

# LINE OF DUTY DEATH REPORT

F2020-06 • July 2019

1000 FREDERICK LANE, MORGANTOWN, WV 26508 • 304.285.5916

## ***Seasonal Wildland Firefighter Dies from Hyperthermia During Training Hike—California***

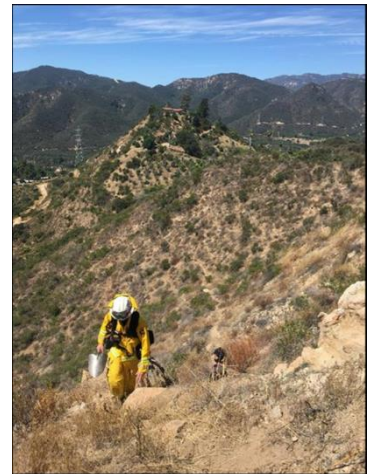
### **Executive Summary**

On July 28, 2019, a 29-year-old male seasonal wildland firefighter (FF1) was on a training hike with his engine crew, which included a fire captain (FC) and a second seasonal firefighter (FF2). The crew was wearing full wildland personal protective equipment (PPE) consisting of wildland jacket and shirt, wildland helmet with shroud, and boots. The crew also carried a fire line hand tool and wore their wildland web gear, which is a special backpack that holds their radio, fire shelter, water bottles and other wildfire related equipment.

The hike is in a rural location by the wildland fire station. During the crew's second time around the 1.45-mile hike, FF1 began stumbling and losing his balance. FF2 assisted FF1 through a steep rocky outcrop to an area where FF1 could rest. Once the FC recognized a possible heat-related emergency, he directed FF1 to remove his web gear and PPE to cool down. Due to his rapidly declining condition from the heat related illness, FF1 was unable to remove his gear as asked, so FF2 initiated cooling measures by removing the PPE and pouring water over the head and chest of FF1, then using a wildland jacket to shade FF1.

As FF1's status further declined, the FC notified dispatch of a firefighter down and requested fire units, a hoist rescue helicopter and air ambulance helicopter for transport. The hoist helicopter was necessary to remove FF1 from the steep and rugged terrain (Exhibit 1). The hoist helicopter flew FF1 to a landing zone at a nearby school where the air ambulance helicopter was waiting for patient transport. The air ambulance helicopter crew initiated advanced life support and cooling measures on FF1 and flew him to the closest hospital, where he was pronounced dead.

The medical examiner listed FF1's primary cause of death as hyperthermia due to environmental exposure to heat, with obesity as a significant condition.



**Exhibit 1. Hiking trail. Photo courtesy of the fire department.**

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### **Key Recommendations**

The National Institute for Occupational Safety and Health (NIOSH) offers the following recommendations to help reduce the risk of heat stress-related injuries and fatalities among firefighters at this and other fire departments across the country.

*Key Recommendation 1: Fire department members should be trained on the early signs, symptoms, and treatment of heat-related illness (HRI), especially heat stroke which is a medical emergency.*

*Key Recommendation 2: Provide preplacement and annual medical evaluations to all firefighters consistent with National Fire Protection Association (NFPA) 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments.*

*Key Recommendation 3: Perform an annual physical ability evaluation (physical ability test) for all firefighters as outlined in NFPA 1500.*

*Key Recommendation 4: Adopt a standardized comprehensive fitness and wellness program to benefit all firefighters consistent with NFPA 1583-Health Related Fitness Programs for Fire Department Members.*

*Key Recommendation 5: Firefighters working in remote locations should preplan for the possibility of an employee becoming ill or injured during training or incident response.*

*Key Recommendation 6: Seasonal firefighters should train and acclimate prior to beginning their assignment in the wildland environment.*

