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Introduction to Occupational Heat Stress

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Introduction:

Occupational Heat Stress

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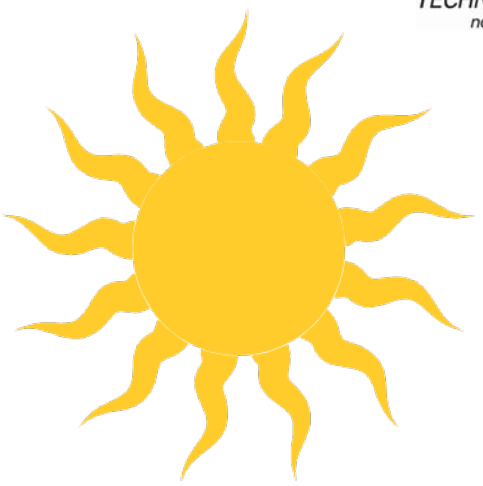
Occupational Heat Stress Learning Objectives

- Reduce risk of heat disorders and stroke.
- Reduce accidents and injuries.
- Reduce risk of human error.
- Maintain performance.
- Reduce cost of absenteeism.



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Course Outline

- Heat Stress Defined
- Contributors to Heat Stress
- The Body's Response
- Monitoring for Heat Stress
- Heat Stress Controls
- The Management of Heat Stress

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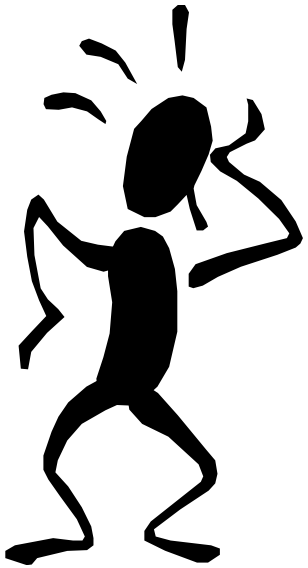
Where the Heat Comes From



- Metabolic Heat from Converting Food to Energy and Using It to Do Work
- Heat may be Added by the Environment
- Heat may Be Taken Away by the Environment
- Clothing Can Trap the Heat

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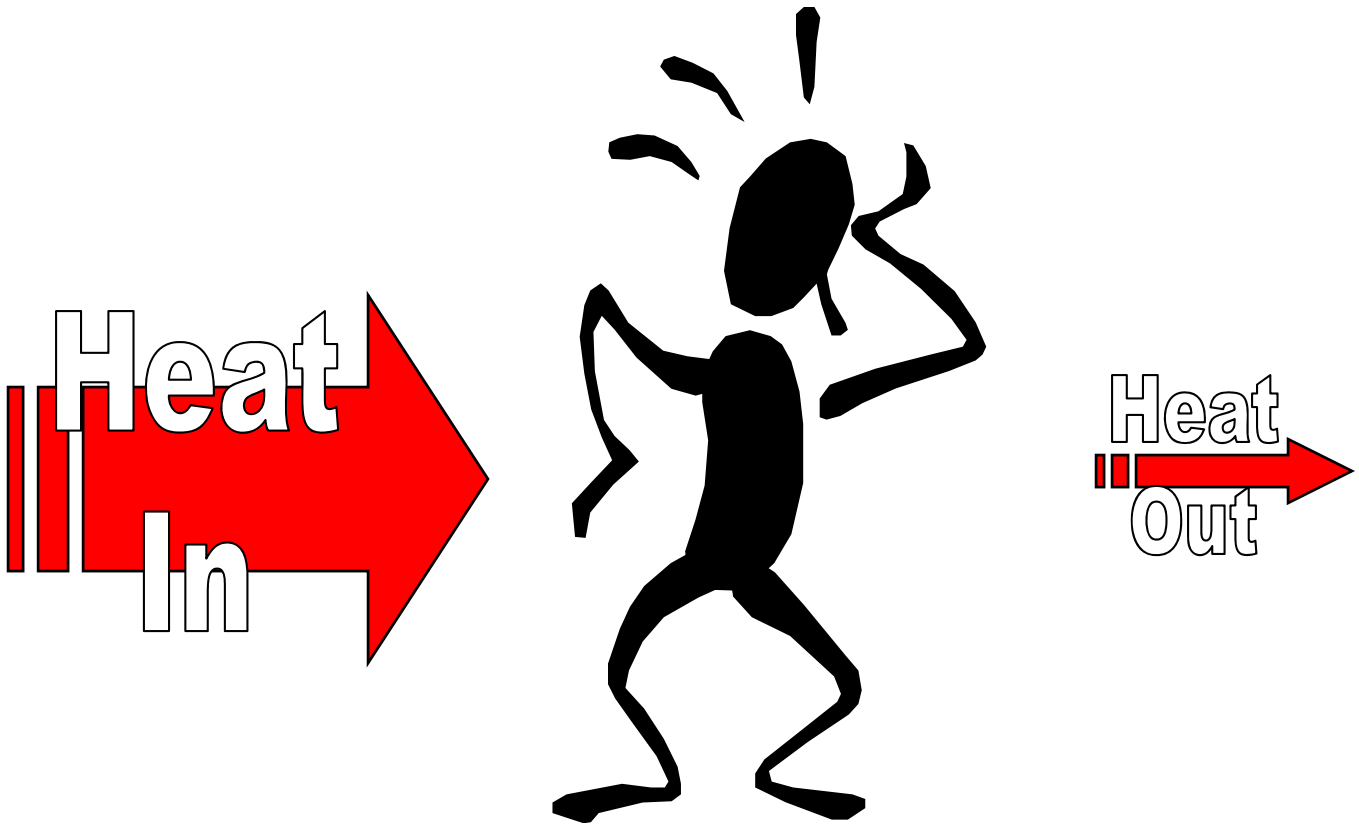
Loss of Thermoregulation Balance



