



**Brookhaven  
National  
Laboratory**



# Heat Stress

07/16/08 SHSD Bob Selvey x-3066

## Q: True or False

The “**HEAT**” in Heat Stress comes from the interaction of:

- Ambient Temperature and
- Humidity and
- Wind (Evaporation)

**A: False**

**Heat Stress is caused when the heat of metabolism from work is not lost to the environment at a rate sufficient to maintain a proper body core temperature.**

# What is Heat Stress ?

1. When we work, our body produces  
**heat = metabolism.**
2. We lose that metabolic heat to the environment by:
  - **sweat** (evaporation)
  - **wind cooling** (convection)
3. When environmental and/or work conditions prevent losing metabolic heat = **heat stress potential**



## Key Factors in Heat Stress

- **Work load and**
- **Hot and humid weather and/or**
- **PPE blocks evaporation and wind**

# Examples of different work levels in “jobs”



# Work Load Activities: ACGIH Examples

**Resting**  
115 kcal/hr

Sitting Quietly  
Sitting with moderate arm movements

**Light**  
180 kcal/hr

Sitting with moderate arm & leg movements  
Standing with light work at machine or bench while using mostly arms  
Using a Table saw  
Standing with light or moderate work at machine or bench and some walking about

**Moderate**  
300 kcal/hr

Scrubbing in a standing position  
Walking about with moderate lifting or pushing  
Walking on level at 6 Km/hr while carrying 3 Kg weight load

**Heavy**  
415 kcal/hr

Carpenter sawing by hand  
Shoveling dry sand  
Heavy assembly work on a noncontinuous basis  
Intermittent heavy lifting with pushing or pulling (e.g., pick and shovel work)

**Very Heavy**  
520 kcal/hr

Shoveling wet sand

# Contributing Environmental Factors Increasing the Risk of Heat stress

<b>Temperature</b>	<b>Warmer temperatures</b> decrease gradient between metabolism temp and ambient temp
<b>Humidity</b>	<b>Higher humidity</b> cuts down sweat evaporation
<b>Radiant Heat</b>	<b>Direct sunlight</b> heats the skin and clothing
<b>Air Velocity</b>	<b>Low wind</b> decreases sweat evaporation

The BNL Site Wide  
notification is based on data  
from an  
*Area Heat Stress Monitor*  
that measures data called  
**WBGT**

Wet Bulb  
(WB)

Dry Bulb  
(T)

Globe  
(G)

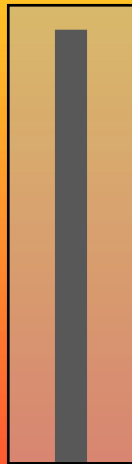


Site Notification is based on

# Wet Bulb- Globe - Temperature

$$\text{WBGT} = 0.7 \text{ WB} + 0.2 \text{ GT} + 0.1 \text{ DB}$$

WB



Effected by:  
- Humidity  
- Wind

Wet Sock  
Cover

WET

GT



Effected by:  
- Sunlight  
- Ambient Temp.

Black Hollow  
Bulb

GLOBE

DB



Plain  
Thermometer

BULB



# BNL notification system

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1. **Ambient Temperature measured at centralized location**
2. **Messages sent out:** (automated means of sending information)
  - a.) **Internet Web page** (automatically updated)
  - b.) **E-mail alerts**
  - c.) **Pager message** to Verizon Wireless Pagers
    - Provide real-time data on the Heat Stress Index
    - Allows **modified work, rather than stop work.**

# Web Page Message

## Heat Stress Conditions

*You Must Refresh This Page To Access Data For The Current Date And Time*

**Current Conditions: HEAT STRESS ADVISORY**

*When Heat Stress conditions exist, the appropriate Work-Rest regimen appears in red.  
All temperatures are 10-minute averages and are stated in degrees Fahrenheit.  
This information is updated Monday - Friday during regular working hours.*

**WBGT INDEX (OUTDOOR)**

**86**

**DATE AND TIME**

**05/19/2000 11:54:21 05/**

**TIME OF LAST UPDATE**

**05/19/2000 11:54:21**

**Hourly Work-Rest regimen based on the current WBGT Index and the Work Load Level**

**Light Work Load**

**Normal Work Conditions**

**Moderate Work Load**

**50% Work - 50% Rest**

**Heavy Work Load**

**25% Work - 75% Rest**

**WBGT Index (Outdoor) = 0.7Wet Bulb + 0.2Globe + 0.1Dry Bulb**

**Wet Bulb Temp**

**77.1**

**Globe Temp**

**95.6**

**Dry Bulb Temp**

**85.2**

# E-mail message



If incoming e-mail message alert is activated, a message signaling the user that this e-mail mail has been received will pop up on the computer screen

