VULCAN MINE

Mine Operating Procedure

Heat Stress Management

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1. PURPOSE

The purpose of this procedure is to provide practical guidance about how to manage heat exposure at Vulcan mine, in order to prevent heat stress, heat exhaustion or heat stroke.

2. SCOPE

This procedure is applicable to all persons at the Vulcan Mine including employees, contractors, service providers and visitors. Specifically, this procedure has been developed to assist coal mining operations satisfy requirements of section 143 of the Coal Mining Safety and Health Regulation 2017 (3) & Guidance Note – QGN32 Guidance note Managing Heat Stress in Surface Coal Mines

3. DEFINITIONS

Authorised Person	A person who has the required competencies and who has been appointed by the Site Senior Executive to carry out a designated scope of duties.
CMSHA	Queensland Coal Mining Safety and Health Act (1999).
CMSHR	Queensland Coal Mining Safety and Health Regulation (2017).
CMW	Coal Mine Worker.
Competent Person	Competence for a task at a coal mine is the demonstrated skill and knowledge required to carry out the task to a standard necessary for the safety and health of persons.
JHA	Job Hazard Analysis.
MOP	Mine Operating Procedure.
SHMS	Safety and Health Management System.
SEG	Similar Exposure Group
Take 5	Personal Risk Assessment.

4. PROCEDURE

4.1. Working in Hot Environments

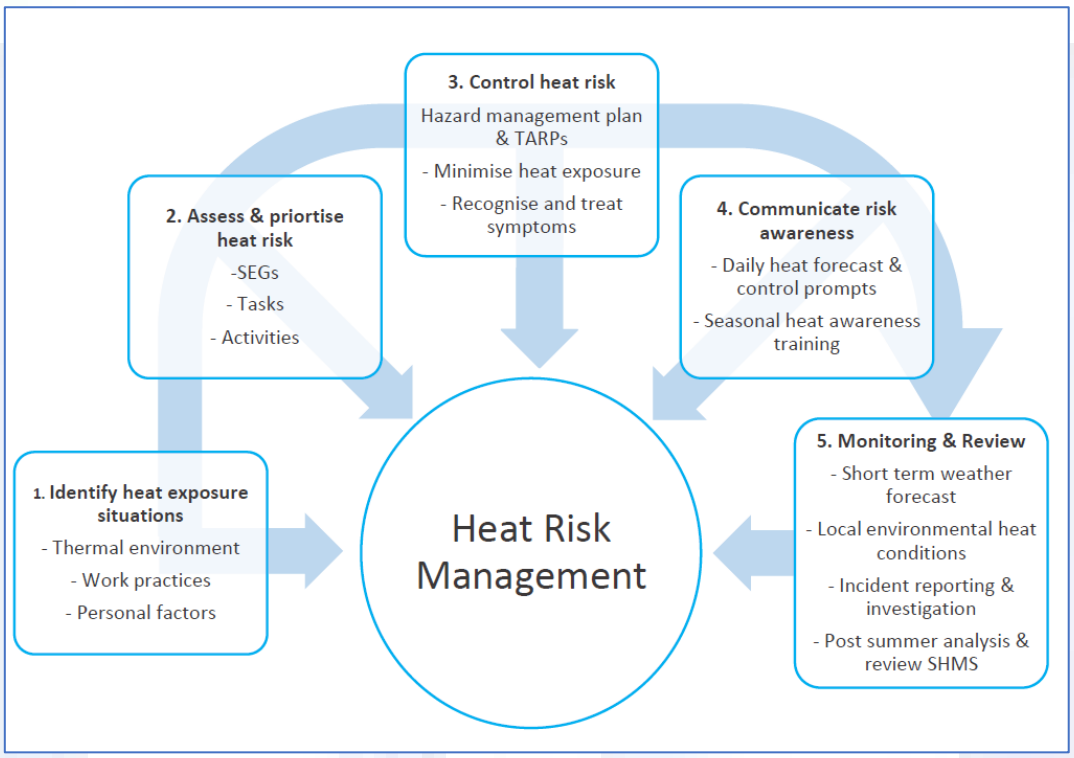
Exposure to moderate to high ambient thermal conditions is the predominant heat exposure risk within the Queensland surface mining industry. Deliberate and systematic management of heat exposure is required to minimise the risk of over-exposure leading to adverse health and safety incidents.

