HEAT STROKE
It Could Happen to You!

"We have to train like we work. Actually we train harder than we work. We train hard to work hard."

Captain Sam

"This was one of the most severe cases of heat stroke that we have ever seen."

Physician at the Hospital

Facilitated Learning Analysis
Pacific Southwest Region
July 2016

Contents

1. Summary

On July 16, 2016, this Type 2 Initial Attack (IA) Hand Crew started work at 0730 hours. They loaded up in their buggies and drove to the bottom of a physical training (PT) hike on the FH Trail.

Upon arrival, they conducted weather and safety briefings. Prior to beginning their hike, they also performed IA drills (saw work and line construction) and conducted an After Action Review on their IA drills.

Hiking up the FH Trail began at approximately 1030 hours. At approximately 1125 hours, Apprentice John and Squad Leader Tom—who both had medical experience—were requested to head back down the FH Trail to tie-in with another crewmember who was struggling and being encouraged by Captain Sam.

Looking down the FH Trail toward the Helispot above the fire.

John Collapses, Becomes Unresponsive, Loses Consciousness

During their descent, open flames from a fire that had just started below them began to grow. In a hurry to get out of harm's way, John turned his ankle and needed to hold onto Tom's line gear to continue progressing. Once in a safe spot, John collapsed, became unresponsive, and lost consciousness.

A Cal Fire helicopter assigned to the fire diverted, picked up John, had him assessed by a Paramedic, and flew him directly to a medical center. Twenty-six hours later, after being diagnosed with heat stroke, John was moved to a Level 1 Trauma Center for further tests, treatment, and therapy. He is expected to make a full recovery.

2. Narrative

The Type 2 Initial Attack Hand Crew got back home from a fire on Monday, July 11. They had one day off, then started their normal work week on Wednesday. For the next two days, they conducted moderate fitness training, had Initial Attack drills, briefings, training, and continued their focus toward recertification from a Type 2 IA Hand Crew back to an Interagency Hotshot Crew.

The FH Tail provides a fairly typical hike for this Type 2 IA Hand Crew. The hike has a 1.5 mile multi-stage ridge with a 1,645-foot elevation gain. The crew is normally dropped off at the bottom. Crew carriers are driven around and parked at the top of the hike.

On that Friday for PT, the crew did their FH Trail hike.

The weather was moderate that week, with temperatures below average for that time of year. This provided the crew the opportunity to hike this very exposed and normally very hot PT hike. The entire crew made it to the top somewhat together with only a couple of crewmembers talking of leg cramps, including Apprentice John.

Therefore, that Friday night after that PT hike, John drank water and Gatorade, as he had learned through years of experience.

During Hike, Smoke Noticed Down Below

The next day, Saturday, July 16, was the last day of the work week before a three-day weekend. The crew started at their regular time of 0730 hours. They went through morning checks and drove to the bottom of the FH Hike. While the buggies were being bumped to the top of the hike, the crew conducted IA drills (chainsaw work and line construction).

After IA drills were complete, the crew conducted an After Action Review on their IA drills, discussed the weather, had a safety briefing and then started the hike. Shortly after the hike began there was a noticeable separation of the crew. Captain Sam and Apprentice Eric lagged behind. After reaching the "turnaround point" Captain Mark noticed a small smoke down below the ridge and notified Dispatch.

After a short time at the turnaround point, Apprentice John and Squad leader Tom, who both had the most medical experience, were asked by Captain Sam to head back down the hill just in case any issues came up with Eric. During their descent, open flames from the fire down below became visible.

Tom told John: *"We're in a bad spot, don't panic. Watch your footing, but we need to move faster because we're walking too slowly."*

Red circle indicates the fire's location below Squad Leader Tom and Apprentice John during their descent down the mountain.

John Becomes Unconscious
After picking up the pace, it got to a point where John was holding onto Tom's line gear to try to keep up.

John was having trouble keeping his footing and ended up twisting his ankle.

When they finally got to a point on the ridge where Tom felt safe, John told Tom that he *"couldn't hike anymore"* and that he was sorry.

Tom said it *"isn't a big deal and to drink some water."* While sitting down and drinking some water, John became unconscious and unresponsive. There was no way that Tom could have moved John without help.

Ambulance and Hoist Helicopter Ordered
While Tom and John were hiking down the hill, Captain Mark sent the rest of the crew to finish the hike. They were then to load up in the buggies to head to the fire, which was quickly becoming established down below them.

With Superintendent Charlie acting as a lookout, Captain Mark headed down the hill. Captain Sam moved side hill toward the fire to get a better view of it. He told Eric to go down the ridge to where the engines were pulling in to engage the fire.

By the time Apprentice John had lost consciousness, at 1202 hours, Captain Mark had tied-in with John and Squad Leader Tom. Captain Mark proceeded to order an ambulance and hoist helicopter through Dispatch.

Tom and Mark tried to move John downhill to meet the incoming ambulance but were having trouble moving John, who was still unresponsive.

