3M Personal Safety Division
3M™ QUESTemp° ™ Heat Stress Monitors

Robust Construction

From the Market Leader

QUESTemp° 32 User Manual

TABLE OF CONTENTS

Up and Running

1. Make sure the wet bulb's wick is clean. Fill the reservoir with distilled water.
2. Place the QUESTemp in the work area in a safe location approximately 3.5 feet off the ground.
3. Turn the unit ON. If the battery voltage displayed during the power-on sequence is less than or equal to 6.4 volts, replace or recharge the batteries.
4. Use the arrow keys to set the display to the desired items.
5. Allow 10 minutes for the sensors to stabilize to the environment before taking readings.

Check Wick and Fill Natural Wet Bulb

The QUESTemp uses a cotton wick immersed into a reservoir containing distilled water. Ordinary tap water should not be used, as the contaminants that are left behind after evaporation will shorten the life of the wick and cause high readings. If the wick is discolored it should be replaced. To **replace the wick**, slide the old wick off the top of the sensor. Place a new wick over the sensor, making sure that the bottom of the wick is down in the reservoir.

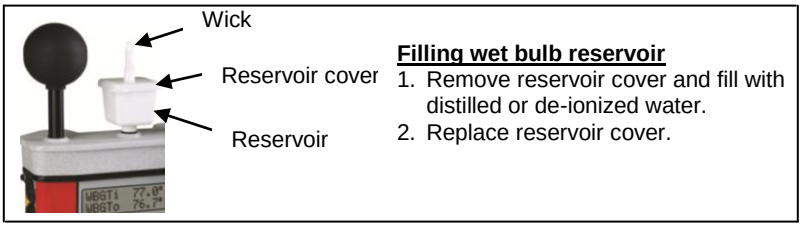


Figure 1-1: Filling wet bulb reservoir

Measurements

QUESTemp°32

The QUESTemp°32 portable area heat stress monitor computes the Wet Bulb Globe Temperature (WBGT). The WBGT is an accepted measurement for determining the heat stress level imposed on an individual in a given environment. The QUESTemp°32 measures three parameters: ambient or dry bulb temperature (DB), natural wet bulb temperature (WB), and globe temperature (G).

In addition to the WBGT, the QUESTemp°32 measures relative humidity (RH) and computes the Heat Index (HI) or Humidex. The QUESTemp°32, using inputs on the side of the instrument, has the ability to connect to two additional sensor arrays for monitoring up to three locations simultaneously.

Wet Bulb Globe Temperature

The WBGT is a weighted average of the three temperature sensors using the following formulas:

WBGT (indoor) = 0.7WB + 0.3G (denoted as "WBGTi" on the display)

WBGT (outdoor) = 0.7WB + 0.2G + 0.1DB (denoted as "WBGTo" on the display)

☑ ***NOTE:*** *The resulting WBGT can be compared to indices of work-rest regimens (stay times) based upon the work loads. (Please see Appendix A for published heat exposure tables.)*

Heat Index / Humidex

The Heat Index is determined using the dry bulb temperature and relative humidity. Based upon charts available from the U.S. National Weather Service, Heat Index represents how an average person feels relative to climate conditions. For a constant temperature, if the humidity rises, so does the heat index.

The Heat Index is defined over a temperature range of 70°F - 120°F (21°C - 49°C) and a relative humidity range of 30% - 99%. Outside of this range, the instrument will show dashes in the display for the Heat Index.

The Humidex is used primarily in Canada and is very similar to the Heat Index. The values are slightly different. The Humidex is defined over a temperature range of 70°F - 109°F (21°C - 43°C) and a relative humidity range of 20% - 99%. Outside of this range, the instrument will show dashes in the display for the Humidex.

Keypad Operation

The unit operates using a membrane keypad with 4 keys. The I/O ENTER key responds when the key is released while all other keys respond when the key is pressed.

I/O Enter

The unit turns on with a single key press. The unit turns off by holding the key down while a countdown of 3-2-1 occurs in the lower right corner of the display. This key is also used to enter setup changes.

