

NFPA 2001 (2004 Ed.)

Standard For Clean Agent Extinguishing Systems

Presented by:

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For:

SFPE Southeastern Chapter

KEY POINTS

- **AGENT TOXICITY ISSUES (45 mins.)**
 - INERT AGENTS
 - HALOCARBON AGENTS
- **CUP BURNER (2 mins.)**
 - NEW TASK GROUP
- **Q&A (13 mins.)**

KEY TERMS

- Cardiac Sensitization
- Asphyxiation
- NOAEL
- LOAEL
- PBPK Model
- Arterial Blood Level
- Cup Burner Value
- Design Concentration
- Exposure Time
- Pre-Discharge Alarm

INERT AGENT TOXICITY

- **FIRE EXTINGUISHING PROCESS**
 - DISCHARGE INERT AGENT
 - DISPLACES OXYGEN
 - REDUCES OXYGEN TO ABOUT 12%
 - FIRE CAN'T SUSTAIN COMBUSTION
 - FIRE IS EXTINGUISHED
 - LOW O₂ LEVEL HARMFUL TO HUMANS

INERT AGENT TOXICITY

- **ASPHYXIATION**
 - VERY MISUNDERSTOOD
 - FUNCTION OF O₂% AND TIME
 - TOO LITTLE OXYGEN (O₂)
 - OVER TOO MUCH TIME
 - EQUALS DEATH

INERT AGENT TOXICITY

AGENT TRADE NAME	CUP BURNER	NOAEL	LOAEL
ARGONITE	35	43	52
FE-13	12.9	30	>50
FE-25	8.7	7.5	10.0
FM-200	6.6	9	10.5
HALON 1301	4.1	5	7.5
INERGEN	31	43	52
NN100	31	43	52
NOVEC 1230	4.5	10	>10

INERT AGENT TOXICITY

- **NFPA 2001 (2004 Ed)**
 - AGENT % - LTE **43** (GTE 12% O₂)
 - OCCUPIED SPACES – LTE 5 m. EXPOSURE
 - AGENT % - GT **43** & LTE **52** (12 TO 10)
 - OCCUPIED SPACES – LTE 3 m. EXPOSURE

INERT AGENT TOXICITY

- **NFPA 2001 (2004 Ed)**
 - AGENT % - GT **52** & LTE **62** (10 TO 8)
 - NOT OCCUPIED – LTE 30 s. EXPOSURE
 - AGENT % - GT **62** (LT 8)
 - NOT OCCUPIED SPACES – NO EXPOSURE

HALOCARBON TOXICITY

- **FIRE EXTINGUISHING PROCESS**
 - VARIES BETWEEN AGENTS
 - HEAT ABSORPTION IS THE PRIMARY MECHANISM
 - GENERALLY, OXYGEN LEVELS REMAIN AT SAFE LEVELS FOR HUMANS

HALOCARBON TOXICITY

- **CARDIAC SENSITIVITY**
 - HISTORY – CARBON TETRACHLORIDE
 - ARTERIAL BLOOD LEVEL
 - PLUS ADRENALINE
 - EQUALS HEART ARRHYTHMIA
 - BREATHING = BLOOD LEVEL
 - DISCHARGE = STRESS/ADRENALINE

HALOCARBON TOXICITY

- **CS TESTING – BEAGLES**
 - SIX DOGS ON TREADMILL
 - BREATHING AGENT % FOR 5 MINUTES
 - SHOCKED WITH ADRENALINE
 - HEART EFFECT MEASURED
 - ARTERIAL BLOOD LEVEL MEASURED
 - ONE OR MORE DOGS