From: Heat Stress

Date: 05/22/2008 13:45

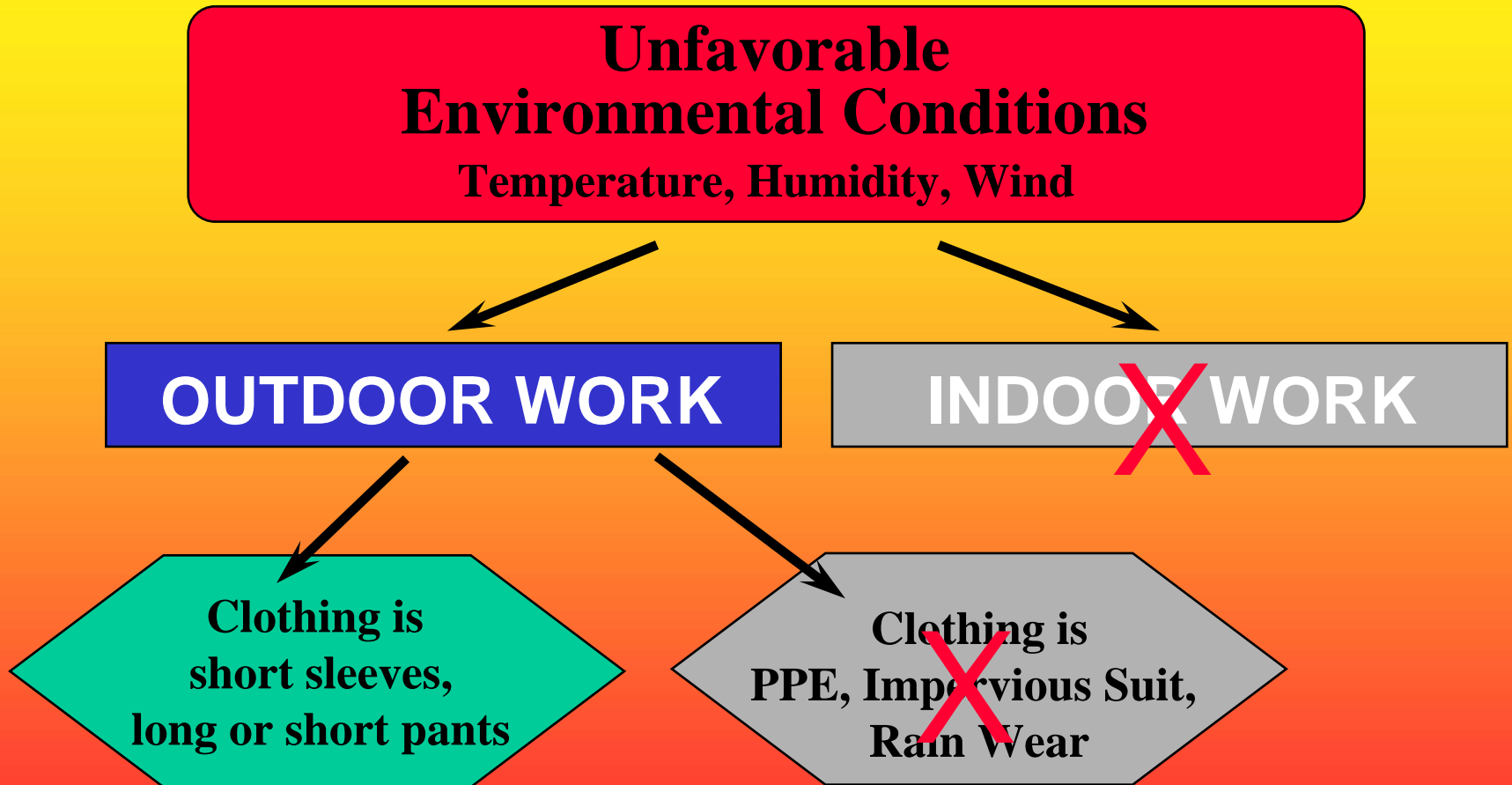
Heat Stress Index is 87 degrees Fahrenheit.  
Light Activity - 0% rest, Moderate Activity - 50% rest, Heavy Activity - 75% rest, Very Heavy Activity - 75% rest.

