

Risk Assessment and Heat Stress Management Programme



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Heat Stress Risk Assessment



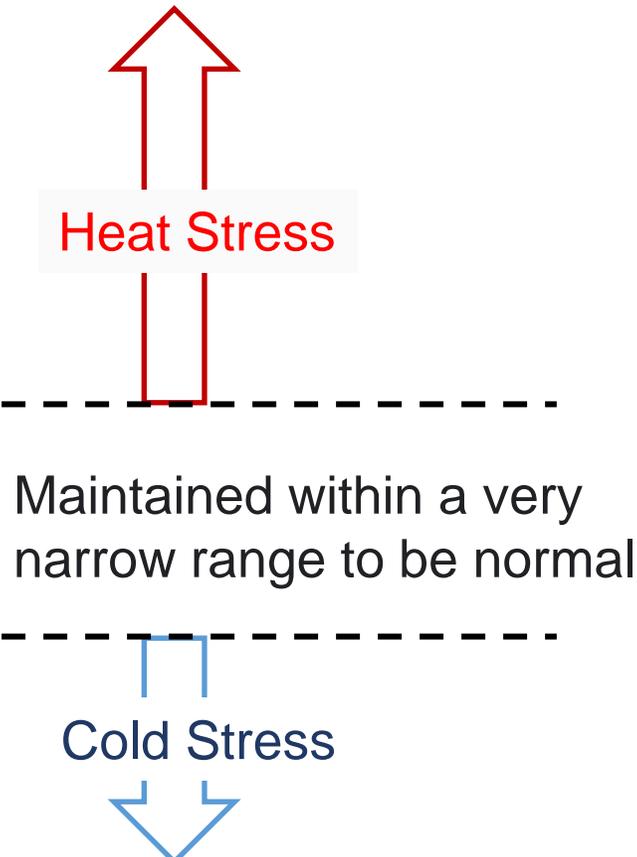
Heat Stress impact on health and corresponding Deep Body Core Temperature

Impact on health	Deep Body Core Temperature
Hyperpyrexia	> 40 °C
Hyperthermia or fever	38 °C and above
Normal	36.5 to 37.5 °C
Hypothermia	< 35 °C

Heat Stress

Maintained within a very narrow range to be normal

Cold Stress



Core Body Temperature & Effects

Core Temperature	Effects
44°C	Almost certainly death will occur
43°C	Normally death, or there may be serious brain damage, continuous convulsions & shock; cardio-respiratory collapse will likely occur
42°C	Subject may turn pale or remain flushed & red; may become comatose, severe delirium, vomiting, & convulsions can occur
41°C	Medical emergency - fainting, vomiting, severe headache, dizziness, confusion, hallucinations, delirium & drowsiness
40°C	Hyperpyrexia - fainting, dehydration, weakness, vomiting, headache & dizziness
39°C	Severe sweating, flushed & red, fast heart rate & breathlessness
38°C	Hyperthermia - hot, sweating, thirsty, uncomfortable
37°C	Normal
<35°C	Hypothermia - Max. shivering



Identification of activities/processes with Heat Stress hazard

Examples of heat generating processes / activities subjected to outdoor heat exposure

Construction

- General outdoor works
- Hot Works
- Landscaping
- Tunnelling works (CAW)



Marine

- Engine room
- Boiler rooms
- Hot Works
- Outdoor works
- Confined space works



Manufacturing

- Food production
- Foundries
- Metal working
- Ovens/ furnaces
- Iron/ Steel Mills
- Rubber manufacturing



Others

- Laundry/ Dryers
- Heat exchangers/ reactors
- Incinerators/ power plants



Evaluation of heat stress risk level

Wet Bulb Globe Temperature (WBGT)

- An index for rating thermal environment.
- Formulated to prevent core temperature > **38°C (100°F)**
- Considers air temperature, radiant heat & humidity of environment.
- Used with workload & clothing to assess heat stress.