HALOCARBON TOXICITY

- NOAEL AND LOAEL CONCEPTS
- COST LIMITATIONS & DATA
- MARKET VIABILITY

HALOCARBON TOXICITY

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HALOCARBON TOXICITY

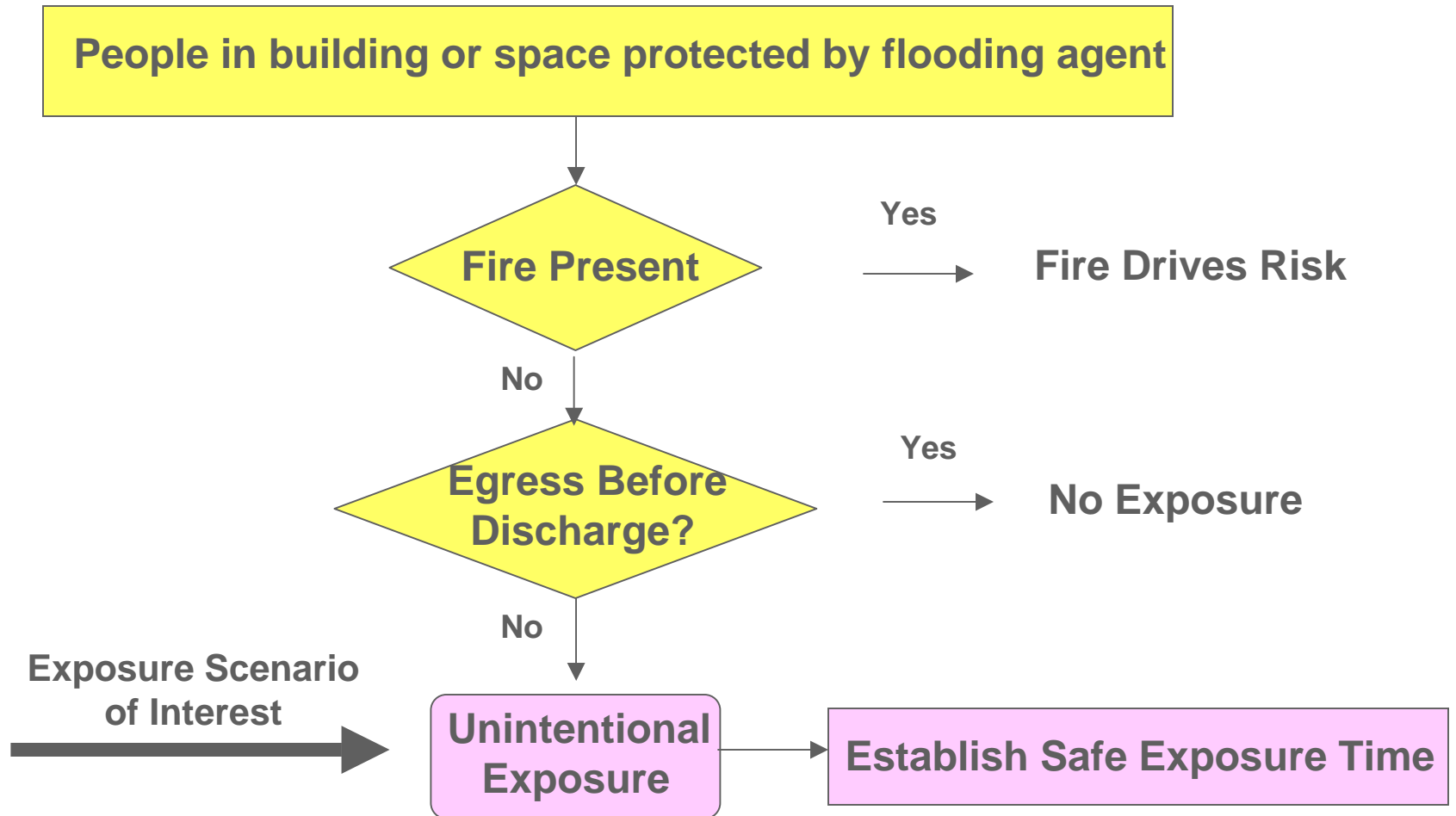
- ORIGINAL RULES TOO STRICT
- MARKET NEEDED RELAXATION
- COMMITTEE DEMANDED SCIENCE
- SCIENCE IS PBPK MODEL
- MODEL FULLY VALIDATED
- MODEL VERY CONSERVATIVE
- MODEL ALLOWS RELAXATION