Difficulty Moving John Downhill
Tom began to treat John by pulling off John's medical pack. He removed John's line gear, took off his long-sleeve Nomex shirt, and cut away John's t-shirt. Tom then applied cold packs under John's armpits and groin while trying to provide as much shade for John as he could with his body.

Tom and Mark tried to move John downhill to meet the incoming ambulance but were having trouble moving John, who was still unresponsive.

Fire behavior at 1045 hours.

Cal Fire had an Air Attack Group Supervisor (ATGS) with two air tankers over the fire as well as an incoming helicopter.

Request to Use Helicopter
Captain Mark contacted the Incident Commander, informed him of the situation, and asked to use the helicopter, H-301.

H-301 was not configured for a medical evacuation, but understood the urgency of the situation.

They proceeded to drop off two helitack crew members near the fire then continued with three crew members to the knob above John's current location.

Red circle indicates the midway point from the bottom where John became unconscious and where the Helispot was located to load and transport John. (For an entire incident layout, see legend on next page.)

Tom and Mark continued to drag/carry John down the hill toward the newly arrived ambulance. Helitack Captain Don along with helitack crewmembers Ethan and Chase proceeded by foot to help Mark and Tom carry John. H-301 landed briefly and the five placed John in between the seats in the helicopter.

H-301 shown on right. Photo above shows the inside of H-301 where John was placed for transport.

John Flown to Hospital
Helitack Captain Don and crewmembers Ethan and Chase flew John to the ambulance parked below. After landing, the paramedic (P-EMT) at the ambulance performed a brief evaluation and made the decision to fly John directly to the hospital in H-301.

At the hospital, the receiving personnel were concerned about a possible spine

and neck injury. They had been notified about an incoming patient receiving a traumatic injury. It took some prompting from Helitack Captain Don to have them forgo the C-collar and backboard and unload him from the helicopter quickly.

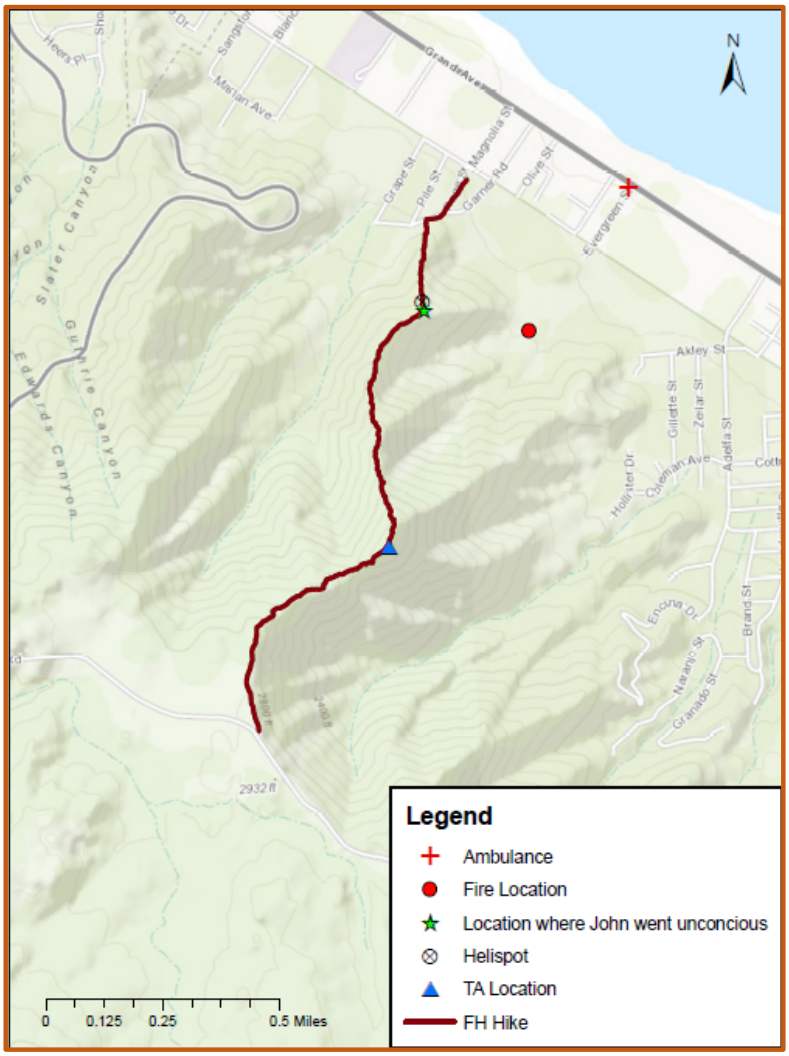
Patrol Tony Becomes Hospital/Family Liaison
Patrol Tony, who was waiting at the bottom of the hill (near the ambulance) in case he was needed to transport or assist, went immediately to the hospital. He became the Hospital/Family Liaison.

Patrol Tony stayed and visited with John, his wife Mary, and John's mother Patricia, throughout John's treatment and hospital stay. It helped that Patrol Tony had the skill, knowledge, and experience as a Forest Service Honor Guard Member to take a role in assisting John's family.

