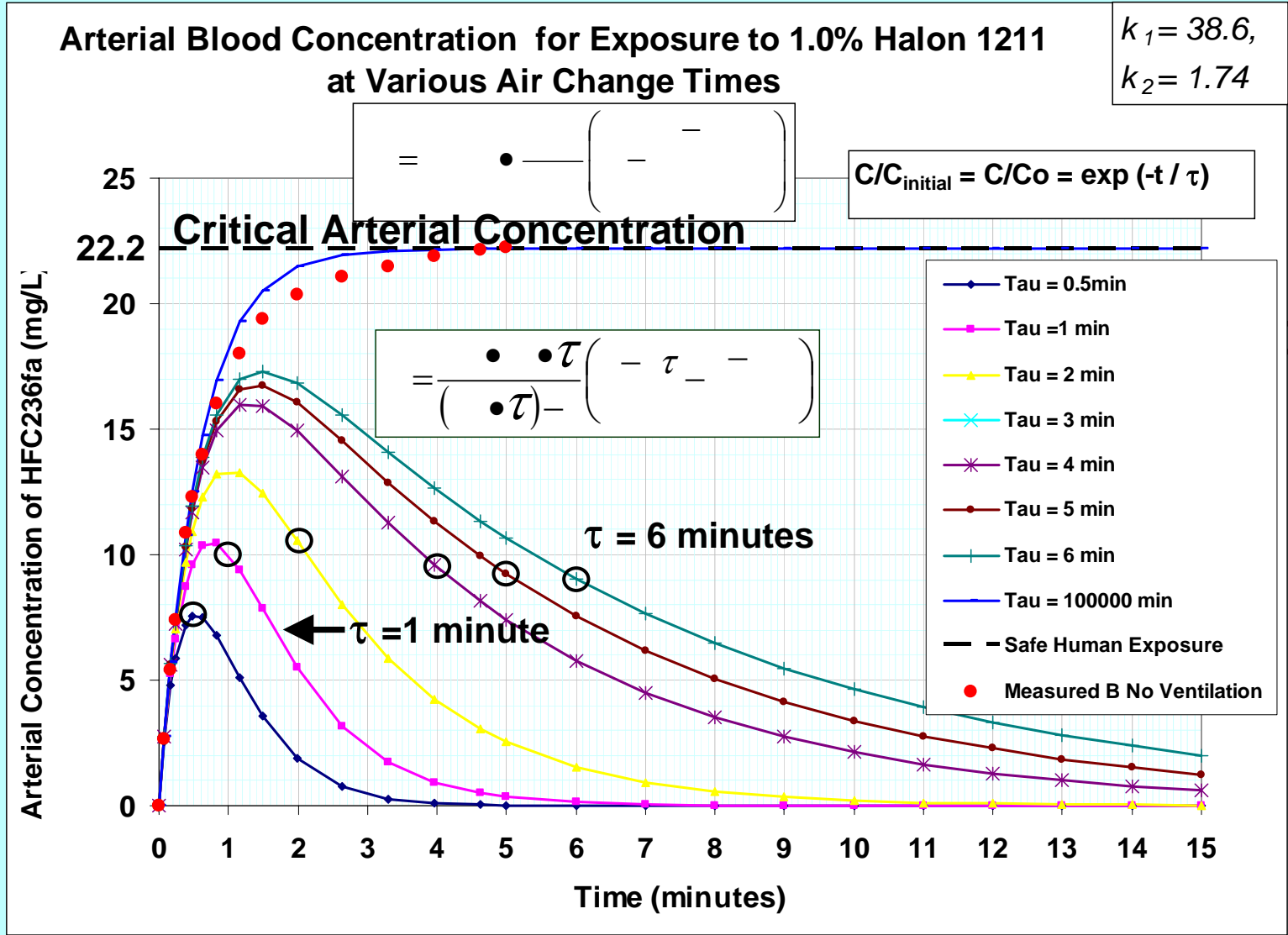
$\tau$  = Air Change Time

where:  $C(t) = C_0 \cdot \text{Exp}(-t/\tau)$

Solution:

