SECTION 11:
HEAT STRESS PROGRAM

Environmental conditions, work demands, and clothing requirements may increase body temperature and cause heat stress. Heat stress can diminish employee's work performance and adversely affect their health and safety. The normal response to heat stress is *sweating, an elevated body temperature,* and *an increased heart rate.* These responses mean that the employee is at an increased risk for a heat illness, fatigue, an accident, or an error in judgment. Employee well-being and an increase in productivity can be achieved through a program which manages heat stress.

A satisfactory program includes prevention of heat stress through education and training. The training program should emphasize: 1) recognizing the signs and symptoms of heat illness, 2) stressing the need for adequate water intake, 3) replacing the lost salt by maintaining the correct electrolyte balance through proper nutrition, and 4) pre-job planning.

Methods for controlling heat stress may include: 1) adjusting the movement of air, such as floor fans or a portable air conditioner(man-cooler), 2) retreating to an air-conditioned room, 3) providing cooling vests for use with chemical protective clothing, or 4) adjusting the work/rest schedule to accommodate the amount and type of work being performed.

The Heat Stress Prevention Guidelines (developed by the Texas Operations Thermal Stress Prevention Team) provides additional information on: the heat illnesses (heat rash, muscle cramps, exhaustion, and stroke), adjusting the work/rest schedule, acclimatization, employee heat stress evaluation, recommendations for supervisors, and methods for control.

This section contains the following documents:

1. **Heat Stress Program Guidelines**
   The Heat Stress Prevention Guidelines details the minimum requirements for an acceptable heat stress program within Louisiana Division.

2. **Heat Index Table and Overhead Transparency**
   This table provides the apparent temperature the body feels from the combined effects of humidity and temperature.

3. **Resources for Heat Stress Prevention Training**
   This section contains a list of some of the resources for training on heat stress which are available through the LAD Safety and Industrial Hygiene Departments.

Heat Stress Prevention Guidelines

October 1992

Written by the Texas Operations Thermal Stress Prevention Team
L.F. Bullard, Chairman
J.M. Boswell, M.D.
B.J. Fondren, R.N.
O.F. McDonald, C.I.H.

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I. RECOGNITION

A. Mechanisms for Regulating Temperature

The human body has several mechanisms for regulating temperature. These mechanisms act to maintain deep body temperature narrowly centered at 98.6° Fahrenheit. This temperature of 98.6 ±0.5° F is necessary for normal functioning of the brain and vital organs. The body is very versatile in maintaining a stable core temperature.

The body must deal with two primary heat sources, environmental and internal. The environmental heat source is the heat produced by the surroundings. The internal heat source is the heat produced by the metabolic process. Food, when digested, is used at the cellular level to energize the bodily functions, including the movement of muscles. This process results in a continuous release of metabolic heat inside the body. The level of activity determines the amount of heat produced.. Heat production increases with exercise or exertion.

B. Heat Transfer

Conduction, convection and radiation are the mechanisms by which heat is transferred from one object or location to another.

Conduction is the transfer of heat through solids. This is a direct transfer of heat from object to object. An example of conduction is a hot iron pressing a shirt.

Convection is transfer of heat through fluids. This is a transfer of heat from a gas or a liquid to another fluid. An example of convective heating is boiling water. The pan receives heat through conduction from the heat source and transfers its heat to the adjacent water. Heat is then transferred from water molecule to water molecule through convection currents.

Radiation is the transfer of heat in wave form from a source to an object The wave can pass through a fluid such as air or through a vacuum. Radiation is the process by which the sun heats the earth. The red-hot coils of an electric heater or an open flame also produce radiant heat.

C. Heat Stored in the Body

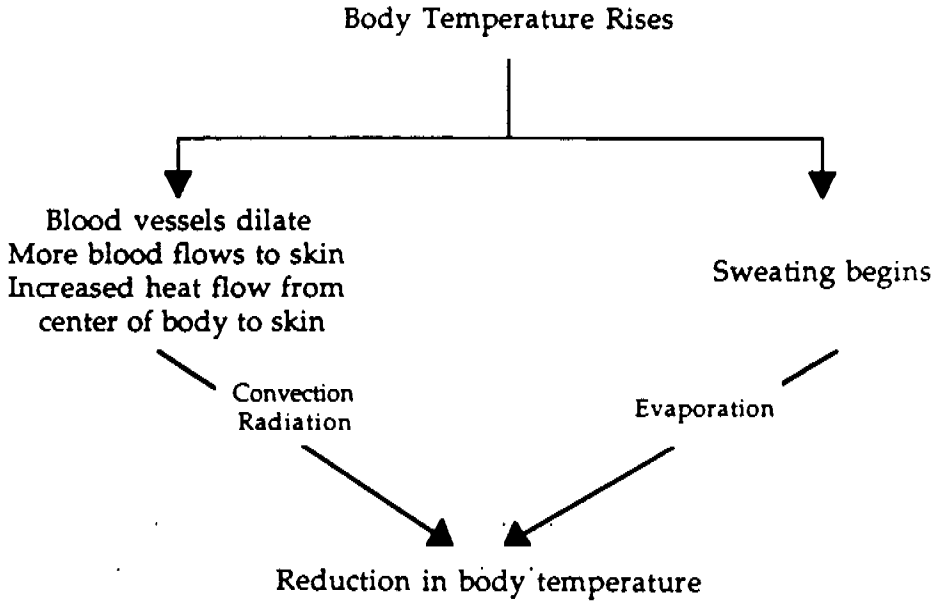
Heat stored in the body depends on the heat gained or lost to the environment and the heat gained from metabolism. Normal body temperature represents a balance between heat production and heat loss. Heat leaves the body by four methods:

- Evaporation of perspiration
- Convection of air around the body
- Conduction through clothing
- Radiation into the surrounding air

Evaporation can only cause heat loss. Metabolism can only result in heat gain. Heat can either be gained or lost through convection, conduction, and radiation.

The most important mechanism for dissipating heat during exertion is the evaporation of perspiration. Evaporation is dependent on the ambient air temperature, the humidity, and the air movement. When the body's heat production exceeds the level the body can remove or when the body cannot compensate for fluids and electrolytes lost though perspiration, the temperature of the body's inner core will begin to rise and a heat-related illness may develop. The risk of heat illness is increased by high temperature, high humidity, and/or bright sunlight.

The following diagram represents the normal response to heat when the body is providing adequate cooling.



D. Ideal Working Temperature

An individual performing light to moderate work can best dissipate excess heat when the ambient temperature is approximately 72° F. This assumes normal conditions of relative humidity and good air movement. This ideal temperature may be adjusted for extremes of work activity.

The following chart shows how a combination of heat and humidity can produce apparent temperatures as much as 15 to 30 degrees higher than the actual mercury readings. The apparent temperature appears in the square where the air temperature column and the humidity line meet. The readings within the bold box make up the "danger zone" where heat stroke or collapse are more likely to occur. The heat stress index may go off the scale when the sun comes out immediately after a summer thunderstorm and standing water is quickly evaporating. This chart is reproduced in Appendix B in a size suitable for overhead transparency presentation.

TEMPERATURE/RELATIVE HUMIDITY CHART

	AIR TEMPERATURES °F										
	70	75	80	85	90	95	100	105	110	115	120
Relative Humidity	APPARENT TEMPERATURE °F										
0%	64	69	73	78	83	87	91	95	99	103	[illegible]
10%	65	70	75	80	85	90	95	100	105	111	[illegible]
20%	66	72	77	82	87	93	99	105	112	120	[illegible]
30%	67	73	78	84	90	96	104	113	123	135	[illegible]
40%	68	74	79	86	93	101	110	123	137	151	
50%	69	75	81	88	96	107	120	135	150		
60%	70	76	82	90	100	114	132	149			
70%	70	77	85	93	106	124	144				
80%	71	78	86	97	113	136					
90%	71	79	88	102	122						
100%	72	80	91	108							

E. Factors Contributing to Heat Stress

A person's ability to adapt to hot weather or working conditions and to tolerate exposure may vary. Given the right circumstances, anyone can be susceptible to heat stress. Contributing factors that predispose a person to heat stress disorders include:

- Age - infants and elderly persons are at particularly high risk
- Chronic illness or a recent illness (especially illness causing dehydration), mental illness, or depression
- Prolonged exertion under heat stress with inadequate time allowed for rest and fluid replacement
- Lack of proper acclimatization
- Poor physical condition and/or obesity
- The use of major tranquilizers, diuretics, and other drugs that may impair the ability to sweat or to regulate body heat
- Recent overindulgence in alcoholic beverages
- Previous heat stroke or severe heat exhaustion. An individual once affected should be exposed to subsequent heat stress with great caution, if at all.

F. Heat Illness

Whenever the normal cooling actions do not occur a heat illness may result. Typical heat disorders include heat rash (prickly heat), heat cramps, heat exhaustion, and heat stroke.

1. Heat Rash

Symptoms

Symptoms may include a skin rash over the arms, shoulders, chest, and behind the knees accompanied by tingling or prickly feeling.

Treatment

√When a heat rash has developed, avoid hot environments and sunshine, avoid scratching, and take a shower after each activity that produces sweat.

Prevention

√After working in a hot environment, take a shower, dry the skin thoroughly, change undergarments, and stay in a cool place.

2. Heat Cramps

Symptoms

Symptoms include a sudden onset of cramps of the skeletal or abdominal muscles. Muscles are painful and usually "knotted". While usually not serious, heat cramps can cause serious pain and, if the abdominal muscles are involved, the attack may resemble appendicitis. The muscles involved are normally those used in performing the job, such as the muscles of the arms and legs. It is important to note that the cramps are sometimes seen in individuals who are otherwise healthy and in good condition.

