

# instructions for

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# QUESTEMP<sup>o</sup>15

## Area Heat Stress Monitor

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56-070  
11/97  
Rev. C

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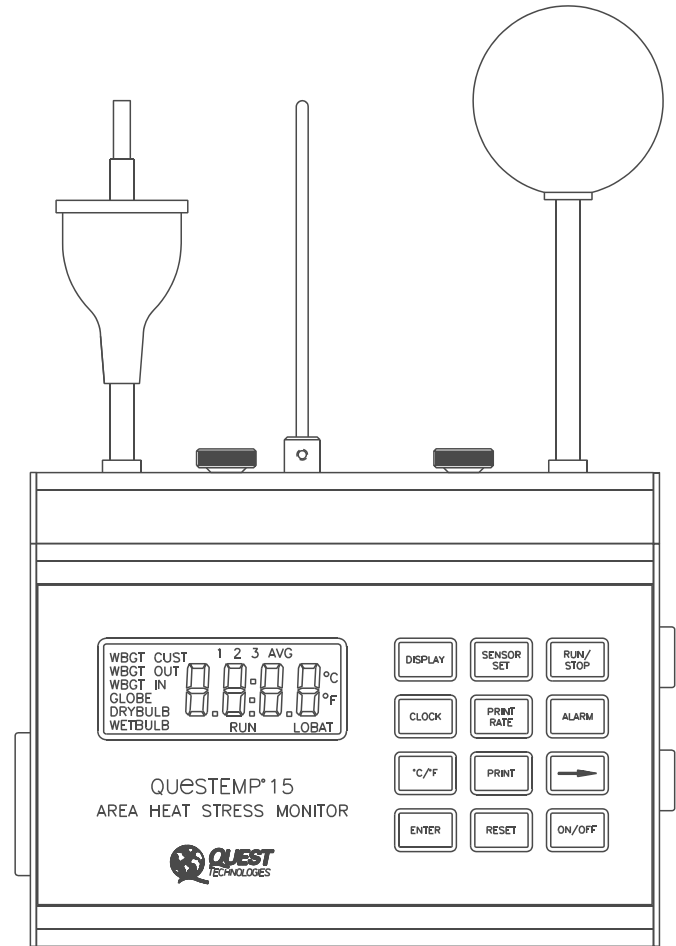


Figure 1 Questemp 15

## I. INTRODUCTION

The Questemp<sup>o</sup>15 is a compact, portable area heat stress monitor which computes the WBGT index. The WBGT index is an accepted method for determining the heat stress level imposed on an individual in a given environment. The Questemp<sup>o</sup>15 measures three parameters: ambient or dry bulb temperature (DB), natural wet bulb temperature (WB) and globe temperature (G). The WBGT index is a weighted average of these measurements according to the formulas:

$$\text{WBGT (indoor)} = 0.7\text{WB} + 0.3\text{G}$$

$$\text{WBGT (outdoor)} = 0.7\text{WB} + 0.2\text{G} + 0.1\text{DB}$$

The Questemp<sup>o</sup>15 will display indoor or outdoor WBGT as well as any of the individual sensor temperatures used to compute the WBGT reading. In addition, the customer may modify the constants via a PC to create a custom WBGT index. Temperature may be displayed in either degrees Celsius or Fahrenheit. The temperature sensor array is easily removed for remote sensing applications.

Up to 41 hours of temperature data may be stored in the Questemp<sup>o</sup>15's internal battery backed memory. A data output port allows connection to a serial or parallel printer or to a personal computer. An alarm temperature may be set which allows the unit to be used for on-site monitoring. The alarm will operate a relay which may be used to interface the Questemp<sup>o</sup>15 to external equipment.

The Questemp<sup>o</sup>15 has a hardware upgrade available which will allow three sensor arrays to be used for simultaneous temperature monitoring of three different locations. These three WBGT readings may be averaged per ISO 7243 to obtain a composite index.

## II. FEATURES AND OPERATION

### DISPLAY

The large liquid crystal display indicates the selected temperature reading in degrees C or F. Separate annunciators to the left of the temperature indicate which reading is being displayed. The annunciators 1 2 3 indicate which sensor array's reading is being displayed in a multiple sensor array application. The AVG annunciator indicates that the weighted average of three sensor arrays (per ISO 7243) is being displayed for a selected WBGT index.

The RUN indicator shows that data logging is being performed. A low battery indicator (LOBAT) is also included.

### KEYPAD

#### **DISPLAY**

Depressing the DISPLAY key will cause the displayed temperature to cycle through the following measurements: WBGT OUT (outdoor WBGT index), WBGT IN (indoor WBGT index), GLOBE temperature, DRYBULB temperature and WETBULB temperature. An additional measurement is WBGT CUST (user defined WBGT index) which will have a value if the parameters have been entered with a PC via the data port.

#### **SENSOR SET**

This key is only active for the Questemp<sup>o</sup>15 upgraded with the three sensor option. Depressing the SENSOR SET key will cause the indicated temperature to cycle through sensor set 1, 2 and 3 as indicated on the display. If three sensor sets are in use and a WBGT reading is being displayed an additional parameter (AVG) may be selected using this key. This is the weighted average of the three WBGT indices per ISO 7243:

$$((2 * \text{WBGT1}) + \text{WBGT2} + \text{WBGT3}) / 4 = \text{WBGT weighted average}$$

Refer to the MULTIPLE SENSOR OPERATION section of this manual for more information on this measurement.

#### **RUN/ STOP**

The RUN/STOP key is a toggle function which will start and stop data storage. The RUN annunciator on the display indicates when the Questemp<sup>o</sup>15 is logging data. All data is logged at 30 second intervals. While in the RUN mode CLOCK, PRINT RATE, ALARM, and PRINT may be viewed but not altered.

