



Potential Exposures and Hazards in Wildland Fire Fighting

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Overview

- NIOSH introduction
- Overview of wildland fire fighting
- Potential health hazards involved in wildland fire fighting
- Related NIOSH activities and resource materials



WFF working 2014 King Fire in CA [The Atlantic]

NIOSH Introduction

NIOSH 101

Occupational Safety and Health Act of 1970 created 2 agencies focused on workplace health and safety

- National Institute for Occupational Safety and Health (NIOSH)
- Occupational Safety and Health Administration (OSHA)

	Federal Agency of Origin	Mission	Issue
NIOSH	Department of Health and Human Services	<ul style="list-style-type: none">• Education• Research	Recommendations
OSHA	Department of Labor	<ul style="list-style-type: none">• Regulation• Enforcement	Citations

NIOSH Health Hazard Evaluation (HHE) Program

- NIOSH HHEs focus on workplace health hazards and can be requested by
 - Agency / Management representatives
 - Employees (may be confidential)
 - Union
- Both IH and Medical components
- HHE final reports are searchable public documents on the HHE website
www.cdc.gov/niosh/hhe



Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health



Health Hazard Evaluation Program

What Employers Should Know

Request an Evaluation

Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health



HHEs Related to Wildland Fire Fighting

HHEs were done concerning:

- Exposures to eronite and silica during forest management and fire suppression activities—MT
- Exposures to Libby amphibole asbestos during forest management—MT
- Rhabdomyolysis in Wildland Fire Fighters (WFFs) – ID
- Carbon monoxide exposure at a wildfire base camp – CA
- Chainsaw emissions among forestry workers – WA
- WFFs' exposure to carbon monoxide-CO

How do I know if I have rhabdomyolysis?

The only sure way is to seek medical care. A licensed healthcare provider will determine if you need to have a serum creatine phosphokinase (CPK or CK) test to look for muscle proteins in the blood. You cannot tell by symptoms alone if you have rhabdomyolysis.

Severe cases of rhabdomyolysis require hospitalization to monitor the heart and kidneys and to provide emergency treatment for dangerous heart rhythms and loss of kidney function. High rates of intravenous fluids are needed to flush out the muscle proteins and electrolytes without damaging the kidneys. If the kidneys fail immediate dialysis is needed. Sometimes kidney function does not recover, requiring a lifetime of dialysis.

Rhabdomyolysis can be treated without complications if it is recognized early.

What should I do if I have symptoms?

Listen to your body! If your muscles hurt more than expected, if you can't tolerate exertion that you previously could, or if your urine turns unusually dark you should:

- Stop your current activity
- Tell your supervisor or trainer about your symptoms
- Seek immediate care at the nearest medical center
- Ask to be checked for rhabdomyolysis

Reporting your symptoms is not a sign of weakness.

Early detection could save your career and your life!



Back of Rhabdomyolysis fact sheet created as part of 2011 HHE; note NWCG stamp



Overview of Wildland Fire Fighting

Definitions

National Wildfire Coordinating Group (NWCG) Glossary:

- **Wildfire:** “an unplanned, unwanted wildland fire including unauthorized human-caused fires, escaped wildland fire use events, escaped prescribed fire projects, and all other wildfires where the objective is to put the fire out.” Includes grass, brush, and timber fires.
- **Wildland:** “an area in which development is essentially non-existent, except for roads, railroads, power lines, and similar transportation facilities. Structures, if any, are wildly scattered.”
- **Fuel:** “Any combustible material, especially petroleum-based products and wildland fuels. ”



Surface fire burning grass, leaves, & twigs



Crown fire burning tops of trees and shrubs
[Photos by Maulik Joshi]

More Wildfires vs. More News Coverage?

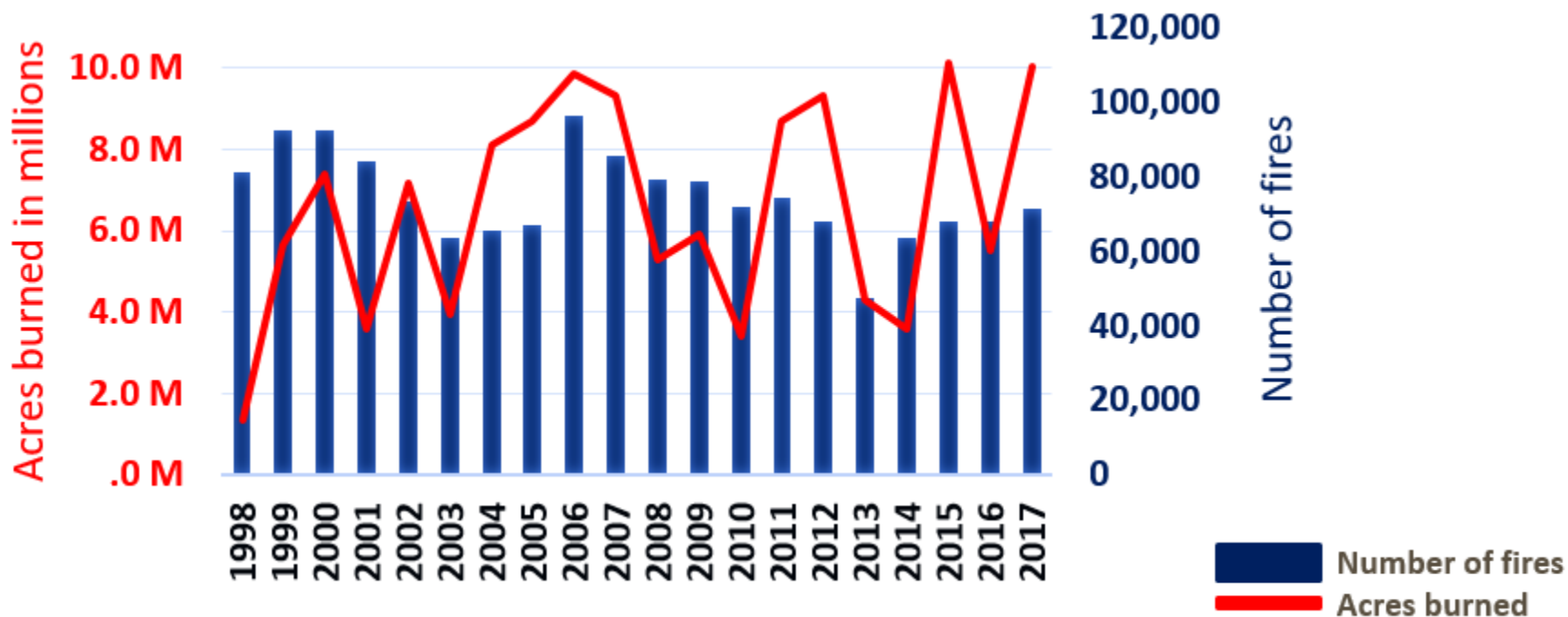


A firefighter runs while trying to save a home as a wildfire tears through Lakeport, Calif., Tuesday, July 31, 2018. (AP Photo/Noah Berger, File) THE ASSOCIATED PRESS