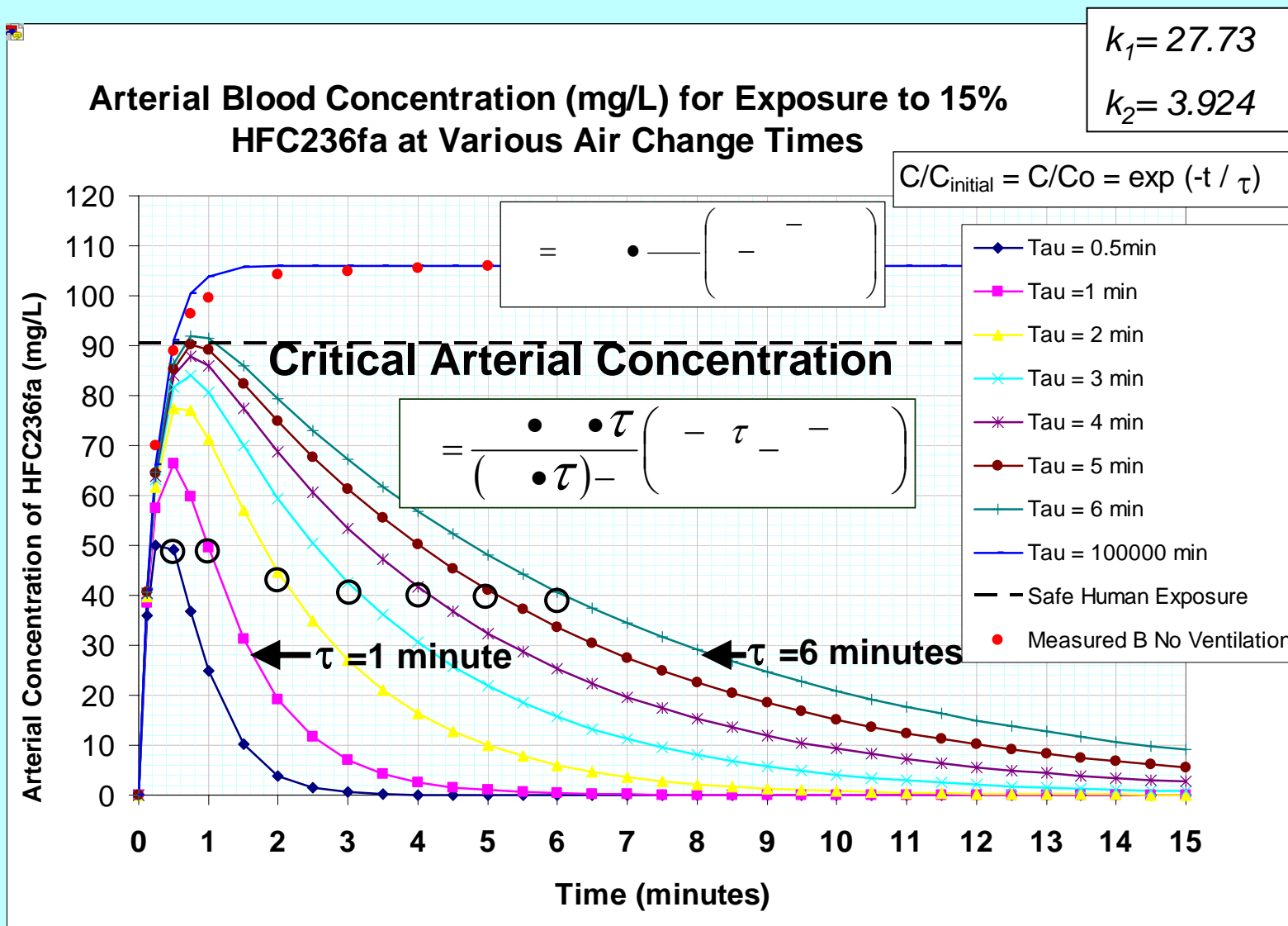
$$= \frac{\bullet \bullet \tau}{(\bullet \tau) -} \left( \begin{matrix} - & \tau & - \\ - & & - \end{matrix} \right)$$

# KINETIC MODELING OF ARTERIAL HALON 1211 BLOOD CONCENTRATION IN VENTILATED AIRCRAFT



The peak arterial concentrations are used to develop the selector curves