The impact of heat exposure on workers can affect physical and mental performance and this may contribute indirectly to an increase in safety related incidents. Trends in incidents of work-related injury have coincided with elevated ambient temperatures and the warmer summer months.

While incidents of heat stroke are rare, mild to moderate symptoms of heat exhaustion and less severe incidents of heat related illnesses (including heat rash, syncope and cramps) are more common and typically present as ad-hoc individual events during the summer. In addition, workers often describe experiencing fatigue-like symptoms after being repeatedly exposed to moderate to high heat conditions for prolonged periods. These unpleasant physiological and psychological side effects have been referred to as 'heat hangovers'

Management of heat exposure should be a structured and systematic approach that considers the impacts of:

- Environmental conditions
- Physically demanding work
- Process generated heat
- Clothing and PPE
- Health and individual factors.



4.2. Identification of Hot Working Conditions

Hot work areas or hot working conditions shall be identified by Supervisors or by CMWs, prior to commencing and shall be listed with appropriate controls on the risk assessment.

Major heat disorders are not likely to occur where healthy fit workers are acclimatised, wearing light suitable clothing and have adequate water and salt intake, provided that heat exposure is appropriately managed.

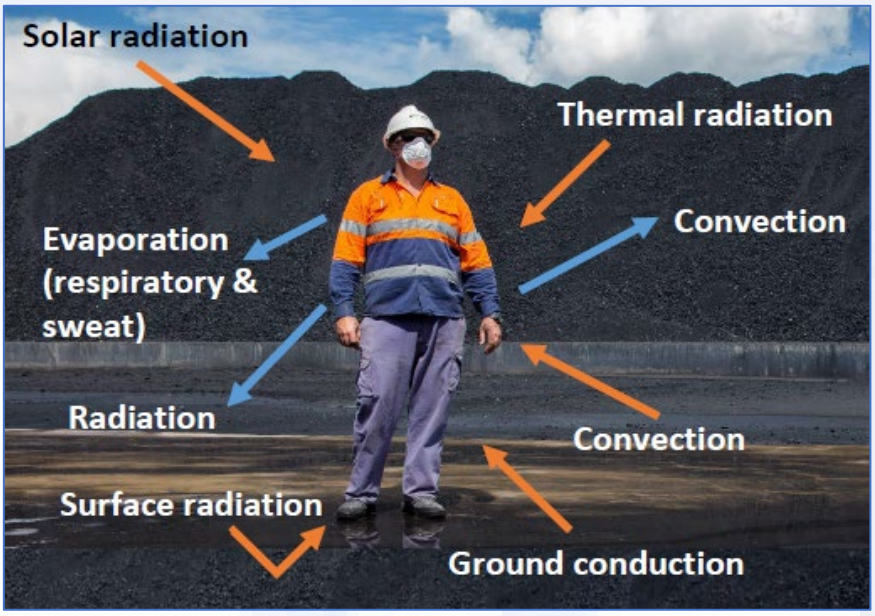
High-risk days are where the temperature is forecast to exceed 40 degrees Celsius. On high-risk days, Supervisors shall remind people that the heat stress potential is increased and remind them to take special precautions over and above those normally employed during the already hot summer period, such as:

- Ensure personnel intake of fluids is consistent with TARP recommendations;
- Ensure personnel are taking regular rest breaks. Breaks are to be in shaded and/or climate-controlled areas;
- Personnel are to monitor each other regularly as part of the process of ensuring that no one becomes heat affected (Buddy System); and
- Personnel are to be aware of the VUL-ATT-001-Urine Based Heat Stress Diagnosis Tool and how it is used to self-monitor hydration levels (Appendix A: Urine Colour Chart).