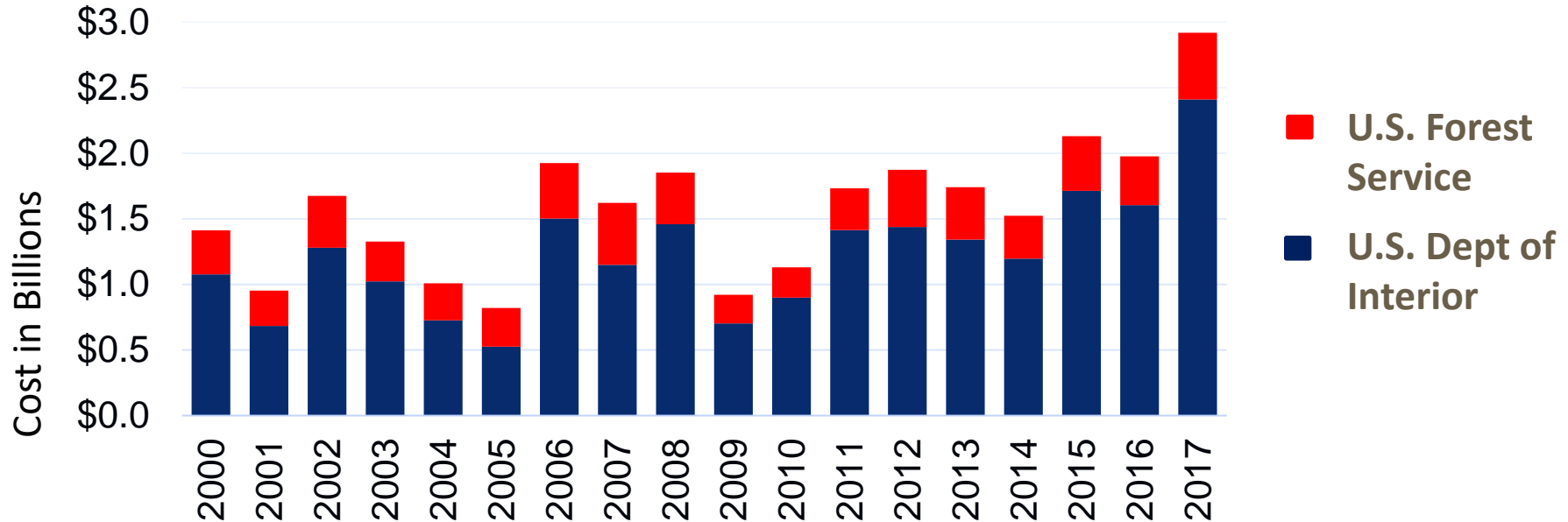
Recent Wildfire Statistics

- Fewer fires but they're larger; burning more land per fire



Source: National Interagency Fire Center (NIFC)

Federal Wildland Fire Fighting Suppression Costs



This does NOT include costs incurred by state, local, or other agencies!

Who Employs Wildland Fire Fighters (WFFs)?

- Federal Agencies
- State Based Agencies
- Local Fire Departments
 - Some WFFs are also structural FFs
- Contractors
- National Guard
- Bureau of Prisons



Community Programs For Prisoners

California Inmates On Frontline Of The Wildfire Battle:
What Are The Benefits?

Many Different Types of WFFs

- Employment types
 - Full-time year round
 - Full-time during fire season
 - Volunteer
 - Contractors
 - On-call or “militia” defined by National Interagency Fire Center (NIFC) as “people with non-fire fighting jobs for most of the year volunteer for duty at all levels of fire fighting”



WFF Qualifications

- Multiple aspects: Physical fitness for duty, academic requirements, etc.
- Voluntary adherence to NWCG and National Fire Protection Agency (NFPA) standards
- Some agencies may have:
 - their own qualification systems
 - task-based instead of job-title based qualifications





- Cal Fire WFFs respond to 5,600 wildland fires per year
 - 6,100 full-time year-round and 2,600 seasonal WFFs
 - 3,500 inmates, state wards, or conservation corps members
 - 600 volunteers
- Additional facets of Cal Fire
 - Emergency services provider
 - Administers training, education, and certification programs for both structural and wildland fire fighters
 - Resource Management Program

Challenges to WFF Surveillance

- Counting total number of WFFs
 - No single, unique job title or category for WFFs at any level of gov't
 - Some federal WFFs are categorized as forestry and fuels technicians which includes many types of outdoor based forestry workers
- Structural fire fighters (paid career and volunteer) often perform both wildland and structural fire fighting
- Highly mobile workforce
 - Some WFFs take on new roles or employment within or between seasons at a single agency
 - Some WFFs stay in same role but change agencies



WFF Fire Season Tasks

- Fire season historically March–October
- Tasks focused on fire suppression and management including
 - Digging fire line
 - Operating equipment used to create access paths, remove fuels, and extinguish fires
 - Bulldozers
 - Chainsaws
 - Aircraft
 - Many other roles and support functions



WFFs digging fire line on Rim Fire in Stanislaw National Forest, CA, 2013 [U.S. Forest Service photo by Mike McMillan]