#### **CLOCK**

The Questemp<sup>o</sup>15 has an internal real time clock/calendar. The date and time information will be stored along with the data while in the data storage mode. Depressing CLOCK will display the current time in 24 hour format. To change the time, depress CLOCK a second time which will cause the single minutes digit to flash. Depressing the ARROW key will increment the value for minutes. Depressing ENTER will store this value and cause the tens of minutes digit to flash. Use the ARROW and ENTER keys in the same manner to select and store the tens of minutes, single hours and tens of hours digits. After storing the time, the display will show month and day which are set in the same way. After depressing ENTER to store the tens of months digit the year will be displayed which is set in the same manner. After setting the year the display will return to the selected temperature. To simply review the time and date depress CLOCK followed by ENTER three times.

## PRINT RATE

The PRINT RATE key determines the time interval between data points on the printout. The Questemp<sup>o</sup>15 stores data every thirty seconds regardless of this setting, but the user may wish to condense the printout. The Questemp<sup>o</sup>15 prints according to the print rate selected at the time of printing, not that selected while storing data.

The output data interval is programmable from 30 seconds to 1 hour. Depressing the PRINT RATE key displays the previously selected time between data points. To change this time depress PRINT RATE a second time which will cause the display to flash. Depressing the ARROW key will step through the choices .5, 1, 2, 5, 10, 15, 30 and 60 minutes. Depressing ENTER stores this value and returns the display to temperature.

## ALARM

The ALARM key is used to set a threshold temperature for a particular WBGT reading. Depressing ALARM displays '-AL-' and the current sensor set and WBGT index or individual sensor reading which will trigger the alarm. To change these settings depress ALARM a second time. **Warning:** Individual sensor alarm levels are only settable serially, pressing alarm a second time will cause a default to WBGT OUT. Using the DISPLAY and SENSOR SET keys select the WBGT index (WBGTOUT, WBGTIN or WBGTCUST) and the sensor set (1, 2, 3 or AVG) for which you wish to program an alarm. Depressing ENTER stores that information and displays the current alarm temperature in degrees C or F. To change units depress the °C/°F key and the temperature will be converted. To accept this temperature depress ENTER. To change this temperature depress the ARROW key. The tenths digit will begin flashing and its value may be incremented by depressing the ARROW key. Depressing ENTER will store the displayed value and cause the ones digit to flash. Using the ARROW and ENTER keys, program the remaining digits. Once you begin to change the temperature the units may not be changed. The maximum alarm temperature is 199.9°C (391.8°F).

After entering the hundreds digit the display will show either "no" or "nc" in reference to the relay contacts available at the ALARM jack. "no" stands for normally open relay contacts which will close when the temperature reaches or exceeds the alarm temperature. "nc" stands for normally closed contacts which will open when the alarm temperature is reached or exceeded. This choice allows flexibility when interfacing the Questemp<sup>o</sup>15 with external equipment. Depressing the ARROW key will toggle between "nc" and "no". Depressing ENTER will store your choice and return to the temperature display. See ALARM JACK for further information.

## °C/°F

Depressing this key causes the displayed temperature or WBGT index to switch between degrees Celsius or degrees Fahrenheit. The printout obtained from the data port will also be in the selected temperature units.

## PRINT

Depressing the PRINT key causes the baud rate to be displayed. If the Questemp<sup>o</sup>15 is set up for a parallel printer 'Prll' will be displayed. To select a different baud rate or a parallel printer, depress PRINT a

second time. This will cause the display to flash, and the selection may be changed by depressing the ARROW key. The choices are 300, 600, 1200, 2400, 4800, 9600 baud or parallel. Depressing the ENTER key stores this selection and causes data to be sent via the data port to a printer. While printing "Prin" will be displayed. After printing, the temperature display will return.

During a printout depressing PRINT again will halt printing and return to the temperature display. This may be useful for changing printout parameters such as temperature units or sample rate. Data will be retained in the unit and may be printed at any time. See PRINTING DATA for more information.



The ARROW key is used to change menu selections while programming the Questemp<sup>o</sup>15.

## ENTER

Depressing this key causes a menu selection to be stored in memory. All menu selections are saved through subsequent power ON/OFF cycles.

## RESET

Depressing RESET and holding for 3 seconds clears the data memory. The display will count down from 3 to 0 followed briefly by dashes.

## ON/OFF

Depressing ON/OFF turns on power to the Questemp<sup>o</sup>15. Depressing and holding ON/OFF for 3 seconds turns off power to the unit. The display will count down from 3, displaying either 3 2 1 0 or 3 2 1 ALE if the Wake-up Alarm is enabled. Refer to Wake-up Alarm section for details. Turning the unit off does not clear the data from memory.

## CONNECTORS

**DATA PORT** The data port is a 25 pin D-sub connector which may be used as either a printer output or a RS-232C port. A parallel printer may be connected to the Questemp<sup>o</sup>15 via a standard IBM PC to Centronics interface cable (Quest model 056-019). The data port may be connected to a RS-232C serial printer via a custom cable (Quest 056-922). The data port may also be used for connection to the RS-232C port of a PC for sending data to the PC or controlling the Questemp<sup>o</sup>15 from the PC. This is accomplished via a custom cable (Quest 056-937).

**ALARM JACK** The alarm jack connects to a set of relay contacts which are activated if the programmed alarm value is exceeded. These contacts may be used to alert external equipment that the alarm temperature has been exceeded. The contacts may be programmed to either open or close when the alarm temperature is exceeded. Refer to the ALARM KEY section for details.

The jack is a miniature phone type (1/8"). The relay contacts are rated at 1A, 30VDC and are isolated from the circuitry of the Questemp<sup>o</sup>15.

*\* THE ALARM JACK SHOULD NEVER BE CONNECTED TO AC LINE VOLTAGE (120V). TO CONTROL AC LINE VOLTAGE THE ALARM JACK MUST CONTROL AN INTERMEDIATE ISOLATED SWITCHING DEVICE. CONTACT QUEST TECHNOLOGIES FOR DETAILS.*

**SENSOR 2 AND SENSOR 3 JACKS** The sensor 2 and 3 jacks are part of a hardware upgrade option that will allow simultaneous monitoring of up to three sensor arrays. The data from these arrays may be analyzed separately or combined into a weighted average WBGT reading per ISO 7243.

