Safety, Health and Environment National Authority

INDUSTRY GUIDANCE NOTE

TOPIC: **MANAGING HEAT STRESS AT WORKPLACE**				Reference Number: **2024/IGN/01**
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INDUSTRY GUIDANCE NOTE (IGN)

MANAGING HEAT STRESS AT WORKPLACE

1. INTRODUCTION

1.1 Purpose

The purpose of this industry guidance note (IGN) serves as a guidance and reference on matters pertaining to the management of heat stress in a workplace. Brunei's climate is becoming warmer with a mean temperature increase of 0.25^{0}*C per decade (Brunei Darussalam National Council on Climate Change)* and working in Brunei's hot and humid weather can put employees at an increased risk of heat stress especially for outdoor workers.

2. GLOSSARY OF TERMS AND ABBREVIATIONS

TERMS	DEFINITION
Acclimatisation	The physiological adaptation of the body to external or environmental temperature, where the body maintains an internal temperature of around 37.5°C. Beneficial physiological adaptations that occur during repeated exposure to a hot environment. (CDC)
Fatigue	Weariness or exhaustion from labour, exertion, or stress.
Hygrometer	Instrument used in meteorological science (study of the atmosphere, including weather and climate) to measure the humidity or amount of water vapour in the air.
Parameter	Any of a set of physical properties whose values determine the characteristics or behaviour of something.
Thermoregulation	The maintenance of an optimum temperature range by an organism.
ABBREVIATIONS	**DEFINITION**
HD	Humidex
IGN	Industry Guidance Note
PPE	Personal Protective Equipment
WBGT	Wet Bulb Globe Temperature
WSH	Workplace Safety and Health

WSHO, 2009	Workplace Safety and Health Order 2009, the primary law on Workplace Safety and Health in Brunei Darussalam enforced on 1st August 2013, sets the general framework to which all workplaces must comply.

2.1 Scope

This IGN sets out the general information and practical guidelines related to the prevention of heat stress at the workplace covering amongst others, the following:

a) how to recognise factors which contribute to heat stress;
b) various methods described which are to be used in order to measure heat stress;
c) how to conduct risk assessment related to heat stress;
d) how to manage and introduce controls for managing heat stress and
e) first-aid in relation to heat stress.

2.2 Applicable Laws and Regulations

All occupiers, employers, self-employed persons, principals, self-employed persons, and persons at work shall comply with the applicable laws and regulations, in particular to those listed below:

a) Workplace Safety and Health Order (WSHO), 2009

Section 11 specifies that it shall be the duty of every occupier to take, so far as is reasonably practicable, such necessary measures to ensure that –

(a) the workplace;
(b) all means of access to or egress from the workplace; and
(c) any machinery, equipment, plant, article or substance kept in the workplace, are safe and without risks to the health of every person within those premises, whether or not the person is at work or is an employee of the occupier.

Section 12(1) specifies the duty of employers to take, so far as is reasonably practicable, such measures to ensure that the work environment is safe and without risk to their employees' safety and health.

Section 13(1) specifies the duty of a self-employed person (whether or not he is also a contractor or sub-contractor) to take, so far is reasonably practicable, such measures as are necessary to ensure the safety and health of persons (not being his employees) who may be affected by any undertaking carried on by him at the workplace.

Section 14(1) specifies the duty of principals to take, so far is reasonably practicable, such measures as are necessary to ensure the safety and health of any contractor engaged by the principal when at work; any direct or indirect sub-contractor engaged

by such contractor when at work; any employee employed by such contractor or sub-contractor when at work who may be affected by any undertaking carried on by him in the workplace.

Section 14A(1) specifies the duties of every principal in relation to contractors to take, so far as is reasonably practicable, such measures as are necessary to ensure that any contractor engaged by the principal has the necessary expertise to carry out the work for which the contractor is engaged by the principal to do and has taken adequate safety and health measures in respect of any machinery, equipment, plant, article or process used, or to be used, by the contractor or any employee employed by the contractor.

Section 14A(3) states that the duty imposed on every principal where they have taken adequate safety and health measures in respect of any machinery, equipment, plant, article or process used, or to be used, includes ascertaining that the contractor engaged by the principal has conducted a risk assessment in relation to the safety and health risks posed to any persons who may be affected by the work and has informed any person who may be affected by the work, the nature of the risk involved in the work and any measure or safe work procedure which is implemented at the workplace.

Section 15 specifies that persons at work (employees) have a duty to use the provided protection intending or other means for securing their safety, health and welfare while at work, and to cooperate with their employer or principal or relevant persons. Any person at work is to ensure that they do not willfully or recklessly act in a way that endangers himself and others at the workplace.

b) Workplace Safety and Health (General Provisions) Regulations, 2014

Regulation 10 stipulates that it is the duty of the occupier of a workplace to take all reasonably practicable measures to ensure that persons at work in the workplace are protected from **excessive heat** or cold and harmful radiation.

c) Workplace Safety and Health (Risk Management) Regulations, 2014

Regulations 4(1), 4(2) and 4(3) stipulate the duty of the employer, self-employed person, and principal of every workplace to take all reasonably practicable steps to eliminate any foreseeable risk to any person who may be affected by his undertaking in the workplace. If the risk cannot be reasonably eliminated, then the employer, self-employed person or principal shall take reasonably practicable steps to minimise such risks and safe work procedures to control such risks that are to be put in place.

d) Workplace Safety and Health (Construction) Regulations, 2014

In a compressed air environment such as in tunnelling works, Regulations 99(1) specifies that the temperature in any working chamber, man-lock or medical lock, in a worksite shall not exceed 29^{0}C and the relative humidity shall not exceed 85%.

3. RESPONSIBILITIES

The responsibility of managing heat stress at work is not only limited to the duty of occupiers, employers, self-employed persons, principals and employees, but it also requires the duty of appointed Workplace Safety and Health (WSH) Officers, WSH Co-ordinators or the WSH Committees to assess and manage excessive heat at the workplace.