John Flown to Level 1 Trauma Center
John underwent tests and treatment (body cool-down, IV fluids) for heat stroke. Twenty-six hours later, he was flown to a Level 1 Trauma Center for additional testing, treatment (induced coma, plasma transfusion, IV fluids) and physical therapy.

Eleven days after the incident, John's voice was a little raspy from being intubated, but he will make a full recovery and be out of the hospital within the week.

The final pitch that John would have had to be carried down to be transported in the ambulance.



["TA Location" is the turnaround point where Apprentice John and Squad Leader Tom hiked to before turning around and heading back down the FH Trail.]

Everyone on the crew (including Apprentice John) said that he would have made it to the top of the FH Hike without difficulties if the fire hadn't occurred.

3. Incident Time Line – July 16, 2016

Time	Temperature Top/Bottom	Wind Speed (mph) Gust/Sustained	Actions
0730	71/58	2/7	Crew started the day.
0800			Drove to Lake (for IA drills and PT hike).
0830	78/66	3/7	Weather Briefing/6 Minutes for Safety.
0930	81/67	3/8	Initial Attack drills.
1000			AAR on IA Drills.
1030	85/76	4/9	Started FH Hike.
1045			Noticeable separation of two crew members.
1125			The majority of the crew waited on a knob (turnaround point). At this time Captain Sam requested two members of the crew with medical experience to head back down.
1130	87/80	2/9	As the two crew members (Tom and John) were hiking back down the hill, Captain Mark, who was on knob, noticed smoke below at the bottom.
1140			The two crew members that were sent down could see the smoke and then open flames. Tom did not like their location in relationship to the fire, so they started moving rapidly down the hill.
1145	87/80	0/9	John twisted his ankle. John then held onto Tom's line gear to move faster down the hill. Mark began working his way down the hill.
1155			When they got to a point that Tom felt out of harm's way, they stopped. When firefighter John sat down, he lost consciousness. His line gear, Nomex shirt, and hardhat were removed and t-shirt cut away. Water was poured on him and cold packs were placed under his armpits and in his groin.
1202			By this time, Mark had made it to Tom and John's location. He made the decision to order an ambulance and hoist helicopter (FF down with heat exhaustion).
1205			Cal Fire H-301 was over the fire. Mark requested through the IC that H-301 be diverted to transport John.
1215			H-301 drops off extra helitack crewmembers, lifts off and lands below John with 3 helitack crewmembers. Mark and Tom load John into helicopter.
1218			H-301 lands near ambulance. Paramedic assesses John.
1220	89	0/8	Decision is made to fly John instead of transport via ambulance. He is flown to Inland Valley Medical Center.
1330	93/91	0/9	Last RAWS readings for the incident.

4. Related Situational Information

Muscles in the body are inefficient in turning energy (from food and from stores in the body) into force.

Only 30 percent of the total energy used in a muscle cell contraction converts into force when flexing a muscle. The other 70 percent of the energy becomes heat as it releases from the muscle. An example of this is shivering when cold. While the muscles are inefficient in converting that energy directly into force, they help maintain body temperature around 98.6°F (Fahrenheit) or 37.0°C (Celsius).

A unique component contained in this FLA report is that these individuals had to move swiftly to a more safe location down the ridge after the completion of a training hike. A study conducted by Schwane et al. indicated that while downhill running requires less oxygen uptake than uphill running, it does result in more muscle damage. This is due to the eccentric contractions involved in downhill running or hiking.

Eccentric muscle contractions are a "braking" contraction where the muscle stays contracted while also lengthening to allow for controlled movement.

Another example of an eccentric contraction is lowering a dumbbell slowly during a bicep curl. More muscle disruption and injury occurs during an eccentric contraction compared to a concentric contraction, where the muscle shortens when contracted.

When the body cannot remove the added heat due to exertion or environment, symptoms of heat stress, heat cramps, and heat stroke can occur in no particular order.

When this work is done on the muscle, the muscle absorbs energy either in the form of heat or elastic recoil. What becomes of that absorbed energy depends on how the muscle is being used. The muscles in the legs while hiking downhill with a pack serve as a shock absorber or damper and can potentially absorb enough energy during the eccentric contractions to increase body temperature. While this would probably not directly lead to a heat-related illness, it is important to recognize the amount of demand placed on the body when hiking both from a mechanical and a thermal perspective.

Initial Training Drills Plus Demands of Uphill Hike Could Have Increased Core Body Temps Exceeding 100 Degrees

The demand of the initial training drills that morning compounded with the demand of the hike would allow for a reasonable prediction of a core body temperature exceeding 100°F. Depending on the aerobic fitness of the individuals on the crew, temperature regulation (consisting of both pacing to reduce internal heat production and allowing the body to cool) would then play a crucial role in the capacity of each individual to continue to perform in this environment.

As the fire potential developed from visible smoke to observed flames near the base of the slope, the need to reach a safer location likely resulted in continued elevation of body temperature to near critical levels for each individual.

