

## FESHM 4250: Temperature Extremes

### Revision History

<b>Author</b>	<b>Description of Change</b>	<b>Revision Date</b>
Jonathan Staffa & David Baird	<ul style="list-style-type: none"><li>• Added standard chapter format to document</li><li>• Adopted current American Conference of Governmental Industrial Hygienists Threshold Limit Values (TLVs)</li><li>• Changed responsibilities from D/S/C ESH groups to ESH Points of Contact. An ESHPOC may be a Divisional Safety Officer or a representative from the ESH&amp;Q Section.</li></ul>	May 2015

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## HEAT STRESS

### 1.0 INTRODUCTION

Heat stress depends on work rate as well as environmental heat load. When the body cannot cope with an excess heat load, three heat illnesses may occur. The most severe is heat stroke, which is characterized by dry skin, rapidly rising body temperature, collapse and death unless there is a prompt reduction in body temperature. Heat exhaustion is characterized by clammy moist skin, weakness, nausea, headache, low blood pressure and a weak pulse. Collapse will occur unless there is prompt rest and replenishment of lost electrolyte. Heat cramps are characterized by painful muscle spasms that disappear with rest and electrolyte replacement.

### 2.0 DEFINITIONS

Wet-Bulb Globe Temperature (WBGT) - an index used to quantify stress caused by radiant and convective heat, humidity, and wind. WBGT values are calculated using one of the following equations:

- With direct exposure to sunlight:  $WBGT_{out} = WBGT$  taken outside

$$WBGT_{out} = 0.7 T_{nwb} + 0.2 T_g + 0.1 T_{db}$$

- Without direct exposure to the sun:  $WBGT_{in} = WBGT$  taken inside

$$WBGT_{in} = 0.7 T_{nwb} + 0.3 T_g$$

Where:  $T_{nwb}$  = natural wet bulb temperature (sometimes called NWB)

$T_g$  = globe temperature (sometimes called GT)

$T_{db}$  = dry bulb (air) temperature (sometimes called DB)

### 3.0 RESPONSIBILITIES

#### 3.1 Supervisors

The supervisor of work in hot environments shall notify their division/section/center Environment, Safety and Health Point of Contact (ESHPOC) prior to the start of work.

#### 3.2 Division/Section/Center ESHPOC

The division/section/center ESHPOC shall ensure that all industrial hygiene (IH) testing needed to estimate the hazards of hot-weather work is performed.

### **3.3 Environment, Safety, Health and Quality (ESH&Q) Section Industrial Hygiene (IH) Group**

The ESH&Q Section IH Group is responsible for sampling and maintaining industrial hygiene equipment used to quantify heat stress potential.

## **4.0 PROCEDURES**

Exposure to heat stress should be evaluated by ESH&Q Section IH Group whenever there is a concern about this hazard. Assessment is based on Wet Bulb Globe Thermometer readings plus work levels and/or the effect(s) heat stress is having on the workers.

### **4.1 Control Implementation**

If heat stress is found to be a problem, then the following controls should be implemented.

- a. The workload should be initially reduced and gradually increased over the first week of exposure. This should include newly assigned workers and those recently returning from a serious illness or long vacation.
- b. Individuals should not work alone. In the event that one experiences heat illness, the other(s) present can arrange for help.
- c. Individuals should drink a cup of cool water every 15-20 minutes.
- d. Consider modification of work activities, schedules and locations.

#### 4.2 Table 1. Screening Criteria for Heat Stress Exposure (WBGT values in °C)<sup>1</sup>

Table 1 below is for assessing and controlling heat exposures.

Allocation of Work in a Cycle of Work and Recovery	Threshold Limit Value (TLV) <sup>®</sup> (WBGT values in °C)				Action Limit (WBGT values in °C)			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
75 to 100%	31.0	28.0			28.0	25.0		
50 to 75%	31.0	29.0	27.5		28.5	26.0	24.0	
25 to 50%	32.0	30.0	29.0	28.0	29.5	27.0	25.5	24.5
0 to 25%	32.5	31.5	30.5	30.0	30.0	29.0	28.0	27.0

- A. Light Work: Sitting with light manual work with hands or arms, and driving. Standing with some light arm work and occasional working.
- B. Moderate Work: Sustained moderate hand and arm work, moderate arm and leg work, moderate arm and truck work, or light pushing and pulling. Normal walking.
- C. Heavy Work: Intense arm and trunk work, carrying, shoveling, manual sawing; pushing and pulling heavy loads; and walking at a fast pace.
- D. Very Heavy Work: Very intense activity at fast to maximum pace.
- E. TLVs should be corrected for clothing as follows:

Clothing Type	Addition to WBGT °C
Work cloths (long sleeve shirt and pants)	0
Cloth (woven material) coveralls	0
Double-layer woven clothing	3
SMS polypropylene overalls	0.5
Polyolefin coveralls	1
Limited-use vapor-barrier coveralls	11

<sup>1</sup> Note: Detailed information on this table and its application is available in the latest versions of the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents & Biological Exposure Indices

## **COLD STRESS**

### **5.0 INTRODUCTION**

Cold stress standards are intended to prevent workers from the severest effects of cold stress (hypothermia) and cold injury, and to describe exposures to cold working conditions under which it is believed that nearly all workers can be repeatedly exposed without adverse health effects.