# KINETIC MODELING OF ARTERIAL HFC236fa BLOOD CONCENTRATION IN VENTILATED AIRCRAFT



$\tau =$  Air Change Time

The peak arterial concentrations are used to develop the selector curves

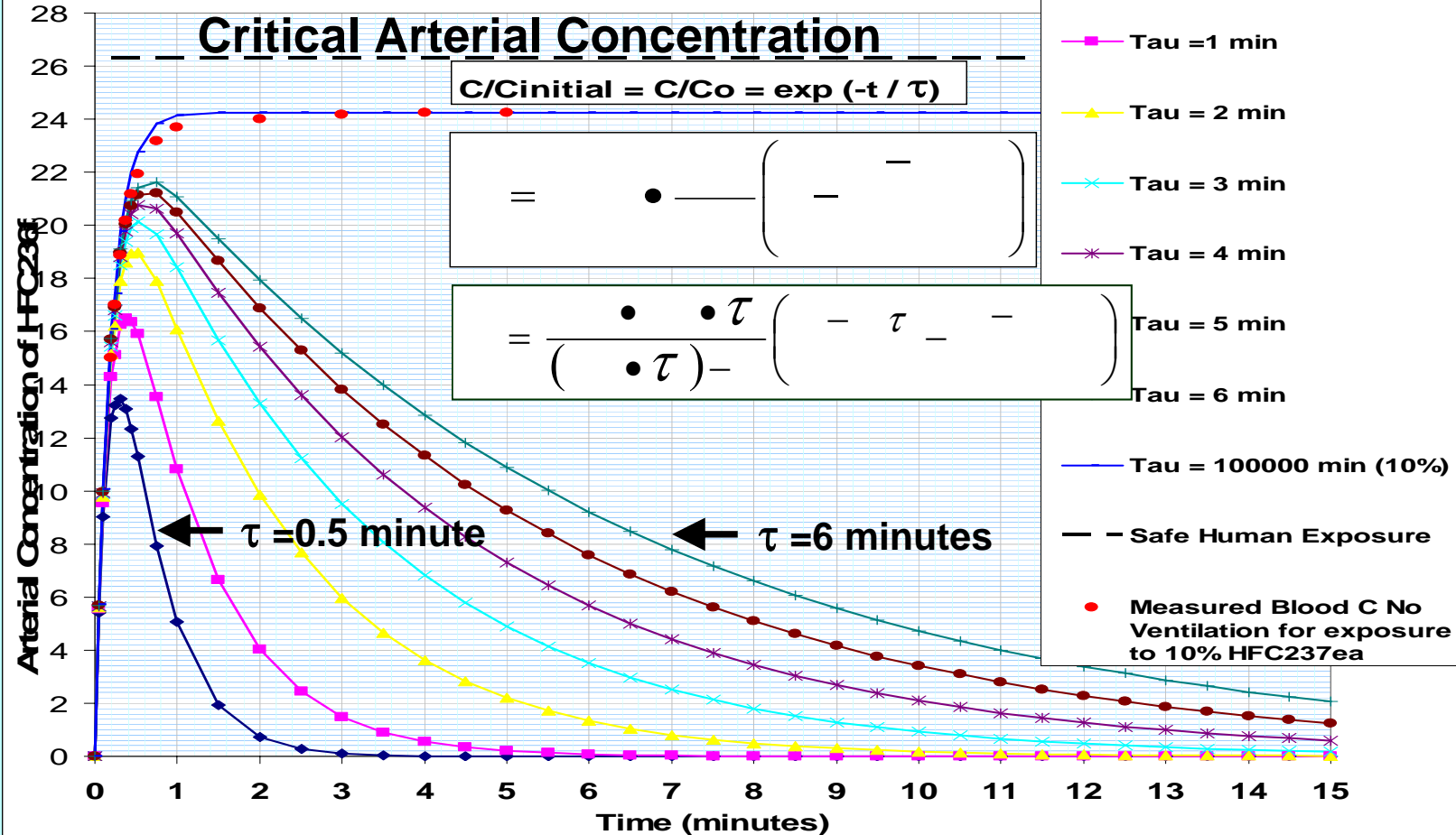
# KINETIC MODELING OF ARTERIAL HFC237ea BLOOD CONCENTRATION IN VENTILATED AIRCRAFT



