SAFETY AND HEALTH
INDUSTRIAL HYGIENE
Thermal Stress Program

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Introduction:

This program is a general approach to risk prevention and minimization of workplace conditions associated with Thermal Stress. It is designed to help leaders and individuals to assess, prevent, and minimize health effects associated with extreme cold and hot conditions. Special focus has been placed on the prevention of possible contributing factors as is known in current scientific literature and current best clinical and occupational health practice. Special attention is given to the following factors:

1. Physical and physiological factors
2. Risk Assessment
3. Acclimatization
4. Control Options
5. Medical Surveillance
6. Training & Awareness

KUC will strive to eliminate occupational illness and any factors that affect the ability of its staff to work safely and productively. Additionally this program will serve as a mechanism for fundamental awareness and understanding of Thermal Stress Management principles and practices.

The assessment tools and guidance provided in this program will be utilized under the premise of adapting the workplace to the worker. It is each employee's responsibility to raise any concerns, critical issues and ideas for improvement to their leadership.

I. Heat Stress:

The potential for heat stress at KUC is mainly associated with the smelting operation and some specific tasks at the Bingham Canyon Mine, Refinery Tankhouse, Power Plant and Tailings Impoundment.

People who work indoors in a climate-controlled environment are unlikely to be at risk of suffering effects of heat stress.

1. **Physical and physiological factors:** The potential for heat-induced illnesses is not dependent on any one factor but is usually associated with a combination of task, environmental and personal conditions. Task and environmental factors that need to be considered are:

   a. Temperature
   b. Humidity
   c. Air movement

d. Radiant temperature of surroundings (eg. from direct sunlight and furnaces)
e. Clothing (can interfere with evaporative heat loss)
f. Personal protective equipment (PPE)
g. Physical activity (contributes to metabolic heat generation).

Personal factors which can influence the onset of heat illness include:

a. Age
b. General health
c. Weight and physical fitness
d. Hydration status (the amount of water in the body)
e. Acclimatization
f. Alcohol and Drugs

2. **Effects on Humans**

The human body operates within a very narrow core temperature band. Normal internal core body temperature usually ranges between 36.8°C and 37.2°C.

a. Heat stroke: which is a state of thermoregulatory failure, is the most serious of the heat illnesses. Heat stroke is usually considered to be characterized by hot, dry skin; rapidly rising body temperature; collapse; loss of consciousness; and convulsions. If deep body temperature exceeds 40°C (104°F), the danger of heat stroke is imminent.

b. Heat exhaustion: while serious, is initially a less severe heat injury than heat stroke, although it can become a preliminary to heat stroke. Heat exhaustion is generally characterized by clammy, moist skin; weakness or extreme fatigue; nausea; headache; no excessive increase in body temperature; and low blood pressure with a weak pulse. Without prompt treatment, collapse is inevitable.

c. Heat cramps: are characterized by painful spasms in one or more skeletal muscles. Heat cramps may occur in persons who sweat profusely in heat without replacing salt losses or unacclimatized personnel with higher levels of salt in their sweat.

d. Heat collapse (Fainting)**:** The brain does not receive enough oxygen because blood pools in the extremities resulting in loss of consciousness. In order to prevent, workers should gradually become acclimatized to the hot environment.

e. Heat rash: Is the most common problem in hot work environments.

Prickly heat is manifested as red papules and usually appears in areas where the clothing is restrictive. In most cases, heat rash will disappear when the affected individuals returns to a cool environment.

f. Heat fatigue: The signs of heat fatigue include impaired performance of skilled sensorimotor, mental, or vigilance jobs. There is no treatment for heat fatigue except to remove from heat stress before a more serious heat-related condition develops.

3. **Heat Stress Workplace Assessment:**

A workplace assessment for heat stress should begin with an assessment of work areas or activities where employees have experienced excessive fatigue, muscle cramps, dehydration, dizziness, or other symptoms of heat related stress.

Heat stress can be assessed with an estimation of several criteria including work rate, clothing requirements, and measurements of the ambient conditions. These guidelines for evaluating employee heat stress are found in the ACGIH publication, *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*.

a. Environment: The Wet-Bulb Globe Temperature (WBGT) is a useful index to be used to evaluate environmental contributions to heat stress. It is influenced by air temperature, radiant heat, air movement, and humidity.

b. Work rate: corresponds to metabolic activity while performing work duties. As work demands increase the metabolic rate increases.

c. Clothing**:** Ideally, free movement of cool, dry air over the skins surface maximizes heat removed by both evaporation and convection. Evaporation of sweat from the skin is the predominant heat removal mechanism.

