# GROUP OCCUPATIONAL HEALTH STANDARD 3
# THERMAL STRESS MANAGEMENT

**DATE: 1 APRIL 2019**

| DATE | NAME | CHANGE | APPROVED | REVISION |
|---|---|---|---|---|
| 01.09.2017 | Keith Ashby | Issued for Use | ExCo | 0 |
| 01.04.2019 | Ross Jennings, Jade Pratt, Julia Lee & Keith Ashby | Reformatted, removed exposure periods and threshold limits.<br>Section 3.3.1 – Addition of reference to Queensland Government Heat Stress Calculator.<br>Section 3.3.2 – Addition of Above Ground Low Temperatures<br>Appendix 1 – Addition of Adverse Cold Effects | Exco | 1 |

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# 1. INTENT

This IGO standard details the requirements for managing the exposure of personnel to thermal stress to prevent adverse health outcomes.

# 2. APPLICATION

This standard shall apply to all IGO sites and projects (exploration, construction and development) and to all IGO employees, contractors (including sub-contractors) and visitors to IGO sites and projects. All IGO sites and projects shall comply with the provisions of this standard.

# 3. REQUIREMENTS

## 3.1 Thermal Stress Risk Assessment

All IGO mine sites and the IGO exploration team must complete a Thermal Stress Risk Assessment. This risk assessment must be conducted in accordance with the ***IGO GSS 3 – Safety Risk Management***.

The purpose of this risk assessment is to determine the general level of thermal risk posed to employees given the location and nature of the work being completed at the site or project.

To assist those completing the thermal stress risk assessment, an overview of the consequential effects of thermal stress are presented in Appendix 1. An overview of the factors that can cause heat stress and the mechanisms to control the impacts of heat stress are addressed in Appendix 2.

The outcomes of risk assessments shall be documented and entered into the site register such that a permanent record of the risk assessment is retained.

The Thermal Stress Risk Assessment must be reviewed if and when a material change occurs in the nature of the work completed, or a work environment at a mine site or an exploration project materially changes.

## 3.2 Thermal Stress Management Plan

Where any given IGO site (or exploration team) has an overall thermal stress risk of 'Moderate' or greater, the site or exploration team must have a current Thermal Stress Management Plan.

The purpose of the Thermal Stress Management Plan is to provide site-specific directives on the management of thermal stress. The Thermal Stress Management Plan must address the following key elements:

- Temperature Monitoring, and specifically, the responsibilities of both employees, supervisors & as relevant, ventilation officers in the completion of temperature monitoring
- The completion of circumstance or job specific thermal risk assessments (Section 3.3)
- Fitness for working in a Thermal Stress Risk Environment (Section 3.4)
- Site or project specific responsibilities (Section 3.5)
- Where relevant, task specific emergency response requirements (Section 3.6)
- Thermal Stress Training (Section 3.7)

## 3.3 Circumstance or Job Specific Thermal Risk Assessment

### 3.3.1 Above Ground – High Temperatures

For some specific tasks or in some specific environments where the thermal risk is likely to be higher than is normal for the site or exploration project, and hence the controls identified in the site's Thermal Stress Management Plan may be inadequate, a circumstance or job specific risk assessment must be completed using the Queensland Government Heat Stress Calculator.

https://fswqap.worksafe.qld.gov.au/etools/etool/heat-stress-basic-calculator-test/

If the risk is calculated to be high risk, the work must not proceed until the task has been reviewed by a competent person such as an occupational hygienist and adequate controls have been established (if possible).

### 3.3.2 Above Ground- Low Temperatures

Environments where the thermal risk is likely to be lower than is normal for the site or exploration project a circumstance or job specific risk assessment must be completed. It is incumbent on both the employee and supervisor to exercise judgement, or take advice, to ensure their people are not unduly placed at risk as other factors may require consideration. Refer to Appendix 1and Appendix 2.

### 3.3.3 Below Ground

In the absence of an alternate approved by the site GM, IGO imposes work restrictions related based on temperature and air flow. Refer to Appendix 3. It is not uncommon for specific areas of an underground mine to be significantly hotter than other areas. These 'hot spots' shall be subject to a JSEA or SWP as prepared by the site.

