The Potential Reduction of Firefighter Exposure to Carbon-Based Carcinogens in Structure Fires Through the Use of Class A Compressed Air Foam Systems

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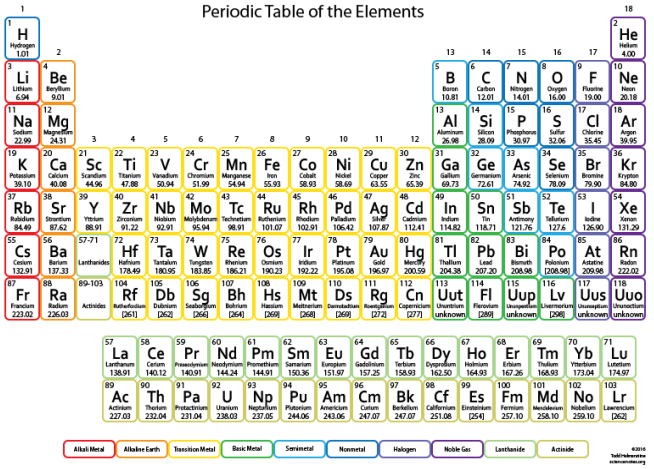
Applied Research Project

- Research completed to meet the requirements for the Applied Research Project for the Executive Analysis of Fire Service Operations in Emergency Management (R0306) of the Executive Fire Officer Program through the National Fire Academy- Submitted January 2016
- Recipient of the Don Manno Award for Excellence in Research from the International Association of Fire Chiefs- EFO Section

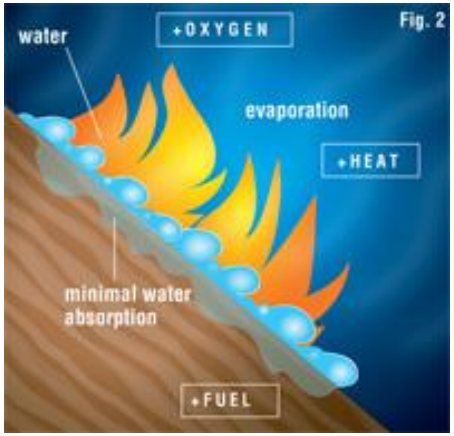
WHY?

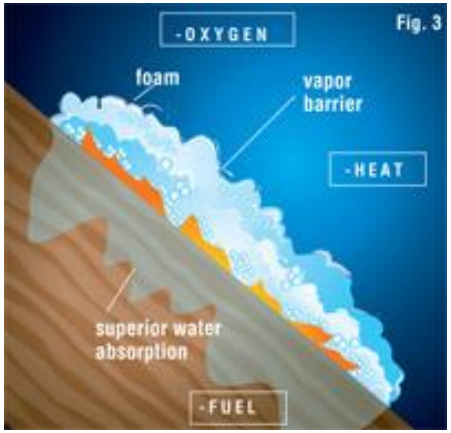
- **Knowledge of basic chemistry**
- HS Physics/Chemistry Teacher
- **Modern Fire Behavior**
- Dave Dodson, Pete Van Dorpe, Phil Jose (ROAM), UL Tests, NIST Data, Drager: CO/HCN videos, Cal Poly Tech 2014
- **Understand the Toxic Byproducts of combustion**
- Off gassing of synthetic materials based upon their composition (solidified comfortable gasoline).
- Crude Oil in a cracking tower.



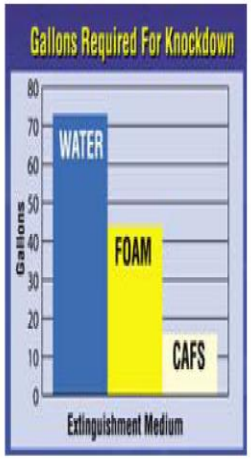
WHY?

