The Elephant on the Fire Ground: Secrets of NFPA 1584 Compliant Rehab

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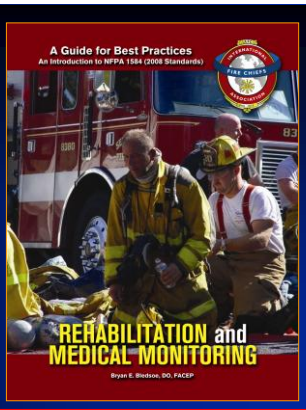
Resources



Disclosures

- I am on the speakers bureau for Masimo Corporation and Dey, LLP
- I am the Fire/EMS technical editor for Fire Engineering magazine.
- I do not intend to discuss any unlabeled or unapproved uses of drugs or products.

Firefighting

- Greatest short surge physiologic demands of any profession.
- 10% firefighter time spent on fireground
  - 50% of deaths & 66% of injuries occur on scene.

Firefighter LODDs – Likely Culprits:

- Medical condition
- Fitness
- Rehab

Attempts to reduce FF deaths

- Medical condition
  - NFPA 1582 set medical requirements for firefighting
- Fitness
  - NFPA 1583 set fitness standards
- Rehab
  - The next ~~logical step~~
  - For fit, medically qualified firefighters

What is Rehab?

- "Restore condition of good health"
- Mitigate effects of physical & emotional stress of firefighting:
  - Sustain or restore work capacity
  - Improve performance
  - Decrease injuries
  - Prevent deaths

Firefighter Rehab – NFPA 1584

- National Fire Protection Association 1584 "Standard on the Rehabilitation Process for Members During Emergency Operations and Training Exercises"
- Originally issued in 2003, revision effective December 31, 2007.
- Every fire department responsible for developing and implementing rehab SOGs

NFPA 1584 Scope

Covered:
- Rescue
- Fire suppression
- EMS
- Haz Mat mitigation
- Special Ops
- Other emer svces incl. public, private, military & industrial FDs

NOT Covered:
- Industrial fire brigades (emergency brigades)
- Fire teams
- Plant emerg organizations
- Mine emerg teams

Elements of Compliance

- SOGs outline how rehab will be provided at incidents and training exercises (where FF expected to work 1 hour or more)
- Minimum BLS level transport capable EMS on scene
- Integrated into IMS

But we're adults…

Firefighters should know as much as professional athletes about rest, hydration, and endurance.

Hydration and Prehydration

- Firefighters are often dehydrated
- Prehydrate for planned activities:
  - 500 ml fluid within 2 hours prior to event
- Hydrate during events:
  - Water appropriate most of the time
  - Sports drinks after first hour of intense work or 3 hours total incident duration
- Best to consume small amounts (60-120 ml) very frequently - Typical gastric emptying time limits fluid intake to no more than 1 liter per hour.

Sports Drinks

- Usually contain electrolytes and carbohydrates
- Osmolarity (concentration) formulated for maximal absorption
- Absorption limited by gastric emptying time (COH)
- Dilution will extend gastric emptying time and lead to nausea / vomiting

NFPA 1584 - Overview

1. Ongoing education on when & how to rehab.
2. Provide supplies, shelter, equipment, and medical expertise to firefighters where and when needed.
3. Create a safety net for members unwilling or unable to recognize when fatigued.

Who's Responsible for What?

- Department: develop and implement SOGs
- Company Officer:
  - Assess his/her crew every 45 minutes
  - Suggested after 2nd 30-min SCBA bottle
  - Or single 45- or 60-min bottle
  - Or after 40 min intense work without SCBA
- Company Officers can adjust time frames to suit work or environmental conditions

Who's Responsible for What?

