



GUIDELINES ON WET BULB GLOBE TEMPERATURE (WBGT) MONITORING FOR OUTDOOR WORK



1. MONITORING OF ENVIRONMENTAL HEAT STRESS

- 1.1 The most widely used indicator for assessing heat stress is the Wet Bulb Globe Temperature (WBGT). WBGT is an internationally recognised measurement that reflects the main environmental factors contributing to heat stress. Besides air temperature, WBGT is also affected by humidity, wind speed, and solar radiation. It is a simple and quick technique of measuring the environmental factors which correlate with deep body temperature and physiological response to heat.
- 1.2 The WBGT is calculated using measurements of the natural wet bulb temperature (Tnwb), the globe temperature (Tg), and the dry bulb air temperature (Ta).
- 1.3 For outdoors with a solar load (i.e., radiation from the sun), WBGT is calculated as follow:

$$\text{WBGT}_{(\text{outdoor})} = 0.7 \text{ Tnwb} + 0.2 \text{ Tg} + 0.1 \text{ Ta}$$

- 1.4 For indoor environment or outdoor under shade, WBGT is calculated as follow:

$$\text{WBGT}_{(\text{indoor})} = 0.7 \text{ Tnwb} + 0.3 \text{ Tg}$$

2. WHO TO MONITOR WBGT

- 2.1 Workplaces with outdoor work activities are required to monitor WBGT hourly especially during the hotter periods of the day to determine heat stress risk levels so that timely actions can be taken to protect workers.
- 2.2 Construction sites (with contract sums of \$5 million or more), shipyards and the process industry, are required to have a WBGT meter on-site for localised measurements. These sectors are more likely to have prolonged outdoor work activities and other heat-generating equipment in the workplace so workers may face a higher risk of heat stress.
- 2.3 WBGT measurements at the workplace can be conducted by anyone who is familiar with the operation of the WBGT meter.
- 2.4 The remaining workplaces are more likely to have intermittent outdoor exposure activities and can refer to myENV app's WBGT readings. When referring to the myENV app, workplaces will need to ensure that the WBGT readings from the nearest weather station to the workplace is used, by checking that location

services are turned on. (Refer to Annex A on how to access WBGT readings from myENV app)

3. WHERE TO MEASURE WBGT

- 3.1 The meters used to monitor WBGT should always be located near work areas so that the readings obtained will be representative of the environmental conditions that workers are exposed to.
- 3.2 There should be at least one point of outdoor WBGT measurement conducted at the workplace. For larger workplaces, multiple points of measurement are recommended.
- 3.3 When additional heat sources are present in the workplace, such as generator sets, compressors and other heat-generating machinery or equipment, WBGT monitoring should also be conducted at these areas.
- 3.4 For measurements within hazardous zones requiring ATEX/IECEx equipment, WBGT meters must be suitable for use in hazardous zones. If such a WBGT meter is not available, alternative measurements could be taken outside of the hazardous zones using non-ATEX/IECEx certified WBGT meter.

4. SPECIFICATION AND CALIBRATION OF WBGT METER

- 4.1 Meters used for measuring WBGT should meet the following specifications:

Measurement parameters of WBGT meter	Range	Resolution	Accuracy
WBGT (Outdoor) WBGT (Indoor)	10 - 50°C	0.1°C	± 2°C
Natural wet bulb temperature	10 - 50°C	0.1°C	± 1°C
Globe temperature	10 - 60°C	0.1°C	± 2°C
Dry air/ambient temperature	10 - 50°C	0.1°C	± 1°C

Table 1: Specification of WBGT meter*

*Note: The range, resolution and accuracy in the table applies to both measured and calculated parameters.

4.2 All meters must be calibrated annually or according to manufacturer's specifications. If the manufacturer did not specify any frequency, the meters must be calibrated annually. The WBGT meter may be calibrated by suppliers authorised by the manufacturer or Singapore Accreditation Council (SAC)-accredited laboratories.

