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### Caution



TWL-1S is an environmental meter and should only be used as a reference.

Good judgment and care are required when making any decisions about safety and health. Your TWL-1S Heat Stress Detector is designed to provide accurate measurement provided that you follow the instruction described in this manual. Any improper uses might cause measurement error or damage to the device.

#### Prior to any measurement:

- Make sure your TWL-1S is in good condition and within factory calibration.
- Allow TWL-1S to acclimatize to the environment for 10 min if any significant changes in temperature and humidity occur (e.g. when moving TWL-1S from indoors to outdoors).



# Quick guide



Emit radio signal to pagers

\*TWL value is based on 120 sec average values of dry bulb, globe bulb, humidity and wind speed.

# **Display Anatomy**

#### — Mode Banner

Toggle among 7 modes by Mode key (a) Mode correspondent units



#### **Timer Banner**

Count down 2 min during TWL calculation Count down based on risk level Change countdown timer by Timer key 읁



#### **Battery Indicator**

Change batteries when the sign is empty []

### 1 Introduction

Heat illness can be vital. However, with proper precautions, it can be avoided. Thermal Work Limit (TWL) is a heat index calculated from environmental parameters, including dry bulb temperature, wet bulb temperature, globe bulb temperature and wind speed and accommodates for clothing factors as well as human physiological status to estimate a safe maximum continuous suitable metabolic rate. It is designed primarily for self-paced workers who are well hydrated and acclimatized in the working condition.

TWL (W/m <sup>2</sup> )	Backlight	Work Time	Risk Level
TWL ≥ 140	Green	– – min*	Low Risk
115 ≤ TWL < 140	Yellow	– – min*	Medium Risk
TWI < 115	Red	20 min	High Risk

Table 1: Thermal Work Limit (TWL) zones and management intervention.

\*safe for all continuous self-paced work

TWL-1S Heat Stress Detector offers a compactly designed hardware with deliberate software and user-friendly interface.

- TWL dependent backlight informs users the risk level.
- Work timer reminds users the work/rest schedule, and actively notifies the remote pager when it counts down to zero.

### 2 Package

- TWL-1S Heat Stress Detector x1
- User manual x1
- Tripod x1
- Pager x1

- Certificate of Conformity x1
- Data logger USB cable x1
- AAA battery x4
- AA battery x1

# 3 Getting Started

#### 3.1 Meter Setup

- Insert 4 AAA batteries into the battery holder with proper orientation.
- Long press Power key (O) to turn on TWL-1S Heat Stress Detector.
- Place the meter on a tripod, preferably 1 m above the ground, for proper placement.

Expose the meter to the environment for 10 min for equilibrium for any significant changes in temperature and humidity (e.g. indoor to outdoor and vice versa).

- Press Mode key (③) to toggle among 7 modes.
- Press TWL key (TWL) to calculate a TWL value.

#### 3.2 Pager Setup

- Insert 1 AA battery into the battery holder with proper orientation.
- The pager beeps once when it is ready.

# 4 Instruction

For explanatory purpose, all icons are presented in Display Anatomy (page iv). However, during daily operation, only part of these icons is displayed.

#### 4.1 Power

- Long press Power key (O) to turn on or off the device.
- When left without any operation for 15 min, the device turns off automatically.

### 4.2 Mode

- Press Mode key (ⓐ) to toggle among 7 modes.
- It shows real time value for 6 modes (Dry Bulb/Wet Bulb/Globe Bulb/Wind Speed/Humidity/WBGT).
- TWL value is not real time. Calculation is only triggered by pressing TWL key (TWL).

# 4.3 TWL

- Before any calculation, the TWL mode shows ----- w/m<sup>2</sup>.
- Press TWL key (TWL) to calculate a TWL value.
- It takes 2 min to compute a TWL value because 2-min average is more representative than a snapshot.
- When calculating a TWL value, the screen shows average wind speed from the 1<sup>st</sup> second to current moment.
- When calculating, TWL icon blinks and a countdown timer shows the time remains.
- When the calculation is done, a TWL value and correspondent risk icon shows alone with the suggested work time as indicated in Table 1.

