Wisconsin Contractors Institute

HEAT SAFETY FOR CONTRACTORS

Course Number 23719
2 CE Hours

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OVERVIEW

This course will address working in both outdoor and indoor heat environments, because millions of U.S. workers are exposed to heat in their workplaces. Although illness from exposure to heat is preventable, every year, thousands become sick from occupational heat exposure, and some cases are fatal. Most outdoor fatalities, 50% to 70%, occur in the first few days of working in warm or hot environments because the body needs to gradually tolerate over time. The process of building tolerance is called heat acclimatization. Lack of acclimatization represents a major risk factor for fatal outcomes.

Occupational risk factors for heat illness include heavy physical activity, warm or hot environmental conditions, lack of acclimatization, and wearing clothing that holds in body heat. Hazardous heat exposure can occur indoors or outdoors during any season if the conditions are right, not only during heat waves.

There are many industries where workers have suffered heat related injuries.

Outdoors:

- Agriculture
- Construction – especially road, roofing, and other outdoor work
- Construction – roofing work
- Landscaping
- Mail and package delivery
- Oil and gas well operations

Indoors:

- Bakeries, kitchens, and laundries (sources with indoor heat-generating appliances)
- Electrical utilities (particularly boiler rooms)
- Fire Service
- Iron and steel mills and foundries
- Manufacturing with hot local heat sources, like furnaces (e.g., paper products or concrete)
- Warehousing

Course Outcomes:

1. Define heat-related illness and the role employers, supervisors, and workers play in recognizing and preventing heat-related injury.
2. Describe proper acclimatization procedures and their direct impact on the health and safety or workers.
3. Analyze environmental and personal risk factors that contribute to heat illness, and discuss engineering controls that can reduce heat-related illness.

FINAL EXAM QUESTIONS:

1. **What percentage of outdoor fatalities occur on the first few days of working in warm or hot environments?**
   A. 10-20%
   B. 20-30%
   C. 30-40%
   D. 50-70%

2. **Why do outdoor fatalities from heat illness often occur within the first few days of work?**
   A. The body needs to gradually learn to tolerate heat over time
   B. Workers forget to drink water
   C. Supervisors often ignore the signs of illness
   D. Forecasts rarely predict the correct temperature

3. **The process of building tolerance is called heat _____.**
   A. Illness
   B. Stroke
   C. Acclimatization
   D. Socialization

4. **Occupational risk factors for heat illness include:**
   A. Heavy physical activity
   B. Working in warm or hot environments
   C. Wearing clothing that holds in body heat
   D. All the above

5. **True or false: both indoor and outdoor facilities can create environments that cause heat related injuries.**
   A. True
   B. False

6. **Which of the following is a key element of an effective heat illness prevention program?**
   A. Encouraging workers to skip breaks
   B. Ignoring symptoms of heat-related illnesses
   C. Training workers on heat stress prevention
   D. Avoiding any outdoor work during hot weather

PLANNING AND SUPERVISION

Heat-related illness can affect workers in many industries at indoor or outdoor worksites. Job-related risk factors include outdoor work in warm weather; heat sources, such as ovens, fire, or hot tar; strenuous physical activity; and heavy or non-breathable wok clothes. When these or other heat hazards are present, employers should plan to protect workers.

Heat Illness Prevention Plan

Employers should create a written plan to prevent heat-related illness. Important elements to consider when creating the heat plan are:

- Who will provide oversight daily?
- How will new workers gradually develop heat tolerance?
- Temporary workers may be more susceptible to heat and require closer supervision.
- Workers returning from extended leave (typically defined as more than two weeks) may also be at increased risk.

- How will the employer ensure that first aid is adequate and the protocol for summoning medical assistance in situations beyond first aid is effective?
- What engineering controls and work practices will be used to reduce heat stress?
- How will heat stress be measured?
- How can the National Weather Service respond to a heat advisory or heat warning?
- How will we determine if the total heat stress is hazardous?
- What training will be provided to workers and supervisors?

Everyday Supervision

Heat conditions can change rapidly, and management commitment to adjusting heat stress controls is critical to prevent heat illness. An individual at the worksite should monitor conditions and implement the employer's heat plan throughout the workday. This individual can be a foreman, job site supervisor, plant manager, safety director, or anyone with the proper training. Proper training includes knowing how to identify and control heat hazards, recognize early symptoms of heat stress, administer first aid for heat-related illnesses, and activate emergency medical services quickly when needed. Ideally, the individual responsible for the heat plan should be on-site where the workers are. On-site monitoring allows accurate determination of heat stress. The responsible individual at the site should be fully trained on the means and methods to contact and report to the employer any adverse heat-related conditions that may develop on the site and any signs and symptoms of heat-related illness experienced by any of the workers. The responsible individual in a central location should estimate heat stress using the best available methods for remote estimation.

Heat-Related Illnesses

Several heat-related illnesses can affect workers, and some of the symptoms are non-specific. This means that when a worker performs physical labor in a warm environment, any unusual symptom can be a sign of overheating.