Note: It is incumbent on both the employee and supervisor to exercise judgement, or take advice, to ensure their people are not unduly placed at risk as other factors may require consideration. IGO empowers its people (employees or contractor's employees) to take, and its Supervisors and Managers to impose, rest periods or make such other arrangements, including stopping work, as reasonably required.

## 3.4 Fitness for Working in a Thermal Stress Risk Environment

Fitness for work shall be assessed in accordance with IGO Occupational Health Standard 1 –Fitness for Work.

Note: It should be noted that individuals who are overweight are at significantly higher risk of experiencing heat stress and heat related illness. Further it is noted that individuals who are new to working in hot environments are typically those most likely to be affected by the heat.

Note: It should be noted that health conditions such as cardiovascular disease, diabetes, hypertension and certain medications can increase the risk for frostbite and hypothermia.

## 3.5 Site or Project Specific Responsibilities

### 3.5.1 Individuals

Without limiting IGOs responsibility to provide a safe place of work and a safe system of work, all personnel who have the potential to work in an environment where there is a risk of thermal stress shall complete IGOs Thermal Stress Training and:

- Inform a supervisor before starting work if they have or have recently had any illness that may increase their risk of thermal stress;

- Stop working immediately upon any early symptoms of thermal stress and inform their supervisor or co-worker;
- Look out for their co-workers, and;
- Comply with the requirements of the site's Thermal Stress Training.

#### 3.5.2 Supervisors and Ventilation Officers

Supervisors, and Ventilation Officers on mine sites, shall monitor environmental temperatures as required by the site's Thermal Stress Management Plan.

#### 3.5.3 Registered Manager

The Registered Manager, or their documented delegate, is responsible for the preparation and maintenance of both the site's Thermal Stress Risk Assessment and Thermal Stress Management Plan.

### 3.6 Specific Emergency Response Requirements

Subject to the outcome of the site's Thermal Stress Risk Assessment, where the site has an elevated risk of a person becoming heat stressed, suffering heat stroke or alternatively cold stress or other cold related illnesses, specific consideration must be given to the related emergency response requirements. These controls must be documented in the Thermal Stress Management Plan.

### 3.7 Thermal Stress Training

Where any given IGO site (or exploration team) has a Thermal Stress Management Plan, the site or team shall ensure that their employees and contractors are provided with training related the potential affects of exposure to thermal stress, how hazard is to be managed, and other relevant matters addressed in the Plan.

## 4. PERFORMANCE MEASURES

Conformance with this standard will be assessed through regular audits and assessments.

## 5. OTHER INFORMATION

### 5.1 IGO Standards

- IGO Common Management System Standard 10 – Operations, Integrity, Design and Commissioning
- IGO Occupational Health Standard 1 – Fitness for Work
- IGO Group Safety Standard 3 – Safety Risk Management

# APPENDIX 1: OVERVIEW OF THE AFFECTS OF THERMAL STRESS

A person's core temperature is affected by their environment, their activity and by the ability of the body to retain or lose this core heat. The extent of any rise is related to the physical work level. Skin temperature on the other hand depends on several environmental conditions.

Increased blood flow through the skin allows body core heat to be dissipated at the body surface. Evaporation of sweat cools the skin and in conjunction with increased skin blood flow assists in achieving thermal balance. On the other hand, vasoconstriction can result in lack of oxygen, nutrients and toxic build-up to the extremities as the body compensates to thermoregulate in situations where the body loses heat faster than it can be produced.

The body uses its own water reserves to generate sweat, so maintaining body temperatures within safe limits. Sweat loss if not replaced leads to dehydration which in turn puts a strain on the circulation causing the heart to beat at a higher rate, additionally sweat rate is reduced, so affecting thermoregulatory capacity and adaptation.

A description of the symptoms of the various cold effects is tabulated in Table 1.

