Petroleum Development Oman L.L.C.

Heat Stress Management

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ii Revision History

The following is a brief summary of the 4 most recent revisions to this document. Details of all revisions prior to these are held on file by the issuing department.

Version No.	Date	Author	Scope / Remarks
Version 1	24-05-2017	Sawai, Salim MCOH	First draft
Version 2	01/01/2023	Said Al Sabari MCOH5	Alignment with OPAL standard

iii Related Business Processes

Code	Business Process (EPBM 4.0)

iv Related Corporate Management Frame Work (CMF) Documents

The related CMF Documents can be retrieved from the Corporate Business Control Documentation Register CMF.

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1 ABBREVIATIONS & DEFINITIONS

Term	Definition
ANSI	American National Standards Institute
BMI	Body Mass Index
EPA	US Environmental Protection Agency
HAP	Heat Alert Program
HCP	Health Care Provider
HSE	Health, Safety & Environment
HR	Heart Rate
MD	Ministerial Decision
MIC	Man In Charge
MOH	Ministry of Health
MOL	Ministry of Labor
MSHA	Mine Safety and Health Administration
NIOSH	National Institute for Occupational Safety and Health
OPAL	Oman Society for Petroleum Services
ORS	Oral Rehydration Solution
OSHA	Occupational Safety and Health Administration
OSHEMCO	Operators' Safety, Health and Environment Managers Steering Committee
PPE	Personal Protective Equipment
RH	Relative Humidity
TWL	Thermal Work Limit
WHO	World Health Organization
USG	Urine Specific Gravity
JSRS	Joint Supplier Registration System

2 GLOSSARY

Term	Definition
Acclimatization	The physiological changes that occur in response to a succession of days of exposure to environmental heat stress and reduce the strain caused by the heat stress of the environment; and enable a person to work with greater effectiveness and with less chance of heat illness.
Body Heat Balance	Steady-state equilibrium between body heat production and heat loss to the environment.
Heat Cramp	A heat-related illness characterized by spastic contractions of the voluntary muscles (mainly arms, hands, legs, and feet), usually associated with restricted salt intake and profuse sweating without significant body dehydration. Occurs after prolonged vigorous exercise or strenuous physical activity, especially in hot climates. There is a sudden onset of pain and cramps in extremities. In occasional cases, there may be nausea and hypotension and in some cases hyperventilation.
Heat Exhaustion	A heat-related illness characterized by elevation of core body temperature above 38°C (100.4°F) and abnormal performance of one or more organ systems, without injury to the central nervous system. Heat exhaustion may signal impending heat stroke. Heat exhaustion may sometimes be a progression from heat cramps, but, more often, occurs independent of heat cramps and it is more severe condition. It is more likely in the dehydrated, unfit, the elderly and those who have high blood pressure. It is caused by both salt and water loss.
Heat Strain	The physiological response to the heat load (external or internal) experienced by a person, in which the body attempts to increase heat loss to the environment in order to maintain a stable body temperature.
Heat Stress	The net heat load to which a worker is exposed from the combined contributions of metabolic heat, environmental factors, and clothing worn which results in an increase in heat storage in the body.
Heat Stroke	An acute medical emergency caused by exposure to heat from an excessive rise in body temperature [above 41.1°C (106°F] and failure of the temperature-regulating mechanism. Injury occurs to the central nervous system characterized by a sudden and sustained loss of consciousness preceded by vertigo, nausea, headache, cerebral dysfunction, bizarre behavior, and excessive body temperature. Heat stroke is caused by exactly the same conditions as heat exhaustion. It begins as heat exhaustion, but when the body's system for losing heat is overwhelmed the core temperature rises rapidly and tissue damage occurs. This affects mainly the brain, kidneys and liver. The circulation collapses. Heat Stroke can be of two types – Classic and Exertional Classic Heat Stroke : • Accepted definition of "heatstroke" includes confusion, unconsciousness, and/or convulsions, accompanied by a lack of sweating. • Not Common in occupational settings Exertional Heatstroke : • Common in Occupational settings • Profuse sweating is one of the common sign • Exertional heatstroke is caused by combination of heat exposure and heavy physical exertion. • It can lead to a condition called Rhabdomyolysis, in which muscle tissue breaks down, releasing large amounts of potassium and Proteins into the blood; leads to Cardiac Arrhythmias, Seizures and Kidney damage (NIOSH 2016)

Term	Definition
Heat Syncope (Fainting)	Collapse and/or loss of consciousness during heat exposure without an increase in body temperature or cessation of sweating, similar to vasovagal fainting except that it is heat induced. A heat related condition where blood, which would normally be circulated to the heart and brain, tends to pool in the leg veins, thereby causing fainting. The veins lack tone when initially exposed to hot climates.
Heat Tolerance	The physiological ability to endure heat and regulate body temperature at an average or better rate than others, often affected by the individual's level of acclimatization and physical conditioning.
Heavy Work	Carrying, climbing, lifting, pushing, whole-body work.
Humidity, Relative (RH)	The ratio of the water vapor present in the ambient air to the water vapor present in saturated air at the same temperature and pressure.
Light work	Sitting or standing, light arm work.
Paced work	The work rate is not under the worker's control. It is generally determined by work process or work flow.
Qualified Health Care Professional	An individual qualified by education, training, and licensure/regulation and/or facility privileges (when applicable) who performs a professional service within his or her scope of practice in an allied health care discipline, and independently reports that professional service.
Self-paced work	The work rate is under the worker's own control.
Sweating, Thermal	Response of the sweat glands to thermal stimuli.
Temperature Regulation	The maintenance of body temperature within a restricted range under conditions of positive heat loads (environmental and metabolic) by physiologic and behavioral mechanisms.
Thermal Stress	The sum of the environmental and metabolic heat load imposed on the individual.
Thermal Work Limit (TWL)	The Thermal Work Limit (TWL) is the heat stress index which is used to enable management of safe work in heat. It is defined as the limiting (or maximum) sustainable metabolic rate that well-hydrated, individuals can maintain in a specific thermal environment.
Heat Alert Program (HAP)	Heat Alert Program (HAP) is a program to communicate Heat Stress Index and/or TWL to all affected parties.
Work	Physical efforts performed using energy from the metabolic rate of the body.