# 4.4 Backlight

- Press Backlight key (\*) to turn on the colorful backlight of the LCD (Quick Guide, page iii). The color corresponds with the TWL range and risk (Table 1).

### 4.5 Timer

- Short pressing Timer key (⊕) sets the timer.
- Long pressing Timer key (⊕) starts/ends the timer.
- This key only works in High Risk (Red) zone as green and yellow zones do not have work time limits.

#### 4.6 Paging

- Press Paging key ( ♠) to call the remote pagers.
- Paging signal covers 200 meters on average, but the range may vary with topology.

#### 4.7 Pager

- When triggered by TWL-1S, the pager beeps and vibrates.
- Press the side button (right figure, dashed circle) to stop.
- Both red zone and the expiration of work timer trigger the pager 3 times with 1min interval.



#### 4.8 Battery

- Alkaline batteries can sustain more than 120 hours when operated continuously.
- Dry batteries and rechargeable batteries are also applicable but with shorter lifetime.
- Download data when the battery bar is empty ([]), otherwise some data might be lost.

# 5 Data Logging

#### Step1: Configuration

- Download software (TWLIT) from Scarlet website (www.scarlet.com.tw) and install the software on a PC/laptop.
- Turn on TWL-1S detector and connect TWL-1S to the PC/laptop by a USB cable.
- Launch the software, and set sampling rate (minimum 10 min).
- · Disconnect the meter from the computer, and TWL-1s is ready for data logging.

### Step2: Data logging

- Long press Mode key (③) to turn on data logging mode and the meter displays SUrE.
  - Press Mode key (☉), if you agree to enter the data logging mode.
  - Press Timer key (𝔅), if you do NOT agree to enter the data logging mode.
- When the screen shows *rEC*, the device is collecting and recording data; *Idle* means no data are recorded.
- Long press Timer key (𝔅) to quit data logging mode.

#### Step3: Download data

 Connect to the computer to download the data via the PC side software you installed in the Configuration session.

#### Important:

- Be sure to download the data before entering next data logging mode; otherwise, the data will be overwritten.
- ♦ Do not leave the meter uncharged for too long; otherwise, the data might be lost.

### 6 Recalibration

Calibration drift happens over time. Regular recalibration is necessary to ensure the accuracy of the measurement.

Humidity sensors can be recalibrated using the RH calibration kit which includes saturated salt solutions and two sealed containers. We suggest that you have the humidity sensor calibrated every 6 months. Please contact the sales representatives for RH calibration kit, instruction and services.

**Temperature** sensors (dry air and globe bulb) typically do not require recalibration because the calibration drift is negligible during the product lifetime.

**Wind speed** is calibrated against an intermediary standard calibrated under MEASNET cup anemometer calibration procedure before it leaves the factory. However, we recommend that you have the anemometer checked every 6 month. Please contact the sales representatives for wind speed test and bearing replacement.

#### 7 Polypropylene Filter

A polypropylene (PP) fiber is applied to protect the temperature and humidity sensors from dust while allowing water vapor (moist humid air) to pass through.

It is suggested to replace the PP filter every 2-6 months depending on the usage condition. Please contact the sales representatives if you wish to change the filter.

#### 8 Example for a Construction Site

At a construction site, environmental characteristics are significantly different at different locations. For example, direct sunlight and strong wind might occur at a rooftop while ventilation is limited at a basement. It is suggested to deploy TWL-1S Heat Stress Detectors at different spots to reflect actual situation.

Once the TWL-1S Heat Stress Detector is turned on and set up per the instruction mentioned in Section, the meter is ready for measuring the environmental parameters and computing a TWL value. Users can operate TWL-1S with the function keys described in Section 4. Based on the calculated TWL value, the TWL-1S Heat Stress Detector automatically sets up the work timer as suggested in Table 1.

If the TWL value is in the Red Zone, TWL-1S will automatically send a warning signal to notify a supervisor through a pager 3 times with 1 min interval. The supervisor can set and start the work timer. When the timer counts down to zero, the pager beeps and vibrates, notifying the supervisor to announce an intermission. Once the intermission is due, the supervisor can turn on the TWL-1S again and press TWL key (TWL) to calculate a new TWL value.