4.2.1 Thermoregulation

Thermoregulation is a continuous and automatic process performed by the body to ensure core body temperature is controlled within a very narrow range of temperature (~37°+/- 1°C) and is essential for maintaining normal body functions and wellbeing. This temperature equilibrium requires a constant exchange of heat between the body and the external environment. If this control is lost and the core temperature begins to rise, various physiological responses occur which can lead to adverse health and safety effects.

The primary heat load on the body is generated by physical work. Since body heat is produced in proportion to the intensity of physical work, higher intensity results in greater body heat production. Most of this excess body heat needs to be dissipated to the environment to prevent its storage. The body automatically activates the primary heat loss mechanisms of increased skin blood flow and sweating. Elevated skin blood flow increases skin temperature and heat loss via radiation and air flow across the skin (convection), while sweating dissipates heat via evaporation.

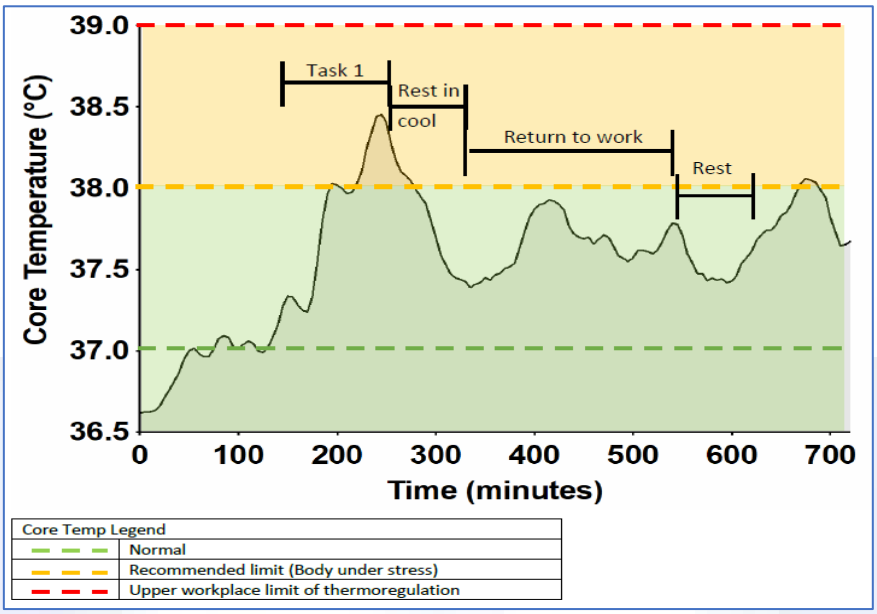


The efficiency of the body's primary heat loss mechanisms is determined by environmental conditions, with higher temperatures limiting heat loss by radiation and convection, and when combined with high relative humidity, limiting evaporation of sweat.

The amount and rate of heat exchange is governed by a range of factors including:

- Environmental conditions (ambient temperature, relative humidity, radiant heat, wind speed)
- Metabolic workload (physical activity performed by of the coal mine worker, higher work rates produce more body heat)
- Personal and pre-disposing factors (physical fitness, acclimatisation, hydration, use of cooling, clothing)

Core temperature fluctuations during a routine shift showing the real-time impacts of thermoregulation and demonstrates the rise and fall of core temperature as a direct result of applying work rest regimes.



4.3. Health Effects

Occupational exposure to heat can result in a range of adverse health and safety effects including impaired performance, injuries, illness, disease, and death.

Heat-related symptoms are broadly classified based on frequency and severity:

- Chronic Low-Grade Cases
- Isolated High-Grade Cases
- Chronic Low-Grade Cases include fatigue, irritability, headaches, cramp and rashes.

Isolated High-Grade Cases include symptoms of the heat-related illnesses of heat exhaustion and heat stroke. The impact of workplace heat exposure is not just limited to heat stress symptoms or heat-related illness. Workplace accidents / injuries peak during the hottest months and more specifically, during heatwaves. Heatwave periods also elevate the risk of occupational heat-related illness by approximately four to seven times higher than that of non-heatwave periods. The impact of heat extends beyond the work shift, with workers reporting impaired sleep, decreased appetite and strained family relationships following sustained periods of exposure to work in heat conditions.