4. HEAT STRESS IN BRUNEI DARUSSALAM

4.1 Heat Stress Definition

Heat stress is a condition when the accumulation of heat in the body exceeds the body's natural ability to remove the excess body heat. Such accumulation of heat in the body can be from a combined contribution of heavy physical exertion, environmental factors (i.e. air temperature, humidity, air movement, and radiant heat), and clothing requirements as further elaborated under Part 5 below. When the core body temperature rises above the normal range of 36.1°C to 37.2°C, the functionality of the body will be affected.

The excess accumulated heat usually harms the body ranging from mild in the form of heat rash, heat cramps and heat exhaustion to permanent damage of vital organs that can lead to fatal heat stroke, if not treated immediately. Such illnesses can induce symptoms such as sweating, dizziness, fatigue, elevated blood pressure and heart rate which will all impair workers' performance. It is therefore crucial to maintain a manageable body temperature as heat stress is a medical emergency where untreated heat stress can lead to a heat stroke and in severe cases, even leading to death.

4.2 Brunei Climate

Brunei Darussalam has a tropical climate where it is hot and humid throughout the year. Brunei is in a region affected by northeast monsoon and southwest monsoon. The periods with lower-than-average heavy rainfall are normally between February to March, whereas the driest and hottest months of the year with an average high temperature of up to 32.0°C are generally between April and May. Generally, plans to mitigate heat stress should be in place during these hotter seasons.

4.3 Affected Occupations

All types of work can be affected by heat stress if the conditions are met. However, there are occupations that generally require heavy physical work to be done in hot and humid environments, henceforth are more likely to be impacted by heat stress. These hot and humid environments can occur either indoors or outdoors. Occupations that are generally affected by heat stress are illustrated in Table 1 as seen below.

INDOORS	OUTDOORS

• Brick Factory
• Steel working
• Electricity generating plants
• Petrochemical plants
• Oil and chemical refineries
• Interior construction and renovation work
• Boiler room
• Commercial Kitchens
• Bakeries
• Warehouse
• Laundries/Dobi
• Welders
	• Construction and repair work
	  ◦ Road
	  ◦ Housing and buildings
	  ◦ Bridges
	  ◦ Brick Layering
	  ◦ Welders
	  ◦ External painters
	• Oil and gas sectors (e.g. those working on offshore and onshore platforms)
	• Excavation and grading
	• Roofing
	• Agriculture/Harvesting
	• Fisheries
	• Forestry/Logging
	• Car wash
	• Cable Installation
	• Painting
	• Postman/Food Delivery

Table 1: Example of activities or workplace at risk of heat stress.

5. FACTORS CONTRIBUTING TO HEAT STRESS

Work can be defined as the physical exertion of the body. Physical exertion of the body produces heat. Naturally, in response to the rise in body heat, the body produces sweat and increases the heart rate. When the sweat on the skin evaporates, the body cools

down as a result. However, this natural cooling system from the body can be affected due to excessive exposure to heat.

The three contributing factors to heat stress at the workplace are:

- The Working Environment
- The Health Condition of Workers
- The Nature of The Work

5.1 Working Environment

Heat stress is mainly caused by high ambient temperature, the presence of a heat source at the workplace which causes the ambient temperature to rise, and the relative humidity that traps the heat and affects evaporation of sweat.

The following are some of the environmental risk factors of heat stress:

a) **Ambient Temperature**: High ambient temperature and solar radiation exposure raise the body temperature.
b) **Air Movement**: Airflow helps with the evaporation of sweat. Low wind velocities or minimal airflow reduces the rate of evaporation and consequently slows down the body's cooling system.
c) **Ambient Humidity**: Evaporation rate also depends on the relative humidity. Humidity is the saturation level of water vapour in the air. A higher humidity will result in a low evaporation rate.
d) **Direct Heat Source**: Working close to sources of heat such as machinery and steam. Examples of working close to sources of heat are working in a brick-firing foundry, working in power plants and working in commercial kitchens.
e) **Reflection of Solar Radiation**: When solar radiation bounces off surfaces, this is called the Albedo effect. Working close to light-coloured surfaces outdoors under direct sunlight may induce heat stress due to the reflected heat. Furthermore, dark-coloured surfaces absorb the radiation and heat from the sunlight. Extra care needs to be taken when working on light-coloured surfaces such as concrete and light-coloured roofs or rooftops.

5.2 Health Condition of Workers

A worker's condition further factors into how susceptible they are to heat stress:

a) **Inadequate Heat Acclimatisation**: The body may adapt or get used to working in a hot environment gradually over time, and this is known as heat acclimatisation. Heat stress is likely to affect workers who are not acclimatised to the hot weather, especially for workers who come from cooler climates or had a long leave from work because their bodies have not adapted to the tolerance to heat.

b) **Inadequate Nutrition and Dehydration**: Inadequate nutrition generally decreases a person's immunity and may affect his/her heat tolerance. A dehydrated worker may result in less sweating which corresponds directly with the reduction of the worker's ability to cool himself/herself. To prevent dehydration, a diet containing high water content foods can aid absorption and retain water e.g. cucumber, tomatoes, watermelon, bell peppers etc.
c) **History of Heat Illness:** Heat stress is also more likely to affect workers who have a history of heat-related illnesses. Examples of heat- related illness include heat rash, heat exhaustion, heat syncope (fainting) or heat stroke.
d) **Medical Condition or Illness**: Workers who are unwell or under specific medical conditions such as diabetes and obesity can affect thermoregulation – the ability to maintain core body temperature. It is important to screen workers for health conditions that may increase their susceptibility to heat injuries prior to employment.
e) **On Medication**: Workers who are on certain medications may affect the body's ability to retain water, and this would affect sweating, while other medications may affect heart rate. Examples of heat response-impairing medications include antidepressants, antihistamines, and supplements containing ginseng, nicotine, caffeine etc.
f) **Fatigue and Sleep Deprivation**: Accumulated fatigue could result in the body becoming more easily affected by heat stress as the body lacks the energy to properly regulate the core body temperature. Fatigue includes lack of sleep and adequate rest.
g) **Motivated Worker and/or Complacent Worker**: A highly motivated worker and/or complacent may ignore early signs and symptoms to continue with their work until a severe heat stroke occurs.

