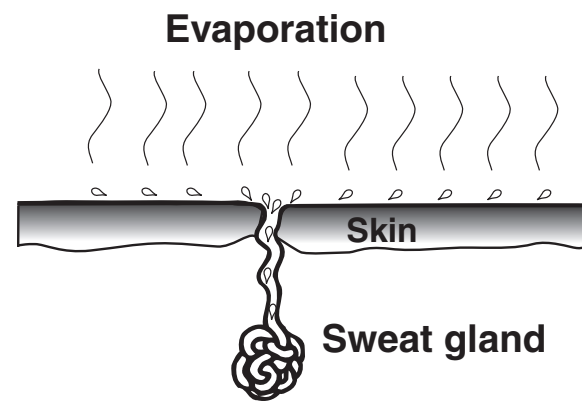


When hard work is performed in a hot environment, blood is sent to the skin to cool the body, primarily through evaporation of sweat. As sweating continues, often at a rate of more than 1 liter per hour, the body loses lots of fluid. That can compromise heart and circulatory function and the ability to work. If fluids are not replaced, the temperature-regulating process begins to break down, work becomes impossible, and the possibility of life-threatening heat stroke increases dramatically.



Heat Disorders

Heat stress disorders include heat cramps, heat exhaustion, and heat stroke.

Heat cramps are involuntary muscle contractions caused by failure to replace fluids or electrolytes, such as sodium and potassium. Cramps can be relieved with stretching and by replacing fluids and electrolytes.

Heat exhaustion is characterized by weakness, extreme fatigue, nausea, headaches, and a wet, clammy skin. Heat exhaustion is caused by inadequate fluid intake. It should be treated by resting in a cool environment and replacing fluids and electrolytes.

Heat stroke is a medical emergency caused by failure of the body's heat controls. Sweating stops and

the body temperature rises precipitously. Heat stroke is characterized by hot dry skin, a body temperature above 105.8 °F (41 °C) mental confusion, loss of consciousness, convulsions, or even coma. Send for medical help **at once** and begin rapid cooling with ice or cold water, fanning the victim to promote evaporation. Treat for shock if necessary. For rapid cooling, partially submerge the victim's body in cool water.

Prevention

You can prevent the serious consequences of heat disorders by improving your level of fitness and becoming acclimated to the heat.

Maintaining a high level of **aerobic fitness** is one of the best ways to protect yourself against heat stress. The fit worker has a well-developed circulatory system and increased blood volume. Both are important to regulate body temperature. Fit workers start to sweat sooner, so they work with a lower heart rate and body temperature. They adjust to the heat twice as fast as the unfit worker. They lose acclimatization more slowly and regain it quickly.

Acclimatization occurs in 5 to 10 days of heat exposure as the body:

- Increases sweat production
- Improves blood distribution
- Decreases the heart rate, and lowers the skin and body temperatures.

You can acclimatize by gradually increasing work time in the heat, taking care to replace fluids, and resting as needed. You maintain acclimatization with periodic work or exercise in a hot environment.

On the Job

The heat stress chart illustrates how temperature and humidity combine to create moderate or high heat stress conditions.

Be alert for heat stress when radiant heat from the sun or nearby flames is high, the air is still, or when you're working hard, creating lots of metabolic heat.

Some organizations use the WBGT Heat Stress Index. The index uses dry bulb, wet bulb, and black globe temperatures. The temperatures are weighted to indicate the impact of each measure on the worker:

- **Wet bulb** (humidity) accounts for 70%
- **Black globe** (radiant heat and air movement) accounts for 20%
- **Dry bulb** (air temperature) accounts for 10%.

Heat stress indexes do not take into account the effects of long hours of hard work, dehydration, or the impact of personal protective clothing and equipment.

When heat stress conditions exist, you must modify the way you work or exercise. Pace yourself. There are individual differences in fitness, acclimatization, and heat tolerance. Push too hard and you'll be a candidate for a heat disorder. When possible:

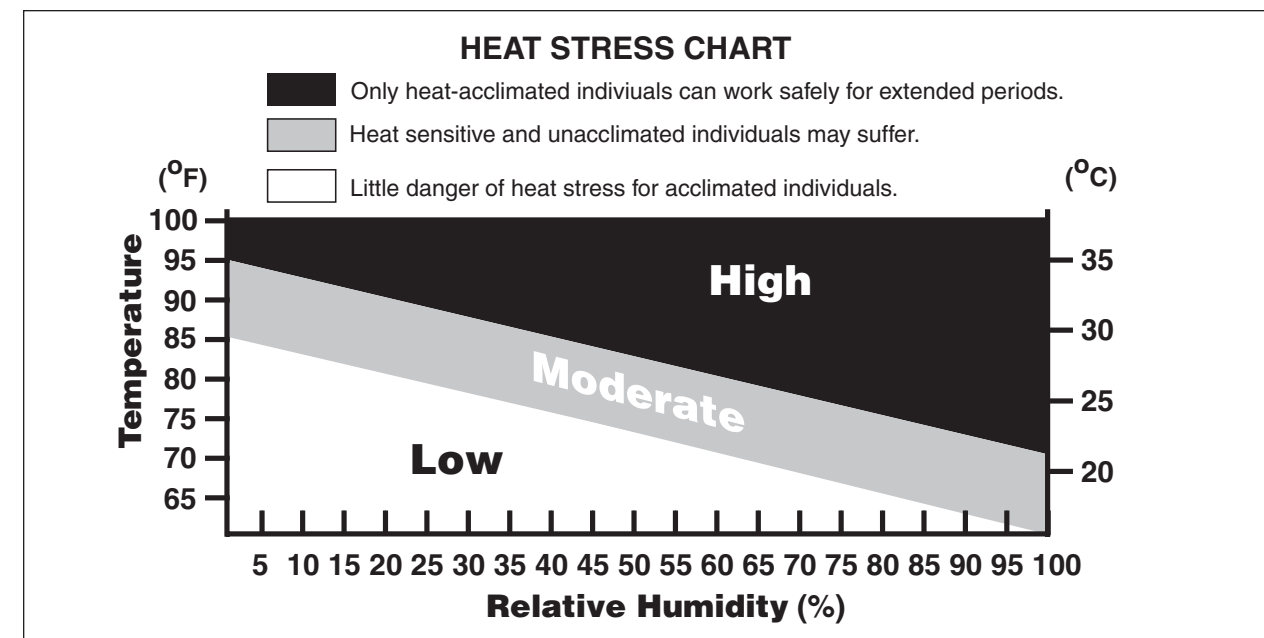
- Avoid working close to heat sources
- Do harder work during cooler morning and evening hours
- Change tools or tasks to minimize fatigue
- Take frequent rest breaks as you work.

Most important, maintain hydration by replacing lost fluids.

Hydration

Studies on wildland firefighters indicate that fire suppression activities generate about 7.5 kilocalories of heat each minute worked, or over 400 kilocalories for each hour. Additional heat (about 180 kilocalories per hour) comes from the environment and the fire. The total heat load amounts to 580 kilocalories per hour (400 + 180 = 580).

Complete evaporation of 1 liter of sweat removes 580 kilocalories of heat. That means that a firefighter needs to evaporate about 1 liter (slightly more than 1 quart) of sweat during each hour of work. Maintaining body fluids is essential for sweating. That means you must hydrate **before, during, and after work**.



Before work you should take extra fluids to prepare for the heat. Drink 1 to 2 cups of water, juice, or a sport drink before work. Avoid excess caffeine. It hastens fluid loss in the urine.

While working, take several fluid breaks every hour, drinking at least 1 quart of fluid. Drink as much as you can during the lunch break. Water is your greatest need during work in the heat. Studies show that workers drink more when lightly flavored beverages are available. Providing a portion of fluid replacement with a carbohydrate/electrolyte sport beverage will help you retain fluids and maintain energy and electrolyte levels.

After work, you need to continue drinking to replace fluid losses.

Thirst always underestimates fluid needs, so you should drink more than you think you need. Rehydration is enhanced when fluids contain sodium and potassium, or when foods with these electrolytes are consumed along with the fluid.

Sodium lost in sweat is easily replaced at meals with liberal use of the salt shaker. Unacclimatized workers lose more salt in the heat so they need to pay particular attention to salt replacement. Don't overdo salt intake; too much salt impairs temperature regulation. Excessive salt can cause stomach distress, fatigue, and other problems. Make potassium-rich foods like bananas and citrus fruits a regular part of your diet, and drink lots of lemonade, orange juice, or tomato juice. In fire camp, limit the amount of caffeine drinks such as coffee and colas because caffeine increases fluid loss in the urine. Avoid alcoholic drinks. They also cause dehydration. Avoid sharing water bottles except in emergencies.

You can assess your hydration by observing the volume, color, and concentration of your urine—low volumes of dark, concentrated urine, or painful

urination indicate a serious need for rehydration. Other signs of dehydration include a rapid heart rate, weakness, excessive fatigue, and dizziness. Rapid loss of several pounds of body weight is a certain sign of dehydration. Rehydrate before returning to work. Continuing to work in a dehydrated state can lead to serious consequences, including heat stroke, muscle breakdown, and kidney failure.