**AC ADAPTER JACK** This jack accepts an optional AC adapter (Quest model 056-067) to power the Questemp<sup>o</sup>15 from 115 VAC power. The jack is a miniature phone type (1/8") and accepts 9 to 12VDC. The jack polarity is tip positive. Use of the adapter automatically disconnects the battery.

### III. SENSORS

**NATURAL WET BULB THERMOMETER** The natural wet bulb thermometer gives an indication of the effects of humidity on an individual. Relative humidity and wind speed are taken into account by measuring the amount of evaporative cooling taking place at a thermometer covered with a moistened wick. The Questemp<sup>o</sup>15 uses a cotton wick immersed into a reservoir which must be kept filled with 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 and sponge 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. Slide the sponge over the wick and into the reservoir.

**GLOBE THERMOMETER** The globe thermometer gives an indication of the radiant heat exposure to 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<sup>o</sup>15 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.

### IV. USING THE QUESTEMP<sup>o</sup>15

When making an area heat stress measurement the Questemp<sup>o</sup>15 should be placed at a height of 3.5 feet (1.1m) for standing individuals or 2 feet (.6m) for seated individuals in the area. Tripod mounting is recommended to get the unit away from anything that might block radiant heat or airflow. A 1/4"x20 threaded bushing is available on the bottom of the Questemp<sup>o</sup>15 for mounting to a standard photographic tripod. Do not stand close to the unit during sampling.

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

Turn on the Questemp<sup>o</sup>15 by depressing the ON/OFF key. All segments on the display will momentarily turn on, followed by a brief display showing the software revision number. If the unit contains any previous run time the display will momentarily display "dAtA". Check the display for the low battery indicator and replace the battery if LOBAT is displayed. If the battery is good enough to turn the unit on but too low to run effectively, "LbAt" will be displayed momentarily before the unit shuts down. If this occurs, replace the battery. Select the desired temperature display by depressing the appropriate key. Select the temperature units by depressing the °C/°F key. If data storage is desired, depress and hold RESET to clear any old data from memory and then depress RUN. If the memory is not reset the new data will be appended to the previous data until the available memory is filled.

### V. BATTERY REPLACEMENT

The LOBAT indicator on the display shows that the battery should be replaced. When the LOBAT indicator first turns on it indicates approximately 8 hours of life for an alkaline battery. If run with a low battery the unit will run until the battery voltage falls to a level below which the Questemp<sup>o</sup>15 cannot run effectively. The unit will then stop running and momentarily display "LbAt" before shutting itself down in an orderly fashion. The battery compartment is located on the rear of the Questemp<sup>o</sup>15. To replace the battery, open the compartment by lifting one end of the cover. This will expose the battery and connector. Replace only with a standard 9 volt alkaline battery (NEDA 1604A).

To retain data and clock/calendar settings it is recommended that the 9 volt battery be left in the Questemp<sup>o</sup>15. This is the primary memory backup battery. An internal lithium cell will retain the memory during battery changes, but it is not recommended that the unit be left for long periods without a battery. When the Questemp<sup>o</sup>15 is operated from the AC line the 9 volt battery is automatically disconnected from the circuit. If AC line power is removed, the power supply plug should be removed from the Questemp<sup>o</sup>15 and the unit shut off so that the 9 volt battery can resume primary memory backup.

### VI. CALIBRATION

A calibration sensor module (Quest model 056-937) is included for verifying the temperature accuracy of the Questemp<sup>®</sup>15. To check the calibration, remove the sensor assembly and plug the calibration module into the Questemp<sup>®</sup>15. With the unit set to read in degrees Celsius, repeatedly depress the DISPLAY key and verify that the 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/or calibrated.

#### VII. REMOTE MONITORING

In some applications it may be desirable to have the sensors remote from the Questemp<sup>®</sup>15. An example might be an ambient temperature environment above the 60°C temperature rating of the Questemp<sup>®</sup>15 electronics. The sensors may be removed from the Questemp<sup>®</sup>15 and connected via an extension cable or cables. A 25 foot shielded extension cable is available from Quest (model 056-924). The Questemp<sup>®</sup>15 will operate with up to 100 feet of cable with no loss of accuracy. The user should be cautioned that using long lengths of cable in environments with a high amount of electrical noise may cause interference.

To remove the sensor array, unscrew the knurled knobs on the top of the array. Pull the sensor array straight up from the body of the Questemp<sup>®</sup>15 to disengage the connector between the two. The extension cable may now be connected between the 9 pin connector on the bottom of the sensor array and that on the top of the Questemp<sup>®</sup>15. A 1/4"x20 threaded bushing is available on the bottom of the sensor array for tripod mounting.

#### VIII. MULTIPLE SENSOR OPERATION

##### INDEPENDENT MULTIPLE AREA MONITORING

An upgraded Questemp<sup>®</sup>15 with multiple sensors may be used to monitor up to 3 separate areas. Simply connect additional sensor arrays to the SENSOR 2 and SENSOR 3 jacks with remote cables. By depressing the SENSOR SET key you can select the temperature of any one of sensor arrays 1, 2 or 3 to be displayed. The measurement will be that selected by using the DISPLAY key. Attempting to read the temperature of an empty sensor array jack will display "----".