5.3 The Nature of the Work

The intensity of workload (light, moderate, heavy or very heavy), the rate of work (fast or slow), the type of work (strenuous or sedentary) and the type of clothing worn can also contribute to heat stress in a workplace.

Below are three examples of how the nature of work can affect heat stress.

a) **Workload**: The metabolic rate of a worker increases with the intensity and load of their work. The intensity is categorised into light, moderate, heavy, and very heavy work. The intensity also considers whether the work is done standing or seated, if it is one-handed or two-handed work, sedentary or if the worker needs to move around.
b) **Duration**: The duration of the work will determine how long the body will have to sustain the metabolic rate and regulate the body temperature that is already affected by the environment.
c) **Worker Clothing**: Bulky, thick clothing and impermeable Personal Protective Equipment (PPE) may limit air movements and the cooling effect of sweating

resulting in reduced heat loss from the body and an increase in heat load on the body.

Employers must allocate sufficient workers and resources such as the provision of mechanical aid to reduce the workload of workers to prevent the risk of heat injury. If aid is not available, where practicable, employers should consider providing regular rest breaks for strenuous work activities and the provision of suitable rest areas that are shaded and well-ventilated as well as ways for employees to rehydrate e.g., a water refill station.

6. HEAT STRESS MEASUREMENT

There are several means of heat stress indices available to measure heat stress at the workplace. This IGN will include a brief of Humidex (HD) and Wet Bulb Globe Temperature (WBGT). Employers or occupiers are required to take note that the measurement of heat stress of a worker shall be part of the risk management process.

6.1 Humidex

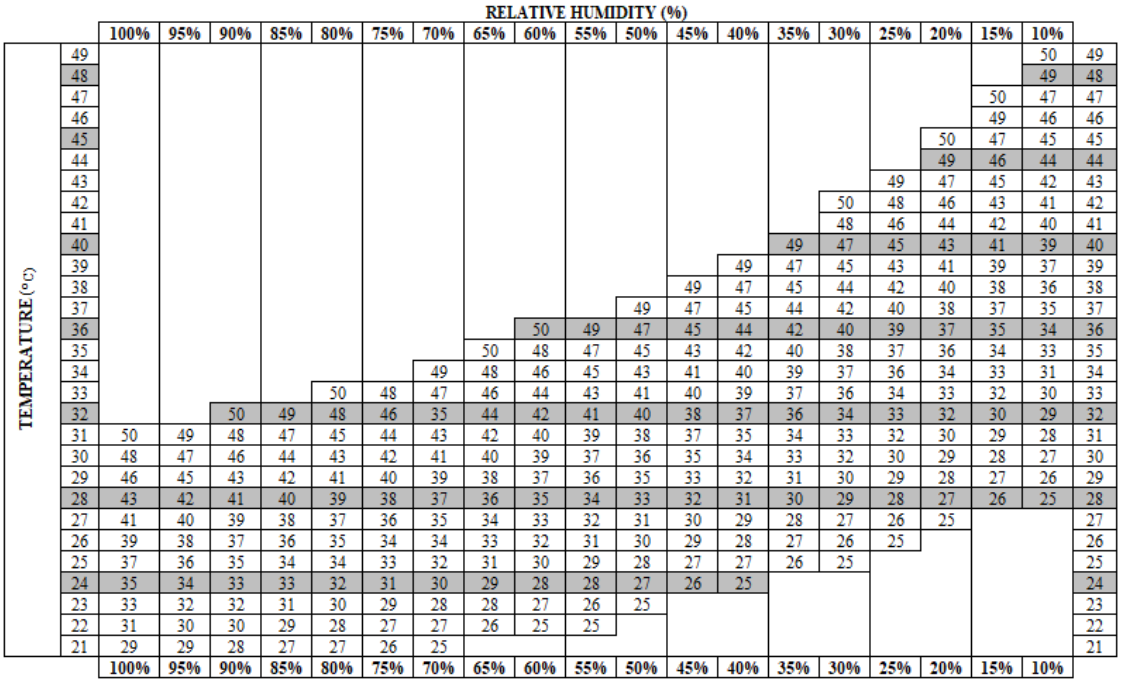
One method to determine heat stress is by using the humidity index, better known as Humidex (HD). HD is a simple tool that interprets how hot we feel when relative humidity is taken into account with actual air temperature. These parameters can be obtained by using a thermal hygrometer.

As mentioned in Part 5, heat stress depends on other factors from the workplace apart from the relative humidity and workplace temperature. Occupational Health Clinics for Ontario Workers, from Canada, known also as OHCOW, developed the Humidex Heat Stress Response Plan in 2020 which takes into account both radiant heat and clothing. The Heat Stress Response Plan was created for a mild Canadian summer where the high average temperature and humidity can be related to Brunei's climate.

The Humidex Response Plan is based on the Wet Bulb Globe Temperature (WBGT) index, adopting the recommendations of the American Conference of Governmental Industrial Hygienists (ACGIH®). These WBGTs were then translated to HD. Humidex 1 refers to unacclimatised workers doing "moderate" physical work or acclimatised workers doing "heavy" physical work. Meanwhile, Humidex 2 refers to unacclimatised worker doing "light" physical work or acclimatised workers doing "moderate" work.

At low levels of heat stress, HD values from 25 – 39 (Humidex 1) or HD values from 32 – 44 (Humidex 2), a Heat Stress Alert notice should be put out, and a Heat Stress Alert warning should be announced if conditions worsen. Drinking water needs to be provided and supervisors should ensure workers stay hydrated with 15 minutes of rest for every hour of work. At moderate levels of heat stress (amber levels), supervisors are to allow the workers to rest 30 minutes for every hour of work and observe the workers for any

signs of heat stress. At high levels of heat stress (red and maroon levels), more rest shall be allowed for workers, up to 45 minutes for every hour of work.