- **Previous research on Class A and B foam agents**
- Necessity on their function and not just for Class A and Class B fires.
- **Agent application method**
- 2 Dimensional vs. 3 Dimensional

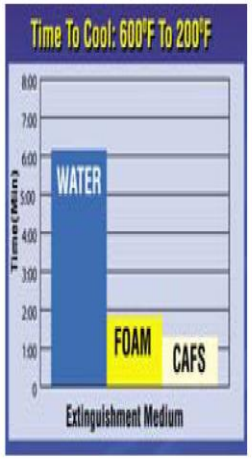




Class A foam 40% better than water



Class A foam 71% better than water



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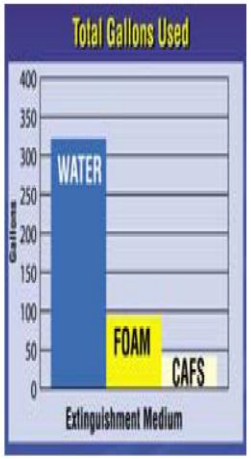
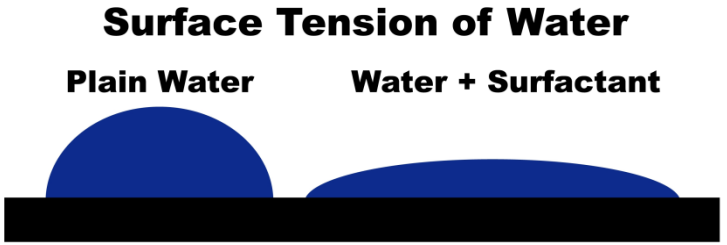
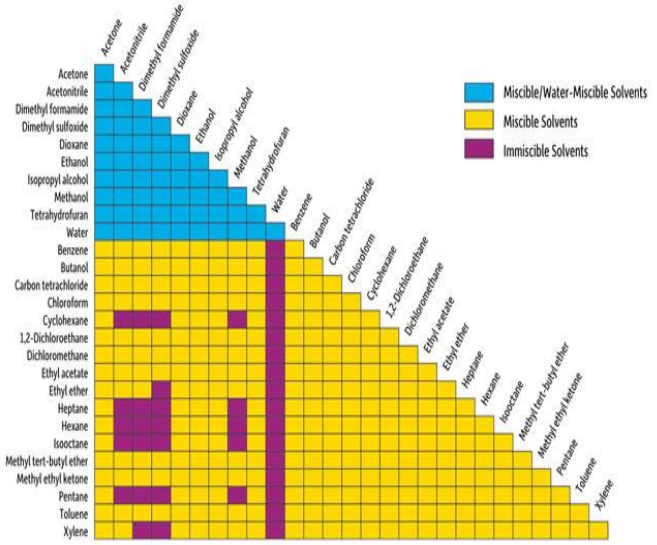


https://www.fireresearch.com/foampro/why-foam/

WHAT- AMERICAN FIRE SERVICE

- **"Today's fires are truly"**
- Hazmat Incidents
- **Chemical/Physical Properties of Class A Foam**
  - Surfactants: reduces water surface tension
  - Carbon-philic: loves carbon based particles
  - Affinity: Miscibility of polar solvents and hydrocarbons
  - Polar solvent: water and polar solvent makes a polar solvent

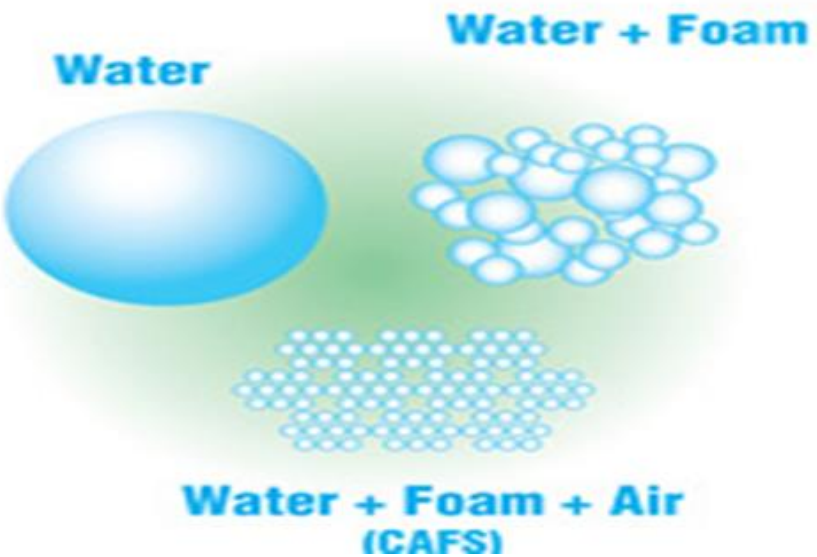




What

- **Agent Application: 2-D v 3-D Fire and Fire Suppression**
  - 3 Dimensional Fire Compartment Environment
  - Tens of thousands of tiny-hard bubbles.