While viewing live readings, pressing and releasing the key will cause the display to view the next available sensor bar (indicated in the upper right corner of the display).

Up Arrow

Changes which items appear in the display. Scrolls up.

Down Arrow

Changes which items appear in the display. Scrolls down.

Setup

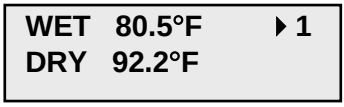
Allows changing the setup parameters. Three parameters are available: Celsius or Fahrenheit, the language, and Heat Index or Humidex. Press setup to access the parameters. Use the arrow keys to switch between the two parameters. Use the enter key to change the parameters. Press setup again to exit.

Displayed Items

The number in the upper right corner indicates which sensor bar's data is displayed. 1 indicates the sensor bar placed on (or attached to) the top of the instrument. Sensors 2 and 3 are labeled on the side of the unit. W indicates the weighted average which only appears if a WBGT is displayed and all three sensor bars are attached.

The following measurements can be accessed on the display:

Screen 1:
WET (WET BULB)
DRY (DRY BULB)



Screen 2: GLOBE

Screen 3: WBGTi (WBGT INDOORS)
WBGTo (WBGT OUTDOORS)

Screen 4: RH (Relative Humidity)
H.I. (Heat Index) or Humidex

Screen 5 : BAT (BATTERY VOLTAGE)

Placement for monitoring/testing

The QUESTemp should be placed at a height of 3.5 feet (1.1m) for standing individuals or 2 feet (.6m) for seated individuals. Tripod mounting is recommended to get the unit away from anything that might block radiant heat or airflow. A 1/4"x20 threaded bushing on the bottom of the instrument allows mounting to a standard photographic tripod. Do not stand close to the unit during sampling.

Make sure that the wet bulb reservoir is filled with distilled water and that the cotton wick is clean and fully wetted. After adding water or placing the unit in a new environment, allow ten minutes for the globe and wet bulb readings to stabilize.

A series of dashes appear in the display if one of the following occur:

- The Heat Index or Humidex is outside of its allowable range
- The temperature is outside of its allowable range
- A temperature sensor has failed

Sensors

Natural Wet Bulb Thermometer

The natural wet bulb thermometer gives an indication of the effects of humidity on an individual. Relative humidity and air flow are taken into account by measuring the amount of evaporative cooling taking place at a thermometer covered with a moistened wick. The QUESTemp uses a cotton wick immersed into a reservoir containing distilled water. Ordinary tap water should not be used, as the contaminants that are left behind after evaporation will shorten the life of the wick and cause high readings. If the wick is discolored it should be replaced. To replace the wick, slide the old wick off the top of the sensor. Place a new wick over the sensor, making sure that the bottom of the wick is down in the reservoir.

Globe Thermometer

The globe thermometer gives an indication of the radiant heat exposure on an individual due to either direct light or hot objects in the environment. This is accomplished by placing a temperature sensor inside a blackened copper sphere and measuring the temperature rise. The WBGT index is based on the response of a 6 inch diameter globe. The QUESTemp uses a 2 inch diameter globe for a faster response time. The temperature of the 2 inch globe is correlated to match that of a 6 inch globe.

As an option, a sensor array with a 6 inch diameter globe is available.

Dry Bulb Thermometer

The dry bulb thermometer measures the ambient air temperature. This measurement is used in the outdoor WBGT calculation when a high solar radiant heat load may be present. The series of white plates surrounding the sensor shield it from radiant heat.

Relative Humidity Sensor

A relative humidity sensor is located in a compartment inside of the sensor bar housing. Slots in the housing allow air to circulate around the sensor.

Remote, Sensors 2 and 3

The top sensor bar (sensor 1) may be removed from the instrument and used through a remote cable. Shelter the instrument and remote the sensor bar if the measured environment is expecting heavy rain or if temperatures are above 60°C.