Heat cramps can occur when the temperature is not unusually hot, or when the sun is not unusually bright. The onset may be during or after work. At one time it was thought that the loss of electrolytes from the muscle cells caused heat cramps. This is probably not so. The cause is not fully understood. In the past, salt tablets were sometimes taken for heat cramps. Taking salt will not correct heat cramps and can actually be harmful!

Treatment

√Heat cramps are rarely serious or long-lasting.
√Rest, water, and the opportunity to cool are necessary to alleviate the problem.
√Remove the employee to a cool environment and remove any unnecessary clothing.
√Call for an ambulance.
√Gently massage the affected muscles.
√Provide small amounts of cool water to drink.
√An employee with abdominal cramps may not be able to tolerate water so do not delay transport to a medical facility where additional treatment can be administered.

Prevention

√Drink sufficient water starting at the beginning of the shift.
√Maintain a proper salt-balanced diet.

3. Heat Exhaustion

Symptoms

The major signs of heat exhaustion are pale, clammy skin, profuse sweating, and extreme tiredness or weakness. The affected individual may have headache, nausea, vomiting, and/or a loss of appetite. The individual may faint.

Treatment

√An individual with any signs or symptoms of heat exhaustion should be treated as for mild shock.
√Care should be immediate.
√While someone is calling for the ambulance, move the employee to a cool environment.
√Remove any unnecessary clothing.
√Place the person on his back with his FEET elevated.
√If the person is conscious, offer small amounts of cool water to drink.
√Do not delay prompt transport to a medical facility.

Prevention

√Maintain proper cardiovascular fitness through proper exercise and diet
√Do not overdo it on hot days.
√Rest in a cool area at regular times during the work day.
√Drink fluids from the beginning of the work day.
√Remember, thirst is not an adequate stimulus to maintain sufficient fluid in the body.

4. Heat Stroke

Symptoms

Heat stroke is the least common but the most serious form of heat stress. It occurs when heat exposure overwhelms the body's mechanisms for dissipating excess heat. Sweating ceases, so this major mechanism for heat loss by the body no longer functions. Heat then continues to build up in the body to the point where body cells, particularly those in the brain, can be permanently damaged. There is usually a history of prolonged exposure to heat, particularly in a humid environment where it is difficult for sweat to evaporate. There is a sudden onset of symptoms including red or flushed skin, hot dry skin (although the person may have been sweating earlier), and extremely high body temperature, often to 106°F. The pulse changes from rapid and full to rapid and weak. There also may be dizziness, nausea, vomiting, headache, confusion, and loss of consciousness. Muscle twitching and convulsions may be seen.

Treatment

Heat stroke is a true LIFE-THREATENING EMERGENCY! The individual's temperature rises so high that brain damage and death will result if cooling doesn't take place quickly.

√Call for an ambulance immediately when heat stroke is suspected.

√Transport to a medical facility should not be delayed.

√Begin cooling the individual while waiting for the ambulance.

√Move the employee to a cool environment and remove any unnecessary clothing.

√Place the employee on his back with his HEAD elevated.

√Sponge his body with cool water and fan him. Fanning will cause the individual to cool more quickly because of the increased air movement around him.

√Another tactic would be to cover the individual with sheets soaked in cool water.

√Do not give the person stimulants such as coffee, tea, or cola beverages.

√Recognition and early treatment can prevent permanent brain damage and death.

Prevention

√Maintain cardiovascular fitness through proper exercise and diet.

√Work in shady areas, if possible, with plenty of ventilation.

√Rest often in cool areas.

√Drink fluids at regular intervals, such as every 20 minutes, starting at the beginning of the work shift.

√Share the work load with another worker when possible.

√If possible, do the hardest work early in the day when it's cooler.

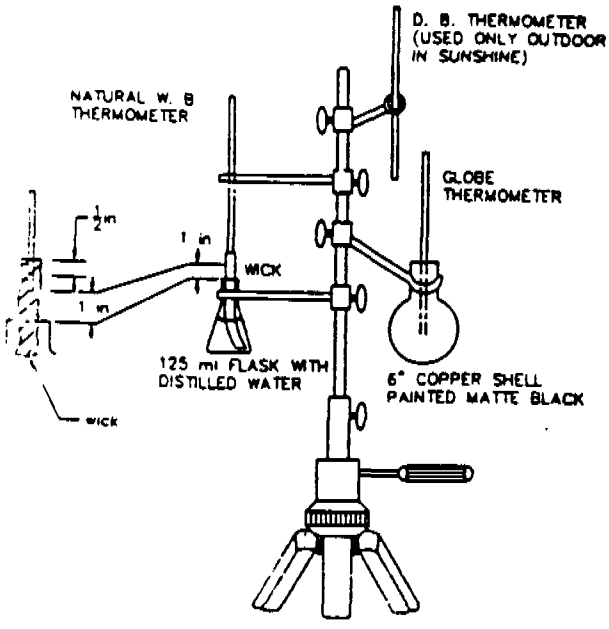
II. EVALUATION

A. Measuring Heat Exposure

It is not practical to monitor a worker's core body temperature to ensure maintenance of acceptable internal temperatures. Therefore, the American Conference of Governmental Industrial Hygienists (ACGIH) adopted the Wet Bulb Globe Temperature (WBGT) as the most suitable index for assessing heat stress for exposed workers. This index applies to workers wearing normal work clothes. The National Institute for Occupational Safety and Health (NIOSH), the Occupational Safety and Health Administration (OSHA), and the American Industrial Hygiene Association (AIHA) also recommend percent of work and rest times for a work period (work/rest regimens). The Electric Power Research Institute (EPRI) and the U.S. Navy recommend the maximum time that a worker can continue working (stay time). All recommendations are based on the WBGT.

For personal monitoring, EPRI also recommends that the worker be alerted when the physiological readings exceed a predetermined level. There are several brands of personal heat stress monitors commercially available that alert workers of possible heat stress. The monitors give users specific information on their physiological state so exposure can be extended to the limits of physiological strain. This information must then be combined with the worker's subjective judgement, to limit heat stress exposures to safe levels. Research shows that body temperature combined with heart rate are the best indicators of acute heat stress exposures.

B. The Wet Bulb Globe Temperature Index



Conditions of heat stress in a work environment are determined using the Wet Bulb Globe Temperature Index (WBGT). A globe thermometer, a dry bulb thermometer and a natural wet bulb thermometer are used to determine the index. The three thermometers are arranged as close together as possible without blocking the other by shading or exclusion of natural air currents. Normally all measuring devices are attached to a common stand. The dry bulb thermometer must be shielded from the sun and the other radiant surfaces of the environment without restricting the airflow around the bulb. It must be accurate to ±0.5° C. The natural wet bulb has a mercury in glass

thermometer accurate to ±0.5° C with a wet cotton wick sock surrounding the thermometer bulb. An Erlenmeyer flask containing distilled water holds the wick. Approximately 1/2 inch of wet sock should be allowed between the flask and the bulb of the thermometer. The globe thermometer is a mercury thermometer with the bulb centered in a copper shell painted matte black.

The following equations are used to calculate the WBGT Index.

Outdoors with solar (sun) load: WBGT = 0.7 NWB + 0.2 GT + 0.1 DB

Indoors or outdoors with no solar load: WBGT = 0.7 NWB + 0.3 GT

Where: WBGT = Wet Bulb Globe Temperature Index
NWB = Natural Wet-Bulb Temperature
DB = Dry-Bulb Temperature
GT = Globe Temperature

C. **Permissible Heat Exposure**

There is no OSHA standard covering exposure to heat, except the General Duty Clause that stipulates that employers must furnish employees "Employment free from recognized hazards likely to cause physical harm."

The ACGIH-recommended threshold limit values (TLVs) for heat stress are based on the WBGT reference to heat stress conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse health effects. The WBGT values apply to acclimatized employees with adequate water intake and suitable light weight clothes. In general, use of TLVs for heat stress should be used with caution. The TLVs are very conservative and may be misleading. Many natural environments such as the Gulf Coast regions, as well as other parts of the country, routinely exceed the values on the table below. Consultation with your industrial hygienist and/or physician to determine appropriate work/rest schedules is recommended. The following table lists the TLVs for heat stress.

PERMISSIBLE HEAT EXPOSURE TLVs
Wet Bulb Globe Temperature (Degrees Fahrenheit)

WORK/REST	LIGHT WORK	MODERATE WORK	HEAVY WORK
Continuous work	86	80	77
Work 75%/Rest 25%	87	82	78
Work 50%/Rest 50%	89	85	82
Work 25%/Rest 75%	90	88	86

Light Work (up to 200 KCAL/HR): Sitting or standing to control machines, performing light hand or arm work.

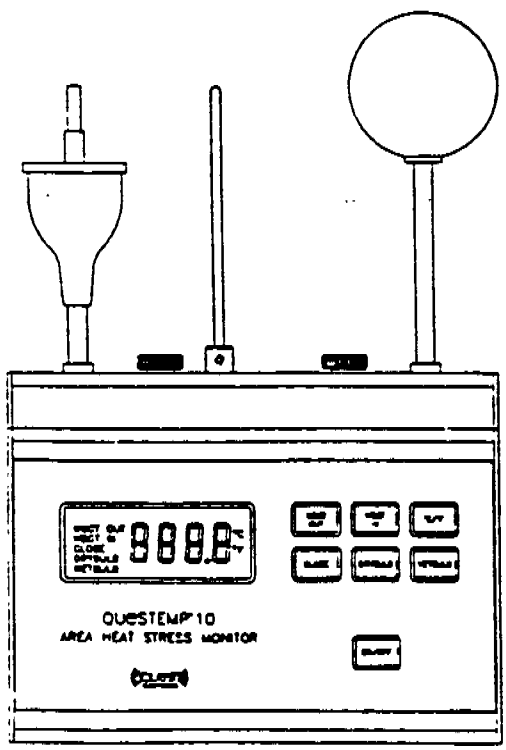
Moderate Work (200-350 KCAL/HR): Walking about with moderate lifting and pushing.