# Digital pager/cell phone message



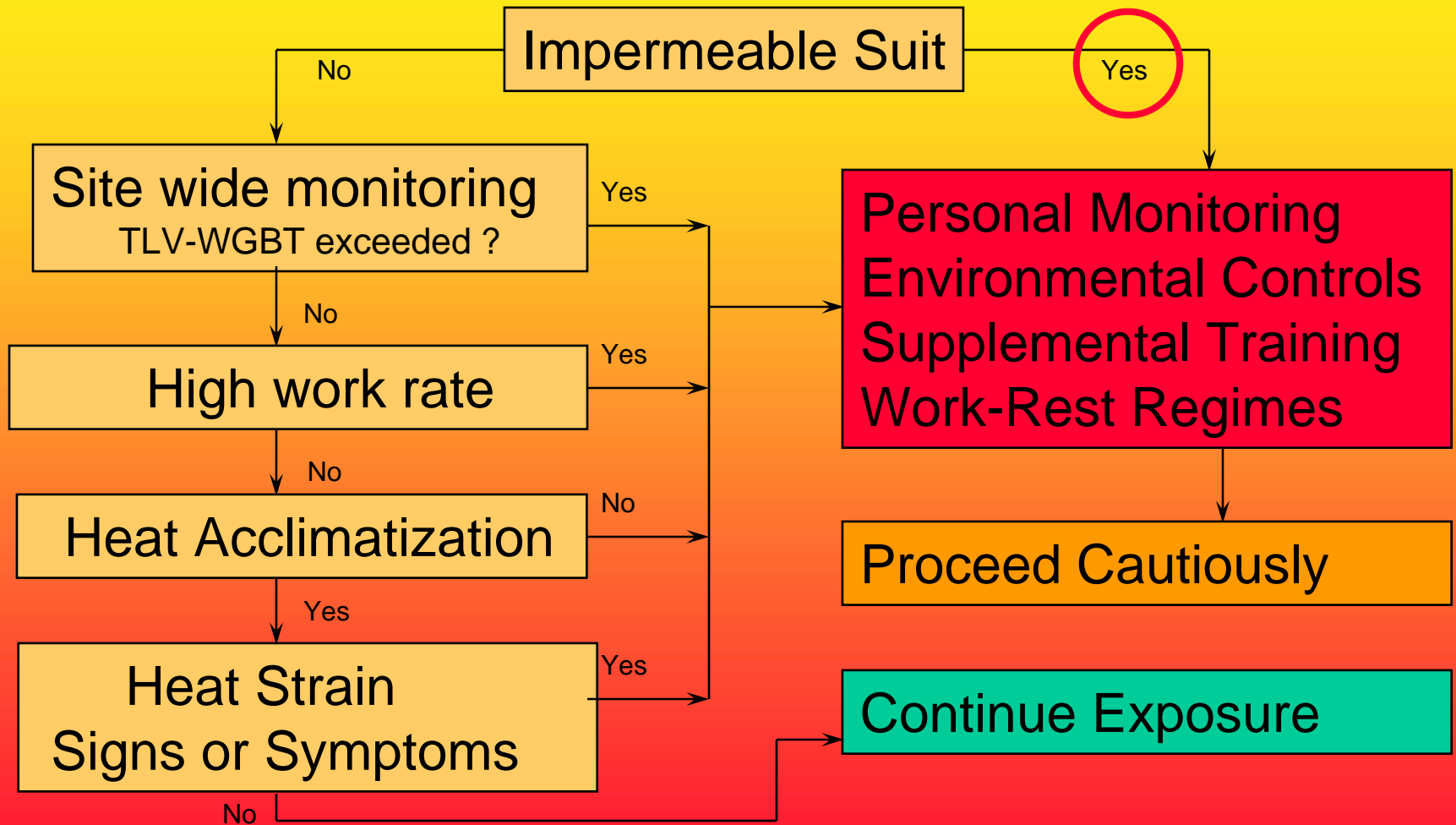
# When does Site Notification alert system apply ?