The National Institute for Occupational Safety and Health (NIOSH) initiated the Fire Fighter Fatality Investigation and Prevention Program to examine deaths of fire fighters in the line of duty so that fire departments, fire fighters, fire service organizations, safety experts and researchers could learn from these incidents. The primary goal of these investigations is for NIOSH to make recommendations to prevent similar occurrences. These NIOSH investigations are intended to reduce or prevent future fire fighter deaths and are completely separate from the rulemaking, enforcement and inspection activities of any other federal or state agency. Under its program, NIOSH investigators interview persons with knowledge of the incident and review available records to develop a description of the conditions and circumstances leading to the deaths in order to provide a context for the agency's recommendations. The NIOSH summary of these conditions and circumstances in its reports is not intended as a legal statement of facts. This summary, as well as the conclusions and recommendations made by NIOSH, should not be used for the purpose of litigation or the adjudication of any claim.

For further information, visit the program Web site at [www.cdc.gov/niosh/fire](http://www.cdc.gov/niosh/fire) or call toll free 1-800-CDC-INFO (1-800-232-4636).



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### **Introduction**

On July 28, 2019, a 29-year-old male seasonal wildland firefighter (FF1) suffered a heat stroke during a training hike and died. The U.S. Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this fatality on August 2, 2019. NIOSH contacted the affected department to gather additional information and initiate the investigation. Three members, including a medical officer, investigator, and a firefighter safety specialist from the NIOSH Fire Fighter Fatality Investigation and Prevention Program conducted an on-site investigation.

During the investigation, the NIOSH personnel interviewed the following people:

- *Fire Chief*
- *Safety Officer*
- *Training Chief*
- *Incident Commander*
- *Fire Captain*
- *Firefighter 2*
- *Rescue Helicopter Captain*
- *Flight Medic*
- *Union Representative*

NIOSH personnel reviewed the following documents:

- *Fire Department Serious Accident Review Team (SART) Report*
- *Fire Department Standard Operating Guidelines*
- *Department Incident Report*
- *Training Records*
- *Mutual Aid incident Reports*
- *Medical Air Transport Incident Report*

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- *Emergency Department Medical Records*
- *Autopsy Report*
- *Medical Examiner Report*
- *Safety Plan*
- *Heat Illness Prevention Plan*
- *Injury Illness Prevention Plan*
- *Wellness/Fitness Plan*
- *2019 Annual Focus on Safety*

### **Fire Department**

The department delivers fire protection and emergency medical services to 42 communities through 35 fire stations with over 500 first responders and 48 civilian staff. The department is comprised of 30 full-time stations and 5 seasonal stations that are staffed for the wildland season. Fifteen of the thirty-five fire stations have advanced life support (ALS) response. The department has eight battalions and staffs a communication center with 21 personnel.

The department responds to approximately 2,344 square miles within the county that covers a diverse topography from the coast to mountain elevations over 6,500 feet.

In 2018, the department ran over 7,000 calls with an average response time of 10 minutes. Much of the response area is in rural country and 73 of the 7,000 calls were remote-area-rescues, including approximately 48 hoist rescues.

### **Employment and Training**

Pre-employment requirements include that the applicant be a minimum of 18-years-old at time of appointment. In addition, candidates must have the ability to follow oral and written directions; perform heavy physical work; exercise good judgment in hazardous fire suppression activity; accept and benefit from training in fire suppression work and techniques; work safely with others; live in a fire station compatibly with others; respond quickly to oral commands or signals in emergency situations and have knowledge of good physical work methods.

Once selected, seasonal firefighters attend a basic firefighter school consisting of 219 hours over a five-week period. The five-week course includes both classroom and physical skills training with approximately 129 hours of lecture, 80 hours of activities and 10 hours of testing. Required training for seasonal firefighters that can be obtained after appointment includes Basic Firefighter certificate, confined space awareness, HazMat First Responder, Federal Emergency Management Agency (FEMA) IS-100: Introduction to Incident Command System, FEMA IS-700: An Introduction to the National Incident Management System, FEMA IS-800: Introduction to the National Response Framework, cardiopulmonary resuscitation (CPR) and at a minimum Public Safety First Aid - Emergency Medical Services (EMS) training.

