Cold Environments – General – Fact Sheets

WHY SHOULD WE BE CONCERNED ABOUT WORKING IN THE COLD?

Working in cold environments can be not only hazardous to your health but also life threatening. It is critical that the body be able to preserve core body temperature steady at + 37°C (+ 98.6°F). This thermal balance must be maintained to preserve normal body functioning as well as provide energy for activity (or work!). The body's mechanisms for generating heat (its metabolism) have to meet the challenge presented by low temperature, wind and wetness – the three major challenges of cold environments.

How do we lose heat to the environment?

Radiation

Radiation is the loss of heat to the environment due to the temperature gradient. In this case, it is the difference between the temperature of the air and the temperature of the body (your body's core temperature is +37°C). Another factor important in radiant heat loss is the size of the surface area exposed to cold.

Conduction

Conduction is the loss of heat through direct contact with a cooler object. Heat loss is greatest if the body is in direct contact with cold water. The body can lose 25 to 30 times more heat when in contact with cold wet objects than in dry conditions or with dry clothing. Generally, conductive heat loss accounts for only about 2% of overall loss. However, with wet clothes the loss is increased 5 times.

Convection

Convection is the loss of heat from the body to the surrounding air as the air moves across the surface of the body. The rate of heat loss from the skin by contact with cold air depends on the

air speed and the temperature difference between the skin and the surrounding air. At a given air temperature, heat loss increases with wind speed.

Evaporation

Evaporation is the loss of heat due to the conversion of water from a liquid to a gas. In terms of human physiology, it is:

- Perspiration/Sweating – evaporation of water to remove excess heat.
- "Insensible" Perspiration – body sweats to maintain humidity level of 70% next to skin. Particularly in a cold, dry environment, you can lose a great deal of moisture this way and not notice that you have been sweating.
- Respiration – air is heated as it enters the lungs and is exhaled with an extremely high moisture content.

It is important to recognize the strong connection between fluid levels, fluid loss, and heat loss. As body moisture is lost through the various processes, the overall circulating volume is reduced which can lead to dehydration. This decrease in fluid level makes the body more susceptible to hypothermia and other cold injuries.

How do we produce and retain heat within the body?

In order to survive and stay active in the cold, the constant heat loss has to be counterbalanced by the production of an equal amount of heat. Heat is both required and produced at the cellular level as a result of complex metabolic processes that convert food – a primary source of energy – into glycogen. Glycogen is a substance (biochemical compound) that is the "fuel" for biochemical processes underlying all life functions, heat production included.

Factors important for heat production include:

- Food intake.
- "Fuel" (glycogen) store.
- Fluid balance.
- Physical activity.
- Shivering – a reflex reaction, which increases the body's heat production (up to 500%) when necessary. This reaction is limited to a few hours because of depletion of muscle glycogen and the onset of fatigue.

Heat retention and tolerance to cold also depends on the body's structure, certain reflex and behavioral mechanisms that retain heat within the body as well as what you are wearing. They are:

- Size and shape of the body (surface to volume ratio).
- Layer of fat under the skin (Subcutaneous adipose tissue).
- Decreased the blood flow through the skin and outer parts of the body.
- Insulation (layering and type of clothing).

How do we maintain thermal balance?

Cold challenges the body in three major ways (temperature, wind and wetness). Depending on the severity of cold conditions, heat loss can occur. The body maintains its heat balance by increasing production of the heat and activating heat retention mechanisms.

Heat Production	+	Heat Retention	=	Cold Challenge	-	Thermal Balance
• food intake • activity • shivering		• decreased superficial blood flow • clothing				

In the situation where more heat is lost than the combined heat production processes and heat retention mechanisms can generate, the core body temperature drops below +37°C. This decrease causes hypothermia which can impair normal muscular and mental functions.

Heat Production	+	Heat Retention	<	Cold Challenge	=	Hypothermia
• food intake • activity • shivering		• decreased superficial blood flow • clothing				

What are some examples of jobs in which cold may be an occupational hazard?

Workers at risk of suffering due to the cold include:

- Outdoor workers including:
    - Road builders, house builders and other construction workers.
    - Hydro and telecommunications linemen.
    - Police officers, fire fighters, emergency response workers, military personnel.
    - Transport workers, bus and truck drivers.
    - Fishers, hunters and trappers.
    - Divers.
- Workers in refrigerated warehouses.
- Meat packaging and meat storage workers.
- Outdoor recreation workers (and enthusiasts).

How does cold affect work performance?

Uncomfortably cold working conditions can lead to lower work efficiency and higher accident rates. Cold impairs the performance of complex mental tasks. Manual tasks are also impaired because the sensitivity and dexterity of fingers are reduced in the cold. At even lower temperatures, the cold affects the deeper muscles resulting in reduced muscular strength and stiffened joints. Mental alertness is reduced due to cold-related discomfort. For all these reasons accidents are more likely to occur in very cold working conditions.

Are there any factors that determine an individual’s response to the cold?

Response in Men and Women

Studies have shown that response to cold in women can differ from that of men. While the core body temperature cools more slowly in women, women are not usually able to create as much metabolic heat through exercise or shivering. In

addition, the rate of cooling of the extremities

(feet, hands) is faster among women. As a result, women are generally at a greater risk of cold injury.

Predisposing Conditions

Susceptibility to cold injury varies from person to person. In general, people in good physical health are less susceptible to cold injury. While anyone working in a cold environment may be at risk, the following conditions may make the risk of cold injury greater:

- Age (infants less than one year, and older adults are more susceptible).
- Diseases of the blood circulation system.
- Injuries resulting in blood loss or altered blood flow.
- Previous cold injury.
- Raynaud’s Phenomenon.
- Fatigue.
- Consumption of alcohol or nicotine (smoking).
- Use of certain drugs or medication.

Can you become acclimatized to cold?

Acclimatization is the term given to the development of resistance to, or tolerance for, an environmental change. Although people easily adapt to hot environments, they do not acclimatize well to cold. However, frequently-exposed body parts can develop some degree of tolerance to cold. This adaptability is noticeable among fishermen who are able to work with bare hands in extremely cold weather. The blood flow in their hands is maintained in conditions which would cause extreme discomfort and loss of dexterity in unacclimatized persons.