Heavy Work (350-500 KCAL/HR): Pick and shovel work.

D. Heat Stress Survey

1. Area Survey

A heat stress survey should be completed to determine potential for heat stress and to incorporate administrative and/or engineering controls. A drawing showing where WBGT Index readings were taken should be included. Readings should be taken in areas where employees work.

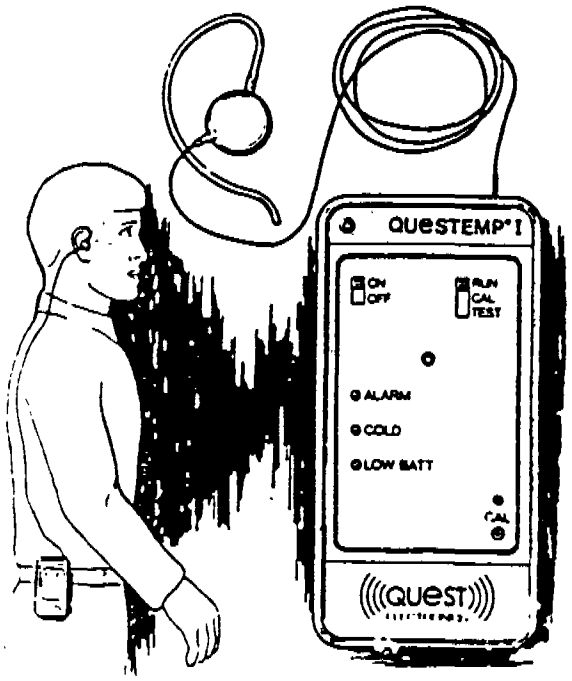


Heat stress monitors can be used to determine WBGT indices. A suitable monitor available for use is the Wibget®, manufactured by Reuter-Stokes of Canada. The Wibget is a compact, portable instrument to be used for measuring environmental factors contributing to human heat stress. It contains data storage and transmission capabilities that increase the convenience of obtaining these measurements and improve the accuracy of manual recording. The Wibget electronics include a digital readout, a function switch, a Fahrenheit or Celsius scale selection switch, data memory, charger input, serial interface and recorder output. The Wibget allows for rapid determination of dry bulb temperature, natural wet bulb temperature and globe temperature. It also computes the indoor and/or outdoor WBGT. The Wibget requires an environment-dependent stabilization time. To get optimum accuracy, the instrument should be left in the environment to be measured, at a height of approximately 4 feet above the floor and at least 18 inches from the operator for 3 to 5 minutes before taking readings. The meter must not be exposed to temperatures above 150° F.

When instruments are not available to determine the WBGT Index, use available information such as relative humidity from the local weather forecast and a simple dry bulb temperature measurement. Thermometer readings should be taken after being exposed to the same area for at least 20 minutes.

2. Personnel Survey

Personal monitors survey the individual not the environment. Exposure to heat stress should be terminated when the heart rate or the body temperature reaches critical values or when the worker experiences symptoms of heat illness. While the likelihood of any of these events increases with the magnitude and duration of the heat exposure, they may not occur at the same time. All three factors should be considered by workers exposed to heat stress.



A personal heat stress monitor currently available from Quest Electronics is the QUESTEMP°II®. It monitors the human body's temperature via the ear canal. Any offset between the ear and body temperatures is adjusted for by calibrating directly to the individual's oral temperature. It is an alerting device that warns the user that their body temperature has risen above the "safe" level and that action should soon be taken to allow the body to cool. The monitor acts as an aid and DOES NOT replace the individual's own feelings and judgement.

The hypothalamus, at the base of the brain, is the body's temperature controller. The ear canal borders the hypothalamus and will track its temperature changes once the canal is isolated from the outside environment. A small sensor is placed in the ear canal, via an E.A.R.® earplug, which will monitor the change in the body's temperature and set off an audible alarm when the level reaches a preset limit. The recommended limit is 38°C (100.4°F) according to the World Health Organization and has been accepted by the ACGIH, NIOSH, and the International Organization for Standardization. These organizations also recognize that closely monitored, acclimatized individuals may have a higher tolerance limit of up to 39°C (102.2°F). As the temperature rises above the limit, the risk of heat related problems occurring increases. The QUESTEMP°II has the capability of setting the initial alarm level between 38°C and 39°C and it will automatically produce a secondary alarm if the temperature exceeds 0.5°C above the initial alarm level. This monitor is currently under evaluation by Industrial Hygiene Services, Texas Operations.

Since some workers are more susceptible to heat stress than others, supervision often controls maintenance tasks with preset work intervals, or stay times, which are conservatively selected to protect all personnel. The personal monitor was designed to measure the responses of individual workers to heat stress and provide an alert when stress levels become too high. As a result, many workers can safely extend their stay time on the job, sometimes by 100% or more, depending on the type of protective clothing worn. With each individual working closer to their personal limit, productivity is improved and maintenance jobs are completed quickly.

Heat stress situations are usually areas with poor ventilation, high relative humidity, and air temperatures usually in excess of 80° Fahrenheit. Special situations should be evaluated for heat stress prior to commencement. For example, a vessel entry situation should be closely evaluated prior to the actual entry.

III. CONTROL

Once the area has been evaluated, the next step is to determine the control necessary (if any) to reduce the potential for heat illness. There are a variety of approaches to the control or prevention of heat stress and related problems. The individual should be informed of the potential heat stress situations and advised of the various practices available for protection. Various supervisory practices may help prevent heat stress. Engineering controls can be implemented to alleviate the heat stress problem.

A. Individual Heat Stress Prevention Practices

The individual should be aware of practices to use to prevent heat stress. The following is a summary of recommended heat stress prevention practices.

1. Prevent excessive loss of body fluid. Drink small amounts of water (approximately one cup) every 15 or 20 minutes. Start drinking at the beginning of the work period. Thirst is NOT an adequate stimulus to maintain the proper amount of fluid in the body.

2. Replace salt lost due to sweating by maintaining the correct electrolyte (minerals such as magnesium, potassium, sodium and calcium) balance in the body. This can be done by eating well-balanced meals. Normal salting of food should be sufficient. Consult a physician prior to increasing salt intake. Salt tablets SHOULD NOT be used. Most workers will take salt tablets like any other pills with about half a cup of water. It takes 8 to 10 ounces of water to dissolve one salt tablet. Since the worker taking the salt tablets is probably already dehydrated, 16 to 20 ounces of fluid are needed to dissolve the salt. Therefore, the body must make up the difference between what is needed and what was ingested. Salt, a very corrosive element, must be diluted and dissolved. To make up the fluid deficiency, the body has only three fluids available: mucus, digestive juices and blood plasma. The most readily available fluid is the digestive juices that are concentrated hydrochloric acid. This acid does not dissolve the salt but it does ulcerate the stomach wall. The mucus will tend to coat the stomach wall and prevent the ulceration, but it will not dissolve the salt. Therefore, the only fluid available to dissolve the salt is blood plasma. The plasma will make up the difference needed to dilute the salt, but its effect is to drop blood pressure and blood volume. The following is a list of the adverse effects of using salt tablets.

- Sodium is supplied in excessive amounts
- Stomach wall may ulcerate
- Blood pressure is altered
- Decreased blood volume
- Dehydration is worsened

"Gatorade," "QuicKick," "Sqwincher," and other electrolyte drinks are

approved for use, but they are not necessary and they do not replace water. Water does not require as much energy to metabolize and should be used during normal working hours.

3. Keep your body fit. Fat layers act as insulators and slow the body's ability to remove heat. Your heart also works harder if you are carrying around extra weight. Eat well-balanced meals and get plenty of sleep each night. If your job is not physically demanding, exercise regularly to maintain your fitness.

4. Some medicines reduce heat tolerance. Keep your doctor informed of the heat exposure of your job.

5. Alcohol and drugs should be avoided. Addictive drugs reduce heat tolerance and alcoholic beverages increase body water loss.

6. Wear the proper, suitable dress. Wear loose fitting clothing whenever possible.

B. Supervisory Functions

Supervisors should be aware of the heat stress associated with the work in their areas. They should understand their role in preventing heat illness for those in their area of responsibility. A few specific recommendations for the supervisor are:

1. Provide periodic training on the recognition and prevention of heat stress for employees exposed to hot environments.

2. Allow employees to adequately acclimate themselves to the heat. Acclimation increases the heat tolerance while decreasing the risk of heat illness. An acclimated worker can sweat more and have less increase in pulse rate and body temperature than the non-acclimated worker. Introduce new workers to heat exposure gradually. The following is a recommended schedule for introducing new non-acclimated workers to hot work areas.

Number of Days On the Job	Recommended Exposure % of Normal Daily Exposure
1	50
2	60
3	70
4	80
5	90
6	100

3. If the work exposure warrants, implement a work/rest regimen according to the work load (light, medium, and/or heavy) and the WBGT reading. The ACGIH work/rest regimen which was discussed earlier in this manual can also be found in the Threshold Limit Values (TLV) booklet under heat stress.