$$k_1 = 13.0$$

$$k_2 = 5.36$$

Arterial Blood Concentration (mg/L) for Exposure to 10% HFC227ea at Various Air Change Times



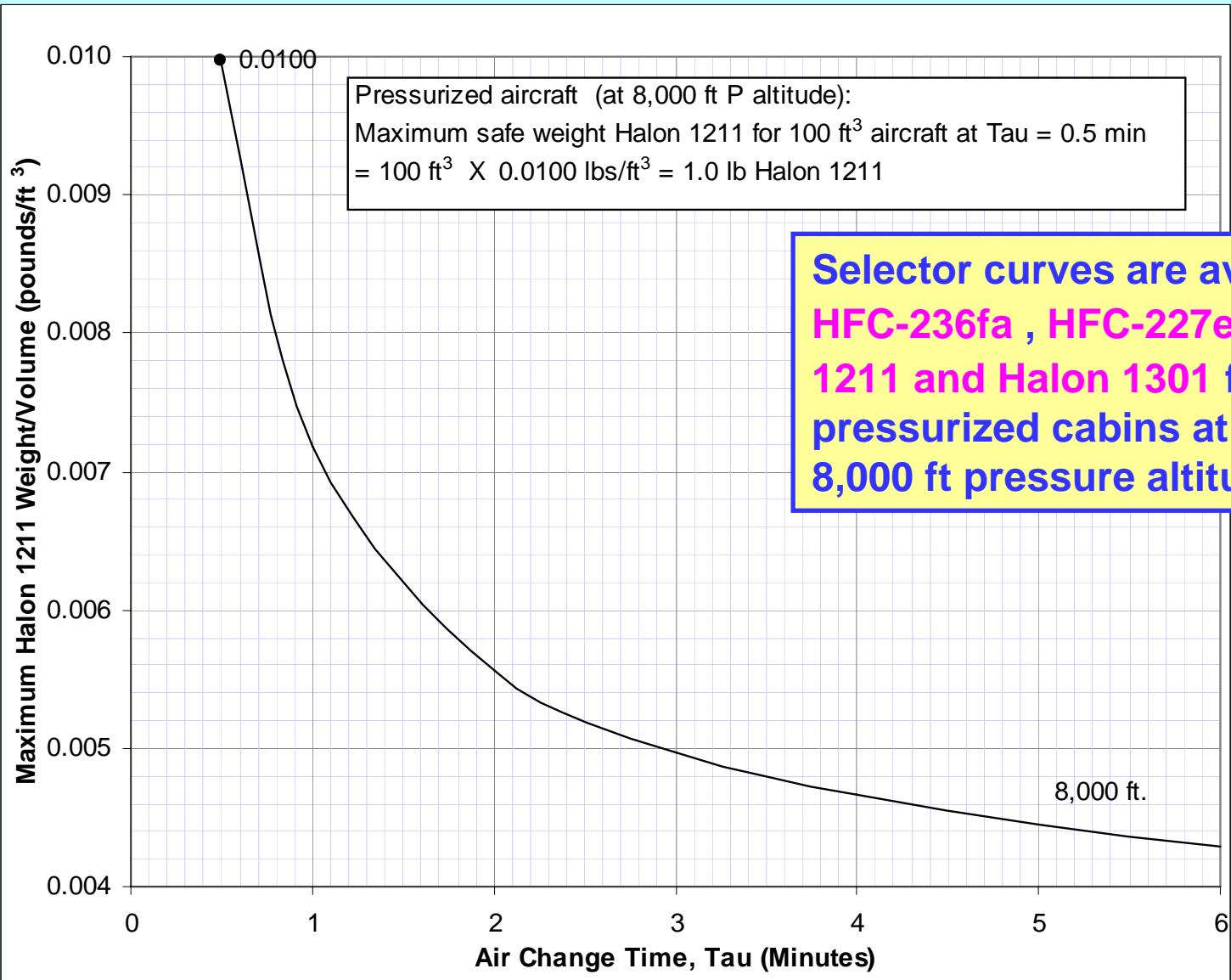
$\tau$  = Air Change Time

The peak arterial concentrations are used to develop the selector curves

# Halon 1211 SELECTOR FOR PRESSURIZED VENTILATED COMPARTMENTS



*Perfect mixing assumed*

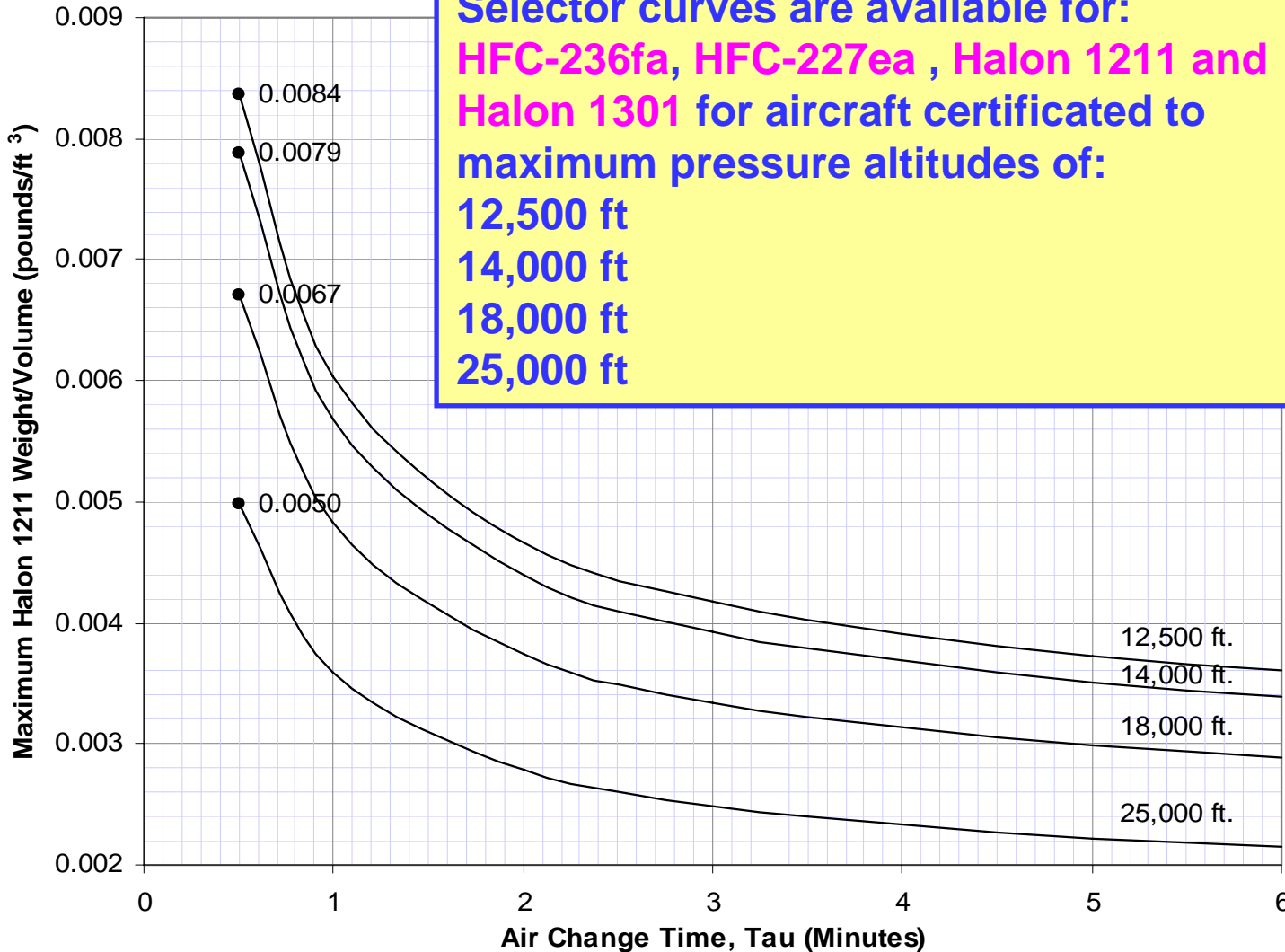


# Halon 1211 SELECTOR FOR UNPRESSURIZED VENTILATED COMPARTMENTS



Selector curves are available for:  
HFC-236fa, HFC-227ea, Halon 1211 and  
Halon 1301 for aircraft certificated to  
maximum pressure altitudes of:  
12,500 ft  
14,000 ft  
18,000 ft  
25,000 ft