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After successfully completing the basic firefighter school, the seasonal firefighters are assigned to a fire station where they train and work out with their crews. Aside from training that is facilitated through the Department Training Division, individual crews can participate in their own additional training programs if desired.

### **Preplacement/Periodic/Return to Work Medical Evaluation**

Seasonal firefighters are required to complete a medical questionnaire. At the time of the interview, this department did not require them to complete an annual medical examination by a department physician as recommended in NFPA 1582. The seasonal firefighter position only requires them to obtain a periodic medical evaluation if he/she has suffered an on-duty heat-related illness (HRI). The department's 2019 Heat Illness Prevention Plan states *“Employees exposed to potentially hazardous levels of heat stress shall receive periodic medical examinations, combined with the respiratory protection program, which shall include an assessment of risk factors peculiar to the work environment and associated tasks. This assessment shall include a history of heat-related illnesses by the employee.”*

### **Wellness/Fitness Programs**

The department implemented a comprehensive fitness program that outlines specific work-out routines and standards in late 2019. However, at the time of FF1's fatality, the rural station had minimal exercise equipment and used the hike for physical training. The department allows one hour daily for physical training and provides some exercise equipment. The department's 2019 Heat Illness Prevention Plan states that *“All employees have the responsibility to be physically fit to perform the variety of tasks and assignments within their classification. Employees shall be responsible to maintain their level of awareness regarding heat illness prevention, This includes but is not limited to: environmental conditions, adequate hydration, work/rest cycles, acclimatization, physical fitness, medical monitoring, medical treatment protocols, exogenous factors (medications, drugs, alcohol, etc.) and the effect of personal protective clothing and equipment on the body.”*

### **Investigation**

On July 28, 2019, a wildland engine company was on a training hike in a remote and rugged area when a seasonal firefighter developed heat stroke and died. The engine company consisted of a Fire Captain (FC), the deceased seasonal firefighter (FF1), and a second seasonal firefighter (FF2).

At 8:00 a.m. on Sunday, July 28, 2019, fire crews were completing a shift change. The FC and FF2 were coming on duty, while FF1 had worked a relatively less strenuous shift the day before on a fuels management project that was not considered physically demanding. As the crew was having a light breakfast, they discussed the days weather and the FC's plan to perform a hike for the day's physical training.

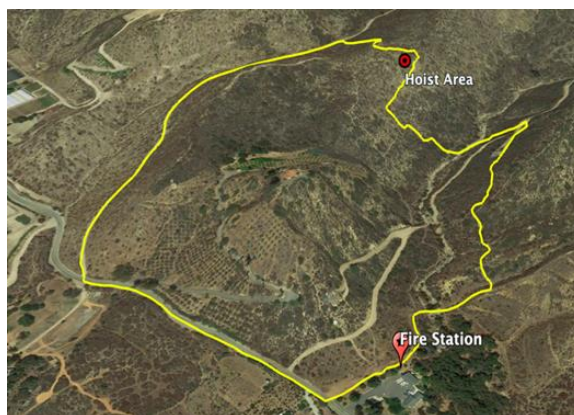
The weather for the day was mostly sunny, 73–78 degrees Fahrenheit (°F), relative humidity 63%, winds from the southwest at 2 miles per hour (mph) with gusts up to 10 mph (taken at local remote area weather station [RAWS] station at 10:22 a.m.) The heat index rating on this day was 22–25, indicating minimal risk for a heat related illness (Heat Index Appendix C).



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At approximately 8:30 a.m., the three-member crew prepared for the hike by donning full personal protective equipment (PPE), consisting of single layer wildland Nomex<sup>®</sup> jacket and pants, wildland helmet, gloves, webgear, and a wildland handtool for a combined weight of approximately 20 pounds. Prior to starting the hike, the FC briefed FF1 and FF2 that he expected a station standard for the hike of 30 minutes or less.