WFF Off-Season Tasks

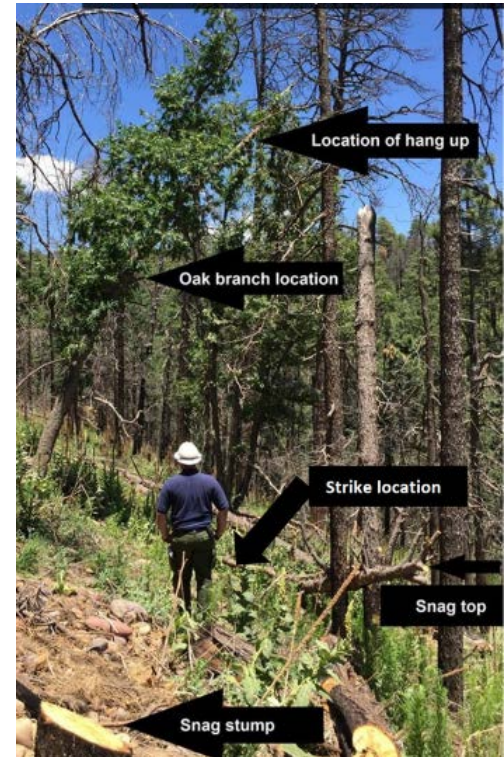
- Wildland Urban Interface (WUI) is a transition zone between developed and undeveloped land
- Off-season tasks may focus on
 - Resource management
 - Widening WUI in higher risk areas
 - Fuel reduction efforts including advising homeowners on compliance with Defensible Space guidelines



Wildfire in WUI near housing development in San Diego, 2003 [Photo by John Gibbons/San Diego Union-Tribune]

WFF On-Duty Fatalities

- In past 18 years, 21 on-duty WFF fatalities reported*
- Cause of death
 - #1 Vehicle related includes both aircraft and ground vehicles
 - #2 Medical events (i.e. sudden cardiac death, stroke, etc.)
 - #3 Entrapment
 - #4 Struck by accidents (i.e. tree, truck, etc.) †



Tree Strike Diagram [Photo from Wildland Fire LLC]

*<https://blogs.cdc.gov/niosh-science-blog/2017/02/16/wildland-ff-surveillance/>

†<https://wildfiretoday.com/2016/01/19/entrapments-is-the-fourth-leading-cause-of-wildland-firefighter-fatalities/>

WFFs: What We Don't Know or Partially Know

- Total number and types of workers
- Demographics
- Day to day tasks
- Exposures
- Off season or other work
- Non-fatal injuries
- Non-fatal illnesses
- Health outcomes



Photo by [Todd Wycoff](#), New Jersey Forest Service

So let's focus on what we DO know about wildland fire fighting....

Potential Health and Safety Hazards in Wildland Fire Fighting

Examples of WFF Safety and Health Hazards

Safety Hazards

- Aircraft incidents
- Burns
- Electrocution from power lines
- Environmental conditions (e.g., lightning, steep or remote terrain)
- Scrapes and cuts from tools and equipment
- Slips, trips and falls
- Struck-by objects, such as trees, rocks, or vehicles
- Vehicle rollovers or collisions

Wildland Fire Fighting Hot Tips to Stay Safe and Healthy

Every year, hundreds of thousands of acres of land burn across the United States and wildland fire fighters (WFFs) are asked to protect our lives, our homes and our forests.¹ But fires are unpredictable and dangerous. In fact, over 200 on-duty WFF fatalities occurred between 2001 and 2012.²

WFFs often work long hours for many days under stressful conditions, which can negatively impact their health, increase the likelihood of on-duty injury and affect performance.³ This fact sheet was developed to keep WFFs safe and healthy.



Photo by George Brimley, US Forest Service

<https://www.cdc.gov/niosh/docs/2013-158/pdfs/2013-158v2.pdf?id=10.26616/NIOSH PUB2013158>

Health Hazards

- Ash, dust and burning debris
- Contact with plant irritants and sensitizers (e.g., poison ivy, thorns)
- Environmental conditions (e.g., lightning, cold weather)
- Fatigue
- Hazardous materials and gases
- Heat-related illness
- Insect bites or stings
- Respiratory illnesses
- Rhabdomyolysis⁷
- Smoke contaminants
- Stress

Safety Hazards – Motor Vehicle Accidents

- Leading cause of WFF fatalities
- ↑ risk for MVAs due to
 - Poor visibility
 - Fatigue
 - Speed



Driving through wildfire, 2015 [Photo by Bob Flavin]

- Vehicles with ↑ risk rollover
 - High centers of gravity
 - Cargo shifting during turns
 - Working on steep inclines



Above: Photo of crashed tanker in 2012 WFF fatality [Photo courtesy of local police department]; Below: Similar tanker as one involved in fatality. [Photo by NIOSH]*



Safety and Health Hazard: Terrain

- Wildfires may occur in remote areas with steep and/or unstable terrain
- Crossing terrain may result in:
 - Safety hazards: sprain/strain, trauma from slip/trip/fall, etc.
 - Health hazards from exertion and/or heat: dehydration, rhabdomyolysis, etc.



FF climbing steep terrain in CA.
[Stan Lim, San Bernardino Sun]

WFF Health Hazards: Heat Exposure

Heat Stress = Net heat load from:

- Ambient environmental conditions
- Active heat source (i.e., fire)
- Metabolic heat
 - Muscle activity (exertion)
 - Fever

Muscle work ↑ carrying extra weight of:

- Personal protective equipment (PPE)
- Tools
- Water and food supplies



Wildland FF using drip torch for prescribed burn
[News.Delaware.Gov]

Heat Related Illness (HRI)

- Heat Strain – body’s response to heat stress. May be dependent on several factors:
 - Acclimatization status
 - Ability to disperse heat (meds ↓HR, heat trapping PPE, etc.)
- Wide spectrum of HRI
- Heat Stroke= mental status change while in a hot environment
 - Most severe form of HRI → life threatening!
 - Buddy system