The sensor 2 and sensor 3 jacks on the side of the instrument allow simultaneous monitoring of up to three sensor arrays using connecting cables.

Cable lengths of up to two hundred feet (61 meters) may be used without a decrease in accuracy provided the environment does not contain strong electromagnetic fields.

The data from these arrays may be viewed separately or combined into a weighted average WBGT reading per ISO 7243. Change the displayed sensor bar by pressing and releasing the enter key. The upper right corner of the display shows the current sensor bar. 1 refers to the top sensor bar, 2 and 3 are labeled on the side of the unit, W indicates the weighted average which only appears if a WBGT is displayed and all three of the sensor bars are attached.

Tri-Sensor Weighted Average

Per the recommendations outlined in ISO 7243 :1989, when the temperature in the space surrounding a worker is not uniform, it is necessary to determine the WBGT index at three heights corresponding to the worker's ankles, abdomen and head and perform a weighted average on those values. It is computed using the formula:

$$WBGT_w = (WBGT_{head} + (2 \times WBGT_{abdomen}) + WBGT_{ankles})/4$$

The QUESTemp always assigns the top sensor bar the double weighting. This calculation is shown if a WBGT display has been selected and if 3 sensor sets are connected.

Operational Check

A verification module, Quest model 054-544, may be used to check the operation of the QUESTemp. Remove the top sensor bar and plug the verification module into the top of the unit. With the QUESTemp set to read in degrees Celsius, verify that the displayed readings match those printed on the module within +/-0.5°C.

If the readings are not within the +/-0.5°C tolerance, then have the unit serviced and calibrated.

Power Options

There are 3 options for powering the QUESTemp: a 9-volt alkaline battery, a NiMH (Nickel Metal Hydride) rechargeable 6-cell battery pack, and an AC adapter. A door on the back of the unit allows the user access to the 9-volt battery. The rechargeable battery pack is located inside of the unit. If the rechargeable battery pack ever needs to be replaced, it can be accessed by removing the screws from the bottom panel of the unit.

The 2-position switch located in the battery compartment must be set by the user if the power supply method is changed. The up position is for the 9 volt battery. The down position allows for either the AC adapter or the rechargeable batteries. The AC adapter will trickle charge the rechargeable batteries if they are in place or it will simply allow for line power operation of the unit.

9-V Alkaline Battery Replacement

WARNING: Replace batteries only in a non-hazardous environment.

The 9-volt battery should be replaced or the NiMH battery pack should be recharged when the voltage drops below 6.4 volts. The battery voltage is displayed when the instrument is turned on. While turned on, the battery voltage can be displayed at any time by pressing the up or down arrow keys to move through the display until the battery voltage screen appears. If, while operating, the battery voltage drops below 6.4 volts, the display will automatically switch to the display showing the battery voltage along with a low battery message. After a low battery occurs, the unit will continue to operate for approximately 8 hours. When the battery voltage falls to 6.2 volts or below, the unit will automatically turn off.

Replace only with an approved 9-volt alkaline battery.

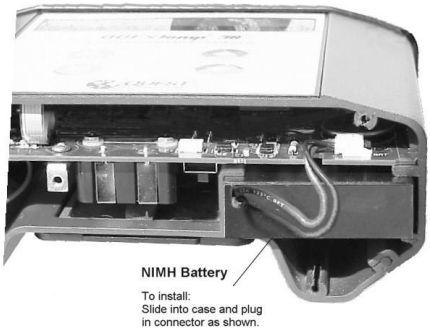
Approved 9-Volt Batteries

Eveready: Energizer 522, EN22, 6LR61
Duracell: MN1604
Panasonic: 6LR61, 6AM6X
Rayovac: A1604
UltrLife: U9V

NiMH Battery Pack

WARNING: Recharge batteries only in a non-hazardous environment.

The NiMH rechargeable battery pack is charged in the instrument using Quest's AC adapter #015-910. A discharged battery pack requires an "overnight" charge of 16 hours. Leaving the AC adapter plugged in for extended lengths of time or when operating the instrument will not harm the rechargeable batteries.