http://new.fatare.com/living-room-on-fire/



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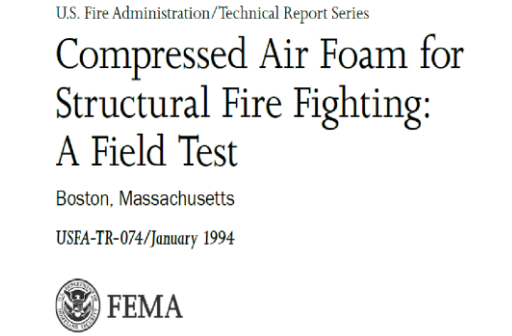
How

- Previous Tests/Trials
- FEMA 1994 Boston FD
- Cal Poly Tech AFG (Korman, 2014)
- UL Performance of Special Extinguishment Agents for Fire Fighter Use Sept. 30, 2008
- EFO ARPs- many science based research projects
- CAFS/Foam Industry: Hale, Pierce, Darley, Chemguard, National, CAFS advocates (Brooks & Colletti), Jim Cottrell Assoc.
- Europe (UK-ARFF Class B) (2012) ARFF Working Group: *Compressed Air Foam Systems (CAFS) and Flourine Free Foam In Future Aviation Safety and Aircraft Rescue & Fire Fighting Efficiency*
- *by Kim T. Olsen*


U.S. Fire Administration/Technical Report Series

Compressed Air Foam for Structural Fire Fighting: A Field Test

Boston, Massachusetts

USFA-TR-074/January 1994

FEMA

How

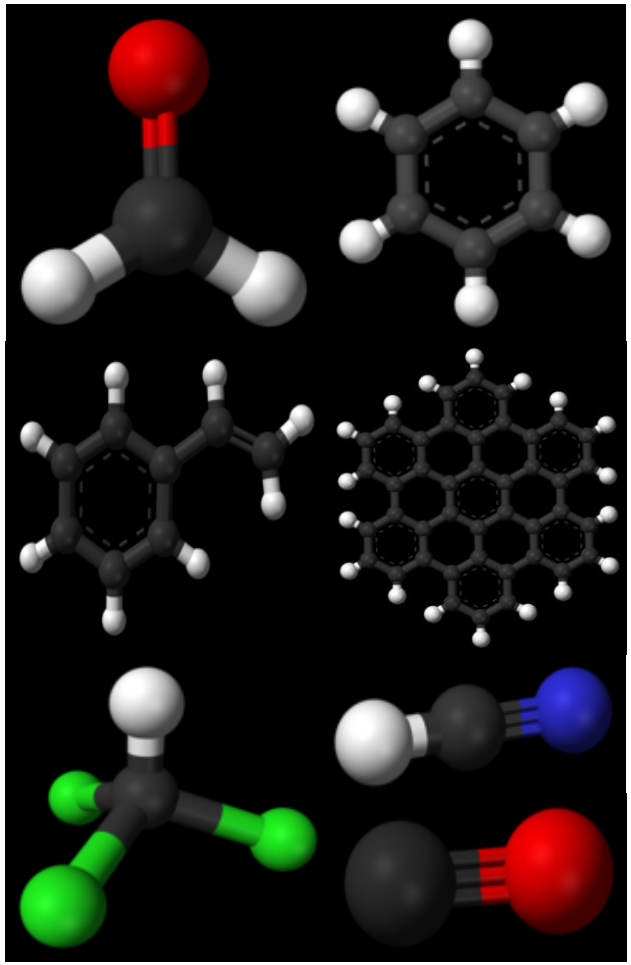
- Replication of best test practices
- Field Validity
- Firefighter Cancer Support Network- White Paper