Fire Near Los Angeles Grows In Triple-Digit Heat

Tuesday, September 1, 2009

NPR



Acclimatization Programs

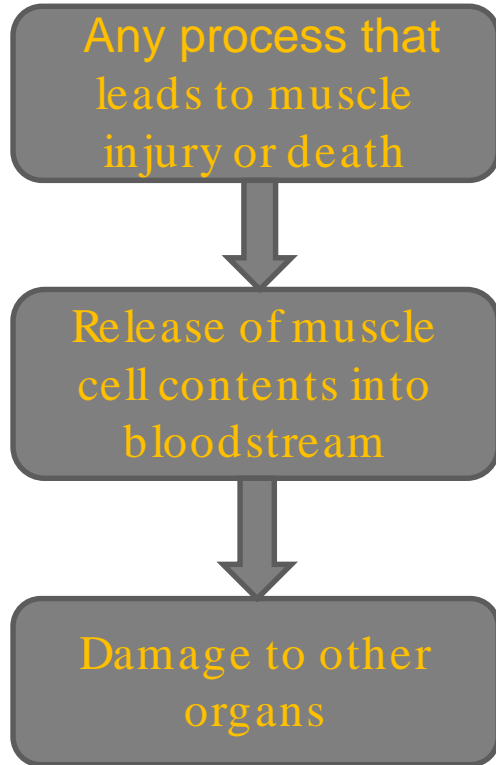
- WFFs may be sent anywhere in the U.S. to fight a fire
- May have differences in climate and/or elevation between
 - WFFs' home and 1st fire of season
 - Location of current fire and next fire
- Acclimatization programs account for these differences to ↓ risk of
 - HRI
 - Altitude sickness



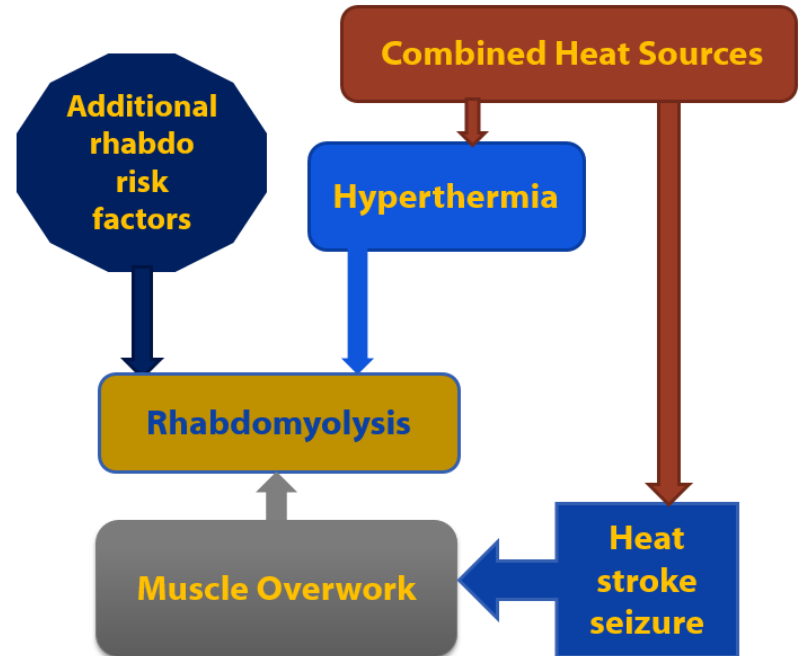
Martin Fire September 2018 Jackson WY
at 10,000 ft above sea level [Photo by Bill
Gabbert on wildfiretoday.com]

Rhabdomyolysis (rhabdo)

- **Rhabdo Progression Sequence**



- **Relationship of Primary WFF Rhabdo Risk Factors**



Rhabdo in WFFs

- Extent unknown → lack of systematic surveillance systems
- U.S. Forest Service National Technology and Development Program reported 26 cases of rhabdo with medical complications; 2008–2016
 - 5 cases of compartment syndrome*

Division of the 26 rhabdo cases by suspected inciting event

Physical Training	Number of Cases
PT Run	6
PT Hike	2
Other PT	6
Work Capacity Test	3
Total PT	17

Fire Suppression	Number of Cases
Initial Attack	2
Extended Attack	5
Prescribed Burn	1
Unknown	1
Total Fire Suppression	9

Wildland Fire Fighter Rhabdomyolysis Educational Materials

- Initially developed as part of 2010 HHE requested by NWCG*
- Released May 2018

ATTENTION: HEALTHCARE PROVIDERS

- + I am a wildland fire fighter.
- + I am at increased risk for rhabdomyolysis.

The Centers for Disease Control and Prevention urges healthcare providers to be alert for rhabdomyolysis in wildland fire fighters. Check serial serum creatine phosphokinase (CPK or CK) levels when any of the following signs and symptoms are present: heat-related illness, dark urine, muscle pain, or exercise intolerance.



WHAT WILDLAND FIRE FIGHTERS NEED TO KNOW ABOUT RHABDOMYOLYSIS



Rhabdomyolysis (often called rhabdo) is the breakdown of damaged muscle tissue that releases proteins and electrolytes into the blood. These things can damage the heart and kidneys, result in permanent disability, and can even be fatal. Rhabdomyolysis can be caused by exertion and becoming overheated. Early treatment can prevent serious medical problems.

Because exertion in a hot environment is such a fundamental part of the job, fire fighters need to be able to quickly recognize the potential danger and get medical attention right away if they are not feeling well.

What can increase your risk for rhabdo?

- Prolonged, intense physical exertion
- Increased core body temperature
- Some cold and allergy medications
- Certain antibiotics
- Dietary supplements, such as creatine
- Common prescription medications such as statins that lower cholesterol

There are many risk factors for rhabdo and we still don't know all of them. You should check with your healthcare provider to ensure you don't have any of the known risk factors for rhabdo. People with no known rhabdo risk factors can get rhabdo. We don't know enough to completely eliminate your risk for rhabdo.



Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

RHABDOMYOLYSIS IN WILDLAND FIRE FIGHTERS: A PATIENT POPULATION AT RISK

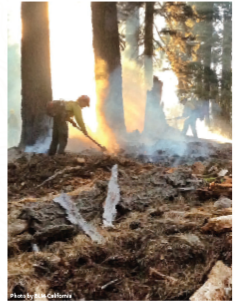


Wildland fire fighting involves exposure to heat and prolonged, intense exertion. These factors increase the risk for rhabdomyolysis. Healthcare providers can prevent debilitating consequences. Be alert to wildland fire fighters reporting rhabdomyolysis signs and symptoms. Have a low threshold to check serial serum creatine phosphokinase (CK) in wildland fire fighters.