- EMS staff must have authority to detain in rehab or transport when obvious indicators of inability to return to full duty are present

IC Rehab Decision Points

IC Rehab Decision Points

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Danger | Extreme Caution | Extreme Danger

IC Rehab Decision Points

Humidex from Temperature and Relative Humidity Readings

Temperature (°C)

Relative Humidity (%)	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
100	29	31	33	35	37	39	41	43	45	48	50	53	55	58									
95	28	30	32	34	36	38	40	42	44	47	49	51	54	56	59								
90	28	30	31	33	35	37	39	41	43	45	48	50	52	55	57	60							
85	27	29	31	32	34	36	38	40	42	44	45	49	51	53	55	58							
80	26	28	30	32	33	35	37	39	41	43	45	47	50	52	54	57	59						
75	26	27	29	31	33	34	36	38	40	42	44	46	48	50	53	55	57						
70	25	27	28	30	32	33	35	37	39	41	43	45	47	49	51	53	56	58					
65	24	26	27	29	31	32	34	36	38	40	42	43	45	47	50	52	54	56					
60	24	25	27	28	30	32	33	35	37	38	40	42	44	46	48	50	52	54	57				
55	23	24	26	27	29	31	32	34	36	37	39	41	43	45	46	48	50	52	55	57			
50	22	24	25	27	28	30	31	33	34	36	38	40	41	43	45	47	48	51	53	55	57		
45	22	23	24	26	27	28	30	32	33	35	37	38	40	42	43	45	47	49	51	53	55	57	
40			24	25	26	28	29	31	32	34	35	37	39	40	42	44	45	47	49	51	53	54	56
35				24	26	27	28	30	31	33	34	35	37	39	40	42	43	45	47	49	50	52	54
30							27	28	30	31	33	34	36	37	39	40	42	43	45	47	48	50	52
25										30	32	33	34	36	37	39	40	42	43	45	46	48	49
20																		40	41	43	44	45	47

Humidex Range (°C)	Degree of Comfort
Less than 29	No discomfort
30-39	Some discomfort
40-45	Great discomfort avoid exertion
Above 45	Dangerous
Above 54	Heat Stroke imminent

IC Rehab Decision Points

Wind Chill Chart

Temperature (°F)

Wind (mph)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5		36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10		34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15		32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20		30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25		29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30		28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35		28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40		27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45		26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50		26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55		25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60		25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes | 10 minutes | 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

What about informal rehab?

- Perfectly acceptable in NFPA 1584
- Company or crew level rehab:
  - SCBA cylinder changes
  - Work transitions (firefighting to overhaul)
  - Small or routine incidents
  - When IC fails to recognize need for rehab

Informal Rehab Requirements:

1. Fluids
2. Shelter
3. Place to remove PPE
4. Seating for members

Nine Key Components of Rehab

1. Relief from climatic conditions
2. Rest and recovery
3. Cooling or rewarming
4. Re-hydration
5. Calorie and electrolyte replacement
6. Medical Monitoring
7. EMS tx according to local protocols
8. Member accountability
9. Release

1. Relief from Climatic Conditions

An area free from smoke and sheltered from extreme heat or cold is provided

1. Relief from Climatic Conditions

- Rehab unit with awning, tent, commercial misters…
- Portable heaters, enclosed unit
- Removed, but not too far from incident
- Vestibule area for removal and storage of PPE

2. Rest and Recovery

- Members afforded ability to rest for at least 10 minutes or as long as needed to recover work capacity

2. Rest and Recovery

- Chairs or seating for each member in rehab area

3. Cooling or Rewarming

- Members who feel hot should be able to remove their PPE, drink water, and be provided with a means to cool off.
- Members who feel cold should be able to add clothing, wrap in blankets, and be provided with a means to warm themselves.

Heat Stress

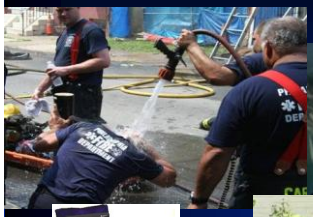
- Body temp should remain 98.6°F ± 1.8° (37°C ± 1°)
- Heat stress = heat load imposed on body
- Internal
  - Exertion
- External
  - Ambient and radiant heat
  - Heat trapping (PPE)

Heat Strain

- Heat strain = the adjustments made in response to heat stress
  - Biochemical
  - Physiological: sweating, tachypnea, vasodilation, tachycardia, etc.
  - Psychological