**Table 1 – Cold Adverse Effects**

| Adverse Effect | |
|---|---|
| **Chilblains** | Permanent damage of capillary beds due to skin exposed to temperatures just above freezing. Chilblains usually affect facial extremities, fingers and toes. It is characterised by inflammation/ redness, itching, possible blistering, and ulceration. |
| **Trench Foot** | Occurs due to prolonged exposure to damp or cold conditions. Wet feet loses heat 25-times faster than dry feet. Restriction of blood circulation to the feet resulting in necrosis of the skin tissue as the body attempts to compensate for the heat loss. Symptoms vary from skin reddening, swelling, tingling pain or numbness, bleeding under the skin, blisters or ulcers through to gangrene. |
| **Frost Bite** | Injury caused the permanent damage of body tissue from freezing. Reduces blood flow and feeling to the extremities (e.g. nose, ears, cheeks, chin, fingers, or toes). Symptoms include tingling or stinging, numbness or aches and bluish or pail waxy skin. |
| **Hypothermia** | Prolonged exposure resulting in the body losing heat faster than it can be produced. A body temperature that is too low can affect cognitive thought resulting in the individual not recognising or treating the symptoms. Early symptoms include shivering, fatigue, loss of coordination, confusion or disorientation. Late symptoms include blue skin, dilated pupils, slow pulse or breathing, no longer shivering or loss of consciousness. |
| **Cold Water Immersion** | Onset is significantly quicker than hypothermia as water conducts heat away from the body 25 times faster than air. |

Most adverse effects arise from a failure of the body's heating mechanisms, vasoconstriction resulting necrosis or as a result of depleting stored energy.

A description of the symptoms of the various heat effects is tabulated in Table 2.

**Table 2 – Heat Adverse Effects**

| Adverse Effect | – |
|---|---|
| **Skin problems** | Caused by blockage of sweat ducts and associated inflammation of the skin (e.g. prickly heat). |
| **Heat strain** | This is the change in pulse, body temperature and sweating. It may lead to heat illness if the heat load continues. Heat strain is characterised by increases in deep body temperature, heart rate, blood flow to the skin and water and salt loss due to sweating. |
| **Heat illness** | This is a feeling of weakness, dizziness and nausea. The person loses concentration. Safety awareness and performance may deteriorate. |
| **Heat exhaustion** | If there is insufficient replacement of water loss from sweating, progressive dehydration occurs. These can be pallor, profuse sweating, hypotension, rapid heart rate, alteration of consciousness, thirst and increase in body temperature. Blood pooling may cause fainting. Salt deficiency, especially following long periods of sweating may also produce a form of heat exhaustion and can cause muscle cramps. |
| **Heat stroke** | This is more severe and may be life threatening. A person may become irritable, confused and apathetic before a life-threatening stage is reached. The person may also have fits. The body temperature is high (over 40□C) and the skin may be hot and dry. Heat stroke can occur if treatment is not given immediately. Any increase in body core temperature beyond that point is life threatening and must be treated accordingly. |

Most adverse effects arise from a failure of the body's cooling mechanisms or as a result of overloading of the system.

Normally, several physical and physiological mechanisms assure transfer of excess body heat to the environment. Even when the body is at rest, heat is generated by normal metabolism. With exercise, the heat produced by muscle activity rises rapidly. This generated heat is moved to the skin by the blood with the aim of transferring body heat to the environment. Heat may then be lost through convection, evaporation of sweat, radiation and conduction.

To maintain the appropriate body temperature three issues are essential:

- The metabolic heat produced must be transferred to the skin via the circulation for dissipation;
- The sweat glands must be able to produce the necessary amount of sweat; and
- The sweat must be able to evaporate.

Failure in any of these mechanisms for heat transfer may cause the body core temperature to rise, leading to heat strain and subsequent heat illness.

Additionally, for the successful maintenance of the thermoregulatory system, adequate fluids must be consumed to prevent dehydration. When the air temperature is above skin temperature (around 36° C), evaporation of sweat is the main mechanism for the body to lose heat.

# APPENDIX 2: THERMAL RISK ASSESSMENT – MATTERS FOR CONSIDERATION

This appendix is intended to provide guidance as to the various factors that should be given consideration as part of a site's Thermal Stress Risk Assessment.