4.3 The minimum requirements for calibrating WBGT meters are:

Parameter	Calibration Points	Accuracy
Dry bulb temperature	50 °C	± 1°C
Humidity	33% and 75%	± 5%
Globe temperature	50 °C	± 2°C

Table 2: Minimum requirements for calibration of WBGT meters

4.4 The list of local service providers offering calibration services for WBGT meters is at this URL: <https://go.gov.sg/wbgtcalibration>

5. IMPORTANT POINTS TO OBTAIN ACCURATE WBGT READINGS

5.1 Check that the meter is in good condition and the surface of the black globe temperature probe should be smooth and without dents.

5.2

5.3 After setting up the WBGT meter, ensure sufficient time (based on manufacturer's recommendation or at least 10 minutes) to allow the meter to reach an equilibrium with the environmental conditions before taking any measurements.

5.4 The WBGT meter should be positioned at around 1 metre above the ground and is recommended to be mounted on a tripod during measurements. Anyone taking WBGT measurements should stay clear of the meter to prevent accidental blockage of the temperature or airflow sensors.

5.5 .

- 5.6 The WBGT meter should be placed under direct sun exposure and not blocked by buildings or shade.



Figure 1 & 2: Examples of WBGT meter setup

- 5.7 Radiant heat from ground surfaces such as concrete, or asphalt will affect WBGT readings. Measurements should be taken at locations where ground surfaces are similar to areas where work is carried out.

- 5.8 .

6. KEEP RECORDS OF WBGT MEASUREMENTS

- 6.1 Record hourly WBGT measurements. When WBGT ($^{\circ}\text{C}$) is 32 or higher, a minimum rest break of 10 minutes hourly under shade must be provided to workers carrying out heavy physical activities. Longer rest breaks should be provided as WBGT increases.
- 6.2 A sample record sheet for WBGT readings is provided in Annex B for reference.

7. OTHER RECOMMENDATIONS

- 7.1 Continuous monitoring of WBGT using real-time meters provides an automated recording of WBGT measurements and triggers alerts for prompt interventions