##### WBGT MEASUREMENTS WITH RESPECT TO THE TEMPERATURE UNIFORMITY OF AN ENVIRONMENT (per ISO 7243 : 1989)

When the temperature in the space surrounding a worker does not

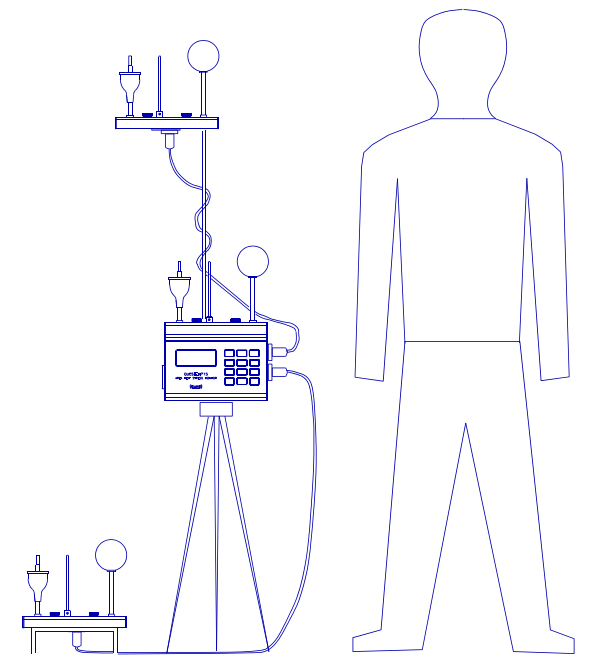


Figure 14 ASSEMBLED RACK

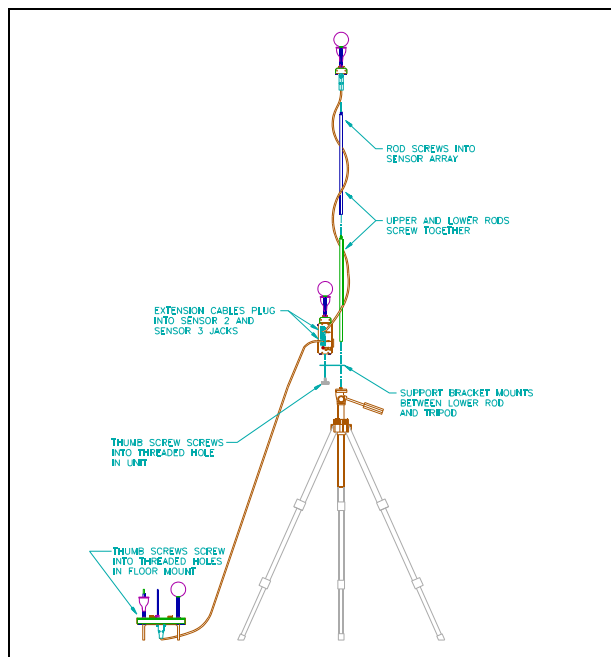
have a constant value it is necessary to determine the WBGT index at three heights corresponding to the worker's ankles, abdomen and head and perform a weighted average on those values. This value is displayed by using the SENSOR SET key to select AVG and is computed using the formula:

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

The Questemp<sup>o</sup>15 always assigns SENSOR 1 the double weighting. This calculation is only valid for 3 WBGT indices. The Questemp<sup>o</sup>15 will only display this value if a WBGT display has been selected using the DISPLAY key and if 3 sensor sets are connected. Otherwise, "----" will be displayed. For further information refer to ISO 7243 :1989 (E) "Hot environments - Estimation of the heat stress on working man, based on the WBGT-index".

#### QUEST ISO TRI-SENSOR MOUNTING RACK

The Questemp<sup>o</sup>15 with 3 sensor option comes with a tripod and hardware for mounting the sensor arrays at the proper heights to



perform the **Figure 15 Tri-Sensor Rack Assembly**

weighted average WBGT reading. To assemble this mounting rack refer to Figure 3. The Questemp<sup>o</sup>15 electronics must be mounted in the center (abdomen) position for the proper weighted average calculation. Figure 2 shows the fully assembled mounting rack.

#### IX. ALARM

The Questemp<sup>o</sup>15 has an alarm feature which will signal the user that the environment is above a user selectable WBGT index. This threshold may be assigned to any one of the WBGT indexes for one of sensor sets 1, 2, 3 or average. In addition, the temperature read by any single sensor (wet bulb, dry bulb, or globe) of any sensor set may also serve as an alarm threshold. This feature is available as a serial command only and may not be set through the keypad.

When the assigned WBGT index or sensor temperature equals or exceeds the threshold three things will happen to signal the operator:

- 1) The temperature display will flash, alternately displaying the selected temperature and "-AL-"
- 2) The alarm relay (available via the ALARM jack) will switch states. (i.e. if the alarm was set up to be normally open "no" then it will switch states to close the contacts.)
- 3) The following message will be sent out via the data port:  
"A01 05-23-91 11:02:01 \*\*\*\* Temp. Alarm TRIGGERED \*\*\*\*"

When the assigned WBGT index or sensor temperature drops below the threshold three things will happen to signal the operator:

- 1) The display will stop flashing
- 2) The alarm relay will switch back to its normal state, normally open or normally closed as programmed in the ALARM menu.
- 3) The following message will be sent out via the data port:  
"A02 05-23-91 11:09:21 \*\*\*\* Temp. Alarm RESET \*\*\*\*"

Any assigned WBGT index or individual sensor temperature that exceeds the alarm level will be indicated on a printout. The alarm level indicated will be that programmed at the time of printing. CAUTION: the printed alarm level setting may be altered prior to printing.

For details regarding programming the alarm and connecting the ALARM jack to external equipment refer to the ALARM key, ALARM jack and ASCII COMMAND SEQUENCES sections of this manual.

#### X. DATA STORAGE

By depressing the RUN/STOP key data storage is either started or stopped. Data storage is indicated by the RUN annunciator on the display. Data is stored in a sequential manner. Starting and stopping data storage without clearing the memory simply adds the new data after the old. All data stored is treated as one block whether or not it is time continuous. If the memory fills, data storage stops and 'FULL' will be displayed. The RUN annunciator will turn off indicating that data storage has stopped. Depress any key to restore normal operation. To erase all data points, depress and hold the RESET key for three seconds. The display will count down from 3 to 0. Releasing the key prior to zero will leave the data intact.