# 9 Trouble Shooting

First, ensure the batteries are properly inserted. If any error code shows on the LCD, please check Table 2 for solutions

Table 2: Er	ror codes	and solutions
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Error cod	e Defect	Solution		
DRY (Dry	DRY (Dry Bulb Temperature)			
E02	Measured air temp. is lower than specified range.	Leave the meter in regular air temp. for 30 min.		
E03	Measured air temp. is higher than specified range.	Leave the meter in regular air temp. for 30 min		
E31	Circuit AD defect	Sent back to repair		
GLB (Glob	e Bulb Temperature)			
E02	Measured temp. is lower than specified range	Leave the meter in regular air temp. for 30 min.		
E03	Measured temp. is higher than specified range	Leave the meter in regular air temp. for 30 min.		
E31	Circuit AD defect	Sent back to repair		
HUM (Hu	midity)			
E04	Temp. error causes this defect	Refer temp. error code to fix		
E11	Humidity calibration error	Re-calibration correctly.		
E33	Humidity circuit error	Sent back to repair.		
WET (We	t Bulb Temperature)			
E02	WET is lower than specified range	Leave the meter in regular air temp. for 30 min.		
E03	WET is higher than specified range	Leave the meter in regular air temp. for 30 min.		
E04	Caused by DRY or HUM error	Refer temp. and RH error code to fix		
WND (Wi	nd Speed)			
E31	Hardware defect	Sent back to repair		
WBGT				
E02	WBGT is lower than specified range	Leave the meter in regular air temp. for 30 min.		
E03	WBGT is higher than specified range	Leave the meter in regular air temp. for 30 min.		
E04	Caused by DRY/GLB/HUM error	Refer temp. and RH error code to fix		
TWL				
E02	TWL is lower than specified range	Leave the meter in regular air temp. for 30 min.		
E03	TWL is higher than specified range	Leave the meter in regular air temp. for 30 min.		
E04	Caused by DRY/GLB /HUM/WND error	Refer temp. and RH error code to fix		

Parameters	Range	Resolution	Accuracy
Globe Bulb	0-80 °C	0.1 °C	Indoor: ±1.0 (15-40°C); ± 1.5°C (others)
Temperature			Outdoor: ±1.5 (15-40°C); ± 2.0°C (others)
Air Temperature	0-50 °C	0.1 °C	±0.6 °C
Humidity	5-95%	0.1%	±3% (25°C; 10-90%RH)
			±5% (others)
Wind Speed	0.5-10 m/s	0.1 m/s	±(2% of reading+0.2) m/s

#### 10 Specification

### 11 Certification

The TWL-1S Heat Stress Detector is certified by CE mark following the EN 61326-1:2006 Electrical Equipment for Measurement, Control and Laboratory Use.

TWL-1S Heat Stress Detector has also received a third party certification for its temperature and humidity sensors from SGS, a globally renowned company for inspection, verification, testing and certification.

#### 12 Disclaimer

This manual was written by Scarlet Tech Co. Ltd. for the use of TWL-1S Heat Stress Detector. The product and its documentation (including this manual) are provided "as is" and without warranty of any kind, either expressed or implied, including but not limited to the implied warranties of merchantability, fitness for a particular purpose or non-infringement. In no event shall Scarlet Tech's total liability to you for all damages, losses and cause of action exceed the amount paid for the product and its documentation.

#### 13 Acronym

AD EHS RI-CoP 11.0	Abu Dhabi Environment, Health and Safety Regulatory Instrument Code of		
	Practice 11.0-Safety in the Heat		
HAAD	Health Authority Abu Dhabi		
EHS	Health, Safety and Environment		
EHSMS	Environment, Health and Safety Management System		
LCD	Liquid Crystal Display		
TWL	Thermal Work Limit		
EHS EHSMS LCD TWL	Health, Safety and Environment Environment, Health and Safety Management System Liquid Crystal Display Thermal Work Limit		

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