3 PURPOSE

This document is initially applicable to energy and minerals industry sector for roll out and implementation in the first phase and to be expanded to other sectors in the second phase, in Sultanate of Oman. The purpose of this standard is to minimize potential detrimental health effects resulting from excessive heat that may result from working outdoors or within indoor environments with elevated temperatures. This document establishes guidelines to assess and minimize employee health risks resulting from heat stress exposure.

This standard complies with Oman Labor Law No. 35/2003, Ministerial Decision (MD) No. 286/2008 and subsequent MD No. 322/2011 and OPAL Heat Stress Management Standard (OPAL-STD-HSE03- Rev 1) as intended to represent best industry practice.

4 APPLICABILITY

This document is applicable to all Industrial sectors of the Sultanate of Oman. The target populations to benefit from this standard are Occupational Health and Safety professionals like OccupationalHealth Professional ,

Industrial Hygienists, HSE advisors, Health Care Providers (HCP).This including employees, managers, supervisors and heat exposed workforce.

5 REQUIREMENTS

5.1 Introduction

Heat stress is the net heat load, consisting of the sum of environmental and metabolic heat to which a person is subjected. Heat strain is the body's physiologic response to heat stress.

People may be at risk for heat stress and concomitant heat strain, when exposed to hot environments or even when engaged in strenuous physical activities.

Exposure to hot environments and extreme heat, indoors or outdoors, can result in illnesses, including heat rashes, heat cramps, heat exhaustion, heat syncope, and heat stroke.

Contact with hot surfaces, steam, or fire may result in other heat injuries, such as burns.

Heat can also increase workers' risk of injuries, as it may result in sweaty palms, fogged-up safety glasses, dizziness, and may reduce brain function responsible for reasoning ability, creating additional hazards. Occupational exposure to heat can also result in reduced productivity.

To address this hazard, PDO has developed this Standard for Heat Stress Management Programs. It addresses the recognition, treatment, and prevention of heat-related illnesses by providing guidance for medical supervision, hygienic practices, and training programs and is also designed to prevent harmful effects from interactions between heat and toxic chemical and physical agents.

The recommendations and requirements were developed to ensure that adherence to them will:

(1) Protect against the risk of heat-related illnesses and heat-related reduction in safety performance.

(2) Be achievable by techniques that are valid and reproducible and,

(3) Be attainable by means of existing techniques.

5.1.1 Estimation of Risks

A World Health Organization (WHO) scientific group on health factors involved in working under conditions of heat stress concluded that "it is inadvisable for deep body temperature to exceed 38°C (100.4°F) in prolonged daily exposure to heavy work".

The physiological response to heat stress varies within the human population. Thus, heat illness is determined by both core temperature and symptoms, rather than core temperature alone.

5.2 Ministerial Decision Regarding Summertime Working Hour's Restrictions

The Oman Ministry of Manpower has issued a Ministerial Decision regarding summertime working hour's restrictions, as captured in Article 16/3 of MD No. 286/2008, whereby during the period of hot summer months (June, July and August), restricted work periods in the hottest part of the day (12:30 PM – 03:30 PM) is mandated, unless waived by the Ministry, as per MD No. 322/2011.

5.3 Heat Balance and Heat Exchange

An essential requirement for continued normal body function is that the deep body core temperature be maintained within the range of about 37°C (98.6°F) ± 1°C (1.8°F). Achieving this body temperature equilibrium requires a constant exchange of heat between the body and the environment.

5.3.1 Effects of Clothing on Heat Exchange

Any form of protective work clothing will pose some limitations on tolerance to heat stress by altering the physiologic responses of the human body, which include reducing the efficiency of evaporative heat loss (sweating) and increasing the demands upon the cardiovascular system.

5.3.2 Acclimatization to Heat

When workers are exposed to hot work environments, they readily show signs of distress and discomfort, such as increased core temperatures and heart rates, headache or nausea, and other symptoms of heat exhaustion.

On repeated exposure to a hot environment, there is a marked adaptation in which most individuals perform the work with a lowered skin and core temperature and reduced Heart Rate (HR) and a higher sweat rate (i.e., a reduced thermoregulatory strain) and with none of the heat stress related symptoms that may have been experienced initially.

Full heat acclimatization occurs with relatively brief daily exposures to working in the heat.

It is important to understand that heat acclimatization increases efficiency of sweat glands and thereby the sweat rate; therefore, workers will have an increased water replacement requirement.

Acclimatization to work in hot, humid environments provides adaptive benefits that also apply in desert environments, and vice versa. However, acclimatization may not necessarily afford tolerance to a heat wave, which is a sudden abrupt increase in environmental thermal conditions.

An acclimatization plan should be implemented at all workplaces where workers are exposed to heat. Refer to Appendix A for a sample of Acclimatization Plan (see ***Table-A)***.