HALOCARBON TOXICITY

OLD RULES

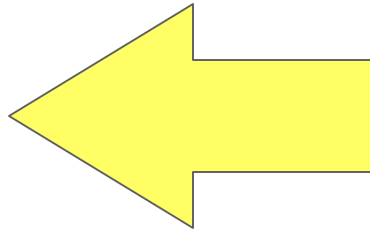
DESIGN CONCENTRATION	NORMAL OCCUPANCY	EXPOSURE TIME LIMIT	NOTES
HALOCARBONS 1996 Edition of NFPA 2001			
LTE NOAEL	OCCUPIED	NO LIMIT	
GT NOAEL	NOT OCCUPIED	0 SECONDS	
GTE NOAEL	OCCUPIED	0 SECONDS	EXCEPTION FOR CLASS B HAZARDS

Applicable Exposure Scenarios



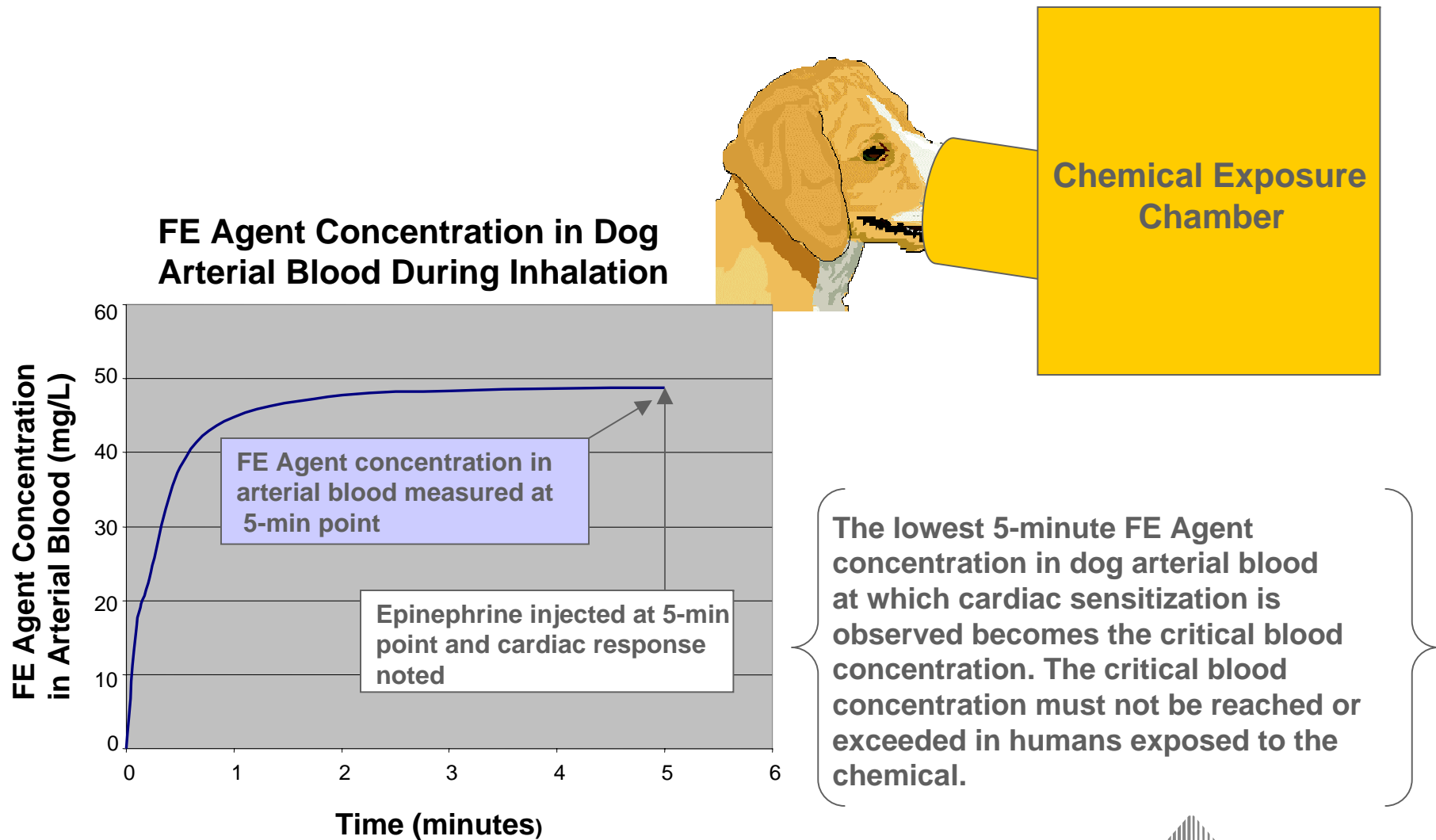
Overview of Process

Determine “critical” arterial blood level of FE Agent



- Expose epinephrine treated dogs to FE agent via inhalation
- Determination lowest exposure concentration that causes cardiac sensitization (LOAEL in dog)
- Measure FE agent arterial blood level attained during LOAEL exposure in dog

