

# THE POTENTIAL REDUCTION OF FIREFIGHTER EXPOSURE TO CARBON-BASED CARCINOGENS IN STRUCTURE FIRES THROUGH THE USE OF CLASS A COMPRESSED AIR FOAM SYSTEMS

Gary Baum MS Ed, MA Ed, EFO, CFO  
Lead Instructor  
Fox Valley Career Center Fire Science  
Deputy Chief  
Reddick Community Fire Protection District  
Reddick, IL



# WHY?

- Knowledge of chemistry
- HS Freshman Physics/Chemistry
- Modern Fire Behavior
- Dave Dodson, Pete VanDorpe, Phil Jose (ROAM), UL Tests, NIST Data, Drager: CO/HCN videos, Cal Poly Tech 2014
- Understand the Toxic Byproducts of combustion
- New Car/Carpet Smell
- Off gassing of synthetic materials based upon their composition (solidified comfortable gasoline).
- Crude Oil in a cracking tower.
- 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 v. 3 Dimensional



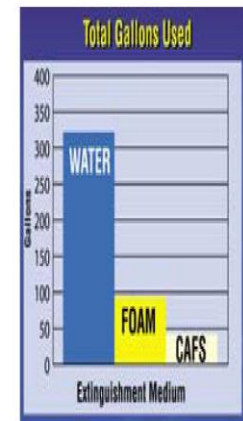
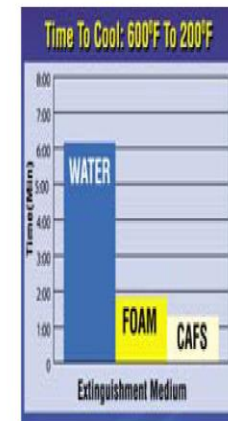
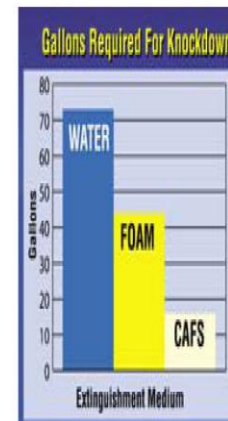
Periodic Table of the Elements



Class A foam 40% better than water

Class A foam 71% better than water

Class A foam 71% better than water



# WHAT

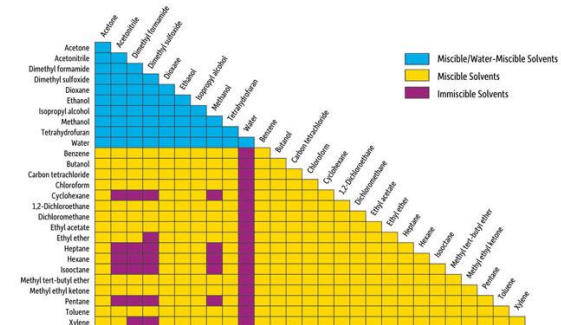
- “Today’s fires are truly”
- **Hazmat Incidents**
- **Chemical/Physical Properties of Class A Foam**
  - **Surfactants-reduces water surface tension**
  - **Carbon-philic: loves carbon based particles**
  - **Affinity- Miscibility of polar solvents and hydrocarbons**
  - **Polar solvent- water and polar solvent makes a polar solvent**
- **Agent Application: 2-D v 3-D**
  - **3 Dimensional Fire Compartment Environment**
  - **Tens of thousands of tiny-hard bubbles.**



## Surface Tension of Water

Plain Water

Water + Surfactant



# 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 solid projects
- **CAFS/Foam Industry: Hale, Pierce, Darley, Chemguard, National, CAFS advocates, Jim Cottrell Assoc., Europe (UK-ARFF Class B)**
- Replication of best test practices
- Field Validity
- Firefighter Cancer Support Network- White Paper

U.S. Fire Administration/Technical Report Series

## Compressed Air Foam for Structural Fire Fighting: A Field Test

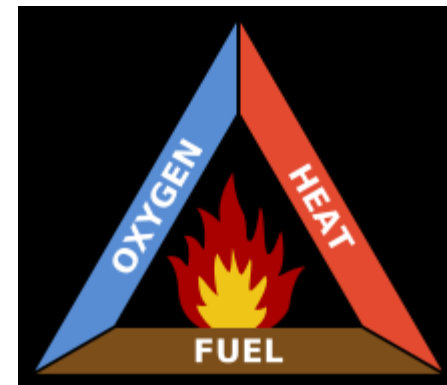
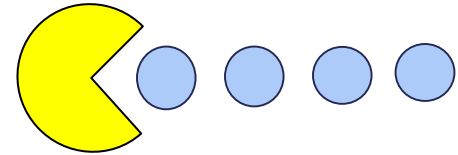
Boston, Massachusetts