Elements of wildland fire response and training associated with an increased risk for rhabdomyolysis are:

- Carrying heavy loads, such as chainsaws and gear packs weighing up to 110 pounds
- High levels of exertion, such as carrying heavy loads over rugged, steep terrain
- Exposure to heat from the fire, the environment, and generated by physical effort
- Rigorous training and physical fitness tests

Death and permanent disability of fire fighters have been associated with heat stress and rhabdomyolysis in fire fighters (NIOSH 2009, 2012, 2014). Rhabdomyolysis may be misdiagnosed as heat stress or dehydration as the presenting signs and symptoms can be similar (NWCG 2011). Rhabdomyolysis can have debilitating or deadly consequences if not quickly diagnosed and treatment started.



Fire fighter Trainee Suffers Fatal Exertional Heat Stroke During Physical Fitness Training—Texas

A case report of a NIOSH fire fighter fatality investigation highlighting the close relationship between fire fighting, heat and rhabdo

2009-17 Date Released: June 2010

The initial diagnoses were hyperthermia, severe dehydration, and heatstroke, with heatstroke complications including:

- Rhabdomyolysis
- Acute renal failure
- Disseminated intravascular coagulation



Centers for Disease Control and Prevention
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* [https://wildfiretoday.com/documents/Rhabdomyolysis NIOSH report.pdf](https://wildfiretoday.com/documents/Rhabdomyolysis%20NIOSH%20report.pdf);
<https://www.cdc.gov/niosh/firefighters/health.html>

Wildfire Smoke

- Complex and dynamic mixture
- Smoke composition and degree of WFF exposure to smoke affected by
 - Vegetation material
 - Soil composition
 - Atmospheric conditions (i.e. inversion layers or ↓ wind)
- Many different compounds released
- Synergistic effects



Photo by George Broyles, US Forest Service

Potential Components of Wildfire Smoke

- Volatile Organic Compounds (VOCs)
- Carbon Monoxide (CO)
- Methane
- Nitrous oxide
- Benzene
- Acrolein
- Formaldehyde
- Particulates

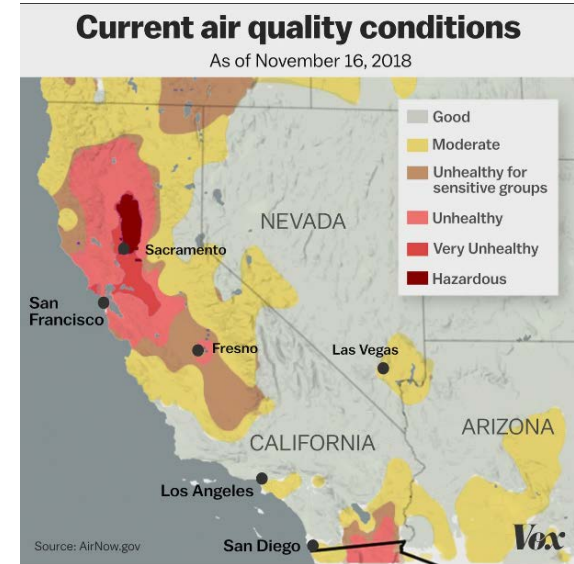


Smoke plumes from wildfires



Wildfire Smoke Health Effects- Respiratory

- Respiratory effects
 - WFFs' lung function worsens over fire season
 - ↑inflammatory markers cross-season *
 - ↑ risk exacerbation of asthma or other chronic respiratory conditions
- Caution: Studies were over a single fire season and had small sample sizes
 - Current NIOSH WFF study is testing over 3 successive fire seasons



Health Effects of Other Wildfire Smoke Components

- Polyaromatic hydrocarbons (PAHs)
 - Products of combustion found in soot
 - Some PAHs are carcinogens
- Sulfur dioxide may irritate eyes and lungs
- Respirable silica → silicosis
- Particulates (PM_{2.5}) ↑ risk
 - Heart attack
 - Pulmonary embolus
 - Stroke*



WFFs arrive to smoky area of White Tail Fire, SD, 2017
[Photo by Bill Gabbert]

Wildfire Ash Composition

- Characterization by U.S. Geological Service
- Black ash: partially combusted plant material
 - Particle size too big to be respirable
 - Mostly charcoal
- White ash: High temp fire → complete combustion
 - Very fine PM_{2.5}; respirable size <10 μm
 - Minerals (silica, calcium, magnesium)
 - Local soil deposits: arsenic, lead, chromium, asbestos, zinc*
- Health hazards have not yet been widely studied



Respirator Use by WFFs

- In 2012 the National Fire Protection Association (NFPA) developed a standard for respirator use during wildland fire management activities
 - NIOSH would certify that a respirator met these criteria
- No respirator has been developed to meet the standard, thus there currently are no approved respirators for use during wildfire management activities
- June 2018 Department of Homeland Security awarded contract to develop a respirator that met the NFPA standard by November 2019

Why is NIOSH involved with Respirators?

Federal mandate for NIOSH to test and certify all respirators used in the workplace

National Personal Protective Technology Laboratory (NPPTL)

- Established in 2001 as a division NIOSH
- Conducts laboratory and field research, surveillance, standards development, interventions, and conformity assessment activities for many types of PPE.
- Manages the NIOSH respirator approval program and post-market evaluations
- <https://www.cdc.gov/niosh/npptl/>

Promoting productive workplaces
through safety and health research / **NIOSH**

Self-Contained Breathing Apparatus (SCBA) Evaluation in Support of the Fire Service



Occupational Noise Exposure Limits

- OSHA Permissible Exposure Limit (PEL): 90 dBA 8 hour time weighted average (TWA)
- OSHA Action Level: 85 dBA 8 hour TWA → Hearing Conservation Program is required
- NIOSH Recommended Exposure Limit (REL)
 - 85 dBA 8 hour TWA OR
 - 140 dBA impulse noise



Photos from Peterson Special YouTube video

Equipment	Noise (dBA)
Bulldozer no cab	101-103
Bulldozer with insulated cab	85
Quick cut saw	96

NIOSH HHE – Noise from Chainsaws and Wood Chipper in WFFs

- We measured WFF noise exposures
 - Over full-shift for 5 WFFs during 2 days of fuel reduction activities
 - During various tasks during 30– 120 minutes training activities for 7 WFFs
- We collected direct noise measurement of chainsaws at cutting surface = 100 dBA

Table 1: Range of firefighters' full shift time-weighted average noise exposures (dBA) during fuel reduction activities on May 9–10, 2016.