4. **Controls:** The most effective means of limiting health effects resulting from high temperatures is by controlling the exposure. Heat stress exposure controls include the following:

a. Engineering Controls: Consider engineering controls that reduce the metabolic rate, provide general air movement, reduce process heat and water vapor release, and shield radiant heat sources.

b. Administrative Controls: Consider administrative controls that set acceptable exposure times, allow sufficient recovery, and limit physiological strain.

i. It is recommended that tasks be scheduled so that the workload is spread equally across all crew members.

ii. Encourage drinking small volumes (approximately 1 cup) of cool water (or other acceptable fluid replacement drink) about every 20 minutes.

iii. Regular tasks, which require work in high risk thermal conditions, should be rotated regularly between operators. To further reduce the risk, operators may also help each other by regular rotating task components (within a certain task).

iv. Employees should be allowed to take a short (few minutes) non-scheduled break if they feel that the job is causing them excessive pain or discomfort. This is *not* intended as a smoke or coffee break.

v. Encourage healthy lifestyles, ideal body weight, and electrolyte balance.

vi. Encourage co-worker observation to detect signs and symptoms of heat strain in others.

c. Personal Protective Equipment (PPE): where elimination and engineering or administrative controls are not adequate to reduce the risk of thermal stress below acceptable thresholds PPE must be utilized. Below are a few PPE choices that can be purchased through the KUC PPE guide:

i. Isotherm Cool Vests

ii. Cap Coolers

iii. Aluminized Clothing

iv. Carbon X gloves & Hoods

5. **Acclimatization Scheduling**

Persons who work regularly in a hot environment become acclimatized. Acclimatization reduces heat discomfort, increases the effectiveness of sweating, reduces salt loss and returns recovery rate to normal. Persons differ in their ability to acclimatize to heat. Extra attention should be given to those returning to work after an extended absence from hot exposure situations (e.g. >14 days), as acclimatization can be lost.

a. For new workers, the schedule should be no more than 20% exposure to heat on day 1 and an increase of no more than 20% exposure each additional day.

b. For workers who have had previous experience with the job, the acclimatization schedule should be no more than 50% on Day 1, 60% on Day 2, 80% on Day 3, and 100% on Day 4.

II. Cold Stress:

The potential for cold stress at KUC is mainly associated with outdoor operations and maintenance activities at the Bingham Canyon Mine and Tailings Impoundment during the winter months.

1. **Physical and physiological factors**: The potential for cold-induced illnesses is not dependent on any one factor but is usually associated with a combination of task, environmental and personal conditions. Task and environmental factors that need to be considered are:

   a. Temperature
   b. Humidity (higher humidity inhibits evaporative heat loss from the body)
   c. Wind speed (wind chill factor; as wind speed increases, the effective air temperature near the body decreases)
   d. Clothing (provides insulation)
   e. Personal protective equipment (PPE)
   f. Physical activity (contributes to metabolic heat generation).

   Personal factors which can influence the onset of cold stress include:

   a. Age (older adults are more vulnerable to hypothermia than younger persons)
   b. General health (some people do not shiver or react to cold; shivering produces body heat)
   c. Physical fitness (improves the capacity to shiver)
   d. Hydration state (amount of water in the body)
   e. Medication / drugs (certain medications prevent the body from regulating temperatures normally, such as anti-depressants, sedatives, tranquilizers and cardiovascular drugs)
   f. Alcohol (increases risk of hypothermia)
   g. Acclimatization.

2. **Effects on Humans**

   The physiological responses resulting from exposure to cold environmental conditions include shivering, vasoconstriction, increased oxygen consumption, accelerated respiration and pulse rate, elevated blood pressure, and a significant increase in cardiac output.

Fatal exposures to cold among workers have almost always resulted from accidental exposures involving failure to escape from low air temperatures or from immersion in low temperature water. Pain or numbness in the extremities may be the first early warning of danger to cold stress. The single most important aspect of life-threatening hypothermia is the fall in the deep core temperature of the body.

3. Cold Stress Risk Assessment:

Risk assessment for thermal stress should begin with an assessment of work areas or activities where employees have experienced pain or loss of feeling in extremities, frostbite, severe shivering, excessive fatigue or other symptoms of cold related stress.

REVISION HISTORY:

MOC#	Description of Change	Prepared By	Date
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