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Heat Stress: Definition

Net Heat Load on the Body from the Combined Contributions of Metabolic Heat Production and External Environmental Factors.

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Heat Strain: Definition

The Net Physiological Load Resulting from Heat Stress (the body's response)

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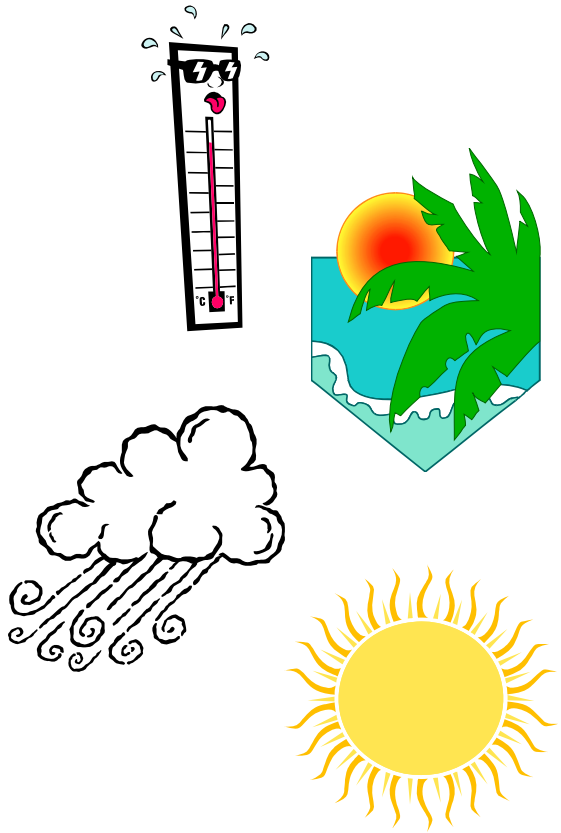
Environmental Factors

- Temperature
- Evaporative Potential
- Air Movement
- Radiant Heat



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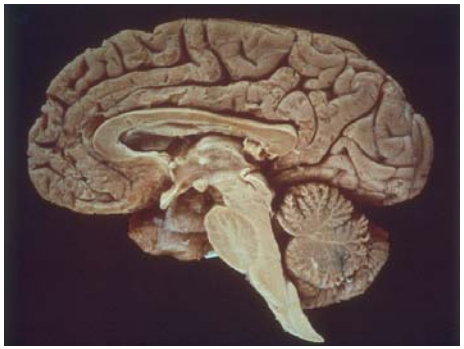
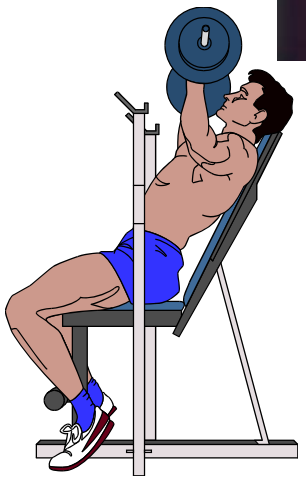
Our Body