The hike is an established trail that has been frequently used by fire crews over 10 years for physical fitness training (Exhibit 2). However, the 30-minute time standard was not part of the standard procedure or required to complete the hike. The trail is a loop located in a remote and rugged area that starts and ends at the fire station. It is approximately 1.45 miles and traverses from a relatively flat dirt jeep trail to a very steep single path terrain. Throughout the hike there are two prominent slopes. The first slope averages 10% grade, with a maximum slope of 87% grade. The hike then crosses a drainage before starting the second and steeper section of the trail, where the average grade is 23%, with the steepest grade at 97%.



**Exhibit 2. The 1.45-mile trail used for physical training. Photo courtesy of Google Earth image.**

At approximately 8:40 a.m., the crew began their hike with the FC and FF2 leading FF1. The FC and FF2 would occasionally stop to let FF1 catch up as he was slower. FF1 completed the hike in 40 minutes and 40 seconds, far slower than the 30-minute station standard established by the FC.

Since the station standard of 30 minutes established by the FC was not met, the FC decided that the crew should do the hike an additional time. The FC advised FF1 and FF2 to take a 20-minute rest, cool off, and rehydrate before they started the second attempt at the hike. During the break, FF2 noticed that FF1 appeared tired and did not appear to have fully recovered from the first hike, but FF2 did not mention this to the FC.

At approximately 9:40 a.m., the engine crew started the second hike. On the second hike, the FC placed FF1 in front as the lead with FF2 and him following. The FC noticed that FF1 was having difficulty navigating the turns on the trail but would speed up his pace on the straight portions of the trail. Both FF2 and the FC told FF1 to pace himself and rest if needed. As they passed through the drainage and began to ascend the second slope of the hike, the FC noticed FF1 struggling as he took several breaks. Moments later, FF1 stopped and told the FC he was exhausted, but wanted to finish the hike. The FC then took the handtools from both firefighters and told FF2 to assist FF1 up the trail. According to the FC, he did not realize FF1 was suffering from a HRI at this point. Although FF1 was tired, he was still able to communicate with the FC, and never complained about nausea, headache, or dizziness.

As the crew hiked along the steeper portion of the trail, FF2 noticed that FF1 was stumbling and losing his balance. At the direction of the FC, FF2 positioned himself behind FF1 and held on to his webgear

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as they were climbing up a steep rocky portion of the trail (Exhibit 3). FF2 continued to assist FF1 through the steep rocky area until they reached the top of the outcropping. Once the crew reached the top, FF1 fell forward and sat down. The FC directed FF1 to remove his webgear and wildland jacket to cool down, but due to the onset of hyperthermia, FF1 was unable to comply. FF2 removed FF1's helmet, webgear, wildland jacket and t-shirt in an effort to cool him down. FF2 poured bottled water over FF1's upper body and shaded him with his Nomex<sup>®</sup> jacket to help cool him down. Concerned about FF1's mental status, the FC asked him his name and if he knew where he was. FF1 stated his name and that he wanted to finish the hike but was unable to answer any other questions asked by the FC.

Recognizing FF1's mental status was declining, the FC contacted dispatch at 10:38 a.m. requesting medical response for a firefighter down. The FC also requested a rescue hoist helicopter due to the remote location and the inability to access by vehicles. The dispatch for a medical with rescue was initiated and included a Battalion Chief and fire engine from the FC's department, mutual aid fire engine and medic ambulance from the neighboring department, hoist rescue helicopter and an air ambulance helicopter. The FC established command and assumed Incident Commander (IC). At 10:45 a.m., the IC updated dispatch that FF1 was breathing but not alert or oriented.

At 11:02 a.m. the mutual aid fire engine and medic ambulance arrived at the crew's fire station, with the department engine arriving closely behind. IC directed these units to set up a landing zone at the elementary school approximately one mile away from the down firefighter. The IC directed his department engine to stage at the fire station and for its crew to hike to FF1's location with additional water and ice. At 11:17 a.m. the air ambulance helicopter arrived at the landing zone as directed by the IC.