A data point consists of the time and the temperatures of the GLOBE, WETBULB and DRYBULB sensors. Data is stored every thirty seconds while in RUN. The Questemp°15 has the capacity to store 41 hours of data for a single sensor array. Multiple sensors, if used, will also have their temperatures stored. This will reduce the available RUN time to 18 hours for two sensor arrays or 12 hours for three sensor arrays.

While in the RUN mode the CLOCK, PRINT RATE, ALARM and PRINT function settings may be viewed but not altered.

The Questemp°15 with the 3 sensor option will only store data from sensors which are connected at the time RUN is depressed. During a RUN period, plugging in an additional sensor will not add that sensor's data to the printout. Depressing RUN twice to stop and restart data collection will activate that sensor.

#### XI. PRINTING DATA

A parallel or serial printer may be used to obtain a hardcopy of data stored in the Questemp°15. The printer is connected via the DATA PORT 25 pin connector located on the left side of the unit. To configure the Questemp°15 for a printer type and to set the baud rate for a serial printer, refer to the menu instructions under the PRINT KEY section of this manual.

To connect a parallel printer to the Questemp°15, use a standard PC printer cable (Quest #056-019). Connect the 25 pin male plug to the DATA PORT and the 36 pin Centronics plug to the parallel printer.

To connect a serial (RS-232C) printer to the Questemp°15, a special cable is available from Quest (#056-922). One end of this cable is labeled HEAT STRESS MONITOR END and must be connected to the DATA PORT on the Questemp°15. The other end is labeled RS-232C TO PRINTER and must be plugged into the printer. The baud rate must be set the same on both the printer and the Questemp°15.

To print data, depress the PRINT key followed by the ENTER key. Depressing PRINT again will abort the printout.

The Questemp°15 will automatically print the data for each sensor array present at the beginning of data storage. After printing the data for the third array (if all three sensor arrays are present), the weighted average

data for the three sensors (per ISO 7243) will be printed.

The printout, in the form of an ASCII text file, may be sent to an IBM compatible PC via the RS-232C port. No special software is needed. Prior to depressing the PRINT key on the QUESTEMP°15 type the following simple commands at the DOS prompt:

```
MODE COM#: [baud],N,8,1,P <ENTER>
COPY COM#: [filename] <ENTER>
```

where # is the number of the communications (COM) port to which the Questemp°15 is connected. 1, 2, etc.

baud is the baud rate for which the QUESTEMP15 is currently set.

filename is any acceptable 8 character MS-DOS filename.

**NOTE:** All temperature data is printed in either degrees Celsius or Fahrenheit depending upon which mode the Questemp°15 is in at the time of printing.

A typical printout followed by a description is shown on the following pages.



**SAMPLE PRINTOUT**

QUEST TECHNOLOGIES  
QUESTEMP<sup>®</sup>15 WBGT AREA HEAT STRESS MONITOR

Software Version Number: 1.9      Serial Number: KL1040001

Name: -----  
Location: -----  
-----  
-----

<sup>1</sup>Date: 7-APR-91  
<sup>2</sup>Start Time:11:13:15    End Time:12:13:39    Total Run Time:01:00:14

<sup>3</sup>Alarm Level Setting - Sensor Set #1    WBGT OUT: 107.5 degree F  
<sup>4</sup>Print Rate: 10 minute

<sup>5</sup>WBGT CUSTOM: 0.50 WB + 0.50 GLOBE + 0.00 DB

<sup>6</sup>-----  
**SENSOR SET #1**  
-----

|             | <sup>7</sup> HIGH<br>TEMP | TIME  | <sup>8</sup> LOW<br>TEMP | TIME  | <sup>9</sup> AVG.<br>TEMP |
|-------------|---------------------------|-------|--------------------------|-------|---------------------------|
| WET BULB    | 104.0                     | 11:53 | 103.1                    | 11:13 | 103.7                     |
| DRY BULB    | 107.6                     | 11:53 | 107.0                    | 11:13 | 107.3                     |
| GLOBE       | 122.3                     | 12:03 | 112.5                    | 11:13 | 118.7                     |
| WBGT IN     | 108.1                     | 12:03 | 106.2                    | 11:13 | 107.2                     |
| WBGT OUT    | 107.7                     | 12:03 | 107.0                    | 11:13 | 107.1                     |
| WBGT CUSTOM | 109.9                     | 12:03 | 108.3                    | 11:13 | 109.0                     |

<sup>10</sup>-----  
**TIME**    WET    DRY    GLOBE    WBGT\_I    WBGT\_O    WBGT\_C    ALARM  
-----

|       |       |       |       |       |       |       |   |
|-------|-------|-------|-------|-------|-------|-------|---|
| 11:13 | 103.1 | 107.0 | 112.5 | 106.2 | 106.0 | 108.3 |   |
| 11:23 | 103.3 | 107.2 | 114.3 | 106.5 | 106.3 | 108.6 |   |
| 11:33 | 103.8 | 107.3 | 117.2 | 107.3 | 107.1 | 108.8 |   |
| 11:43 | 103.9 | 107.5 | 119.1 | 107.5 | 107.3 | 109.4 | * |
| 11:53 | 104.0 | 107.6 | 120.6 | 107.9 | 107.6 | 109.7 | * |
| 12:03 | 104.0 | 107.6 | 122.3 | 108.1 | 107.7 | 109.9 | * |
| 12:13 | 104.0 | 107.5 | 121.9 | 108.0 | 107.6 | 109.8 | * |