Hypothalamus
-the Body's Temperature Control Center

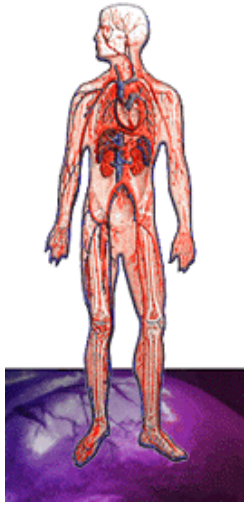


Our body eliminates excess heat through

- *Perspiration*



- *Blood Flow*



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Internal Factors

- Fluid Balance
  - *Is there sufficient hydration?*
- Metabolism (work load)
  - *How much heat is generated?*
- Perspiration
  - *Ability to remove the heat*

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Complicating Factors

- Age, weight
- Diet
- Alcohol / Drugs
- Health
  - *Medication*
- Acclimatization / conditioning

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Assessments Likely to Fail

- Thirst
  - *lagging indication – possibly already dehydrated*
- Self Appraisal
  - *self awareness is important but under heat strain, judgment is impaired*

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Self Regulation

Conditions can often work against self regulation and safety

- Pay Incentives
  - *High work rate to make more money*
- Macho Phenomenon
  - *I can handle it*
- Emergencies
  - *High psychological and physical stress*

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Heat Stress Symptoms

- Sweat Cessation
  - *Skin may be hot and dry*
- Skin Color Change
  - *Rash*
- Shivering
- Irritability
- Disorientation

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Heat Stress Consequences

- Fatigue, Tired Feeling
- Reduced Productivity
- Increased Errors, Accidents

- Risk of Heat Related Disorders

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When Responses Fail, Reactions Occur

- Rash
- Cramping
- Exhaustion
- Syncope (fainting)
- Stroke
- Death

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Signs of Exhaustion and Dehydration

- Thirst
- Weakness
- Headache / Dizziness
- Loss of Coordination

Proper Response

- Cool Down / Rest
- Hydrate (drink)
- Seek Medical Attention

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Syncope

Pooling of blood in extremities
resulting in blurred vision, dizziness, and fainting

Proper Response

- Lay down
- Hydrate
- Seek Medical Attention

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Stroke

Medical Emergency

- Hot Skin, Elevated Body Temperature, Fast Pulse
- Possible Convulsions, Delirium, Unconsciousness

Proper Response

- Immediate Cooling
- Emergency Medical Care (911)

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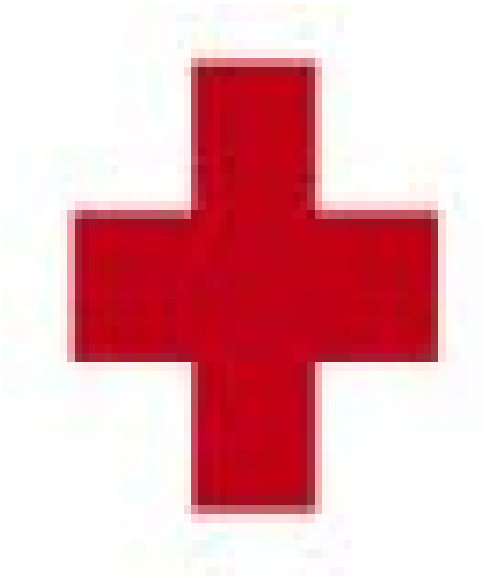
First Aid



- Awareness training
- Look for signs in coworkers
- Drink Fluids
- Lie down, remove heavy gear and clothing
- Provide emergency cooling methods
- Emergency transportation or call 911

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Industrial Hygiene Model

- Identify
- Monitor
- Control
  - *Eliminate*
  - *Minimize*
- Protect
  - *Work / Rest*
  - *PPE*
  - *Training*

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Two Areas for Assessment

- Environmental

  Evaluate the Ambient Environment and Its Affects on the Person

- Individual

  Evaluate the Heat Being Generated Within the Person and/or other Physiological Affects

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Possible Approaches

Environmental

The most commonly used measurements:

- Heat Index
- WBGT

Individual

- Core Temperature
- Heart Rate
- Sweat Rate
- Urine Sodium Level
- Oxygen Consumption

