SPECIALIZED BUILDERS

DEB Construction, LLC

Heat-Illness Prevention Plan

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Occupational Safety and Health Administration (OSHA)

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This heat-illness prevention plan is provided as a resource and is not designed to address all work site scenarios and heat stress hazards. It is designed to help employers reduce the development of heat-related illnesses in healthy, physically fit workers. It is not designed to meet state, local, or other regulatory requirements on heat stress. It is not designed to protect workers with medical conditions or preexisting conditions that put them at risk of heat stress. It is recommended that employers medically screen workers prior to work in hot environments, especially when physical exertion is required. It is recommended that employers seek further information on heat stress and prevention using OSHA-provided resources and applicable regulations, available both online and via area offices.

DEB CONSTRUCTION, LLC
Heat-Illness Prevention Plan

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I. INTRODUCTION

The following Heat-illness Prevention Plan was prepared using guidelines provided by the Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), and the American Conference of Governmental Industrial Hygienists (ACGIH). This heat-illness prevention plan is provided as a resource and is not designed to address all work site scenarios and heat stress hazards. It is designed to help employers reduce the development of heat-related illnesses in healthy, physically fit workers. It is not designed to meet state, local, or other regulatory requirements on heat stress. It is not designed to protect workers with medical conditions or preexisting conditions that put them at risk of heat stress. It is recommended that employers medically screen workers prior to work in hot environments, especially when physical exertion is required. It is recommended that employers seek further information on heat stress and prevention using OSHA-provided resources and applicable regulations, available both online and via area offices.

The general approach addresses five (5) key areas of heat-illness prevention, as outlined below.

1. **Training workers and supervisors** on heat-illness prevention strategies, as well as recognizing and reporting the signs and symptoms of heat-related illnesses.

2. Monitoring weather and workplace conditions.

3. **Conducting a heat hazard assessment** of common environmental and work-related heat stress factors, when appropriate.

4. **Implementing heat-illness prevention strategies** to reduce heat stress. This includes:

    a. Reducing worker exposure to heat-stress conditions.

    b. Establishing an acclimatization program to help workers adapt to working in the heat.

    c. Ensuring workers are provided with adequate water, shade, and rest periods.

    d. Monitoring workers for early signs and symptoms of heat stress, including the use of physiological measures of body temperature, recovery heart rate, and/or body weight.

5. **Planning for heat-related medical emergencies** and ensuring victims receive prompt medical attention.

II. PURPOSE

This heat-illness prevention plan was developed to provide supervisors and workers

with training and tools to help protect them from heat-related exposures and illnesses.

III. SCOPE

Each work site and job task can be unique and contain a number of heat stress hazards that must be addressed prior to the beginning of work and during work activities. Supervisors and workers are responsible for assessing these hazards and taking necessary corrective actions to reduce heat-related illnesses.

IV. DEFINITIONS

Both OSHA and NIOSH provide the following definitions, in their various publications on heat stress and heat stress prevention.

A - G

Acclimatization: The physiological changes that occur in response to a succession of days of exposure to environmental heat stress and reduce the strain caused by the heat stress of the environment; and enable a person to work with greater effectiveness and with less chance of heat injury.

Body Heat Balance: Steady-state equilibrium between body heat production and heat loss to the environment.

Body Heat Balance Equation: Mathematical expression of the relation between heat gain and heat loss, expressed as $S = (M - W) \pm C \pm R \pm K - E$

Body Heat Storage (S): The change in heat content (either + or −) of the body.

clo: A unit expression of the insulation value of clothing, 1 clo = 5.55 $kcal \cdot m^{2} \cdot h^{-1} \cdot °C^{-1}$. A clo of 1 is equal to the insulation required to keep a sedentary person comfortable at 21°C (~70°F). It is also sometimes expressed as 1 clo = 0.155 $m^{2} \cdot °C \cdot W^{-1}$.

Conductive Heat Transfer (K): The net heat exchange involving the direct transfer of heat via direct contact between two mediums (solid, liquid, or gas) that have a temperature differential.

Convective Heat Transfer (C): The net heat exchange by convection between an individual and the environment.

Evaporative Heat Transfer (E): Rate of heat loss by evaporation of water from the skin or gain from condensation of water on the skin, expressed as $kcal \cdot h^{-1}$, $W \cdot m^{-2}$, or W.

H to N

Heat Cramp: A heat-related illness characterized by spastic contractions of the voluntary muscles (mainly arms, hands, legs, and feet), usually associated with restricted salt intake and profuse sweating without significant body dehydration.

Heat Exhaustion: A heat-related illness characterized by elevation of core body temperature above 38°C (100.4°F) and abnormal performance of one or more organ systems, without injury to the central nervous system. Heat exhaustion may signal impending heat stroke.

Heat Strain: The physiological response to the heat load (external or internal) experienced by a person, in which the body attempts to increase heat loss to the environment in order to maintain a stable body temperature.

Heat Stress: The net heat load to which a worker is exposed from the combined contributions of metabolic heat, environmental factors, and clothing worn which results in an increase in heat storage in the body.

Heat Stroke: An acute medical emergency caused by exposure to heat from an excessive rise in body temperature [above 41.1°C (106°F] and failure of the temperature-regulating mechanism. Injury occurs to the central nervous system characterized by a sudden and sustained loss of consciousness preceded by vertigo, nausea, headache, cerebral dysfunction, bizarre behavior, and excessive body temperature.

Heat Syncope: Collapse and/or loss of consciousness during heat exposure without an increase in body temperature or cessation of sweating, similar to vasovagal fainting except that it is heat induced.

Heat Tolerance: The physiological ability to endure heat and regulate body temperature at an average or better rate than others, often affected by the individual's level of acclimatization and physical conditioning.

Humidity, Relative (RH): The ratio of the water vapor present in the ambient air to the water vapor present in saturated air at the same temperature and pressure.

Hyperpyrexia: A body core temperature exceeding 40°C (104°F).

Hyperthermia: A condition where the core temperature of an individual is higher than 37.2°C (99°F). Hyperthermia can be classified as mild (37.2–38.5°C; 99–101.3°F), moderate (i.e., heat exhaustion [38.5–39.5°C; 101.3–103.1°F]), profound (>39.5°C; 103.1°F), or profound clinical hyperthermia (i.e., heat stroke [>40.5°C; 104.9°F]), and death can occur without treatment (>45°C; 113°F).

Metabolism (M): Transformation of chemical energy into free energy that is used to perform work and produce heat.

O to S

Pressure, Atmospheric (Pa): Pressure exerted by the weight of the air, which averages 760 mmHg at sea level and decreases with altitude.

Pressure, Water Vapor (Pa): The pressure exerted by the water vapor in the air.

Qualified Health Care Professional: An individual qualified by education, training, and licensure/regulation and/or facility privileges (when applicable) who performs a professional service within his or her scope of practice in an allied health care discipline, and independently reports that professional service.

Radiant Heat Exchange (R): The net rate of heat exchange by radiation between two radiant surfaces of different temperatures.

Recommended Alert Limit (RAL): The NIOSH-recommended heat stress alert limits for unacclimatized workers.

Recommended Exposure Limit (REL): The NIOSH-recommended heat stress exposure limits for acclimatized workers.

Rhabdomyolysis: A medical condition associated with heat stress and prolonged physical exertion, resulting in the rapid breakdown of muscle and the rupture and necrosis of the affected muscles.

Sweating, Thermal: Response of the sweat glands to thermal stimuli.

T to Z

Temperature, Ambient (t_a): The temperature of the air surrounding a body. Also called air temperature or dry bulb temperature.

Temperature, Core Body (t_{cr}): Temperature of the tissues and organs of the body. Also called Core Temperature.

Temperature, Dew-point (t_{dp}): The temperature at which the water vapor in the air first starts to condense.

Temperature, Globe (t_g): The temperature inside a blackened, hollow, thin copper globe measured by a thermometer whose sensing element is in the center of the sphere.

Temperature, Natural Wet Bulb (t_{nwb}): The wet bulb temperature under conditions of the prevailing air movement.

Temperature, Oral (t_{or}): Temperature measured by placing the sensing element under

the tongue for 3 to 5 minutes.

Temperature, Psychrometric Wet Bulb (t_{wb}): The lowest temperature to which the ambient air can be cooled by evaporation of water from the wet temperature-sensing element with forced air movement.

Temperature, Rectal (t_{re}): Temperature measured 10 centimeters (cm) into the rectal canal.

Temperature, Skin (t_{sk}): Temperature measured by placing the sensing element on the skin.

Temperature, Tympanic (t_{ty}): True tympanic temperature is measured by placing the sensing element directly onto the tympanic membrane and recording the temperature. Estimates of tympanic temperature are usually obtained by placing a device into the ear canal close to the tympanic membrane.

Temperature Regulation: The maintenance of body temperature within a restricted range under conditions of positive heat loads (environmental and metabolic) by physiologic and behavioral mechanisms.

Thermal Insulation, Clothing: The insulation value of a clothing ensemble.