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# The BNL WGBT site wide warning can not be used when workers wear **impermeable clothing**

e.g. Tyvek, Kleen-guard, Rain Suits or Clothing that insulates worker



# Personal Monitoring

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- **Sustained Heart Rate:**  $180 \text{ bpm} - \text{age} > \text{Measured heart rate}$   
Example:  $180 - 50 \text{ years old} = 130$ ; Worker is O.K. if bpm is 129 or less
- **Recovery Heart Rate:** Heart Rate  $< 110$  bpm at 1 minute after peak work effort
- **Body core temperature:**  $> 100.4\text{F} / 101.3\text{F}$   
(unacclimatized / acclimatized)
- **Symptoms/Complaints from workers:**  
fatigue, nausea, dizziness, lightheadedness
- **Dosimeter monitoring**

# Precautions (Preventing Heat Illnesses): Administrative Controls, Environmental Controls & PPE

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<b>Work Breaks</b>	Divide hour in 15 minute intervals & follow work-rest regimen
<b>Shade</b>	Shield work area or break area from direct sunlight
<b>Air Movement</b>	Fans, unobstructed breezes, A/C



# Precautions (Preventing Heat Illnesses): Administrative Controls, Environmental Controls & PPE

<b>Clothing</b>	<ul style="list-style-type: none"><li>- Short sleeves,</li><li>- Cotton</li></ul>
<b>Personal Protective Equipment</b>	<ul style="list-style-type: none"><li>- Ice vests,</li><li>- Wet headbands,</li><li>- Vortex suits</li></ul>
<b>Fluid Intake</b>	<ul style="list-style-type: none"><li>- Cool water every 20 minutes,</li><li>- Salt in food</li><li>- Gatorade® drinks</li></ul>

# Sources of Info at BNL

- Web Class: Heat Stress Prevention (TQ-HEATSTRESS)
- SHSD Heat Stress Web page
- SBMS: Natural Hazards on the Environment

**BROOKHAVEN**  
NATIONAL LABORATORY

**NATURAL ENVIRONMENTAL HAZARD FACT SHEET**

## Heat Stress

**I. HAZARD OVERVIEW:**

Heat stress is a name given to a collection of health hazards that can occur as a result of strenuous work in hot, humid environments. The effects range from minor discomfort to life threatening implications.

The cause of heat stress is:

1. Metabolic heat: When we work, our body produces heat.
2. We LOSE most of that metabolic heat to the environment by:
  - Sweat (evaporation)
  - Wind cooling (convection)
3. When environmental and/or work condition prevents losing enough metabolic heat, health consequences result = heat stress. The major conditions make us more susceptible to heat stress are:
  - Hot and humid weather
  - PPE blocks evaporation and wind

**II. PREVENTION AND PROTECTION**

**A. WBGT Site Monitoring:**



BNL provides environmental monitoring for Heat Stress conditions in the late spring, summer, and early fall. These notifications can alert workers of environmental conditions, that when mixed with strenuous work, make the worker susceptible to heat stress.

The WBGT (Wet Bulb-Globe-Temperature) factors the ambient temperature, humidity, and wind speed into a matrix of health hazards depending on the work activity level. The BNL site notification system alerts workers and management when hazardous conditions occur throughout the day on the BNL site.

Notifications are available via:

- Internet at [BNL Heat Stress Web Page](#)
- Email messages
- Text message paging for cell phones and text message pagers.

To be advised of the potential for heat stress, contact the Heat Stress SME to set up notification on your computer, pager, or phone.



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**B. Personal Dosimetry and Individual Physical Condition Assessment Monitoring:**

A personal dosimeter is the best method for monitoring individual susceptibility to heat stress and is the only valid method when the WBGT site alert notification system is not indicative of heat stress risk in an actual work situation that varies from the site wide monitoring location. Dosimetry and individual physical condition assessment is needed in the following cases:

- Work is done in impermeable suits (such as Tyvek®)
- Work needs to be done in conditions exceeding the WBGT
- A worker is in atypical health or has a pre-disposition to heat disorders.

Contact a Facility Support Representative or IH Representative for use of a dosimeter.

The personal heat stress dosimeter is:

- A Thermometer worn in the ear like a noise ear plug
- Logs internal body temperature
- Alarms in danger situations
- It measures an equivalent of the body core temperature



When workers are doing heavy work that causes them to work longer than the WBGT alert allows or when wearing impermeable suits, monitor workers' physical condition and halt work if one or more of the following conditions occur:

- Sustained (several minutes) heart rate in excess of 180 beats per minutes (bpm) minus the individual's age in years (i.e., 180-age = acceptable sustained heart rate)
  - Body core temperature exceeds 38C (100.4F)
  - Recovery heart rate at one minute after peak work effort is greater 110 bpm
  - Symptoms of sudden and severe fatigue, nausea, dizziness, or lightheadedness
- Contact the SME or IH Representative for assistance in conducting this type of ongoing health assessments.