Heat-Related Illness Signs and Symptoms

HEAT STROKE	HEAT EXHAUSTION
Confusion	Fatigue
Slurred speech	Irritability
Unconsciousness	Thirst
Seizures	Nausea or vomiting
Heavy sweating or hot, dry skin	Dizziness or lightheadedness
Very high body temperature	Heavy sweating
Rapid heart rate	Elevate body temperature or fast heart rate

Other signs and symptoms of heat-related illness:

- Heat cramps: muscle spasms or pain, usually in the legs, arms, or trunk.
- Heat syncope: dizziness or fainting.
- Heat rash: clusters of red bumps on the skin that often appears on the neck, upper chest, and skin folds.
- Rhabdomyolysis: muscle pain, dark urine or reduced urine output, or weakness.

Employers and workers should become familiar with the heat symptoms. When any of these symptoms is present, promptly provide first aid. Do not try to diagnose which illness is occurring. Diagnosis is often difficult because symptoms of multiple heat-related illnesses can occur together. Time is of the essence. These conditions can worsen quickly and result in fatalities. When in doubt, cool the worker and call 911.

Heat-Related First Aid

OSHA's Medical Services and First Aid standard and the Medical Service and First Aid in Construction require the ready availability of first aid personnel and equipment. First aid for heat-related illness involves the following principles:

- Take the affected worker to a cooler area (e.g., shade or air conditioning).
- Cool the worker immediately. Use active cooling techniques such as:
  - Immerse the worker in cold water or an ice bath. Create the ice bath by placing all available ice into a large container with water, which is standard practice in sports. This is the best method to cool workers rapidly in an emergency.
  - Remove outer layers of clothing, especially heavy protective clothing.
  - Place ice or cold wet towels on the head, neck, trunk, armpits, and groin.
  - Use fans to circulate air around the worker.
- Never leave a worker with heat-related illness alone.
- The illness can rapidly become worse.
- Stay with the worker.
- When in doubt, call 911!
- Confusion, slurred speech, or unconsciousness are signs of heat stroke. When these types of symptoms are present, call 911 immediately and cool the worker with ice or cold water until help arrives.

Workers new to working in warm environments are at increased risk of heat-related illness. All symptoms should be taken seriously, especially during a worker's first few days. Workers who develop symptoms should be allowed to stop working. They should receive an evaluation for possible heat-related illness.

Heat-related illnesses can be prevented. Prevention requires employers and workers to recognize heat hazards. Management should commit to:

- ➢ Take extra precautions to protect new workers.
- ➢ Train supervisors and workers to control and recognize heat hazards.
- ➢ Determine whether total heat stress is too high for each worker throughout each workday, from the day's conditions, and recognize carryover effect possibilities.
- ➢ Implement engineering and administrative controls to reduce heat stress.
- ➢ Provide sufficient rest, shade, and fluids.

Protecting New Workers

OSHA has found that almost half of heat-related deaths occur on a worker's very first day on the job (Arbury 2014). Over 70 percent of heat-related deaths occur during a worker's first week (Tustin 2018).

These tragedies can be avoided if employers take action to protect new workers. Throughout this section, the term "workers who are new to working in warm environments" includes the following groups:

- New, temporary, or existing employees who start new work activities in warm or hot environments, while wearing additional clothing (e.g., chemical protective clothing), or with increased physical activity.
- Workers returning to work environments with potential exposure to heat hazards after an absence of one week or more, for example, returning from any extended leave.
- Workers who continue working through seasonal changes when temperatures first increase in the spring or early summer.
- Workers who work on days when the weather is significantly warmer than on previous days (i.e., heat wave).

In all the examples above, the workers may not be used to the heat loads on that day. Because of physiological (i.e., related to body function and exertion) and/or behavioral factors, the above workers are at increased risk of heat-related illness.

FINAL EXAM QUESTIONS:

7. Which of the following is NOT an important element to consider when creating a heat plan?

A. Temporary workers are not as susceptible to heat and do not require closer supervision.
B. Who will provide oversight daily?
C. How will new workers gradually develop heat tolerance?
D. How will heat stress be measured?

8. True or false: it is not necessary for anyone to monitor heat conditions at a work site.

A. True
B. False

9. Which of the following individuals is suitable to monitor and implement an employer's heat plan at a work site?

A. A local weather forecaster
B. A sales representative for a construction equipment company
C. A teacher from a nearby institution
D. A job site supervisor or safety director with proper training

10. What is a crucial aspect of the individual responsible for overseeing the heat plan at a work site?

A. Their ability to predict long-term weather patterns accurately
B. Being fully trained to contact the employer and report adverse heat-related conditions
C. Having extensive experience in unrelated industries
D. Their proficiency in accounting software

11. Which of the following is a heat-related illness characterized by a high body temperature, confusion, and hot, dry skin?

A. Heat rash
B. Heat cramps
C. Heat exhaustion
D. Heat stroke

12. Which of the following is a sign or symptom of heat exhaustion?

A. Irritability
B. Seizures
C. Unconsciousness
D. Confusion

13. What is the recommended first aid response for a worker experiencing heat exhaustion?

A. Encourage them to continue working
B. Apply cold compresses to the skin
C. Administer pain medication
D. Move them to a cooler place, give fluids, and allow rest

14. In heat-related first aid, cooling techniques should be utilized. Which of the following is not an active cooling technique?