Wet Bulb Globe Temperature (WBGT): This is an environmental temperature arrived at by measuring dry air temperature, humidity, and radiant energy (i.e., usually direct sunlight being absorbed by clothing), used to calculate a thermal load on the person.

Work: Physical efforts performed using energy from the metabolic rate of the body.

V. COMPANY POLICY

DEB CONSTRUCTION, LLC is dedicated to protecting employees from on-the-job illnesses and injuries. All employees have the responsibility to work safely on the job. The purpose of this plan is to supplement our existing safety and health program and to ensure employees recognize heat stress hazards and act appropriately to address those hazards. The general approach addresses five (5) key areas of heat-illness prevention, as outlined below.

Main Elements of Heat-Illness Prevention Plan

Control	Description
1. Train supervisors and workers	Train supervisors and workers on heat-illness prevention strategies, as well as how to recognize and report the signs and symptoms of heat-related illnesses.
2. Monitor weather and workplace conditions	Monitor the weather of the workplace conditions and take preventative measures to protect workers when the temperatures exceed 70 °F (21 °C).
3. Conduct a heat hazard assessment when temperatures exceed 70 °F	Determine an effective wet-bulb globe temperature (WBGT-Effective) and use established recommended alert limits (non-acclimatized workers) and exposure limits (acclimatized workers) to determine the level of risk to heat stress.
4. Implement heat-illness prevention strategies	Implement appropriate heat-illness prevention strategies based on established risk levels for heat stress.
5. Plan for heat-related medical emergencies	Ensure adequate supervision, first aid, and medical services are readily available in the event a worker suffers from a heat-related illness.

Employee Training and Responsibilities

Each employee will be trained in heat-illness prevention and will strictly adhere to the recommended practices, except when doing so would expose him/her to a greater hazard. If, in the employee's opinion, this is the case, the employee is to notify their supervisor of their concern and have the concern addressed before proceeding.

Employer Responsibilities

On the job, it is the responsibility of the Safety Manager to implement this Heat-Illness Prevention Plan. Continual observational safety checks of work operations and the enforcement of the safety policy and procedures shall be regularly enforced. The supervisor is responsible for correcting any unsafe practices or conditions immediately.

It is the responsibility of the employer to ensure that all employees understand and adhere to the policies and procedures of this plan. It is also the responsibility of the employee to bring to management's attention any unsafe or hazardous conditions or practices that may cause injury to either themselves or any other employees. The Safety Manager must approve any changes to the Heat-Illness Prevention Plan.

Designated Safety Manager: Timothy Jones | General Superintendent

Supervisors: Jean Lee | HR Manager, DEB Superintendents

VI. TRAINING

To ensure workers are prepared to work safely under hot conditions, all employees and supervisors who may be exposed to heat stress and heat-related illnesses will receive training on the following topics:

Elements of the Company's Heat-Illness Prevention Plan

1. Training
2. Monitoring
3. Hazard Assessment
4. Heat-Illness Prevention Strategies
5. Emergency Preparedness

Risk Factors for Heat Stress

Environmental risk factors for heat stress

1. Temperature
2. Humidity
3. Air movement
4. Radiant heat (e.g., sun exposure)

Work-related risk factors for heat stress

1. Physical exertion
2. Clothing

Personal risk factors for heat stress

1. Age
2. Physical fitness
3. Acclimatization
4. Medical conditions
5. Medications
6. Alcohol and/or drug use
7. Caffeine

How the Body Handles Heat

1. Increased heart rate
2. Increased blood circulation to the skin

3. Evaporative cooling from sweating

The importance of acclimatization

1. Reduces risks of dehydration and salt loss
    a. Sweating and evaporative cooling becomes more efficient
    b. Salt loss becomes more efficient
2. Core body temperature maintained more efficiently
3. Reduces strain on the heart
    a. Blood circulation to the skin becomes more efficient
    b. Recovery heart rate improves
4. The human body needs to acclimate to hot environments, typically 10-14 days
    a. Gradually increase exposure to hot environment over 7-14 days
    b. Avoid prolonged exertion during the hottest times of day
    c. Schedule heavy exertion for cooler parts of the day
5. Acclimatized workers will need 2-3 days of re-acclimatization if they stop working under heat-stress conditions for more than a week.

The importance of consuming water throughout the work shift

1. One cup (8 oz.) of cool water or an electrolyte replacement fluid every 15-20 minutes; four cups of water every hour.
2. Increased water intake may be needed to account for increased physical exertion and/or sweating.
3. However, too much water intake can be dangerous and lead to headache, nausea, vomiting, and/or mental confusion.
4. Physiological monitoring may be necessary under extreme conditions
    a. If sweat is not trapped within clothing, then we can monitor body weight, which should not drop below 1.5% of the starting body weight.
    b. Urine color is another indicator of potential dehydration.
        i. Normal urine should be pale yellow.
        ii. Use a urine color chart to help determine if you are properly hydrated. Some diets, medications, and illnesses may affect results.

The importance of rest breaks and shade throughout the work shift

1. Prolonged physical exertion and muscle activity will increase the body's core temperature and reduce the body's ability to cool itself. Short rest breaks are necessary to allow blood to flow to the skin to be cooled.
2. Rest breaks slow down the buildup of heat in the body from prolonged muscle activity.
3. Rest breaks are also important for the heart and allow your heart rate to recover from sustained heat stress and physical exertion.
4. Rest breaks in the shade help with cooling, especially if there is air movement with cool air.

Heat-Related Illnesses

The following information needs to be covered in training on heat-related illnesses, including the cause, preventative measures, signs and symptoms, first aid treatment, and reporting requirements.

Heat Rash

1. Cause: Irritation of skin due to excessive sweating
2. Preventative measures:
    a. Wear loose-fitting clothing that allows sweat to dissipate
    b. Wear freshly laundered clothing each day
    c. Avoid working in sweat-soaked clothing for prolonged periods (e.g., changing clothing at breaks as needed)
    d. Wash sweat-soaked areas with mild soap and water and dry thoroughly at breaks and after your shift ends
3. Signs and symptoms:
    a. Itchy and painful clusters of red blisters
    b. Common to the neck, chest, groin, armpits, and creases of the elbows and knees
4. First aid treatment:
    a. Move the person to a cool location
    b. Have the person take a cool shower
    c. Thoroughly dry the skin following shower

    d. Continue to ensure skin is cleaned and dried frequently, especially before and after shifts
    e. Seek medical treatment if the rash persists for more than two days or if the rash becomes infected
5. Reporting: Report to supervisor and safety manager

Heat Cramps

1. Cause: Depletion of salt and water in the body due to excessive sweating. This is a precursor to more serious heat exhaustion and/or heat stroke.
2. Preventative measures:
    a. Acclimatization to heat helps reduce salt and water loss
    b. Drink adequate amounts of water throughout the day
    c. Salt your food to taste
3. Signs and symptoms:
    a. Muscle cramps, spasms, and/or pain
    b. Common to major muscles used for work (e.g., arms, legs, abdominal and back muscles)
4. First aid treatment:
    a. Move the person to a cool location
    b. Provide the person with an electrolyte replacement fluid to replace lost salt and water
    c. Seek medical treatment if cramps persist or other heat-illness symptoms develop (e.g., elevated body temperature, elevated heart rate, headache, dizziness, etc.)
5. Reporting: Report to supervisor and safety manager

Heat Syncope

1. Cause: Prolonged standing or sudden rising from a sitting or resting (supine) position; dehydration can be a contributing factor
2. Preventative measures:
    a. Acclimatization to heat helps reduce dehydration
    b. Drink adequate amounts of water throughout the day
    c. Break up long periods of standing with small rest breaks
    d. Rise slowly from sitting or resting positions
3. Signs and symptoms:

a. Light-headedness or dizziness
b. Fainting

4. First aid treatment:
    a. If he/she is only slightly dizzy and able to move, have two people assist and carefully move to a cool location and have the person lay down on their back with feet elevated above heart level; provide small amounts of water
    b. If the dizziness persists, request immediate first aid and/or medical attention
    c. If he/she faints, then secure the area, elevate his/her feet above heart level, and request immediate first aid and/or medical attention; do not allow him/her to get up quickly or walk about
5. Reporting: Report to supervisor and safety manager

Heat Exhaustion

1. Cause: The body's inability to cool itself, often due to a combination of several factors (e.g., high temperatures, humidity, physical exertion, dehydration, clothing that blocks sweat evaporation, and/or alcohol use). This is a serious condition that can lead to a life-threatening heat stroke.
2. Preventative measures:
    a. Acclimatization to heat helps reduce dehydration
    b. Drink adequate amounts of water throughout the day
    c. Take small rest breaks in the shade to allow the body to recover from heavy physical exertion and heat exposure
    d. Protect skin against sunburn, which reduces the body's ability to cool itself
    e. If possible, perform heavier physical labor towards the cooler part of the day (e.g., early morning or evening)
3. Signs and symptoms:
    a. Elevated core body temperature of 100.4 to 102.2 °F (38 to 39 °C); oral temperature 99.6 to 101.4 °F
    b. Weak, but rapid pulse (elevated heart rate)
    c. Cool, moist skin (person may appear pale with clammy skin)
    d. Excessive sweating
    e. Headache and possible irritability

f. Fatigue or weakness
g. Dizziness and/or feeling faint
h. Nausea and/or vomiting
i. Decreased urine output