USFA-TR-074/January 1994



# THEORY:

- Toxic carbon based byproducts of combustion
- Off gassing of gas, vapors, aerosols
- Suspended in a 3-D atmosphere
- 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 less water, SHLOAD of bubbles, Philic, Affinity
- Similarity as to how PKP attacks the leg of the fire triangle by “inerting” the free forming radicals of Class B combustion
- Removal of fuel = removal of toxic byproducts



# DATA COLLECTION

- Burn Cell- 40' with room constructed inside
- Fuel Load- Donations/Curbside
- Gas Monitoring- Fire Growth
- Fire Behavior- UL NIST
- Suppression- Repetition, Best Practices
- Data Collection- Drager Tubes
- Overhaul- Ventilation, Monitors
- Dates- 3 Dates
- Decontamination-
- Gross/Field Decon: PPE/SCBA
- Personal Hygiene



# LIMITATIONS

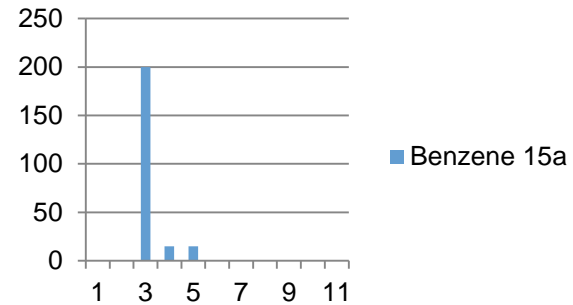
- **Dates:** 3 Separate Dates: Tuesday, Thursday, Tuesday
- **Structure:** 40' Shipping Container- Room ~ 15' x 8' x 9'
- **Fuel Load:** Couch, Love Seat, Stuffed Chairs
- **Monitoring Equipment:** +/- Colorimetric Tubes 15%
- **Field Test-** Field Test is a Field Test, Validity. However, ever fire is 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- 1<sup>st</sup> 3 Fires- well based foam, 2<sup>nd</sup> 3 Fires bucket educted.



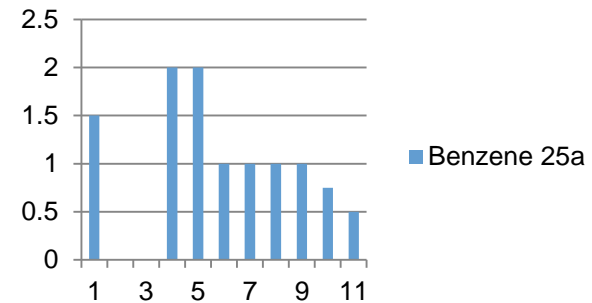
# RESULTS

- 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

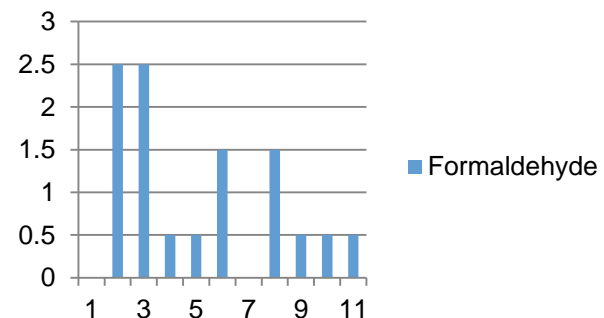
### Benzene 15a



### Benzene 25a



### Formaldehyde





# GOING FORWARD/ADDITIONAL RESEARCH

- Field Tests repeated- *Theory into law*
- More Equipment Required- *material, more foam concentrates, etc.*
- Fireground Monitoring Equipment
- Lab Based Testing



# USE OF CAFS & CLASS A FOAM: GOING FORWARD

- Outside/ In Approach- Reduce Exposure
- Vapor Suppression- Not argued
- Post Fire Environment
  - Overhaul- CAFS
  - 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
- Use of PPE/SCBA early on scene



