OSHAcademy™
Occupational Safety & Health Training

Heat and Cold Stress Safety

At times, employees are forced to work in extreme temperatures. Working in extreme hot and cold temperatures for a long period of time can cause severe health damage, such as heat exhaustion and hypothermia. This course offers information to employers and employees on measures they should take to prevent the illnesses and possible death caused by extreme temperatures.

This page intentionally blank

OSHAcademy Course 602 Study Guide

Heat and Cold Stress Safety

This study guide is designed to be reviewed off-line as a tool for preparation to successfully complete OSHAcademy Course 602.

Read each module, answer the quiz questions, and submit the quiz questions online through the course webpage. You can print the post-quiz response screen which will contain the correct answers to the questions.

The final exam will consist of questions developed from the course content and module quizzes.

We hope you enjoy the course and if you have any questions, feel free to email or call:

OSHAcademy

15220 NW Greenbrier Parkway, Suite 230
Beaverton, Oregon 97006
www.oshatrain.org
instructor@oshatrain.org
+1.888.668.9079

Disclaimer

Revised: April 6, 2021

This page intentionally blank

Contents

Course Introduction

When the weather's too hot or cold, workers can suffer.

Workers at greater risk of heat stress include those who are 65 years old and older, are overweight, have heart disease or high blood pressure, or take medications that may be affected by extreme heat.

If not treated, heat exhaustion – the symptoms of which include dizziness, headache, and sweaty skin – can lead to heat stroke. The symptoms of heat stroke include red, dry skin; confusion; and fainting. Heat stroke can kill you.

Workers who are exposed to extreme cold or work in cold environments may be at risk of cold stress. Extremely cold or wet weather is a dangerous situation that can cause occupational illness and injuries such as hypothermia - a condition in which the body uses up its stored energy and can no longer produce heat.

Prolonged exposure to cold temperature can result in frostbite, trench foot, and chilblains.

This course presents information to employers and employees on the hazards and measures they should take to prevent illness and death caused by extreme hot and cold temperatures.

Module 1: Heat Stress Safety

Introduction

People suffer heat-related illness when the body's temperature control system is overloaded. The body normally cools itself by sweating. However, in some conditions, sweating isn't enough. In such cases, a person's body temperature rises rapidly. Very high body temperatures may damage the brain or other vital organs.

Several factors affect the body's ability to cool itself during extremely hot weather. When the humidity is high, sweat will not evaporate as quickly, reducing the body's ability to release heat quickly.

Other conditions that can limit the ability to regulate body temperature include:

- old age
- obesity
- dehydration
- mental illness
- sunburn
- alcohol use
- youth (ages 0-4)
- fever
- heart disease
- poor circulation
- prescription use

OSHA Regulations

Although there is not a specific OSHA standard for heat stress, employees are protected under the "General Duty Clause of the OSH Act" because heat –related illnesses are a serious hazard. The general duty clause states that employers are required to *"… provide a place of employment free from recognized hazards that are causing or likely to cause death or serious physical harm to its employees."* This includes heat-related hazards that are likely to cause death or serious bodily harm.

Quiz Instructions

After each section, there is a quiz question. Make sure to read the material in each section to discover the correct answer to these questions. Circle the correct answer. When you are finished go online to take the final exam. This exam is open book, so you can use this study guide.

1. When do most outdoor workplace heat-related fatalities occur?

a. During the first few days of work
b. Within one month after being hired
c. During the first year of employment
d. When the temperature exceeds 50 degrees F

The Dangers of Extreme Heat

Workers, who are exposed to hot and humid conditions, including the outdoors, factories and hot kitchens, are at the most risk for heat illness. Workers doing heavy work or wearing bulky protective clothing and equipment are also at risk. Some workers also might be at a greater risk than others if they haven't built up a **tolerance** to hot conditions. This process usually takes about 5-7 days.

For the human body to maintain a constant internal temperature, the body must get rid of excess heat. This is achieved primarily through sweating. The evaporation of sweat cools the skin, releasing large amounts of heat from the body.

The human body has a normal core temperature between 97°F and 99°F, but on average, a normal body temperature is 98.6°F (37°C). To maintain this temperature without the help of warming or cooling devices, the surrounding environment needs to be at about 82°F (28°C). At higher temperatures, sweating may not be sufficient to cool the body.