A. Immerse the worker in cold water or an ice bath
B. Remove outer layers of clothing
C. Offer a warm beverage
D. Use fans to circulate air

15. Which of the following is NOT a symptom of heat exhaustion?

A. Excessive sweating
B. Nausea
C. Dizziness
D. Dry, hot skin

16. **True or false: If there is any doubt whether someone is experiencing heat illness, it is best to cool the worker and call 911.**

A. True

B. False

17. **Prevention requires employers and workers to recognize heat hazards. Management should commit to providing sufficient rest, shade, and _____.**

A. Clothing

B. Fluids

C. Fans

D. Sunscreen

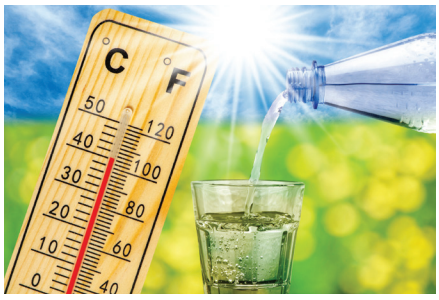
18. **Sam went on a family vacation for two weeks. Upon his return, his supervisor decides to perform extra check-ins with him because he is now considered to be new to the warm working environment. Is his supervisor correct in this decision?**

A. Yes

B. No

BUILDING HEAT TOLERANCE: ACCLIMATIZATION

The term "acclimatization" means that the body gradually adapts and tolerates higher levels of heat stress. Workers new to working in warm environments may not be acclimatized to heat because their bodies need time to adapt to working in hot conditions.



Acclimatization results from the following changes in the way the body works:

- Body produces more sweat → more evaporative cooling.
- Sweat contains less salt loss → less likely to develop electrolyte imbalances and heat cramps.
- Body is more efficient at getting rid of heat → slower heart rate and slower body temperature increase.
- More blood flows to the skin → more efficient cooling through the skin.

Other factors that differ from person to person (e.g., general physical fitness) may affect acclimatization.

Unacclimatized Workers do not sweat efficiently, and their sweat contains more salt. Their body temperature and heart rate increase more quickly when working. These workers' blood flow is not optimized for heat dissipation. In addition to the heat-specific acclimatization factors listed above, new workers may lack sufficient physical fitness. In *Acclimatized Workers*, sweating rate is higher, which helps dissipate heat through evaporative cooling. Their sweat contains less salt, which prevents the development of electrolyte imbalances. They also maintain lower body temperature and heart rate and have increased blood flow to the skin, which helps lose heat.

The first days of a new job or work activity can contain unique psychological and behavioral pressures. While every situation is different, some new workers may be at greater risk because they:

- Push their bodies excessively hard to demonstrate that they can do the work.
- Do not yet know how to perform physical tasks efficiently to conserve energy.
- Do not recognize the importance of taking breaks and drinking plenty of fluids.
- Ignore heat-related symptoms or continue working despite symptoms.
- Acclimatization, resting, drinking water, and finding shade takes time.
- Some new workers experience self-generated or external expectations and pressures.

To protect new workers from heat-related illness, employers should do the following:

- ✓ Schedule new workers to work shorter amounts of time in the heat, separated by breaks, in heat stress conditions.
- ✓ Give new workers more frequent rest breaks.
- ✓ Train new workers about heat stress, symptoms of heat-related illness, and the importance of rest and water.
- ✓ Monitor new workers closely for any symptoms of heat-related illness.
- ✓ Use a buddy system and don't allow new workers to work alone.
- ✓ If new workers talk about or show any symptoms, allow them to stop working. Initiate first aid. Never leave someone alone who is experiencing symptoms!
- ✓ These increased precautions should last for 1-2 weeks. After that time, new workers should be acclimatized to the heat and can safely work a normal schedule.

Lack of Acclimation

Can lack of acclimatization be problematic for workers not new to the job? The answer is: yes. New workers are not the only ones who might be unacclimatized. Workers can lose their heat tolerance during an extended absence (e.g., vacation or sick leave). They can also lose heat acclimatization during the winter when temperatures are cooler. Existing workers are at increased risk of heat-related illness in specific situations: returning to warmer work environments after an absence of one week or more, when temperatures first begin to increase in the spring or early summer, and whenever the weather is significantly warmer than on previous days. In each of these situations, employers should gradually allow workers to gain heat tolerance and use the same protection strategies that are used for new workers. Additional heat protections should be maintained for at least one week because unacclimatized workers who feel fine on their first day in warm conditions might develop heat-related illnesses on a subsequent day.

Work Duration for New Workers

New workers need time to acclimatize unless they have previously worked in hot environments. To prevent heat-related illnesses, they should work shorter workdays in the heat during their first 1-2

weeks. OSHA and NIOSH recommend the "Rule of 20 percent" for building heat tolerance:

- ***20 percent First Day:*** New workers should work only 20 percent of the normal duration on their first day.
- ***20 percent Each Additional Day:*** Increase work duration by 20 percent on subsequent days until the worker is performing a normal schedule.