CONCENTRATION DATE TIME VALIDITY				Fuel Load: 1 couch	
Suppression Agent: Water, 1-3/4" line with 125 gpm TFT Adjustable Gallon Combination Nozzle					
MAXIMUM: 8687.7 ppm			04 Dec 2018 11:51:02		
MINIMUM: 0.0 ppm			04 Dec 2018 11:46:02		
AVERAGE: 6401.2 ppm					
BENZENE					
DATE	TIME	MAX	MIN	AVG	
4-Dec-10	11:46:02	0.6	0	0.0 ...	
4-Dec-10	11:46:32	1.2	0.9	0.1 ...	
4-Dec-10	11:47:02	12.9	6.1 9	.3 ...	
4-Dec-10	11:47:32	14.6	7.3 9	.8 ...	
4-Dec-10	11:48:02	120.3	98.5	63.5 ...	
4-Dec-10	11:48:32	1200.2	1107.3	1047.7	
4-Dec-10	11:49:02	3687.2	2099.4	2237.1	
4-Dec-10		4287.4	4199.2	4237.1	
4-Dec-10	11:50:02	6687	5099.4	6412.1	
4-Dec-10	11:50:32	7187.5	7099.4	7227	
4-Dec-10	11:51:02	8687.7	7039.3	7213.1	
4-Dec-10	11:51:32	8571.4	7567.4	7347.1	
4-Dec-10	11:52:02	8606.1	8497.9	8546.4	
4-Dec-10	11:52:32	8516.2	8419.4	8406.5	
4-Dec-10	11:53:02	8445.1	8294.2	8381.5	
4-Dec-10	11:53:32	8317.3	8179.4	8253.6	
4-Dec-10	11:54:02	8200.2	8107.3	8147.7	
4-Dec-10	11:54:32	7687.2	7099.4	7237.1	
4-Dec-10	11:55:02	7287.4	6199.2	6237.1	
4-Dec-10	11:55:32	6687	5099.4	5412.1	
4-Dec-10	11:56:02	6187.5	4099.4	4227	
4-Dec-10	11:56:32	6082.7	4039.3	4213.1	
4-Dec-10	11:57:02	6287.4	6199.2	6237.1	
4-Dec-10	11:57:32	5087	5099.4	5412.1	
4-Dec-10	11:58:02	4187.5	4099.4	4227	
4-Dec-10	11:58:32	8622.5	8556.1	8596.3	
4-Dec-10		8606.1	8497.9	8546.4	
4-Dec-10	11:59:32	8607.2	8419.4	8486.5	
4-Dec-10	12:00:02	8445.1	8294.2	8381.5	
4-Dec-10	12:00:32	8517.3	8179.4	8253.6	
4-Dec-10	12:01:02	8210.2	8107.3	8147.7	
4-Dec-10	12:01:32	7687.2	7099.4	7237.1	
4-Dec-10	12:02:02	7264.4	6199.2	6237.1	
4-Dec-10	12:02:32	6686	5099.4	5412.1	
4-Dec-10	12:03:02	5146.5	4099.4	4227	
4-Dec-10	12:03:32	3687.7	2039.3	2213.1	
4-Dec-10	12:04:02	1434.2	513.1	1210	
4-Dec-10	12:04:32	961.2	527.1	410.1	