Job	Number of measurements	Results based on OSHA action level criterion	Results based on OSHA PEL criterion	Results based on NIOSH REL criterion
Sawyer/swamper	8	89.6–95.2	88.8–94.8	95.1–99.3
Sawyer/swamper supervisor	2	86.4–87.8	85.5–86.8	91.9–92.8
Noise Exposure Limits (8-hour work shift)		85.0	90.0	85.0
Noise Exposure Limits (10-hour work shift)		83.4	90.0	84.0

Table 2: Task-based noise exposures (dBA) during training session activities on May 9–10, 2016.

Training activity	Measurement duration (minutes)	Results based on OSHA action level criterion	Results based on OSHA PEL criterion	Results based on NIOSH REL criterion
Operating chipper	31	97.7	97.6	100.0
Feeding chipper	32	97.8	97.7	100.4
Pulling brush to chipper	29	97.2	97.1	99.5
Instructing and observing trainees using a chain saw	122	67.9	21.7	74.9
Trainees observing and using a chain saw (3 measurements)	40–92	84.2–85.0	81.0–84.1	88.2–93.6

2017 U.S. Forest Service/NIOSH WFF Noise Exposure Study

- 48% (85 of 174) of WFFs jobs had noise levels > NIOSH REL of 85 dBA over an 8 hour shift*

Table 2. Summary of wildland fire fighters noise exposures based on OSHA and NIOSH occupational exposure limits.

Job description Activity/task	OSHA PEL (90 dBA)			NIOSH REL (85 dBA)		
	Lavg (dBA)	TWA (dBA)	Dose (%)	Leq (dBA)	TWA (dBA)	Dose (%)
ATB operator	71.9 ± 6.8	59–85	1–51	84.3 ± 3.5	79–93	15–637
Bulldozer operator	78.6 ± 21	43–113	0–1,995	89 ± 11.7	72–112	5–51,804
Engine operator	67.6 ± 9.4	52–82	1–73	81.7 ± 5.5	75–97	3–503
Equip operator	72.7 ± 13	56–94	1–144	84.7 ± 7.1	76–100	10–3,522
Helitack crewmember	64.3 ± 11.9	47–91	0–111	80 ± 7	71–102	4–1,486
Helicopter pilot	86.8 ± 2	88–92	79–136	90.7 ± 1.1	92–94	490–749
Heavy equipment operator	62.3 ± 6.5	55–79	1–22	79 ± 4	75–90	3–338
Leaf blower	80.8 ± 2.5	78–84	18–43	88.4 ± 1.9	87–91	142–377
Masticator/chipper operator	92.4 ± 5.3	88–103	72–583	97.8 ± 4	94–105	891–10,871
Pump operator	78.9 ± 4.1	78–85	19–53	89.1 ± 3.5	87–95	177–950
Sawing/swamping	89.5 ± 5.2	80–103	26–606	96.9 ± 3.6	91–106	280–9,250
UTV/buggy operator	73 ± 5.6	61–83	4–38	84.2 ± 3.8	76–93	4–202
Water tender operator	66.1 ± 8.4	54–79	1–23	80.9 ± 3.9	76–87	14–170
Weed whip operator	80.7 ± 3.8	77–86	15–58	87.6 ± 2.5	85–91	99–401

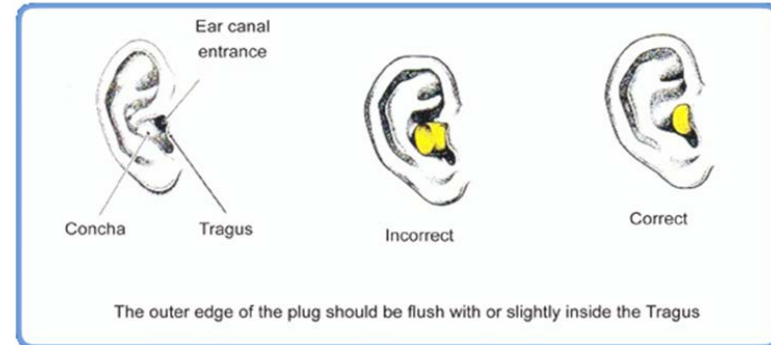
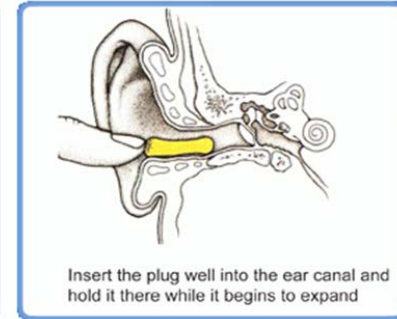
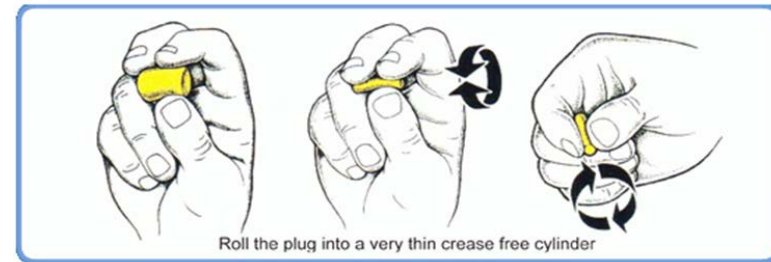
* 2017 Broyles et al

Synergistic Exposures: Noise and

- Synergistic exposure
 - Noise induced hearing loss is greater than expected when there is concurrent 2nd exposure than if noise was the sole exposure
- Synergistic chemicals WFFs may encounter
 - Carbon Monoxide (CO) exposure from
 - Wildfire smoke
 - Exhaust from gasoline/diesel powered tools (chainsaw, wood chipper, power generator)
 - Lead present in local soil deposits or in residential fire debris