In the range of 90° and 105°F (32° and 40°C), employees may experience heat cramps and exhaustion, and between 105° and 130°F (40° and 54°C), heat exhaustion is possible. Temperatures over 130°F (54°C) often lead to heatstroke. Employees should limit work in temperatures over 90°F.

2. How long does it take for workers to build up a tolerance to hot conditions?

a. A day or two
b. 5-7 days
c. Two weeks
d. 20 days or more

Factors in Heat-Related Illnesses

Excessive exposure to hot environments can cause a variety of heat-related health problems. Body temperature can rise to dangerous levels if precautions are not taken immediately. Heat illnesses can range from heat rash and cramps to heat exhaustion and heat stroke.

Heat Rash

Heat rash often occurs in hot, humid environments where sweat doesn't evaporate from the skin. The sweat ducts become clogged and result in a rash. Heat rash can be very uncomfortable. Victims of heat rash will see clusters of red bumps on the skin. The rash usually appears on the neck, upper chest and folds of the skin. To prevent heat rash, employees should work in cooler and less humid environments, if possible. Also, make sure to keep the affected area dry.

Heat Cramps

Heat cramps may happen alone or with other heat-related illnesses. They are painful muscle spasms caused by dehydration while performing hard physical labor in a hot environment. The cramps may be caused either by too much or too little salt. Tired muscles are also very susceptible to heat cramps.

Treatment

If a worker experiences heat cramps, (usually caused by too much salt in the body due to sweating) employers should:

- have worker rest in shady, cool area
- worker should drink water or other cool beverages (not alcohol)
- have worker wait a few hours before returning to strenuous work
- have worker seek medical attention if cramps don't go away

3. What is the cause of heat cramps?

a. Too much or little sugar
b. Too much or little salt
c. Too much or little magnesium
d. Too much or little water

Heat Exhaustion

Heat exhaustion is caused by the loss of large amounts of fluid. This can happen by sweating and sometimes with an extensive loss of salt. An employee suffering from heat exhaustion still sweats, but may also experience the following symptoms:

- cool, moist skin
- headache
- dizziness
- weakness
- irritability
- heavy sweating
- nausea or vomiting
- light headedness
- thirst
- fast heart beat

Treatment

You will need to have the victim lie down or sit in a cool or shady area. He or she will need to drink plenty of cool liquids, preferably a sports drink with carbohydrates and electrolytes. You should also spray water or apply cool, wet cloths to the victim's head and torso. Using a fan can also speed evaporation and lower his or her body temperature. If signs or symptoms get worse or do not improve in about an hour, the victim should be taken to a medical clinic or hospital to be evaluated by medical staff.

4. What causes heat exhaustion?

a. Too much water in the blood
b. Too much calcium in the body
c. A loss of a large amount of fluid
d. A loss of too much potassium in the muscles

Heat Stroke

Heat stroke is the most serious heat-related illness. It occurs when the body's temperature-regulating system fails and sweating becomes an inadequate way of removing excess heat. **Heat stroke requires immediate medical attention and can result in death.** When heat stroke doesn't kill immediately, it can shut down major body organs causing acute heart, liver, kidney and muscle damage, nervous system problems, and blood disorders.

Signs an employee may be suffering from heat stroke are:

- confusion
- fainting
- seizures
- excessive sweating or red, hot, dry skin
- very high body temperature
- unconscious

Treatment

There are several steps to take when you notice someone showing the signs of heat stroke. Once you have called for emergency help, lay the victim on his or her back unless he or she is unconscious. Make sure to remove any objects close by if the victim has a seizure. If the worker is conscious, provide cool water to drink. Also, place ice packs under the armpits and in the groin area to cool them down.

5. What is the most serious heat-related illness?

a. Heat cramps
b. Heat exhaustion
c. Heat stroke
d. Heat rash

Real-Life Scenario

On August 1st, 2006, a 44-year-old Hispanic migrant farm worker died after succumbing to heat stroke while working in a tobacco field on a farm in North Carolina. The victim arrived on the farm from Mexico on July 21st, 2006 and he was assigned to work in the tobacco fields, where he worked for the next week. On August 1st, 2006, it was hot and humid with a heat index (a measure of the combined effects of high temperatures and high humidity on the body) between 100 and 110. He had been working in a tobacco field when around 3 pm, he complained to the crew leader that he wasn't feeling well. The victim drank some water and was driven back to his housing and left alone to rest. A short time later, he was found unconscious on the steps of the house. Emergency medical service (EMS) personnel were immediately called and responded within five minutes. The victim was taken to the hospital where his core body temperature was recorded at 108 Fahrenheit and was pronounced dead. Heat stroke was listed as the death on the death certificate.