Specifications

Measurements

Globe, dry bulb, wet bulb, WBGTin, WBGTout, WBGT weighted average (if 3 sensor sets), relative humidity, Heat Index, Humidex.

Temperatures given in Celsius or Fahrenheit.

Languages

English, French, Spanish, Italian, German.

Housing

Designed water resistant to a light rain or mist. If rain is frequent, best practice would be to remote the sensor bar and keep the instrument sheltered.

Size

Height 9.2in (23.5cm); Width 7.2in (18.3mm); Depth 3.0in (7.5mm)
Dimensions include mounted sensor assembly.

Weight

2.6 lbs. (1.2 kg) with mounted sensor assembly.

Sensor Types

Temperature: 1000 ohm platinum RTD
Humidity: Integrated circuit with capacitive polymer sensor

Accuracy

Temperature: +/-0.5°C between 0°C and 120°C
Relative Humidity: +/-5% between 20 to 95% (non-condensing)

Operating Temperature Range

Sensor Assembly: -5°C to +100°C
Electronics: -5°C to 60°C

Remote Sensor Bars

2 x 15pin D-sub jacks are located on the side of the unit for plugging in 1 or 2 additional sensor bars by using remote cables up to 200 feet (61m). The top sensor bar can also be remote with a cable.

Power Options

9V alkaline, 7.2V NiMH rechargeable pack (charged in the unit), or AC adapter wall power cube (AC adaptor will operate the unit or recharge the NiMH battery pack).

Battery Life

9V alkaline: 140 hours
Rechargeable Nickel Metal Hydride: 300 hours
(Adding additional sensor bars reduces battery life.)

Charge Time (NiMH Battery Pack)

16 hours (charge in the unit)

Safety Approvals

ETL, cETL: Class I,II,III Groups A,B,C,D,E,F,G, Temperature code T3
KEMA 04ATEX1072 X <Ex> II 2 G EEx ia IIC T3
CE mark

Product Markings and Special Conditions

KEMA 04ATEX1072 X
<Ex> II 2 G EEx ia IIC T3

Compliance with Essential Health and Safety Requirements has been assured by compliance with: EN 50014 : 1997 and EN 50020 : 2002

The year of manufacture is determined by the third character in the instrument's serial number. "A" was manufactured in 2001, "B" in 2002, "C" in 2003, "D" in 2004 and so forth.

Special conditions for safe use:

1. Only the following battery types may be used:
   Non-rechargeable battery:

Type	Manufacturer
U9V	Ultralife
MN1604	Duracell
522 or EN22 or 6LR61	Energizer
A1604 or BR232	Rayovac
6LR61 or 6AM6	Panasonic

   Rechargeable battery:
   Integral NiMH battery pack type DC2121.

2. The batteries may not be replaced or charged within the hazardous area.

3. The rechargeable battery may only be recharged with class 2 charger, rated 9Vdc, 1 A max.

4. The plugs or sockets market "SENSOR 2" and "SENSOR 3" may not be used within the hazardous area.

APPENDIX A: Heat Exposures Tables

ACGIH

Screening Criteria for Heat Stress Exposure. WBGT values in °C.

☑ *NOTE: according to the ACGIH's guidelines, the temperature values represent a work and rest process which is explained in the standards. Please refer to the ACGIH TLV's and BEIs for specific details.*

Work and recovery (TLV)	Light	Moderate	Heavy	Very Heavy
75% to 100%	31.0	28.0	26.0*	23.5*
50% to 75%	31.0	29.0	27.5	25.5*
25% to 50%	32.0	30.0	29.0	28.0
0% to 25%	32.5	31.5	30.5	30.0

Work and recovery (Action Limit)	Light	Moderate	Heavy	Very Heavy
75% to 100%	28.0	25.0	22.5*	20.0*
50% to 75%	28.5	26.0	24.0	22.5*
25% to 50%	29.5	27.0	25.5	24.5
0% to 25%	30.0	29.0	28.0	27.0

*Values not specified by ACGIH have been estimated for continuity.