Cooling Methods

1. Passive
2. Active



Passive Cooling: Evaporation

- Evaporation: water changing from liquid to vapor.
- Even warm water will cool if it evaporates quickly
- Increased humidity diminishes effect

Active Cooling: Convection

- Convection: air stream directed at an object
- Increased temp diminishes effect
  - Changes from cooling to heating above 95°F ambient air temp (the median skin temp)

Active Cooling: Radiation

- Radiation: loosing heat to a cooler environment
- Shade required
- Cooling suits or air conditioning units not typically available on scene

Active Cooling: Conduction

- Conduction: skin contact with a colder material
- Cold ground, cold water, ice, snow
- Water can render PPE ineffective

Active Cooling: Cold Drinks

- Cold Drinks
  - Serves dual purpose of hydration and cooling
- Ability to cool may be limited on scene
  - Drinks usually stored warm - must be cooled or only benefit is hydration

Active Cooling: Devices

- Commercial cooling devices:
  - Forearm immersion chair
  - Vacuum assisted palm cooling
- Limited by size, cost, need for multiple units, user support on scene

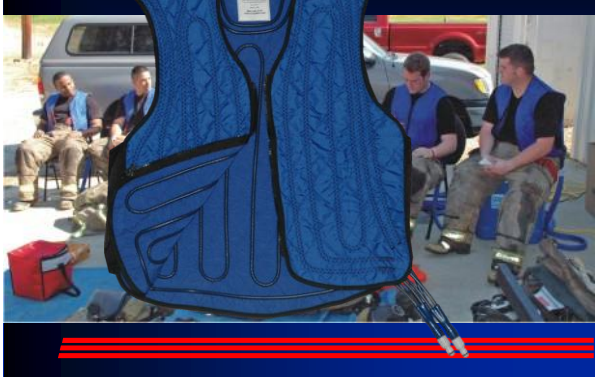
Active Cooling: Cold Towels

- Cold towels employ conductive cooling
- Effective in all temp and humidity levels
- Ice water and cold towels are the most effective method of treating exertional heat illness

Cold Towel – 3 Bucket System

- Bucket 1: sanitizing solution
  - ¼ cup bleach/gallon
- Bucket 2: rinse
  - Clear water removes any left over bleach
- Bucket 3: regeneration
  - Ice water restores cooling effect

Activ… …Vests…



4. Re-hydration

- Potable fluids to satisfy thirst on scene
- Carbonated, caffeinated, high carbohydrate drinks are NOT appropriate

4. Re-hydration

The truth about caffeine:

- Increases urine output
- Does not usually dehydrate (compensatory decline)
- Consumption < 800 mg appears safe for athletes

4. Re-hydration

- Fluid losses of up to 2 liters per hour are not unusual
- No reliable method of assessing hydration status on scene
  - Weights
  - Urine specific gravity
  - ? Saliva testing

4. Re-hydration

- Encourage continued hydration post-incident

5. Calorie and electrolyte replacement

- For longer duration events (exceeding 3 hours or when members are likely to work for more than 1 hour)
- Whenever food is available, means to wash hands and faces must also be provided.

Food

- Fruits, meal replacement bars, carbohydrate drinks…
- 30-60 grams carbohydrate per hour
- High fat foods inappropriate

PowerBar

Medical Monitoring vs. Emergency Care

Medical monitoring: observing members for adverse health effects (physical stress, heat or cold exposure, environmental hazards)

Emergency Care: treatment for members with adverse effects or injury.