5.4 Heat-Related Illnesses at Work

A summary of categories, clinical features, prevention, and first-aid treatment of heat-related illnesses is presented in Appendix B (see ***Table-B***).

5.5 Fundamental and Risk Based Heat Stress Controls

Heat Stress Management will involve both fundamental controls and additional risk based controls, which are implemented when the fundamental controls are inadequate for the protection of workers.

5.6 Basic Thermal Risk Assessment

While Thermal Work Limit (TWL) remains the cornerstone of assessment of environmental thermal stress, It has to be borne in mind by the work crew that it is not mandatory to use basic thermal work assessment tool before start of the work shift.

However, this basic thermal risk assessment application/tool may be used on occasions when access to measure thermal work limit is not available. Also, basic thermal risk assessment application/tool is not a

replacement of thermal work limit. It is a qualitative risk assessment tool that can be used by a crew leader or supervisor. This assessment covers three parts: the types of hazards, the metabolic rate, and the apparent temperature.

The tool/app can be downloaded on to smartphones via the below URL:
https://www.aioh.org.au/resources/tools/

5.7 Measurement of Heat Stress

Heat Stress is defined as sum of environmental and non-environmental factors (e.g, clothing and work/metabolic rate), which are of sufficient magnitude to result in Heat Strain,which is defined as the physiological response of the body to an increase in heat storage in deep tissues. Since the predominant mechanism of causation of heat stress is due to environmental and work conditions, the cornerstone of measurement of heat stress is by assessment of thermal parameters in the workplace.

5.7.1 Thermal Work Limit

The Thermal Work Limit (TWL) is the heat stress index to enable management of safe work in hot work environment. It is defined as the limiting (or maximum) sustainable metabolic rate that well-hydrated, acclimatized individuals can maintain in a specific thermal environment, within a safe deep body core temperature (< 38.2 °C or 100.8 °F) and sweat rate (< 1.2 kg or 2.6 lb per hour).

TWL is calculated from environmental parameters (refer to below input) assuming that workers are well hydrated and acclimatized to the conditions and are self-paced.

Input

- Dry Bulb/ambient air Temperature (°C)
- Wet Bulb Temp. (humidity/evaporation rate, °C)
- Globe Temp. (radiant heat)
- Wind Speed (m/s)
- Atmospheric pressure

Output

- Thermal Work Limit (TWL, W/m^2)

= Maximum rate at which heat can be lost to the environment in the given conditions

TWL can be measured with simple instruments that can be procured from vendors in the market (guidance on procurement can be made available). Instruments calibration to be applied as per the manufacture recommendations.

However, if a site is unable to procure, online resource can be made use to input the parameters shown below link to calculate the TWL readings:

TWL-calculator-v-6.3.xls (live.com)

Note: Download the xl file to be able to calculate TWL. Instruction to use the xl sheet is provided within.

TWL Calculator

The XL sheet can display the TWL when the parameters are input in relevant fields. In the XL file, enter the environmental parameters to calculate the Thermal Work Limit.

It gives a measure of the maximum safe work rate for the conditions. If TWL is too low then even low rates of work cannot safely be carried out continuously that requires extra rest breaks and other precautions to make safe work. Safe intervention for safe management of work is shown in Appendix C (See ***Table-C***).

The following variables must be taken into account when applying the TWL criteria which is based on environmental conditions alone. i.e. further caution should be taken if the following risk factors associated with the individual or tasks are identified;

- Heavy, forced pace or precision work (the harder someone works the greater the amount of body heat generated)
- Worker clothing, PPE and RPE
- Worker age, fitness, medical conditions, medications, diet.
- Accessibility to water and cool rest area

5.7.1.1 Posting of warning signs in dangerous heat stress areas

Dangerous Heat Stress Areas

In work areas and at entrances to work areas, readily visible warning signs should be posted. These signs should contain information on the required protective clothing or equipment, hazardous effects of heat stress on human health, and information on emergency measures for heat injury or illness. This information should be arranged as shown in Appendix D.

Emergency Situations

In any area where there is a likelihood of heat stress emergency situations occurring, the warning signs required in this section should be supplemented with signs giving emergency and first aid instructions, as well as emergency contact information.

Additional Requirements for Warning Signs

All hazard warning signs should be printed in English and, where appropriate, in the predominant language of workers unable to read English. Workers unable to read the signs should be informed of the warning printed on the signs and the extent of the hazardous area(s). All warning signs should be kept clean and legible at all times.

5.8 Medical Monitoring & Provision of First Aid and Emergency Treatment

Employers should establish a medical monitoring program for workers with occupational exposure to hot environments.

5.8.1 Program Oversight

The employer should assign responsibility for the medical monitoring program to a responsible healthcare provider. The responsible healthcare provider should be a qualified physician or other qualified health care professional who is informed and knowledgeable about the following:

1. Potential workplace exposures to heat and hot environments.

2. Identification and management of heat-related illnesses.
3. Administration and management of a medical monitoring program for occupational hazards.

   - Random physiologic monitoring may be undertaken by site nurse or site doctor to evaluate effectiveness of controls.

4. Physiological Monitoring Program Components are:

   - Hydration Monitoring (Urine Specific gravity) (measured with Digital Refractometer)
   - Heart Rate Monitoring (continuous and Spot) Blood Pressure Monitoring (as needed) (measured with Aneroid BP Manometer)
   - PEFR (as needed) (measured with simple PEF meter)
   - Aural Temperature (measured with digital thermometer)
   - Core body temperature (for selected Cases) (proprietary)

Actions to be performed by Site Nurse or Site Doctor or Qualified Health Professional:

Measure parameters of Physiological monitoring and document/ record them in appropriate record sheets on the spot and upon returning to nursing station.