Heat Stoke: Potentially Fatal Condition

Heat stroke is a potentially fatal condition caused by increased body temperature typically above 104°F. Performing physical tasks at high intensities can lead to internal heat production. External conditions, such as high temperatures and humidity, can also result in heat accumulation in the body to this elevated level. When the body cannot remove the added heat due to exertion or environment, symptoms of heat stress, heat cramps, and heat stroke can occur in no particular order.

One of the best ways to prevent against heat-related illnesses is to train ahead of time at varying intensities in the heat. Training in hot temperatures will allow the body to make changes to improve performance, both in intensity and duration, in warm environments. The intensity of this activity can range from a slow jog or hike where conversation is still possible, to short durations of higher intensity.

Additionally, rest and recovery following environmental and physical stress is essential to continue to improve and function in this occupation. Diet, hydration, and monitoring well-being should be emphasized off the clock as well as while on the job. Hydration is not drinking when thirsty, it is a day-in day-out commitment to allow the body to perform at a variety of wildland firefighter activities. Dehydration can be cumulative during consecutive days of work regardless of environmental temperatures.

Hydration is not drinking when thirsty, it is a day-in day-out commitment to allow the body to perform at a variety of wildland firefighter activities.

MTDC Findings

The Missoula Technology and Development Center (MTDC) has observed the physical tasks of wildland firefighting through numerous studies dating back many years. Research by MTDC since 2013 (manuscript in progress) has observed hotshot crews averaging an energy expenditure of 12 calories per minute will hiking uphill into a worksite on a large fire.

The National Institute of Organizational Health and Safety classifies this level of exertion as "Extremely Hard". To meet this demand expected of hotshot crews, MTDC is currently in the process of developing new fitness standards to represent the demands of physical tasks on the fire line.

A key component of this effort is the development of a physical training program to help individuals train throughout the year for multiple objectives such as physical capacity, strength, flexibility, heat tolerance, and much more.

5. Lessons Learned, Considerations, Suggestions

What would I do differently next time—knowing what I know now?

What did I learn? What should my peers and management learn from this experience?

A. Physical Fitness – *Am I really physically fit for this job?*

Getting a new job in fire management or when moving from one module to another (helitack, engine, IHC, etc.), personnel need to be aware and prepared for the "required" physical fitness criteria. Contact the module or agency you are moving to and be certain that you are ready for the first day—to be better by the last day of the season.

In this incident, Apprentice John had joined the crew on May 18, two months before suffering from heat stroke.

During physical training he was not the fastest or strongest person on the crew but was improving every week and was successful on fires and during training.

John's eating habits were nothing to be concerned about either. His meals are always well rounded. He rarely consumes alcohol or energy drinks and he doesn't take any supplements.

When asked if what happened to John was a surprise, the entire crew, John, and his family, all said: **"YES!"**

B. Incident within an Incident (IWI) – *What if the "Plan" isn't working?*

Fire management personnel, modules, teams, etc. must have an Incident within an Incident (IWI) emergency plan in place and known before a tragedy occurs. The "plan" has to be flexible and fluid enough, so that if what you want and need is not timely, then you can adapt and have a successful outcome.

The plan is important but the planning and consideration of potential "What Ifs?" is vitally important. There are times when an interested party wants to intervene and help by asking: *"What's going on and can I help?"* However, during the chaos of an emergency, it's best to listen, keep watch, and "help" when asked.

In addition, the next level "supervisor" may need to assist when he/she is certain that mistakes are being made (rare instance).

Radio Interference Wanting to Help
On this incident, there was some radio interference from outside the IWI situation from persons who wanted to help. The personnel involved (H-301, Captain Mark, Helitack, and Squad Leader Tom did not purposely ignore this radio traffic but rather stayed within the "plan" and focused on what was needed to be successful.

Helicopter Medevac Prevented a More Serious Outcome
Mark and Tom could not have dragged or carried John down the hill (no stokes or basket) the distance (approximately ¼ mile) to the ambulance on that terrain in the necessary timeframe to prevent a different, much more serious outcome.

Patrol Tony said the physician at the hospital stated that: *"This was one of the most severe cases of heat stroke that we have ever seen."*

C. Connectivity – *Is leadership aware of what we do?*

Supervisors and leaders are not only responsible but also accountable for their subordinate personnel. A good leader is a "Leader of Leaders" and gives his/her people the flexibility to make changes and corrections on their own. He/she doesn't need to know exactly what their crew members are doing, but they should know how they operate, function, and what the physical requirements of the job are.

"Are we pushing too hard?"

District Ranger

There should be a connectivity and sharing of risk up, down, and laterally through the chain of command so *everyone* understands the job, mission risk, and exposure to the hazards.

After this medical incident, leadership (District Ranger) asked: *"How did we get here?"*

There can be a gap between leadership and employees: *How much risk do employees take to get the job done? And how much risk do administrators/managers think and say is acceptable?*

The goal of this Heat Stroke FLA is to help us:
Learn, Grow, and Be Better!

On this incident, Cal Fire H-301 was not configured for a medical extraction, but because the situation was life threatening, they adapted to the situation and saved a life.