6. Medical Monitoring in Rehab

6. Medical Monitoring in Rehab

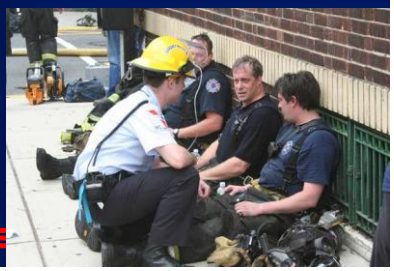
Specifies minimum 6 conditions be screened:

1. CP, dizzy, SOB, weakness, nausea, h/a
2. General c/o (cramps, aches, pains…)
3. Sx heat or cold-related stress
4. Changes in gait, speech, behavior
5. Alertness and orientation x 3
6. Any VS considered abnormal locally

6. Medical Monitoring in Rehab

Local (FD) medical monitoring protocols:

1. Immediate EMS treatment and transport
2. Close monitoring in rehab area
3. Release



6. Medical Monitoring in Rehab

- Vital signs per FD protocol
- Options suggested:
  - Temperature
  - Pulse
  - Respiration
  - Blood pressure
  - Pulse oximetry
  - CO assessment (pulse CO-oximetry)

Vital Signs

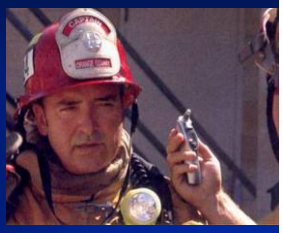
- Many departments do not measure
- No evidence or published studies:
  - Determine when treatment necessary
  - Predict type or duration of rehab needed
- Vitals may help set parameters for monitoring, treatment, transport, release
- Must be evaluated in context

Temperature

- Core temp most accurate
  - NL = 98.6-100.6°F (37-38.1°C)
  - Best measured rectally or temp transmitter
- Oral or tympanic used in field
  - Oral 1°F (0.55°C), tympanic 2°F (1.1°C) less
- Multiple user & environmental potentials for error

Temperature

- Elevated temps by measurement or touch suggest possible heat related illness
- NOTE: normal oral or tympanic temps do not exclude heat illness!



Temperature

- No danger level for core body temp
- FF temps continue to rise for 20+ min. of rehab even with active cooling measures
- No clear guidance on temp for release from rehab. Consider further eval for members above NL

Pulse

- NL = 60-80, many influences.
- Very important to interpret in context of individual.
- Recovery rate may be more significant than actual heart rate.
- If > 100 after 20 min rest, further eval needed before release
- Pulse ox offers accurate measure

Respiratory Rate

- NL = 12 – 20, should ↑ with fever and exercise
- Should return to normal with rest

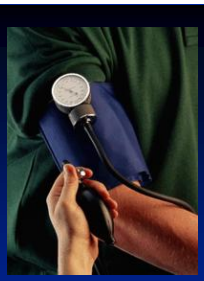
Blood Pressure

- Most measured
- Least understood
- Very contextual
- Tremendous potential for error

Blood Pressure

<u>Sources of error</u>:

1. Cuff size
2. Arm placement
3. NIBP



<u>Potential for cross contamination</u>:

- Need to decon between each use

Blood Pressure

- NFPA suggests members with SBP > 160 or DBP > 100 not be released from rehab.
- Oddly, hypotension (SBP < 80) is probably of far greater concern than high blood pressure…

Abandoned Tire Dump Fire

- Saratoga County, NY (Waterford)
- June 2002 – 10 million tires in abandoned tire dump caught fire
- 15 departments on scene, 8 days
- Rehab for 2,882 firefighters
- Pulse ox at door, TPR/BP inside

Restrospective Review

- 100% of firefighters with abnormal temp, respirations or BP had abnormal pulse ox (O_2 sat or HR)
- Upstate NY rehab protocol now measures only:
  - HR
  - Oxygen saturation
  - Carbon monoxide (SpCO%)

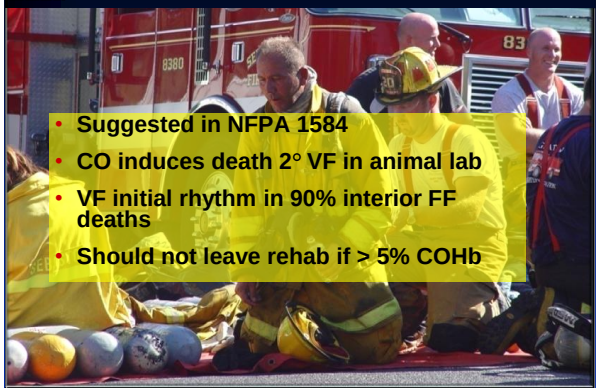
Pulse Oximetry

- Non-invasive measurement of oxygen and blood flow
- NL = 95-100%
- Most oximeters cannot differentiate oxyhemoglobin from carboxyhemoglobin
- Members with SpO_2 < 92% should not be released from rehab