## Heat Stress Factors

There are six factors influencing a person's capacity for heat exchange with the environment:

- Air temperature (dry bulb). Above 36º C the body can gain heat from the environment.
- Absolute humidity (wet bulb temperature). When the absolute humidity is high, evaporation of sweat is reduced, thereby reducing the body's opportunity to lose its heat.
- Radiant heat from objects such as the sun, furnaces, and other hot surroundings. The direction of heat transfer depends on the absolute temperature difference between the body and the surrounding surfaces. It is not affected by the air temperature or humidity.
- Air movement. This can influence both convection and evaporation and can have a marked effect on heat exchange at the exposed skin surfaces (face, arms, legs). Convective heating or cooling does depend on the air temperature. Air movement assists with the evaporation of sweat from the skin and hence cooling capacity.
- Muscular activity. This is the most significant as it imposes a variable heat load. Work rates may increase heat production up to ten times the resting level and can cause a rapid body heat rise if this cannot be lost to the surroundings.
- Clothing. This can have a major effect on the amount of heat transfer from body. Clothing may limit convective exchange and may interfere with the body's capacity to lose heat through evaporation of sweat. However clothing can reduce the radiant heat to the body from surrounding surfaces (firefighters, furnace operators, underground motors and machinery).

## Key Controls – Environment & Systems

Excessive heat load can be due to radiation, convection, unsuitable clothing or body metabolism. Consistent with the hierarchy of control measures generally applied to health and safety hazards, the employer should ensure that exposure to heat is limited by:

- not exposing employees to heat so far as is practicable
- isolating sources of heat, so far as is practicable, through shielding, containment and remote handling techniques, if applicable
- providing engineering controls, such as ventilation, to reduce heat loads
- adopting safe work practices and appropriate administrative procedures such as job rotation.

The radiant heat load may be reduced by insulation (shielding) or relocation of heat sources, use of barriers or reflective screens with aprons and covering exposed parts of the body. The convective heat load may be reduced by lowering the air temperature and increasing the air velocity (e.g. fans). For extreme conditions, (e.g. during certain confined space maintenance activities) air or ice cooled clothing may be used. In general, clothing is chosen to allow ready evaporation of sweat.

## Key Controls – People management

**Ensure Appropriate Water Consumption**

Sweat rates can be as high as 2 litres/hour for those performing heavy physical labour in the heat. Consequently, dehydration can occur quickly. Thirst indicates that moderate dehydration is already established. Therefore, potable water must be readily available for all persons working in hot work

environments. The water must be palatable by being cool (6-15º C) and can be flavoured for example, with weak cordial. For the same reason, provision of warm liquids and thermos should be made available to workers in cold environments.

**Self-Testing**

In hot work environments, IGO shall make arrangements to readily enable employees and contractors to self-test their urine to assess the specific gravity and total urinary chloride level (Fantus Test or equivalent). The result will inform the individual as to whether or not they are well hydrated, partially dehydrated or unacceptably dehydrated. The use and interpretation of urine tests shall be addressed in Thermal Stress Training.

**Heat Acclimatisation**

Through acclimatisation, employees have the ability to increase tolerance to work in heat. Full acclimatisation takes 7-14 days with 3 hours activity per day. Acclimatisation usually increases water requirements as acclimatisation increases sweating but reduces salt loss.

**Fitness for Work**

Good physical condition will reduce the likelihood of thermal strain. Those that are more than 20% overweight are more prone to developing heat illness symptoms. Those that are fit will most readily acclimatise and have some 'protection'.

Health conditions such as cardiovascular disease, diabetes, hypertension and certain medications can increase the risk for frostbite and hypothermia.

**PPE**

Clothing that is both loose fitting and made from cloth that "breathes" may be appropriate. Artificial fibre cloth such as nylon is not recommended in heat stress situations. It is important not to obstruct evaporation from the skin. Protective covering such as wide brim hats, long sleeved shirts and shoes is recommended in situations where radiant heat is likely to be a problem, such as outdoors.

For cold environments layering provides better insulation. The fitting of clothes and cold weather gear should promote the circulation of warm blood to the extremities and be dry. Boots should be waterproof and insulated. Clothing should protect the ears, face, hands and feet in extremely cold weather conditions.