Real-Life Scenario

On June 27th, 2003, a 41-year-old male laborer died from heat stroke one day after being taken to the hospital. The laborer was working on an addition to a factory, sawing boards to make concrete forms. He worked until 5:00 pm that day and was in the parking lot on his way to his car when he apparently collapsed. A worker on the second shift at the factory was taking scrap material outside to a dumpster when he found the victim on the ground. The company receptionist called EMS and the supervisor went to the parking lot to administer emergency care to the laborer until EMS arrived. When paramedics arrived, they recorded the laborer's body temperature as 107 Fahrenheit. He was transported to a local hospital where he died the next day with an internal body temperature of 108 Fahrenheit.

To prevent similar incidents from occurring, investigators made the following recommendations:

- Employers should train supervisors and employees to recognize symptoms of heat exhaustion/stroke when working in high heat index and/or humid conditions.
- To avoid dehydration and heat stress/stroke, employees should be given frequent breaks and be provided water and other hydrating drinks when working in humid and hot conditions.
- Work hours should be adjusted to accommodate environmental work conditions such as high heat index and/or high humidity.

6. To avoid heat-related illness, work hours should be adjusted to accommodate environmental work conditions such as _____.

a. the duration of a job or task
b. high heat index and/or high humidity
c. maximum performance exposure limits
d. turnover of atmospheric conditions

Preventing Heat Illnesses Using Controls

Engineering Controls

Engineering controls can eliminate or reduce exposure to heat-related hazards by properly designing tools, equipment, machinery, and the facility. The best engineering controls to prevent heat-related illness is to make the work environment cooler and to reduce manual workload with mechanization. A variety of engineering controls can reduce workers' exposure to heat:

- Air conditioning (such as air-conditioned crane or construction equipment cabs, air conditioning in break rooms)
- Increased general ventilation
- Cooling fans
- Local exhaust ventilation at points of high heat production or moisture (such as exhaust hoods in laundry rooms)
- Reflective shields to redirect radiant heat
- Insulation of hot surfaces (such as furnace walls)
- Elimination of steam leaks
- Cooled seats or benches for rest breaks
- Use of mechanical equipment to reduce manual work (such as conveyors and forklifts).
- Misting fans that produce a spray of fine water droplets

7. Reflective shields, local exhaust ventilation, and cooling fans are examples of _____.

a. administrative controls
b. safety controls
c. engineering controls
d. equipment controls

Administrative Controls -Work Practices

Some worksites cannot be cooled by engineering controls. At those locations, employers should use administrative controls to modify work practices when heat stress is too high to work safely. Consider the following activity modifications:

- Modify work schedules and activities for workers who are new to warm environments.
- Schedule shorter shifts for newly hired workers and unacclimated existing workers. Gradually increase shift length over the first 1-2 weeks.
- Require mandatory rest breaks in a cooler environment (such as a shady location or an air-conditioned building). The duration of the rest breaks should increase as heat stress rises.
- Consider scheduling work at a cooler time of day, such as early morning or late afternoon.
- Reduce physical demands as much as possible by planning the work to minimize manual effort (such as delivering material to the point of use so that manual handling is minimized).
- Rotate job functions among workers to help minimize exertion and heat exposure.
- Ensure that workers drink an adequate amount of water or electrolyte-containing fluids. Avoid drinking hot beverages during lunch and afternoon breaks.
- Employers should have an emergency plan that specifies what to do if a worker has signs of heat-related illness and ensures that medical services are available if needed.
- Workers should watch out for each other for symptoms of heat-related illness prepared to administer appropriate first aid to anyone who is developing a heat-related illness.
- Administer appropriate first aid to any worker who is developing a heat-related illness.
- In some situations, employers may need to conduct physiological monitoring of workers.
- Implement a buddy system for new workers and in heat stress environments.