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Key Body Temperatures

The World Health Organization recommends workers should maintain their body temperature below 38°C or 38.5°C when closely monitored

37° C	98.6° F	Normal
38° C	100.4° F	Long Exposure
38.5° C	101.3° F	
39° C	102.2° F	Short Exposure
41° C	105.8° F	Life Threatening

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Heat Index

- Combination of Temperature & Humidity
- Gives “Feel Like” Temperature
- Used Primarily in the USA
- Assumes shade, radiant heat (Sun) is not accounted for
- Screening Tool: Not in Regulations

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Wet Bulb Globe Temperature

- Dry Bulb: Shielded Thermometer
  - Air Temperature
- Wet Bulb: Wet Wick over Thermometer
  - Temperature, Humidity, and Airflow
- Globe: Black Copper Globe over Thermometer
  - Radiant Heat (sunlight)

WBGT Index provides work/rest guidelines intended to keep worker's body temperature below 38°C

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WBGT Index

Used to determine hourly work/recovery periods

- Measure WBGT
- Classify Type of Work Load
  - *Resting, Light, Moderate, Heavy, Very Heavy*
- Apply Correction Factors for Clothing if needed
- Determine work/recovery ratio

Classification of Activities

Resting	Sitting Quietly, Some Arm Movement
Light	Sitting, Standing, Some Arm/leg Movement, Small Hand Tool Use
Moderate	Walking, Carry Moderate Loads, Active Arm Work
Heavy	Some Heavy Lifting, Active Movement
Very Heavy	Lifting or Moving Heavy Objects with little or no break between movements

WBGT Correction Factors for Clothing (in °C)

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Clothing Type	WBGT Correction
Work clothes (long sleeve shirt and pants)	0°
Cloth (woven Material) Coveralls	0°
Double-layer woven clothing	+3°
SMS polypropylene coveralls	+0.5°
Polyolefin coveralls	+1°
Limited-use vapor-barrier coveralls	+11°

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Screening Criteria
Heat Stress Exposure
Threshold Limit Values (Action Limit)

Work vs. Recovery (per Hour)	Work Load: Light	Moderate	Heavy	Very Heavy
	Temperature in Degrees C			
75% to 100%	31.0 (28.0)	28.0 (25.0)		
50% to 75%	31.0 (28.5)	29.0 (26.0)	27.5 (24.0)	
25% to 50%	32.0 (29.5)	30.0 (27.0)	29.0 (25.5)	28.0 (24.5)
0% to 25%	32.5 (30.0)	31.5 (29.0)	30.5 (28.0)	30.0 (27.0)

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U.S. Army Flag System

HEAT CATEGORY	WBGT INDEX, °F	EASY WORK		MODERATE WORK		HARD WORK	
		WORK /REST	WATER INTAKE, QT/HR	WORK /REST	WATER INTAKE, QT/HR	WORK /REST	WATER INTAKE, QT/HR
1	78-81.9	NL	1/2	NL	3/4	40/20 min.	3/4
2 (Green)	82-84.9	NL	1/2	50/10 min.	3/4	30/30 min.	1
3 (Yellow)	85-87.9	NL	3/4	40/20 min.	3/4	30/30 min.	1
4 (Red)	88-89.9	NL	3/4	30/30 min.	3/4	20/40 min.	1
5 (Black)	> 90	50/10 min.	1	20/40 min.	1	10/50 min.	1

