

**APPENDIX P**  
**RECOGNITION & TREATMENT OF HEAT AND COLD STRESS**

## APPENDIX P

### RECOGNITION AND TREATMENT OF HEAT AND COLD STRESS

When performing spill or leak investigation or spill or leak response, it is possible that you, the spill responder, may have to work under extremely harsh physical conditions. Depending on the site location, the facility environment, and the weather/season, the possibility of unusually hot or cold temperatures increases the risk of heat and cold stress. This appendix discusses the prevention, symptoms, and treatment of hypothermia and frostbite under extremely cold temperatures as well as heat stress under extremely hot temperatures.

#### A. Hypothermia and Frostbite

In performing emergency response, exposure to cold temperature and/or water, may lead to hypothermia and/or frostbite. Under these unusual conditions, the body will react to protect itself based on signals originating in the brain. When the brain recognizes any dangerous temperature drop in the body core, it signals the body to make adjustments to compensate for the imbalance.

##### 1. Hypothermia

When exposed to unusually cold temperatures, the body will attempt to preserve the normal temperatures of vital internal organs. The first reaction will be the slowing of blood flow to the arms and legs (vasoconstriction - the constricting of blood vessels in the extremities); this preserves energy and warm blood for the body core. If there is continued heat loss and if the body core temperature drops below 95°F (35°C), the body will begin to shiver. This is your first real warning sign of hypothermia as the body tries to generate more heat. Shivering will cause the metabolic heat production to increase to several times the normal rate. Continued heat loss, accompanied by a body core temperature drop to 90°F (32.2°C) or below, results in speech difficulty, loss of manual dexterity, slow reactions, mental confusion and muscle rigidity (muscle hypertonias). If exposure to the cold continues, further heat loss will occur until the body's resources are exhausted. If cold blood from extremities reaches the heart and the brain, heart failure and coma will result and inevitably lead to death. Death occurs when the body core temperature falls below 78°F (25.6°C).

##### 2. Frostbite

In performing response activities, if exposure occurs in temperatures that are below freezing (30°F or below), frostbite or trench foot (immersion foot) may accompany or complicate the symptoms of hypothermia. Frostbite is the freezing of living tissues that causes a breakdown of cell structure in the affected area. Injury due to frostbite may range from superficial redness of the skin, slight numbness and blisters, to the obstruction of blood flow (ischemia), blood clots (thrombosis) or skin discoloration due to insufficient oxygen in the blood (cyanosis). Frostbite may affect the extremities after prolonged exposure to below freezing temperatures, or when the skin comes into contact with objects, such as machinery or metal tool handles, whose surface temperature is below freezing. Trench foot is caused by continuous exposure to cold combined with persistent dampness or immersion in water. Injuries in this case include permanent tissue damage due to oxygen deficiency, damage to capillary walls, severe pain, blistering, tissue death and ulceration.

Additionally, cold exposures may either induce or intensify vascular abnormalities. These include chilblain (a swelling or sore), Raynaud's disease, acrocyanosis (blains of hands and feet) and thromboangiitis (inflammation of the innermost walls of blood vessels accompanied by clot formation). Workers suffering from these ailments should take particular precautions to avoid chilling. Hypothermia damages both the body's internal temperature mechanisms (hypothalamus) and the peripheral mechanisms to prevent heat loss (vasoconstriction and perspiration). These effects may last up to three years.

When performing response activities spill responders must be looking out for the first signs of hypothermia. Warning signals must not be ignored, and prompt treatment is crucial (as discussed below). Precautions you and your staff can take to reduce prolonged exposure to severe conditions, and the risk of hypothermia and frostbite include the following:

- # Alternate work patterns, limiting the amount of exposure to any one individual;
- # Continuously exercise arms and legs to prevent loss of circulation and body heat; and
- # Check temperature of any machinery or hand tools you will be using and wear gloves.

## **B. Treatment of Hypothermia and Frostbite**

If hypothermia occurs, prompt attention and first aid procedures can mean the difference between life and death for the victim. These procedures include the following (as a general rule, treat all injuries in the order of their importance to preserving life):

### **1. For hypothermia:**

1. Give artificial respiration and stop any bleeding, if necessary.
2. Bring the victim into a warm room or shelter as quickly as possible.
3. If the victim cannot be moved (e.g., because of a spinal injury), carefully place newspapers, blankets or some other insulation between him and the ground.
4. Remove all wet clothing.
5. Provide an external heat source, for the body cannot generate it own heat. Wrap the victim in prewarmed blankets, place him or her in the liner of a portable hypothermia treatment unit, put the torso (not the extremities) into a tub of warm water or use body-to-body contact to rewarm the body core. These measures will slowly reopen the peripheral circulation, minimizing the possibility of after-shock or after-drop (the flowing of cooled, stagnated blood from the limbs to the heart), which may cause ventricular fibrillation, cardiac arrest or death.
6. Do not allow the victim to sleep.
7. Give warm, sweet drinks -- no alcohol or pain relievers.