4. Additional supervisory considerations should include:
   - working in the shade when feasible;
   - performing the hardest work early in the morning and saving the lighter work for the warmer time of the day;
   - using fans for general ventilation when working in poorly ventilated areas;
   - using the proper personal protective equipment, such as reflective aprons to shield or reflect radiant heat;
   - providing cool vests for use with impermeable clothing or in extremely hot environments; and
   - sharing the work between two or more workers to reduce individual exertion.

C. Engineering Controls

The third major process for preventing or controlling heat illness is engineering controls. Determination of the principal heat components should prove beneficial in adopting appropriate engineering controls. The following table lists several controls that have proved useful in controlling heat exposures. (Notice: there are some duplications from the other two levels of controlling heat illness.)

Heat Component	Possible Action
Metabolism	Mechanization of the job Sharing the work load Increasing rest time
Radiation	Minimize the line-of-sight to the source Insulation of furnace walls Reflective screens Reflective aprons Cover exposed parts of the body

Convection	If air temperature is above 95°F, reduce convective heat gain by: •Lowering air temperature •Lowering air velocity •Wearing clothing If air temperature is below 95 °F, reduce convective heat gain by: •Lowering air temperature •Increasing air velocity •Removing clothing
Evaporation	Increase by: •Increasing air velocity •Decreasing humidity

D. Special Situations

Severe heat stress situations can rapidly arise out of a work environment when the employee is wearing totally encapsulated suits or chemical resistant materials that do not allow for normal evaporation of perspiration and venting of heat. Evaluation of the dry bulb temperature, wet bulb temperature, radiation heat, and metabolic heat load are not adequate to provide timely warning. A normal evaluation using WBGT would be meaningless.

Employees in these situations should be adequately acclimated to the hot environment, receive training designed to prevent heat stress disorders, be provided with frequent breaks in cooler areas (as many as three per hour), and be provided with adequate make-up fluids.

1. Work/Rest Schedule

A work/rest schedule for preventing heat stress while working in impermeable clothing is given below. It is based on the ambient air temperature, yet uses a work/rest schedule similar to the ACGIH WBGT schedule. Additional work practices are recommended such as self-paced work and regular fluid replacement programs.

Heat Stress Prevention
Impermeable Clothing Work/Rest Schedule

Temperature (degrees F)	Maximum Stay Time (minutes)	Minimum Rest Time* (minutes)
72-79	40	20
80-87	30	30
88-?	20	40

*Rest in a cool location with adequate air movement provided by fans and/or air conditioners.

2. Work Practices When Working in Impermeable Clothing

Metabolism is the major source of heat load when working in impermeable clothing such as chemical protective clothing. The clothing severely limits sweat evaporation. The following work practices are recommended to prevent heat stress.

•Fluid Replacement - drink one quart of water prior to beginning work and one quart each hour after that.

•Self-paced work - workers must adjust the pattern of work to avoid overexposure. Exposure must be terminated with onset of symptoms of heat stress.

•Scheduling - perform work, if possible, during cooler hours and share work loads with additional persons.

•Acclimation - following illness, vacation, or absence from work of two weeks or longer, follow approved acclimation schedule based on a five-day period.

•Cool Vests - to be worn under the impermeable clothing. Following are descriptions of four types of cool vests.

a. The ILC Dover Model 1905 Cool Vest contains a battery and pump that circulates cool liquid through the vest. The vest is made of heat-sealed, urethane-coated nylon with an inner bladder through which the liquid flows. A backpack contains the pump, rechargeable battery and a plastic bag to hold water and ice. Approximately one liter of water and 5 pounds of standard ice cubes can be used; the total weight would be approximately 12.5 pounds. The Cool Vest comes in one size only with side straps to tighten the vest against the torso. The cost of the ILC system including two batteries and one battery charger is approximately $350.

b. The SteeleVest has a torso vest with six pockets (three in front, three in back) for the frozen gel packs. The vest has a cotton canvas shell and the pockets are externally insulated with Thinsulate. The vest uses approximately 10 pounds of frozen gel packs making the total weight of the system approximately 11 pounds. The vest comes in one size only with two straps to tighten the vest around the torso The cost of the SteeleVest including two sets of gel packs is approximately $200.

c. The American Stay Cool Vest has a nylon vest with six pockets (two in front, four in back) for frozen gel packs. The vest holds 5 pounds of frozen gel packs; total weight of the system is approximately 5.5 pounds. The vest has side lacing to adjust the fit and available in sizes small, medium and large. The cost of the American vest including two sets of gel packs is approximately $60.

d. The Encon Heat Stress Vest and Air Distribution System has a Buna-N coated nylon vest with sewn-in air distribution channels. The system requires connection to supplied air with a 25 foot air supply hose. A personal air conditioner (vortex tube) is attached to a waist belt and can create a temperature as much as 40 degrees F cooler than the incoming air. Vest, belt and vortex combined weight is under 3 pounds. The cost of System A (Torso Cooling) that includes vest, personal air conditioner and waist belt is approximately $355. The cost of System B (Torso/Face Cooling) that includes vest with facial air collar, personal air conditioner and waist belt is approximately $475.

APPENDIX A

Listing of Training Presentations, Articles and Reports

A. **Presentations**

The following training materials are available through Industrial Hygiene Services, B-101, telephone (409) 238-1281.

1. 35mm Slide/Narrative Presentation - "Heat Stress May Cause Heat Illness", American Conference of Governmental Industrial Hygienist (ACGIH).
2. Posters - "Heat Stress May Cause Heat Illness", ACGIH.
3. Video - "Heat Stress Prevention", Video Training Source, Inc., 10:35 minutes.
4. Booklet - "Understanding and Preventing Heat Stress", Krames Communications.
5. Slide/Narrative Presentation - "Heat Stress", LB, 30 minutes.
6. Slide/Narrative Presentation - "Heat Stress and Cold Stress", OM, 30-45 minutes (can be separated into two presentations).

LAD Video Library

7. Video - The Performance Factor , 11 mins.

B. **Articles and Reports**

Copies of the following articles and reports are available from Industrial Hygiene Services, B-101, telephone (409) 238-1281.

1. Bernard, Thomas E., Kenney, W. Larry, O'Brien, John F., "Personal Monitor for Heat Stress Exposures", Highlights of EPRI Development and Evaluation Project from Westinghouse R&D Center.
2. McDonald, Oliver F., "Health and Safety Information Document - Heat Stress Prevention", August, 1989.
3. Pimental, Nancy A., Avellini, Barbara A., "Effectiveness of Three Portable Cooling Systems in Reducing Heat Stress", March, 1988.
4. Fleming, Susan H., "OSHA Reminds Employers/Employees to Protect Against Heat Stress", May 12, 1989.
5. Coleman, Sheldon R., "Heat Storage Capacity of Gelled Coolants in Ice Vests", American Industrial Hygiene Association Journal, June, 1989.
6. Radnofsky, Dr. M. I., "The Impact of Heat Stress on Productivity", Industrial Hygiene News.
7. Shirley, M.D., Paul D., "Disturbances Due to Heat", Conn's Current Therapy, 1987.
8. Fulton, David R., "Heat Stress", Fulton H.S.M. Consultants, Inc., 1989.
9. Roberts, PhD, PE, Darrell L., Schuman, MD, Dr PH, Stanley H., Smith, MS, David J., "Preventing Heat-related Hazards Important for Outdoor Workers", Occupational Health & Safety, June, 1987.
10. "Heat Stress", Vallen Safety Supply Company.
11. Bernard, T.E., Kenney, W.L., Balint, L., "Heat-Stress-Management Program for Nuclear Power Plants", Prepared for Electric Power Research Institute, February, 1986.