For example, if the normal workday lasts 8 hours, then new workers should work no more than 1 hour and 40 minutes (20 percent of 8 hours) on their first day in the heat. They can spend the rest of the workday without heat stress. They should be given at least one rest break during their working period. By following the Rule of 20 Percent, new workers will work a full schedule by the end of their first week. The Rule of 20 Percent should protect the most physically fit workers with no medical problems. Other workers may sometimes require more time to adapt to heat – up to 14 days. When in doubt, give workers more days to acclimatize. As the duration of work increases, workers will need more rest breaks to recover from the heat load. To become acclimatized to heat, workers should perform tasks similar in intensity to their expected work. For example, if a new worker has been hired to lay bricks outdoors in hot weather, he should lay bricks during his first week. Doing light work may not acclimate a worker to their job's demands. Remember, to help workers build heat tolerance, reduce the work's duration but not the work's intensity.

Training and Heat Hazard Recognition

Supervisors and workers should be trained about heat hazards. They should also learn about prevention and first aid. Topics should include:

- Types of heat-related illness, including how to recognize common signs and symptoms.
- Importance of immediately providing first aid to affected workers.
- Procedures for contacting emergency medical services.
- Importance of protecting new "unacclimatized" workers. This includes work practices to help workers develop acclimatization.
- Job-related and personal risk factors for heat-related illness.
- Fluid replacement guidelines.
- Appropriate work/rest cycles (i.e., mandatory rest breaks) when heat stress is high.
- Importance of taking rest breaks in areas that are cooler than the worksite—for example, shade or air-conditioned rooms.
- Heat Hazard Recognition

Many factors have a role in creating an occupational heat stress risk for workers. These factors include:

- Environmental conditions (such as air temperature, humidity, sunlight, and airspeed), especially on sequential days.
- Heat sources (e.g., hot tar ovens or furnaces) exist in the work area.
- Level of physical activity, i.e., the workload leading to body heat production.
- Use of clothing or protective gear that can reduce the body's ability to lose excess heat.
- Individual/personal risk factors.
- Workload considerations are described at length in the OSHA Technical Manual. Common values given for categories of work are included in the table on Workload.

You should consider the above factors when evaluating heat stress risk to workers. Heat-related illness prevention starts by determining if a heat hazard is present in the workplace.

Two heat sources contribute to the risk of heat-related illness. Environmental heat is produced by warm or hot surroundings. Metabolic heat, generated by the body, is related to workload (physical activity). To determine workers' total heat stress, employers must assess both of the above heat sources. Employers should compare the total heat stress to published occupational heat guidance. This step allows employers to determine if the work conditions are too hot. Employers should be aware of any heat advisories from the National Weather Service. They should know that workers may experience heat stress at temperatures much lower than public heat advisories. Remember: Physical labor increases the heat experienced by workers. Sports physiologists recognize that heat-related illness may occur, surprisingly, at low to moderate temperatures, including below 65°F when workload is very heavy (Armstrong 2007).

FINAL EXAM QUESTIONS:

19. What is the purpose of acclimatization in the context of heat-related illness prevention?

A. To increase sensitivity to heat
B. To reduce the need for breaks
C. To help the body adapt to higher temperatures
D. To enhance resistance to cold temperatures

20. The term acclimatization means:

A. The body gradually adapts to and tolerates higher levels of heat stress
B. Researching and preparing for heat illness
C. Understanding variables that make environments more risky for heat illness
D. Rapidly introducing the body to extreme temperatures for long periods

21. Which of the following is NOT a change that occurs after acclimatization?

A. Body produces more sweat
B. Sweat contains less salt loss
C. Body is more efficient at getting rid of heat
D. Less blood flows to the skin

22. A specific worker does not sweat efficiently, and their sweat contains more salt. They are considered _____.

A. In training
B. Unacclimatized
C. Acclimatized
D. Efficient

23. Which of the following factors contributes to the increased risk of new workers for heat-related illnesses during the initial days of a new job or work activity?

A. Knowing how to perform physical tasks efficiently

B. Recognizing the importance of taking breaks and drinking fluids

C. Pushing their bodies to demonstrate that they can do the work

D. Being fully acclimatized to the heat

24. True or false: New workers should be placed on the same schedule as seasoned veterans so they can get used to the working conditions.

A. True

B. False

25. Which of these options contribute to loss of acclimatization?

A. Extended absence

B. Winter months

C. Vacation

D. All the above

26. How long should heat protections be maintained for unacclimatized workers who feel fine on their first day returning to work?

A. Protections can cease

B. Two days

C. Two weeks

D. One week

27. OSHA and NIOSH both recommend the "Rule of ___ Percent" for building heat tolerance.

A. 0

B. 10

C. 20

D. 30

28. According to work duration guidelines, if a new worker is in the 1-2 week acclimatization period and the work day is normally 8 hours, how long should they work on their first day in the heat?

A. 30 minutes

B. 1 hour, 40 minutes

C. 2 hours, 20 minutes

D. 4 hours

29. True or False: When becoming acclimatized to heat, the duration of work should be reduced, but not the intensity of work.