D. Aviation – *Can or will an assigned aircraft do different tasks/missions?*

In a life-threatening emergency situation do not assume that a non-emergency dedicated helicopter or resource (equipment, personnel) will not break away from their suppression/aerial assignment and come help you.

If possible, fire management personnel will make an effort to help other personnel in jeopardy. Do not doubt – until you request assistance. Call them, use clear text, explain the emergency situation, and let them make the Go-No Go decision.

On this incident, Cal Fire H-301 was not configured for a medical extraction, but because the situation was life threatening, they adapted to the situation and saved a life.

Air tanker drops retardant on the fire that broke out below the crew's physical training FH Hike route.

E. Climatic Conditions – ***What do we have to know about the weather before physical activity or training?***

Knowing the current, predicted weather is an important criteria for being successful in physical training. If the weather is too hot, maybe the activity should be started at an earlier time of day or postponed to later in the day when temperatures begin to cool.

Evaluating the weather, terrain, and determining the risk and exposure to personnel is key to being successful without any mishaps or injuries.

On this incident, Crew Leadership did take the weather into account and did their FH Hike during below normal temperatures and conditions.

F. Physical Training – ***Am I feeling OK today?***

Think of the training that you have done lately and plan to do in the near future. What is the intended focus of each workout and how does it contribute to your overall goals as a wildland firefighter? For example, are you emphasizing endurance, strength, heat tolerance, recovery, hiking strength, work hardening, flexibility, etc.?

How does your daily training emphasis change throughout the week or season? Additionally, what intensity level is intended for each workout? Be sure to think on an individual *and* crew level. As a crew, you should decide what is important to train for, but this can also apply to the individual level.

PT programs should not just prepare us for wildfire suppression activities but also work to manage the long-term health of the individual and crew as a whole. The ability to handle the physical tasks associated with this occupation can be crucial in our ability to accomplish production goals without undue fatigue and without becoming a hazard to ourselves, or to our coworkers.

Different Thresholds

Our bodies have different thresholds for this arduous work that we perform. Last year, physical training injuries were the third highest group of total wildland firefighter injuries (2015 LLC Incident Review Summary). The biggest principle lacking from PT programs is typically RECOVERY!

Recovery has many forms, ranging from a day of rest to a "facilitated recovery" by resting a muscle group after a day of hard training and then focusing on another muscle group. Active recovery workouts can also be beneficial by engaging in a less intense and lower volume activity following a day of training.

Physical capacity has always been a large component of job performance in wildfire suppression activities. Our training to perform safely in a wildfire environment must be diverse because the job is diverse. While an exercise session may exceed an hour, typical athletic performance training should comprise the following phases:

- Warm-up (5-10 min; Ex: Range of Motion, Stability, Foam-Rollers—it's OK to sweat here!)
- Stretching (>10 min; Ex: Dynamic stretching can be part of your warm-up.)
- Conditioning or sports-related exercise (20-60 min; Ex: Endurance, heat tolerance, recovery, etc.)
- Cool-down/Stretching (5-10 min; Low/Moderate intensity; Ex: Static stretching, 30-120 sec. each stretch.

G. Fire Season – ***Do we work harder on an incident than in training?***

Captain Sam from this incident explained to the FLA Team that *"We have to train like we work—actually we have to train harder than we work."*

Tasks, missions, and assignments on incidents vary. Personnel can pace themselves based on the situation: dig faster more efficiently when the ground is easier; dig slow in difficult terrain.

To stay sharp during slow fire seasons, fire personnel train more strenuously.

"How much risk do employees take to get the job done—verses how much risk administrators say is acceptable?

Risk Management is about managing risk—not about managing outcomes."

FLA Team

H. Job Hazard Analysis (JHA) – ***Is there something better?***

A job Hazard Analysis identifies the task/mission (hiking, driving, etc.), then the hazards (rolling rocks, steep terrain, narrow roads, traffic, etc.), and then lists the mitigations (8-inch-high boots, personnel spacing, clean windshields, drive slower, etc.) that are in place. However, the JHA does not identify risk.

Better Tool

A better tool is the 215R Risk Analysis Matrix. A 215R is a risk analysis/assessment that identifies:

- The task/mission;
- Hazards;
- Probability of exposure to the hazards;
- Consequences of the exposure, the risk level (high, moderate, or low);
- The mitigations; and
- The identification of the residual risk level.

The final portion of this Risk Matrix is whether the residual risk level is acceptable or not (Yes-No).

Using this 215R Risk Analysis Matrix/assessment triggers a conversation about the exposure of personnel to the hazards—and whether or not the risk is worth the benefit.

An example is flying helicopters and dropping water. That is high risk. But without dropping water, ground resources could also be at high risk with fire behavior, spotting, slop overs, etc. that could endanger their lives. Personnel (helicopter pilot) have to weigh and think/talk about the exposure to the hazards, the risk verses gain/benefit, before they make risk decisions.

[For more detailed information on the 215R Risk Matrix, see Appendix 2 and Appendix 3.]