TEMPERATURE (°C)	RELATIVE HUMIDITY (%)																		
	100%	95%	90%	85%	80%	75%	70%	65%	60%	55%	50%	45%	40%	35%	30%	25%	20%	15%	10%
49																		50	49
48																		49	48
47																		50	47	47
46																		49	46	46
45																	50	47	45	45
44																	49	46	44	44
43																49	47	45	42	43
42															50	48	46	43	41	42
41															48	46	44	42	40	41
40														49	47	45	43	41	39	40
39													49	47	45	43	41	39	37	39
38												49	47	45	44	42	40	38	36	38
37											49	47	45	44	42	40	38	37	35	37
36									50	49	47	45	44	42	40	39	37	35	34	36
35								50	48	47	45	43	42	40	38	37	36	34	33	35
34							49	48	46	45	43	41	40	39	37	36	34	33	31	34
33					50	48	47	46	44	43	41	40	39	37	36	34	33	32	30	33
32			50	49	48	46	35	44	42	41	40	38	37	36	34	33	32	30	29	32
31	50	49	48	47	45	44	43	42	40	39	38	37	35	34	33	32	30	29	28	31
30	48	47	46	44	43	42	41	40	39	37	36	35	34	33	32	30	29	28	27	30
29	46	45	43	42	41	40	39	38	37	36	35	33	32	31	30	29	28	27	26	29
28	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	28
27	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25			27
26	39	38	37	36	35	34	34	33	32	31	30	29	28	27	26	25				26
25	37	36	35	34	34	33	32	31	30	29	28	27	27	26	25					25
24	35	34	33	33	32	31	30	29	28	28	27	26	25							24
23	33	32	32	31	30	29	28	28	27	26	25									23
22	31	30	30	29	28	27	27	26	25	25										22
21	29	29	28	27	27	26	25													21
	100%	95%	90%	85%	80%	75%	70%	65%	60%	55%	50%	45%	40%	35%	30%	25%	20%	15%	10%	

HUMIDEX 1 1) Moderate physical work for unacclimatized worker 2) Heavy physical work for acclimatized worker	RESPONSE	HUMIDEX 2 1) Light physical work for unacclimatized worker 2) Moderate physical work for acclimatized worker
25-29	Worker should be provided water	32-35
30-33	Heat Stress Alert notice. Start recording hourly T and RH.	36-39
34-37	Heat Stress Alert warning. Workers need to drink more water.	40-42
38-39	Work with 15 min/hr relief	43-44
40-41	Work with 30 min/hr relief	45-46
42-44	Work with 45 min/hr relief	47-49
45 or over	Only medically supervised work should be allowed	50 and over

Figure 1: Humidex Chart and recommended action plan to mitigate heat stress in a workplace adapted from Occupational Health Clinics for Ontario Workers, Canada, OHCOW, 2017.

Note: T and RH stand for temperature and relative humidity consecutively.

6.2 Humidex-Based Heat Stress Management Plan

Along with the Humidex Chart and Humidex Response Plan (Figure 1), below are steps to be followed in order to properly utilise HD which incorporates the OHCOW Humidex-Based Heat Response Plan.

These are the five steps that help determine the actions to be taken in order to reduce heat stress.

Step 1: Training

a) All personnel in a workplace, especially managers, supervisors, and workers require training in identifying the signs and symptoms of heat stress, and the ways to prevent them.
b) Everyone has different levels of heat tolerance. Heat tolerance depends on health status, fitness, history of injuries, medications that may affect thermoregulation, and so on (see Part 5.2). Workers should be able to work at their own pace considering the various factors that can affect their heat tolerance.
c) In addition to work pace, workers should be able to take regular rest breaks and drink enough water, generally one litre per hour or one cup every 20 minutes.

Step 2: Select a Measurement Location

a) Ideally, multiple measurements of workplace air temperature and humidity can be taken from different zones that have the same heat exposures. The highest heat stress zone reading can be used to come up with the best action plan.
b) Temperature readings taken from indoors do not correspond accurately to outdoor temperature readings. Find a representative location in each zone for ideal measurements.

Step 3: Measure Workplace Humidex

a) Use a suitable thermal hygrometer to obtain air temperature and humidity readings.
b) Use the Humidex Chart (Figure 1) to determine the corresponding Humidex value. Consider adjustments for clothing and radiant heat, as stated in Step 3 and Step 4.
c) Use the adjusted Humidex values to find the appropriate response in the Humidex Response Plan as illustrated in (Figure 1).
d) Make a record of the measurements.

Step 4: Adjust for Clothing

- Clothing should be as breathable as possible to allow the evaporation of sweat while being appropriate to work requirements. Light clothing reduces workload; hence it reduces metabolic rate and heat produced by the body.
- The response plan (Figure 1) assumes that a worker is wearing a light shirt, trousers, undergarments, socks and shoes.
- 5° HD should be added to the HD value obtained from Figure 1 for a worker wearing cotton coveralls on top of the assumed light clothing or double layer of clothing.

- For other forms of clothing and material, estimate the correction factor by comparing it with cotton coveralls. For example, gloves, hard hats, aprons and protective sleeves add 1° or 2° of Humidex.

Step 5: Adjust for Radiant Heat

- Add 2° to 3° to the obtained HD value for outdoor work in direct sunlight between 10 am – 4 pm (consider cloud cover).
- For indoor radiant heat exposures, use direct sunlight as a comparison to make appropriate adjustments and adjust the correction factor by adding 2° to 3° to the HD measurement appropriately. This requires the use of your training, knowledge, and experience to judge the exposure level.

Example of how to measure HD adjusted for clothing and direct sunlight:

An experienced construction worker is wearing cotton coveralls on top of light clothing (double layer) under direct sunlight. The workplace temperature is 32°C with relative humidity 45% at 11 am in the morning.

Temperature	: 32°C	
Humidity	: 45%	
Humidex	: 38°	(From Figure 1)
Adjust for Clothing	: +5°	
Adjust for Radiant Heat	: +2°	
Final Adjusted Humidex	: 45°	

Recommended Actions (Work-Rest Cycle):
Moderate physical work with 30 minutes of rest in every hour of work.

6.3 Humidex using a mobile application

There are some simple heat index mobile applications that are available to use to determine HD which have features to:

1) input workplace GPS location and automatically determines HD based on local weather information; or
2) manually input workplace temperature and relative humidity from a thermal hygrometer to obtain the heat index.