<sup>11</sup>-----  
**SENSOR SET #2**  
-----

|             | HIGH<br>TEMP | TIME  | LOW<br>TEMP | TIME  | AVG.<br>TEMP |
|-------------|--------------|-------|-------------|-------|--------------|
| WET BULB    | 104.0        | 11:53 | 103.1       | 11:13 | 103.7        |
| DRY BULB    | 107.6        | 11:53 | 107.0       | 11:13 | 107.3        |
| GLOBE       | 122.3        | 12:03 | 112.5       | 11:13 | 118.7        |
| WBGT IN     | 108.1        | 12:03 | 106.2       | 11:13 | 107.2        |
| WBGT OUT    | 107.7        | 12:03 | 107.0       | 11:13 | 107.1        |
| WBGT CUSTOM | 109.9        | 12:03 | 108.3       | 11:13 | 109.0        |

**TIME**    WET    DRY    GLOBE    WBGT\_I    WBGT\_O    WBGT\_C    ALARM  
-----

|       |       |       |       |       |       |       |   |
|-------|-------|-------|-------|-------|-------|-------|---|
| 11:13 | 103.1 | 107.0 | 112.5 | 106.2 | 106.0 | 108.3 |   |
| 11:23 | 103.3 | 107.2 | 114.3 | 106.5 | 106.3 | 108.6 |   |
| 11:33 | 103.8 | 107.3 | 117.2 | 107.3 | 107.1 | 108.8 |   |
| 11:43 | 103.9 | 107.5 | 119.1 | 107.5 | 107.3 | 109.4 | * |
| 11:53 | 104.0 | 107.6 | 120.6 | 107.9 | 107.6 | 109.7 | * |
| 12:03 | 104.0 | 107.6 | 122.3 | 108.1 | 107.7 | 109.9 | * |
| 12:13 | 104.0 | 107.5 | 121.9 | 108.0 | 107.6 | 109.8 | * |

**SAMPLE PRINTOUT**

<sup>12</sup>-----  
**SENSOR SET #3**  
-----

|             | HIGH<br>TEMP | TIME  | LOW<br>TEMP | TIME  | AVG.<br>TEMP |
|-------------|--------------|-------|-------------|-------|--------------|
| WET BULB    | 104.0        | 11:53 | 103.1       | 11:13 | 103.7        |
| DRY BULB    | 107.6        | 11:53 | 107.0       | 11:13 | 107.3        |
| GLOBE       | 122.3        | 12:03 | 112.5       | 11:13 | 118.7        |
| WBGT IN     | 108.1        | 12:03 | 106.2       | 11:13 | 107.2        |
| WBGT OUT    | 107.7        | 12:03 | 107.0       | 11:13 | 107.1        |
| WBGT CUSTOM | 109.9        | 12:03 | 108.3       | 11:13 | 109.0        |

**TIME**    WET    DRY    GLOBE    WBGT\_I    WBGT\_O    WBGT\_C    ALARM  
-----

|       |       |       |       |       |       |       |   |
|-------|-------|-------|-------|-------|-------|-------|---|
| 11:13 | 103.1 | 107.0 | 112.5 | 106.2 | 106.0 | 108.3 |   |
| 11:23 | 103.3 | 107.2 | 114.3 | 106.5 | 106.3 | 108.6 |   |
| 11:33 | 103.8 | 107.3 | 117.2 | 107.3 | 107.1 | 108.8 |   |
| 11:43 | 103.9 | 107.5 | 119.1 | 107.5 | 107.3 | 109.4 | * |
| 11:53 | 104.0 | 107.6 | 120.6 | 107.9 | 107.6 | 109.7 | * |
| 12:03 | 104.0 | 107.6 | 122.3 | 108.1 | 107.7 | 109.9 | * |
| 12:13 | 104.0 | 107.5 | 121.9 | 108.0 | 107.6 | 109.8 | * |

**PRINTOUT DESCRIPTION**

1. The date when the first run period occurred is shown.
2. Start time shows when the unit was first put into the RUN mode. End time shows when the unit was last taken out of the RUN mode. Total run time refers to the total amount of time spent in the RUN mode. An asterisk will appear after the total run time if multiple run periods took place.
3. At the time of printing, the current alarm level settings are shown.
4. Print rate refers to the frequency which logged data is printed. Data is logged every 30 seconds in the RUN mode but the print rate is used to condense the data. As an example, a 10 minute print rate would print every twentieth set of temperature information (every 10 minutes).
5. The WBGT custom formula is shown. The formula can only be entered into the Questemp<sup>®</sup>15 via a personal computer.
6. Sensor set #1 refers to the sensor rack plugged into the top of the unit. For a standard Questemp<sup>®</sup>15 without the multiple sensor upgrade, this will be the only sensor set of data printed out.
7. For each sensor and WBGT index, the maximum temperature that occurred over the entire run time is printed along with the time of occurrence.
8. For each sensor and WBGT index, the minimum temperature that occurred over the entire run time is printed along with the time of occurrence.

9. For each sensor and WBGT index, the average temperature over the entire run time is printed.
10. Logged data for the WET bulb, DRY bulb, GLOBE, WBGT Indoor, WBGT Outdoor, and WBGT Custom are printed according to the print rate. An asterisk will appear under the alarm column if an alarm condition occurred at the corresponding time.
11. For a multiple sensor upgraded Questemp°15, sensor set #2 data is printed.
12. For a multiple sensor upgraded Questemp°15, sensor set #3 data is printed.
13. For a multiple sensor upgraded Questemp°15, the weighted WBGT averages of each of the three sensor sets is printed. This information is useful when measuring using the three sensor set configuration per ISO #7243.

## XII. USING THE QUESTEMP°15 WITH A PERSONAL COMPUTER

The Questemp°15 can communicate with a PC via an RS-232C port. All front panel control functions as well as a few additional functions may be invoked via ASCII commands. A special RS-232C cable is available from Quest (#056-936) for connection to a PC. This is not the same as the RS-232C printer cable.

To connect the Questemp°15 to the PC, simply plug the end of the cable marked 'HEAT STRESS MONITOR' to the data port on the Questemp°15 and the end marked 'RS-232C TO COMPUTER' to the appropriate COM port on your personal computer. Be sure to set the baud rates to the same value on both units. Refer to the PRINT KEY section of this manual.