Heart rate monitoring data measured by Polar heart rate monitors and Core Body Temperature monitors are to be downloaded into docking station and saved onto computer for further analysis.

While measurement of urine specific gravity refractometer (refer to Appendix E) is easy and takes just a minute. Measurement and recording of Heart data and Core temperature data requires appropriate training by vendor (a few hours of training and practice)

Generally, urine samples are analyzed in rest rooms, on site (necessary biomedical waste disposal precautions and procedures are required to be followed).

5.8.2 Medical Monitoring Program Elements

Recommended elements of a medical monitoring program for workers at risk of heat-related illnesses and injuries should include:

1. Fitness to work evaluation;
2. Regularly scheduled or periodic follow-up medical evaluations as and when required;
3. Reports of incidents of heat-related illnesses and injuries;
4. Periodic evaluation of data; and
5. Worker education /health awareness (Refer to Section 5.13 Heat Stress Awareness Program).

5.8.2.1 Medical Evaluations

The purpose of preplacement and periodic medical evaluations of persons working at a particular hot job is:

1) To determine if the persons can meet the demands and stresses of the hot job, with reasonable assurance that the safety and health of the individuals and/or fellow workers will not be placed at risk;

2) To inquire whether persons have already suffered from an adverse health effect from heat stress exposure; and

3) To work with management to modify the job as necessary.

Based on the findings from these evaluations, more frequent and detailed medical evaluation may be necessary.

5.9 Control of Heat Stress and Heat Stress Reduction Measures

Actions that can be taken to control heat stress and strain are listed in ***Table-1***.

Table-1. Checklist for Controlling Heat Stress and Strain

Item	Actions for consideration
1. Engineering Controls:	
• Reduce physical demands of the work; use powered assistance for heavy tasks (i.e. mechanization). • Interpose line-of-sight barrier; use furnace wall insulation, metallic reflecting screen, heat reflective clothing; cover exposed parts of body. • Provide shaded areas where practical to reduce heat stress. • If air temperature is above 35°C (95°F), reduce air temperature, reduce air speed across skin, and wear clothing. • Mist spraying and non-mist spraying cooling fans wherever possible. Provide air-conditioning including portable air-conditioner where appropriate. • If air temperature is above 35°C (95°F), increase air speed across skin and reduce clothing to achieve maximum evaporative cooling by sweating (Emax). • Increase cooling by decreasing humidity and/or increasing air speed. • Provide more cool rooms and/or shades for rest.	
2. Administrative Controls:	
• Gradually increase exposure time in hot environmental conditions over 7–14 days. • For new workers, the schedule should be no more than 20% of the usual duration of work in the hot environment on day 1 and no more than 20% increase each day. • For workers with experience with the job, the regimen should be no more than 50% of the usual duration of work in the hot environment on day 1, 60% on day 2, 80% on day 3, and 100% on day 4. • Shorten duration of each exposure; allow frequent short breaks; more-frequent short exposures are better than fewer long exposures. • Staff rotation. • Schedule very hot jobs in cooler parts of day when possible. • Implement TWL or equivalent. • Heat Stress Index Communication. • Encourage water intake at frequent intervals to prevent dehydration.	

Item	Actions for consideration

- Provide shaded and/or air-conditioned space nearby.
- Worker medical evaluations.
- Provide adequate portable water.
- Train all workers and raise heat awareness.
- Add extra personnel to reduce exposure time for each member of the crew.
- Introduce working in pairs (buddy system).
- Suspend piece-rate payment mechanisms.
- Where physically demanding tasks are involved in hot environments or in work areas with high process heat, workers may be encouraged to drink appropriate electrolyte drinks, in consultation with site medical doctor or head of medical section.

  - For faster absorption from gut, total concentration of salt and sugars (osmolality) should be lower than plasma osmolality (less than 280 mOsm/kg).

3. Personal protective clothing and equipment:

- Reflective clothing, Hats/ helmets.
- Choose light coloured materials for clothing. The weight of clothing materials should not be more than 210 gsm (grams per square meter) and minimum 80% cotton unless the fabric is fire retardant.
- **Devices/Clothing to cool the body and reduce heat stress**

  When unacceptable levels of heat stress occur, it is sometimes useful to utilize a variety of body cooling apparel and/or devices to provide additional mitigation measures of heat stress.

  Such cooling devices/apparel can range from

  (1) water-cooled garments,

  (2) air-cooled garments,

  (3) cooling vests, and

  (4) wetted over garments,

  (5) Cooling skull caps,

  (6) Cooling bandanas and so on.

  Each of these auxiliary body cooling approaches might be applied as deemed practical in alleviating risk of severe heat stress in alignment with specific workplace setting (based on PPE Risk Assessment).

  These cooling systems have substantial limitations within a work setting.

  Overall, reduction of heat stress by use of body cooling devices/apparel allows work to continue, but does not eliminate the constraints imposed by workplace specific encapsulating protective clothing and gear and may result in degradation or slowing down of performance.

  <u>The employer should provide an appropriate body cooling vests if requested by the employees</u>

5.10 Record Keeping

5.10.1 Enviromental Heat

The employer should establish and maintain an accurate record of all measurements made to determine environmental and metabolic heat exposures to workers, as required in this recommended standard (see 5.6 Measurement of Heat Stress).

5.10.2 Medical Surveillance

The employer should establish and maintain an accurate record for each worker subject to medical monitoring.