START: 04Dec10 12:00:02		STOP: 04Dec10 12:18:32					
CONCENTRATION DATE TIME VALIDITY				Fuel Load: 1 Couch			
Suppression Agent: Water, 1-3/4" line with 125 gpm TFT Adjustable Gallon Combination Nozzle							
MAXIMUM: 8687.7 ppm 04Dec10 12:05:02				MINIMUM: 0.0 ppm 04Dec10 12:00:02			
				AVERAGE: 6401.2 ppm			
BENZENE							
DATE	Time	MAX	MIN	AVG			
4-Dec-10	13:00:02 P	0.2	0	0.0 ...			
4-Dec-10	13:00:32 P	0.4	0	0.1 ...			
4-Dec-10	13:01:02 P	12.2	6.4	6.2 ...			
4-Dec-10	13:01:32 P	14.6	7.3	6.8 ...			
4-Dec-10	13:02:02 P	120.3	98.5	93.5 ...			
4-Dec-10	13:02:32 P	1200.2	1107.3	1047.7			
4-Dec-10	13:03:02 P	3687.2	2099.4	2237.1			
4-Dec-10	13:03:32 P	4287.4	4199.2	4237.1			
4-Dec-10	13:04:02 P	6687	5099.4	6412.1			
4-Dec-10	13:04:32 P	7187.5	7099.4	7227			
4-Dec-10	13:05:02 P	8687.7	7039.3	7213.1			
4-Dec-10	13:05:32 P	8571.4	7567.4	7347.1			
4-Dec-10	13:06:02 P	8606.1	8497.9	8546.4			
4-Dec-10	13:06:32 P	8516.2	8419.4	8406.5			
4-Dec-10	13:07:02 P	8445.1	8294.2	8381.5			
4-Dec-10	13:07:32 P	8317.3	8179.4	8253.6			
4-Dec-10	13:08:02 P	8200.2	8107.3	8147.7			
4-Dec-10	13:08:32 P	7687.2	7099.4	7237.1			
4-Dec-10	13:09:02 P	7287.4	6199.2	6237.1			
4-Dec-10	13:09:32 P	6687	5099.4	5412.1			
4-Dec-10	13:10:02 P	6187.5	4099.4	4227			
4-Dec-10	13:10:32 P	6082.7	4039.3	4213.1			
4-Dec-10	13:11:02 P	6287.4	6199.2	6237.1			
4-Dec-10	13:11:32 P	5087	5099.4	5412.1			
4-Dec-10	13:12:02 P	4187.5	4099.4	4227			
4-Dec-10	13:12:32 P	8622.5	8556.1	8596.3			
4-Dec-10	13:13:02 P	8606.1	8497.9	8546.4			
4-Dec-10	13:13:32 P	8607.2	8419.4	8486.5			
4-Dec-10	13:14:02 P	8445.1	8294.2	8381.5			
4-Dec-10	13:14:32 P	8317.3	8179.4	8253.6			
4-Dec-10	13:15:02 P	8200.2	8107.3	8147.7			
4-Dec-10	13:15:32 P	7687.2	7099.4	7237.1			
4-Dec-10	13:16:02 P	7287.4	6199.2	6237.1			
4-Dec-10	13:16:32 P	6687	5099.4	5412.1			
4-Dec-10	13:17:02 P	6187.5	4099.4	4227			
4-Dec-10	13:17:32 P	4687.7	2039.3	2213.1			
4-Dec-10	13:18:02 P	1634.6	519.8	1200.1			
4-Dec-10	13:18:32 P	1361.2	527.1	410.1			

START: 05 Dec 2018 11:30:01		STOP: 05 Dec 2018 1:38:31		Fuel Load: 1 Couch			
CONCENTRATION DATE TIME VALIDITY							
Suppression Agent: CAFS 0.5% Brand 1 125 gpm wet CAFS							
MAXIMUM: 2091.9 ppm 05Dec18 11:34:31				MINIMUM: 0.4 ppm 05Dec18 11:48:31			
BENZENE				AVERAGE: 64.6 ppm			
DATE	TIME	MAX	MIN	AVG			
5-Dec-18	11:30:01	18.6	17.2	17.9 ...			
5-Dec-18	11:30:31	30.7	18.1	24.9 ...			
5-Dec-18	11:31:01	28.3	18.6	21.6 ...			
5-Dec-18	11:31:31	28.1	18.5	21.0 ...			
5-Dec-18	11:32:01	31.9	19.7	26.1 ...			
5-Dec-18	11:32:31	32.3	17.4	19.4 ...			
5-Dec-18	11:33:01	121.7	32.3	78.7 ...			
5-Dec-18	11:33:31	162.8	121.7	142.3 ...			
5-Dec-18	11:34:01	913.5	162.8	538.2			
5-Dec-18	11:34:31	2091.9	1025.4	1558.6			
5-Dec-18	11:35:01	845.4	222	533.7 ...			
5-Dec-18	11:35:31	524.6	216.8	370.7 ...			
5-Dec-18	11:36:01	266.7	119.2	192.5 ...			
5-Dec-18	11:36:31	113.7	12.2	62.7 ...			
5-Dec-18	11:37:01	82.2	46.2	64.2 ...			
5-Dec-18	11:37:31	11.2	10.3	10.8 ...			
5-Dec-18	11:38:01	10.3	9.3	9.8 ...			
5-Dec-18	11:38:31	9.6	7.7	8.8 ...			

START: 05 Dec 2018 12:58:42

STOP: 05 Dec 2018 13:19:12

Fuel Load: 1 Couch

Suppression Agent: CAFS 0.5% Brand 2 AFFF Liquid Foam/Wetting agent 125 gpm wet CAFS