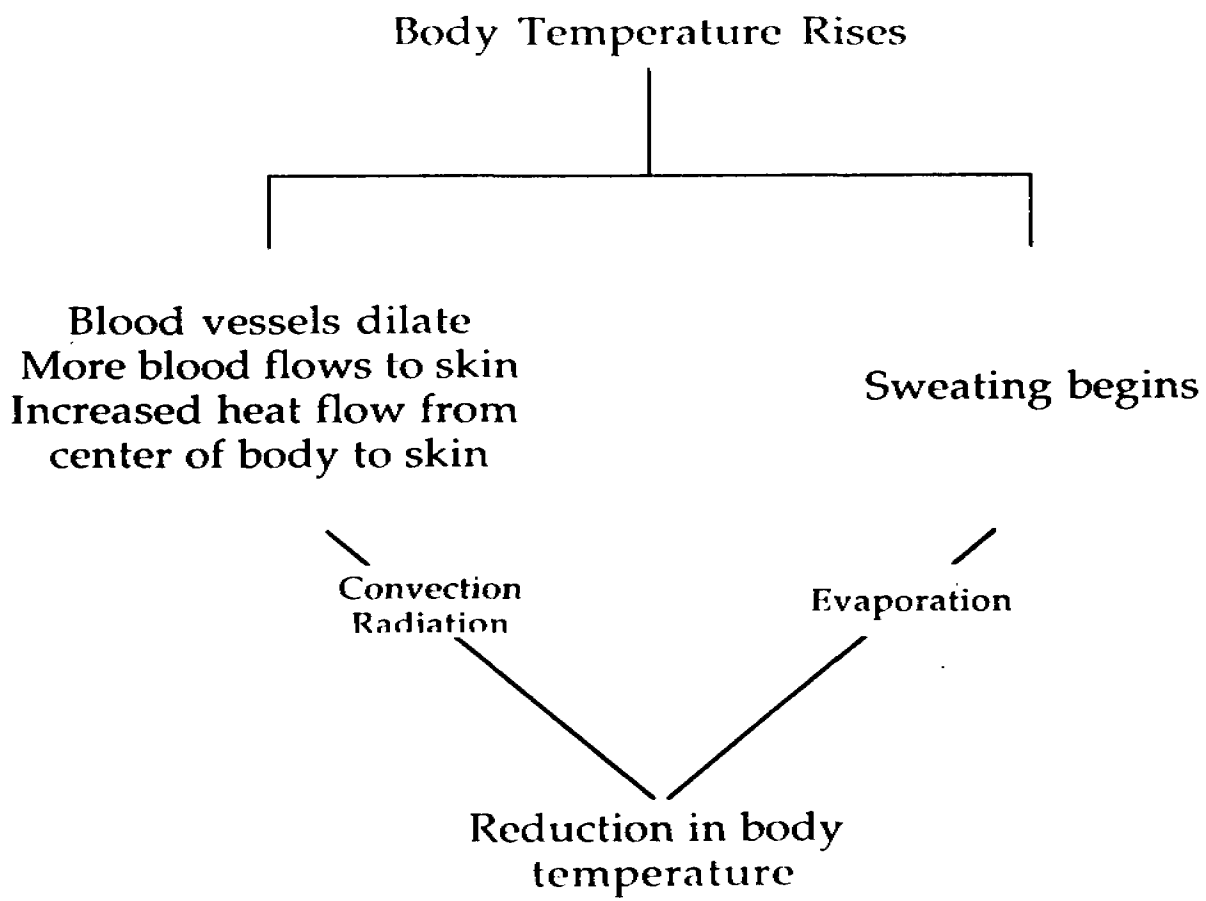
APPENDIX B

Training Overheads

The following pages are provided for use as overheads for heat stress training.

lfb
6/30/92

THE BODY'S NORMAL RESPONSE TO HEAT



TEMPERATURE/RELATIVE HUMIDITY CHART

	AIR TEMPERATURES °F										
	70	75	80	85	90	95	100	105	110	115	120
Relative Humidity	**APPARENT TEMPERATURE °F**										
0%	64	69	73	78	83	87	91	95	99	103	107
10%	65	70	75	80	85	90	95	100	105	111	116
20%	66	72	77	82	87	93	99	105	112	120	130
30%	67	73	78	84	90	96	104	113	123	135	148
40%	68	74	79	86	93	101	110	123	137	151	
50%	69	75	81	88	96	107	120	135	150		
60%	70	76	82	90	100	114	132	149			
70%	70	77	85	93	106	124	144				
80%	71	78	86	97	113	136					
90%	71	79	88	102	122						
100%	72	80	91	108							

Source: The National Weather Service, Alvin, Texas

PERMISSIBLE HEAT EXPOSURE TLVs

Wet Bulb Globe Temperature (Degrees Fahrenheit)

WORK/REST	LIGHT WORK	MODERATE WORK	HEAVY WORK
Continuous work	86	80	77
Work 75%/Rest 25%	87	82	78
Work 50%/Rest 50%	89	85	82
Work 25%/Rest 75%	90	88	86

Light Work (up to 200 KCAL/HR): Sitting or standing to control machines; performing light hand or arm work.

Moderate Work (200-350 KCAL/HR): Walking about with moderate lifting and pushing.

Heavy Work (350-500 KCAL/HR): Pick and shovel work.

lb

ACCLIMATION SCHEDULE

Number of Days On the Job	Recommended Heat Exposure % of Normal Daily Exposure
1	50
2	60
3	70
4	80
5	90
6	100

Heat Stress Prevention
Impermeable Clothing Work/Rest Schedule

Temperature (degrees F)	Maximum Stay Time (minutes)	Minimum Rest Time* (minutes)
72 - 79	40	20
80 - 87	30	30
88 - ?	20	40

*Rest in a cool location with adequate air movement provided by fans and/or air conditioners.

Heat Index Table

Environmental Temperature (°F)

Relative % Humidity	70	75	80	85	90	95	100	105	110	115	120
	Apparent Temperature *										
0	64	69	73	78	83	87	91	95	99	103	107
10	65	70	75	80	85	90	95	100	105	111	116
20	66	72	77	82	87	93	99	105	112	120	130
30	67	73	78	84	90	96	104	113	123	135	148
40	68	74	79	86	93	101	110	123	137	151	
50	69	75	81	88	96	107	120	135	150		
60	70	76	82	90	100	114	132	149			
70	70	77	85	93	106	124	144				
80	71	78	86	97	113	136					
90	71	79	88	102	122						
100	72	80	91	108							

*** Combined index of heat and humidity = what it "feels like" to the body.**

How to Use the Heat Index Table

1. Locate th Env. Temp. across the top row.
2. Locate the Rel. % Humidity down the left side.
3. Follow across and down to find the Apparent Temp.
4. Det rmine the Heat Stress Risk on the chart at the right.

Apparent Temperature	Heat Stress Risk with Physical Activity and/or Prolonged Exposure
95 -105	Heat cramps or heat exhaustion possible
105 - 130	Heat cramps or heat exhaustion likely, Heatstroke Possible
131 and >	Heatstroke highly likely

NOTE: This Heat Index chart is designed to provide general guidelines for accessing the potential severity of heat stress. Individual reactions to heat will vary. In addition, studies indicate that susceptibility to heat disord rs tends to increase with age.

NOTE: Exposure to full sunshine can increase Heat Index values by up to 15 degrees (F).

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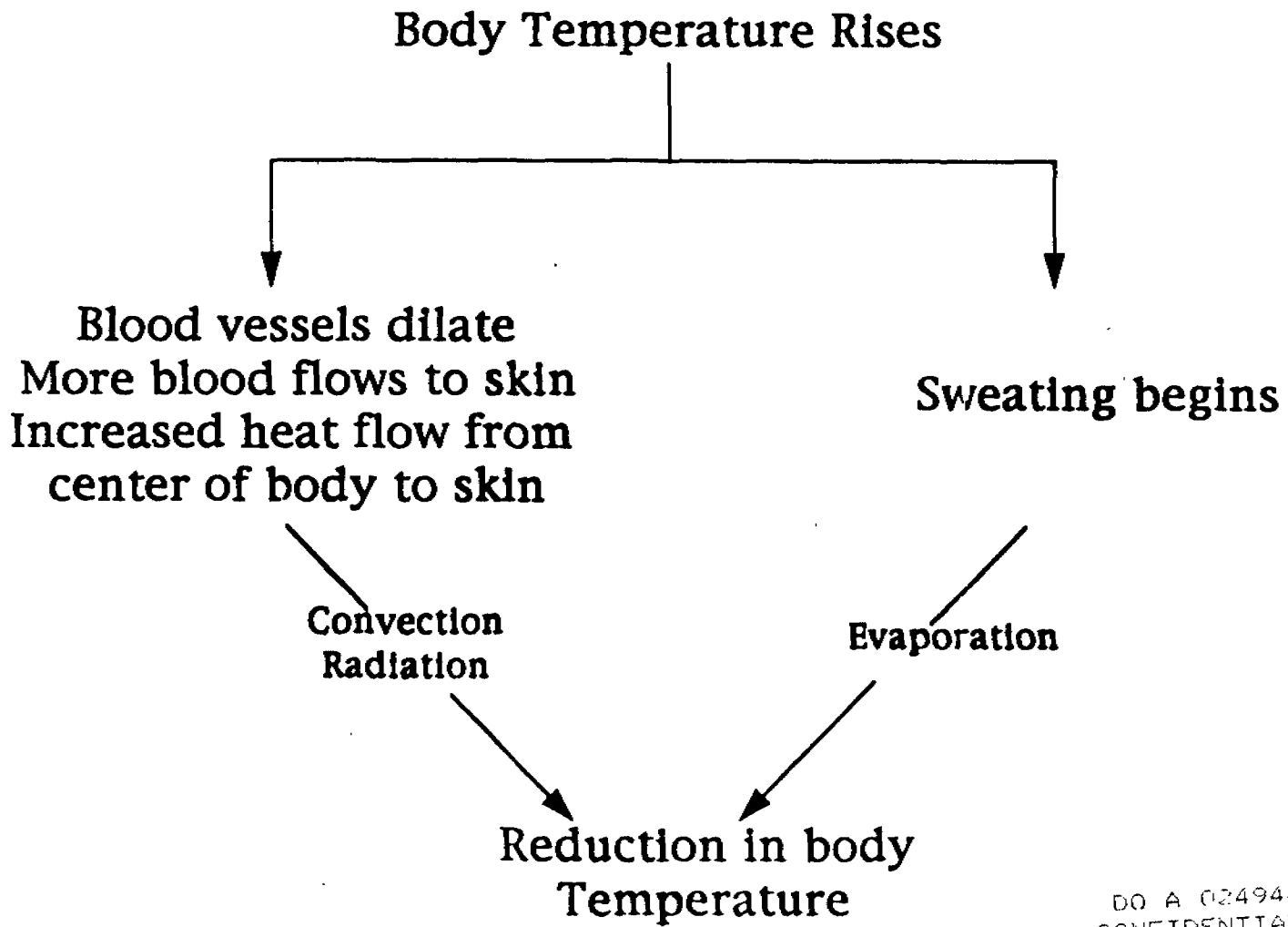
THE BODY'S NORMAL RESPONSE TO HEAT



TEMPERATURE/RELATIVE HUMIDITY CHART

Relative Humidity	AIR TEMPERATURES °F										
	70	75	80	85	90	95	100	105	110	115	120
	APPARENT TEMPERATURE °F										
0%	64	69	73	78	83	87	91	95	99	103	107
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50%	69	75	81	88	96	107	120	135	150		
60%	70	76	82	90	100	114	132	149			
70%	70	77	85	93	106	124	141				
80%	71	78	86	97	113	136					
90%	71	79	88	102	122						
100%	72	80	91	108							

Source: The National Weather Service, Alvin, Texas

HEAT STRESS

TEMPERATURE/RELATIVE HUMIDITY CHART

Relative Humidity	AIR TEMPERATURES °F APPARENT TEMPERATURE °F										
	70	75	80	85	90	95	100	105	110	115	120
0%	64	69	73	78	83	87	91	95	99	103	107
10%	65	70	75	80	85	90	95	100	105	111	116
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Source: The National Weather Service, Alvin, Texas

lb

II. B. 1/93

This chart shows how a combination of heat and humidity can produce apparent temperatures as much as 15 to 30 degrees higher than the actual mercury readings.