At approximately 11:19 a.m. the IC spotted the rescue helicopter flying overhead and used an orange flag to get their attention and direct them to his location. The rescue helicopter hovered as Rescuer 1 stepped off the helicopter skid with a medical bag and the needed rescue equipment.

The FC and FF2 assisted Rescuer 1 to get FF1 packaged in the Bauman bag (Exhibit 4) to be hoisted, as the rescue helicopter lifted off to prepare for hoisting. While packaging FF1, the crew placed ice brought in by rescue crews around him for cooling. The Bauman bag wraps around the body and provides an anchor point that attaches to the hoist cable.



**Exhibit 3. The steepest and rocky portion of the trail. Photo courtesy of the fire department.**



**Exhibit 4. The Bauman Bag. Photo by NIOSH.**

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At 11:33 a.m., FF1 was hoisted from the remote drainage by the rescue helicopter (Exhibit 5) and flew him to the landing zone where paramedics from a neighboring fire department and the crew from the air ambulance (flight nurse and paramedic) were waiting. The landing zone was not big enough for both helicopters, so the air ambulance lifted off the ground after dropping off the crew to make room for the rescue helicopter to land. County EMS policy does not allow for the county owned rescue helicopter to transport patients to a hospital, this is viewed as a conflict with the contract between the county and private transport companies.

At 11:38 a.m., the rescue helicopter landed and transferred patient care to the air ambulance crew (Exhibit 6). FF1 was pale, diaphoretic, and unresponsive as he was moved into the medic ambulance for patient care. The ALS crews removed the Nomex<sup>®</sup> pants, socks, and boots from FF1 and placed ice packs on his axillary, inguinal and carotid areas as additional cooling measures. ALS crews ventilated FF1 using a bag valve mask (BVM) and nasopharyngeal airway (NPA) with an oxygen flow rate of 15 liters per minute. The first temperature taken was 100.2°F (external) at 11:38 a.m. The Battalion Chief assumed IC at 11:44 a.m. FF1 was loaded into the air ambulance helicopter at approximately 12:04 p.m. and flown to the closest hospital.

FF1 arrived at the hospital by air ambulance at approximately 12:11 p.m. On arrival at the hospital, FF1 remained unresponsive and had a core temperature of 107°F. He was immediately intubated and was placed on the Artic Sun<sup>™</sup> 5000 Temperature Management System, a non-invasive cooling system that works by circulating chilled water in pads directly adhered to the skin. He was then admitted to the Intensive Care Unit in respiratory and renal failure with anuria. FF1 went into cardiac arrest at 2:36 a.m. Resuscitative efforts were unsuccessful, and he was pronounced dead at 3:07 a.m. on July 29, 2019.

### Cause of Death

According to the death certificate, the medical examiner listed the victim's cause of death as hyperthermia due to environmental exposure to heat. Obesity was listed as a significant condition.

### Discussion

Hyperthermia, elevated core body temperature (CBT), is a condition when the CBT of an individual is higher than 99°F (37.2°C). Heat stroke is the most serious HRI and is characterized by a change of mental status while in a hot environment. This can include a wide range of signs and symptoms including confusion, difficulty performing routine tasks, and lack of motor coordination to seizure, loss of consciousness, and death. Heat stroke can cause death or permanent disability if emergency



**Exhibit 5. Rescue Hoist Helicopter. Photo courtesy of the fire department.**



**Exhibit 6. Air Ambulance Helicopter lifting off. Photo courtesy of the fire department.**



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treatment is not quickly initiated [NIOSH 2016]. Heat exhaustion is a less severe type of HRI and can often precede the onset of heat stroke.

FF1's body temperature at 11:21 a.m. prior to air transport was 100.2°F (37.9°C). His skin was pink and diaphoretic. He was unresponsive with a rapid and weak heart rate at the radial artery pulse check site. Initial cooling measures appeared to be inadequate as FF1's CBT on arrival to the emergency department (ED) 50 minutes later had risen to 107.6°F (42°C).