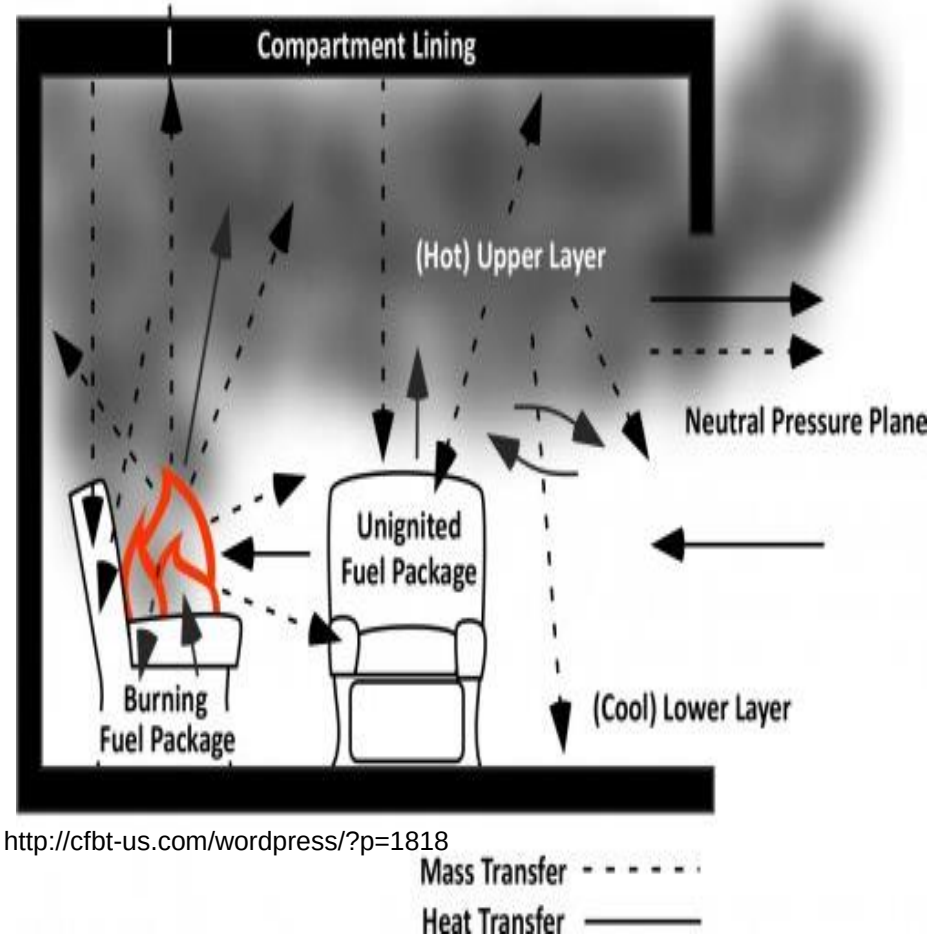
Taking Action Against Cancer in the Fire Service

FIREFIGHTER CANCER SUPPORT NETWORK

THEORY:

- **Toxic carbon based byproducts of combustion**
- Off gassing of gas, vapors, aerosols
- **Suspended in a 3-D atmosphere**