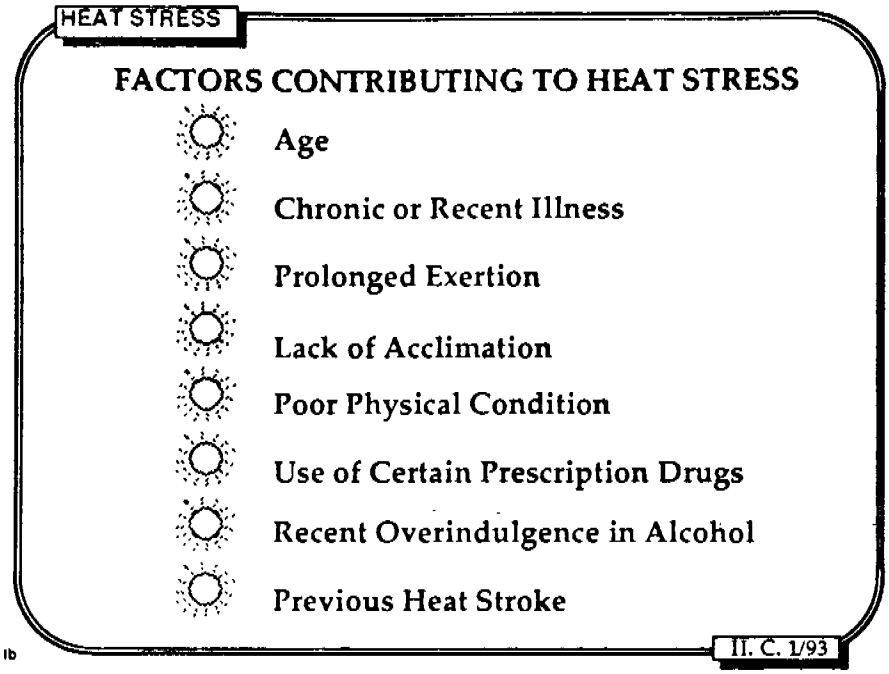
The apparent temperature appears in the square where the air temperature column and the humidity line meet.

The readings within the bold box make up the "danger zone" where heat stroke or collapse are more likely to occur.

The heat stress index may go off the scale when the sun comes out immediately after a summer thunderstorm and standing water is quickly evaporating.

FACTORS CONTRIBUTING TO HEAT STRESS

- Age
- Chronic or Recent Illness
- Prolonged Exertion
- Lack of Acclimation
- Poor Physical Condition
- Use of Certain Prescription Drugs
- Recent Overindulgence in Alcohol
- Previous Heat Stroke



Age - infants and elderly persons are at particularly high risk

Chronic illness or a recent illness (especially illness causing dehydration such as diarrhea and/or vomiting), mental illness or depression

Prolonged exertion under heat stress with inadequate time allowed for rest and fluid replacement

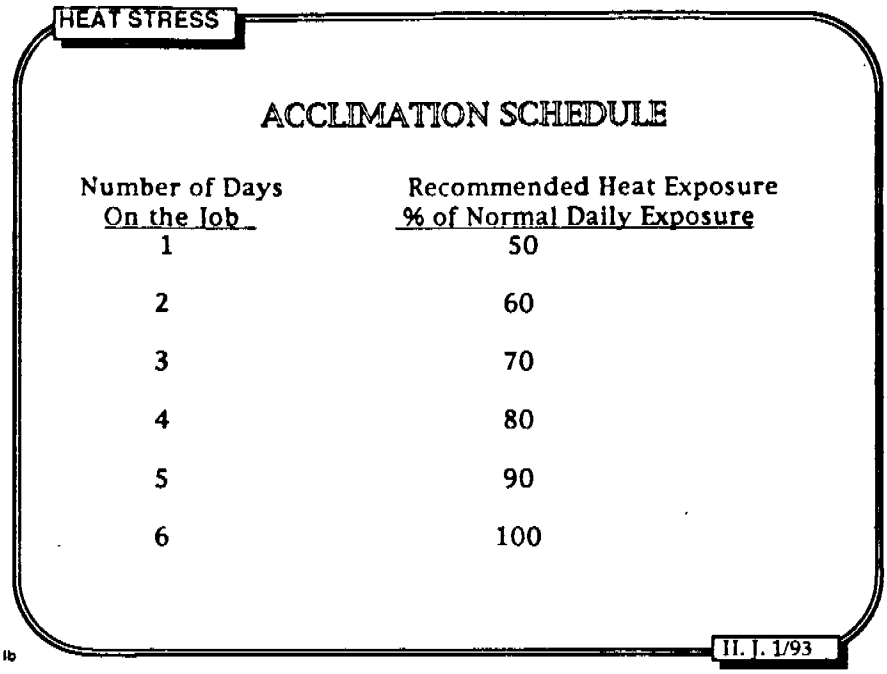
Obesity

The use of major tranquilizers, diuretics, and other drugs that may impair the ability to sweat or to regulate body heat

Previous heat stroke or severe heat exhaustion- an individual once affected should be exposed to subsequent

ACCLIMATION SCHEDULE

Number of Days On the Job	Recommended Heat Exposure % of Normal Daily Exposure
1	50
2	60
3	70
4	80
5	90
6	100



This chart represents a recommended schedule for introducing new non-acclimated workers to hot work areas.

Introduce new workers to heat exposure gradually.

Allow employees to adequately acclimate themselves to the heat following illness, vacation or absence from work of two weeks or longer.

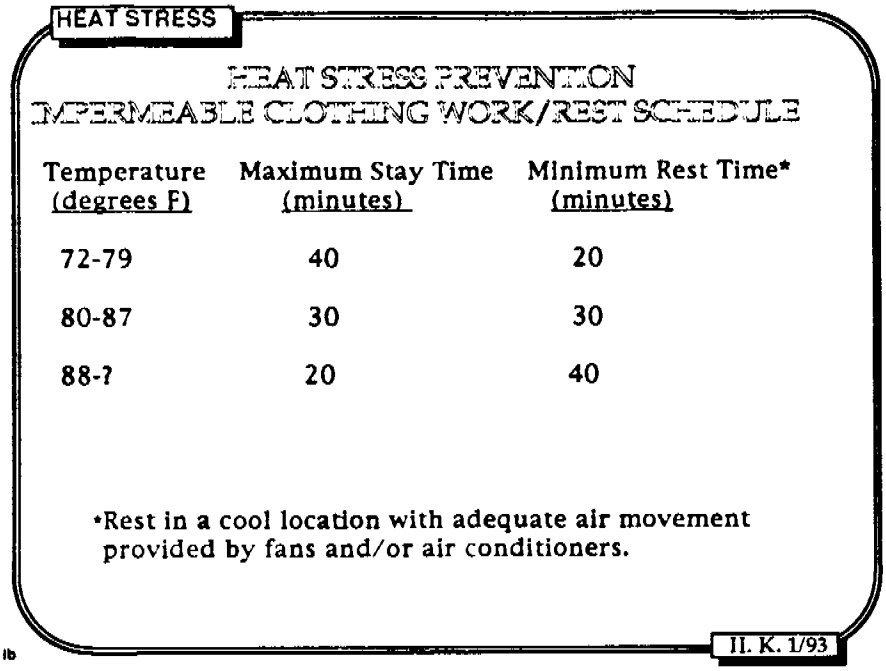
Acclimation increases the heat tolerance while decreasing the risk of heat illness.

An acclimated worker can sweat more and have less increase in pulse rate and body temperature than the non-acclimated worker.

HEAT STRESS PREVENTION
IMPERMEABLE CLOTHING WORK/REST SCHEDULE

Temperature (degrees F)	Maximum Stay Time (minutes)	Minimum Rest Time* (minutes)
72-79	40	20
80-87	30	30
88-?	20	40

*Rest in a cool location with adequate air movement provided by fans and/or air conditioners.



This chart gives a work/rest schedule for preventing heat stress while working in impermeable clothing.

It is based on the ambient air temperature.