CO Assessment

- Carbon monoxide is present at all fires and a leading cause of death
- NFPA suggests any member exposed to CO or with CO s/s be assessed for CO poisoning
- Exhaled CO meter or pulse CO-Oximeter are two detection devices

CO Assessment in FF Rehab?



- Suggested in NFPA 1584
- CO induces death 2° VF in animal lab
- VF initial rhythm in 90% interior FF deaths
- Should not leave rehab if > 5% COHb

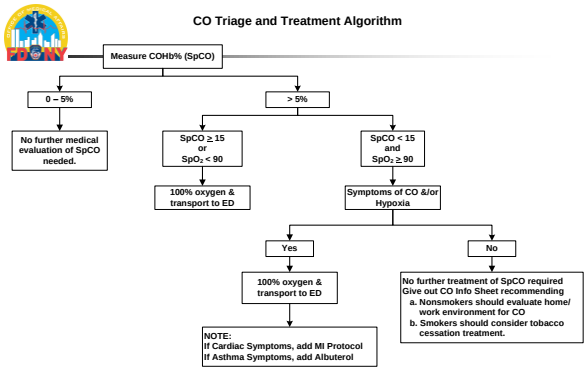
CO Poisoning Assessment

CO Poisoning Assessment

CO levels

- Non-smokers = 0 – 5%
- Smokers 5 – 10%
- If > 15%, treat with high flow O_2
- Between 10 – 15%, assess for s/s, treat if necessary
- Release from rehab requires normal CO level per local protocol

Triage & Treatment Algorithm



Cyanide

- Consider at all fire scenes
- All patients in cardiac arrest
- Any patient in shock, especially if low CO level
- Treat with cyanide antidote kit

Paris Fire Brigade

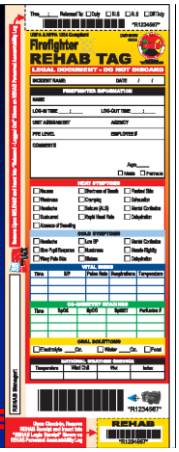
7. EMS Tx according to local protocol

- Available on scene
- Monitoring documented in FD data collection system
- When tx or xpt, copy medical report to employee medical record

8. Member Accountability

- Track members assigned to rehab
- IC must know whereabouts (i.e.: when they enter rehab and when they leave)

Potential Solution:



Time___:___ Released To: ☐ Duty ☐ BLS ☐ ALS ☐ Off Duty

R1234567

USFA & NFPA 1584 Compliant

DMS-05696 ©2009

Firefighter

REHAB TAG

LEGAL DOCUMENT - DO NOT DISCARD

INCIDENT NAME: DATE / /

FIREFIGHTER INFORMATION

NAME

LOG-IN TIME ____:____ LOG-OUT TIME ____:____

UNIT ASSIGNMENT AGENCY

PPE LEVEL EMPLOYEE #

COMMENTS

Age____

☐ Male ☐ Female

Remove Upon RELEASE and Insert into "Released - Logged Out" Sleeve on REHAB Personnel Accountability Log

Made in the USA

HEAT SYMPTOMS

☐ Nausea	☐ Shortness of Breath	☐ Flushed Skin
☐ Weakness	☐ Cramping	☐ Exhaustion
☐ Headache	☐ Seizure (ALS)	☐ Mental Confusion
☐ Sunburned	☐ Rapid Heart Rate	☐ Dehydration
☐ Absence of Sweating		

COLD SYMPTOMS

☐ Headache	☐ Low BP	☐ Mental Confusion
☐ Slow Pupil Response	☐ Numbness	☐ Muscle Rigidity
☐ Waxy Pale Skin	☐ Blisters	☐ Dehydration