Determination of the arterial blood level of HFC FE Agent during cardiac sensitization test.



The lowest 5-minute FE Agent concentration in dog arterial blood at which cardiac sensitization is observed becomes the critical blood concentration. The critical blood concentration must not be reached or exceeded in humans exposed to the chemical.

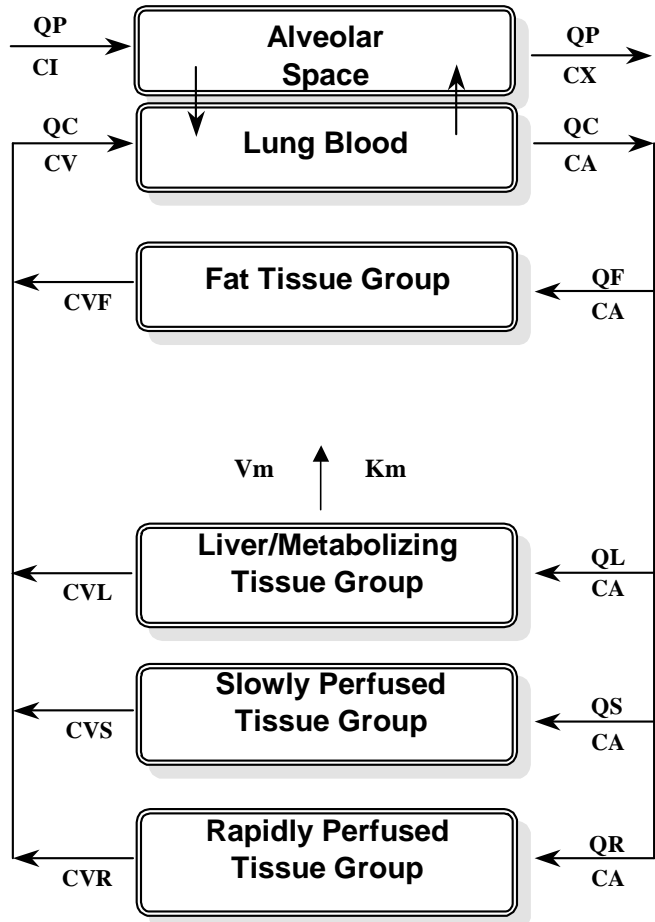
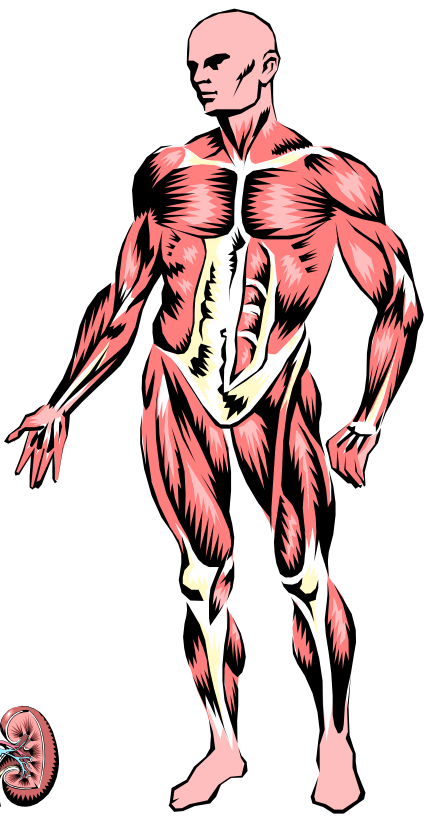
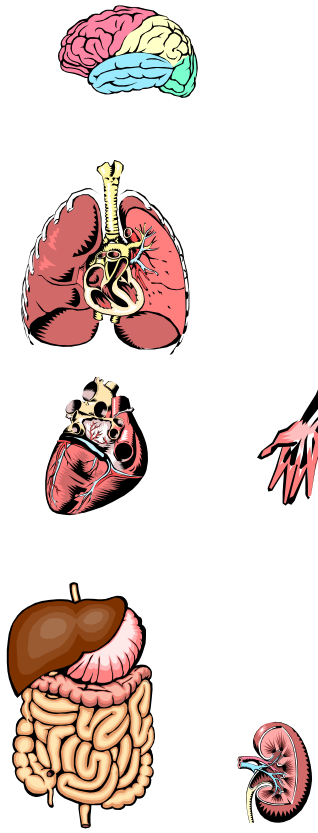
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Simulate FE Agent concentration in arterial blood of “rapid/high uptake” humans during inhalation exposure