**Work Scheduling**

Where practicable, adjustment of work schedules and hot jobs may need to be made. Activities in the earlier part of the day (before 10 am) and later in the day (after 3 pm) should be considered to avoid the maximum heat conditions found in the middle of the day (unless working in cold environments). Consideration may need to be made to re-scheduling work according to weather conditions. In hot conditions relative humidity over 75% contributes a substantial risk to heat injury.

**Intensity of required work**

Sustained physical activity can cause a rapid rise in body core temperature which may exceed the body's capacity to dissipate this heat to the environment. It may be necessary to provide adequate and regular rest periods to minimise heat production, or to provide for self-paced work. The provision of air-conditioned retreats and cooled fluids may also assist in maintaining appropriate body temperature. Resting or performing other tasks in cool (<25ºC), low to moderate humidity surroundings reduces considerably the effects of hot work. Rest areas should be located close to the hot work areas in order to encourage their use.

## Acclimatisation requirements

Repeated exposure to heat over a period (usually not less than seven days) produces physiological changes enabling a person to respond more efficiently to the heat demands; this is acclimatisation. This increases water requirement, reduces strain, improves performance and comfort. There are reductions in core temperature and heart rate reached at the same rate of work as before, there is an increase in blood volume, the body sweats more readily and the salt content of sweat is decreased.

Each site's Thermal Stress Risk Assessment shall address the need for acclimatisation. In the event that it is determined that acclimatisation is required for certain tasks or work places, the requirements for acclimatisation must be addressed in the site's Thermal Stress Management Plan

Regarding acclimatisation, it is noted that:

- Acclimatisation begins with the first exposure, progresses rapidly and may be well developed in about one week for some.
- Resting or inactivity in the heat produces only slight acclimatisation. An individual must work in the heat (or cold) to acclimatise.
- Subjects in good physical condition acclimatise more rapidly and can do more work in the heat. Good physical condition, however, does not in itself confer acclimatisation. Also, individuals differ widely in their ability to acclimatise.
- Acclimatisation to high heat loads will enhance performance at less severe conditions but will only provide partial benefits for more severe conditions.
- Within about three weeks to a month, acclimatisation effects are lost and hardly any traces are to be found after a few months. Staying in good physical condition helps retain acclimatisation.
- It is IGOs standard that:
- Unacclimated employees should be acclimatised over a period of 7 days. The acclimatisation schedule should begin with 50 percent of the anticipated total work load and time exposure of the first day, followed by daily 10 percent increments building up 100 percent total exposure on the sixth day.
- Previously acclimatised employees who return from four or more consecutive days of illness should be subject to a Return to Work Plan and this may require re-acclimatisation.

# APPENDIX 3: EFFECTIVE TEMPERATURE

In the absence of an alternate approved by the site GM, IGO imposes work restrictions related based on temperature and air flow. Specifically, IGO has adopted the Effective Temperature Chart[1] (see Figure 1) as a tool to provide general guidance on when work is to be restricted given elevated workplace temperatures and or reduced air velocities.

## Use of Effective Temperature Chart Cards

The chart is used as follows. Given that the wet bulb temperature, dry bulb temperature and air velocity are known for a given work environment, the user places a straight edge on Figure 1 so as to connect the measured wet bulb and dry bulb temperatures. Next, the user follows the diagonal line associated with the known air velocity to the point where it intercepts the temperature line. This point of intersection will fall within a coloured area of the chart.

With reference to the colour coded result, the user then examines Table 1 to ascertain the restrictions (if any) placed on work.