4. First aid treatment:
    a. Seek immediate medical care (call 911)
    b. Immediately help the person cool off
        i. Move the person to a cool location
        ii. Remove or loosen unnecessary clothing
        iii. Have them drink small amounts of cool water
        iv. Spray skin with cool water and fan rapidly to increase evaporation and cooling
        v. Monitor body temperature and continue cooling efforts until body temperature returns to a normal temperature below 99 °F (37 °C).
        vi. Implement additional heat stroke treatments if the body temperature does not decrease below 100 °F (37.8 °C) after 30 minutes or increases above 102 °F (38.9 °C).
5. Reporting: Report to supervisor and safety manager

Heat Stroke

1. Cause: The body is unable to cool itself and regulate core body temperature. This is a serious and life-threatening condition that requires immediate medical attention (call 911).
2. Preventable measures: Same as for heat exhaustion
3. Signs and symptoms:
    a. Elevated core body temperature above 104 °F (40 °C); oral temperature above 103.2 °F
    b. Hot, dry skin or heavy sweating
    c. Mental confusion, agitation, and/or irrational behavior
    d. Clumsiness
    e. Slurred speech
    f. Fainting or a loss of consciousness
    g. Seizures or convulsions

4. First aid treatment:
    a. Call 911 and seek immediate medical attention for the victim; do not wait as their life depends on getting immediate medical care.
    b. Provide immediate and aggressive cooling to their body
        i. Elevate feet above heart level
        ii. Remove or loosen unnecessary clothing
        iii. Pack ice in groin and armpit areas
        iv. Soak skin with cool water and fan rapidly and vigorously to increase cooling of the skin
        v. As an alternative, immerse them in a tub of cool water or spray the body with large amounts of cool water
        vi. Do not give the person fluids to drink, especially if unconscious.
        vii. Monitor body temperature and continue cooling efforts until body temperature returns to a normal temperature below 99 °F (37 °C).
    c. Administer CPR as needed, if blood circulation or breathing stops, until emergency medical services arrive
5. Reporting: Report to supervisor and safety manager

Rhabdomyolysis

1. Cause: Sometimes caused by a combination of heat stress and prolonged physical exertion, muscle starts to break down and die, releasing proteins and electrolytes into the bloodstream. This is a potentially life-threatening condition affecting the kidneys and requires immediate medical attention.
2. Preventative measures:
    a. Same as for heat exhaustion and heat stroke.
    b. Avoid overexertion, such as lifting objects heavier than you can comfortably lift or straining muscles to a point where they can no longer function properly.
    c. Those with diabetes, thyroid conditions, or muscular dystrophy are at greater risk.
    d. Those with a viral infection, such as flu, HIV, or herpes, are at greater risk.
    e. Use of alcohol and illegal drugs, such as heroin, cocaine, and amphetamines can increase the risk.
    f. Some medications, such as antipsychotics or statins, can increase

the risk.

3. Signs and symptoms:
    a. Muscle cramps, pain, and/or loss of range
    b. Joint pain and/or stiffness
    c. Swelling of muscles
    d. Weakness and a decreased ability to perform physical exertion for even a small amount of time
    e. Dark urine (similar to tea or cola in color)
    f. If kidney damage and/or failure occurs the following life-threatening indicators may be observed:
        i. Shortness of breath
        ii. Irregular heartbeat
        iii. Swelling in the legs and feet
        iv. Seizures
        v. Coma
4. First aid treatment:
    a. Seek immediate medical care for the victim (IV fluids and treatments to combat toxic proteins in the blood are needed to prevent kidney failure)
5. Reporting: Report to supervisor and safety manager

Heat-illness Prevention Strategies

When the Risk Level is High Incorporate Physiological Monitoring

1. Oral Temperature
    a. It is important to make sure the thermometer is stored in a cool environment and not exposed to temperatures above 95 °F.
    b. Readings should not be taken within 15 minutes of consuming hot or cool liquids and foods or if breathing heavy (mouth breathing).
    c. Oral temperatures should not exceed 99.5 °F.
    d. As a precautionary measure, when the oral temperature is elevated above 99.1 °F, adjust the work-rest schedule to increase the frequency and duration of rest breaks or take other preventative measures.
2. Heart Rate Recovery
    a. The method involves taking an initial pulse rate reading at the beginning of a scheduled rest break. With the worker sitting and resting, an initial pulse rate

reading is collected (P1) and if the pulse rate is above 110 bpm, then pulse rate readings are collected at a two-minute (P2) and four-minute (P3) interval.

b. If the pulse rate does not drop to below 110 bpm during the test, then this indicates heat stress conditions are above an acceptable level. The resting heart rate is too high, which indicates the work rate is too high for the individual.
c. With a starting pulse rate above 110 bpm, if the difference between two-minute intervals is less than 10 bpm, then this also indicates heat stress conditions are above an acceptable level. The heart rate is not effectively recovering at rest, which also indicates the work rate is too high for the individual. It could also indicate dehydration.
d. There can be variation among individuals, and some may exhibit much lower or higher resting pulse rates. A qualified medical provider should examine individuals with pre-work pulse rates above 100 bpm when at normal rest. High resting pulse rates could be indicative of an underlying medical condition.

3. Additional Measures to Help Reduce Dehydration
    a. Body Weight
        i. Assumes that the worker is wearing clothing that will allow sweat to evaporate from the skin and not be trapped within the clothing (e.g., chemical protective and impermeable suits can trap sweat).
        ii. Use a reliable scale that can read body weight within ± 0.25 lbs.
        iii. If body weight reduces by more than 1.5%, then the person is likely not taking in enough water to replace the water lost due to sweating.
    b. Urine Color
        i. Urine color can be a good indicator of potential dehydration, which can lead to heat stress and heat-related illnesses.
        ii. In some cases, underlying diseases, medications, or even some foods may affect urine color.
        iii. Check urine color against a color chart.
        iv. Normal urine should be pale yellow. A darker color indicates potential dehydration.

Engineering Controls

1. Reduce physical exertion and physical demands of work through the use of powered tools and equipment, especially for tasks involving heavy lifting.
2. Reduce radiant heat loading from the sun or other sources of radiant heat (e.g., furnaces, combustion engines and compressors, hot surfaces, heated transfer lines, windows receiving intense sun, etc.). One effective method is to place line-of-sight, reflective barriers between the heat source and workers. Another method is to insulate hot surfaces, such as furnaces.
3. If air temperatures are below 95 °F, then increase the air speed across the skin of workers using fans or air movers, to aid in evaporative cooling.
4. If air temperatures are above 95 °F, then reduce air speed across the skin of workers, to reduce convective heat transfer from air to the skin.
5. If humidity is below 50%, then evaporative coolers and portable fans with water mist systems can be used to effectively cool the air by about 10 to 20 °F.
6. Decrease humidity to below 50% to increase evaporative cooling from sweating.

Administrative Controls

1. Adjust the work schedule to ensure workers are acclimated to work in hot conditions.
2. Schedule work or work requiring heavy physical exertion during the coolest parts of the day.
3. Modify the work-rest schedule to shorten heat exposure periods by including frequent rest breaks. Shorter, more frequent breaks are more effective than longer, less frequent rest breaks.
4. Encourage adequate water intake at frequent intervals to prevent dehydration (e.g., one 8-ounce cup of cool water or an electrolyte replacement fluid every 15 to 20 minutes).
    a. The supervisor or foreman is responsible for making sure drinking water is provided, plus:
        i. Ensure that water containers are clean and sanitary prior to filling.
        ii. Ensure water containers are filled at a sanitary location.
        iii. Provide sufficient disposable cups and a place for disposing of cups.
        iv. Ensure workers do not share cups and dispose of used cups.
        v. Prohibit workers from opening the cooler top to fill cups and instead have workers use the provided spigot.

b. Pure and cool potable water must be made available to workers at no additional cost.
    i. Do not use water from irrigation, sprinklers, or firefighting systems.
    ii. Do not use water from a garden hose, as it may contain contaminants from the hose and/or bacteria and other microbes.
c. Water quantities need to be sufficient and at least 1 quart per worker per hour for the entire shift.
d. Locate water containers as close as practicable at all times.
e. Encourage workers to frequently drink water and not wait until thirsty.

5. Provide a shaded and/or air-conditioned space nearby for rest and water breaks.
6. Train workers on the recognition of the signs and symptoms of heat-induced illness and heat-illness prevention strategies.
7. Alert workers to extreme heat events or heat stress conditions and provide a short review of the heat-illness prevention strategies for the day.
8. Work in pairs (buddy system) and monitor each other for signs and symptoms of heat stress or illness.
9. Avoid caffeine and alcohol before and during working in a hot environment.
10. Report illnesses or medical conditions that may put them at risk of heat stress (e.g., diarrhea, fever, infection, etc.)
11. Medically screen for work in hot environments.