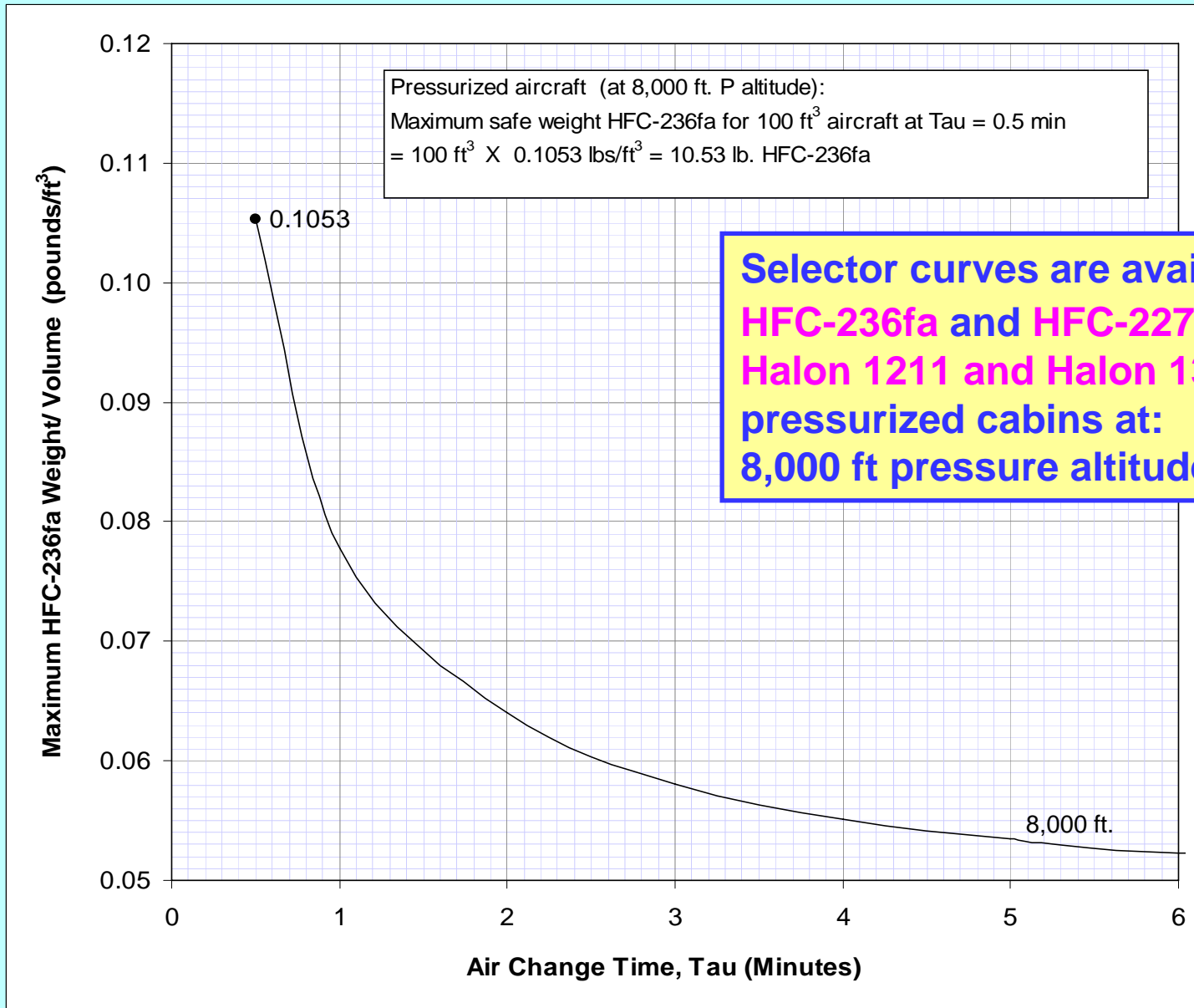
*Perfect  
mixing  
assumed*



# HFC-236fa SELECTOR FOR PRESSURIZED VENTILATED COMPARTMENTS



*Perfect mixing assumed*

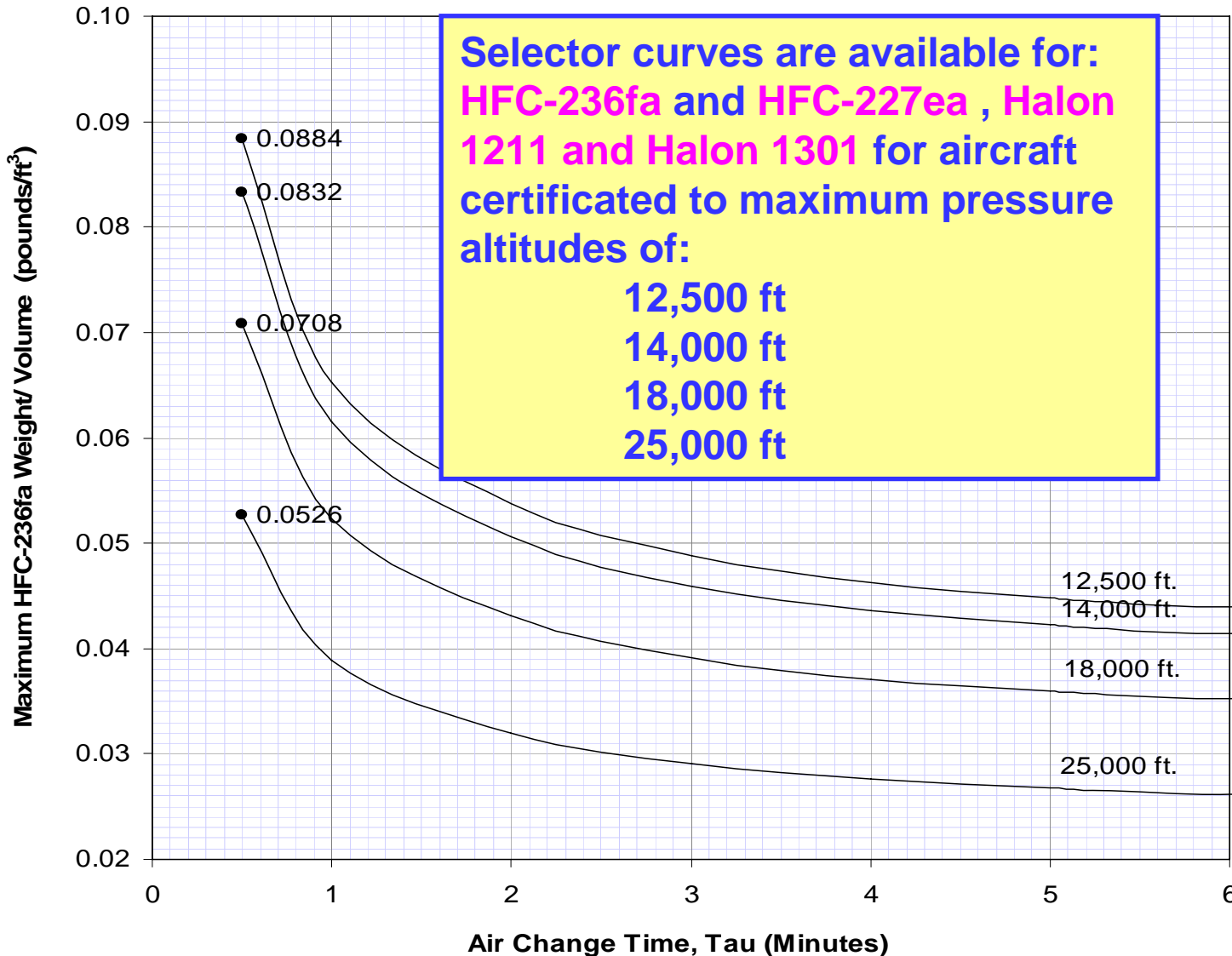




# HFC-236fa SELECTOR FOR UNPRESSURIZED VENTILATED COMPARTMENTS



*Perfect mixing assumed*



# Halon 1211 SELECTOR FOR VENTILATED UNPRESSURIZED COMPARTMENTS

Perfect  
mixing  
assumed



- If the air change time is unknown, or exceeds 6 minutes, do not exceed the maximum safe Halon 1211 W/V ratio for unventilated aircraft for the certificated pressure altitude:  
List
- *The total weight of agent for all extinguishers in the aircraft cabin is the basis for these maximum safe weight/volume ratios.*
- Ventilate immediately, preferably overboard after successfully extinguishing the fire. Increase ventilation to the highest possible rate, and turn off any air recirculation systems, if equipped.
- *All unpressurized aircraft should descend immediately at the maximum safe rate to an altitude that is as low as practicable.*
- *Unpressurized aircraft equipped to fly above 12,500 feet should also follow additional precautions in 8.3.2 to prevent the hazards of low oxygen hypoxia (oxygen masks or nasal cannula as applicable).*