The recommended action or warnings will usually appear in the application after the calculation of HD to allow for an informed decision.

Note: *This approach is not the best practice as it does not accurately measure the temperature of the workplace where a worker is exposed*.

6.4 Wet Bulb Globe Temperature

Wet Bulb Globe Temperature (WBGT) is a more reliable device for measuring heat stress in a workplace. It measures the heat stress to which a worker is exposed. The parameters considered when using WBGT are the ambient air temperature, relative humidity, wind velocity, and solar radiation.

2A	2B
	

Figure 2A: An example of a standard WBGT device with black globe, wet bulb, and dry bulb thermometer attachments.

Figure 2B: An example of a handheld WBGT device using sensors.

Figure 2A is a standard WBGT device that consists of three modules: a black globe thermometer, a wet bulb thermometer, and a dry bulb thermometer (components A, B, and C respectively). Figure 2B is a handheld WBGT device.

However, standard WBGT devices can be expensive. As an alternative, there are smaller devices that are more affordable (shown in Figure 2B) that use sensors to measure the parameters and can produce similar results. WBGT meters must be calibrated at least once a year or according to the manufacturer's specifications.

Allocation of Rest in a Work and Rest Cycle	WBGT limit for acclimatised worker (°C)			
	Light	Moderate	Heavy	Very Heavy
Minimal rest or 15min/hour	31.0	28.0	-	-
15-30min/hour	31.0	29.0	27.5	-

30 to 45min/hour	**32.0**	**30.0**	**29.0**	**28.0**
45min/hour to no work	**32.5**	**31.5**	**30.5**	**30.0**

Table 2: Work and rest cycle suitable for acclimatised workers according to WBGT readings.

Allocation of Rest in a Work and Rest Cycle	**WBGT limit for unacclimatised person (°C)**			
	Light	**Moderate**	**Heavy**	**Very Heavy**
Minimal rest or 15min/hour	**28.0**	**25.0**	**-**	**-**
15-30min/hour	**28.5**	**26.0**	**24.0**	**-**
30 to 45min/hour	**29.5**	**27.0**	**25.5**	**24.5**
45min/hour to no work	**30.0**	**29.0**	**28.0**	**27.0**

Table 3: Work and rest cycle suitable for unacclimatised workers according to WBGT readings.

PHYSICAL WORK INTENSITY	ACTIVITY	EXAMPLES
Light	Light manual work (office work), arm and leg work, slow walking or driving. Operating Equipment, travel by conveyance, sitting with moderate movement of arms.	Desk work, typing; driving in light traffic; Assembly-line work; Supervising a worksite.
Moderate	Moderate hand and arm work, handling of moderately heavy material, light pushing or pulling, fruit or vegetable harvesting, and normal walking. Carrying equipment/supplies weighing 10-20 kg Jack-leg drilling; Installing ground support; Loading explosives.	Delivering mail; Driving heavy machinery; industrial cleaning; Picking fruits and vegetables; cooking food in a commercial kitchen; Warehouse work; and loading and unloading trucks.

Heavy	Intense arm and trunk work, heavy pushing or pulling, concrete block laying, and fast walking. Climbing; Carrying equipment/supplies weighing more than 20kg; Installing utilities; Using hand tools (shovel, fin-hoe, scaling bar) for extended periods; Some construction tasks	Sawing; roofing. Restocking shelves; asbestos removal.
Very heavy	Very intense arm work, climbing stairs or ladder, running. Some construction tasks; Very intense activity at a fast to maximum pace; Climbing stairs with heavy gear	Intense digging or shovelling; sledgehammer; Stone or brick masonry; Firefighting.

Table 4: Examples of Work at Different Intensity Levels.

Adopted from Heat Stress: Work/Rest Schedules CDC.GOV
and Preventing Heat Stress at Work
WorkSafeBC (2023)

There are two sets of permissible WBGT limits. Table 2 and Table 3 as seen previously show the WBGT limits for acclimatised and unacclimatised workers respectively, and the recommended resting time in an hour of work according to different work intensities. The permissible WBGT limit depends on two parameters i.e. the metabolic demands or work intensity of the task and work-rest cycle (proportion of work within an hour). The upper limit for WBGT readings shall be where only light work can be done with the most rest allocated, in this case, WBGT 32.5°C for acclimatised workers and WBGT 30.0°C for unacclimatised workers.

In order to determine the degree of heat stress exposure and the allocation of rest work cycles, the metabolic rates of a person's activities need to be considered. The examples of physical work intensity: light, moderate, heavy and very heavy are illustrated in Table 4.

6.5 Record Heat Stress Readings

To monitor heat stress, it is suggested to have an HD log or WBGT log (refer to **Appendix A**) at the workplace. It is advisable to record the readings on an hourly basis or as indicated in the risk management plan. In workplaces with high heat stress values, it is recommended to measure and record heat stress readings before any work starts and at

regular intervals throughout the day. Examples of high-risk workplaces include outdoor/open construction sites, bakeries, commercial kitchens, laundries, compressed air tunnels, incinerators, and power plants.

7. RISK MANAGEMENT IN RELATION TO EXCESS HEAT

Under the WSH (Risk Management) Regulation, 2014, regulations 4(3)(b), 4(3)(c) and 4(3)(d) refer to the practicable measures that may be taken to minimise or control the risks. Prior to developing these control measures, all heat sources need to be identified by conducting a risk assessment of the workplace. Heat stress may be eliminated from the workplace by allowing workers to perform work during a cooler time of the day or the use of machinery to reduce workload. If the heat risk cannot be eliminated, then other feasible measures from the hierarchy of controls such as engineering control, administrative control, and provision and use of suitable PPE should be considered.

7.1 Engineering Control

Engineering controls are straightforward steps that can be undertaken and implemented and, therefore should be prioritized. These include:

a) Providing sufficient ventilation for the indoor environment. This may include the use of exhaust fans to remove hot and humid air or to use of air-conditioning to lower the ambient temperature and regulate humidity. Portable fans may be used outdoors to improve airflow.
b) Heat barriers or any form of barrier that can minimise convection and radiation of heat between workers and sources of heat, especially in confined spaces.
c) Using mechanical aid to reduce employee workload. Reducing the production of metabolic heat means that heat stress may be more manageable but allows more work to be done. An example is using conveyor belts for transport of materials.