Protective Clothing and Equipment Controls

1. Provide clothing designed to keep the body cool, such as air, cooled fluid or ice-cooled conditioned clothing.
2. Provide reflective clothing to reduce radiant heat loading from the sun or hot surfaces radiating heat.
3. If air temperatures are below 95 °F and the worker is protected from radiant heat, then decrease clothing coverage or layers (when feasible) to increase evaporative cooling from the skin. Caution: Do not remove clothing designed to protect workers from chemical, mechanical, or other hazards without conducting a proper evaluation to address those hazards.
4. If air temperatures are above 95 °F, then increase clothing coverage to reduce air speed across skin of workers, which can help reduce convective heat transfer from air to the skin.

VII. MONITORING WEATHER AND WORKPLACE CONDITIONS

The Safety Manager and supervisors are responsible for monitoring the daily weather and workplace conditions to determine if workers will be exposed to temperatures greater than 70 °F (21 °C). The National Weather Service (www.weather.gov) should be used to monitor weather conditions. Public weather observation alternatives include Intellicast (www.intellicast.com) and Weather Underground (www.wunderground.com). Use the closest weather station to the worksite location.

If the temperatures are anticipated to exceed 70 °F (21 °C) for more than an hour during the work shift, then a heat hazard assessment needs to be performed. The following additional weather information is required for the heat hazard assessment.

- Air temperature (°F)
- Humidity (%)
- Wind speed (mph)
- Barometric pressure (inches)
- Longitude and latitude
- Cloud cover

VIII. HEAT HAZARD ASSESSMENT

When weather or workplace conditions are anticipated to exceed 70 °F (21 °C), a heat hazard assessment must be conducted to take into account environmental and work factors associated with heat stress and heat-related illnesses. Temperature, humidity, wind speed, and solar irradiance are environmental factors that must be taken into account.
Work factors include metabolic work rate (physical exertion) and clothing. These factors are all accounted for using an effective wet-bulb globe temperature (WBGT-Effective).

Use of a heat index, which only takes into account temperature and humidity, is not recommended. The heat index does not take into account wind speed, radiant heat, clothing and metabolic heat from physical exertion, which are all factors that can contribute to heat stress and heat-related illnesses.

Instead, WBGT-Effective and threshold limits established by NIOSH are used to assess risk and recommend effective heat stress controls. Further details and an example of this method are available in the OSHA Technical Manual, Section III, Chapter 4 on Heat Stress

(www.osha.gov) and the NIOSH Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments (www.cdc.gov/niosh). The following heat hazard assessment steps and guidelines are provided here and on the site-specific worksheet (Appendix A).

Step 1: Calculate WBGT Using Weather Data

Argonne National Laboratory (ANL) developed a calculator that uses validated and literature-supported algorithmic equations to determine WBGT from National Weather Service weather data. The calculator uses an outdoor WBGT model described by Dr. James C. Liljegren in the *Journal of Occupational and Environmental Hygiene*, published in August 2008. This product includes software produced by UChicago Argonne, LLC under Contract No. DE-AC02-06CH11357 with the Department of Energy. The calculator is available as a downloadable zip file from OSHA at:

http://www.osha.gov/dts/osta/otm/otm_iii/wbgtutil.zip

The calculator uses the following required weather and location information to determine WBGT:

a. Air Temperature (°F) during the hottest hour of the work shift
b. Barometric Pressure (inches of Hg)
c. Relative Humidity (%) during the hottest hour of the work shift
d. Wind Speed (mph) during the hottest hour of the work shift
e. Date (MONTH DAY, YEAR; e.g., January 1, 2019)
f. Time (HH:MM AM/PM; e.g., 12:00 PM) during the hottest hour of the work shift
g. Longitude and latitude (degrees) – input in "Options"
h. Solar Irradiance (W/m^2) based on Table 1 below, plus date, time of day, and location (longitude and latitude)

Table 1. Estimated Solar Irradiance Based on Cloud Cover

Reported Cloud Cover	Irradiance (W/m^2)
Sunny	990
Mostly Sunny, Partly Sunny/Cloudy Scattered Clouds	980
Mostly Cloudy	710
Cloudy	250

Source: OSHA as adapted from A. Ben Jemaa, et al. (2013) *Energy Procedia*, Volume 42, Pages 406-415.

The data entered into the calculator needs to be accurate to produce an accurate WBGT estimate. This includes time, date, longitude, latitude, and barometric pressure, as these are used to adjust irradiance before calculating the WBGT.

The end-result output that will be used in the next steps is the "Wet Bulb Globe Temperature" in units of °F. Record the WBGT and proceed to step two.

Step 2. Add Clothing Adjustment Factor

As recommended by OSHA, the ACGIH Clothing Adjustment Factor (CAF) can be determined from Table 2 below and added to the previous WBGT to produce an effective WBGT value, termed WBGT-Effective. The formula for determining the effective WBGT is:

$$WBGT\text{-}Effective = WBGT + CAF$$

Table 2. Clothing Adjustment Factors (CAF)

Clothing Worn	CAF (°F)
Work clothes (long sleeves and pants). Examples: Standard cotton shirt/pants.	0
Coveralls (w/only underwear underneath). Examples: Cotton or light polyester material.	0
Double-layer woven clothing.	5.4
SMS (spunbond/meltblown/spunbond) Polypropylene Coveralls	0.9
Polyolefin coveralls. Examples: Micro-porous fabric (e.g., Tyvek™).	1.8
Limited-use vapor-barrier coveralls. Examples: Encapsulating suits, whole-body chemical protective suits, and firefighter turn-out gear.	19.8

Source: OSHA Technical Manual as adopted from ACGIH "2017 TLVs and BEIs" and converted to °F.

Step 3. Determine the Metabolic Heat

Select a work category in Table 3 that best represents the workload using the provided examples as a guide. Select the heaviest workload activity to account for the highest metabolic heat for use in the next step, which will help ensure proper controls are in place to protect workers.

Using guidelines provided by OSHA, the formula below was used to adjust the estimated metabolic heat (MH) for body weight.

$$MMMM = \frac{MMEEEEMMMMMMMMEEEEE\ hhEEMMEE\ (EEnn\ WWMMEEEEWW) \times WWMMWWWWEEWW\ MMMMbbbb\ wwEEEEwwhhEE\ (EEnn\ MMMMWW.)}{111111\ MMMMWW.}$$

Table 3. Work Category Based on Metabolic Work Rates

Work Category	Examples	Estimated Metabolic Heat (Watts) for 154 lb. Person	Estimated Metabolic Rate (Watts) for 200 lb. Person	Estimated Metabolic Heat (Watts) for 250 lb. Person	Estimated Metabolic Heat (Watts) for 300 lb. Person
Light	Sitting, standing, light arm/hand work, and occasional walking	233	303	377	454
Moderate	Normal walking, moderate lifting	349	454	565	**681***
Heavy	Heavy material handling, walking at a fast pace	465	**605***	**753***	**907***
Very Heavy	Pick and shovel work	580	**754***	**940***	**1131***

Adapted from OSHA Technical Manual, NIOSH Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments, *and* ACGIH "2017 TLVs and BEIs"

*** These activities are not recommended for persons of this body weight working under heat-stress conditions. Special precautionary measures must be taken to reduce physical exertion and continually monitor workers for physiological signs of heat stress (e.g., body temperature and/or heart rate).**

Step 4. Determine Exposure Threshold Limit

A NIOSH-recommended exposure limit (REL) is used to establish the exposure threshold for the implementation of workplace controls for heat stress in healthy workers already acclimated to work in hot environments. The NIOSH recommended alert level (RAL) is an exposure threshold for use with unacclimatized workers. Use the provided tables and/or formulas to determine the appropriate threshold for later comparison to the WBGT-Effective. If the WBGT-Effective exceeds the REL or RAL temperature, then controls must be implemented to protect workers from heat stress and heat-related illnesses.

Acclimated Workers: Recommended Exposure Limit (REL)

The formula for calculating the NIOSH REL in °F for acclimated workers working continuously without prolonged rest breaks, where MH is the metabolic heat in Watts, is:

$$RREERR = 11.88 \times (1166.77 - 1111.11\ WMMwww_{1111}\ MMMM) + 3333$$

When working for shorter intervals, workers may be able to work in higher temperatures without adverse heat-related health effects. The NIOSH REL is designed to take work/rest schedules into consideration, which are provided below. Use Tables 4 to 7 to determine the REL for different work/rest schedules, work categories and body weights.