Clothing

Personal protective clothing strikes a balance between protection and worker comfort. Australian researchers have concluded that:

The task for firefighter's clothing is not to keep heat out but to let it out!

About 70% of the heat load comes from within, from metabolic heat generated during hard work. Only 30% comes from the environment and the fire. Wear loose-fitting garments to enhance air movement. Wear cotton T-shirts and underwear to help sweat evaporate. Avoid extra layers of clothing that insulate, restrict air movement, and contribute to heat stress.

Individual Differences

Individuals differ in their response to heat. Some workers are at greater risk for heat disorders.

The reasons include inherited differences in heat tolerance and sweat rate. Excess body weight raises metabolic heat production. Illness, drugs, and medications can also influence your body's response to work in a hot environment.

Check with your physician or pharmacist if you are using prescription or over-the-counter medications, or if you have a medical condition.

You should always train and work with a partner who can help in the event of a problem. Remind each other to drink lots of fluids and keep an eye on each other. If your partner suffers a heat disorder, start treatment immediately.

Summary

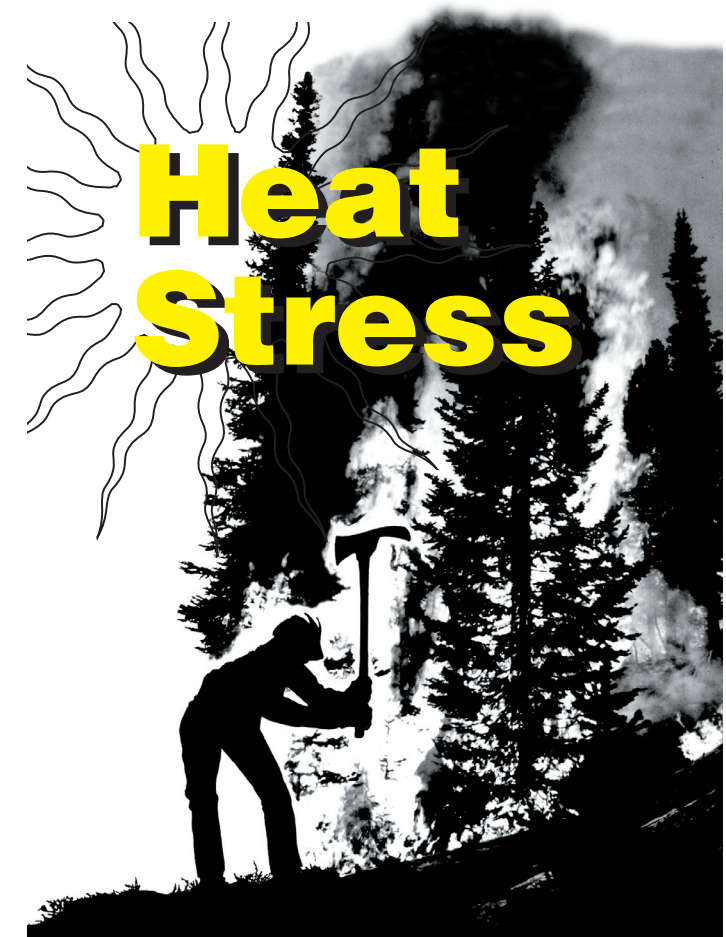
- Prevention**
- Improve or maintain aerobic fitness
 - Acclimate to the heat
- On the job**
- Be aware of conditions (temperature, humidity, air movement)
 - Take frequent rest breaks
 - Avoid extra layers of clothing
 - Pace yourself
- Hydrate**
- Before work—drink several cups of water, juice, or a sport drink
 - During work—take frequent fluid breaks*
 - After work keep drinking to ensure rehydration
 - Remember, only **you** can prevent dehydration
- Partners**
- Always work or train with a partner

* Sport drinks with carbohydrate and electrolytes encourage fluid intake, provide energy, and diminish urinary water loss. The carbohydrate also helps maintain immune function and mental performance during prolonged arduous work. Drinks with caffeine and alcohol interfere with rehydration by increasing urine production.

For more information consult: Sharkey, Brian J., *Fitness and Work Capacity* (order NFES No. 1596), available from NIFC c/o Great Basin Cache Supply, 3833 South Development Ave., Boise, ID 83705

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Heat Stress

Wildland firefighting is arduous work. Shifts are long, often in steep terrain and at higher elevations. The weather is usually hot and dry, and the fire increases exposure to heat. This brochure focuses on the risks of heat stress, and what the firefighter should do to minimize those risks.

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