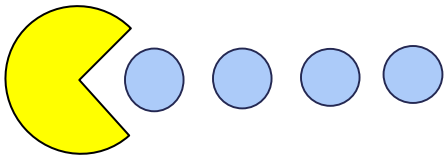


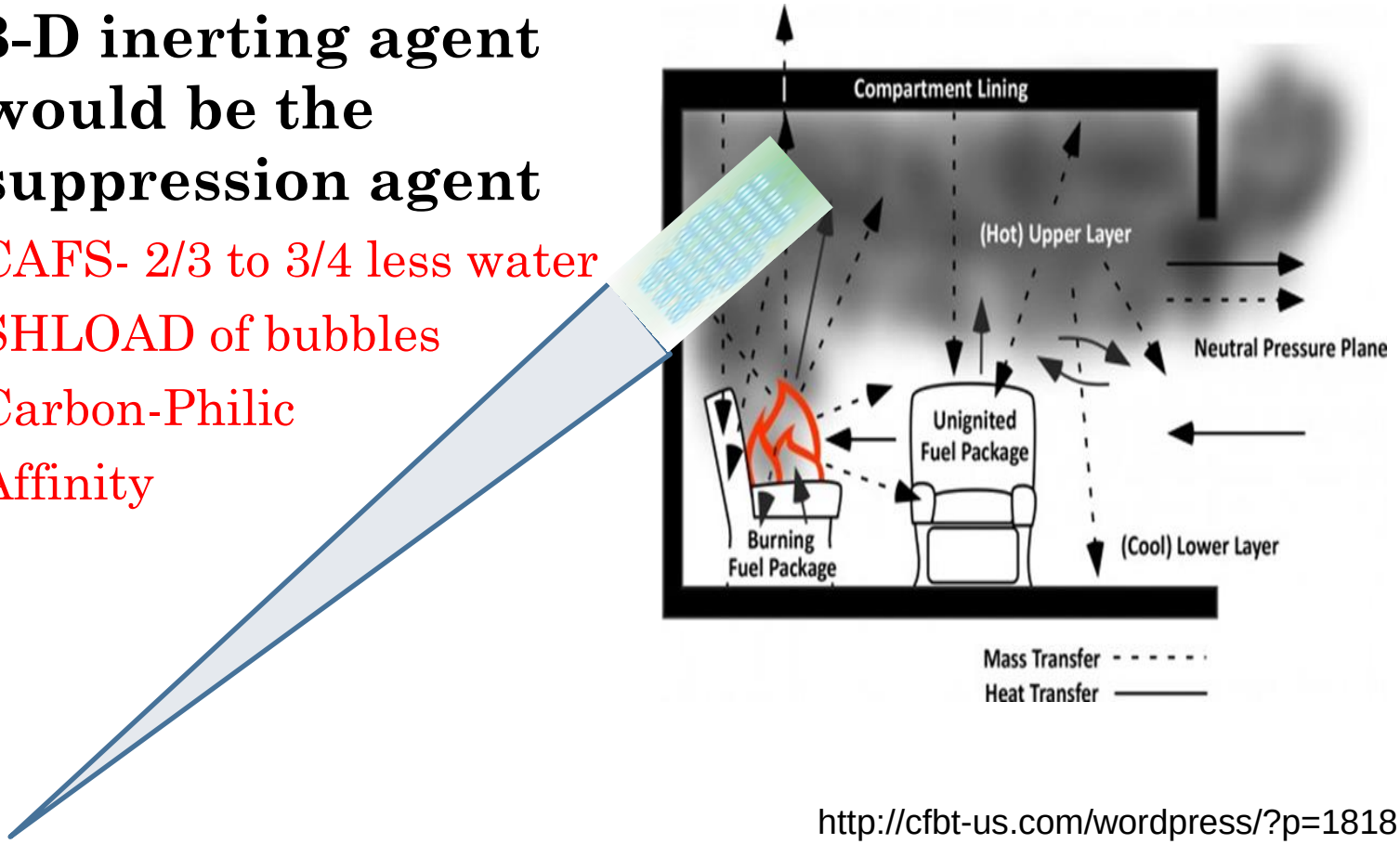


http://cfbt-us.com/wordpress/?p=1818

THEORY:

- **Potential reduction caused by injecting a 3-D "inerting" agent into a 3-D fire compartment**
- **3-D inerting agent would be the suppression agent**
- CAFS- 2/3 to 3/4 less water
- SHLOAD of bubbles
- Carbon-Philic
- Affinity