Indoor (without exposure to sun):

$$\mathbf{WBGT = 0.7T_{nwb} + 0.3T_g}$$

Outdoor (with exposure to sun):

$$\mathbf{WBGT = 0.7T_{nwb} + 0.2T_g + 0.1T_a}$$

T_{nwb} : Natural wet bulb temperature

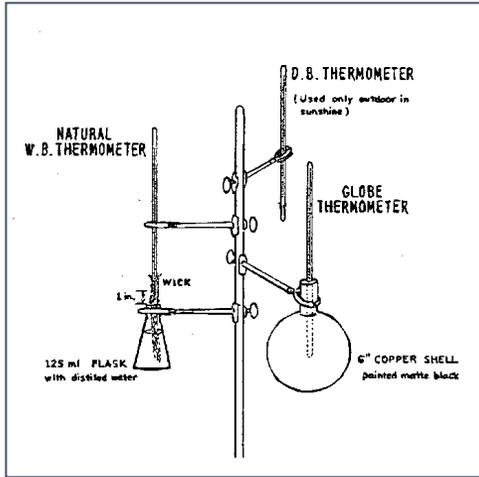
T_g : Globe temperature

T_a : Dry bulb air temperature



Measuring WBGT

Equipment to measure WBGT at the workplace



Heat stress monitors



Handheld heat stress meters

WBGT measurements should be carried out:

- as close as possible to where workers is expected to work in
- at multiple locations in the work site
- prior to the commencement of work daily
- during work especially for outdoor work



Risk Characterisation - WBGT Limits

WBGT	Heat Stress Risk Level	Recommended Control Measures
< 31°C	Low	Implementation of Heat stress management programme
31 to 31.9°C	Moderate	Implementation of Heat stress management programme + General Risk controls for Preventing Heat Stress
≥ 32°C	High	Implementation of Heat stress management programme + General and Job Specific Risk Controls for Preventing Heat Stress

Direct reading from the meter could be used as a proxy for the heat stress risk level



Heat Stress Control Measures



Measures to eliminate or reduce heat stress risks – Hierarchy of control

Elimination / Substitution

- Do away with hot process / operation
- Use induction heating instead of conventional heating
- Substitute gas or flame cooker with induction cooker
- Substitute electrical oven with microwave oven
- Use laser cutting instead of flame cutting

Engineering Control

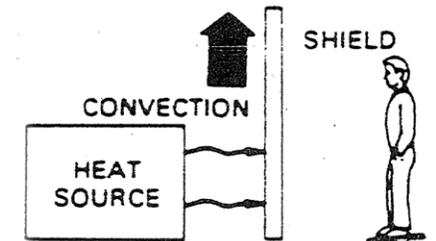
- Insulate hot surfaces
- Use reflective screen against radiant heat
- Reduce emissivity
- Apply local exhaust ventilation
- Apply dilution ventilation
- Use spot cooling
- Use evaporative cooling
- Increase or reduce humidity
- Isolate, relocate hot sources
- Automate or mechanise work

Administrative Control

- Acclimatisation
- Work-rest regime
- Work rotation
- Work scheduling
- Adequate water intake (250ml every 20 to 30 mins)
- Daily checks for workers feeling unwell
- Worker's training to recognise early signs of heat stress



Induction heating



Shielding



Water intake



General Risk Controls for Preventing Heat Stress

Moderate Risk



Environmental Monitoring

- Monitor WBGT / environmental heat stress condition and past reports of heat-related disorders

Workers' Personal Health

- Pre-placement medical screening to identify workers who are susceptible to heat-related injury
- Encourage healthy lifestyle, maintain ideal body weight
- Adequate salt intake from diets
- Monitor and counsel workers who abuse alcohol or other intoxicants
- Monitor workers who need to take medication that may compromise normal cardiovascular, blood pressure, body temperature regulation, and renal or sweat gland functions

Work Practices

- Verbal and written instructions, annual training and information on heat injuries
- Acclimatisation – adjust expectation of those returning to work after absence from heat exposure situations
- Encourage workers to drink one glass of cool water every 20-30min
- Allow self-limitation of heat exposure



Refer to WSH Guidelines on Managing Heat Stress

Job Specific Risk Controls for Preventing Heat Stress

High Risk

Engineering Control

- General or Local ventilation e.g. blower/stand fans
- Shield radiant heat sources e.g. temporary shelters to provide shade
- Engineering controls that reduces metabolic rate e.g. mechanical devices for material handling

Admin Control

- Schedule work to cooler part of day (avoid 11am to 3pm)
- Allow sufficient recovery time
- Limit physiological strain