7.2 Administrative Control

Administrative controls include implementing policies, internal Standard Operating Procedures (SOPs) and programs in the workplace to reduce or eliminate risks.

a) As part of the general medical screening process of workers prior to employment, it may be necessary to screen them for certain health conditions or medications that may increase the detrimental effects of heat stress on a worker or decrease their heat resistance.
b) Persons in charge or supervisors in a workplace must check on the well-being of the workers before any work can start. Frequent monitoring of the well-being of workers at work is necessary for managing or reducing heat stress conditions.
c) Acclimatisation should always be the main priority in a project where heat stress conditions are present. In one research reported by the Occupational Safety and

Health Administration (OSHA), most of the fatalities in their research sample were due to workers not being acclimatised. Acclimatisation is the physiological adaptation to thermal conditions. It takes around 7 to 14 days, with a gradual increase in work time and exposure to the workplace and the source of heat stress for a worker's body to become acclimated (see **Appendix B** for heat acclimatisation schedule).

Workers who are required to undergo the Heat Acclimatisation Programme include:

i. New workers on their first day at work. New workers can be people who are involved with the work for the first time, workers from another country with colder climates or workers from countries with similar dry air temperatures but with lower average humidity than Brunei.

ii. Workers coming back from a lengthy break. Acclimatisation may be lost over a long weekend, as short as three days. This includes workers who must work outdoors again after a period of working indoors where the temperature is significantly lower, especially if the outdoor work is under the sun.

iii. Workers coming back from injury or illness recovery. Minor illnesses may take 1-2 weeks for full recovery such as sore throats, or the common cold. More severe injuries or illnesses would take more time. The body may take more time acclimating to environmental conditions when it needs to recover to its normal healthy condition as well. A doctor's consultation may be required to ensure that the worker has fully recovered and is able to work in heat-stress conditions again.

d) A proper work-rest cycle can also be implemented to ensure the safety of the workers while getting work done. For example:

i. Heavy physical work or work in the open under direct sunlight should be scheduled for cooler parts of the day.
ii. Allow for more rest breaks when work is done in very hot weather or when heavy physical work is involved.
iii. A suitable resting area should be set up beforehand. For outdoor work, the resting area should be shaded and well-ventilated.
iv. Provision of cool drinkable water.
v. As it is necessary for workers to rehydrate, the provision of toilets is as important.
vi. Reminders for workers to stay hydrated. For example, the use of a urine colour chart for workers to assess their hydration level (refer to **Appendix C**).

e) Worker rotation/shifts can help limit the worker's exposure to heat stress. Rotation is possible if there are enough workers available.

f) Employers and workers, especially appointed first aiders, should be trained, made aware and reminded of the importance of understanding heat stress, its signs and symptoms, and how to respond to heat stress incidents.
g) Dangers of heat stress should be mentioned in toolbox talks and safety briefings when it can be a major concern, such as in construction or factories with hot temperatures or humidity.
h) It is the responsibility of everyone involved in the workplace to be vigilant of any signs and symptoms of heat stress in others in order to keep everyone safe.

Workers should report to their supervisors or persons in charge if they are feeling unwell. Similarly, supervisors or persons in charge should not easily dismiss any reports with the assumption that workers are taking too much time resting.

In a workplace where heat stress danger is present, lone work is highly discouraged. A buddy system may be implemented where it is the responsibility of the two workers to observe each other for any signs and symptoms of heat stress, thus ensuring that one can call for medical assistance if required.

Warning signs must be placed appropriately where heat stress danger is present. For example, by placing warning signs at construction site entry points and the actual working areas, or entry points of confined spaces. Warning signs must be clean, clear, away from any obstruction, and use relevant language. Figure 3 as seen below is an example of a warning sign suggested by NIOSH.

Figure 3: Example of heat stress warning sign.

7.3 Personal Protective Equipment

Personal Protective Equipment (PPE) is dependent on the type of work being done and the work environment and the following are recommended:

a) Wear light-coloured clothing as it absorbs less radiated heat compared to dark-coloured clothing.
b) Workers can wear light-coloured hard hats and hats with wide brims to protect the face and neck from the sun.
c) Reflective PPE can be used for work that is in close proximity with hot machinery or equipment.

d) PPE should be lightweight to reduce the workload on the body. Loose-fitting clothing is also advisable as they are made of sweat-permeable material is recommended to promote evaporative cooling, but care needs to be taken to avoid any clothing from getting caught on any machinery.
e) If the type of work requires full body protection where evaporation of sweat is restricted, consider using suits with built-in ventilation or airflow.

A risk prevention checklist can assist a WSH Officer or Co-ordinator in identifying heat hazards and possible preventive measures that can be implemented to ensure the safety of persons in the workplace. An example of a heat stress prevention checklist can be found in **Appendix D**.

8. SIGNS AND SYMPTOMS OF HEAT STRESS

Principals, employers, occupiers, WSH Officers and WSH Co-ordinators need to raise the awareness of all workers of the signs and symptoms of heat stress. Signs are indicators that can be observed by other people. Symptoms are an indication of a present condition a person may be experiencing. Being able to recognise and identify the signs and symptoms of heat stress can save lives as the onset of heat illnesses can happen very quickly. Table 5 seen below details some conditions that can be identified from a heat stress casualty.

SIGNS	SYMPTOMS
General Appearance • **Fainting spells, especially after a change in stance or after prolonged standing** • **Staggering** • **Unconsciousness** • **Seizure**	**General condition** • **Feeling faint or 'seeing stars'** • **Loss of balance, feeling dizzy** • **Feeling weak** • **Nausea** • **Headache** • **Blurring vision or increased sensitivity to light**
Cardio-respiratory (heart and lung) • **Hyperventilating**	**Cardio-respiratory** • **Shortness of breath** • **Chest discomfort** • **Palpitations (fast heartbeat)**
Limbs and muscles • **Muscular cramping**	**Limbs and muscles** • **Cramping in lower limbs** • **Tingling sensation or numbness in the hands**

Gastrointestinal (stomach) • **Vomiting** • **Sudden loss of bladder or bowel function**	**Gastrointestinal** • **Dry mouth** • **Vomiting** • **Abdominal pain**
Behaviour • **Confused, disoriented** • **Irritable, anxious** • **Aggressive**	
Dermatological (skin) • **Dehydrated with dark sunken eyes and/or parched lips**	

Table 5: Physiological and behavioural signs and symptoms of heat stress.