8. Keep the victim still. Do not try to walk.
9. Do not rub numb skin.
10. Get medical help as soon as possible.

## **2. For frostbite:**

1. Wrap the victim in woolen cloth and keep dry until he or she can be brought inside.
2. Do not rub, chafe, or manipulate frozen parts.
3. Bring the victim indoors.
4. Place the victim in water (102° to 105°F) and make sure the water remains warm. Test the water by pouring it on the inner surface of your forearm. Never thaw affected parts if the victim has to go back out into the cold. The affected area may be refrozen.
5. Do not use hot water bottles or a heat lamp, and do not place the victim near a hot stove.
6. Do not allow the victim to walk if his or her feet are affected.
7. Have the victim gently exercise the affected parts once they are thawed.
8. Seek medical aid for thawing of serious frostbite, because the pain will be intense and tissue damage will be extensive.

## **C. Effects of Heat Stress**

When performing response activities, prolonged exposure to unusually hot conditions can result in heat stress. Heat stress will occur if the body's physiological processes fail to maintain a normal body temperature because of excessive heat exposure. Physical reactions to heat stress can range from mild (e.g., fatigue, irritability, anxiety, and loss of dexterity) to fatal. This section will discuss the effects, prevention, and monitoring of heat stress for the following heat related problems:

- # Heat rash;
- # Heat cramps;
- # Heat exhaustion; and
- # Heat stroke.

When faced with any problem caused by heat stress, prompt emergency care is important for preventing any further heat stress or injury. Standard reference books should be consulted for specific treatment. The four heat-related problems are discussed below.

## **1. Heat Rash**

A heat rash occurs as a result of continuous exposure to heat and humid air, and is aggravated by chafing clothes. A heat rash will decrease a persons ability to tolerate heat and make physical activity stressful.

## **2. Heat Cramps**

Heat cramps usually affect people working in hot environments and perspiring a great deal. The loss of salt from the body through perspiration causes very painful cramps in the leg and abdominal muscles. Heat cramps may also result from drinking iced water or other drinks either too quickly or in too large a quantity. The symptoms of heat cramps include the following:

- # Muscle cramps in legs and abdomen;
- # Pain accompanying cramps;
- # Faintness; and
- # Profuse perspiration.

To provide emergency care for heat cramps, remove the patient to a cool place. Make the victim drink sips of cool liquids such as "Gatorade" or its equivalent. To relieve pain from heat cramps, apply manual pressure directly to the cramped muscle. If there is any indication of a more serious problem move the paint to a hospital as soon as possible.

## **3. Heat Exhaustion**

When response activities require working long hours in unusually hot conditions, special precautions must be taken to prevent heat exhaustion. This disorder may be associated with heat cramps and, if not addressed promptly, can lead to more severe heat stress disorders. Heat exhaustion occurs as the body tries to lower its abnormally high temperature by transporting blood from the interior of the body to the surface. During this transfer, the skin vessels become dilated and large amounts of blood begin to pool in the skin. If the victim remains standing for a long period of time, blood will pool in the lower extremities and may lead to an inadequate return of blood to the heart and eventually to physical collapse. The symptoms of heat exhaustion are listed below:

- # Weak pulse;
- # Rapid and usually shallow breathing;
- # Generalized weakness;
- # Pale, clammy skin;
- # Profuse perspiration;
- # Dizziness;

- # Appearance of having fainted (the patient responds to the same treatment administered in cases of fainting); and
- # Unconsciousness.

To provide emergency care to victims of heat exhaustion, move the patient to a cool place and remove as much clothing as possible. If conscious, make the victim drink sips of cool water, "Gatorade" or its equivalent. If possible, fan the patient continually to remove heat by convection, but do not allow chilling or overcooling. If there is any indication of a more serious problem, treat the patient for shock, and move him to a medical facility as soon as possible.

#### **4. Heat Stroke**

Heat stroke is a result of a profound disturbance to the body's ability to regulate its own temperature, and may occur after prolonged heat exhaustion. A heat stroke is associated with high fever and collapse, and if not treated promptly may result in convulsions, unconsciousness and even death. Causes of heat stroke include direct exposure to sun, poor air circulation, poor physical condition, and advanced age (over forty). When working in unusually hot conditions, symptoms of heat stroke must never be ignored. Heat stroke can be life-threatening; it has been estimated that twenty percent of all heat stroke cases are fatal. The symptoms of heat stroke are listed below:

- # Dry, hot and flushed skin;
- # Dilated pupils;
- # Early loss of consciousness;
- # Full and fast pulse;
- # Breathing deep at first, later shallow and even almost absent;
- # Muscle twitching, growing into convulsions; and
- # Body temperature reaching 105° to 106° degrees or higher.