8. Modified work schedules, rest breaks, and job rotation are examples of _____.

a. regulatory controls
b. work practice controls
c. engineering controls
d. administrative controls

Personal Protective Equipment

In most cases, heat stress should be reduced by engineering or administrative controls. However, in some limited situations, special cooling devices can protect workers in hot environments:

- insulated suits
- reflective clothing
- infrared reflecting face shields
- cooling neck wraps

In extremely hot conditions, the following thermally conditioned clothing might be used:

- Vest that receives cooled air from a vortex tube connected to an external compressed air source.
- Jackets or vests with reusable ice packs or phase change cooling packs in the pockets.
- Workers should be aware that use of certain personal protective equipment (e.g., certain types of respirators, impermeable clothing, and head coverings) can increase the risk of heat-related illness.

9. In addition to engineering and administrative controls, which of the following could be effective to reduce heat-related stress?

a. job rotation
b. special cooling devices
c. physiological monitoring
d. reflective shields

Module 2: Cold Stress Safety

Introduction

Anyone working in a cold environment may be at risk of cold stress. Some workers may be required to work outdoors in cold environments and for extended periods, for example, snow cleanup crews, sanitation workers, police officers and emergency response and recovery personnel, like firefighters, and emergency medical technicians.

When the body is unable to warm itself, cold related stress may occur. Cold stress occurs by driving down the skin temperature and eventually the internal body temperature (core temperature). Over time, your body will begin to shift blood flow from your extremities (hands, feet, arms and legs) and outer skin to the core areas (chest and abdomen). This allows exposed skin and the extremities to cool rapidly and increases the risk of frostbite and hypothermia. Combine this with cold water, and trench foot may also be a problem. This may lead to serious health problems, and may cause tissue damage, and possibly death.

Risk factors that contribute to cold stress include:

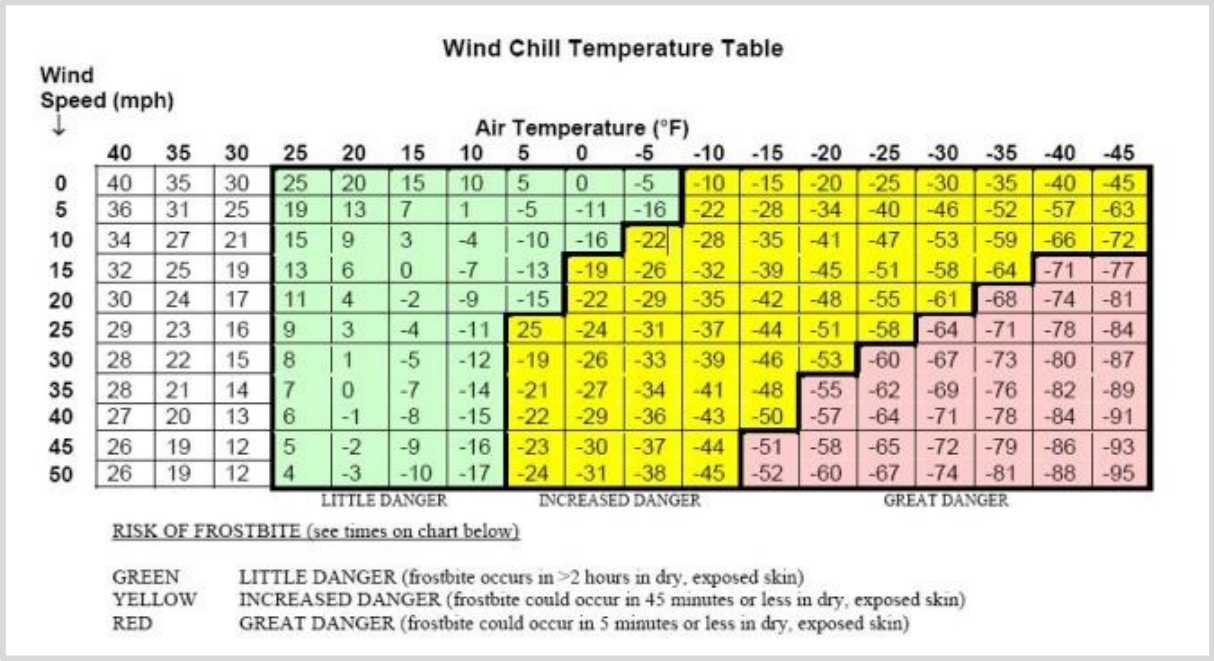
- Cold air temperatures,
- high velocity air movement,
- wetness/dampness of the air,
- dressing improperly,
- exhaustion or poor physical conditioning, and
- predisposing health conditions (e.g., hypertension, hypothyroidism, and diabetes)