A. True

B. False

30. Which of the following topics is most relevant to heat hazard training for supervisors?

A. Job-related and personal risk factors for heat-related illness

B. How to read a weekly forecast

C. Effective management techniques in construction

D. Communication strategies

31. Which of the following is the least related to creating occupational heat stress risk for workers?

A. Use of clothing or protective gear

B. Level of physical activity

C. Willingness to work

D. Air temperature, humidity, sunlight, and airspeed

32. Two heat sources contribute to the risk of heat-related illness: environmental heat and _____ heat.

A. Ambient

B. Solar

C. Exertion

D. Metabolic

33. Studies have shown that sports physiologists find heat-related illnesses to occur at temperatures including below ____ when workload is very heavy.

A. 45°F

B. 55°F

C. 65°F

D. 75°F

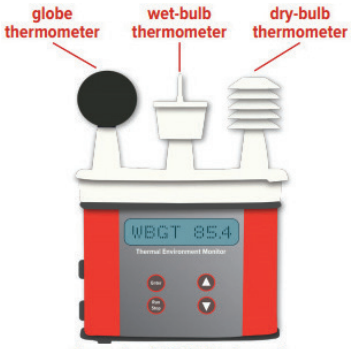
ENVIRONMENTAL HEAT

Environmental heat is more than just temperature. Four factors contribute to heat stress in workers:

1. Air temperature.
2. Humidity. High relative humidity makes it difficult for the body to cool itself through sweating.
3. Radiant heat from sunlight or artificial heat sources such as furnaces.
4. Air movement. In most situations, the wind helps workers cool off.

An environmental heat assessment should account for each factors. OSHA recommends the use of wet bulb globe temperature (WBGT) monitor to measure workplace environmental heat. WBGT devices contain three different thermometers:

- A dry bulb thermometer to measure the ambient air temperature.
- A natural wet bulb thermometer to measure the potential for evaporative cooling.
- A black globe thermometer to measure radiant heat.



Example of WBGT Equipment

The WBGT instrument should be placed close to the work location. For example, if the work is in direct sunlight, then the WBGT instrument should be in the sun. Employers should always follow the WBGT manufacturer's setup, calibration, and use instructions. WBGT has important advantages over other environmental heat measurements. One major advantage is that WBGT accounts for all four major environmental heat factors — temperature, humidity, radiant heat, and wind. In contrast, standard thermometers only assess one factor (air temperature).

Heat Index is another common way to measure heat stress. It is measured in the shade and combines air temperature and relative humidity to represent how hot the conditions feel at rest. The heat index does not account for the effects of wind, sunlight, radiant heat sources, or workload. Air (dry bulb) temperature also ignore relative humidity. All these factors can influence the total heat stress experienced by workers. Workplace environmental heat should be measured on-site using WBGT meters. The use of heat index is a less desirable substitute. While local weather reports based on meteorological data from observation stations can be useful, the readings from these stations may not reflect the conditions at the specific worksite. Heat conditions at the worksite may differ, from cloud cover and humidity to local heat sinks. The potential error increases with distance from the weather station. In addition to possible distance-based errors, weather reports can be inaccurate if the worksite has features that affect heat conditions. These features include:

- **Indoor Work —** A weather report cannot gauge conditions inside a building.
- **Direct Sunlight —** Weather services measure temperature and Heat Index in the shade. Work in the sun may be considerably hotter. Direct sunlight can increase Heat Index by up to 13.5°F (7.5°C).
- **Heat Sources —** Weather reports cannot account for the heat generated by fires, hot tar or other materials, ovens, other hot equipment, or heat-absorbing surfaces such as roads and roof surfaces.
- **Wind Blockage —** Some worksites may be hotter than surrounding areas because of structures that block air movement. Examples include trenches and bowl-shaped athletic stadiums.
- **Reflective Material —** Water, metal, or other materials can reflect sunlight onto workers.

At worksites with the above features, weather reports are unlikely to provide accurate estimates of environmental heat. Employers should use an on-site measurement such as WBGT. NIOSH, ACGIH, the U.S. military, and many athletic organizations recommend WBGT for measuring heat stress in workers and athletes. OSHA has compiled a set of tools that facilitate estimation of WBGT from historical weather data.

The Heat Index does not measure worksite heat as accurately as WBGT. Employers should not rely on Heat Index alone for the most accurate hazard assessment. Some employers may find the Heat Index helpful as part of a more comprehensive workplace hazard assessment. Outdoor workers have died of heat stroke when the day's maximum Heat Index was only 86°F. OSHA has found that less severe heat-related illnesses can happen at even lower Heat Index values. Employers who choose to monitor the Heat Index should be aware of the heat-related illness risk for workers below the national and local weather service heat advisory warnings for the general public. The NIOSH/OSHA Heat App uses the Heat Index, a screening tool. It does not replace a more accurate WBGT-based hazard assessment, which is the core tool occupational health professionals use (ACGIH 2017, NIOSH 2016).

FINAL EXAM QUESTIONS:

34. Which of the following is NOT listed as an environmental factor contributing to workers' heat stress?

A. Air temperature
B. Humidity
C. Radiant heat
D. Cloud cover

35. A wet bulb globe temperature (WBGT) monitor contains which of these thermometers?

A. Dry bulb thermometer
B. Natural wet bulb thermometer
C. Black globe thermometer
D. All the above

36. The natural wet bulb thermometer in a WBGT measures:

A. Ambient air temperature
B. Potential for evaporative cooling
C. Radiant heat
D. Humidity levels

37. True or false: One major disadvantage of the WBGT is that it accounts for all four major environmental heat factors.

A. True
B. False

38. Which of the following choices is considered a major environmental heat factor?

A. Humidity
B. Cloud cover
C. Rainfall total
D. Freeze potential

39. What common way to measure heat stress is measured in the shade and combines air temperature and relative humidity to represent how hot the conditions feel at rest?