9. FIRST AID TREATMENT

If a worker is found to have signs or symptoms of heat stress, first aid must be given immediately by appointed first aiders in the workplace. A suggested first-aid procedure for heat illness comprises two key steps:

a) Determining a worker's **level of consciousness** by using the **AVPU Scale**; and
b) On-site treatment using the **7R approach.**

9.1 The AVPU scale

AVPU is the acronym for "**A**lert, **V**erbal response, response to **P**ain and **U**nresponsive". Table 6 seen below is the AVPU scale that is used to quickly assess the level of consciousness of a person affected by heat stress.

Alert	**The worker is fully awake with spontaneous eye opening.**
Verbal	**Eyes do not open spontaneously but the worker responds appropriately when spoken to.**
Pain	**The worker does not respond to verbal stimuli but moves or groans in response to painful stimuli.**
Unresponsive	**The worker does not respond to stimuli.**

Table 6: The AVPU scale shows the state of a casualty depending on their response.

First aiders should check the mental state of the worker if it is suspected that the cause is due to heat stroke. The mental state is checked by asking the following 3 questions:

1) Do you know your name? (Indicate Person)
2) Do you know where you are? (Indicate Place)
3) Do you know if it is morning, afternoon or night? (Indicate Time)

When conducting this check and treatment as mentioned in this section, the First Aider may also record these alongside all treatment rendered by him, as required under Regulation 5(4)(a) of the Workplace Safety and Health (First Aid) Regulations, 2021.

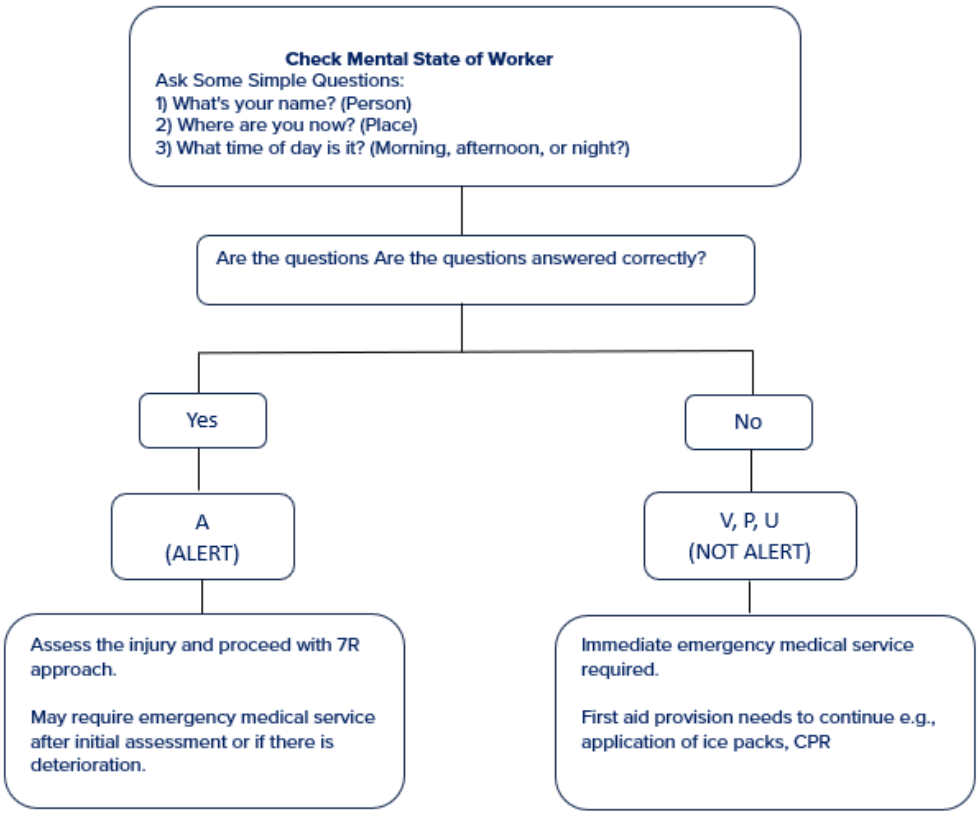


Figure 4: Steps taken when a worker is found to have any sign or symptom of heat stress.

If the worker can answer the three questions correctly, they are considered Alert, and the first aider can proceed with the **7R approach** for heat injury treatment. The worker may still require emergency medical service especially if there is deterioration in their condition.

If the worker is not Alert (V, P, and U) then emergency medical service is urgently required, and first aid should be administered until paramedics arrive.

9.2 The 7R Approach

The 7R Approach shown in Table 7 is a series of steps that can be used by first aiders for treating the casualty when there is a heat stress-related incident. The persons in charge of a workplace must ensure that the workplace and persons involved are ready to implement the **7R approach** if the steps are to be followed. This includes but is not limited to, the preparation of first aid kits, fluids for rehydration, accessibility for calling medical services, and safe access for medical services vehicles and personnel.

PROCEDURE	EXPLANATION
Recognise symptoms	**Recognise the symptoms of heat stress and report them immediately.**
Rest casualty	**Rest the affected worker in a cool area with good ventilation, away from any source of heat and direct sunlight.**
Remove clothing	**Remove or loosen excess clothing (while preserving the modesty of the worker).**
Reduce body temperature	**Reduce the body temperature immediately by applying or massaging with ice packs or wet towels or cool water. Fanning may also help. If available, cooling blankets can be used, and workers can be subjected to cold water immersion.**
Rehydrate	**Rehydrate by providing fluids. Do not provide fluid by mouth for unconscious casualties as this may cause choking.**
Resuscitate	**Perform cardiopulmonary resuscitation (CPR) if a worker becomes unconscious and if the first aider is trained to do so. Immediately call for help.**
Rush to hospital	**Call for emergency services or ambulance if a worker is unconscious.**

Table 7: 7R approach stating the steps for heat injury first aid.