1. Why does exposed skin and the extremities cool rapidly in cold temperatures?

a. Heat does not transfer as rapidly to organs
b. Blood becomes thicker causing low heat transfer
c. Blood flow shifts to supply core areas
d. Blood flow slows at lower temperatures

Wind Chill

Wind chill is the combination of air temperature and wind speed. For example, when the air temperature is 35 degrees Fahrenheit, and the wind speed is 30 miles-per-hour, your exposed skin receives conditions equivalent to the air temperature being a mere 22 degrees Fahrenheit. While it is obvious that below freezing conditions combined with inadequate clothing could bring about cold stress, it is also important to understand it can also be brought on by warmer temperatures (such as 50 degrees Fahrenheit) combined with some rain and wind.



Wind Chill Temperature Table

Wind Speed (mph) ↓	Air Temperature (°F)																
	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
0	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	25	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95

LITTLE DANGER — INCREASED DANGER — GREAT DANGER

RISK OF FROSTBITE (see times on chart below)

GREEN LITTLE DANGER (frostbite occurs in >2 hours in dry, exposed skin)
YELLOW INCREASED DANGER (frostbite could occur in 45 minutes or less in dry, exposed skin)
RED GREAT DANGER (frostbite could occur in 5 minutes or less in dry, exposed skin)

2. Which of the following are the two primary factors affecting wind chill?

a. Exposure and humidity
b. Humidity and temperature
c. Wind and humidity
d. Wind and temperature

Common Cold-Induced Problems

Hypothermia

Hypothermia means “low-heat,” which is a potentially serious health condition. This occurs when body heat is lost faster than it can be replaced. When the core body temperature drops

below the normal 98.6 degrees Fahrenheit to around 95 degrees Fahrenheit, you will see the following symptoms:

- uncontrollable shivering
- memory lapses
- drowsiness
- slow speech
- frequent stumbling
- exhaustion

Treatment

Without early recognition and active care, hypothermia can be deadly. Here are some things you can do, if you recognize someone who is dealing with hypothermia:

- gently move the victim to a warmer place
- remove wet clothing
- cover the victim with something dry and warm
- If available, contact Emergency Medical Services. If you are far from professional medical care, start re-warming the person. Place him near a heat source and put containers of warm water in contact with the skin.

Scenario

On January 4th, 2008, an employee and co-worker were securing a large tug boat that broke loose during a storm and was drifting towards waterfront homes. The two employees off-boarded the work boat and boarded the tug boat. At some point, the work boat became detached from the tug boat and drifted away. One of the employees dove into the frigid water to catch the work boat. However, he couldn't reach it and re-boarded the tug boat. He found another smaller vessel on board the tug boat and boarded it. He was going to float out to get the work boat. The small boat capsized and the employee was hanging onto the boat, waiting for rescue workers. The rescue took about 45 minutes. He was transferred to a hospital and later died from complications related to hypothermia.

3. When do the symptoms of hypothermia begin to appear?

a. When the core temperature lowers to 85°F
b. When the peripheral temperature reaches 90°F
c. When the core temperature drops to about 95°F
d. When the peripheral temperature dips below 98°F

Frostbite

Frostbite is a severe reaction to cold exposure that causes freezing in the deep layers of skin and tissues. Frostbite can cause permanent damage and even cause amputation of the affected area. While frostbite usually occurs when temperatures are 30 degrees Fahrenheit or lower, wind chill factors can allow frostbite to occur in above freezing temperatures.

Frostbite usually affects the extremities, particularly the feet and hands. (see picture) However, frostbite can also affect the ears and nose. The affected body part will be cold, tingling, stinging or aching followed by numbness. The skin color turns red, then purple, then white, and is cold to the touch. There may also be blisters in severe cases.

Treatment

Early recognition and care for a frostbitten victim can reduce or even eliminate future complications. **Minor** frostbite can be treated by simply re-warming the area using skin-to-skin contact, such as a warm hand. If more serious, get the person to a warmer place.

Here are some more treatment tips:

- Remove any jewelry from the affected areas.
- Place clean pads between frostbitten fingers and toes.
- Wrap the affected part with a clean towel or pad.