Rapid identification and treatment initiation for heat stroke is critical. According to both the FC and FF2, they did not observe some of the common symptoms of HRI, such as dizziness, headache or nausea until FF1 collapsed. FF1 was observed having trouble navigating turns in the trail followed by stumbling with loss of balance. These are consistent with signs of heat-related illness that can rapidly lead to heat stroke.

Once FF1's heat-related illness was identified and cooling measures begun, hospital treatment was delayed due to the remote location of the fire station and its associated hiking trail. It took approximately 1½ hours to transport FF1 from the rural mountain area to a medical facility for appropriate treatment. Although the FC and FF2 poured water on FF1 to encourage evaporative heat loss and tried to shield him from the sun as soon as they recognized he likely had heat stroke, this was not effective to prevent his core temperature from elevating to a life-threatening level.

Weather for that day indicated a relatively low risk for HRI. The air temperature at 10:22 a.m. on July 28 at the RAWS located five miles away from the incident was 78°F (25°C) with a humidity of 63%. Heat Index calculators can assist in determining the level of concern for HRI given the known conditions. One calculator, the Humidex Chart for HRI, indicates that the weather that morning would have been "Alert Level 1", the lowest level of concern on the Humidex Chart [Appendix C]. Humidex Level 1 (30–39) *Caution: Fatigue and faintness are possible with physical activity or prolonged exposure. The most likely at risk are those performing heavy work for extended periods of time.*

FF1 was 5 feet 11 inches tall and weighed 279 pounds with a body mass index (BMI) of 38.9. As per *About Adult BMI | Healthy Weight, Nutrition, and Physical Activity | CDC*, a BMI  $\geq 30.0$  is considered obese [Centers for Disease Control and Prevention 2020]. Research studies have found that obesity is a risk factor for HRI, with a series of occupational deaths finding a high prevalence of obesity, diabetes, hypertension, and cardiac disease in workers who died of HRI [Tustin 2018]. These medical risk factors can increase the risk of HRI due to decreased thermoregulatory ability, disordered skin vasodilation, impaired sweating response, dehydration, and inability to increase cardiac output. This finding has also been seen in athletes such as football players, with an increased risk of HRI associated with obesity [Kerr 2013]. Studies of army recruits also show that fitness and body fat are associated with a higher risk of HRI, indicating that those with low fitness levels and/or obesity should be medically evaluated before engaging in intense physical activity, especially in warmer months [Bedno 2014]. Considering the weather conditions based on the Heat Index that morning was not remarkable and the FC and FF2 had no complications, it is likely that FF1's obesity was a significant factor that contributed to his death.

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### **Recommendations**

***Recommendation #1: Fire Department Members should be trained on the early signs, symptoms, and treatment of Heat Related Illnesses, especially heat stroke.***

Discussion: The department has a written policy and formal training program on recognizing the signs and symptoms of HRI. All members of the 3-person crew had completed the annual training for HRI. However, prior to FF1 collapsing, the FC and FF2 both stated that they did not see any of the typical symptoms associated with HRI such as altered mental status, nausea, vomiting, or complaints of a headache. There may have been indicators that were not recognized at the time as heat related, such as weakness, tiredness, and fatigue.

***Recommendation #2: Ensure all fire department members are cleared for duty by a physician knowledgeable about the physical demands of firefighting, the personal protective equipment used by firefighters, and the various components with NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments [NFPA 2022a].***

Discussion: The department only requires seasonal firefighters to complete a health questionnaire. While the department is not required by law to complete a pre-placement medical evaluation by a physician in accordance with NFPA 1582, doing so would help to ensure the health and safety of all firefighters. A medical evaluation of a candidate should be conducted prior to the candidate being placed in training programs or fire department emergency response activities, with the purpose of detecting physical or medical conditions that could adversely affect his/her ability to safely perform the essential job tasks. Screening for medical conditions and medications that could increase risk for HRI should also be implemented.