5.10.3 Heat-related Illness Surveilance

The employer should establish and maintain an accurate record of any heat illness or injury and the environmental and work conditions at the time of the illness or injury.

5.10.4 Heat Alert Program

Companies shall establish Heat Alert Program (HAP) during summer months to ensure measures are in place to prevent heat related illnesses.

5.11 Heat Index Communication

Heat Stress Index Communication requires mitigation measures to protect workers throughout the range of acclimatization, heat tolerance and physical strength and endurance from the effects of heat stress, for all required work activities to be performed.

The Heat Index Communication is executed, in accordance with the following steps:

1) The person In Charge/ Supervisor of each facility, rig, hoist, worksite, or his delegate is responsible to determine the Color Category, in accordance with the TWL or equivalent, at the worksite.
2) Company is responsible for ensuring that the Color Category is communicated to all of their Workforce including Contractors and Subcontractors.
3) All Contractor HSE Representatives and the Operations Control Room Operators or MIC's are responsible for communicating heat index at their location, directly upon receipt of information changing the Heat Index Level.

5.12 Protection from Sunburn

It is recommended that protection from sunburn be incorporated into the heat stress management system.

This should be accomplished by provision of sunscreen barrier lotions and reminding workers of the importance of protecting uncovered skin, as well as the recommendation that sunglasses should be worn.

5.13 Heat Stress Awareness Program

A documented mandatory heat stress awareness program shall be in place for all who work in hot environments. Workers, supervisors and managers should be trained about the prevention and first aid of heat-related illness before they begin work in a hot environment. Heat prevention training should be reinforced on hot days.

Employers shall provide a heat stress awareness program that effectively communicate to all workers about the following:

1) Recognition of the signs and symptoms of the various types of heat-related illnesses—such as heat cramps, heat exhaustion, heat rash, and heat stroke — and in administration of first aid (see ***Table-B***).
2) The causes of heat-related illnesses and the personal care procedures that will minimize the risk of their occurrence, such as drinking enough water and monitoring the color and amount of urine output.
3) The proper care and use of heat-protective clothing and equipment and the added heat load caused by exertion, clothing, and personal protective equipment.
4) The effects of non-occupational factors (drugs, alcohol, obesity, etc.) on tolerance to occupational heat stress.
5) The importance of acclimatization (see ***Table-A***).
6) The importance of immediately reporting to the supervisor any symptoms or signs of heat-related illness in themselves or in their coworkers.
7) The employer's procedures for responding to symptoms of possible heat-related illness and for contacting emergency medical services if needed.

In addition to being informed about each of those topics, supervisors should be trained on the following:

1) How to implement appropriate acclimatization.
2) What procedures to follow when a worker has symptoms consistent with heat-related illness, including emergency response procedures.

   NOTE:

   Employer's Emergency Response Procedure must include provision for timely emergency transportation/evacuation of worker suffering Heat Stress Illness to facilities capable of providing all required medical tests and treatment, including performing emergency surgery, if required.
3) How to monitor weather reports.
4) How to respond to hot weather adversaries.
5) How to monitor and encourage adequate fluid intake and rest breaks.

A buddy system should be initiated, in which workers on hot jobs are taught to recognize the early signs and symptoms of heat-related illness. Each worker and supervisor who has received the instructions is assigned the responsibility for observing, at periodic intervals, one or more fellow workers to determine whether they have any early symptoms of a heat-related illness. Any worker who exhibits signs and symptoms of an impending heat-related illness should be sent to the first-aid station for more complete evaluation and possible initiation of first-aid treatment.

Additional training and educational materials are available from:

- NIOSH at http://www.cdc.gov/niosh/topics/heatstress/
- OSHA at https://www.osha.gov/SLTC/heatstress/prevention.html#training
- Cal/OSHA at http://www.dir.ca.gov/DOSH/HeatIllnessInfo.html

Medical, Nursing and Paramedical staff engaged in field work may need periodic refresher training in dealing with cases of Heat Illness and determining requirements of referrals and transfers to higher medical centers for advanced treatment in critical cases.

Upon completion of training, workers should be tested, to verify their awareness of the hazards and symptoms of heat stress illnesses and the proper appropriate first aid treatment, as well as the mitigation measures to be implemented. Heat Stress Survey Form can be utilized for this purpose.

5.14 Review and Audit

The Standard for Heat Stress Management will be reviewed every three years at the direction of the PDO, to identify opportunities for improvement. Improvement in the effectiveness, efficiency, completeness, and ease of implementation will be considered. These reviews will consider results of HSE assessments, HES performance and the extent to which HSE compliance objectives have been achieved. The findings and recommendations of previous reviews, changes in regulations, business conditions, and best practice concepts will also be considered. The results of this review will dictate whether changes to this procedure are necessary.

5.14.2 Program Audit and Evaluation

1) Company shall perform an annual review of this program. The audit protocol and the evaluation will include the following three phases, as a minimum:
   a) Audit of the Heat Stress Management program operation;
   b) Survey that consults workers on effectiveness of engineering and administrative measures to reduce heat stress and of heat stress awareness campaigns.
   c) Field inspection of engineering control measures being used to evaluate understanding of administrative controls, equipment storage, use, care and calibrations if required.
2) Workplace evaluations will be conducted during normal area walkthroughs and during Heat Stress Management Awareness training classes. The Company shall continually evaluate the work areas to ensure that this program is being properly implemented and that it continues to be effective. This evaluation will include maintaining an up-to-date list of departments and job titles that require or use heat stress management. Affected employees shall be regularly consulted about the effectiveness of the Heat Stress Management program during walkthroughs and during Heat Stress Awareness training. The Company Heat Stress Management Program shall be updated as required.