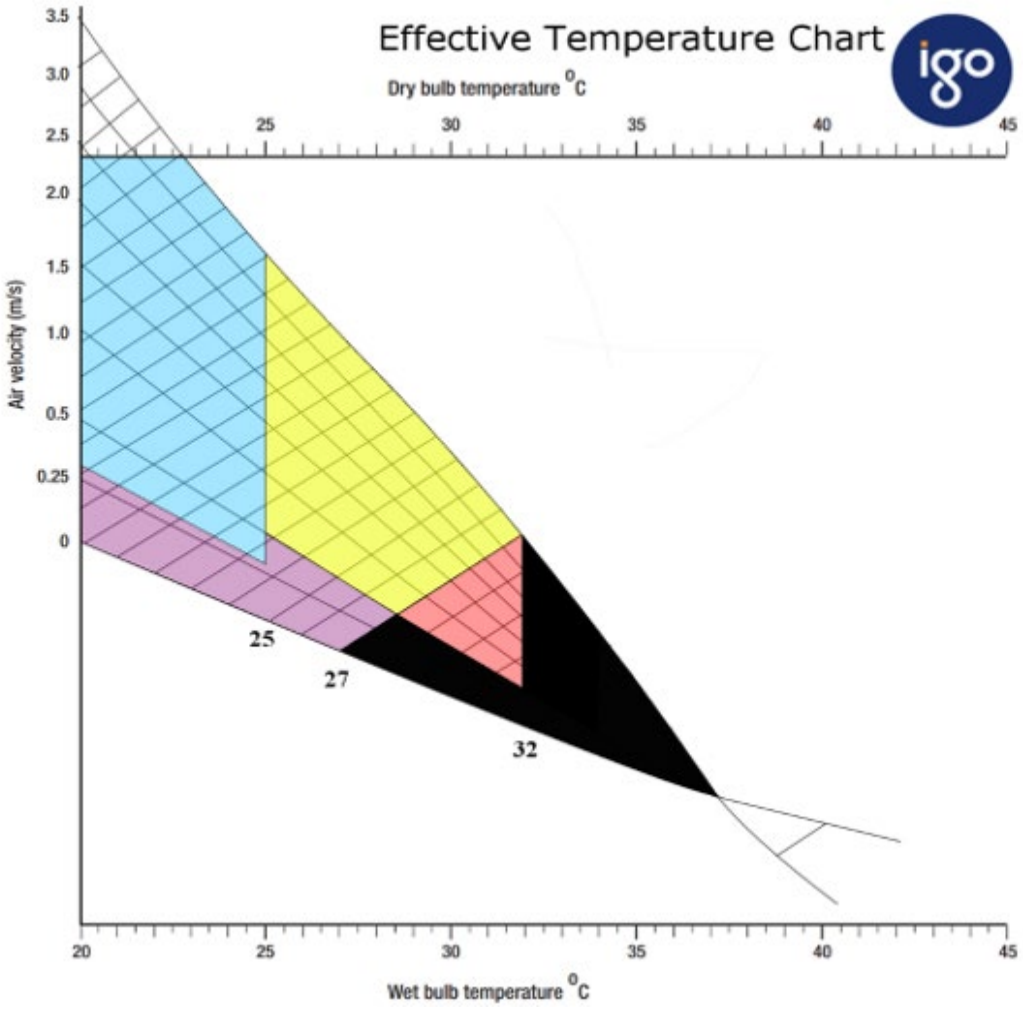


**Figure 1 - Effective Temperature Chart**

[1] As listed in Appendix C of the 'Management and Prevention of Heat Stress – Guideline' issued by the Department of Industry and Resources (pp.16, 1997.)

**Table 3 -** Temperature Related Work Restrictions

| | |
|---|---|
| **Blue** | Unrestricted Work. Note however that if the wet bulb temperature exceeds 25 degrees Celsius, measures shall be taken to ensure that the air velocity is not less than 0.5 metres per second. |
| **Yellow** | Manual labour to be undertaken by acclimatized personnel, with mandated 10-minute break every 2 hours at a minimum, or as required.<br>Un-acclimatized workers are to have a break for 10 minutes every hour, as a minimum |
| **Purple** | No work is permitted in these low air flow environments other than inspections and ventilation improvement works |
| **Red** | Manual labour restricted to 30 minutes per hour or less as required by the individual<br>Shift Supervisor to check or make contact at regular intervals |
| **Black** | All work in affected area to stop |

## Distribution of Effective Temperature Scale Cards

A laminated card containing both the 'Effective Temperature Chart' and the 'Temperature related work restrictions table' shall be provided to all employees and contractors who work underground or in enclosed surface work areas. It is intended that all persons working in such environments be familiar with the use of the chart and the restrictions.