- Develop and validate human PBPK model.
- Use Monte Carlo simulation to describe individuals who take up FE agent quickly and to high levels.
- Use model to keep track of FE agent distribution following inhalation

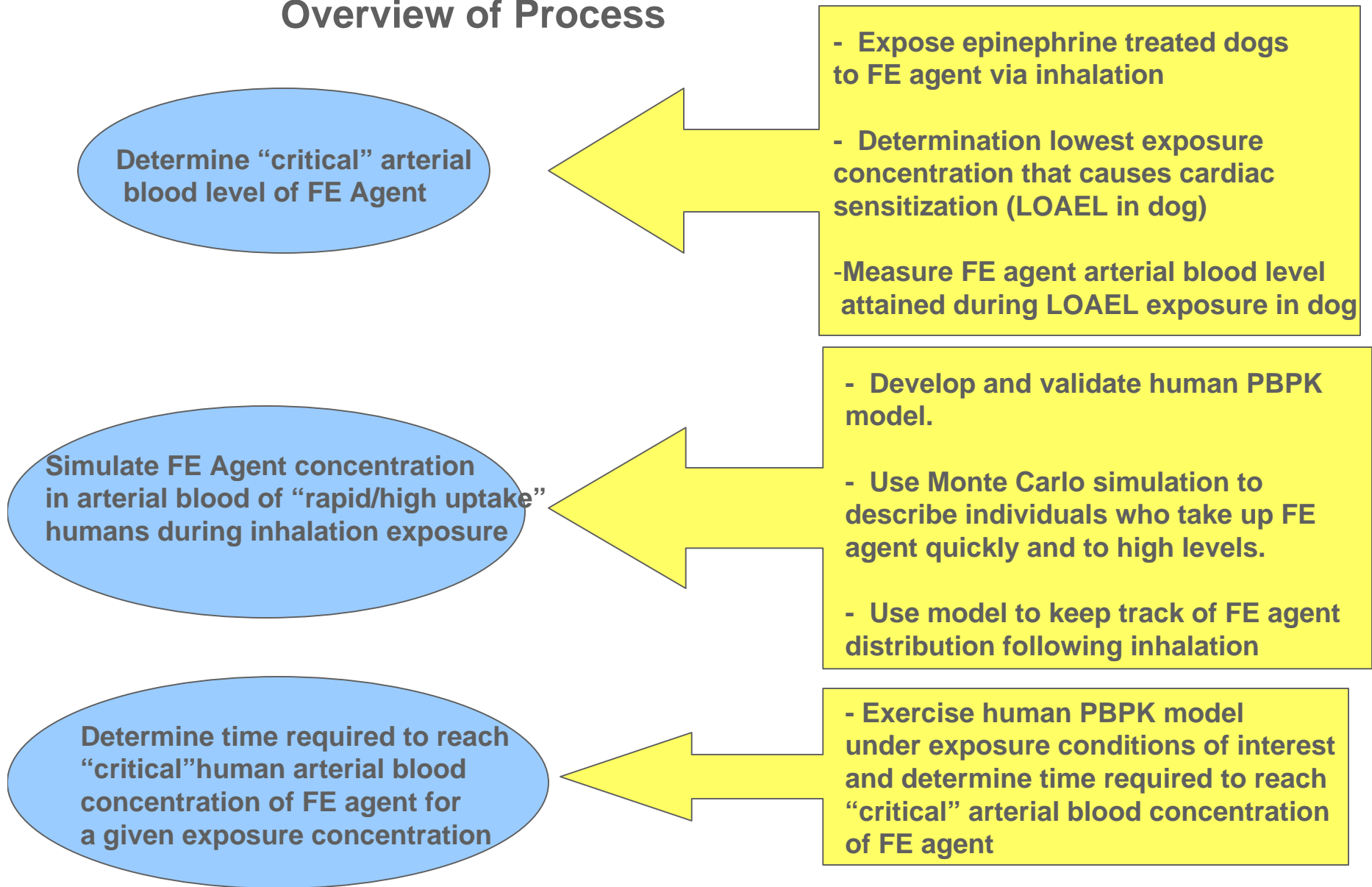


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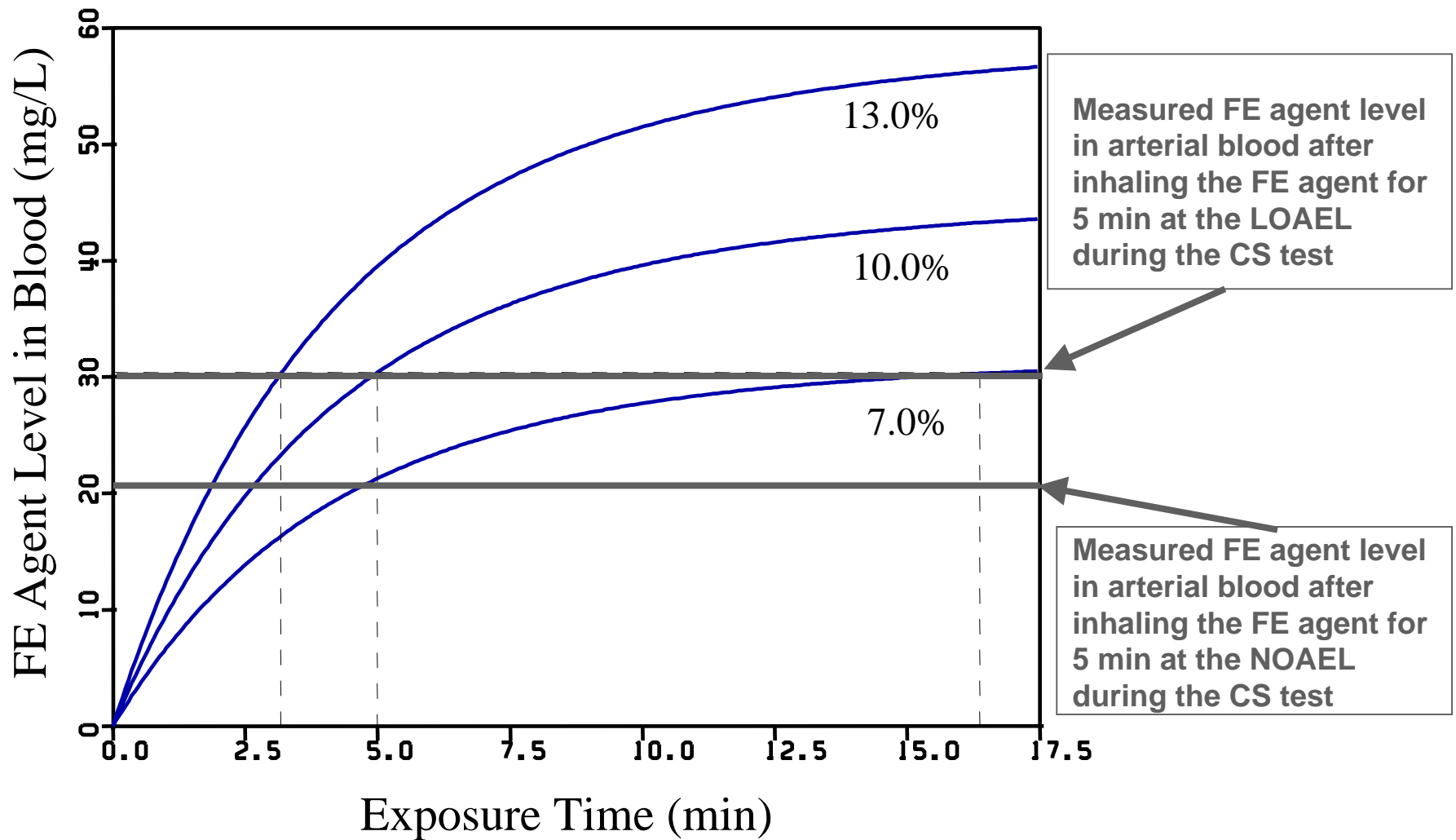
Gary W. Jepson, DuPont Haskell Laboratory