- If the maximum safe Halon 1211 W/V is exceeded, use the safest extinguisher of the recommended rating.
- *The maximum safe Weight/Volume for blends of Halon 1211 and Halon 1301 can be found by assuming the total weight of the blend is Halon 1211.*

# HFC236fa SELECTOR FOR VENTILATED COMPARTMENTS

*Perfect  
mixing  
assumed*



Ventilate immediately after fire extinguished. Increase ventilation to the highest possible rate.

If Air change time is unknown or exceeds 6 minutes, use unventilated data (Prolonged exposure to these agents may be hazardous):

- $W/V = 0.0442$  pounds/ft<sup>3</sup> for Pressurized Cabins at 8,000 ft. P altitude
- $W/V = 0.0371$  pounds/ft<sup>3</sup> for Nonpressurized Cabins at 12,500 ft.
- $W/V = 0.0349$  pounds/ft<sup>3</sup> for Nonpressurized Cabins at 14,000 ft.
- $W/V = 0.0297$  pounds/ft<sup>3</sup> for Nonpressurized Cabins at 18,000 ft.
- $W/V = 0.0221$  pounds/ft<sup>3</sup> for Nonpressurized Cabins at 25,000 ft.

Unpressurized aircraft should descend at **the maximum safe rate to the minimum practicable altitude** to avoid the life threatening hazards of hypoxia resulting from the agent displacing oxygen from the air and to minimize exposure to halogenated agents. This guidance should be followed regardless of ventilation rate.