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7. Appendices

Appendix 1 – Rapid Lesson Sharing: Firefighter Heat Stress Study

Rapid Lesson Sharing

Event Type: Firefighter Heat Stress Study

Date: July 7, 2015

Est. 2002

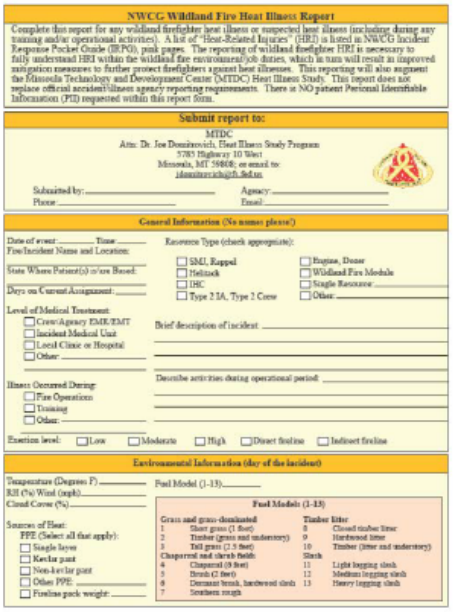
KEY POINTS
From the Firefighter Heat Stress Study

- ✓ **Hydration alone will not prevent a heat-related injury**. You need to combine hydration with good physical fitness and adequate recovery from high-heat producing physical tasks.
- ✓ Your initial hike sets your body's core temperature for the day.
- ✓ Your PPE weight (pack and tool) contributes to high physical demands and higher body temperatures.
- ✓ Performing physical tasks—such as hiking up hills—can increase your body temperature to near-critical levels.
- ✓ Physical work is our biggest producer of body heat. Breaks and appropriate levels of physical exertion are important in mitigating adverse heat related issues.

BACKGROUND

Several important insights regarding firefighter heat stress have been spotlighted from the ongoing NWCG Wildland Fire Heat Illness Study that is being coordinated in conjunction with the Missoula Technology and Development Center (MTDC). This study has been receiving heat-related illness reports from wildland firefighters over the past several years. (Click below to download a copy of this report form [shown on right]:)

http://bit.ly/HRIform


NWCG Wildland Fire Heat Illness Report

Complete this report for any wildland firefighter heat illness or suspected heat illness (including during any training and/or operational activities). A list of "Heat-Related Injuries" (HRI) is listed in NWCG Incident Response Pocket Guide (IRPG), pink pages. The reporting of wildland firefighter HRI is necessary to fully understand HRI within the wildland fire environment/job duties, which in turn will result in improved mitigation measures to further protect firefighters against heat illnesses. This reporting will also augment the Missoula Technology and Development Center (MTDC) Heat Illness Study. This report does not replace official accident/illness agency reporting requirements. There is NO patient Personal Identifiable Information (PII) requested within this report form.

Submit report to:

MTDC
Attn: Dr. Joe Dusitrovich, Heat Illness Study Program
5785 Highway 10 West
Missoula, MT 59808; or email to:
jdusitrovich@fs.fed.us

Submitted by: _____ Agency: _____
Phone: _____ Email: _____

General Information (No names please!)

Date of event: _____ Time: _____
Fire/Incident Name and Location: _____
State Where Patient(s) is/are Based: _____
Days on Current Assignment: _____

Level of Medical Treatment:
☐ Crew/Agency EMR/EMT
☐ Incident Medical Unit
☐ Local Clinic or Hospital
☐ Other: _____

Illness Occurred During:
☐ Fire Operations
☐ Training
☐ Other: _____

Resource Type (check appropriate):
☐ SMJ, Rappel ☐ Engine, Dozer
☐ Helitack ☐ Wildland Fire Module
☐ IHC ☐ Single Resource: _____
☐ Type 2 IA, Type 2 Crew ☐ Other: _____

Brief description of incident: _____

Describe activities during operational period: _____

Exertion level: ☐ Low ☐ Moderate ☐ High ☐ Direct fireline ☐ Indirect fireline

Environmental Information (day of the incident)

Temperature (Degrees F) _____
RH (%) Wind (mph) _____
Cloud Cover (%) _____

Sources of Heat:
PPE (Select all that apply):
☐ Single layer
☐ Kevlar gear
☐ Non-fire gear
☐ Other PPE: _____
☐ Fireline pack weight: _____

Fuel Model (1-13): _____

Fuel Models (1-13)

Grass and grass-dominated		Timber litter	
1	Short grass (1 foot)	8	Closed timber litter
2	Timber (grass and understory)	9	Hardwood litter
3	Tall grass (2.5 feet)	10	Timber (litter and understory)
Chaparral and shrub fields		Slash	
4	Chaparral (6 feet)	11	Light logging slash
5	Brush (2 feet)	12	Medium logging slash
6	Dormant brush, hardwood slash	13	Heavy logging slash
7	Southern rough		

The overall objective of this study is to better understand heat-related illnesses within the wildland fire environment and associated job duties. These findings will result in improved mitigation measures for protecting firefighters from heat illnesses.