When providing emergency care to victims of heat stroke, remember that this is a true emergency. The victim should be immediately transported to a medical facility. Until professional attention is available, move the patient to a cool environment if possible, remove as much clothing as possible, and assure an open airway. Reduce body temperature promptly by dousing the body with water, or preferably by wrapping in a wet sheet. If cold packs are available, place them under the arms, around the neck, at the ankles, or any place where blood vessels that lie close to the skin can be cooled. If convulsions begin, try to protect the patient from injury, especially from tongue biting.

#### **D. Heat Stress Prevention**

Heat stress can cause a decrease in a worker's productivity and, in extreme cases, can cause a worker serious physical illness. Additionally, once someone suffers from heat stroke or heat exhaustion, that person may be predisposed to additional heat injuries. However, proper training and preventive measures can avert these problems. To avoid heat stress, follow these guidelines:

- # Modify work/rest schedules according to monitoring requirements, and mandate work slowdowns as needed.
- # Rotate personnel in different job functions in order to minimize stress or overexertion at one task. If needed, add additional personnel to work teams.
- # Perform work during cooler hours of the day or at night, if adequate lighting can be provided.
- # Provide shelter (air conditioned, if possible) or shaded areas to protect personnel during rest periods.
- # Make sure that workers' body fluids remain at normal levels. Daily fluid intake must approximately equal the amount of water lost in sweat, i.e., 8 fluid ounces (0.23 liters) of water must be ingested for approximately every 8 ounces (0.23 kg) of weight lost. The normal thirst mechanism is not sensitive enough to ensure that you drink sufficient water to replace lost sweat. When heavy sweating occurs, encourage the worker to drink more. The following strategies may be useful:
  - Maintain water temperature at 50° to 60°F (10° to 15.6°C).
  - Provide small disposable cups that hold about 4 ounces (0.1 liter).
  - Have workers drink 16 ounces (0.5 liters) of fluid (preferably water or diluted drinks) before beginning work.
  - Urge workers to drink a cup or two of fluids every 15 to 20 minutes, or at each monitoring break. A total of 1 to 1.6 gallons (4 to 6 liters) of fluid per day are recommended, but more may be necessary to maintain body weight.
  - Weigh workers before and after work to determine if fluid replacement is adequate.
- # Encourage workers to maintain an optimal level of physical fitness, and urge them to maintain normal weight levels.
- # Provide cooling devices to aid natural body heat exchange during prolonged work such as field showers or hose-down areas and cooling jackets, vests, or suits.
- # Train workers to recognize and treat heat stress. As part of training, identify the signs and symptoms of heat stress.

## **E. Heat Stress Monitoring**

All supervisors should ensure that their personnel are briefed on the hazards, symptoms, and treatment of heat-related problems. You should avoid wearing impervious clothing when the ambient temperature is 70°F or above. When temperatures exceed 85°F, workers should be monitored for heat stress after every work period. To monitor the heat stress, one or more of the following techniques should be used as a screening mechanism:

- # The heart rate (HR) should be measured by the radial pulse for 30 seconds as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 100 beats per minute. If the HR is higher, the next work period should be shortened by 10 minutes (or 33%), while the length of the rest period stays the same. If the pulse rate is 100 beats per minute at the beginning of the next rest period, the following work cycle should be shortened again by 33 percent.
  
- # Body temperature should be measured with a clinical thermometer as early as possible in the resting period. Oral temperature (OT) at the beginning of the rest period should not exceed 99°F. If it does, the next work period should be shortened by 10 minutes (or 33%), while the length of the rest period stays the same. However, if the OT exceeds 99.7°F at the beginning of the next period, the following work cycle should be further shortened by 33%. OT should be measured again at the end of the rest period to make sure that it has dropped below 99°F.
  
- # Body water loss (BWL) due to sweating should be measured by weighing the worker in the morning and in the evening. The clothing worn should be similar at both weighings; preferably the workers should be nude. The scale should be accurate to plus or minus 1/4 lb. BWL should not exceed 1.5% of the total body weight. If it does, the worker should be instructed to increase his daily intake of fluids. Ideally, body fluids should be maintained at a constant level during the work day. This requires replacement of salt lost in sweat as well.
  
- # Good hygienic standards must be maintained by frequent change of clothing and daily showering. Clothing should be permitted to dry during rest periods. Those developing skin problems should immediately consult medical personnel.