MAXIMUM: 1447.3 ppm 05Dec18 13:14:12 MINIMUM: -10.3 ppm 05Dec18 12:56:03

						AVERAGE: 130.4 ppm	
BENZENE							
DATE	TIME	MAX	MIN	AVG	FLAGS		
5-Dec-18	12:58:42	30.1	23.9	27.7 ...			
5-Dec-18	12:59:12	30.2	14.9	22.0 ...			
5-Dec-18	12:59:42	14.6	11.6	12.6 ...			
5-Dec-18	13:00:12	27.6	11.4	15.9 X..			
5-Dec-18	13:00:42	39	27.6	35.2 ...			
5-Dec-18	13:01:12	44.8	35.6	40.4 X..			
5-Dec-18	13:01:42	36.1	29.4	33.3 X..			
5-Dec-18	13:02:12	32.2	29.4	31.0 ...			
5-Dec-18	13:02:42	32.6	30.3	31.5 ...			
5-Dec-18	13:03:12	32.3	24.5	30.4 ...			
5-Dec-18	13:03:42	24.5	13.6	16.7 ...			
5-Dec-18	13:04:12	35.9	16.5	26.5 ...			
5-Dec-18	13:04:42	35.1	23.3	27.2 ...			
5-Dec-18	13:05:12	23.1	15	18.9 ...			
5-Dec-18	13:05:42	18.7	16.4	17.6 ...			
5-Dec-18	13:06:12	16.7	15.5	16.1 ...			
5-Dec-18	13:06:42	16.5	15.4	15.8 ...			
5-Dec-18	13:07:12	19.3	15.6	17.9 ...			
5-Dec-18	13:07:42	31.1	13.4	22.1 ...			
5-Dec-18	13:08:12	39.5	29.2	31.0 ...			
5-Dec-18	13:08:42	89.5	42	78.2 ...			
5-Dec-18	13:09:12	88.8	68.5	75.3 ...			
5-Dec-18	13:09:42	68.5	62.2	64.2 ...			
5-Dec-18	13:10:12	85.8	60.3	69.0 ...			
5-Dec-18	13:10:42	120.5	68.9	94.6 ...			
5-Dec-18	13:11:12	284.4	120.5	182.2			
5-Dec-18	13:11:42	366.9	274.6	323.1			
5-Dec-18	13:12:12	598.1	366.9	469.3			
5-Dec-18	13:12:42	885.5	598.1	738.6			
5-Dec-18	13:13:12	1170.5	885.5	1026.1			
5-Dec-18	13:13:42	1421.8	1170.5	1305.7			
5-Dec-18	13:14:12	1447.3	1271.9	1403.1			
5-Dec-18	13:14:42	1271.9	542.3	947.9			
5-Dec-18	13:15:12	542.3	221.3	347			
5-Dec-18	13:15:42	221.3	107.9	157.7			
5-Dec-18	13:16:12	107.9	41.7	70.2 ...			
5-Dec-18	13:16:42	41.7	31.6	34.4 ...			
5-Dec-18	13:17:12	32	31.4	31.7 ...			
5-Dec-18	13:17:42	32	31.4	31.7 ...			
5-Dec-18	13:18:12	32.2	31.3	31.8 ...			
5-Dec-18	13:18:42	32.3	31.7	31.9 ...			

START: 05Dec18 15:35:35		STOP: 05Dec18 15:45:07			Fuel Load: 1 Couch		
Suppression Agent: CAFS 0.5% Brand 3 125 gpm wet CAFS							
MAXIMUM: 1968.7 ppm 05Dec18 15:39:36				MINIMUM: 0.7 ppm 05Dec18 15:36:06			
BENZENE				AVERAGE: 106.7 ppm			
DATE	TIME	MAX	MIN	AVG	FLAGS		
5-Dec-18	15:36:06	1.1	0.7	1.5 ...			
5-Dec-18	15:36:36	1.3	0.9	1.6 ...			
5-Dec-18	15:37:06	2.6	2.1	1.5 ...			
5-Dec-18	15:37:36	3.9	6.1	4.5 ...			
5-Dec-18	15:38:06	15.8	6.6	1.1 ...			
5-Dec-18	15:38:36	21.8	2.5	14.2 ...			
5-Dec-18	15:39:06	1189.2	3.3	95			
5-Dec-18	15:39:36	1968.7	589.2	1278.9			
5-Dec-18	15:40:06	518.6	93.5	155.3 ...			
5-Dec-18	15:40:36	165.3	104.6	127.0 ...			
5-Dec-18	15:41:06	343.5	55.3	190.9 ...			
5-Dec-18	15:41:36	81.9	51.6	68.6 ...			
5-Dec-18	15:42:06	55.2	5.4	26.9 ...			
5-Dec-18	15:42:36	55.4	3.8	3.9 ...			
5-Dec-18	15:43:06	45.8	8	3.7 ...			
5-Dec-18	15:43:36	36.8	4.8	2.7 ...			
5-Dec-18	15:44:06	28.3	4.9	1.2 ...			
5-Dec-18	15:44:36	29.1	9.6	3.0 ...			
5-Dec-18	15:45:06	19.7	16.7	47.6 ...			