4.4. Controls

The control strategies employed to reduce heat exposure risks are primarily directed at the factors which affect thermoregulation and the rate of heat exchange between the body and the environment.

These include:

- Engineering controls to either modify the thermal environment where CMWs work or reducing the physical exertion and workload requirements of manual tasks.
- Administrative controls which minimise the duration of exposure to heat while performing work through task rotation, work rest cycles and scheduling work to cooler periods.
- Consider shade tents/gazebos and using ventilation/cooling fans, if possible, in the risk assessment.
- Personal protective equipment selection to optimise heat exchange or wearing specialised cooling garments or vests.
- Health assessment and ongoing surveillance to identify and manage individual CMWs with pre-disposing risk factors including acclimatisation, fitness for work, and medical conditions.

4.5. Hazard Identification

4.5.1 Environmental Factors

Several environmental factors can influence the heat load on the body and should be considered when assessing the risk. These include:

- air temperature (dry bulb)
- humidity (wet bulb and dry bulb temperature)
- air flow / movement (from natural or forced ventilation)
- direct sun exposure (radiant heat)
- radiated heat from hot surfaces (plant, equipment, or ground).

4.5.2 Environmental Conditions

Environmental Conditions can vary across a mine site depending on the specific work location, and may be affected by:

- local topography and depth in-pit, including excavations and stockpile material
- surface type (black coal vs overburden)
- working in open areas without shelter from direct sunlight
- plant structures including confined or partially enclosed spaces (e.g., reclaim tunnels, CHPP infrastructure)
- proximity to radiant heat sources (e.g., machinery, laboratory ovens, spontaneous combustion / reactive ground).

4.5.3 Work Process Factors (physical tasks and activities)

The type of work being performed by CMWs influences how they may become exposed to heat. Influences include:

- Location of CMW in relation to ambient heat (e.g., outdoor, in shade or direct sun, or in proximity to hot surfaces);
- Duration of exposure to heat (e.g., task scheduled to occur at midday or early morning, task role change)
- Work process generated heat (e.g., hot works including welding)
- Intensity of work and self-generated heat through physical exertion of the task (e.g., manual handling, shovelling spillage clean-up)
- Selection of personal protective clothing (e.g., disposable coveralls)

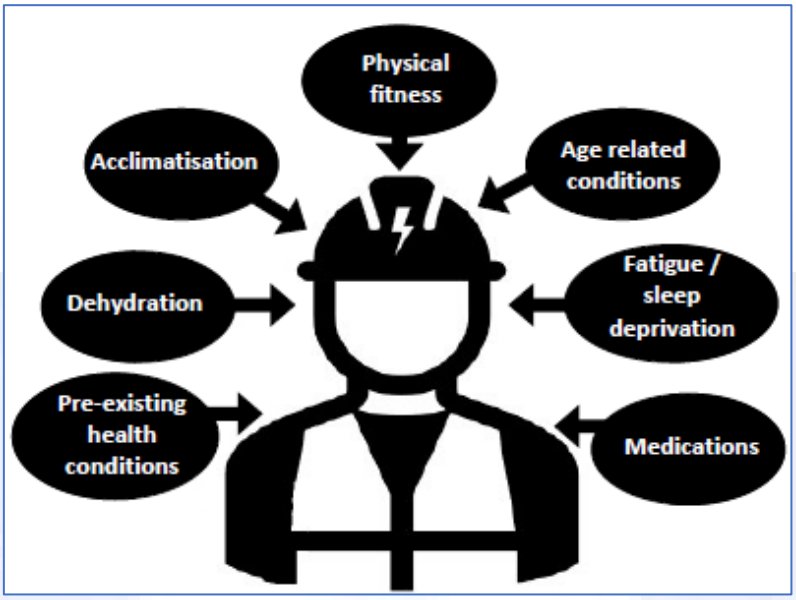
CMWs that operate HME:

- Plant and are positioned inside air-conditioned cabins for a significant part of their shift.
- This group is considered low risk for heat exposure unless these controls fail
- Typically, only exposed to ambient heat conditions intermittently for short durations when exiting vehicles for meal breaks, swapping machines, or during unplanned maintenance or repairs.