Since 2013, 76 individual reports of heat-related incidents have been received. (Many others such incidents have probably been unreported.) From these reports, hiking (20 cases) proved to be the predominant activity when heat illness occurred, followed by line construction (18 cases), and mop-up (16 cases).

Despite adequate hydration, it is still possible to have issues in the heat.

More than three-quarters of these heat-related incidents occurred during the first seven days of an assignment. More than half of the heat-related incidents happened in the firefighter's home state. And, one-half transpired when the individual was in a new position in fire on a wildland fire incident.

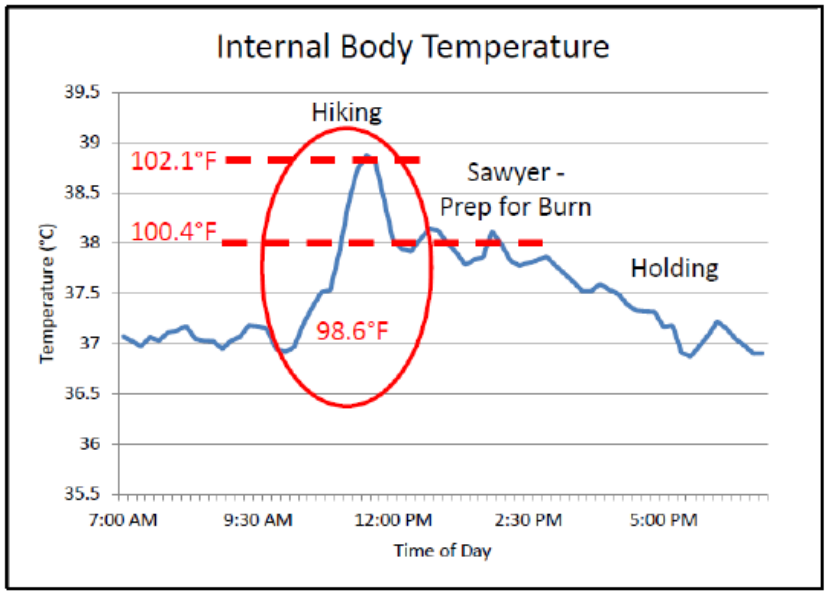
150 FIREFIGHTERS MONITORED BY MTDC

In an attempt to best represent the demand of the occupation and expand upon this data from the heat illness reports, nearly 150 firefighters have also been monitored throughout recent fire seasons by MTDC. Outfitted with a chest strap monitor, several clip-on devices, and having ingested an electronic thermometer capsule, entire work shifts have been recorded since May 2013. More than 60 tasks have been identified in trying to categorize activities on the line. Because firefighters are only sedentary for brief periods of time, these activities can be separated into primarily physical or non-physical activities.

Hiking into Fire in Morning Showed Highest Physical Demands

Only 30 percent of energy used in a muscle contraction is used for force of contraction, while 70 percent of the energy is released as heat. This underscores how physical work results in heat production. The heat produced by our bodies is what causes heat illness—when we cannot get rid of this heat fast enough.

For wildland firefighters, adding to this energy output demand is their pack weight (excluding tool weight), ranging from 35 to 51 pounds. Under this load, hiking into the fire in the morning showcased some of the highest physical demands in firefighting.



During this high-demand activity, as firefighters hike up hills, their body temperature also climbs—often reaching 102°F. Depending on the activity and environment, recovery rarely allows the individual to return to a normal temperature for the next few hours of the work shift. During this extended time period, firefighters have a diminished margin of error in battling the heat, while they battle many other margins on the fire. (See graph above.)

Important to Maintain Low Skin Temperature

Despite adequate hydration, it is still possible to have issues in the heat. Maintaining a low skin temperature is important in allowing heat to transfer from the body. At the same time, monitoring your activity level is crucial for keeping your internal furnace from producing excess heat.

The environment, however, can combat your ability to keep a low skin temperature. Radiant heat from the sun—very prevalent in mop-up and many other fire tasks—warms the skin and impairs the ability of your skin to release heat. In addition, high humidity conditions can reduce the wicking of moisture off your skin to release heat.

The ability to balance heat is different between individuals, and varies on a daily basis.

Each case is unique.

Only the individual truly knows if they are OK.

Signs and Symptoms

When looking at the signs and symptoms reported on the NWCG Heat Illness forms, there is "standard" case of signs and symptoms of a heat related injury. While these common signs and symptoms (see IRPG page 103) will continue to be communicated and underscored, a crew supervisor is not going to truly know if their firefighter is OK. Each case is unique. Only the individual truly knows if they are OK.

Training Hikes

Research on training hikes shows considerable increases in body temperature to near-critical levels. Periods of rest and nutrition/hydration after these hikes allow for the body to recover and adapt to the stress presented in the hike.

Self-awareness of energy, soreness, and body temperature is crucial to ensure that these hikes aren't pushing past what is needed and to allow for adequate recovery to avoid injury. Recovery is not just a shift-to-shift concept. It is also task-to-task and even minute-to-minute recovery process.