***Recommendation #3: Perform an annual physical ability evaluation (physical ability test) for all firefighters as outlined in NFPA 1500 Standard on Fire Department Occupational Safety, Health and Wellness Program [NFPA 2021] and the International Association of Firefighters/International Association of Fire Chief-Wellness Fitness Initiative [IAFF, IAFC 2018].***

Discussion: Full-time members are required to pass the Candidates Physical Ability Test (CPAT) [Appendix A] prior to employment. Seasonal firefighters currently do not participate in a CPAT or an annual physical ability test prior to employment even though they are expected to perform the same essential job tasks as full-time employees.

NFPA 1500 and the WFI, recommend that all firefighters who engage in emergency operations be evaluated annually and certified to meet the physical performance requirements identified in the standard. The purpose is to ensure firefighters are physically capable of performing essential job tasks of firefighting [NFPA 2021].

***Recommendation #4: Adopt a wellness and fitness program to benefit all firefighters consistent with NFPA 1583 – Standard on Health-Related Fitness Programs for Fire Department Members [NFPA 2022b].***

Discussion: The department currently allows one-hour daily for physical training. According to the department's Heat Illness Prevention Plan, *all employees have the responsibility to be physically fit to perform the variety of tasks and assignments within their classification.* The station where FF1 was assigned had a routine of hiking the 1.45-mile trail behind the rural fire station for over a decade.

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Although 20 minutes was a normal time for firefighters assigned at the station, they had established an informal standard of 30 minutes. NFPA 1583 7.1 (2) includes an individualized exercise prescription based on the results from the fitness assessment. FF1 had difficulty meeting the informal standard and should have had a fitness assessment for duty prior to the hike. Once FF1 failed to meet the informal standard, an individualized exercise prescription or performance improvement plan (PIP) should have been developed for him.

***Recommendation #5: Firefighters working in remote locations should preplan for the possibility of an employee becoming ill or injured during training or incident response.***

Discussion: Firefighters who work in remote rural areas should preplan for the potential of a fire department member becoming ill or injured on duty. The National Wildfire Coordinating Group (NWCG) Incident Response Pocket Guide (IRPG) PMS 461 identifies the need to prepare for a medical emergency of firefighting personnel [NWCG 2018]. The IRPG asks three questions:

1. What are we going to do if someone gets hurt?
2. How will get them out of here?
3. How long will it take to get them to a hospital?

These three questions should be considered anytime firefighters are working or training in rural areas.

Although the 1.45-mile hike was routine for firefighters assigned to the rural fire station, consideration must be given to the wellness and fitness of each member. The FC made a timely call for air resources as soon as he recognized FF1 was suffering from an HRI. Even with immediate action, the rescue and transport took approximately 1½ hours to get appropriate care, which played a significant factor in FF1's death.

***Recommendation #6: Seasonal firefighters should be fit and acclimate prior to the beginning their assignment in the wildland environment.***

Discussion: Seasonal firefighters are not employed by the fire department during the winter months, so it becomes critical that they keep fit, train, and acclimate prior to returning work for the wildfire season. Seasonal firefighters returning to work be cleared by a physician in accordance with NFPA 1582 and meet the arduous work requirements, by completing a Work Capacity Test (WCT). Although organizations within California banned the NWCG Pack Test, designed to evaluate a wildland firefighter's work capacity or fitness for duty, work capacity can be determined through other means which are outlined in the WFI.

A common method to determine fitness for duty is a stress electrocardiogram (ECG). Which is a submaximal test that uses the Gerkin treadmill protocol for predicting the maximal oxygen uptake (VO<sub>2</sub> max) of firefighters. One of the great benefits of the stress ECG, is that it is done in a controlled environment like a health facility. Maximal exercise testing is intended to quantify aerobic exercise capacity as oxygen consumption at peak exercise, which is an objective measure that defines the limits of cardiopulmonary function.