1. START: 06Dec18 10:03:58		STOP: 06Dec18 10:13:30		Fuel Load	1 COUCH
Suppression Agent: Water, 1-3/4" line with 125 gpm TFT Adjustable Gallon Combination Nozzle					
MAXIMUM: 9610.9 ppm 06Dec18 10:08:28 MINIMUM: -58.1 ppm 06Dec18 10:03:58 OKAY					
AVERAGE: 5621.8 ppm			BENZENE		
DATE	TIME	MAX	MIN	AVG	
6-Dec-18	10:03:58	-41.5	-58.1	-50.3 ...	
6-Dec-18	10:04:28	-40.7	-55.3	-45.2 ...	
6-Dec-18	10:04:58	-44.8	-56.9	-51.3 ...	
6-Dec-18	10:05:28	-39	-52.2	-42.6 ...	
6-Dec-18	10:05:58	-26.3	-43.4	-36.3 ...	
6-Dec-18	10:06:28	950.8	-43.4	215.1	
6-Dec-18	10:06:58	950.8	185.3	379.3	
6-Dec-18	10:07:28	8522.3	435.1	5270	
6-Dec-18	10:07:58	9596.2	8522.3	9145	
6-Dec-18	10:08:28	9610.9	9335.6	9496.5	
6-Dec-18	10:08:59	9387.1	9161.9	9306.4	
6-Dec-18	10:09:29	9271	9128.9	9202.2	Suppression
6-Dec-18	10:09:59	9213.8	8987.8	9114	
6-Dec-18	10:10:29	8995.2	8704.3	8875	
6-Dec-18	10:10:59	8704.3	8578.2	8632.8	
6-Dec-18	10:11:29	8665.3	8523.9	8600.8	
6-Dec-18	10:11:59	8716.9	8625.7	8671.9	
6-Dec-18	10:12:29	8669	8578	8625.2	
6-Dec-18	10:12:59	8665.6	8519.9	8612.5	
6-Dec-18	10:13:30	8518.1	8437.4	8473.1	



2. START: 06Dec18 10:46:50		STOP: 06Dec18 10:52:50			Fuel Load: 1 Couch		
Suppression Agent: 1-1/2" TFT CAFS Nozzle 1-3/4" Line, Agent Brand 4 at 0.4% Wet CAFS							
MAXIMUM: 6444.0 ppm				MINIMUM: -37.4 ppm			
BENZENE				AVERAGE: 618.4 ppm			
DATE	TIME	MAX	MIN	AVG			
6-Dec-18	10:46:50	-20.6	-37.4	-29.9 ...			
6-Dec-18	10:47:20	-25.6	-33.6	-28.7 ...			
6-Dec-18	10:47:50	-25.2	-32.2	-29.9 ...			
6-Dec-18	10:48:20	36.8	15.4	26.1 ...			
6-Dec-18	10:48:50	6444	39.8	2853.4			
6-Dec-18	10:49:20	2930.1	779.5	1435			
6-Dec-18	10:49:50	2311.7	142.7	1173.3	Suppression		
6-Dec-18	10:50:20	142.7	40.2	76.1 ...			
6-Dec-18	10:50:50	40.2	4.5	16.3 ...			
6-Dec-18	10:51:20	78	4.6	21.5 ...			
6-Dec-18	10:51:50	135	78	92.2 ...			
6-Dec-18	10:52:20	71	58	41.5 ...			
6-Dec-18	10:52:50	38.7	7	22.5 ...			