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Appendix A

An example of WBGT Log: To monitor and assess the heat stress risk level at a workplace.

Example of WBGT Log sheet at Workplace

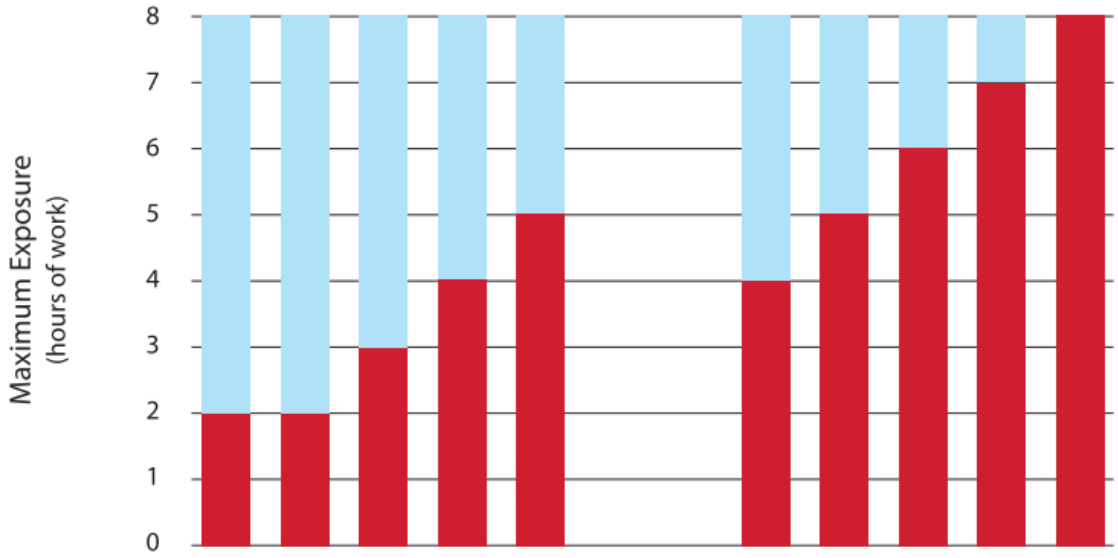
Site:_____

Time: _____ Reading (°C) HIGH  MEDIUM  LOW 	Time: _____ Reading (°C) HIGH  MEDIUM  LOW 	Time: _____ Reading (°C) HIGH  MEDIUM  LOW 

Heat Stress Category – WBGT (°C)	Heat Stress Risk Level	Recommended Actions	
		Work: Rest (mins)	Recommended Water Intake Per Hour (ml)
< 31	Low	45:15	750 ml
31 - 31.9	Moderate	30:15	1000 ml
≥ 32	High	30:30	1000 ml

Appendix B

An example of Heat acclimatisation schedule adapted from Managing Heat Stress in the Workplace, Workplace Safety and Health Guidelines (2020).



	Day 1	Day 2	Day 3	Day 4	Day 5	Sat	Sun	Day 6	Day 7	Day 8	Day 9	Day 10
Admin or light duties	6	6	5	4	3			4	3	2	1	0
Hot environment	2	2	3	4	5			4	5	6	7	8

Appendix C

Urine Colour Chart: This urine colour chart is a simple tool to assess if you are drinking enough water throughout the day.

Appendix D

SELF-ASSESSMENT CHECKLIST: HEAT STRESS AT WORKPLACE

PREVENTIVE MEASURES	YES	NO/NA	REMARKS
RISK ASSESSMENT			
Does your Risk Assessment cover work in a hot environment?			
Has an evaluation of the potential for heat injury been carried out based on a suitable heat stress index?			
Have all the heat sources e.g. hot machines, equipment, pipes, in the work area been identified?			
FITNESS TO WORK			
Have all workers passed their pre-employment medical screening and examination?			
Are supervisors/ line managers proactively checking for workers who are feeling unwell prior to starting work?			
Have workers, who have been ill, been certified by a doctor to be fit to return to work?			
HEAT ACCLIMATISATION			
Are new workers acclimatised to work in a hot environment?			
Are workers returning from prolonged leave, prolonged illness or returning from a colder climate, reacclimatised to work in a hot environment?			
WORKER CLOTHING			
Are workers wearing loose-fitting and light-coloured clothing?			
WORK SCHEDULING			
Is heavy physical work or work under direct sun scheduled for the cooler parts of the day?			
Is there a work rotation for workers exposed to hot working conditions?			

Are workers allowed to take additional rest breaks in very hot weather or after carrying out heavy physical work?			
PREVENTIVE MEASURES	**YES**	**NO/NA**	**REMARKS**
ADEQUATE WATER INTAKE			
Do workers have ready access to cool drinking water?			
Have the workers been advised to stay hydrated throughout the day?			
REST AREA			
Is there a cool or shaded area where workers can rest?			
USE OF MECHANICAL AIDS			
Are mechanical aids e.g. lifting equipment and power tools used to reduce the worker's physical workload?			
WORKPLACE VENTILATION			
Is there adequate ventilation (natural or mechanical) in the work area?			
INSULATION/SHIELDING OF HEAT SOURCES			
Are hot machines, equipment and pipes insulated and/or shielded to minimise heat transfer to the work environment?			
WORKER AWARENESS			
Have the workers been advised to report to their supervisor and/ or see a medical doctor if they are feeling unwell?			
Are the workers aware of the heat injury preventive measures they can take before starting work?			
Are WSH officers, supervisors, workers and appointed first-aiders able to identify the signs and symptoms of heat injury?			
Are emergency procedures established, emergency supplies available, and workers trained to render immediate on-site assistance?			

Appendix D: This heat stress self-assessment checklist is an example of a prevention checklist obtained from the Ministry of Manpower (MoM) of Singapore.