Table 4. Recommended Exposure Limit (REL) for Continuous Work

Work Category	Example	REL for 154 lb. Person	REL for 200 lb. Person	REL for 250 lb. Person	REL for 300 lb. Person
Light	Sitting, standing, light arm/hand work, and occasional walking	85 °F	83 °F	81 °F	79 °F
Moderate	Normal walking, moderate lifting	81 °F	79 °F	77 °F	**75 °F ***
Heavy	Heavy material handling, walking at a fast pace	79 °F	**76 °F ***	**74 °F ***	**73 °F ***
Very Heavy	Pick and shovel work	77 °F	**74 °F ***	**72 °F ***	**71 °F ***

Adapted from NIOSH Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments *and* ACGIH "2017 TLVs and BEIs"

*** These activities are not recommended for persons of this body weight working under heat-stress conditions. Special precautionary measures must be taken to reduce physical exertion and continually monitor workers for physiological signs of heat stress (e.g., body temperature and/or heart rate).**

Table 5. Recommended Exposure Limit (REL) for 75% Work & 25% Rest Each Hour

Work Category	Example	REL for 154 lb. Person	REL for 200 lb. Person	REL for 250 lb. Person	REL for 300 lb. Person
Light	Sitting, standing, light arm/hand work, and occasional walking	87 °F	84 °F	82 °F	81 °F
Moderate	Normal walking, moderate lifting	84 °F	81 °F	79 °F	**78 °F ***
Heavy	Heavy material handling, walking at a fast pace	82 °F	**79 °F ***	**77 °F ***	**76 °F ***
Very Heavy	Pick and shovel work	79 °F	**77 °F ***	**75 °F ***	**73 °F ***

Adapted from NIOSH Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments *and* ACGIH "2017 TLVs and BEIs"

*** These activities are not recommended for persons of this body weight working under heat-stress conditions. Special precautionary measures must be taken to reduce physical exertion and continually monitor workers for physiological signs of heat stress (e.g., body temperature and/or heart rate).**

Table 6. Recommended Exposure Limit (REL) for 50% Work & 50% Rest Each Hour

Work Category	Example	REL for 154 lb. Person	REL for 200 lb. Person	REL for 250 lb. Person	REL for 300 lb. Person
Light	Sitting, standing, light arm/hand work, and occasional walking	89 °F	86 °F	84 °F	83 °F
Moderate	Normal walking, moderate lifting	86 °F	83 °F	81 °F	**80 °F ***
Heavy	Heavy material handling, walking at a fast pace	84 °F	**81 °F ***	**79 °F ***	**78 °F ***
Very Heavy	Pick and shovel work	81 °F	**79 °F ***	**77 °F ***	**75 °F ***

Adapted from NIOSH Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments *and* ACGIH "2017 TLVs and BEIs"

*** These activities are not recommended for persons of this body weight working under heat-stress conditions. Special precautionary measures must be taken to reduce physical exertion and continually monitor workers for physiological signs of heat stress (e.g., body temperature and/or heart rate).**

Table 7. Recommended Exposure Limit (REL) for 25% Work & 75% Rest Each Hour

Work Category	Example	REL for 154 lb. Person	REL for 200 lb. Person	REL for 250 lb. Person	REL for 300 lb. Person
Light	Sitting, standing, light arm/hand work, and occasional walking	90 °F	88 °F	86 °F	84 °F
Moderate	Normal walking, moderate lifting	88 °F	86 °F	84 °F	**82 °F ***
Heavy	Heavy material handling, walking at a fast pace	86 °F	**84 °F ***	**82 °F ***	**80 °F ***
Very Heavy	Pick and shovel work	84 °F	**82 °F ***	**80 °F ***	**78 °F ***

Adapted from NIOSH Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments *and* ACGIH "2017 TLVs and BEIs"

*** These activities are not recommended for persons of this body weight working under heat-stress conditions. Special precautionary measures must be taken to reduce physical exertion and continually monitor workers for physiological signs of heat stress (e.g., body temperature and/or heart rate).**

Unacclimated Workers: Recommended Alert Limit (RAL)

The formula for calculating the NIOSH RAL in °F for unacclimated workers working continuously without prolonged rest breaks, where MH is the metabolic heat in Watts, is:

$$RRCCRR = 11.88 \times (1155.55 - 1111.11\ WWMMww_{1111}\ MMMM) + 3333$$

When working for shorter intervals, workers may be able to work in higher temperatures without adverse heat-related health effects. The NIOSH RAL is designed to take work/rest schedules into consideration, which are provided below. Use Tables 8 to 11 to determine the RAL for different work/rest schedules and body weights.

Table 8. Recommended Alert Limit (RAL) for Continuous Work

Work Category	Example	REL for 154 lb. Person	REL for 200 lb. Person	REL for 250 lb. Person	REL for 300 lb. Person
Light	Sitting, standing, light arm/hand work, and occasional walking	80 °F	77 °F	74 °F	72 °F
Moderate	Normal walking, moderate lifting	75 °F	72 °F	70 °F	**68 °F ***
Heavy	Heavy material handling, walking at a fast pace	72 °F	**69 °F ***	**67 °F ***	**65 °F ***
Very Heavy	Pick and shovel work	70 °F	**67 °F ***	**64 °F ***	**62 °F ***

Adapted from NIOSH Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments *and* ACGIH "2017 TLVs and BEIs"

*** These activities are not recommended for persons of this body weight working under heat-stress conditions. Special precautionary measures must be taken to reduce physical exertion and continually monitor workers for physiological signs of heat stress (e.g., body temperature and/or heart rate).**

Table 9. Recommended Alert Limit (RAL) for 75% Work & 25% Rest Each Hour

Work Category	Example	REL for 154 lb. Person	REL for 200 lb. Person	REL for 250 lb. Person	REL for 300 lb. Person
Light	Sitting, standing, light arm/hand work, and occasional walking	82 °F	79 °F	77 °F	75 °F
Moderate	Normal walking, moderate lifting	78 °F	75 °F	73 °F	**71 °F ***
Heavy	Heavy material handling, walking at a fast pace	76 °F	**73 °F ***	**70 °F ***	**68 °F ***
Very Heavy	Pick and shovel work	73 °F	**70 °F ***	**68 °F ***	**66 °F ***

Adapted from NIOSH Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments *and* ACGIH "2017 TLVs and BEIs"

*** These activities are not recommended for persons of this body weight working under heat-stress conditions. Special precautionary measures must be taken to reduce physical exertion and continually monitor workers for physiological signs of heat stress (e.g., body temperature and/or heart rate).**

Table 10. Recommended Alert Limit (RAL) for 50% Work & 50% Rest Each Hour

Work Category	Example	REL for 154 lb. Person	REL for 200 lb. Person	REL for 250 lb. Person	REL for 300 lb. Person
Light	Sitting, standing, light arm/hand work, and occasional walking	84 °F	81 °F	79 °F	77 °F
Moderate	Normal walking, moderate lifting	81 °F	78 °F	76 °F	**73 °F ***
Heavy	Heavy material handling, walking at a fast pace	78 °F	**76 °F ***	**73 °F ***	**71 °F ***
Very Heavy	Pick and shovel work	77 °F	**74 °F ***	**72 °F ***	**69 °F ***

Adapted from NIOSH Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments *and* ACGIH "2017 TLVs and BEIs"

*** These activities are not recommended for persons of this body weight working under heat-stress conditions. Special precautionary measures must be taken to reduce physical exertion and continually monitor workers for physiological signs of heat stress (e.g., body temperature and/or heart rate).**

Table 11. Recommended Alert Limit (RAL) for 25% Work & 75% Rest Each Hour

Work Category	Example	REL for 154 lb. Person	REL for 200 lb. Person	REL for 250 lb. Person	REL for 300 lb. Person
Light	Sitting, standing, light arm/hand work, and occasional walking	86 °F	83 °F	80 °F	78 °F
Moderate	Normal walking, moderate lifting	83 °F	80 °F	78 °F	**76 °F ***
Heavy	Heavy material handling, walking at a fast pace	81 °F	**78 °F ***	**76 °F ***	**74 °F ***
Very Heavy	Pick and shovel work	80 °F	**77 °F ***	**75 °F ***	**73 °F ***

Adapted from NIOSH Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments *and* ACGIH "2017 TLVs and BEIs"

*** These activities are not recommended for persons of this body weight working under heat-stress conditions. Special precautionary measures must be taken to reduce physical exertion and continually monitor workers for physiological signs of heat stress (e.g., body temperature and/or heart rate).**

Step 5. Determine Risk Level

The risk level is assessed by comparing the WBGT-Effective to the REL for acclimated workers or RAL for unacclimated workers. If the WBGT-Effective exceeds the respective REL or RAL, then additional workplace controls are required to protect workers from heat stress and heat-related illnesses.

Acclimated Workers: Hazard Quotient

A hazard quotient (HQ) is used to evaluate the risk level for acclimated workers. The formula for HQ-Acclimated for use with acclimated workers is:

$$HQ\text{-}Acclimated = \frac{WBGT\text{-}Effective}{REL}$$

Interpretation of the HQ-Acclimated

If the HQ-Acclimated is below 1.0, then no heat stress hazard is anticipated, and workers should be able to perform duties without additional control measures. However, if the HQ-Acclimated exceeds 1.0, then it is anticipated that workers will be at risk of heat stress and heat-related illnesses. In these cases, multiple heat-illness prevention strategies (controls) must be implemented to adequately protect workers. The risk level determined in Table 12 can aid in the implementation of controls.