3. START: 06Dec18 11:27:53		STOP: 06Dec18 11:42:57		Fuel Load: 1 Couch			
Suppression Agent: 1" POK CAFS Nozzle 1" Line, Agent Brand 3 at 0.5% Wet CAFS							
MAXIMUM: 6670.6 ppm 11:32:5 MINIMUM: 11.1 ppm 11:27:53							
DATE	TIME	MAX	MIN	AVG	AVERAGE: 288.1 ppm		
6-Dec-18	11:27:53	14	11.1	13.0 ...			
6-Dec-18	11:28:23	14.5	13.9	14.2 ...			
6-Dec-18	11:28:53	14.6	13.7	14.2 ...			
6-Dec-18	11:29:23	13.7	12.9	13.2 ...			
6-Dec-18	11:29:53	13.2	12.5	12.9 ...			
6-Dec-18	11:30:23	13.7	12.5	13.2 ...			
6-Dec-18	11:30:53	13.6	12.9	13.3 ...			
6-Dec-18	11:31:23	24.9	13.6	18.2 ...			
6-Dec-18	11:31:53	165.4	20.6	92.9 ...			
6-Dec-18	11:32:24	3523.7	97.4	535.6			
6-Dec-18	11:32:54	6670.6	1730.7	3696.7			
6-Dec-18	11:33:24	6546.4	756.9	2565.7	Suppression		
6-Dec-18	11:33:54	756.9	512.4	605.2			
6-Dec-18	11:34:24	820.8	50.2	402.5			
6-Dec-18	11:34:54	137.6	44.5	96.8 ...			
6-Dec-18	11:35:24	134.7	67.9	106.3 ...			
6-Dec-18	11:35:54	67.9	44.4	50.9 ...			
6-Dec-18	11:36:25	53	46.7	50.8 ...			
6-Dec-18	11:36:55	52.2	40.5	46.1 ...			
6-Dec-18	11:37:25	67.5	40.5	49.4 ...			
6-Dec-18	11:37:55	129.4	67.5	103.6 ...			
6-Dec-18	11:38:25	128.5	72	92.7 ...			
6-Dec-18	11:38:55	73.9	61.1	67.2 ...			
6-Dec-18	11:39:26	65.6	58.9	62.2 ...			
6-Dec-18	11:39:56	59.8	55	57.9 ...			
6-Dec-18	11:40:26	60.2	23.2	37.8 ...			
6-Dec-18	11:40:56	42.5	35.8	39.5 ...			
6-Dec-18	11:41:26	38.2	37.5	37.8 ...			
6-Dec-18	11:41:56	38.3	37.7	38.1 ...			
6-Dec-18	11:42:27	38.5	37.8	38.2 ...			
6-Dec-18	11:42:57	37.8	15.6	20.8 .			

4. START: 06Dec18 12:14:14		STOP: 06Dec18 12:24:17		Fuel Load: 1 Couch		
MAXIMUM: 7586.3 ppm 06Dec18 12:19:06		MINIMUM: -11.1 ppm 06Dec18 12:14:42				
Suppression Agent: 1-1/2" TFT CAFS Nozzle 1-3/4" Line, Agent Brand 4 at 0.4% Wet CAFS						
BENZENE						
DATE	TIME	MAX	MIN	AVG	AVERAGE: 1450.2 ppm	
6-Dec-18	12:14:44	6.6	-11.1	-4.1 ...		
6-Dec-18	12:15:15	-5.5	-9.6	-7.1 ...		
6-Dec-18	12:15:45	-4.3	-5.7	-5.0 ...		
6-Dec-18	12:16:15	2.6	-5.1	-1.5 ...		
6-Dec-18	12:16:45	2.5	-2.7	1.4 ...		
6-Dec-18	12:17:15	7.2	1.9	3.6 ...		
6-Dec-18	12:17:45	3.5	1.4	2.2 ...		
6-Dec-18	12:18:15	160	-0.6	65.0 ...		
6-Dec-18	12:18:46	1703.9	160	697.4		
6-Dec-18	12:19:16	7586.3	233	4674.2		
6-Dec-18	12:19:46	7500.9	6966.5	7383.8		
6-Dec-18	12:20:16	7391.1	7133.7	7290.3		
6-Dec-18	12:20:46	7122.8	6284.7	6779.9	Suppression	
6-Dec-18	12:21:16	6284.7	1223.9	4378.4		
6-Dec-18	12:21:46	1223.9	135.4	298.3		
6-Dec-18	12:22:16	135.4	37.6	79.8		
6-Dec-18	12:22:46	37.6	23.6	29.9 ...		
6-Dec-18	12:23:16	23.6	22	22.7 ...		
6-Dec-18	12:23:47	23.8	22	22.7 ...		
6-Dec-18	12:24:17	23.4	22.6	22.9 ...		