To simply retrieve any stored data in the form of an ASCII text file, refer to the section on PRINTING DATA.

### WAKE-UP ALARM

The Questemp°15 has an internal clock/calendar which allows a future power ON (automatic wake-up time) to be programmed via the RS-232 port. When the Questemp°15 turns on under wake-up conditions it may be programmed to perform a sequence of tasks through the use of an auto-execute buffer. Refer to the ASCII COMMAND SEQUENCES section for programming instructions.

An example of programming the auto-execute buffer is shown below.

| <u>Command</u>       | <u>Comment</u>                          |
|----------------------|---|
| &E 0<cr>             | clear old data from auto-execute buffer |
| &E 1<cr>             | begin loading the auto-execute buffer   |
| &Z<cr>               | reset (clear) memory                    |
| &RT 4 0 0<cr>        | start a 4 hour run period               |
| &P<cr>               | after the run, print the data           |
| &O<cr>               | turn unit OFF                           |
| &E 2<cr>             | quit loading the auto-execute buffer    |
| &W 2 3E 10 00 00<cr> | set the auto-wake-up for 10:00 Mon-Fri  |
| &X 2<cr>             | enable auto-execution for wake-up mode  |

The above commands will cause the Questemp°15 to automatically turn itself ON at 10:00am every Monday through Friday. It will then reset the old memory, run for four hours, print the data, and turn itself OFF until 10:00am the next weekday.

**NOTE:** When turning the unit off the display counts down from 3. If the display shows 3 2 1 0 it is indicating that the Wake-up Alarm is disabled. If the display shows 3 2 1 ALE (ALarm Enable) it is indicating that the Wake-up Alarm is enabled and the unit will turn on at the programmed time.

To disable the Wake-up Alarm from the keypad, simply depress and hold down the ON/OFF and RESET keys for the countdown.

## ASCII COMMAND SEQUENCES

**NOTE:** All temperature data returned from the Questemp<sup>o</sup>15 in response to an ASCII command sequence will be in degrees Celsius and will not contain decimal points. (As an example, a returned temperature of 345 would be 34.5°C.)

### Unit Identification:

```
?<cr>      Get unit serial number & revision.
           response: Questempo15 Version 1.3
                   Serial: KL1040001a
```

### Temperature Readings:

```
&A<cr>      Get temperature being displayed in °C
           response: M02 Temp [n1] [n2] = nnnn
           where:  n1 = which data set
                   0 = sensor bar 1
                   1 = sensor bar 2
                   2 = sensor bar 3
                   3 = ISO average
                   n2 = which temperature
                   0 = wet bulb
                   1 = dry bulb
                   2 = globe
                   3 = indoor WBGT
                   4 = outdoor WBGT
                   5 = custom WBGT
```

```
&AG n1 n2<cr> Get Specified temperature in °C
           where:  n1 = which data set
                   0 = sensor bar 1
                   1 = sensor bar 2
                   2 = sensor bar 3
                   3 = ISO average
                   n2 = which temperature
                   0 = wet bulb
                   1 = dry bulb
                   2 = globe
                   3 = indoor WBGT
                   4 = outdoor WBGT
                   5 = custom WBGT
```

```
response: M02 Temp [n1] [n2] = nnnn
```

```
&AS n1 n2<cr> Specify temperature to be displayed
                in currently selected units
           where: n1 = which data set
                   0 = sensor bar 1
                   1 = sensor bar 2
                   2 = sensor bar 3
                   3 = ISO average
                   n2 = which temperature
                   0 = wet bulb
                   1 = dry bulb
                   2 = globe
                   3 = indoor WBGT
                   4 = outdoor WBGT
                   5 = custom WBGT
```

```
response: M01 New Display: n1 n2
```

### Echo Flag Control:

```
&AE<cr>      Report echo status
           response: M29 Timed Echo Flag Set
                   or
                   M30 Timed Echo Flag Reset
           &AE 0<cr> Reset timed echo flag
           response: M30 Timed Echo Flag Reset
           &AE 1<cr> Set timed echo flag
           response: M29 Timed Echo Flag Set
```

The timed echo flag controls the echoing every second of the sensor array temperatures. When the flag is set the following data will be sent every second:

```
M31 t[0][0] t[0][1] t[0][2] t[1][0] ..... t[2][2]
```

The timed echo flag is reset by any of the following: the &AE 0 command, resetting the rts signal or turning the QT-15's power off.

### Check Battery Level:

```
&B<cr>      Check Battery Level.
           response: M03 Battery Level OK
```

or M04 Battery Level Low

**Date Control:**

**&D<cr>** Get current Date.

response: M06 Date: 5-23-1991

**&DS mm dd yyyy<cr>** Set new Date.

where: mm = month 1-12  
dd = day of month 1-31  
yyyy = year i.e. 1991

response: M06 Date: 5-23-1991

**Auto-Execute Buffer Control:**

**&E 0<cr>** Clear auto-execute buffer.

response: M18 Execute Buffer Load Flag Reset; nn bytes used;  
nn bytes free

**&E 1<cr>** Load following commands to auto-execute  
buffer.

response: M17 Execute Buffer Load Flag Set; nn bytes used;  
nn bytes free

**&E 2<cr>** Stop loading commands to auto-execute buffer.

response: M18 Execute Buffer Load Flag reset; nn bytes used;  
nn bytes free

**&E 3<cr>** List commands in auto-execute buffer.

response: M21 Auto-Execute Buffer Listing:

(commands in buffer)

M17 Execute Buffer Load Flag Set; nn  
bytes used; nn bytes free

or

M18 Execute Buffer Load Flag reset; nn  
bytes used; nn bytes free

**Set Display Units:**

**&F<cr>** Get current display units

response: M07 Display set to degrees C  
or  
M08 Display set to degrees F

**&F 0<cr>** Set Degrees C.

response: M07 Display set to degrees C

**&F 1<cr>** Set Degrees F.

response: M08 Display set to degrees F

**Restart Auto Execution:**

**&G<cr>** Go to start of auto-execute file (Only functions when  
autoexecuting)

response: none

**Get Hexdump:**

**&H<cr>** Get hex dump of logged data.

response: (hexdump of logged data)