VITAL SIGNS

Time	B/P	Pulse Rate	Respirations	Temperature

CO-OXIMETRY READINGS

Time	SpO2	SpCO	SpMET	Perfusion #

REHAB Manager:

NATIONAL WEATHER SERVICE

Temperature	Wind Chill	Wet	Index

R1234567

Upon Check-in, Remove REHAB Receipt and Insert into "REHAB Login Receipt" Sleeve on REHAB Personnel Accountability Log

REHAB

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3 STEP CARBON MONOXIDE EXPOSURE ASSESSMENT

1. Was Firefighter Exposed to Smoke? Yes ☐ No ☐

Initial Carbon Monoxide Assessment Parameters

0 - 5%	Considered Normal
5 - 10%	Considered Normal in a Smoker
> 10%	Abnormal in Any Person - Consider High Flow Oxygen
> 15%	Significantly Abnormal in Any Person - Treatment Mandated

2. Initial Carbon Monoxide Assessment SpCO% =

Carbon Monoxide Reassessment Parameters

0 - 5%	Acceptable for Return to Firefighting Activities if Medically Cleared
5 - 10%	Consider High Flow Oxygen until ≤ 5%, Regardless of Symptoms
> 10%	Abnormal, Assess for Symptoms, Consider High Flow Oxygen
> 15%	Significantly Abnormal - Treatment Mandated, Consider Transport

3. Carbon Monoxide Reassessment SpCO% =

Carbon Monoxide Parameters Established by Mike McEvoy, PhD, REMT-P, RN, CCRN • EMS Coordinator - Saratoga County, NY

REHAB Procedures and Processes

Responsible Personnel. Establishing Standard Operating Guidelines is the responsibility of each department's company officer or supervisor on scene. Assessment of his or her crew to determine members in need of rehab must occur every 45 minutes. Individual firefighters and their supervisors should undergo rehab following use of a second 30-minute SCBA cylinder, after a single 45- or 60-minute cylinder, or after 40 minutes of intense work without SCBA. Supervisors are permitted to adjust these time frames depending on work or environmental conditions. In addition, EMS staff must have the authority to detain members in rehab or transport members when there are obvious indications preventing them from return to full duty.

The Incident Commander must establish rehabilitation according to the circumstances of the incident. The rehabilitation process must include the following:

1. **Rest:** ☐ Yes ☐ No Minutes ☐
2. **Hydration:** ☐ Yes ☐ No (replace lost body fluids)
3. **Cooling:** ☐ Yes ☐ No ☐ Active ☐ Passive (passive and/or active)
4. **Warming:** ☐ Yes ☐ No
5. **Medical Monitoring:** ☐ Yes ☐ No
6. **Emergency Medical Care:** ☐ Yes ☐ No ☐ N/A (if required)
7. **Relief from Extreme Climactic Conditions:** ☐ Yes ☐ No (heat, cold, wind, rain)
8. **Calorie & Electrolyte Replacement:** ☐ Yes ☐ No
9. **Accountability Documentation Completed:** ☐ Yes ☐ No

Released by: (Print Name)

Signature: **Time:** :

9. Release

- **Prior to leaving rehab, EMS must confirm that members are able to safely perform full duty.**

Where to from here?

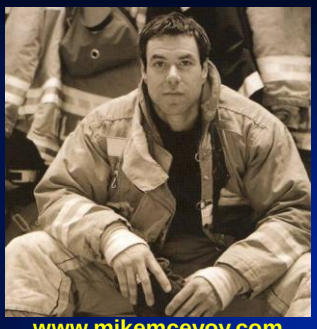
- NFPA 1584 released Q1 of 2008
- Organizations and departments need to review the Standard and decide how to proceed
- States may elect to incorporate all or parts of 1584 into rules or legislation

Rehab Research Needed…

Summary

1. Just Do It…
   - IC must establish a rehab sector
2. Define who will do what…
   - Medical monitoring
   - Emergency Medical Care & Treatment
   - Bring supplies (cooling, shelter, water)
   - Record keeping
   - Accountability

Thank You!



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