5. START: 06Dec18 13:30:47		STOP: 06Dec18 13:42:47		Fuel Load: 1 Couch	
Suppression Agent: 1-1/2" TFT CAFS Nozzle 1-3/4" Line, Agent Brand 3 at 0.5% Wet CAFS					
MAXIMUM: 8152.6 p		BENZENE		MINIMUM: -52.5 ppm 06Dec18 13:30:36	
DATE	TIME	MAX	MIN	AVG	
6-Dec-18	13:30:47	-21.6	-52.5	-29.5 ...	AVERAGE: 130.0 ppm
6-Dec-18	13:31:17	-21.3	-24.1	-22.2 ...	
6-Dec-18	13:31:47	-23.9	-31.8	-26.5 ...	
6-Dec-18	13:32:17	-11.2	-34.7	-29.3 ...	
6-Dec-18	13:32:47	11.2	-17.6	-3.1 ...	
6-Dec-18	13:33:01	7			
6-Dec-18	13:33:47	50.8	-8.1	-2.0 ...	
6-Dec-18	13:34:17	6763.1	50.8	4233.4	
6-Dec-18	13:34:47	8152.6	3440.7	5079.5	
6-Dec-18	13:35:17	8108.5	6818.6	7634.5	
6-Dec-18	13:35:47	7731.7	7160.8	7472.9	
6-Dec-18	13:36:17	7160.8	5660.6	6489.1	Suppression
6-Dec-18	13:36:47	5660.6	325.2	3004.5	
6-Dec-18	13:37:17	377.7	248.1	304.9	
6-Dec-18	13:37:47	386.5	331.4	368.8	
6-Dec-18	13:38:17	331.4	210.9	272.7	
6-Dec-18	13:38:47	210.9	108.5	151.6	
6-Dec-18	13:39:17	108.5	45.9	74.0 ...	
6-Dec-18	13:39:47	45.9	20.6	30.0 ...	
6-Dec-18	13:40:17	20.9	6.8	19.0 ...	
6-Dec-18	13:40:47	19.4	-20.3	6.7 ...	
6-Dec-18	13:41:17	17	14.7	15.8 ...	
6-Dec-18	13:41:47	17.1	5.7	11.3 ...	
6-Dec-18	13:42:17	5.7	1.6	3.1 ...	
6-Dec-18	13:42:47	2.6	1.4	2.1 ...	

6. START: 06Dec18 15:58:40		STOP: 06Dec18 16:08:10			Fuel Load: 1 Couch		
Suppression Agent: 1-1/2" TFT CAFS Nozzle 1-3/4" Line, Agent Brand 3 at 1% Dry CAFS							
MAXIMUM: 8289.8 ppm 06Dec18 16:02:10				MINIMUM: 3.7 ppm 06Dec18 16:08:10			
DATE			BENZENE		AVERAGE: 2533.9 ppm		
6-Dec-18	TIME	MAX	MIN	AVG			
6-Dec-18	15:58:40	38.9	45.3	42.1 ...			
6-Dec-18	15:59:10	38.5	24.6	31.5 ...			
6-Dec-18	15:59:40	1091	126.5	608.7			
6-Dec-18	16:00:10	1789.2	138.3	963.7			
6-Dec-18	16:00:40	4010.5	535.6	2273.5			
6-Dec-18	16:01:10	4203.9	547	2375.4			
6-Dec-18	16:01:40	8092.6	642.3	4367.4			
6-Dec-18	16:02:10	8289.8	7923.1	8095			
6-Dec-18	16:02:40	7930.5	7347.1	7710			
6-Dec-18	16:03:10	7347.1	3557.2	5808.8	Suppression		
6-Dec-18	16:03:40	3557.2	198.2	1629.3			
6-Dec-18	16:04:10	6703	145.2	2392.6			
6-Dec-18	16:04:40	8056.5	6703	7730.8			
6-Dec-18	16:05:10	7369.7	3881.6	6032.2			
6-Dec-18	16:05:40	3881.6	12.3	1152.1			
6-Dec-18	16:06:10	32	5.6	18.8 ...			
6-Dec-18	16:06:40	30.8	19.5	24.3 ...			
6-Dec-18	16:07:10	19.8	6.2	12.8 ...			
6-Dec-18	16:07:40	28.2	13	11.4 ...			
6-Dec-18	16:08:10	13.2	3.7	8.5 ...			

# EFO PROGRAM

- Thank you
- My wife (EFO Widow)
- My classmates/friends/brothers (Phil, Billy, Tim Ray, Joe Murray,
- Fire Service Mentors: Eddie Enright, Pete Van Dorpe, Marty Kunkel, Craig Haigh, Tim Leidig, Rick Isaacks, Mark Cummins and many more!
- Family, Friends, and students (Current & Alumni)
- Dr. Burchell and Monica Kreiter
- Carol Abrahamson
- Supporters: Frank Albello (Drager), Dave Pelton (Solberg Foam), Big Rock, IL Fire Dept., Chris Hohol (Howard, WI Fire Dept.), Jeremy Foxx (Hale), Rick Isaacks & Glenn McClanahan (Johnson Control).
- John Carnegis and NFA/EFO Staff (Angie & Crystal)
- EFO Instructor Cadre
- Chief Robert Bennett (going to bat for the project)
- Expectations of the EFO Program
- God Bless those that serve and have served.
- Public Safety Lives Matter