5.15 PDO Minimum Requirements for Heat Stress Management Program

The Minimum Requirements for an Employer's Heat Stress Management Program are as follows:

1. **Work place and job hazard risk assessment for potential heat stress.** This must be performed for all worksites and all activities.
   - Areas where there is a high risk of heat stress must be provided with proper warning signs.
   - Heat stress reduction measures must be specified for activities which are at risk of heat stress.
2. **Monitoring methods for heat stress**. These must be sufficiently sensitive and accurate that the heat stress (environmental and metabolic) to which a worker is subject is properly evaluated. Application of TWL or equivalent thermal index that takes metabolic rates into consideration shall be implemented to ensure managing safe work.
   - Environmental monitoring must be continuous, at times when there is a risk of heat stress.

3. Employer shall have a reporting mechanism giving details of how the Heat Stress Index is communicated to managers, supervisors and all personnel at the worksite.
    - In the event that physiological monitoring of workers is not performed, the Alert Levels must be sufficiently conservative as to ensure the protection of all workers performing all activities under heat stress.
4. Employers must specify when **engineering and administrative controls** are required to mitigate heat stress.
5. **Identifying working population prone to high, medium and low risk.** This must include assessment by a suitably qualified and certified physician, who has access to the workers' full medical histories. Medical reporting system must ensure proper confidentiality of patient medical data. Employer must require compliance with Physician's recommendations for each worker.
6. Employer must specify procedures for reporting possible Heat Stress Illness and ensuring provision of adequate First Aid measures, follow up treatment, including performance and interpretation of diagnostic tests by suitably qualified medical personnel and rapid transfer of patient to suitable medical facility for emergency treatment or testing, if required.
7. Provision to ensure that workers are assessed by qualified physician and are properly rehabilitated, before returning to work, after treatment for acute and chronic medical conditions or heat stress illness.
8. **Recording and reporting of statistical and trend analyses**. All incidents of heat stress illness must be recorded and reported to Site HSE Officer, HR Officer, MOL and MOH. to discern possible areas of concern or possible improvements
9. **Special or additional measures for summer coupled with fasting days.** These measures must include provision of shaded and air-conditioned resting facilities at worksite, dietary and lifestyle advice and the provision of suitable healthy foods, as well as plentiful provision of fluids in such manner as to be convenient for rehydrating or maintaining proper hydration of workers, as well as ensuring replenishment of electrolytes.
10. **Acclimatization Program** for workers at risk of heat stress shall conform to the recommended schedule of PDO requirement. The acclimation may well start from the second half of May to enable physiological response to be effective.
11. Time of exposure should be temperature-dependent.
    - Work-rest schedules should reduce heat exposure and should be adequate to reliably protect workers, in the event that metabolic monitoring of personnel is not performed.
    - Temperature monitoring and recording must be carried during the day of hot months, but not limited to June, July and August, in order to ascertain peak rise in temperature for corrective and preventive actions.

Acclimatization schedules

Workers with previous exposure[1] to hot environments – Acclimatized	Workers without previous exposure to hot environments – Non acclimatized
Day 1 – 50% exposure Day 2 – 60% Day 3 – 80% Day 4 – 100%	Day 1 – 20% exposure Day 2 – 40% Day 3 – 60% Day 4 – 80% Day 5 – 100%

Notes:[1] Workers returning from an absence (>14 days)

[2] Adapted from Mine Safety and Health Administration (MSHA)–USA [1976-2001]

12. **Facility and minimum infrastructure expected at the workplace:** Employer's minimum specifications for facilities and infrastructure must meet or exceed the requirements of Oman Ministry of Labor Ministerial Decision regarding summertime working hour's restrictions, as captured in Article 16/3 of MD No. 286/2008.
13. Employer must specify suitably cool sleeping and recreational facilities for workers.
14. Address possible deferment of work and scheduling physically demanding work for the coolest parts of the day.
15. Determine membership of committee of Subject Matter Experts (SMEs) to review and update Heat Stress Management (HSM) standard periodically.
16. Employees must abide by the requirements and shall follow the hierarchical controls and use all appropriate PPEs.
17. Employees shall also report immediately any symptoms of heat illness to the supervisor or intervene when fellow workers is affected by heat for rescue and early recovery.

6. REFERENCES

Document Number	Description
RD 35/2003	Oman Royal Decree on Labour Law
MD 286/2008	Ministerial Decision on Regulation of Occupational Safety and Health for Establishments Governed by the Labour Law.
MD 322/2011	Amending certain provisions of the bylaws regulating occupational health and safety in the organizations subject to the Labor Law
MSHA, 1976, 2001	Mine Safety and Health Administration, USA
HAAD, 2013	The Thermal Work Limit Heat Stress Index". *Health Authority - Abu Dhabi*. Archived from the original, retrieved May 15, 2013.
OSHA-NIOSH, 2011	Occupational Safety and Health Administration-The National Institute for Occupational Safety and Health
EPA, 1993	Environmental Protection Agency
DOD, 2007	Department of Defense, USA
NIOSH, 2016	National Institute for Occupational Safety and Health (NIOSH) Criteria for a Recommended Standard - Occupational Exposure to Heat and Hot Environments - Revised Criteria 2016.