Fatal exposures to cold among workers have almost always resulted from accidental exposures involving failure to escape from low environmental air temperatures or immersion in low temperature water. Lower body temperatures often result in reduced mental alertness, reduction in rational decision-making, or loss of consciousness with the threat of fatal consequences.

### **6.0 DEFINITIONS**

Equivalent Chill Temperature (ECT) - The perceived combined effect of cold and wind on exposed skin. Also known as *wind chill factor*.

### **7.0 RESPONSIBILITIES**

#### **7.1 Supervisors**

The supervisor of work in cold environments shall notify their division/section/center ES&H group Point of Contact (ESHPOC) prior to the start of work.

#### **7.2 Division/Section/Center ESHPOC**

The division/section/center ESHPOC shall ensure that all industrial hygiene (IH) testing needed to estimate the hazards of extended cold weather work is performed.

#### **7.3 ESH&Q Section IH Group**

The ESH&Q Section IH Group is responsible for sampling and maintaining industrial hygiene equipment used to quantify cold hazards.

### **8.0 PROCEDURES**

Upon starting work in a very cold environment, the supervisor shall notify the division/section/center ESHPOC, who shall decide if further consideration is necessary. The division/section/center ESHPOC may, with the help of the ESH&Q Section IH Group, perform industrial hygiene sampling to determine the ECT in the work area. At the discretion of the ESH&Q Section IH Group, local weather broadcasts may be used to determine ECT.

For work in environments where the ECT is less than -25°F (-31.7°C), the supervisor shall impose the work/rest regimens shown in Table 2.

Supervisors shall halt all extended cold-weather work in environments of  $<-75^{\circ}\text{F}$  ( $< 59.4^{\circ}\text{C}$ ) ECT.

### 8.1 Table 2. Work/Warm-Up Schedule for a 4-Hour Shift<sup>2</sup>

Air Temp-Sunny Sky		No Noticeable Wind		5 mph wind		10 mph wind		15 mph wind		20 mph wind	
$^{\circ}\text{C}$	$^{\circ}\text{F}$	Max Work Period	Number of Breaks								
-26 $^{\circ}$ to -28 $^{\circ}$	-15 $^{\circ}$ to -19 $^{\circ}$	Normal Breaks	1	Normal Breaks	1	75 min.	2	55 min	3	40 min	4
-29 $^{\circ}$ to -31 $^{\circ}$	-20 $^{\circ}$ to -24 $^{\circ}$	Normal Breaks	1	75 min.	2	55 min.	3	40 min.	4	30 min.	5
-32 $^{\circ}$ to -34 $^{\circ}$	-25 $^{\circ}$ to -29 $^{\circ}$	75 min.	2	55 min.	3	40 min.	4	30 min.	5	Non-emergency work should cease	
-35 $^{\circ}$ to -37 $^{\circ}$	-30 $^{\circ}$ to -34 $^{\circ}$	55 min.	3	40 min.	4	30 in.	5	Non-emergency work should cease			
-38 $^{\circ}$ to -39 $^{\circ}$	-35 $^{\circ}$ to -39 $^{\circ}$	40 min	4	30 min	5	Non-emergency work should cease					
-40 $^{\circ}$ to -42 $^{\circ}$	-40 $^{\circ}$ to -44 $^{\circ}$	30 min	5	Non-emergency work should cease							
-43 $^{\circ}$ & below	-45 $^{\circ}$ & below	Non-emergency work should cease									

### Prevention of Cold Stress

Adequate insulating of dry clothing to maintain core temperature above  $36^{\circ}\text{C}$  ( $96.8^{\circ}\text{F}$ ) must be provided to workers if it is performed at air temperatures below  $4^{\circ}\text{C}$  ( $40^{\circ}\text{F}$ ). The higher the wind speed and the lower the temperature in the work area, the greater the insulation value of the protective clothing required. An equivalent chill temperature can be computed using the air temperature and the wind velocity (see Table 3). "Wind chill factors" can also be heard on local weather broadcasts.

For exposed skin, continuous exposure should not be permitted when the air speed and temperature results in an equivalent chill temperature of  $-32^{\circ}\text{C}$  ( $-25.6^{\circ}\text{F}$ ). Superficial or deep local freezing will occur only at temperatures below  $-1\text{C}$  ( $30.2\text{F}$ ), regardless of wind speed.

The recommended limits for properly clothed workers for periods of work at temperatures below freezing are found in Table 2. Older workers or workers with circulatory problems require special protection against cold injury.

<sup>2</sup> Note: Detailed information on this table and its application is available in the latest versions of the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents & Biological Exposure Indices

**8.2 Table 3. Cooling Power of Wind on Exposed Flesh Expressed as Equivalent Temperature (under calm conditions)\***

Estimated Wind Speed (in mph)	Actual Temperature (°F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (°F)											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(Wind speeds greater than 40 mph have little additional effect.)	<i>LITTLE DANGER</i> In < hour with dry skin. Maximum danger of false sense of security.				<i>INCREASING DANGER</i> Danger from freezing of exposed flesh within one minute.				<i>GREAT DANGER</i> Flesh may freeze within 30 seconds.			
	<b>Trenchfoot and immersion foot may occur at any point on this chart.</b>											

\* Developed by U.S. Army Research Institute of Environmental Medicine, Natick, MA.

□ Equivalent chill temperature requiring dry clothing to maintain core body temperature above 36°C (98.6°F) per cold stress TLV®.