4.5.4 Individual and Pre-disposing Factors

Individual responses to heat exposure will vary significantly between different CMWs performing the same work, due to individual and pre-disposing factors. These factors should be considered when assessing heat exposure risks and during the development and implementation of controls.

Where individual risks are flagged to elevate the risk, control strategies need to consider further reducing exposure by modifying the work environment and practices.



4.6. Shift-based Heat Management Tool

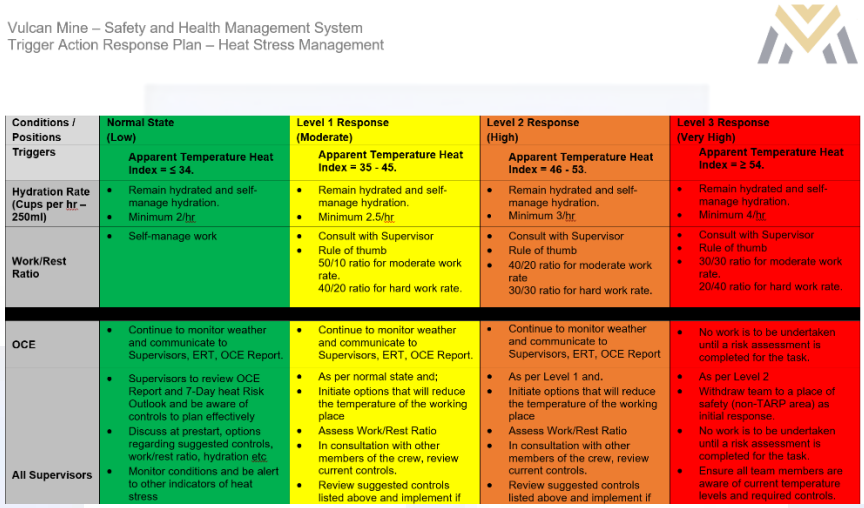
The chosen method for considering factors including environmental factors, estimated workload, clothing, individual factors and the practical application of control measures are listed in the Trigger Action Response Plan - VUL-TAR-006-Heat Stress Management. Environmental temperature and work rate data is used to determine triggers and actions for using the Heat stress management TARP. The OCE is responsible in determining the level of actions required during a heat event.

The TARP includes:

- Key triggers that indicate when additional controls are required
- An escalation process to ensure any increase in the level of risk is considered with appropriate actions to mitigate the effects of the exposure
- Clear definitions, responsibilities and names / positions of those required to implement

The control measures should be designed to limit exposure to CMWs and may include:

- engineering controls
- awareness communication
- task rotation
- work / rest regimes
- restrictions applied to unacclimatised persons
- hydration protocols
- additional monitoring
- the relocation of persons



Vulcan Mine – Safety and Health Management System
Trigger Action Response Plan – Heat Stress Management