PPE

- PPE which were demonstrated to be effective for specific work practices and conditions at the location

Refer to WSH Guidelines on Managing Heat Stress

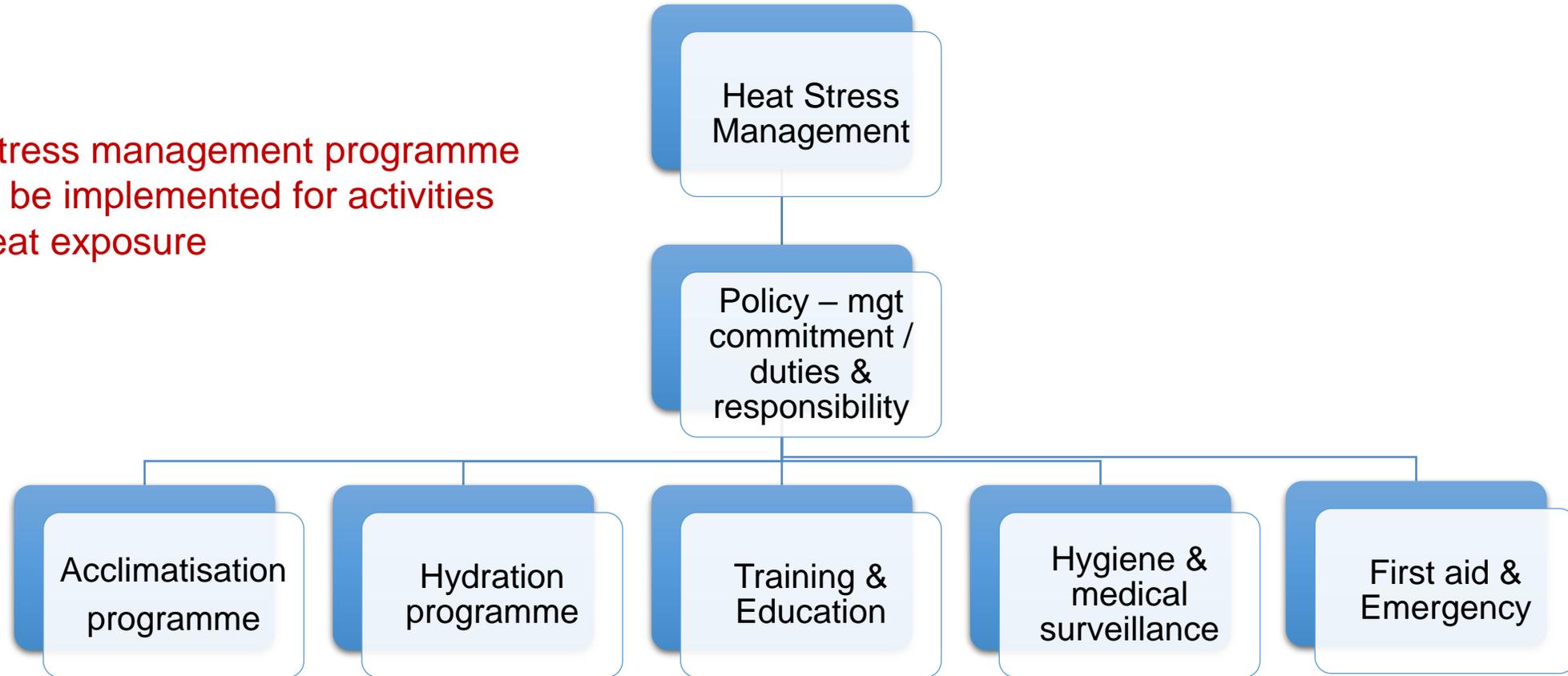


Heat Stress Management Programme



Heat Stress Management Programme- Key Elements

Heat stress management programme should be implemented for activities with heat exposure



Heat Stress Management Programme- Acclimatisation

Acclimatisation - “get used to hot weather”

- A process of physiological adaptation that occurs on continuous exposure to environmental heat
- Takes about 2 weeks to become fully acclimatised
- Noticeably loss after 4 days, completely lost in 3 weeks