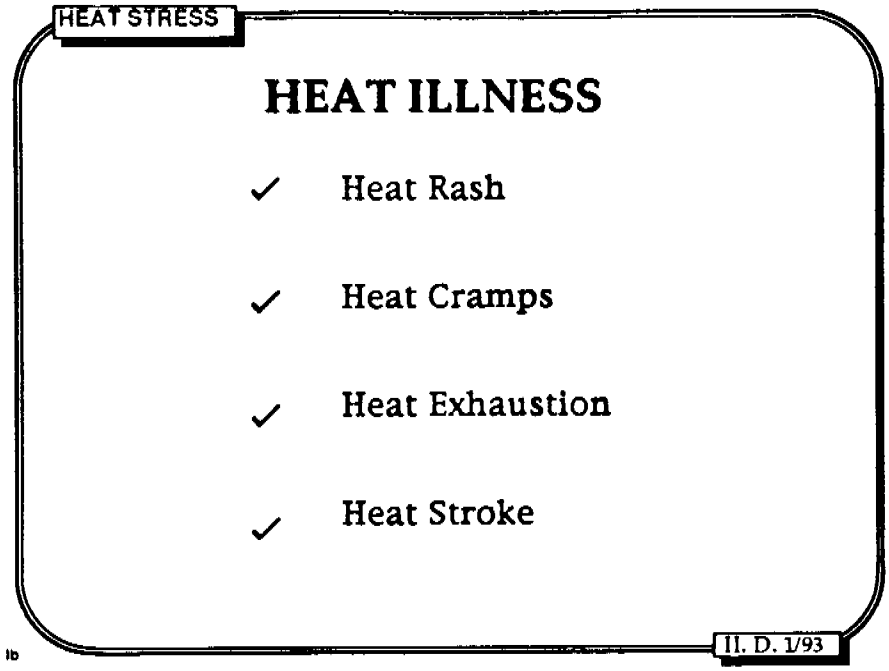
Metabolism is the major source of heat load when working in impermeable clothing such as chemical protective clothing. The clothing severely limits sweat evaporation.

The following work practices are recommended to prevent heat stress while working in impermeable clothing.

- Fluid Replacement - one quart prior to beginning of work and one quart each hour after that.
- Self-paced work - workers must adjust the pattern of work to avoid over exposure. Exposure must be terminated with onset of symptoms of heat stress.
- Scheduling - perform work, if possible, during cooler hours and share work loads with additional persons
- Acclimation - following illness, vacation, or absence from work of two weeks or longer, follow approved acclimation schedule based on a five-day period.
- Cool Vests - to be worn under the impermeable clothing.

HEAT ILLNESS

- ✓ Heat Rash
- ✓ Heat Cramps
- ✓ Heat Exhaustion
- ✓ Heat Stroke



Whenever the normal cooling actions do not occur a heat illness may result.

Typical heat disorders include heat rash (prickly heat), heat cramps, heat exhaustion, and heat stroke.

HEAT RASH

Symptoms
- Skin rash
- Tingling or prickly feeling

Treatment
- Avoid hot environments
- Avoid scratching
- Shower

Prevention
- Shower
- Dry thoroughly
- Change undergarments
- Stay in a cool place

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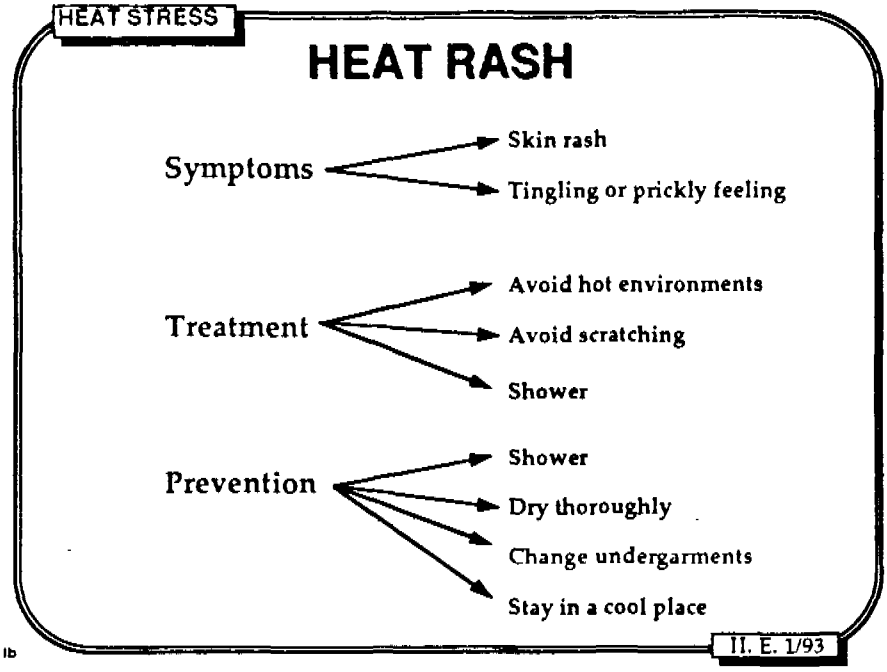


Heat rash also called Prickly Heat

Symptoms - skin rash over the arms, shoulders, chest, and behind the knees accompanied by tingling or prickly feeling on the skin

Treatment - avoid hot environments and sunshine, avoid scratching, and take a shower after each activity that produces sweat

Prevention - after working in a hot environment, take a shower, dry the skin thoroughly, change undergarments, and stay in a cool place after work

See your physician

HEAT CRAMPS

Symptoms

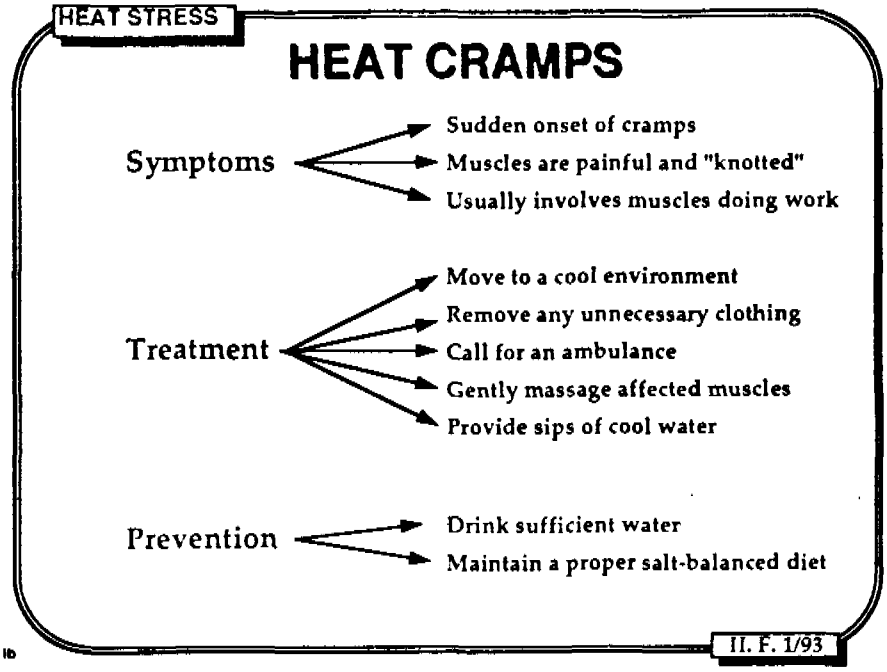
- Sudden onset of cramps
- Muscles are painful and "knotted"
- Usually involves muscles doing work

Treatment

- Move to a cool environment
- Remove any unnecessary clothing
- Call for an ambulance
- Gently massage affected muscles
- Provide sips of cool water

Prevention

- Drink sufficient water
- Maintain a proper salt-balanced diet



Symptoms include a sudden onset of cramps of the skeletal or abdominal muscles.

Usually not serious or long-lasting, but cause serious pain.

If the abdominal muscles are involved, the attack may resemble appendicitis.

Usually the muscles involved are those used in performing the job, such as the muscles of the arms and legs.

Cramps are sometimes seen in individuals who are otherwise healthy and in good condition.

Heat cramps can occur when the temperature is not unusually hot or when the sun is not unusually bright.

May occur during or after work

The cause is not fully understood.

Taking salt will not alleviate heat cramps and can actually be harmful.

DO NOT TAKE SALT TABLETS!