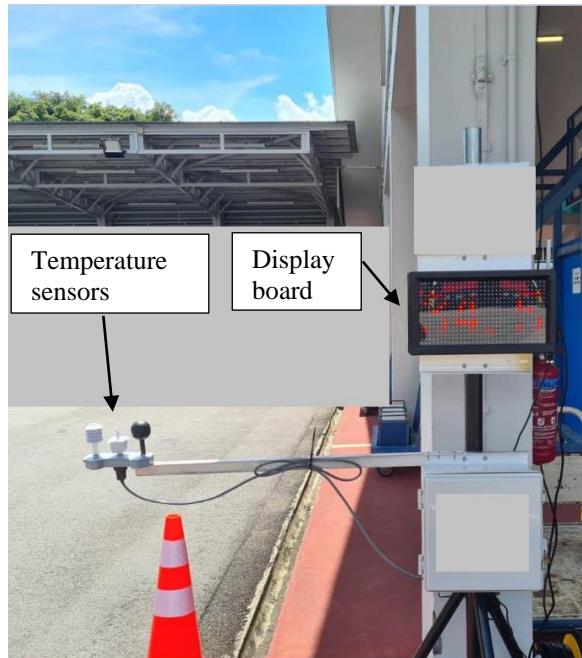


Figure 3: Real-time WBGT meter with display



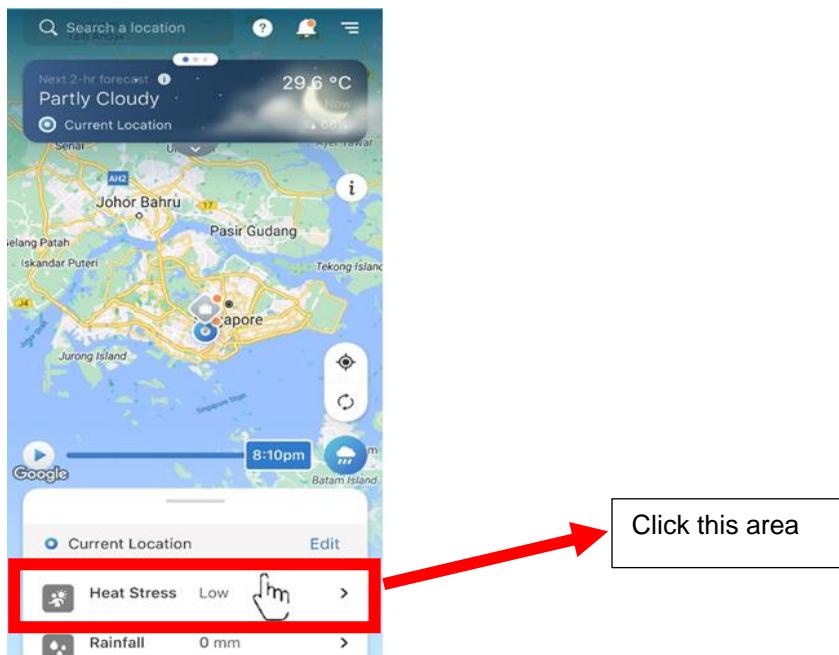
Figure 4: Real-time WBGT monitoring dashboard with alert system

- 7.2 When purchasing WBGT meters, companies should consider the life-time cost of using the meter which includes the calibration cost and calibration frequency.

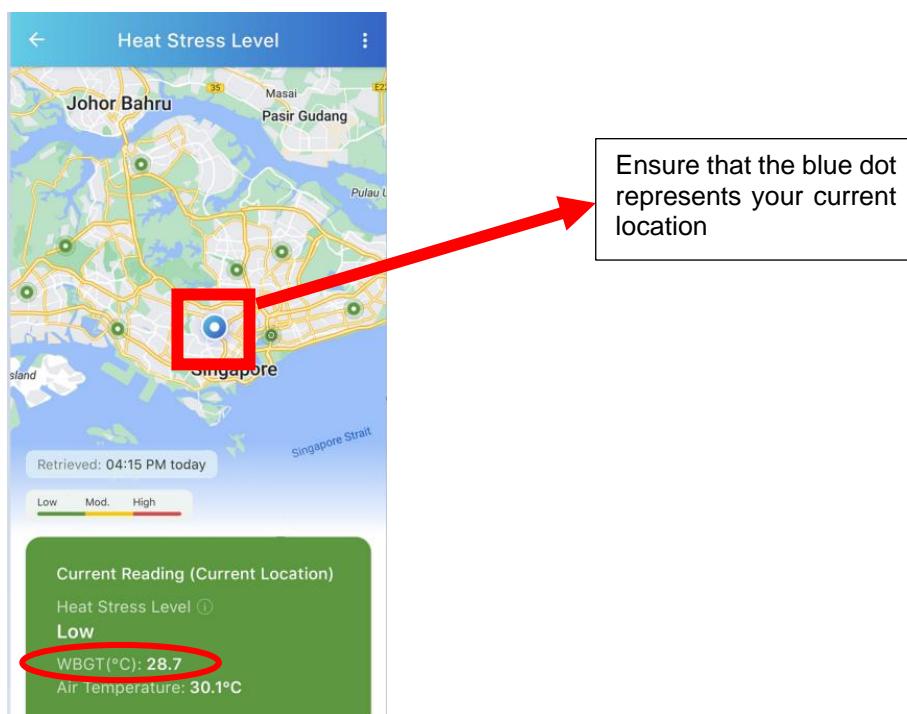
Annex A: How to access WBGT readings from myENV app

The WBGT figures on the myENV app can be accessed through the following steps:

Step 1: Click on the “Heat Stress” icon on the home page



Step 2: Read the WBGT values (circled)



ANNEX B - SAMPLE WBGT RECORD SHEET

Company Name: _____

Address: _____

Monitoring Officer: _____

Monitoring Location: _____

WBGT Model: WBGT Serial No:

WBGT Last Calibration Date:

Measured WBGT (°C)