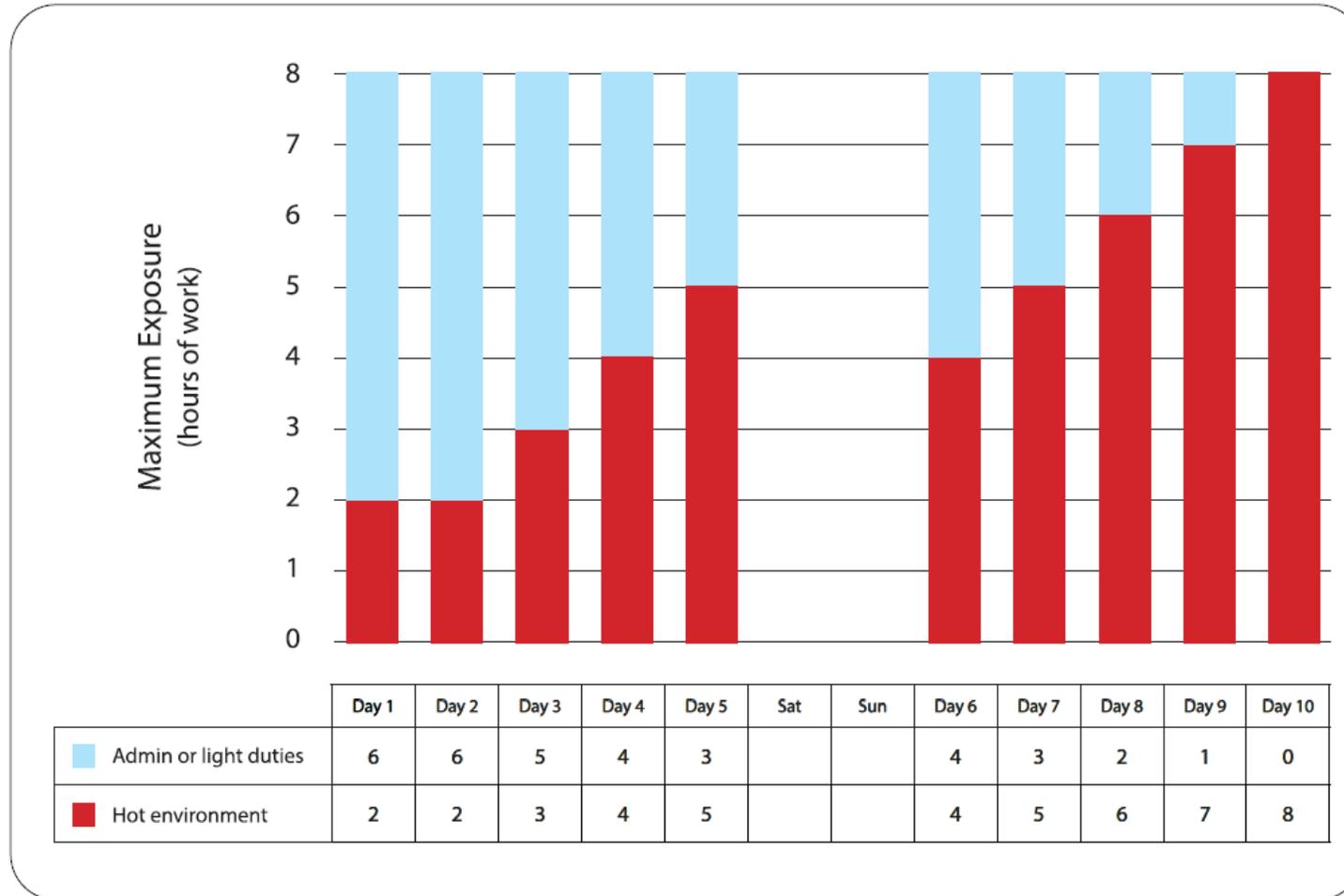
Re- Acclimatisation

- After vacations (more than a week)
- Recovered from Illness (for 4 or more days)



Heat Stress Management Programme- Acclimatisation

Example of 2-weeks acclimatisation cycle



Period of the day when environment is typically hot
11am to 3pm



Heat Stress Management Programme- Hydration Programme

- Ensure that workers carry a filled water bottle at the start of shift
- Encourage workers to refill as often as necessary
- Ready access to drinking water facilities and toilets
- Ensure sufficient break time for drinking and toilet and large work sites
- Workers should drink **250ml of water every 20 to 30 minutes**
- Workers should be reminded to drink water frequently before becoming thirsty in order to maintain good hydration