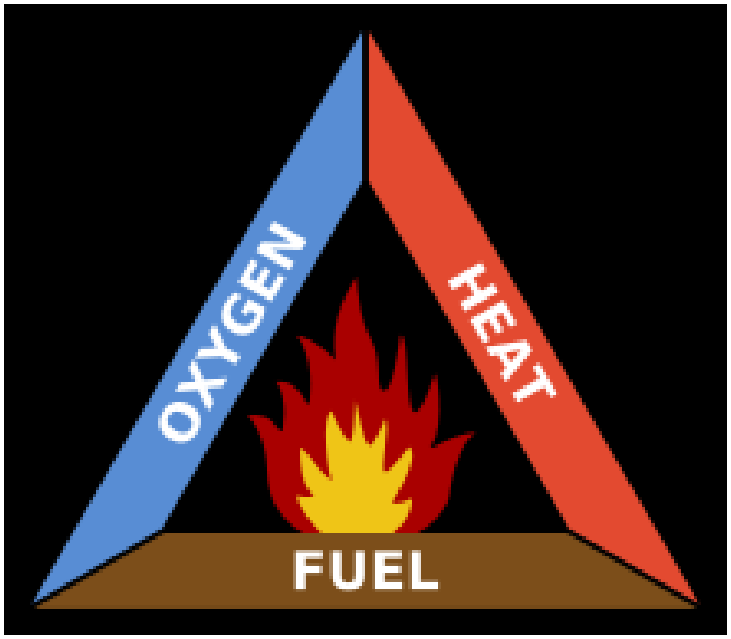


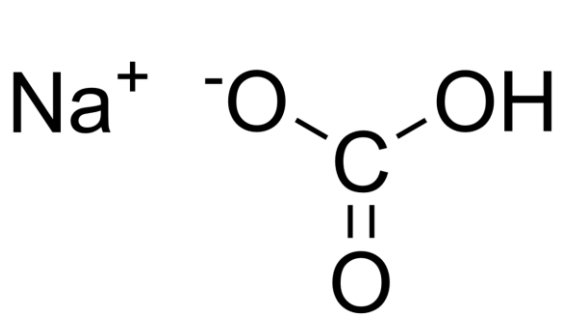


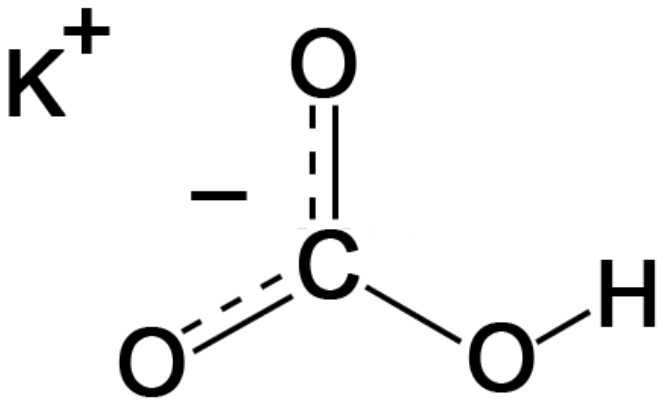
http://cfbt-us.com/wordpress/?p=1818

THEORY:

- **Similarity as to how PKP/Sodium Bi-Carbonate attacks the leg of the fire triangle by "inerting" the free forming radicals of Class B combustion**
- **Removal of fuel = removal of toxic by-products**





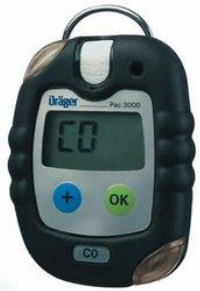


Data Collection

- Burn Cell- 40’ (11.2m) with a room constructed inside.
  16’ x 8.5’ x 9.5’ (4.5m x 2.4m x 2.7m)
- Dates- 3 Dates
- Fuel Load- Donations/Curbside
- Gas Monitoring- Fire Growth
- Fire Behavior- UL NIST
- Suppression- Repetition, Best Practices
- Data Collection- Drager Tubes, PAC and Xam meters.

Data Collection

- Overhaul- Ventilation, Monitors
- Cell re-set for next test fire
- Decontamination-
- Gross/Field Decon: PPE/SCBA
- Personal Hygiene