7. APPENDICES

Appendix A Acclimatization in Workers

Appendix B Heat Related Illnesses

Appendix C Intervention for Safe Management of work at Extreme temperature

Appendix D Examples of Heat Stress Warning Notices

Appendix E Equipments used in Heat Stress Monitoring

Appendix F Urinary indcies of Hydration status

Appendix A: Acclimatization in Workers

Table-A. Acclimatization in workers

Topics	Additional information
Disadvantages of being unacclimatized	• Readily show signs of heat stress when exposed to hot environments. • Difficulty replacing all of the water lost in sweat. • Failure to replace the water lost will slow or prevent acclimatization.
Benefits of acclimatization	• Increased sweating efficiency (earlier onset of sweating, greater sweat production, and reduced electrolyte loss in sweat). • Stabilization of blood circulation. • Work is performed with lower core temperature and lower heart rate. • Increased skin blood flow at a given core temperature.
Acclimatization plan	• Gradually increase exposure time in hot environmental conditions over a period of 7 to 14 days. • For new workers, the schedule should be no more than 20% of the usual duration of work in the hot environment on day 1 and a no more than 20% increase on each additional day. • For workers who have had previous experience with the job, the acclimatization regimen should be no more than 50% of the usual duration of work in the hot environment on day 1, 60% on day 2, 80% on day 3, and 100% on day 4. • The time required for non–physically fit individuals to develop acclimatization is about 50% greater than for the physically fit.
Level of acclimatization	• Relative to the initial level of physical fitness and the total heat stress experienced by the individual.
Maintaining acclimatization	• Can be maintained for a few days of non-heat exposure. • Absence from work in the heat for a week or more results in a significant loss in the beneficial adaptations leading to an increased likelihood of acute dehydration, illness, or fatigue. • Can be regained in 2 to 3 days upon return to a hot job. • Appears to be better maintained by those who are physically fit. • Seasonal shifts in temperatures may result in difficulties. • Working in hot, humid environments provides adaptive benefits that also apply in hot, desert environments, and vice versa. • Air conditioning will not affect acclimatization.

Appendix B: Heat Related Illnesses

Table-B. Heat-Related Illness Categories, medical aspects, and first aid

Signs and symptoms	Examples of predisposing factors	Underlying physiologic disturbance	First aid
(1) Temperature regulation			
Heat stroke			
• Confusion, altered mental status, slurred speech • Loss of consciousness (coma) • Hot, dry skin or profuse sweating • Seizures • Very high body temperature • Fatal if treatment delayed	• Sustained exertion in heat • Obesity and lack of physical fitness • Recent alcohol intake • Dehydration • Individual susceptibility • Chronic cardiovascular disease	• Failure of the central drive for sweating, leading to loss of evaporative cooling and an uncontrolled accelerating rise in temperature.	• A medical emergency: call your local emergency number or national 9999 for emergency medical care • Someone should stay with worker until emergency medical services arrive • Move the worker to a shaded, cool area and remove outer clothing • Cool the worker quickly with a cold water or ice bath if possible; wet the skin, place cold wet clothes on skin, or soak clothing with cool water • Circulate the air around the worker to speed cooling • Place cold wet clothes or ice on head, neck, armpits, and groin; or soak the clothing with cool water
(2) Circulatory hypostasis			
Heat syncope			
• Fainting (short duration) • Dizziness • Light-headedness during prolonged standing or suddenly rising from a sitting or lying position	• Dehydration • Lack of acclimatization	• Pooling of blood in dilated vessels of skin and lower parts of body	• Sit or lie down in a cool place • Slowly drink water, Oral Rehydration Solution (ORS), clear juice.

Signs and symptoms	Examples of predisposing factors	Underlying physiologic disturbance	First aid
(3) Water and/or salt depletion			
Heat exhaustion			
• Headache • Nausea • Dizziness • Weakness • Irritability • Thirst • Heavy sweating • Elevated body temperature • Decreased urine output	• Sustained exertion in heat • Lack of acclimatization • Failure to replace water lost in sweat	• Dehydration • Depletion of circulating blood volume • Circulatory strain from competing demands for blood flow to skin and to active muscles	• Take worker to a clinic or emergency room for medical evaluation and treatment • If medical care is unavailable, call your local emergency number or national 9999 • Someone should stay with worker until help arrives • Remove worker from hot area and give liquids to drink • Remove unnecessary clothing, including shoes and socks • Cool the worker with cold compresses or have the worker wash head, face, and neck with cold water • Encourage frequent sips of cool water
Heat cramps			
• Muscle cramps, pain, or spasms in the abdomen, arms, or legs	• Heavy sweating during hot work • Drinking large volumes of water without replacing salt loss	• Loss of electrolytes in sweat • Water intake dilutes electrolytes • Muscle spasm	• Drink water and/or ORS, have a snack and/or carbohydrate every 15 to 20 minutes • Avoid salt tablets • Get medical help if the worker has heart problems, is on a low sodium diet, or if cramps do
(4) Skin eruptions			
Heat rash (“prickly heat,” “sweat rash”)			
• Looks like red cluster of pimples or small blisters that usually appears on the neck, upper chest, groin, under the breasts, and in elbow creases	• Unrelieved exposure to humid heat with skin continuously wet with unevaporated sweat	• Plugging of sweat gland ducts with retention of sweat and inflammatory reaction	• When possible, a cooler, less humid work environment is best treatment • Keep rash area dry • Powder may be applied to increase comfort • Ointments and creams should not be used