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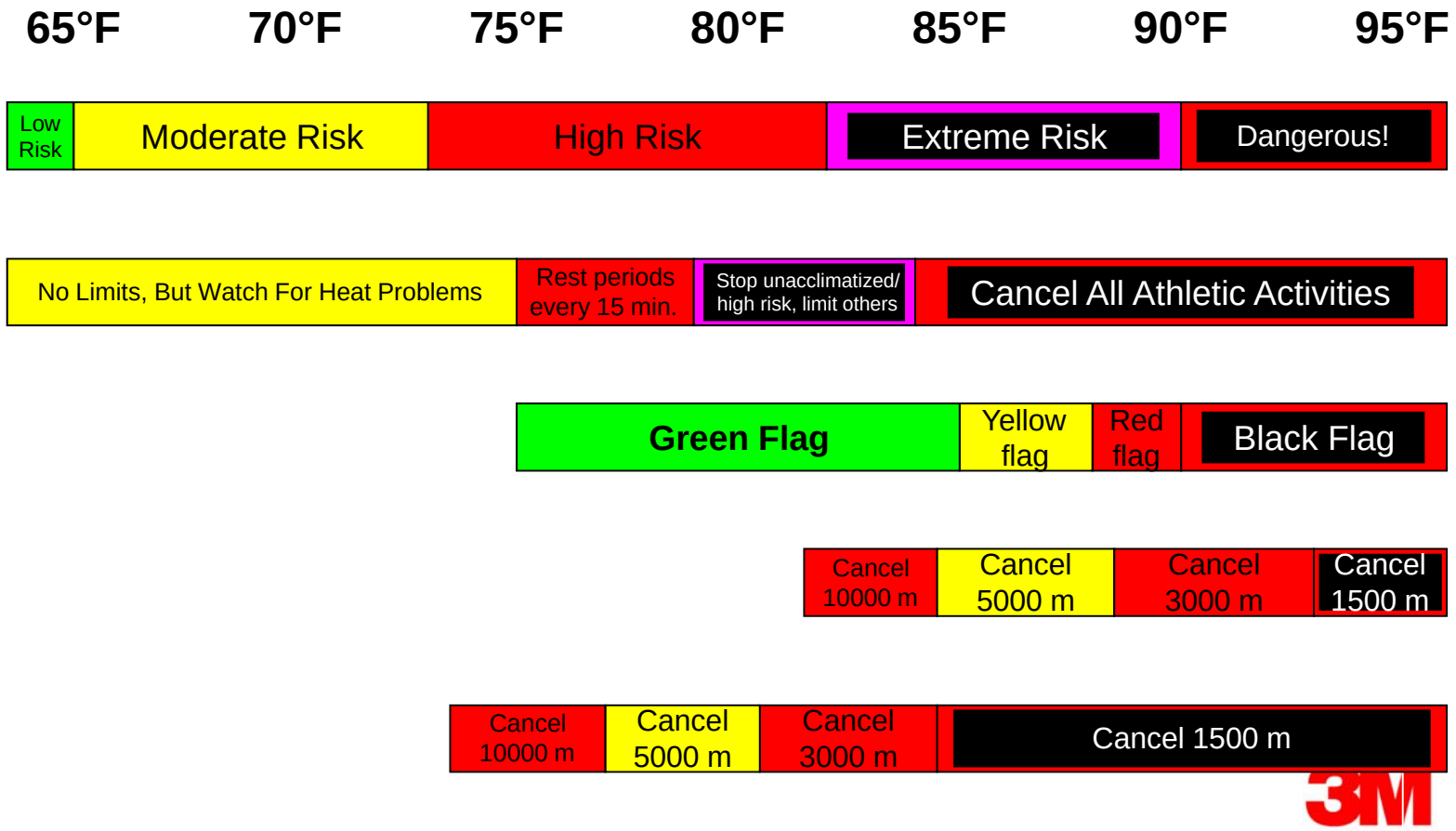
WBGT Guidelines



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Calculating Average from Multiple Exposures

$$\frac{WBGT1 \times t1 + WBGT2 \times t2 \ldots + WBGTn \times tn}{t1 + t2 \ldots + tn}$$

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Heat Stress Program

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- Work evaluation – where are workers exposed to potential heat stress
- Medical Screening
- Training
- Monitoring – WBGT or Individual
- Controls
  - *Work/Rest*
  - *Fluids*
  - *Air flow – add fans if dry bulb is below 38° C*
  - *Personal Protective Equipment (PPE)*

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Medical Screening

- Pre-existing conditions
- Overweight
- Unacclimatized
- Conditioned
- Alcohol, Drugs

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Training

- Management and Workers
  - *Heat Stress & Heat Strain*
  - *Heat Disorders*
  - *Self and Coworker Awareness*
  - *Safe Practices*
  - *First Aid*

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Exposure Controls

- Rest/Work Scheduling
- Re-hydration
- Cooling Vests
- Ventilation
- Humidity Reduction
- Change Process or Procedure
- Clothing

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Hydration

- Drink before, during and after physical labor
- Anticipate conditions: weather, gear, dress, workload
- Drink every 15- 20 minutes
- Make fluids accessible
- Drink cool fluids
- Flavored drinks may increase use
- Replace Electrolytes in extreme conditions

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Sources of Information

- ACGIH
- OSHA
- NIOSH
- ISO
- World Health Organization
- National Athletic Trainer's Association
- National Weather Service
- Experienced Employers

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