REMEMBER:

- ✓ There is more to heat stress than maintaining your hydration out there.
- ✓ The initial shift hike is a key player in resetting the body temperature for the shift. Spiking crews to reduce that initial heavy physical task could be beneficial.
- ✓ Risk management of protection with PPE and releasing body heat needs to be constantly assessed.
- ✓ If you do suspect a heat illness, stop work and begin treatment to cool down the body.

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Appendix 2

Instructions for the 215R (Risk Matrix)

1) Fill out Incident header blocks.
2) Identify the hazards that will affect the Incident, (pre-mitigation columns)
3) What is the frequency, probability or likelihood of the exposure to that hazard affecting the locations and/or groups you have previously identified? Is it often or sometimes, what is it? Write in
4) Identify the severity/consequence of the hazard to your location or group- what is the worst thing that can happen.
5) Look at the severity table and determine the risk level by (vertical-identified probability and then horizontal-identified severity/consequence(s) which block does the line intersect? (High, Moderate or low)
6) List all of the mitigations, warnings and remedies associated with the hazards (what can you put in place to reduce the frequency or consequence?
7) With the mitigations, warnings and remedies in place….have you reduced the frequency or consequence…..if so, write them in the next set of columns (post-mitigation columns)
8) Look at the table and recalculate the risk! Is it the same or have you lowered it because of the change(s) to frequency and or consequences.
9) This is the residual risk (Low, Moderate, High)…what is left AFTER the mitigations, warnings and remedies have been put in place.
10) Is this acceptable to you and/or the personnel working for you…. Yes or no.
11) Remember we all are risk managers and we cannot take all of the risk out of our decisions and/or actions.

12) Sign and date the form for documentation.

	Severity			
Likelihood	Negligible	Marginal	Critical	Catastrophic
Frequent				
Probable				*High*
Occasional				
Remote		*Medium*		
Improbable	*Low*			

Likelihood Scale	
Frequent	Likely to occur often
Probable	Will occur several times.
Occasional	Likely to occur sometime
Remote	Unlikely to occur, but possible.
Improbable	So unlikely, it can be assumed it will not occur.

Severity Scale	
Catastrophic	Results in fatalities and/or loss of local economic stability, infrastructure or relationships.
Critical	Severe injury and/or major damage to local economic stability, infrastructure or relationships.
Marginal	Minor injury and/or minor damage to local economic stability, infrastructure or relationships.
Negligible	Less than minor injury and/or less than minor damage to local economic stability, infrastructure or relationship.

Appendix 3 – 215R Risk Matrix

Incident Action Plan Safety Analysis	Operational Period: **Day**	Incident: **District/Work Station**
Identification of Hazards and Risk Assessment	Assignment: **Hiking/Foot Travel**	Mission Objective(s): **Physical Training/Conditioning**

Pre-mitigation				Division/Group Location							Mitigation(s), Warnings and Remedies	Post-mitigation			
Hazards, Conditions, Situation(s)	**Likelihood**	**Severity**	**Risk Level**									**Likelihood**	**Severity**	**Residual Risk Level**	**Acceptable Yes/No**
Slips and Falls	**Probable**	**Critical**	**HIGH**								**8" boots with non-slip soles. Watch the ground as you walk. Personnel spacing, Have medical supplies on hand.**	**Probable**	**Marginal**	**Medium**	**Yes**
Steep slippery, rocky, loose ground	**Probable**	**Critical**	**HIGH**								**Going downhill- keep weight on heels, weight back, knees bent, walk do not run, shorten stride and watch the ground. Test footing as you go, carry tools on downhill side, etc.**	**Probable**	**Marginal**	**Medium**	**Yes**
Heat Exhaustion	**Probable**	**Catastrophic**	**HIGH**								**Monitor weather, select lower temp days, carry extra fluids, take frequent breaks, pace yourself and watch out for each other.**	**Probable**	**Marginal**	**Medium**	**Yes**
Severe Weather	**Probable**	**Critical**	**HIGH**								**Monitor weather and do not hike during t-storms.**	**Remote**	**Negligible**	**Low**	**Yes**
Insects (bees/hornets)	**Probable**	**Critical**	**HIGH**								Carry Medical equip; ID personnel that are allergic- avoid known areas.	**Remote**	**Marginal**	**Medium**	**Yes**

Operations Section Chief		Date-Time		IC-DR		Date / Time:	
Safety Officer		Date-Time					

Risk Level	Likelihood/Probability	Severity/Consequences
HIGH- Red	**Frequent**- Likely to occur often	**Catastrophic**- Results in fatality/fatalities/or loss of equipment
MEDIUM- Yellow	**Probable**- Will likely occur several times	**Critical**- Severe injury and/or major system damage
LOW- Green	**Occasional-** Likely to occur often	**Marginal**- Minor injury and/or minor system damage
	Remote- Unlikely to occur but possible	**Negligible**- Less than minor injury and/or less than minor system damage.
	Improbable- So unlikely, it can be assumed it will not occur.	