A. Wet bulb
B. Ambient air temperature
C. Heat index
D. Outdoor thermometer

40. Some work sites may be hotter than surrounding areas because of structures that block air movement, known as:

A. Wind blockage
B. Reflective material
C. Heat sources
D. Cloud cover

PHYSICAL ACTIVITY LEVEL

To prevent a hazardous combination of environmental and metabolic heat, employers should be aware of workers' activity level. Workload can be classified as light, moderate, heavy, or very heavy.

- **Light:** Sitting or standing with minimal arm and leg work.
- **Moderate:** Continuous modest intensity, such as light pushing/pulling or normal walking.
- **Heavy:** Intense upper body work such as carrying loads or sawing.
- **Very Heavy:** Intense activity at an almost maximum pace.

Heavy and Very Heavy work carry the highest risk of heat-related illness.

Estimating each worker's workload is important. More protections are necessary for workers who do intense labor (e.g. labor activities that elevate a worker's heart rate and respiration rate through exertion). These workers should be given frequent rest breaks and work should be scheduled in the cooler part of the day. When in doubt about a worker's physical activity level, assume a higher workload or consult a qualified occupational safety and health professional. To figure out if heat stress is too high, employers should consider the job, the environment, and the worker. First estimate the workload. Next measure the environmental heat using WBGT or a similar method. If the worker is wearing clothes or protective equipment that can impair heat dissipation, then add clothing adjustment factors to the measured WBGT. This process yields an "effective WBGT." Determine whether the worker is acclimatized to heat or not. In general, assume that workers are unacclimatized if they have been doing the job for less than 1-2 weeks.

Determination of Whether Work is Too Hot

Use the following tables to determine whether the total heat stress is hazardous.

EFFECTIVE WBGT (°C)	UNACCLIMATIZED WORKERS	ACCLIMATIZED WORKERS
Below 70°F (21°C)	Low risk of heat-related illness	Low risk of heat-related illness
70 to 77°F (21 to 25°C)	Strenuous work possibly unsafe	Low risk of heat-related illness
Above 77°F (25°C)	High risk of heat-related illness with strenuous work	Strenuous work possibly unsafe

Some workers wear clothing that prevents heat dissipation. Examples include coveralls, costumes, or protective gear. These workers experience an "effective WBGT" that feels warmer than the measured ambient WBGT. To determine the effective WBGT for these workers, use the following table.

TYPE OF CLOTHING	CLOTHING ADJUSTMENT FACTOR
Normal work clothes (e.g., long sleeve shirt and pants)	0
Cloth (woven) coveralls*	0
SMS polypropylene coveralls*	0.9°F (0.5°C)
Polyolefin coveralls*	1.8°F (1°C)
Double layer of clothing	5.4°F (3°C)
Limited-use vapor-barrier coveralls*	19.8°F (11°C)

** Coveralls assume that only undergarments, not a second layer of clothing, are worn underneath.*

Table adapted from TLVs® and BEIs®.
Thermal stress: heat stress and heat strain. (ACGIH, 2017).

If Table 1 indicates that the heat stress is potentially unsafe, a more detailed hazard assessment is warranted. Use Table 2 or OSHA's Heat Stress Calculator to determine whether the total heat stress is too high.

WORKLOAD	LIMIT FOR UNACCLIMATIZED WORKERS (ACTION LIMIT)	LIMIT FOR ACCLIMATIZED WORKERS (THRESHOLD LIMIT VALUE)
	EFFECTIVE WBGT	
Light	28°C (82.4°F)	30°C (86°F)
Moderate	25°C (77°F)	28°C (82.4°F)
Heavy	23°C (73.4°F)	26°C (78.8°F)
Very Heavy	21°C (69.8°F)	25°C (77°F)

FINAL EXAM QUESTIONS:

41. Intense upper body work, such as carrying loads or sawing, is considered ____ workload.

A. Light
B. Moderate
C. Heavy
D. Very Heavy

42. What is the recommended method for preventing heat-related illnesses in the workplace?

A. Limiting fluid intake
B. Wearing heavy clothing
C. Taking frequent breaks in shaded areas
D. Ignoring early signs of discomfort

43. If the worker is wearing clothes or protective equipment that can impair heat dissipation, add clothing adjustment factors to measured WBGT, which is known as:

A. PPE
B. Effective WBGT
C. Heat Index
D. Ambient Temperature

44. A work site is determined to have an effective WBGT of 76°F. Which of the following statements is accurate?

A. Strenuous work is possibly unsafe for unacclimatized workers
B. Acclimatized workers have a high risk of heat-related illness
C. There is a low risk of heat-related illness for both unacclimatized and acclimatized works
D. None of the above

45. Some workers wear clothing that prevents heat dissipation. What is the clothing adjustment factor for polyolefin coveralls?