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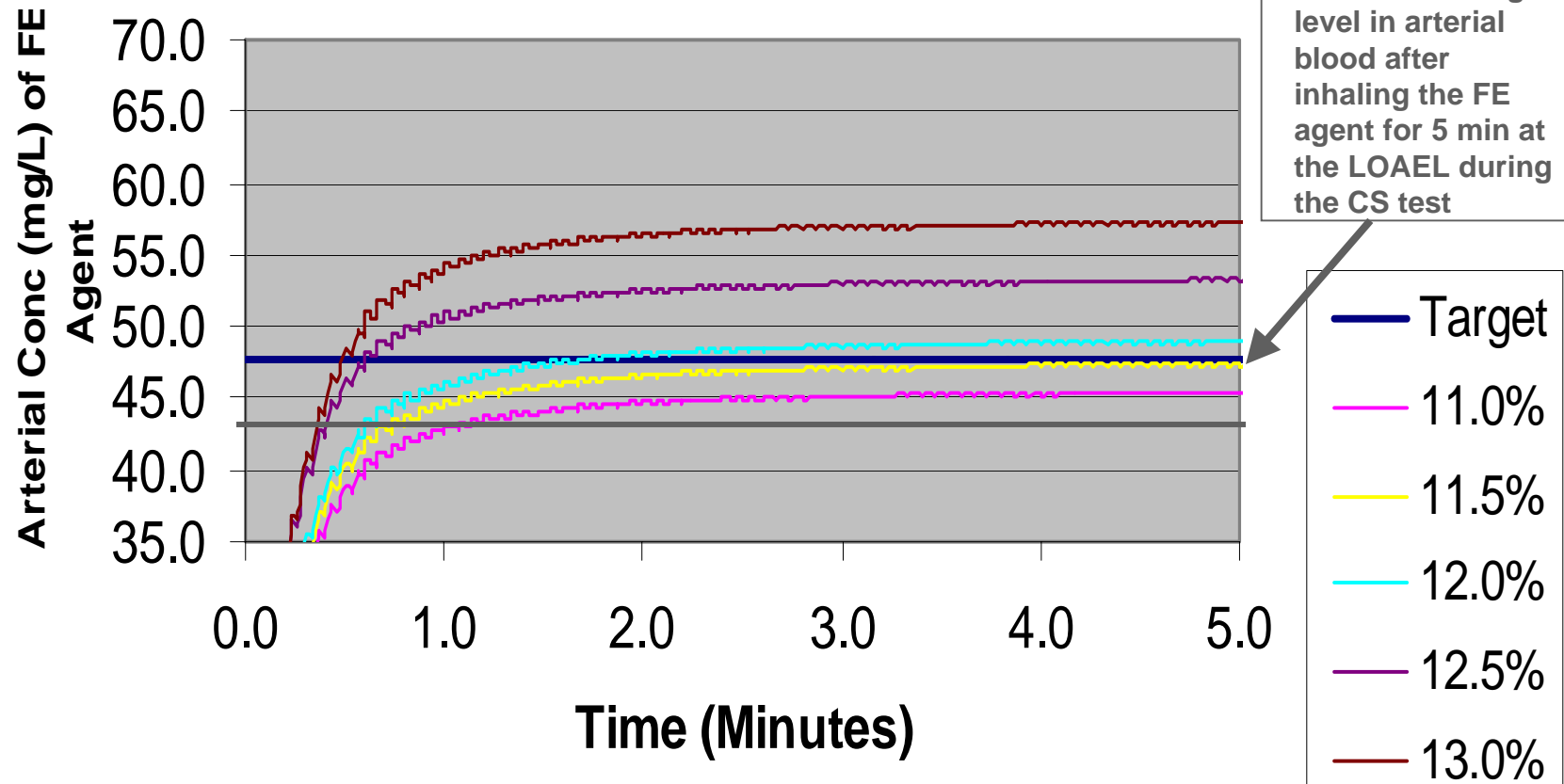
Overview of Process