Cited from "American Conference of Governmental Industrial Hygienists - Threshold Limit Values and Biological Exposure Indices for 2008"; Reprinted with permission from ACGIH

United States Navy

Physiological Heat Exposure Limits (PHEL) Time Table (Without the presence of fuel combustion gases/fuel vapors) is displayed on the following page.

The recommended working hours are shown based on a maximum of eight hours. Naval personnel will follow a category, I - VI, based upon their function.

APPENDIX A: Heat Exposures Tables

PHEL Curves (Total Exposure Time in Hours: Minutes)

WBGT(F)	I	II	III	IV	V	VI
80.0	>8:00	>8:00	>8:00	8:00	6:35	4:30
81.0	>8:00	>8:00	>8:00	8:00	6:35	4:30
82.0	>8:00	>8:00	8:00	7:05	5:25	3:40
83.0	>8:00	8:00	7:45	6:25	4:55	3:20
84.0	>8:00	8:00	7:05	5:55	4:30	3:05
85.0	8:00	7:45	6:30	5:20	4:05	2:50
86.0	8:00	7:05	5:55	4:55	3:45	2:35
87.0	7:25	6:30	5:25	4:30	3:25	2:20
88.0	6:45	5:55	4:55	4:05	3:10	2:10
89.0	6:10	5:25	4:30	3:45	2:50	2:00
90.0	5:40	5:00	4:10	3:25	2:40	1:50
91.0	5:15	4:35	3:50	3:10	2:25	1:40
92.0	4:50	4:10	3:30	2:55	2:15	1:30
93.0	4:25	3:50	3:15	2:40	2:00	1:25
94.0	4:05	3:35	3:00	2:25	1:50	1:15
95.0	3:45	3:15	2:45	2:15	1:45	1:10
96.0	3:25	3:00	2:30	2:05	1:35	1:05
97.0	3:10	2:45	2:20	1:55	1:25	1:00
98.0	2:55	2:35	2:10	1:45	1:20	0:55
99.0	2:40	2:20	2:00	1:40	1:15	0:50
100.0	2:30	2:10	1:50	1:30	1:10	0:45
101.0	2:20	2:00	1:40	1:25	1:05	0:45
102.0	2:10	1:50	1:35	1:15	1:00	0:40
103.0	2:00	1:45	1:25	1:10	0:55	0:35
104.0	1:50	1:35	1:20	1:05	0:50	0:35
105.0	1:40	1:30	1:15	1:00	0:45	0:30
106.0	1:35	1:25	1:10	0:55	0:45	0:30
107.0	1:30	1:15	1:05	0:50	0:40	0:25
108.0	1:20	1:10	1:00	0:50	0:35	0:25
109.0	1:15	1:05	0:55	0:45	0:35	0:25
110.0	1:10	1:00	0:50	0:40	0:30	0:20
111.0	1:05	1:00	0:50	0:40	0:30	0:20
112.0	1:00	0:55	0:45	0:35	0:25	0:20
113.0	0:55	0:50	0:40	0:35	0:25	0:15
114.0	0:55	0:45	0:40	0:30	0:25	0:15
115.0	0:50	0:45	0:35	0:30	0:20	0:15
116.0	0:45	0:40	0:35	0:25	0:20	0:15
117.0	0:45	0:40	0:30	0:25	0:20	0:10
118.0	0:40	0:35	0:30	0:25	0:15	0:10
119.0	0:35	0:35	0:25	0:20	0:15	0:10
120.0	0:35	0:30	0:25	0:20	0:15	0:10
121.0	0:35	0:30	0:25	0:20	0:15	0:10
122.0	0:30	0:25	0:20	0:15	0:15	0:10
123.0	0:30	0:25	0:20	0:15	0:10	0:10
124.0	0:25	0:25	0:20	0:15	0:10	0:05

Electrical power research institute (EPRI)

The recommended working hours are shown based on a maximum of four hours. A time of 4:01 indicates greater than 4 hours.