PPE Controls – Optimize Hearing Protection

- Consider use of dual/double hearing protection (wearing both ear plugs and ear muffs) when using or around equipment that may exceed noise PEL
- Fit test ear plugs*
- Refresher training on proper ear plug insertion techniques
- Annual audiometry as per OSHA Hearing Conservation Program



Proper Ear Plug Insertion Technique

*<https://blogs.cdc.gov/niosh-scienceblog/2013/05/31/well-fit/>

Sawyer Chainsaw Carry

- Some fire fighters are ‘sawyers’ or they have training and are certified to cut down trees and other brush
- May use larger saws to cut larger trees = ↑ weight carried
- Chainsaws carried on shoulder pads may risk nerve compression injury
 - Possible numbness and weakness on side used to carry saw



Above: WFFs carrying chain saws on shoulder pads [Photo by NIOSH]

Left: Yellow circle showing sawyer’s leather carrying pad [Photo by NIOSH]

Other Potential Health Risks from Chainsaw Use

- Hand-arm vibration
 - Numbness, tingling, pain, and/or blanching in hands and arms
- Wood dust exposure
 - Allergy and asthma-like symptoms
 - Rash



Blanched fingers due to hand-arm vibration

WFF Related NIOSH Activities

NIOSH Wildland Fire Program

Promoting productive workplaces
through safety and health research **NIOSH**

FIGHTING WILDFIRES



Wildland Fire Fighter Hotshot Crew moves toward water resupply point before resuming duties. Image provided by US Forest Service Technology and Development Program.

- Partners with fire agencies and researchers to prevent on-duty injuries, illnesses, and deaths from hazards and exposures associated with fighting wildfires
 - Conducts research to better understand exposures and health effects
 - Based in the NIOSH Western States Division in Denver, CO
- <https://www.cdc.gov/niosh/topics/firefighting/>

Wildland Fire Fighter Exposure and Health Effects Study

- 3-year cohort study with six federal fire crews
 - Currently in second year
- Purpose
 - Measure individual exposures to combustion products
 - Assess lung, cardiovascular, and kidney function, and noise induced hearing loss
 - Provide evidence based risk reduction recommendations



NIOSH Spirometry tech coaching WFF study participant through test [Photo by NIOSH]

NIOSH Fire Fighter Fatality Investigation and Prevention (FFFIPP) Program

- Conducts medical and traumatic injury investigations of fire fighter line-of-duty deaths to formulate recommendations for preventing future deaths and injuries
- Recent WFF fatalities investigated by the FFFIPP
 - Heart attack after performing physical fitness training
 - Hyperthermia during pack test
 - Sudden cardiac death while working at a grass fire
 - Vehicle rollovers
 - Struck by accidents on roadways
- <https://www.cdc.gov/niosh/topics/firefighting/default.html>

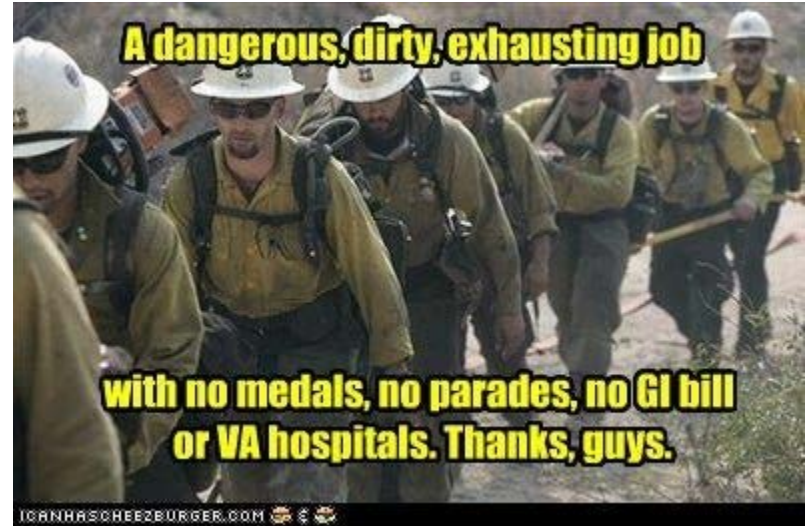
National Firefighter Cancer Registry Program

- Signed into law and funded in FY2019
- Being led by NIOSH <https://www.cdc.gov/niosh/firefighters/health.html>
- Goals include
 - Assembly of a large registry or cohort of firefighters to determine their risk of cancer and other chronic diseases
 - Track underrepresented firefighter subgroups to better understand their unique risks
- Will include WFFs

Conclusions

Wildland Fire Fighters....

- Are a diverse workforce with varied standards across many agencies
- Are being called to respond to fires burning more land than ever before
- Accomplish their mission in environments with many health and safety hazards
- Will have more information on which to base health and safety risk reduction strategies due to ongoing NIOSH work



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Questions?

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For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.



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Full List of Recent WFF Related HHEs with Links

Recent Wildland Firefighting Related HHE's

- Evaluation of eronite and silica exposure during forest management and fire suppression activities in the Custer National Forest. [Health Hazard Evaluation Report, HETA 2013-0061-3244Cdepdf](#)
- Evaluation of employee exposures to Libby amphibole asbestos during forest management activities in the Kootenai National Forest, Montana. [Health Hazard Evaluation Report, HETA 2012-0077-3223Cdepdf](#)
- Extent of Rhabdomyolysis Among Wildland Firefighters, Idaho. (NIOSH Closeout Letter) [Health Hazard Evaluation Report, HETA 2011-0035CdepdfExternal](#),
- Determining Base Camp Personnel Exposures to Carbon Monoxide during Wildland Fire Suppression Activities, California. [Health Hazard Evaluation Report, HETA 2002-0245-3127Cdepdf](#),
- Evaluating chainsaw emissions among forestry workers, Washington. [Health Hazard Evaluation Report, HETA 99 0173-2856Cdepdf](#),
- Assessing wildland fire fighters' exposure to carbon monoxide, Colorado. [Health Hazard Evaluation Report, HETA 98 0173-2782Cdepdf](#),
- Characterizing fire fighters' exposures to chemical contaminants during fire suppression operations, West Virginia. [Health Hazard Evaluation Report, HETA 92-045-2260,Cdepdf](#)