Conditions / Positions Triggers	Normal State (Low) Apparent Temperature Heat Index = ≤ 34.	Level 1 Response (Moderate) Apparent Temperature Heat Index = 35 - 45.	Level 2 Response (High) Apparent Temperature Heat Index = 46 - 53.	Level 3 Response (Very High) Apparent Temperature Heat Index = ≥ 54.
Hydration Rate (Cups per hr – 250ml)	• Remain hydrated and self-manage hydration. • Minimum 2/hr	• Remain hydrated and self-manage hydration. • Minimum 2.5/hr	• Remain hydrated and self-manage hydration. • Minimum 3/hr	• Remain hydrated and self-manage hydration. • Minimum 4/hr
Work/Rest Ratio	• Self-manage work	• Consult with Supervisor • Rule of thumb 50/10 ratio for moderate work rate. 40/20 ratio for hard work rate.	• Consult with Supervisor • Rule of thumb • 40/20 ratio for moderate work rate 30/30 ratio for hard work rate.	• Consult with Supervisor • Rule of thumb • 30/30 ratio for moderate work rate. 20/40 ratio for hard work rate.
OCE	• Continue to monitor weather and communicate to Supervisors, ERT, OCE Report.	• Continue to monitor weather and communicate to Supervisors, ERT, OCE Report.	• Continue to monitor weather and communicate to Supervisors, ERT, OCE Report	• No work is to be undertaken until a risk assessment is completed for the task.
All Supervisors	• Supervisors to review OCE Report and 7-Day heat Risk Outlook and be aware of controls to plan effectively • Discuss at prestart, options regarding suggested controls, work/rest ratio, hydration etc • Monitor conditions and be alert to other indicators of heat stress	• As per normal state and; • Initiate options that will reduce the temperature of the working place • Assess Work/Rest Ratio • In consultation with other members of the crew, review current controls. • Review suggested controls listed above and implement if	• As per Level 1 and. • Initiate options that will reduce the temperature of the working place • Assess Work/Rest Ratio • In consultation with other members of the crew, review current controls. • Review suggested controls listed above and implement if	• As per Level 2 • Withdraw team to a place of safety (non-TARP area) as initial response. • No work is to be undertaken until a risk assessment is completed for the task. • Ensure all team members are aware of current temperature levels and required controls.

4.6.1 Environmental temperature

Forecasted temperature data (Air temperature & Relative humidity) is to be collected by the OCE to evaluate the predicted Heat index, using a Heat Index calculator. This is then to be communicated to the workforce and supervisors via VUL-FRM-11-01-Open Cut Examiners Shift Report and pre shift meetings. Site specific data can also be collected using hand-held measurement devices where data is required from specific work/activity locations e.g., engine bays, enclosed spaces.

4.6.2 Work Rate

A WRAC with a relevant cross section of stakeholders has been undertaken using the mine's current SEGs as a screening tool to identify at-risk SEGs to heat exposure. The risk assessment is qualitative and no measurements are taken into consideration. The likelihood and consequence are rated for each SEG based on the risk matrix. A list of tasks is generated for each priority SEG identified and these are grouped into 'work rate' categories as per below

Work rate	Example
Easy work (normal heart rate) 250 watts	*Using electric tools, walking on flat surfaces, operating equipment, inspection of work, basic fitting, welding and oxy-cutting*
Moderate work (moderate heart rate) 425 watts	*Climbing up & down stairs repetitively, doing polypipe works, carrying equipment 10 to 20kgs*
Hard work (high heart rate) 600 watts	*Using hand tools for long periods (shovels, crow bar, sledge hammer), climbing or carrying heavy equipment over 20kgs uphill*

This list and work area risk assessments are to be used by CMWs and area supervisors to determine the associated work rate of their task.

NOTE:

Where a risk assessment has determined that a SEG may involve exposure to higher-than-normal thermal environments for the majority of a shift cycle, and on an ongoing basis, the assessment should include provisions to address heat intolerance.

4.7. Health / medical surveillance

Where in the course of employment at a mine there is an appreciable increase in risk relating to heat exposure, a notice must be given to the CMW's employer under section 49 of the CMSHR. This could result from changes such as:

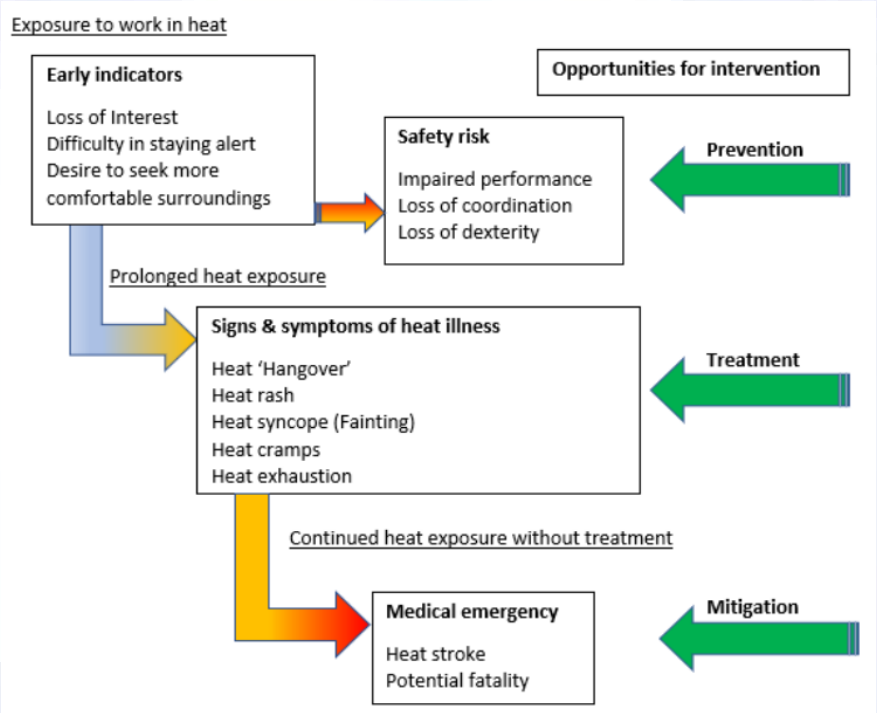
- A change in the worker's role or workplace resulting in an appreciable increase in exposure to heat
- A heat related incident on-site
- Engagement by supervisors or the site health and safety team with their workforce that identifies possible heat intolerance due to a change in their physiological condition, or medication.

A copy of this notice must also be given to the employer's appointed medical adviser (AMA) to consider the worker's frequency of health assessment.

4.8. Signs, symptoms and treatment of heat affected CMWs

Early recognition of symptoms with appropriate first aid treatment is vitally important in reducing the effects of heat strained individuals.

The below figure shows the progression of heat related effects.



Prolonged and uncontrolled exposure to heat can manifest into a range of heat related illnesses. Recognition and responding to the early signs and symptoms can provide an opportunity to prevent or reduce the severity of heat illness.

Signs, symptoms and treatment of **Heat Illnesses**

Signs & symptoms	Treatment
Heat rash • Clusters of red spots / bumps usually on neck and upper chest (prickling sensation)	• Move to cooler place • Keep the affected area dry and clean • Avoid using ointments and creams • Apply cold compress
Heat syncope • Fainting due to inadequate blood flow to the brain	• Lie patient on their back in a cool area with airflow • Elevate patients' legs
Heat cramps • Painful muscle pains and spasms, usually in abdomen arms or legs	• Rest in cool shaded place • Stretch affected muscles • Increase fluid intake with electrolyte supplement and food
Heat exhaustion • Heavy sweating • Cold, pale skin • Fast, strong pulse • Heat cramps • Paleness • Weak, dizzy, nauseous, headache • Nausea and vomiting • Fast, weak pulse • Irritability	• Follow DRSABCD action plan • Rest in cool, shaded place (ideally an air-conditioned room or vehicle) • Maintain airflow over the body • Have cool shower or bath or apply cool wet towels to body • Sip water or suck ice chips with electrolyte supplement • Seek medical attention if symptoms don't improve

It is important to note that **heat stroke** is a medical emergency where treatment within the initial 30 minutes is critical. The emergency response plan should include specific response and treatment of suspected heat stoke events due to the potential severity of the condition is accordance with VUL-PLN-035-Emergency Planning & Response.

Signs, symptoms and treatment of **Heat stroke**

Signs & symptoms	Treatment
Heat Stroke • High body temperature (>40°C) • Hot, dry skin • Fast, strong pulse • Slurred speech • Weak, dizzy, nauseous, headache • Irrational and unusual behaviour • Loss of consciousness / cardiac arrest	• Call emergency services • Follow DRSABCD action plan • Move person to cool, shaded place (ideally an air-conditioned room or vehicle) • Immerse in as cold as possible water from the neck down for 15 mins Or if ice water immersion not available do a combination of the following: • Wet person with cold water under shower, hose or with cloths • Spray skin with water and fan continuously • Apply ice packs (groin, armpits, facial cheeks, palms and soles) • Do not give liquids to drink unless fully conscious

The core body temperature of workers suffering heat stroke needs to be lowered as rapidly as possible, leading to the concept of "cool first, transport second". It is critically important that the first responder starts treatment as soon as possible and does not wait for onsite emergency services to arrive.