# 1<sup>st</sup> ORDER KINETIC MODELING OF ARTERIAL BLOOD CONCENTRATION HISTORIES

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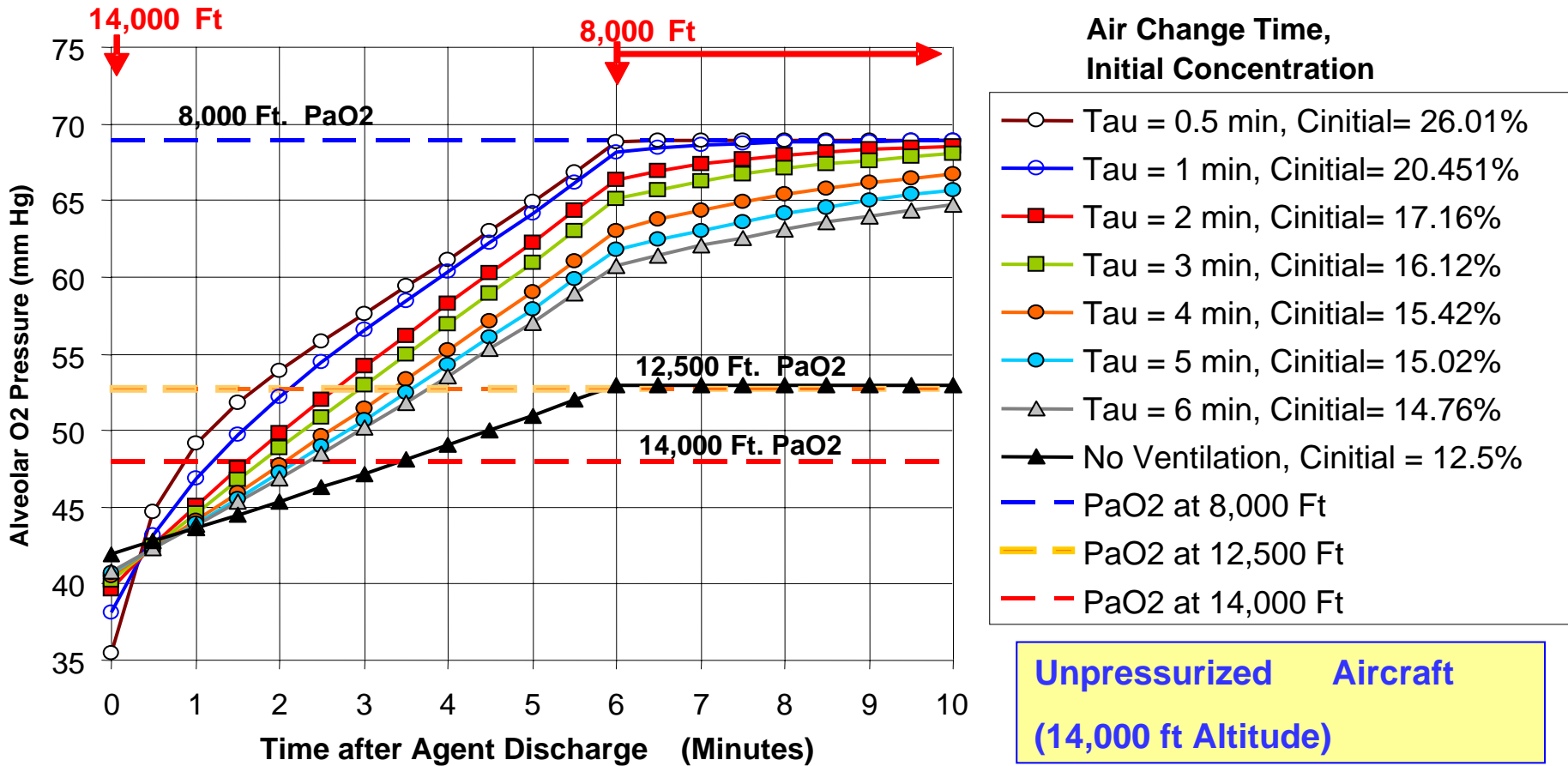


- Provides a *simple mathematical solution* to obtain data needed to develop perfect mixing ventilation tables which will provide maximum safe extinguishing agent weights for a range of compartment volumes and air change times.
- Monte Carlo simulations of arterial blood concentration histories for 5 minute exposures to constant agent concentrations are used as input data for developing equations (95% confidence) for each extinguishing agent.
- PBPK arterial blood data has been published for HFC 236fa and HFC 227fa which accounts for 95% (two standard deviations) of the simulated population having 5 minute arterial blood concentrations below the target concentration.
- Equations can be developed for each agent, which transform agent concentration histories to arterial blood concentration histories in ventilated spaces.
- Demonstrated to work for predicting blood concentration histories for exposures to a constant concentration of agent.
- Has been validated for predicting blood concentration histories for exposures to changing concentrations of agent.

# LOW OXYGEN HYPOXIA AT ALTITUDE: Unpressurized Small Aircraft



Alveolar Oxygen Pressure for Discharge of Maximum Allowable HFC-236fa at  
14,000 Ft Altitude  
Ventilate and Descend at 1,000 Feet per Minute Immediately After Discharge



Unpressurized aircraft currently allowed to fly at: 14,000 ft. for 30 minutes  
12,500 ft. indefinitely

# A/C LANGUAGE FOR HALOCARBON FIRE EXTINGUISHERS

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- Provide safety guidance for halocarbon extinguishers.
- Recommends a minimum UL listed 5 B:C extinguisher for occupied spaces
- The proposed A/C references requirements for hand extinguishers.
- Recommends throw ranges for various sized aircraft
- Recommends a discharge hose or adjustable wand.
- Provides guidance for minimizing risk of low oxygen hypoxia when agent is released at altitude.
- States the maximum weight that **all** extinguishers in a compartment should not exceed, based on agent toxicity, size of compartment, and maximum FAA-allowed altitude of the cabin.

# A/C LANGUAGE FOR HALOCARBON FIRE EXTINGUISHERS

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- May allow increased halocarbon clean agent concentrations in ventilated compartments:
  - Selector graphs can be developed if PBPK data is available.
  - Selector graphs provide the maximum safe weight of agent based on safe concentration at altitude, compartment volume, time for an air change.
  - Provides updated safe handling guidelines based on adverse toxicological or cardiac sensitization events, PBPK modeling, and hypoxia considerations.
  - Operators of non-transport category aircraft should become familiar with the information in this A/C.
- The proposed AC is subject to change/ rewrite by the FAA Aircraft Certification Office.



## CHANGES SINCE LAST UPDATE

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- Do not recommend the use of dry chemical or CO<sub>2</sub> extinguishers.
- The maximum safe Weight/ Volume for blends of Halon 1211 and Halon 1301 can be found by assuming the total weight of the blend is Halon 1211.
- Halons to use same guidelines as other FAA approved halon equivalent extinguishers: Max safe W/V, ratings
- Label “ For aircraft use as an Approved Halon *Equivalent* Extinguisher”
- Label includes” For Aircraft use: Refer to FAA Advisory Circular AC20-42D
- Approved Halon Replacement vs Halon Alternative vs halon equivalent
- Halon Equivalent Extinguisher is an extinguisher containing a clean agent which meets the minimum performance standard for hand-held fire extinguishers (DOT/FAA/AR01/37). Equivalency does not refer to the weight of the agent.





