

WINTER WEATHER HAZARD REMINDER

Wind Chill, Frost Bite, and Hypothermia are three hazards to firefighters during winter/cold weather operations. Now is the time to prepare equipment, apparatus, and personnel for cold weather operations.

Wind chill is the apparent temperature felt on exposed skin due to wind. The degree of this phenomenon depends on both air temperature and wind speed. The wind chill temperature (often popularly called the wind chill factor) is always lower than the air temperature for values where the wind chill formula is valid.

The human body loses heat largely by evaporative cooling and convection. The rate of heat loss by a surface depends on the wind speed above that surface: the faster the wind speed, the more readily the surface cools. For inanimate objects, the effect of wind chill is to reduce any warmer objects to the ambient temperature more quickly. For most biological organisms, the physiological response is to maintain surface temperature in an acceptable range so as to avoid adverse effects. Thus, the attempt to maintain a given surface temperature in an environment of faster heat loss results in both the perception of lower temperatures and an actual greater heat loss increasing the risk to adverse effects such as frostbite and death.

Frostbite (congelatio in medical terminology) is the medical condition wherein localized damage is caused to skin and other tissues due to extreme cold. Frostbite is most likely to happen in body parts farthest from the heart and those with large exposed areas. The initial stages of frostbite are sometimes called "frostnip".

At or below 0° C (32° F), blood vessels close to the skin start to constrict. The same response may also be a result of exposure to high winds. This constriction helps to preserve core body temperature. In extreme cold, or when the body is exposed to cold for long periods, this protective strategy can reduce blood flow in some areas of the body to dangerously low levels. This lack of blood leads to the eventual freezing and death of skin tissue in the affected areas. There are three stages of frostbite. Each of these stages have varying degrees of pain.

Stage 1

First degree frostbite causes skin to appear yellow or white. There may also be slight burning sensations. This stage of frostbite is relatively mild and can be reversed by the gradual warming of the affected area.

Stage 2

Second degree frostbite develops after continued exposure. This stage is characterized by the disappearance of pain and the reddening and swelling of the skin. Treatment in this stage may result in blisters and it may also peel the skin.

Stage 3

Third degree frostbite results in waxy and hard skin. It is at this stage that the skin dies and edema may occur as a result of the lack of blood.

If third degree frostbite is not treated immediately then the damage and the frostbite becomes permanent, nerve damage will occur due to oxygen deprivation. Frostbitten areas will turn discolored, purplish at first, and soon turn black. After a while nerve damage becomes so great that feeling is lost in the frostbitten areas. Blisters will also occur. If feeling is lost in the damaged area, checking it for cuts and breaks in the skin is vital. Infected open skin can lead to gangrene and amputation may be needed.

Hypothermia is a condition in which an organism's temperature drops below that required for normal metabolism and body functions. In warm-blooded animals, core body temperature is maintained near a constant level through biologic homeostasis or thermoregulation. However, when the body is exposed to cold, its internal mechanisms may be unable to replenish the heat that is being lost to the organism's surroundings.

Hypothermia may be divided into accidental hypothermia, which will be discussed here, and therapeutic hypothermia.

Normal body temperature in humans is 36.5° – 37.5° C, (97.7° F – 99.5° F). A number of skin conditions may be associated with hypothermia or may occur with normal body temperature. Symptoms of hypothermia may be divided into the three stages of severity.

Stage 1

Body temperature drops by 1° – 2° C (1.8° – 3.6° F) below normal temperature (down to 35° – 37° C or 95° – 98.6° F). Mild to strong shivering occurs. The victim is unable to perform complex tasks with the hands; the hands become numb. Blood vessels in the outer extremities constrict, lessening heat loss to the outside air. Breathing becomes quick and shallow. Goose bumps form, raising body hair on end in an attempt to create an insulating layer of air around the body (which is of limited use in humans due to lack of sufficient hair, but useful in other species). Victim may feel sick to their stomach, and very tired. Often, a person will experience a warm sensation, as if they have recovered, but they are in fact heading into Stage 2. Another test to see if the person is entering Stage 2 is if they are unable to touch their thumb with their little finger, this is the first stage of muscles not working. They might start to have trouble seeing.