A. 0°F
B. 0.9°F
C. 1.8°F
D. 5.4°F

ENGINEERING CONTROLS

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

Work Practices

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

- Modify work schedules and activities for workers who are new to warm environments.
- Schedule shorter shifts for newly hired workers and unacclimatized 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. 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 and be 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. Avoid drinking hot beverages during lunch and afternoon breaks.

Personal Protective Equipment

In most cases, heat stress should be reduced by engineering controls or work practice modifications. 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 in the pockets with reusable ice packs or phase change cooling packs.

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.

Hydration, Rest, and Shade

Employers should provide cool water for workers to drink. Proper hydration is essential to prevent heat-related illness. Those working two hours or more also provide access to additional fluids containing electrolytes. For short jobs, cool potable water is sufficient. Workers should be encouraged to drink at least one cup (8 ounces) of water every 20 minutes while working in the heat, not just when they are thirsty. For longer jobs that last more than two hours, employers should provide electrolyte-containing beverages such as sports drinks.

Workers lose salt and other electrolytes when they sweat. Substantial loss of electrolytes can cause muscle cramps and other dangerous health problems. Water cannot replace electrolytes; other types of beverages are needed. Water or other fluids provided by the employer should not only be cool, but should also be provided in a location that is familiar to the workers, near the work, easy to access, and in sufficient quantity for the duration of the work. Workers should not rely on feeling thirsty to prompt them to drink. They should be reminded to drink on a regular basis to maintain hydration throughout their shift and beyond.

When heat stress is high, employers should require workers to take breaks. The length and frequency of rest breaks should increase as heat stress rises. Workers should take hourly breaks whenever heat stress exceeds the limits. Breaks should last long enough for workers to recover from the heat. How long is long enough? That depends on several factors, including environmental heat (WBGT), the worker's physical activity level, and the individual worker's personal risk factors. The location of the breaks also matters. If workers rest in a cooler location, they will be ready to resume work more quickly. Breaks should last longer if workers cannot rest in a cool location. Some workers might be tempted to skip breaks. In hot conditions, skipping breaks is not safe! Employers should make sure that workers rest during all recommended break periods. Both NIOSH and ACGIH have recommendations on appropriate lengths of work and rest cycles as a function of the workload and the WBGT (ACGIH 2017, NIOSH 2016)

Workers should be given a cool location to take breaks and recover from the heat. Outdoors might mean a shady area, an air-conditioned vehicle, a nearby building or tent, or an area with fans and misting devices. Indoors, workers should be allowed to rest in a cool or air-conditioned area away from heat sources such as ovens and furnaces.

Personal Risk Factors

Some workers handle heat stress less effectively than others. Heat intolerance happens for a variety of reasons. Personal risk factors include:

- Obesity (body mass index ≥ 30 kg/m^2)
- Diabetes
- High blood pressure
- Heart disease
- Lower level of physical fitness
- Use of certain medications such as diuretics (water pills) and some psychiatric or blood pressure medicines
- Some medications can result in a worker's inability to feel heat conditions and/or the inability to sweat, so symptoms of heat stress may not be evident.
- Alcohol use
- Use of illicit drugs such as opioids, methamphetamine, or cocaine

The above list is not comprehensive. Other medical conditions can also predispose workers to heat-related illnesses.

Employers should recognize that not all workers tolerate heat the same way. Workplace controls should focus on making jobs safe for all the employees. An occupational medical monitoring program can identify workers who are at increased risk of heat illness, while maintaining the confidentiality of workers' health information. When heat hazards are present, workers should receive training about personal factors that can make them more susceptible to heat-related illness. When in doubt, workers should talk to their healthcare provider about whether they can work safely in the heat.

Workers' bodies produce automatic responses to cope with heat stress. Heart rate increases. Sweating becomes more profuse. Eventually skin temperature and core body temperature rise. These physiologic responses can be measured by workers or employers. Physiologic monitoring has several advantages over other methods of monitoring heat stress. Physiologic responses provide a direct and individualized measurement of each worker's response to heat stress. Physiologic measurements can be used to monitor the worker's heat tolerance level. Impermeable clothing, such as chemical protective suits, prevents cooling by sweating and may contribute to heat illness at lower temperatures. Environmental monitoring (i.e., WBGT) does not accurately indicate these workers' heat stress. Physiologic monitoring, such as heart rate measurement, should be used to determine whether their heat stress is too high.

Heart rate is the easiest physiologic parameter to measure. A timepiece is the only required equipment. Workers can be trained to count their pulse. More sophisticated devices like heart rate monitor wristwatches are also available. Some employers also monitor weight changes during a work shift to measure water loss from sweating. Body temperature can be measured by thermometers. Oral, skin, and aural (eardrum) thermometers are less invasive than core body temperature measurements. Caution should be used when interpreting temperature measurements because environmental heat might affect some thermometers.

FINAL EXAM QUESTIONS:

46. Which of the following options is an example of an engineering control that can help reduce workers' exposure to heat?

A. Cooling fans
B. Rest breaks
C. Hydration
D. Shade trees

47. Requiring mandatory rest breaks in a cooler environment is an example of:

A. Engineering control
B. Activity modification
C. Effective WBGT
D. Moderate work intensity

48. In addition to water, what drink is recommended to stay hydrated in hot environments?

A. Coffee
B. Soda
C. Sports drinks
D. Fruit juice

49. Which personal protective equipment (PPE) can be used for preventing heat-related illnesses in extremely hot conditions?