4.9. Return to work after an event

Incidents of heat illness, including suspected heat exhaustion and heat stroke, should be managed in accordance with VUL-MOP-015– Incident Reporting and Investigation.

Return to work guidelines should be followed for the affected worker in accordance with medical advice to re-establish worker heat tolerance prior to undertaking full duties. Consideration should be given to:

- Registered medical practitioner assessment
    - Identification of any potential underlying conditions that the CMW may not have been previously aware of
- Impacts of repeated heat conditions that the CMW may have been exposed to
- Rehydration status
- Planned work activities suitable for worker impacted by a heat related illness on return to work.

4.10. Structured Education, Training and Awareness

The site's SHMS must establish and maintain processes for internal communication between various levels and functions of the mine and the receipt, documentation, and response to relevant communications of the hazards being addressed. This includes communication of any active TARP triggers to CMWs likely to be affected and recorded on the OCE report or other daily communications.

The training needs should be relevant to the specific hazard of working in heat, and all personnel whose work may be impacted by the hazard must receive appropriate training before commencing work.

Training refreshers should be conducted yearly prior to the summer season and / or when TARPs trigger the need for additional awareness - for example during heat wave events.

5. ROLES AND RESPONSIBILITIES

SSE	Shall review and approve this procedure.
HST Superintendent	Shall ensure that all provisions of this procedure are implemented, and that compliance is achieved.
Managers/Superintendents	Shall be responsible for their area of operations and the implementation and application of this procedure; Provide adequate training, information, structure and supervision to ensure that this procedure is implemented; Carry-out a periodic review of activities to ensure the appropriate application and understanding of this procedure; and Ensure immediate and appropriate steps are taken to investigate and rectify any risks to health and safety arising from these activities.
Supervisors	Ensure all CMWs are familiar with, have access to and comply with the requirements set out in this procedure.
All CMWs (including visitors and contactor)	Shall comply with the requirements of this procedure.

6. REFERENCES

- Coal Mining Safety and Health Act 1999 (Qld)
- Coal Mining Safety and Health Regulation 2017 (Qld)
- Guidance Note QGN32 Managing Exposure to Heat in Surface Coal Mines
- RSHQ Safety Bulletin 91 Heat stress
- RSHQ Safety Bulletin 93 Sunlight and other UV radiation risk management
- RSHQ Safety Bulletin 115 Risk management of heat exposure in mining
- RSHQ Safety Bulletin 191 Managing heat exposure in coal mines
- RSHQ Safety Bulletin 198 Managing heat exposure in coal mines
- Urine colour chart: Health Direct

7. RELATED DOCUMENTS

- VUL-ATT-001-Urine Based Heat Stress Diagnosis Tool
- VUL-PLN-035-Emergency Planning & Response
- VUL-MOP-015– Incident Reporting and Investigation
- VUL-FRM-11-01-Open Cut Examiners Shift Report

8. REVIEW

This document shall be reviewed at a minimum every two (2) years, or as follows:

- when there is a change of method and/or technology and/or legal or other requirement that may affect the accuracy of this document;
- when operational changes occur that effect the currency of the document;
- when there has been a significant event to which this document was relevant; and
- as a result of relevant audit findings.

9. DOCUMENT CONTROL

Version	Date	Description	Document Controller
01	21/05/2020	Initial draft	Rachael Dacker
02	26/06/2020	Risk workshop	Shane Johnson
03	14/05/2021	Review & Formatting	Nicole Davey
04	04/08/2023	Review & Update	Kelly Jensen
05	20/09/2023	SHMS Review	Kelly Jensen

10. APPENDIX A: URINE BASED HEAT STRESS DIAGNOSIS TOOL