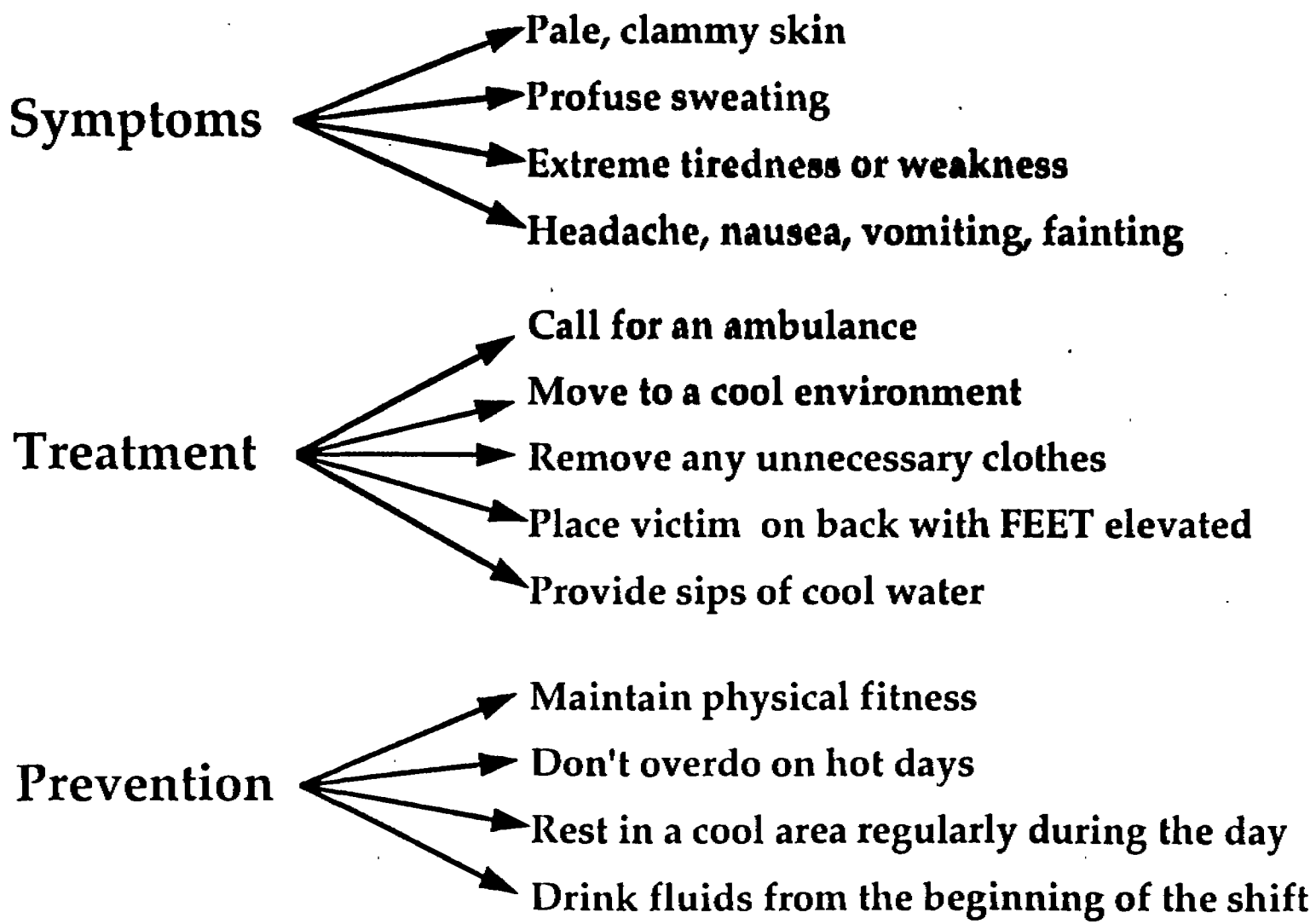
Rest, water and the opportunity to cool are necessary to alleviate the cramps.

An employee with abdominal cramps may not be able to tolerate water so do not delay transport to a medical facility where additional treatment can be administered.

Drink sufficient water starting at the beginning of the shift and continue throughout the shift.

HEAT STRESS

HEAT EXHAUSTION



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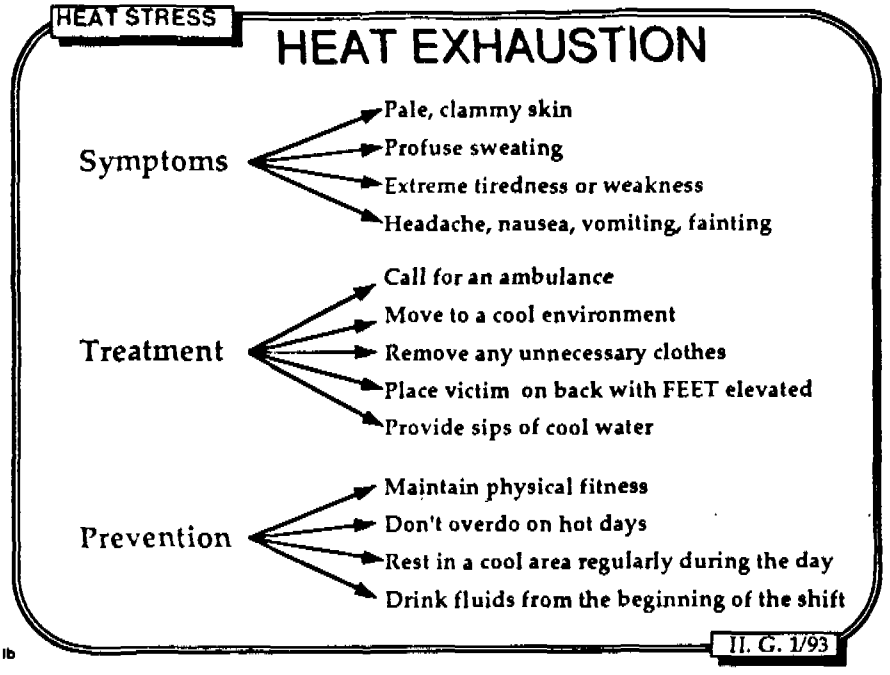


The major signs of heat exhaustion are pale, clammy skin, profuse sweating, and extreme tiredness or weakness.

The victim may have headache, nausea, vomiting, and/or loss of appetite.

The victim may faint.

An individual with any signs or symptoms of heat exhaustion should be treated as for mild shock.

Care should be immediate.

While someone is calling for the ambulance, move the employee to a cool environment.

If the person is conscious, offer small amounts of cool water to drink.

Do not delay prompt transport to a medical facility.

Maintain proper cardiovascular fitness through proper exercise and diet.

Remember, thirst is not an adequate stimulus to maintain sufficient fluid in the body.

HEAT STROKE

Symptoms

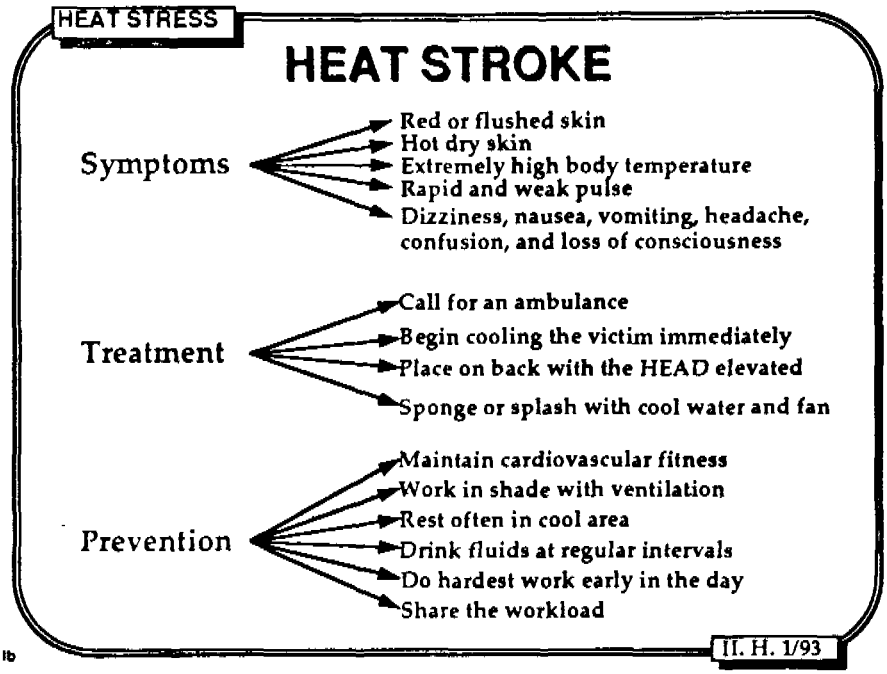
- Red or flushed skin
- Hot dry skin
- Extremely high body temperature
- Rapid and weak pulse
- Dizziness, nausea, vomiting, headache, confusion, and loss of consciousness

Treatment

- Call for an ambulance
- Begin cooling the victim immediately
- Place on back with the HEAD elevated
- Sponge or splash with cool water and fan

Prevention

- Maintain cardiovascular fitness
- Work in shade with ventilation
- Rest often in cool area
- Drink fluids at regular intervals
- Do hardest work early in the day
- Share the workload



SYMPTOMS:

- Heat stroke is the least common but the most serious form of heat stress.
- It occurs when heat exposure overwhelms the body's mechanisms for dissipaing excess heat.
- Sweating, a major mechanism for heat loss, ceases.
- Heat continues to build up in the body to the point where body cells, particularly those in the brain, can be permanently damaged.
- There is usually a history of prolonged exposure to heat, particularly in a humid environment.
- There is a sudden onset of symptoms (hot, dry skin although a person may have been sweating profusely earlier).
- Body temperature of 106°F.
- There may be convulsions and/or muscle twitching.

TREATMENT:

- Heat stroke is a true LIFE-THREATENING EMERGENCY!
- The body temperature rises so high so rapidly that brain damage and death will result if cooling doesn't take place quickly.
- Call for an ambulance immediately when heat stroke is suspected.
- Begin cooling victim by splashing or sponging with cool water and fanning while waiting for the ambulance
- Transport to a medical facility as quickly as possible.
- Do not give anything by mouth to an unconscious person.
- Do not give the victim stimulants such as coffee, tea, or cola beverages.
- Recognition and early treatment can prevent permanent brain damage and death.

PREVENTION:

- Maintain cardiovascular fitness through proper exercise and diet.
- Work in shady areas, if possible, with plenty of ventilation.
- Drink fluids at regular intervals, such as every 20 minutes, starting at the beginning of the shift.
- Share the work load with another worker when possible
- If possible, do the hardest work early in the day when it is cooler

July 19, 1994

HEAT STRESS POSTERS

Information for ordering Heat Stress Posters:

"Heat Stress May Cause Heat Illness"

American Conference of Governmental Industrial Hygienists, Inc.
6500 Glenway Ave.-Bldg. D-7
Cincinnati, Ohio 45211-4438
Phone: (513) 661-7881
Fax #: (513) 661-7195

Set of two (2) posters for $5.00 each set.

Any Questions, please call Darlene x-6181.

Darlene