A. Heavy winter coats
B. Sunscreen
C. Insulated gloves
D. Cooling vests

50. What role does hydration play in preventing heat-related illnesses?

A. It has no impact on heat-related illnesses
B. It helps the body cool down through sweating
C. It increases the risk of heat cramps
D. It leads to over-hydration, causing heat stroke

51. Workers should be encouraged to drink at least one cup (8 ounces) or water every ___ minutes while working in the heat.

A. 10
B. 20
C. 30
D. 40

52. Which of the following is not a necessary consideration for worker hydration?

A. Fluids should be only be accessed when workers are thirsty
B. Fluids should be cool
C. Fluids should be stored in a familiar location
D. Fluids should be of a sufficient quantity for the duration of work

53. True or False: The length and frequency of rest breaks should increase as heat stress rises.

A. True
B. False

54. Which of the following is NOT a personal risk factor that affects how well a worker handles heat stress?

A. High blood pressure
B. Level of physical fitness
C. Clothing choice
D. Use of certain medications

55. _____ monitoring, such as heart rate measurement, should be used to determine whether a worker's heat stress is too high.

A. Wet bulb
B. Personal risk
C. PPE
D. Physiologic

CASE STUDIES

The following heat-related case studies are the result of OSHA enforcement investigations. Some identifying details have been changed to protect the privacy of workers and employers.

Case #1: Roofing worker

In July, a 42-year-old man started a new job as a roofer. His employer did not have a formal plan to protect new workers from heat-related illness, although plentiful water, ice, and Gatorade were available at the site. The worker felt fine during his first two days of work. His third day on the job was slightly warmer, with a high temperature of about 86°F and relative humidity of 57%, for a heat index of 90°F. The worker told his co-workers he felt hot and sick in the afternoon. He climbed down from the roof and went to sit by himself in the sun. When his co-workers checked on him a few minutes later, he had symptoms of heat stroke. He was taken to a hospital, where he died. Scattered clouds may have reduced the radiant temperature somewhat, but reconstruction showed a wet-bulb globe temperature of 82°F based on data from a nearby airport.

Lesson to Learn

Protect new workers during their first two weeks on the job. Make sure they take plenty of rest breaks and drink enough fluids. Never leave workers alone when they complain of heat-related symptoms. Their condition can worsen quickly! Take them to a cool location and provide first aid. Even a brief delay in first aid can make the

difference between life and death. Temperatures do not have to be extremely hot to cause heat stroke in workers. Remember, total heat stress is a combination of environmental heat and workload. Air temperatures in the 80s (°F) are high enough to achieve a Heat Index value of 90°F. They are also high enough to kill some workers.

Case #2: Delivery worker

A 50-year-old man had been working at a delivery company for six years. His job involved driving a vehicle and walking in residential neighborhoods to deliver mail and packages. In late May, the weather suddenly became hotter. On the second day of hot weather, this worker developed heat cramps and heat exhaustion. He was hospitalized for two days with acute kidney failure due to dehydration. His condition improved after intravenous fluid replacement.

Lessons To Learn

Even experienced workers are vulnerable to heat-related illness when the weather becomes warmer. Throughout the first week of warmer conditions, treat all workers as if they need to adapt to working in the heat. Take extra precautions to protect them from heat-related illnesses. Make sure workers drink enough fluids during warm or hot weather.

Case #3: Foundry worker

A 35-year-old employee had worked at a foundry for six years. The indoor workplace had high environmental heat from ovens and molten metal. His normal job tasks were in a cooler area of the building. On the day of the incident, he was asked to work in a hotter environment near an oven. He wore heavy protective clothing to prevent skin burns. After several hours of work, the man collapsed and died of heat stroke.

Lessons to Learn

Heat-related illness can occur indoors. The risk is not limited to outdoor workers. Some types of work clothing prevent the release of heat from the body. Environmental heat measurements underestimate the risk of heat-related illness in these situations. Workers are at risk of heat-related illness when they are reassigned to warmer job tasks.

FINAL EXAM QUESTIONS:

56. In Case Study #1, what was a mistake made by the workers on site?

A. The roofer experiencing heat illness was allowed to sit alone in the sun after exhibiting symptoms

B. The roofer experiencing symptoms was taken to the hospital

C. The roofer was allowed to acclimate over a period of 2 weeks

D. The employer had a formal plan to protect new worker from heat-related illness

57. True or False: As shown in Case Study #1, a worker experiencing heat illness symptoms should immediately be taken to a cool location and provided first aid.

A. True

B. False

58. In Case Study #2, what medical complication occurred due to heat exhaustion?

A. Severe sunburn

B. Acute kidney failure

C. Heat stroke

D. No complications were recorded

59. In Case Study #2, what was the documented sign of heat illness?

A. Increased heart rate

B. Excessive sweating

C. Heat cramps

D. Heat rash

60. What caused heat stroke of the employee in Case Study #3?

A. Working too long in the sun

B. Avoiding hydration

C. Not taking enough breaks

D. Working in a hotter environment than normal with heavy protective clothing