Acclimatization is necessary to prepare wildland firefighters for work in heat stress conditions. Acclimatization is a process of adjustment that occurs in 5 to 10 days of heat exposure. Aerobic fitness is considered one of the best ways to avoid heat stress. A well-developed circulatory system and

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increased blood volume are both important for regulating body temperature. Fit workers start to sweat sooner, so they work with a lower heart rate and body temperature. They adjust to heat twice as fast as the unfit worker.

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### **Investigator Information**

This incident was investigated by the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiac/Medical Team, in Cincinnati, Ohio. TJ Welch is a Firefighter Safety Specialist and co-authored the report. He worked in volunteer, industrial, and municipal fire departments and retired as a Chief Officer. Mr. Welch is a State Certified Fire Officer, founding member of the California Incident Command Certification System (CICCS) and chaired the CICCS committee on Physical Fitness Standards. Dr. Robert Harrison MD, MPH (California Department of Public Health) provides medical consultation, and Laura Styles, MPH (Public Health Institute) also contributed to this report.

### **Disclaimer**

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### **Appendix A Candidate Physical Ability Test**

Participants in the CPAT must navigate eight separate events on a closed course within a span of 10 minutes and 20 seconds. Each event simulates a physical skill or function that firefighters experience on the job.

- Stair Climb
- Hose Drag
- Equipment Carry
- Ladder Raise and Extension
- Forcible Entry
- Search
- Rescue Drag
- Ceiling Breach and Pull

During the test, candidates wear a helmet, gloves and 50-lb weighted vests, designed to simulate the weight of firefighter personal protective equipment. For the stair climb – the first event – candidates will don an additional 25-lb weight, to simulate the carrying of a hose pack into a high-rise fire.

Candidates will be accompanied by a test proctor, who will call out directions for the test events and score the candidate's success in real time.

Each event must be completed exactly as prescribed – if a candidate fails any component of the test, they will fail the entire test. Candidates also fail if they do not complete the eight events within the 10-minute, 20-second time limit.

CPAT Link - <https://www.fctonline.org/cpat/>

## ***Seasonal Wildland Firefighter Dies from Hyperthermia During Training Hike—California***

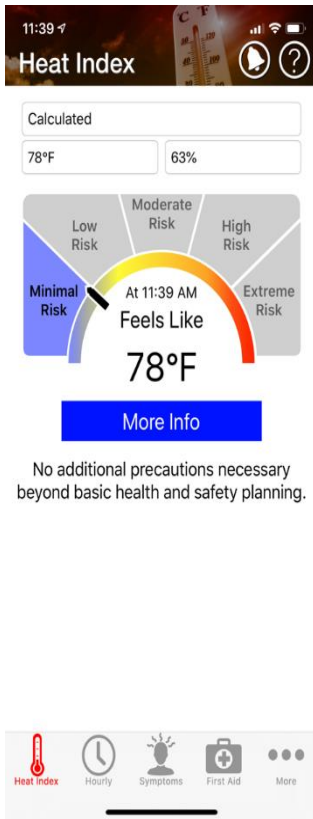
### **Appendix B Body Mass Index Chart**

<b>BMI</b>	<b>Weight Status</b>
Below 18.5	Underweight
18.5 – 24.9	Normal or Healthy Weight
25.0 – 29.9	Overweight
30.0 and Above	Obese

Courtesy of CDC-Assessing BMI

# Seasonal Wildland Firefighter Dies from Hyperthermia During Training Hike—California

## Appendix C Heat Index Calculator



**OSHA/NIOSH Heat Index Calculator 1**

**HEAT STRESS/HEAT-RELATED ILLNESS (continued)**

**HUMIDEX Chart**

Percent Relative Humidity

		20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
Air Temp °C	43																	
	42																	
	41																	
	40																	
	39																	
	38																	
	37																	
	36																	
	35																	
	34																	
	33																	
	32																	
	31																	
	30																	
	29																	
	28																	
	27																	
26																		
25																		
24																		
23																		
22																		
21																		
		20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100

Percent Relative Humidity

54+  
Extreme Danger

46-53  
Danger

40-45  
Extreme Caution

30-39  
Caution