Unacclimated Workers: Hazard Quotient

A hazard quotient (HQ) is used to evaluate the risk level for unacclimated workers. The formula for HQ-Unacclimated for use with unacclimated workers is:

$$HQ\text{-}Unacclimated = \frac{WBGT\text{-}Effective}{RAL}$$

Interpretation of the HQ-Unacclimated

If the HQ-Unacclimated is below 1.0, then no heat stress hazard is anticipated, and workers should be able to perform duties without additional control measures. However, if the HQ-Unacclimated exceeds 1.0, then it is anticipated that workers will be at risk of heat stress and heat-related illnesses. In these cases, multiple heat-illness prevention strategies (controls) must be implemented to adequately protect workers. The risk level determined in Table 12 can aid in the implementation of controls.

Risk Level

Table 12 is a general guideline for use in determining the risk level for heat stress for both acclimated and unacclimated workers. The risk levels can be used to determine the adequacy of controls needed to protect workers.

Table 12. Risk Level for Acclimated and Unacclimated Workers

HQ	**< 1.0**	**1.0-1.02**	**1.03-1.04**	**1.04-1.07**	**> 1.07**
Risk Level	Low	Moderate	High	Very High	Severe

IX. HEAT-ILLNESS PREVENTION STRATEGIES

When the HQ is above 1.0, heat-illness prevention controls need to be implemented to protect workers. The heat-illness prevention strategies are broken down into five (5) steps:

1. First, implement controls aimed at reducing the hazard quotient (HQ).
2. Second, when the risk level is high, very high, or severe, then incorporate physiological monitoring (e.g., body temperature and/or heart rate) as a precautionary measure to identify heat stress before a more serious condition or illness arises.
3. Third, implement engineering controls to reduce heat stress conditions.
4. Fourth, implement administrative controls to address acclimatization issues and/or reduce heat stress conditions.
5. Fifth, provide workers with personal protective clothing and equipment to reduce heat stress conditions.

The heat-illness prevention strategies vary slightly for unacclimated workers. If workers have not worked in a hot environment within the previous week, then those workers must be placed in an acclimatization program designed to gradually acclimate them to work in a hot environment.

Step 1. Implement Controls to Reduce Hazard Quotient and Risk Level

The first step in the heat-illness prevention strategy is to evaluate those factors used in the heat hazard assessment and determine what changes could be made to reduce the hazard quotient (HQ) to a value below 1.0, a low-risk level. Examples of effective controls include:

1. Suspend activities during the hottest part of the day and change to work schedule to cooler times of the day. [HIGHLY EFFECTIVE]
2. Provide shade or shelter from the sun and eliminate solar irradiance to 0 Watts/m^2. [HIGHLY EFFECTIVE]

3. When feasible, eliminate the use of chemical vapor-barrier coveralls, such as encapsulating suits and whole-body chemical protective suits during the hottest parts of the day. [HIGHLY EFFECTIVE]
4. When feasible, eliminate double clothing layers. [HIGHLY EFFECTIVE]
5. When feasible, use mechanical and powered equipment to reduce worker physical exertion, especially heavy physical exertion. This includes the use of forklifts, hoists, earthmoving equipment (backhoes, loaders, and excavators), conveyors, portable power tools (e.g., rotary auger in place of hand shoveling), etc. [HIGHLY EFFECTIVE]
6. When feasible, change the work-rest schedule to ensure workers receive adequate rest breaks, which will decrease the accumulation of body heat. [MODERATELY TO HIGHLY EFFECTIVE]
7. If air temperatures are below 95 °F (skin temperature) and air velocities are less than 1-2 mph, then increasing the air velocity at workers using portable fans can be an effective control to increase cooling. Caution: If air temperatures are above 95 °F, then heat will be added to workers by convection, which puts them at risk of heat stress. [MODERATELY EFFECTIVE]
8. When feasible, adjust work clothing to lighter, more breathable cotton fabrics or change coveralls to a more breathable material. [SLIGHTLY EFFECTIVE]

Step 2. When the Risk Level is High Incorporate Physiological Monitoring

When the risk level is high, very high, or severe, then it is important to incorporate physiological monitoring (e.g., body temperature and/or heart rate) as a measure to identify heat stress before a more serious condition or illness arises. At a minimum, either body temperature or recovery heart rate should be monitored. Body weight is recommended to ensure workers are properly hydrated.

Oral Body Temperature

Oral temperature is inexpensive, reliable, and easy to obtain in the field. It is important to use a reliable and accurate clinical thermometer and to use the thermometer

according to the manufacturer's instructions. Disposable oral thermometers are available and can be an inexpensive solution; however, readings will take longer (e.g., 3-4 minutes). Some digital oral thermometers can deliver accurate readings in as little as 30 seconds. It is important to make sure the thermometer is stored in a cool environment and not exposed to temperatures above 95 °F. In addition, the reading should not be taken within 15 minutes of consuming hot or cool liquids and foods or if the worker is breathing heavily (mouth breathing).

The generally accepted and recommended guideline is that worker oral temperatures should not exceed 99.5 °F. As a precautionary measure, when the oral temperature is elevated above 99.1 °F, adjust the work-rest schedule to increase the frequency and duration of rest breaks or take other preventative measures.

Follow the guidelines in Table 13 for collecting and interpreting oral temperatures.

Table 13. Collection and Interpretation of Oral Temperatures

STEP	Instructions
Schedule times for collection of oral temperature	During the hottest times of the workday, collect oral temperatures at least every hour. Under severe conditions, the cycle should be at least every 30 minutes.
Collect oral temperature	If the worker is not breathing heavily (mouth breathing), then collect oral temperature at scheduled rest breaks, before consumption of water or fluids. If the worker is breathing heavily, then have him/her first drink fluids and collect temperature at the end of a rest break, 15 minutes after drinking fluids.
Thermometer reading less than 99.1 °F	If the thermometer reading is less than 99.1 °F, then resume normal work activities and work-rest schedule.
Thermometer reading 99.2 to 99.5 °F	If the thermometer reading is 99.2 to 99.5 °F, then take precautionary measures to reduce heat stress (e.g., adjust the work-rest schedule or implement additional controls)
Thermometer reading above 99.5 °F	If the thermometer reading is above 99.5 °F, then suspend work and physical exertion within the hot environment and take immediate actions to cool body temperature (e.g., relocate to a cool environment with air movement and provide cool fluids). Monitor body temperature and continue cooling efforts until body temperature returns to a normal temperature below 99 °F. Seek medical attention if the worker exhibits additional signs of heat exhaustion or temperature does not drop or continues to elevate at rest.
Thermometer reading above 101.2 °F	If the thermometer reading is above 101.2 °F, then seek immediate medical attention and take immediate actions to cool his/her body temperature assuming potential heat stroke conditions (e.g., relocate to a cool environment with air movement, remove excess clothing, spray his/her body with cool water and fan vigorously, and pack ice in armpits and groin area).

Recovery Heart Rate (Pulse Rate)

If done properly, the recovery heart rate, as a pulse rate, is a good indicator of body temperature and heat stress. In addition, when a worker becomes dehydrated the volume of blood reduces and the heart rate can increase significantly. For simplicity, a modified Brouha method as described by NIOSH is recommended. The method involves taking an initial pulse rate reading at the beginning of a scheduled rest break. With the worker sitting and resting, an initial pulse rate reading is collected (P1) and if the pulse rate is above 110 bpm, then pulse rate readings are collected at a two-minute (P2) and four-minute (P3) interval. The general guidelines for interpretation are:

1. If the pulse rate does not drop to below 110 bpm (beats per minute) during the test, then this indicates heat stress conditions are above an acceptable level. The resting heart rate is too high, which indicates the work rate is too high for the individual.
2. With a starting pulse rate above 110 bpm, if the difference between two-minute intervals is less than 10 bpm, then this also indicates heat stress conditions are above an acceptable level. The heart rate is not effectively recovering at rest, which also indicates the work rate is too high for the individual. It could also indicate dehydration.

There can be variation among individuals, and some may exhibit much lower or higher resting pulse rates. The heart rate recovery evaluation is designed to account for this. However, a qualified medical provider should examine individuals with pre-work pulse rates above 100 bpm when at normal rest. High resting pulse rates could be indicative of an underlying medical condition.

Methods for Collecting Pulse Rate

The use of a reliable and accurate clinical pulse rate device for the finger, wrist, or chest is recommended. As the pulse rate will change with time, it is important to collect the pulse rate within a consistent and short interval (e.g., 5 to 10 seconds). Use the guidelines provided by the device manufacturer when collecting pulse rates.

The pulse rate can be collected manually by counting the pulses at the inner wrist just below the palm on the thumb or neck to the side of the windpipe over a 30-second timed interval (e.g., using a stopwatch). Use the index and middle fingers to detect a pulse and do not start counting until a reliable pulse can be detected. A slight amount of pressure may be necessary. The number of pulses is then multiplied by 2 to give the pulse rate in bpm.

Follow the guidelines in Table 14 for collecting and interpreting pulse rate and heart rate recovery.