WBGT°C	Light	Moderate	Heavy
28	4:01	4:01	3:00
29	4:01	4:00	2:00
30	4:01	3:00	1:30
31	4:01	2:00	1:15
32	4:00	1:30	1:00
33	3:30	1:15	0:45
34	3:00	1:00	0:40
35	2:30	0:53	0:35
36	2:00	0:45	0:30
37	1:45	0:40	0:25
38	1:30	0:35	0:20
39	1:15	0:33	0:18
40	1:00	0:30	0:15
41	0:53	0:28	0
42	0:45	0:25	0
43	0:38	0:23	0
44	0:30	0:20	0
45	0:28	0:18	0
46	0:25	0:15	0
47	0:23	0	0
48	0:20	0	0
49	0:18	0	0
50	0:15	0	0

APPENDIX B: Accessories

Sensor array with 2 inch globe	56-795
Sensor array with 6 inch globe	56-780
6 Foot shielded remote sensor cable	53-924
25 Foot shielded remote sensor cable	53-925
100 Foot shielded remote sensor cable	53-926
200 Foot shielded remote sensor cable	53-927
120VAC to 9VDC adapter	15-910
220VAC to 9VDC adapter	15-680
Verification module	53-923
Tripod	59-045
Replacement wicks	56-679
Water bottle 2 oz.	56-068
User's manual	56-661

Customer Service

Contacting 3M Detection

Should your 3M equipment need to be returned for repair or for recalibration, please contact the service department at the following number or access the online form via the website. For technical issues, please contact Technical Support.

Should your 3M equipment need to be returned for repair or for recalibration, please contact the service department at the following number or access the online form via the website. For technical issues, please contact Technical Support.

Service Department and Technical Support: 1 (800) 245-0779.
Fax: 1 (262) 567-4047. Office hours are 8:00 a.m. to 5:00 p.m. United States Central.

- **E-mail:** 3Mdetectionmail@mmm.com
- **Website:** www.3M.com/detection

Calibration

The QUESTemp° 32 should be examined regularly by the factory. An annual calibration is recommended. (Please see Service Department above.)

Warranty

3M warrants our instruments to be free from defects in materials and workmanship for one year under normal conditions of use and service. For United States customers, we will replace or repair (our option) defective instruments at no charge, excluding batteries, abuse, misuse, alterations, physical damage, or instruments previously repaired by other than 3M. Microphones, sensors, printers, and chart recorders may have shorter or longer warranty periods. This warranty states our total obligation in place of any other warranties expresses or implied. Our warranty does not include any liability or obligation directly resulting from any defective instrument or product or any associated damages, injuries, or property loss, including loss of use or measurement data.

For warranty outside the United States, a minimum of one year warranty, applies subject to the same limitation and exceptions as above with service provided or arranged through the authorized 3M distributor or our 3M European Service Laboratory. Foreign purchases should contact the local 3M authorized sales agent for details.

About Us

3M Detection Solutions is a world class manufacturer of rugged, reliable instrumentation and software systems that help monitor and evaluate occupational and environmental health and safety hazards, including noise dosimetry, sound level monitoring, heat stress, indoor air quality and select toxic/combustible gases. The 3M Detection brand of instrumentation is used by safety and industrial hygiene professionals to help comply with applicable occupational standards and regulations.

About 3M Personal Safety

3M offers a comprehensive, diverse portfolio of Personal Safety solutions providing respiratory protection, hearing protection, fall protection, reflective materials for high visibility, protective clothing, protective eyewear, head and face protection, welding helmets, and other adjacent products and solutions such as tactical safety equipment, detection, monitoring equipment, active communications equipment and compliance management. In 2012, 3M celebrated 40 years of safety leadership – recognizing the company's respiratory and hearing protection solutions introduced in 1972. Visit www.3M.com/PPESafety or http://m.3m.com/PPESafety for details.

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