Signs and symptoms	Examples of predisposing factors	Underlying physiologic disturbance	First aid
Heat rash ("wildfire")			
• Extensive areas of skin which do not sweat on heat exposure, but present gooseflesh appearance, which subsides with cool environments • Associated with incapacitation in heat	• Weeks or months of constant exposure to heat with previous history of extensive heat rash and sunburn	• Skin trauma (heat rash; sunburn) causes sweat retention deep in skin, reduced evaporative cooling causes heat intolerance	• No effective treatment • Recovery of sweating occurs gradually on return to cooler climate
(5) Muscle tissue injury			
• Muscle cramps/pain • Abnormally dark (tea or cola colored) urine • Weakness • Exercise intolerance • Asymptomatic	• End result of any process that damages skeletal muscle, such as the following: • Prolonged, intense physical exertion • Elevated body temperature (associated with heat stroke) • Use of certain prescription and over-the-counter medications • Use of certain dietary supplements like creatine and caffeine • Use of illicit drugs that can reduce blood flow to muscle tissue, such as cocaine and methamphetamine • Direct injury to the muscle (i.e., trauma, burns) or infections	• Leakage of muscle cell contents into the bloodstream, which may result in seizures, abnormal heart rhythms, nausea, vomiting, fatigue, and kidney damage • Injured muscles located in muscle fascial compartments may swell and cut off blood supply to entire muscle group, which may result in loss of function and permanent disability	• Stop activity • Increase oral hydration (water preferred) • Seek immediate care at the nearest medical facility
Adapted from Minard 1973; DOD 2003; Cervellin et al. 2010; OSHA-NIOSH 2011.			

Appendix C: Intervention for Safe Management of work at Extreme temperature

Table-C. TWL Working Zones: Control Interventions, Rest-work and Rehydration Schedules

Working Zones	Interventions	Rehydration Schedule (per Hr)	Work-Rest Schedule (Minutes)
Low Risk **Unrestricted Zone** **TWL: 140 – 220 <**	**No limits on self-paced work** (NOTE 1) for educated hydrated workers.	Light Work 600 ml – 1 Litre / hr	Safe for **ALL** continuous **self-paced work** (NOTE 1)
Medium Risk **Cautionary Zone** **TWL: 115 -140**	**Cautionary zone indicates situations in which environmental conditions require additional precautions.** • Practicable Engineering control measures to reduce heat stress should be implemented, e.g. provide shade, improve ventilation etc. • Working alone to be avoided. • No unacclimatized person (NOTE 2) to work. • Ensure adequate fluid intakes appropriate for type of work.	Light Work 1l – 1.2 Litres / hr (NOTE 3)	Safe for continuous **self-paced work** (NOTE 1)
		Heavy Work > 1.2 Litres / hr (NOTE 4)	**Continuous paced work** 45 work – 15 rest
High Risk Zone **TWL: < 115**	• **Strict Work/Rest Cycling required.** • No person to work alone. • No unacclimatized person to work. • High Risk induction required emphasizing hydration and identifying signs of heat strain. • Provide sufficient drinking water (2 litre per person) must be on the Job at all times.	All Work > 1.2 Litres / hr (NOTE 5)	Light work 45 work – 15 rest (NOTE 3)
			Heavy Work 20 work – 40 rest (NOTE 4)

NOTES:

1) Self-paced work – workers must be allowed to adjust their work rate according to environmental conditions. Paced work is when the work rate is not under the worker's control.

2) Unacclimatized workers are defined as new workers or those who have been off work for more than 14 days due to illness or on vacation leave (in a cool climate area).

3) Light work – sitting or standing, light arm work.

4) Heavy Work – carrying, climbing, lifting, pushing, whole-body work.

5) At High workloads and/or thermal stress, sweat rates exceed 1.2 Litres / hr. Increasing fluid intake much above this level is not practical due to gastric discomfort as the upper limit for gastric absorption is ~1.5 Litres / hr so control solutions to improve thermal conditions should be implemented in addition to providing adequate hydration to replace sweat lost.

6) Additional Risk Factor:

- Wearing of Additional PPE e.g Chmical suit; RPE
- Heavy or forced paced workload
- High level of task complexity e.g. precision operation
- High level of environmental noise or vibration
- Body Mass Index (BMI) greater than 30
- Aging worker / Unfit worker
- Medical condition or medications taken

Appendix D: Examples of Heat Stress Warning Notices

DANGEROUS

HEAT STRESS AREA

HEAT STRESS–PROTECTIVE CLOTHING OR EQUIPMENT REQUIRED

HEAT STROKE OR OTHER HEAT-RELATED ILLNESS MAY OCCUR

Appendix E: Equipments used in Heat Stress Monitoring

1. **Urine specific gravity monitor**
   This equipment is used to measures the hydration of the employee. This small mobile equipment plays an important role in heat stress monitoring activities at any site

2. **TWL Monitor**

Appendix F Urinary indices of hydration status and action

#	USG Levels	Hydration Level	Action
1	1.001 – 1.015	Normal Hydration adequate	• Fluid intake is adequate to maintain desired hydration status. • Maintain fluid intake.
2	1.016 – 1.020	Alert Slightly Dehydrated	• Extra fluids required • Rehydrate before starting the work
	1.021 – 1.030	Alert Moderately dehydrated	• Extra fluids required. • Rehydrate before starting the work and every 15 to 20 minutes during the shift.
3	≥1.030	Action Significantly dehydrated	• Extra fluid required. • Rehydrate before starting the work and every 15 to 20 minutes during the shift. • Investigate cause of dehydration. • Remove employee from hot workplace. • Employee not to be allowed to perform this work until hydration levels improved. • Recheck USG in 4 hours.