<https://www.cdc.gov/niosh/topics/firefighting/hhe.html>

Addendum Slides

Defensible Space

- ↑ WUI at individual homeowner level
- Removal of fire fuels around home
 - Impedes spread of wildfire
 - Increases safety of WFFs
 - Required by law in some states



Below: Example of clearing defensible space around a home [Photos by WA Department of Natural Resources]

TWO ZONES MAKE UP THE REQUIRED 100 FEET OF DEFENSIBLE SPACE:

ZONE 1: 30 feet of Lean, Clean & Green

- 1 Remove all dead plants, grass and weeds.
- 2 Remove dead or dry leaves and pine needles from your yard, roof and rain gutters.
- 3 Keep tree branches 10 feet away from your chimney and other trees.

ZONE 2: 30-100 feet of Reduced Fuel

- 4 Cut or mow annual grass down to a maximum height of 4 inches.
- 5 Create horizontal spacing between shrubs and trees.
- 6 Create vertical spacing between grass, shrubs and trees.

Use Equipment Properly to Keep from Sparking a Wildfire

- 7 Mow before 10 a.m., and never on a hot or windy day. String trimmers are a safer option (vs. lawnmowers) for clearing vegetation.



VERTICAL SPACING

Large trees do not have to be cut and removed as long as all of the plants beneath them are removed. This eliminates a vertical “fire ladder.”



HORIZONTAL SPACING

Create horizontal and vertical spacing between plants, the amount of spacing will depend on how steep the slope is and the size of the plants.

Graphic from CalFire

http://fire.ca.gov/communications/downloads/fact_sheets/DefensibleSpaceFlyer.pdf

Potential Rhabdo Health Effects

Component released by rhabdo damaged muscle	Potential health effects due to component release
Potassium	<ul style="list-style-type: none">• Abnormal heart rhythms• Seizures
Myoglobin	<ul style="list-style-type: none">• Kidney damage

Some muscles are grouped together in fibrous sheaths called compartments

- Rhabdo damaged muscle may swell ↓ blood supply
- Muscles may die resulting in permanent disability
- Condition known as compartment syndrome



WFF after 5th surgery for compartment syndrome. Had rhabdo after pack test [USFS 2011]

New Structural Fire Fighter Rhabdo Educational Materials

- Released May 2018

ATTENTION: HEALTHCARE PROVIDERS

- + I am a structural fire fighter.
- + I am at increased risk for rhabdomyolysis.

The Centers for Disease Control and Prevention urges healthcare providers to be alert for rhabdomyolysis in structural fire fighters. Check serial serum creatine phosphokinase (CPK or CK) levels when any of the following signs and symptoms are present: heat-related illness, dark urine, muscle pain, or exercise intolerance.



WHAT STRUCTURAL FIRE FIGHTERS NEED TO KNOW ABOUT RHABDOMYOLYSIS



Rhabdomyolysis (often called rhabdo) is the breakdown of damaged muscle tissue that releases proteins and electrolytes into the blood. These things can damage the heart and kidneys, result in permanent disability, and can even be fatal! Rhabdomyolysis can be caused by exertion and becoming overheated. Early treatment can prevent serious medical problems.

Because exertion in a hot environment is such a fundamental part of the job, fire fighters need to know the signs and symptoms of rhabdo to be able to quickly recognize the potential danger and get medical attention right away if they are not feeling well.

What can increase your risk for rhabdo?

- Prolonged, intense physical activity
- Increased core body temperature
- Some cold and allergy medications
- Certain antibiotics
- Dietary supplements, such as creatine
- Common prescription medications such as statins that lower cholesterol etc.

There are many risk factors for rhabdo and we still don't know all of them. You should check with your healthcare provider to ensure you don't have any of the known risk factors for rhabdo.

People with no known rhabdo risk factors can get rhabdo. It can happen after activities you have done in the past without a problem. Even fire fighters and athletes who are in



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RHABDOMYOLYSIS IN STRUCTURAL FIRE FIGHTERS: A PATIENT POPULATION AT RISK



Structural fire response and training involves exposure to heat and prolonged, intense exertion. These factors increase the risk for rhabdomyolysis. Healthcare providers can prevent debilitating consequences. Be alert to fire fighters reporting signs and symptoms of rhabdomyolysis. Have a low threshold to check serial serum creatine phosphokinase (CK) in structural fire fighters.

Elements of fire response and training associated with an increased risk for rhabdomyolysis are:

- Carrying heavy loads such as turnout gear and air packs weighing up to 60 pounds, fire fighting tools weighing up to 80 pounds and incapacitated building occupants
- High levels of exertion, such as victim rescue, climbing ladders and stairs with heavy gear, etc.
- Prolonged exertion during overhaul (i.e. opening walls to check for smoldering embers, etc.)
- Rigorous training and physical fitness tests
- Exposure to heat from the fire, the environment, and physical effort

Death and permanent disability of fire fighters have been associated with heat stress and rhabdomyolysis in fire fighters [NIOSH 2009, 2012, 2014]. NIOSH investigators documented hyperthermia and rhabdomyolysis among structural fire fighters during cadet training which included a live fire exercise. One cadet had a peak core body temperature of 107.2°F; another was hospitalized for rhabdomyolysis [NIOSH 2015].



Fire fighter trainee suffers fatal exertional heat stroke during physical fitness training—Texas

A case report of a NIOSH fire fighter fatality investigation highlighting the close relationship between fire fighting, heat and rhabdo

2009-17 Date Released: June 2010

The initial diagnoses were hyperthermia, severe dehydration, and heatstroke, with heatstroke complications including:

- + Rhabdomyolysis
- + Acute renal failure due to rhabdomyolysis
- + Disseminated intravascular coagulation



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2016 Update to NIOSH Heat Stress Guidance Document

- Available with other resource documents on the NIOSH Heat Stress Topic Page at <https://www.cdc.gov/niosh/topics/heatstress/>
- Can also be accessed directly at <http://www.cdc.gov/niosh/docs/2016-106/default.html>