Simulation of Chemical Levels in Human Arterial Blood During Inhalation of FE Agent



Simulated Human Arterial Blood Levels of FE Agent During Inhalation



PBPK FOR FM-200

%v/v	Ppm	Human Exposure
9.0	90,000	5.00 min.
9.5	95,000	5.00 min.
10.0	100,000	5.00 min.
10.5	105,000	5.00 min.
11.0	110,000	1.13 min.
11.5	115,000	.60 min.
12.0	120,000	.49 min.

PBPK FOR FE-25

%v/v	Ppm	Human Exposure
7.5	75,000	5.00 min.
10.0	100,000	5.00 min.
11.5	115,000	5.00 min.
12.0	120,000	1.67 min.
12.5	125,000	0.59 min.
13.0	130,000	0.54 min.
13.5	135,000	0.49 min.

HALOCARBON TOXICITY

NEW RULES

DESIGN CONCENTRATION	NORMAL OCCUPANCY	EXPOSURE TIME LIMIT	NOTES
HALOCARBONS 2004 Edition of NFPA 2001			
LTE NOAEL	OCCUPIED	5 MINUTES	NO PBPK NEEDED
GT NOAEL & LOAEL	OCCUPIED	PBPK MODEL LIMIT CORRESPONDING TO DESIGN CONCENTRATION AND 5 MINUTES EXPOSURE	NEED PBPK
GT NOAEL & LOAEL	OCCUPIED	PBPK MODEL LIMIT CORRESPONDING TO DESIGN CONCENTRATION LESS THAN 5 MINUTES EXPOSURE	CONDITIONS: 1. APPROVAL BY AHJ 2. EGRESS CALCULATION PROOF 3. ADHERE TO PBPK EXPOSURE LIMIT
LTE LOAEL	NOT OCCUPIED	60 SECONDS	NO PBPK MODEL DATA
GT LOAEL	NOT OCCUPIED	30 SECONDS	NO PBPK MODEL DATA

CUP BURNER TASK GROUP

- **INITIATED JANUARY 2004**
- **INCREASE ACCURACY**
- **INCREASE REPEATABILITY**
- **ADDRESS INERT AGENTS**
- **DEFINE STANDARD APPARATUS**
- **DEFINE TESTING PROTOCOL**

Q & A