Stage 2

Body temperature drops by 2° – 4° C (3.8° – 7.6° F) below normal temperature (33° – 35° C or 91° – 94.8° F). Shivering becomes more violent. Muscle mis-coordination becomes apparent. Movements are slow and labored, accompanied by a stumbling pace and mild confusion, although the victim may appear alert. Surface blood vessels contract further as the body focuses its remaining resources on keeping the vital organs warm. The victim becomes pale. Lips, ears, fingers and toes may become blue.

Stage 3

Body temperature drops below approximately 32° C (89.6° F). Shivering usually stops. Difficulty speaking, sluggish thinking, and amnesia start to appear; inability to use hands and stumbling is also usually present. Cellular metabolic processes shut down. Below 30° C (86.0° F), the exposed skin becomes blue and puffy, muscle coordination becomes very poor, walking becomes almost impossible, and the victim exhibits incoherent/irrational behavior including terminal burrowing or even a stupor. Pulse and respiration rates decrease significantly, but fast heart rates (ventricular tachycardia, atrial fibrillation) can occur. Major organs fail. Clinical death occurs. Because of decreased cellular activity in Stage 3 hypothermia, the body will actually take longer to undergo brain death.

Attached are 2 PDFs for your convenience. One is from OSHA summarizing Wind Chill, Frost Bite, and Hypothermia. The second PDF is a Wind Chill chart for determining the wind chill based on observed conditions.

Information and illustrations for this bulletin were gathered from the Centers for Disease Control and Prevention (CDCP), National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), U.S. Department of Labor (DOL), and National Oceanographic and Atmospheric Administration (NOAA).



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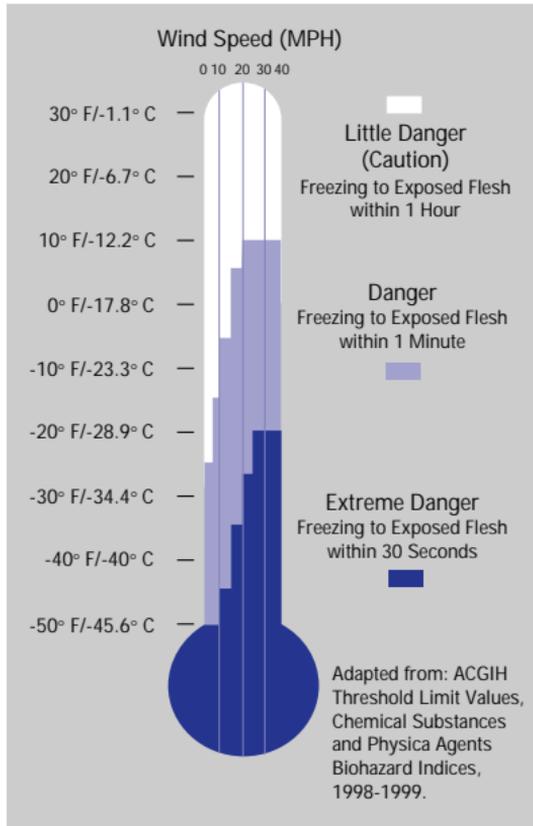
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THE COLD STRESS EQUATION

LOW TEMPERATURE + WIND SPEED + WETNESS = INJURIES & ILLNESS

When the body is unable to warm itself, serious cold-related illnesses and injuries may occur, and permanent tissue damage and death may result.

Hypothermia can occur when *land temperatures* are **above** freezing or *water temperatures* are below 98.6°F/37°C. Cold-related illnesses can slowly overcome a person who has been chilled by low temperatures, brisk winds, or wet clothing.



FROST BITE

What Happens to the Body:

FREEZING IN DEEP LAYERS OF SKIN AND TISSUE; PALE, WAXY-WHITE SKIN COLOR; SKIN BECOMES HARD and NUMB; USUALLY AFFECTS THE FINGERS, HANDS, TOES, FEET, EARS, and NOSE.

What Should Be Done: (land temperatures)

- Move the person to a warm dry area. Don't leave the person alone.
- Remove any wet or tight clothing that may cut off blood flow to the affected area.
- **DO NOT** rub the affected area, because rubbing causes damage to the skin and tissue.
- **Gently** place the affected area in a warm (105°F) water bath and monitor the water temperature to **slowly** warm the tissue. Don't pour warm water directly on the affected area because it will warm the tissue too fast causing tissue damage. Warming takes about 25-40 minutes.
- After the affected area has been warmed, it may become puffy and blister. The affected area may have a burning feeling or numbness. When normal feeling, movement, and skin color have returned, the affected area should be dried and wrapped to keep it warm. **NOTE:** If there is a chance the affected area may get cold again, do not warm the skin. If the skin is warmed and then becomes cold again, it will cause severe tissue damage.
- Seek medical attention as soon as possible.