**Precautions for Preventing Heat Illnesses:**

<b>Work Breaks</b>	Divide the hour in 15-minute intervals & follow work-rest regimen. See Table 1 WBGT Index and Work-Rest regimen (Criteria for Acclimatized Worker) below.
<b>Shade</b>	Shield work area or break area from direct sunlight
<b>Air Movement</b>	Fans, unobstructed breezes, A/C
<b>Clothing</b>	Short sleeve shirt made of cotton
<b>Personal Protective Equipment</b>	• ice vests, wet headbands, Vortex suits
<b>Fluid Intake</b>	• Cool water every 20 minutes • Salt in food • Electrolyte (Gatorade® type) drinks



Table 1: WBGT Index and Work-Rest Regimen (Criteria for Acclimatized Worker)

WBGT Temp in °F [°C]	Light Work Tasks % Rest/Work	Moderate Work Tasks % Rest/Work	Heavy Work Tasks % Rest/Work	Very Heavy Work Tasks % Rest/Work
81.5 (27.5C)	0/100	0/100	25/75	0/100
83 (28.3C)	0/100	25/75	0/100	0/100
85 (29.5C)	0/100	0/100	0/100	75/25
86 (30.0C)	0/100	0/100	75/25	75/25
87 (30.5C)	25/75	0/100	75/25	75/25
88 (31.0C)	25/75	75/25	75/25	75/25
89 (31.5C)	0/100	75/25	75/25	75/25
90.5 (32.5C)	75/25	75/25	75/25	75/25

Table 2: Examples of Work Load Level for Typical Tasks

<b>RESTING</b>	Sitting quietly Sitting with moderate arm movements
<b>LIGHT</b> •200 kcal/hr	Sitting with moderate arm and leg movements Standing with light work at machine or bench using mostly arms Standing with light to moderate work at machine or bench and some walking Using a table saw
<b>MODERATE</b> 200 - 350 kcal/hr	Walking about with moderate lifting and pushing Walking on level at 6km/hr (4 mph) while carrying 3-kg (5-lb) weight load Scrubbing in a standing position
<b>HEAVY</b> 350 - 500 kcal/hr	Pick and shovel work Carpenter sawing by hand Shoveling dry sand Heavy assembly work on a non-continuous basis Intermittent heavy lifting with pushing and pulling
<b>VERY HEAVY</b>	Shoveling wet sand

**III. HEALTH HAZARD INFORMATION: CAUSAL AGENT: SIGNS & SYMPTOMS**

**Personal Factor that increase the risk of heat stress are**

<b>Age</b>	People become more susceptible to heat stress, as
<b>Weight</b>	Excessive weight insulates the body core and incre
<b>Fitness</b>	Fit people are at less risk.
<b>Un-Acclimatized</b>	Acclimatization is a series of physical adaptations t "use to heat" and allows a worker to be less prone do more work in heat.

**Heat Stress Illnesses are**

Disorder Name	Signs and symptoms	What to do
<b>Heat Rash</b> (also known as "prickly heat")	<ul style="list-style-type: none"> <li>• Inflammation of the skin resulting from prolonged exposure to heat and humid air.</li> <li>• Often aggravated by chafing from clothes.</li> </ul>	Recovery is by rest in the shade and washing the affected areas in cool water.
<b>Heat Cramps</b>	<ul style="list-style-type: none"> <li>• Cramps in the extremities (especially legs and hands) or abdomen caused by the depletion of water and salt in the body.</li> <li>• Usually occurs after physical exertion in an extremely hot environment or under conditions that cause profuse sweating and depletion of body fluids and electrolytes.</li> </ul>	Recovery is by rest in the shade and drinking fluids with electrolytes (sports type beverages are good).
<b>Heat Exhaustion</b>	<ul style="list-style-type: none"> <li>• Potentially Serious: weakness, dizziness, nausea.</li> <li>• A result of the body's inadequate effort to give off excessive heat. Although not an immediate threat to life, if not properly treated and exposure to heat continues, could evolve into heat stroke.</li> <li>• Caused by loss of fluids, skin: clammy &amp; moist</li> </ul>	Recovery with rest in shade & drink w/electrolytes
<b>Heat Stroke</b>	<ul style="list-style-type: none"> <li>• Severe and potentially fatal condition resulting from the failure of the body to regulate its core temperature.</li> <li>• Mental Confusion.</li> <li>• Loss of consciousness.</li> <li>• Convulsions.</li> <li>• Body temperature &gt; 106</li> <li>• Hot, dry skin. No sweating.</li> <li>• May die unless treated promptly.</li> </ul>	True medical emergency requiring immediate transport to a medical facility. Call 2222 or 911 from Lab phone for immediate transport to a hospital.

# The End

- Question/Comments?