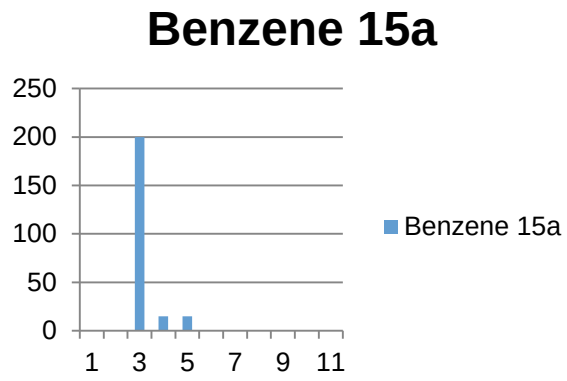


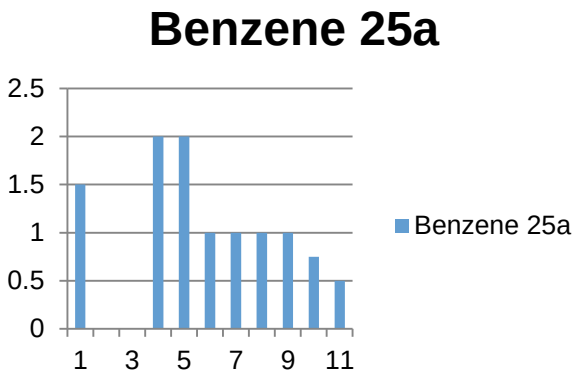
Limitations

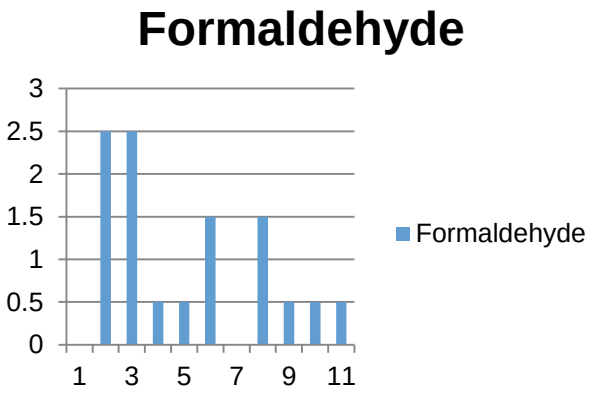
- Dates: 3 Separate Dates: Tuesday, Thursday, Tuesday
- Structure: 40' Shipping Container- Room ~ 16' x 8.5' x 9.5'
- Fuel Load: 1- Couch, 1- Love Seat, or 2- Stuffed Chairs
- Monitoring Equipment: +/- Colorimetric Tubes 15%
- Field Test- Field Test is a Field Test, Validity. However, ever fire is a field test.
- Cross Contamination- every effort made to control/ventilate for cross contamination, CO/HCN monitors, CO/HCN not always a good gauge
- Same hose, nozzle, gpm and cfm
- CAFS: Consistency- 1st 3 Fires- well based foam, 2nd 3 Fires bucket educted.

Results

- Water vs. CAFS
- CAFS reduction vs Water
- Benzene 15A, 25A and Formaldehyde
- CAFS A vs. CAFS B
- CAFS B reduction vs. CAFS A
- Benzene 25A and Formaldehyde







Going Forward/Additional Research

- Field Tests repeated- Theory into law
- More Equipment Required- material, more foam concentrate brands, etc.
- Fireground Monitoring Equipment
- Lab Based Testing
- Class B CAFS

Use of CAFS & Class A Foam: Going Forward

- Outside/ In Approach- Reduce Exposure
- Vapor Suppression- Not argued
- Post Fire Environment
  - Overhaul- CAFS (Do not rely on CO & HCN monitoring alone)
  - Reduce/Eliminate Off Gassing
  - Wider scopes of gas monitoring
  - Investigations- Seattle Fire Dept. SCBA 24 Hr. Post Fire, Arson Investigation
- Decontamination
- continue to integrate
- Best practices- Europe/Germany/International Model
- Use of PPE/SCBA early on scene

EFO Program

- Thank you
- My wife (EFO Widow)
- My EFO classmates/friends/brothers
- Fire Service Mentors: Eddie Enright, Pete Van Dorpe, Marty Kunkel, Craig Haigh, Tim Leidig
- Family, Friends, and students (Current & Alumni)
- Dr. Burchell and Monica Kreiter- Fox Valley Career Center
- Carol Abrahamson
- Supporters: Frank Albello (Drager), Dave Pelton (Solberg Foam), John Dinnsen (Big Rock Fire Dept.), Chris Hohol (Howard Fire Dept.)
- John Carnegis and NFA/EFO Staff (Angie & Crystal)
- EFO Instructor Cadre
- Chief Robert Bennett (going to bat for the project)
- University Of Illinois Fire Service Institute
- Expectations of the EFO Program
- God Bless those that serve and have served.
- Public Safety Lives Matter
- https://nfa.usfa.fema.gov/pdf/efop/efo49838.pdf