HYPOTHERMIA - (Medical Emergency)

What Happens to the Body:

NORMAL BODY TEMPERATURE (98.6°F/37°C) DROPS TO OR BELOW 95°F (35°C); FATIGUE OR DROWSINESS; UNCONTROLLED SHIVERING; COOL BLUISH SKIN; SLURRED SPEECH; CLUMSY MOVEMENTS; IRRITABLE, IRRATIONAL OR CONFUSED BEHAVIOR.

What Should Be Done: (land temperatures)

- Call for emergency help (i.e., Ambulance or Call 911).
- Move the person to a warm, dry area. Don't leave the person alone. Remove any wet clothing and replace with warm, dry clothing or wrap the person in blankets.
- Have the person drink warm, sweet drinks (sugar water or sports-type drinks) if they are alert. **Avoid drinks with caffeine** (coffee, tea, or hot chocolate) or alcohol.
- Have the person move their arms and legs to create muscle heat. If they are unable to do this, place warm bottles or hot packs in the arm pits, groin, neck, and head areas. **DO NOT** rub the person's body or place them in warm water bath. This may stop their heart.

What Should Be Done: (water temperatures)

- Call for emergency help (Ambulance or Call 911). Body heat is lost up to 25 times faster in water.
- **DO NOT** remove any clothing. Button, buckle, zip, and tighten any collars, cuffs, shoes, and hoods because the layer of trapped water closest to the body provides a layer of insulation that slows the loss of heat. Keep the head out of the water and put on a hat or hood.
- Get out of the water as quickly as possible or climb on anything floating. **DO NOT** attempt to swim unless a floating object or another person can be reached because swimming or other physical activity uses the body's heat and reduces survival time by about 50 percent.
- If getting out of the water is not possible, wait quietly and conserve body heat by folding arms across the chest, keeping thighs together, bending knees, and crossing ankles. If another person is in the water, huddle together with chests held closely.

How to Protect Workers

- Recognize the environmental and workplace conditions that lead to potential cold-induced illnesses and injuries.
- Learn the signs and symptoms of cold-induced illnesses/injuries and what to do to help the worker.
- Train the workforce about cold-induced illnesses and injuries.
- Select proper clothing for cold, wet, and windy conditions. Layer clothing to adjust to changing environmental temperatures. Wear a hat and gloves, in addition to underwear that will keep water away from the skin (polypropylene).
- Take frequent short breaks in warm dry shelters to allow the body to warm up.
- Perform work during the warmest part of the day.
- Avoid exhaustion or fatigue because energy is needed to keep muscles warm.
- Use the buddy system (work in pairs).
- Drink warm, sweet beverages (sugar water, sports-type drinks). Avoid drinks with caffeine (coffee, tea, or hot chocolate) or alcohol.
- Eat warm, high-calorie foods like hot pasta dishes.

Workers Are at Increased Risk When...

- They have predisposing health conditions such as cardiovascular disease, diabetes, and hypertension.
- They take certain medication (check with your doctor, nurse, or pharmacy and ask if any medicines you are taking affect you while working in cold environments).
- They are in poor physical condition, have a poor diet, or are older.

The Wind Chill Chart below shows the difference between actual air temperature and perceived temperature, and amount of time until frostbite occurs.

Wind Chill Factor									
Wind Speed (mph)	Actual Air Temperature °F								
	40°	30°	20°	10°	0°	-10°	-20°	-30°	-40°
10	34	21	9	-4	-16	-28	-41	-53	-66
20	30	17	4	-9	-22	-35	-48	-61	-74
30	28	15	1	-12	-26	-39	-53	-67	-80
40	27	13	-1	-15	-29	-43	-57	-71	-84
50	26	12	-3	-17	-31	-45	-60	-74	-88
60	25	10	-4	-19	-33	-48	-62	-76	-91

Frostbite times:

30 minutes	10 minutes	5 minutes
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