Table 14. Collection and Interpretation of Pulse Rates

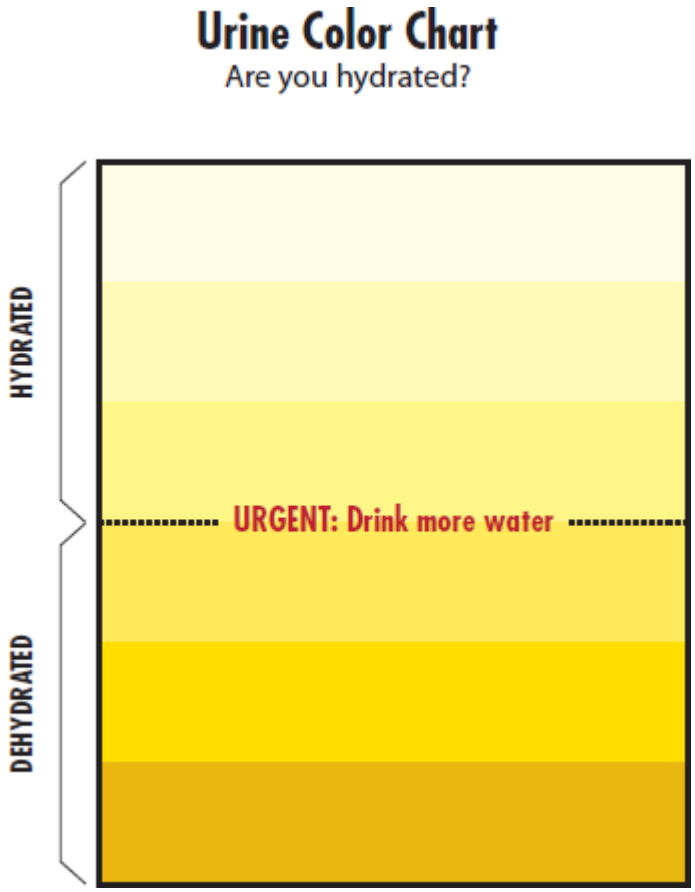
STEP	Instructions
Schedule times for collection of pulse rates	During the hottest times of the workday, collect pulse rates at least every hour. Under severe conditions, the cycle should be at least every 30 minutes. The pulse rate needs to be collected at the start of the rest break, within the first few minutes.
Collect the initial pulse rate (P1)	Have the worker sit on a stool or chair and rest. Collect the initial pulse rate within a few minutes after the worker has stopped working, at the start of the rest break.
If the pulse rate is below 110 bpm	If the pulse rate is below 110 bpm, then resume normal work activities and work-rest schedule.
If the pulse rate is above 110 bpm	If the pulse rate is above 110 bpm, then evaluate heart rate recovery by collecting two additional pulse rate measurements at two-minute intervals.
If the difference between 2-minute intervals is greater than 10 bpm and the pulse rate drops below 110 bpm	If the difference between 2-minute intervals is greater than 10 bpm and the pulse rate drops below 110 bpm, then resume normal work activities and work-rest schedule.
If the difference between 2-minute intervals is less than 10 bpm	If the difference between 2-minute intervals is less than 10 bpm, then suspend work and physical exertion within the hot environment and take immediate actions to cool his/her body temperature (e.g., relocate to a cool environment with air movement and provide cool fluids). Monitor pulse rate and/or body temperature and continue cooling efforts until pulse rate drops below 90 bpm or body temperature returns to a normal temperature below 99 °F. Seek medical attention if worker exhibits additional signs of heat exhaustion or pulse rate and/or temperature do not drop or continue to elevate at rest.
Re-check pulse rate after 10 minutes	If the resting pulse rate remains above 110 bpm after 10 minutes of rest, then seek immediate medical attention and take immediate actions to cool his/her body temperature assuming potential heat stroke conditions (e.g., relocate to a cool environment with air movement, remove excess clothing, spray his/her body with cool water and fan vigorously, and pack ice in armpits and groin area).

Monitoring Weight Loss – In Addition to Body Temperature or Heart Rate Recovery

Weight loss is a good indicator of potential dehydration, which can lead to heat stress and heat-related illnesses. However, it is not a good indicator of heat stress or illness in itself. Having workers check their body weight during rest breaks can be an effective way for them to monitor water intake during work that involves physical exertion. As a general rule, when using a reliable scale that can read body weight within ± 0.25 lbs., if a worker loses more than 1.5% of their body weight then he/she is likely not taking in enough water to replace the water lost due to sweating. This assumes that the worker is wearing clothing that will allow sweat to evaporate from the skin and not be trapped within the clothing (e.g., chemical protective and impermeable suits can trap sweat).

Monitoring Urine Color – In Addition to Body Temperature or Heart Rate Recovery

Urine color can be a good indicator of potential dehydration, which can lead to heat stress and heat-related illnesses. However, it is not a good indicator of heat stress or illness in itself. In some cases, underlying diseases, medications, or even some foods may affect urine color. Having workers check their urine color against a color chart can help them monitor water intake during work that involves physical exertion. Normal urine should be pale yellow. The urine chart below can be used to help a worker determine if he/she is properly hydrated. Some diets, medications, and illnesses may affect results.



Source: NIOSH Occupational Exposure to Heat and Hot Environments (2016)

Step 3. Implement Engineering Controls

When the risk level is moderate or above, implementation of effective engineering controls is recommended over administrative or protective clothing controls. The following are examples of effective engineering controls.

1. Reduce physical exertion and physical demands of work through the use of powered tools and equipment, especially for tasks involving heavy lifting.
2. Reduce radiant heat loading from the sun or other sources of radiant heat (e.g., furnaces, combustion engines and compressors, hot surfaces, heated transfer lines, windows receiving intense sun, etc.). One effective method is to place line-

of-sight, reflective barriers between the heat source and workers. Another method is to insulate hot surfaces, such as furnaces.

3. If air temperatures are below 95 °F, then increase air speed across the skin of workers using fans or air movers, to increase evaporative cooling from the skin.
4. If air temperatures are above 95 °F, then reduce air speed across skin of workers, to reduce convective heat transfer from air to the skin.
5. If humidity is below 50%, then evaporative coolers and portable fans with water mist systems can be used to effectively cool the air by about 10 to 20 °F.
6. Decrease humidity to below 50% to increase evaporative cooling from sweating.

Implement Administrative Controls

When the risk level is moderate or above, then implementation of effective administrative controls is recommended when effective engineering controls are not feasible. Additionally, unacclimated workers must be placed in an acclimatization program designed to gradually acclimate them to work in a hot environment. This includes workers who have not previously worked in a hot environment within the previous week.

Acclimatization Program

The goal of an acclimatization program is to gradually increase exposure time under hot environmental conditions over 7 to 14 days. This allows the body to adjust to the hot conditions, which will result in more efficient and evaporative cooling, a more efficient heart rate recovery, and less stress on the heart. Use the following guidelines for acclimating workers to work under hot conditions.

1. For new workers on day one, schedule less than 20% of the work duration in the hot environment and then increase to no more than 20% each day. As an example, for an 8-hour work shift:
    a. On day one, schedule no more than 1.6 hours under hot conditions.
    b. On day two, schedule no more than 3.2 hours under hot conditions.
    c. On day three, schedule no more than 4.8 hours under hot conditions.
    d. On day four, schedule no more than 6.4 hours under hot conditions.
    e. On day five, schedule no more than 8 hours under hot conditions.
2. For workers with experience on the job, on day one schedule less than 50% of the work duration in the hot environment, 60% on day two, 80% on day three, and

100% on day four. As an example, for an 8-hour work shift:

a. On day one, schedule no more than 4 hours under hot conditions.
b. On day two, schedule no more than 4.8 hours under hot conditions.
c. On day three, schedule no more than 6.4 hours under hot conditions.
d. On day four, schedule no more than 8 hours under hot conditions.

Administrative Controls

The following are examples of effective administrative controls.

12. Schedule work or work requiring heavy physical exertion during the coolest parts of the day.
13. Modify the work-rest schedule to shorten heat exposure periods by including frequent rest breaks. Shorter, more frequent breaks are more effective than longer, less frequent rest breaks.
14. Encourage adequate water intake at frequent intervals to prevent dehydration (e.g., one 8-ounce cup of cool water or an electrolyte replacement fluid every 15 to 20 minutes).
    a. The supervisor or foreman is responsible for making sure drinking water is provided, plus:
        i. Ensure that water containers are clean and sanitary prior to filling.
        ii. Ensure water containers are filled at a sanitary location.
        iii. Provide sufficient disposable cups and a place for disposing of cups.
        iv. Ensure workers do not share cups and dispose of used cups.
        v. Prohibit workers from opening the cooler top to fill cups and instead have workers use the provided spigot.

b. Pure and cool potable water must be made available to workers at no additional cost.
    i. Do not use water from irrigation, sprinklers, or firefighting systems.
    ii. Do not use water from a garden hose, as it may contain contaminants from the hose and/or bacteria and other microbes.
c. Water quantities need to be sufficient and at least 1 quart per worker per hour for the entire shift.
d. Locate water containers as close as practicable at all times.
e. Encourage workers to frequently drink water and not wait until thirsty.