Fact: *Rubbing frostbitten fingers or toes can cause further damage. Frostbitten skin must be warmed slowly. Do not rub or pour hot water directly on the affected area. Instead, immerse the body part in warm water (105 degrees Celsius maximum). Do not warm the skin if there is a chance it will become cold again. Large crystals may form in the tissues, causing further damage.*

Real-Life Scenario

On August 4th, 2004, a worker was wearing a thermo-insulated jacket, overalls, and gloves and began work in the freezer department of a supermarket chain warehouse. His work consisted of selecting produce off warehouse shelves and delivering the product to the designated freezer truck. At the completion of the eight-hour work shift, he went home and soon realized that he was in unbearable pain and the toes on both his feet were black and blistering. He immediately left the house and went to the hospital where his feet were treated for frostbite and he was hospitalized.

4. What condition is an employee suffering from if the skin color turns red, then purple, then white, and is cold to the touch?

a. Trench Foot
b. Frostbite
c. Hypothermia
d. Cold rash

Trench Foot

Trench foot, or immersion foot, is caused by having feet immersed in cold water at temperatures above freezing for long periods of time. It is similar to frostbite but considered less severe. Symptoms usually consist of tingling, itching or burning sensation. Blisters may also be present.

Treatment

When possible, air-dry and elevate your feet, and exchange wet shoes and socks for dry ones to help prevent the development of trench foot.

Treatment for trench foot is similar to the treatment for frostbite. Take the following steps:

- Thoroughly clean and dry your feet.
- Put on clean, dry socks daily.

- Treat the affected part by applying warm packs or soaking in warm water (102° to 110° F) for approximately 5 minutes.
- When sleeping or resting, do not wear socks.
- Obtain medical assistance as soon as possible.

If you have a foot wound, your foot may be more prone to infection. Check your feet at least once a day for infections or worsening of symptoms.

5. If the foot is immersed in cold water for long periods of time, what injury to the foot may occur?

a. Frostbite
b. Trench Foot
c. Neuropathy of the foot
d. General hypothermia

Prevention of Cold Stress

Engineering Controls

Insulating heavy equipment cabs is an effective engineering control method.

Engineering controls can be effective in reducing the risk of cold stress through the design of equipment, materials, and facilities. For example:

Radiant heaters may be used to warm workers.

- Shielding work areas from drafts or wind will reduce the wind chill.
- Using insulating materials on equipment handles, especially metal handles, when temperatures drop below 30 degrees Fahrenheit.

Work Practice Controls

There are several work practice measures to protect workers in cold environments. Here are a few:

- Recognize the environmental and workplace conditions that may be dangerous.

- Learn the signs and symptoms of cold-induced illnesses and injuries and what to do to help workers.
- Train workers about cold-induced illness and injuries.
- Encourage workers to wear proper clothing for cold, wet and windy conditions, including layers that can be adjusted to changing conditions.
- Be sure workers in extreme conditions take a frequent short break in warm, dry shelters to allow their bodies to warm up.
- Try to schedule work for the warmest part of the day.
- Use the buddy system-work in pairs so that one worker can recognize danger signs.
- Avoid exhaustion or fatigue because energy is needed to keep muscles warm.

6. The insulation of equipment and facilities is an example of _____.

a. elimination or substitution
b. safe work practices
c. administrative controls
d. engineering controls

Protective Clothing

Protective clothing is the most important way to avoid cold stress. The type of fabric also makes a big difference. Cotton loses its insulation value when it becomes wet. Wool, silk and most **synthetics**, on the other hand, retain their insulation even when wet. Workers should wear at least three layers of clothing. There should be an inner layer of wool, silk or synthetic to pull moisture away from the body. The middle layer should include a layer of wool or synthetic to provide insulation, even when wet. Then, an outer wind and rain protection layer is needed to allow some ventilation to prevent overheating.

Here are some other protective clothing recommendations:

- Wear a hat or hood. Up to 40% of body heat can be lost when the head is left exposed.
- Wear insulated boots or other footwear.

- Keep a change of dry clothing available in case work clothes become wet.

Employee Training

Training in recognition and treatment of cold stress is important. Supervisors, workers and co-workers should watch for signs of cold stress and allow workers to interrupt their work if they are extremely uncomfortable. Supervisors should also ensure work schedules allow appropriate rest periods and make sure liquids are available. They should use appropriate engineering controls, personal protective equipment and work practices to reduce the risk of cold stress.

All of these measures should be incorporated into the relevant health and safety plans.

7. Which type of fabric loses its insulative qualities when wet?

a. Synthetics
b. Cotton
c. Wool
d. Silk