## CHANGES SINCE LAST UPDATE

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- Consider throw ranges for replacing water extinguishers with halon 1211 equivalent extinguishers for cargo use.
- Guidance For Blends of Halon 1211/Halon 1301
- Lithium battery guidance
- Changes in Marking requirements: “For aircraft use: Refer to FAA Advisory Circular AC20-42D

# CHANGES SINCE LAST UPDATE

## LITHIUM BATTERY GUIDANCE- DELETE

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### Extinguishing fires involving lithium primary and lithium-ion cells with hand held fire extinguishers:

- **Lithium primary (non-rechargeable) cells** are constructed with metallic lithium. Metallic lithium is extremely flammable and cannot be extinguished with the typical hand held extinguishers found on board transport aircraft. However, the amount of metallic lithium in each cell is very small and will consume itself in less than one minute. Lithium primary cells will spray molten lithium as they burn, which can cause severe bodily harm and spread the fire. To fight a fire involving lithium primary cells, isolate the burning appliance and utilize the hand held gaseous extinguishers (Halon 1211 or equivalent) to prevent the spread of the fire to adjacent materials. Avoid using water extinguishers on these cells.
- **Lithium-ion (rechargeable) cells** are not constructed with metallic lithium and do not have the same fire hazard as primary cells. The cells are constructed with a flammable electrolyte. These cells are easily extinguished with gaseous fire extinguishers and present no unusual fire hazards. Halon 1211 or equivalent extinguishers are very effective in controlling this type of fire.

## COMMENTS/ QUESTIONS FOR TASK GROUP

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1. The required hand extinguisher must have a minimum UL 5B:C rating or equivalent EN3 rating **of 34B**.
  - a. Pan size differs for both tests.
  - b. The “C” is not used for EN3 Listing
  - c. Neither UL or FM lists extinguishers according to EN3 test standards, so there should be a recognized EN3 approval body listed in section 9b if EN3 is to be cited).
  - d. Extinguishers approved in this manner should also meet the safe-use guidance in this AC.
  - e. Training requirements of various extinguishers



## COMMENTS/ QUESTIONS FOR TASK GROUP

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2. NFPA 12B is no longer an active standard. Can we quote it? **(ask John). What spec to use for Halon 1211?**
3. Provide Military Spec for Halon 1301?
4. Marking requirement for Halon Extinguishers in new installations: A permanent and legible label must be affixed to these UL listed extinguishers identifying the FAA approval under this AC for use on board commercial aircraft.  
**Label “ For aircraft use as a Halon Equivalent Approved Extinguisher” ADD: ” Refer to FAA Advisory Circular AC20-42D for safe use guidance**
5. Approved Halon Replacement vs Halon Alternative vs Halon Equivalent.
6. The warning placard ”stop ...” alongside all extinguishers or only extinguishers that exceed the safe use guidance?
7. Discharge as soon as the fire is extinguished” should be placed on a placard alongside all extinguishers.



## COMMENTS/ QUESTIONS FOR TASK GROUP

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9. W/V multiplication factors if egress analysis is preformed and approved and escape time < 30 seconds.

- $MF_{HFC236fa,30sec} = 14.84/12.75 = 1.16$
- $MF_{HFC227ea,30sec} = 11.6/10.84 = 1.07$
- $MF_{Halon1211,30sec} = 1.73/1.0 = 1.73$
- $MF_{Halon 1301,30sec} = 17.13/6.25 = 1.14$

10. The safest 5B:C extinguisher at the time of the writing of this AC is HFC-236fa. While this is a true statement, is it appropriate for the FAA to state this?  
*(If no extinguishers meet this safe-use guidance the extinguisher with the lowest minimum safe volume for a given UL extinguisher listing should be installed)*

# COMMENTS/ QUESTIONS FOR TASK GROUP

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## 11. **Dry Chemical Extinguisher:**

- In general, dry chemical fire extinguishers are not recommended for aircraft use, due to potential corrosive effects of the powder mixture. When approving a non-gaseous agent for installation on aircraft, the contamination impact to the structure, wiring and surrounding systems should be evaluated, taking into consideration potential mixing of the agent residue with water.
- The usage of such extinguishers may require specific procedures addressing cleanup.
- Removing dry chemical extinguishers on aircraft may constrict the use of agents for future applications.
- Several dry powder blends have passed the MPS.

## COMMENTS/ QUESTIONS FOR TASK GROUP

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### 11. **OR** Dry Chemical Extinguisher:

Dry Chemical Extinguishers are not recommended due to

- a. The potential for damage to electronic equipment
- b. The possibility of visual obscuration if the agent were discharged into the flight deck area.
- c. The cleanup problems from their use.

# COMMENTS/ QUESTIONS FOR TASK GROUP

## 2B:C Halon Replacement Extinguishers:

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12.

- NFPA 408, Standard for Aircraft Hand Portable Fire Extinguishers, also allows for the use of a 2B:C rated Halon 1211 extinguisher on an aircraft “with a maximum certificated occupant capacity of one to four persons including the pilot...”
- The acceptance of a UL 2B:C rated extinguisher should be continued in this new AC in accordance with AC20-42C and NFPA 408.
- We suggest adding a sentence to this section that states “For small aircraft or helicopters, with a maximum certificated occupant capacity of one to four persons including the pilot, an extinguisher with a minimum rating of 2B:C shall be permitted to be used if the agent is gaseous upon discharge..”
  - Agents that are delivered as a gas can be delivered more effectively in fighting small aircraft fires behind the cockpit instrument panel, where the fire is hidden from view. Streaming agents delivered at close range may backslash which may result in insufficient agent reaching the fire.



## TO DO:

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- Define New Installations



# WORKING GROUP PARTICIPANTS

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# HANDHELD EXTINGUISHER WEB PAGE

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<http://www.fire.tc.faa.gov>