15. Provide a shaded and/or air-conditioned space nearby for rest and water breaks.
16. Train workers on the recognition of the signs and symptoms of heat-induced illness and heat-illness prevention strategies.
17. Alert workers to extreme heat events or heat stress conditions and provide a short review of the heat-illness prevention strategies for the day.
18. Have workers work in pairs (buddy system) and monitor each other for signs and symptoms of heat stress or illness.
19. Instruct workers to avoid caffeine and alcohol before and during working in a hot environment.
20. Instruct workers to report illnesses or medical conditions that may put them at risk of heat stress (e.g., diarrhea, fever, infection, etc.)
21. Medically screen workers for work in hot environments.

Implement Personal Protective Clothing and Equipment Controls

If engineering and/or administrative controls are not feasible, then personal protective clothing and equipment should be used to reduce heat stress conditions. The following are examples of effective personal protective clothing and equipment controls.

1. Provide clothing designed to keep the body cool, such as air, cooled fluid, or ice-cooled conditioned clothing.
2. Provide reflective clothing to reduce radiant heat loading from the sun or hot surfaces radiating heat.
3. If air temperatures are below 95 °F and the worker is protected from radiant heat, then decrease clothing coverage or layers (when feasible) to increase evaporative cooling from the skin. Caution: Do not remove clothing designed to protect workers from chemical, mechanical, or other hazards without conducting a proper evaluation

to address those hazards.

4. If air temperatures are above 95 °F, then increase clothing coverage to reduce air speed across skin of workers, which can help reduce convective heat transfer from air to the skin.

X. MEDICAL EMERGENCIES

When workers are exposed to heat stress conditions, it is critical to ensure adequate supervision, first aid and medical services are readily available in the event a worker suffers from a heat illness. This includes ensuring adequate first aid supplies are available, and supervisors and workers are trained on what to do if a co-worker suffers from a heat-related illness.

First Aid Supplies

The following first aid supplies for heat-induced illnesses need to be on hand.

1. Reliable oral thermometer for checking body temperature.
2. Reliable instrument or timer for checking heart rate.
3. Cool water or electrolyte replacement fluids.
4. Cold packs or ice packs for treatment of heat stroke.
5. Spray bottles with water or an available water source for treating heat stroke.

First Aid Providers

Each work site should have at least one person trained to administer first aid, with two or more preferred. The location, physical address, and phone number of the nearest hospital or emergency medical services must be obtained prior to the beginning of work activities under hot conditions. The following emergency response information must be obtained prior to the beginning of work activities.

1. Names, locations, and phone numbers of all first aid trained supervisors or key personnel on-site.
2. Phone numbers for on-site or local medical emergency services.
3. Address, phone number, and directions from site to closest emergency medical services (e.g., hospital).
4. Physical address and detailed directions for emergency medical services. If the site is a remote location, then check with emergency medical services to ensure they can

find the location. Some providers may require GPS coordinates.

First Aid Guidelines

See Section VI Training for the general first aid guidelines for heat-related illnesses, for supervisors and workers. It is important that all supervisors and workers know how to recognize the signs and symptoms of heat stress, know when to call for emergency medical assistance, and understand what steps they need to take to help the victim of heat stress until emergency services arrive.

XI. ENFORCEMENT

Constant awareness of and respect for heat stress hazards, and compliance with all safety rules are considered conditions of employment. The supervisor, as well as individuals responsible for safety and personnel, reserve the right to issue disciplinary warnings to employees, up to and including termination, for failure to follow the guidelines of this program.

XII. INCIDENT INVESTIGATIONS

All incidents that result in a worker suffering from a heat-related illness, regardless of their nature, shall be investigated and reported to management. It is an integral part of any safety program that documentation takes place as soon as possible so that the cause and means of prevention can be identified to prevent a reoccurrence. A Worksite Incident Form is provided in the Appendix. The form is to be completed and used to initiate an incident investigation with the goal of taking corrective actions to prevent future occurrences.

If an employee suffers from a heat-related illness, or some other related, serious incident occurs, this plan shall be reviewed to determine if additional practices, procedures, or training need to be implemented to prevent similar types of incidents from occurring.

VIII. CHANGES TO PLAN

The Safety Manager will review and approve any changes to the plan. The Safety Manager shall review this plan at least annually to determine if additional practices, procedures or training needs to be implemented to improve heat-illness prevention measures. Workers shall be notified and trained, if necessary, in the new procedures. A copy of this plan and all approved changes shall be maintained at the job site.

APPENDIX A: JOB-SPECIFIC HEAT-ILLNESS PREVENTION PLAN

This plan is specific to the following project, in accordance with company policies and procedures as outlined in the Heat-Illness Prevention Plan:

Description	**Details**
1. Location of Job and Address (attach detailed directions as needed)	
2. Date Prepared or Modified	
3. Plan Prepared By	Name:
	Phone:
4. Plan Approved By	Name:
5. Plan Supervised By	Name:
	Phone:
6. First Aid and Emergency Medical Services Contacts	First Aid Name(s): Phone: Alternate Phone: Emergency Medical Services: Phone: Local Hospital: Phone:

Identified Heat Stress Hazards

Check those that apply:

1. Outside work with sun exposure and temperatures above 70 °F _____
2. Work around hot processes and/or radiant heat sources _____
3. Workers will wear vapor barrier chemical protective suits _____
4. Work under high relative humidity conditions (e.g., greater than 50%) _____
5. Low wind speeds or lack of air movement _____
6. Manual labor and tasks requiring physical exertion _____
7. Workers not acclimated to work in hot environments _____
8. Workers wearing multiple layers of clothing _____
9. Other: _____ _____
10. Other: _____ _____

Does a Heat Hazard Evaluation Need to be Conducted?

Conduct a Heat Hazard Assessment if the answer is "YES" to any of the following:

Condition	NO	YES
Items 1, 2, or 3 were checked above.		
More than two of the above items were checked.		
There is a valid concern regarding heat stress. (*Make note below*)		
Concern:		

Heat Hazard Assessment

Use the National Weather Service data and Argonne Heat Stress Calculator to determine the WBGT for the hottest 1-2 hours of work.

Parameter (Units of Measure)	**Initial Value**	**After Controls Have Been Initiated to Reduce HQ**
Air temperature (°F)		
Relative Humidity (%)		
Barometric Pressure (inches Hg)		
Wind speed (mph)		
Cloud Cover & Resulting Solar Irradiance (Watts/m^2)		
Date (Month, Day, and Year)		
Hottest Time of Day (Hour, Minute, and AM/PM)		
Latitude (°N)		
Longitude (°W)		
Resulting WBGT (°F)		
Clothing Adjustment Factor (CAF)		
WBGT-Effective (°F) = WBGT + CAF		
Determine Work Demands and Metabolic Heat		
Relevant REL or RAL (°F)		
Hazard Quotient (HQ)		
Risk Level		

Corrective Actions that will be taken to Prevent Heat Stress

Step 1: Implement Controls to Reduce Hazard Quotient and Reduce Risk Level

a. Action: _____

b. Action: _____

c. Action: _____

d. Revised Risk Level: _____

Step 2: Implement Physiological Monitoring for High-Risk Levels

a. _____ Oral Body Temperature

b. _____ Heart Rate Recovery

c. Added _____ Body Weight or _____ Urine Color Monitoring for Dehydration

Step 3: Implement Engineering Controls

a. Action: _____

b. Action: _____

c. Action: _____

Step 4: Implement Administrative Controls

a. Action: _____

b. Action: _____

c. Action: _____

Step 5: Implement Protective Clothing or Equipment Controls

a. Action: _____

b. Action: _____

c. Action: _____

APPENDIX B: WORKSITE INCIDENT FORM

This Worksite Incident Form is to be completed and turned in to the employer following any cases of heat-related illness. No matter how serious the illness (e.g., heat cramps or increased resting heart rate), it should be reported to facilitate an investigation and ensure a more serious incident does not occur later. The goal of the investigation of the incident is to take necessary corrective actions to prevent further occurrences.

Worker Name:_____ Date: _____

Worker Job Title:_____ Time: _____

Job Location: _____

Location of incident: _____

WBGT-Effective _____°F and (circle one) REL / RAL _____°F

HQ _____and Risk Level _____

Were you able to interview the worker? ___ Yes ___ No

How many witnesses did you interview? ___

Names and titles of all witnesses interviewed: _____

_____

_____

Provide a detailed description of the incident. Include relevant events leading up to, during, and after the incident.

_____

_____

_____

_____

_____

_____

Identify and describe any of the factors that contributed to the incident below:

1. Failure to follow safety procedures

2. Faulty equipment, machinery or tools

3. An unidentified heat stress hazard(s)

4. The work environment and conditions

5. Environmental conditions (e.g., weather)

6. Improper work procedures

7. Lack of proper training

Recommend corrective actions that should be initiated to prevent future incidents:

_____

_____

_____

_____

Preparer Name: _____

Preparer Signature: _____ Date: _____