Work-rate	Examples
Moderate	Sustained moderate hand & arm work, moderate arm & leg work, arm & trunk work or light pushing & pulling. Normal walking
Heavy	Intense arm & trunk work, carrying, shovelling, sawing, pushing & pulling heavy loads, walking at a fast pace
Very heavy	Very intense activity at fast to maximum pace



Heat Stress Management Programme

- Training and Education

Workers should be educated on following

- Hazards of working in a hot environment
- Risk factors that can increase risk of heat injury
- Symptoms of heat stress
- Possible consequence of Heat Injuries
- Possible preventive measures
- Importance of reporting unwell for self and others
- Identifying signs of heat injury
- Emergency response procedures



Heat Stress Management Programme

- Hygiene and Medical Surveillance

Measure WBGT at the work area to assess the heat stress risk level

- Measure close to where workers is working
- Measure prior to work commencement and at regular intervals throughout the day
- Determine the risk control measures to be implemented



Fitness to work

- Workers should pass pre-placement medical examination and be certified fit to work before being deployed to a hot working environment
- Workers returning from prolonged illness should be certified fit to work by a medical doctor
- Supervisors should carry out daily checks for workers at the start and middle of each work day



Heat Stress Management Programme - First-Aid Emergency

Prepare and conduct drills for emergency response to Heat injuries

Early recognition of heat illness

- Employers, supervisors and workers to be trained to identify early signs and symptoms of heat illness

First-aid treatment

- Adopt the AVPU Scale
- 7R approach to first-aid treatment for heat stress

The AVPU scale comprises four categories:

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 e.g. pinching nail bed.
Unresponsive	The worker does not respond to any stimuli.

Table 7: The 4 categories of the AVPU scale.

7R Approach

The 7R approach to first-aid treatment for heat stress is as follows:

Recognise symptoms	Recognise symptoms of heat stress and report early.
Rest casualty	Get the worker to sit or lie down in a cool shaded area with good ventilation.
Remove clothing	Loosen or remove excess clothing as appropriate (while preserving the modesty of the worker).
Reduce temperature	Reduce body temperature as fast as possible by applying ice packs, wet towels or cool water. Other measures include fanning the casualty (to promote evaporative cooling), the use of cooling blankets and subjecting the worker to cold water immersion.
Rehydrate	Rehydrate by providing fluids. If casualty is unconscious, do not provide fluids by mouth as this may result in choking.
Resuscitate	If the worker becomes unconscious, call for help immediately and resuscitate using principles of cardiopulmonary resuscitation (CPR) if first-aider is trained to do so.
Rush to hospital	Rush worker to the nearest hospital if the worker is not alert.



Key Elements of Heat Stress Management Programme

Fitness to work

- Pre-employment medical examinations for new workers to be fit for work before posted to hot working environment

Heat Acclimatisation

- Implement Heat Acclimatisation Programme to allow workers to adapt to the new working environment and improve their tolerance to heat

Hygiene Surveillance

- Measure WBGT at work areas to assess the heat stress risk level

Work Scheduling

- Schedule heavy physical work or work under direct sun to cooler parts of the day whenever practicable

Shaded Rest Area

- Provide shaded area with good airflow for workers to have their breaks away from the hot outdoor working environment.

Adequate Water Intake

- Make drinking water facilities readily accessible to workers at the work area
- Provide sufficient break time and encourage workers to stay hydrated with regular water intake

Worker Awareness

- Provide training for workers on hazards of working in a hot environment, risk factors, symptoms of heat stress and preventive measures to take

First Aid

- Early recognition of heat illness and preparedness on first-aid treatment and emergency response



Summary

1. With global warming, Singapore is getting hotter and workers doing outdoor manual work are at greater risk of heat injuries from heat stress
2. Heat stress can lead to heat stroke and worker fatalities.
3. Early recognition of heat illness allows worker to be promptly treated
4. Measure Wet Bulb Globe Temperature (WBGT) at the workplace to assess the heat stress risk level
5. Implement risk control and preventive measures to limit workers' exposure to heat and increase their ability to cope with heat
6. Establish and implement an effective Heat Stress Management Programme to prevent heat injuries at the workplace



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