**Identification Codes:**

**&I<cr>** Get unit serial number & software revision.

response: Questemp 15 Version 1.3 Serial: KL1050002

**&IS KL1040001a<cr>** Set unit serial number

response: Questemp 15 Version 1.3 Serial: KL1040001a

**Set Baud Rate:**

**&J n<cr>** Where n = 0 9600 4 600  
1 4800 5 300  
2 2400 6 Prll  
3 1200

response: none

**Keypad Echo control:**

```

&K<cr>   Get keypad echo status.
          response: M27 Keypad echo Flag Set
                   or
                   M28 Keypad echo Flag Reset
&K 0<cr> Reset keypad echo flag.
          response: M28 Keypad echo Flag Reset
&K 1<cr> Set keypad Echo flag.
          response: M27 Keypad echo Flag Set

```

When the keypad echo flag is set, every time a key is pressed, its key code will be echoed or transmitted out the serial port. This flag is automatically reset when the Questemp<sup>®</sup>15 is powered on.

**Questemp<sup>®</sup>15 Keypad Codes**

| Key              | Hex        | ASCII   |
|------------------|------------|---------|
| display          | 0x16       | ^V      |
| clock            | 0x26       | &       |
| C/F              | 0x46       | F       |
| enter            | 0x86       | à       |
| sensors          | 0x15       | ^U      |
| print rate       | 0x25       | %       |
| print            | 0x45       | E       |
| reset            | 0x85       | à       |
| run              | 0x13       | ^S      |
| alarm            | 0x23       | #       |
| advance          | 0x43       | C       |
| on/off           | 0x83       | â       |
| reset+on/off     | 0x52       | R       |
| Reset Countdown  | 0x30+count | 3 2 1 0 |
| on/off Countdown | 0x30+count | 3 2 1 0 |

**Alarm control:**

```

&L<cr>   Get current alarm settings.
&LS n1 n2 n3 n4<cr> Set alarm level.
          where: n1 = which data set
                   0 = sensor bar 1
                   1 = sensor bar 2
                   2 = sensor bar 3
                   3 = ISO average
                 n2 = which temperature
                   0 = wet bulb
                   1 = dry bulb
                   2 = globe
                   3 = indoor WBGT
                   4 = outdoor WBGT
                   5 = custom WBGT
                 n3 = alarm level 0-1999
                   1999 = 199.9 degrees C
                 n4 = alarm relay state
                   0 = no (close contact to alarm)
                   1 = nc (open contact to alarm)
          response: A03 Alarm Level: array= n1 sensor= n2 level= n3
                   contact= n4

```

**Alarm Relay Control:** allows control of alarm relay independent of WBGT index. An actual alarm occurrence will override this control and cause the relay to set and reset normally.

```

&M<cr>   Get relay status.
&MS<cr>  Set alarm (relay to alarm position)
&MR<cr>  Reset alarm (relay to no alarm position)
          responses:(same for all &M commands)
                   A04 Alarm Relay Contacts Closed
                   or
                   A05 Alarm Relay Contacts Open

```

**Set No-Echo Flag:**

&N 0<cr> echo normally  
&N 1<cr> Don't echo RS232 commands  
response to both: none

**On/Off Control:**

&O<CR> Turn unit off.  
response: M09 Unit will turn off when DTR is  
reset  
RTS signal will turn power to the unit on.

**Printout:**

&P<cr> Execute normal Printout.  
If the parallel interface has been selected by the keypad, the printout will go to the parallel printer. If the serial interface is selected, the printout will go to the serial interface. Using a combination cable, a remote RS-232 command can cause a printout to a parallel printer to occur.

**Custom WBGT Control:**

&Q<cr> Get custom WBGT factors.  
&QS n1 n2 n3<cr> Set custom WBGT factors to  
define the equation  
WBGT= (n1 x WETBULB) + (n2 x DRYBULB) + (n3 x GLOBE)  
where: n1, n2, n3 = decimal fractions in  
hundredths (n1, n2 and n3  
need not add up to 100)  
response: (same for all &Q commands)  
M10 Custom WBGT: Wet= n1 Globe= n2  
Dry= n3

**Run Mode Control:**

&R<cr> Toggle Run mode.  
&RT hh mm ss<cr> Start timed run mode. If this  
command is in an Auto-execute file it will  
delay the execution of the next command  
until the timed run is completed.  
where: hh = number of hours  
mm = number of minutes  
ss = number of seconds  
response: (same for both commands)  
M11 Run Mode now ACTIVE  
or  
M12 Run Mode now INACTIVE

**Operational Status:**

&S<cr> Get current Status.  
response: M13 Status: Run Flag= n1 Run-Time= n2 sec. Time  
Left= n3 sec. Alarm Flag= n4  
where: n1= Run Flag  
0 = not in run mode  
1 = Run Mode  
n2 = elapsed Run Time in seconds  
n3 = time left in timed run mode.  
n4 = Alarm Flag  
0 = no alarm  
1 = alarm condition

**Time Of Day:**

&T<cr> Get current time.  
&TS hh mm<cr> Set new time of day.  
where : hh = hours in military time (0-23)  
mm = minutes (0-59)  
response: (same for both commands)  
M14 Time: hrs:min:sec

**Output User Defined Messages:**

```

&U 0<cr> send null code
response: null code

&U 1"string"<cr> send string minus <cr>
response: "string" no <cr>

&U 2"string"<cr> send string with <cr>
response: "string" with <cr>

&U 3"string"<cr> send string with <cr><lf>
response: "string" with <cr><lf>

&U 4 HHH<cr> send hex data character - one hex character
only
response: hex character

&U 5 n1 n2<cr> send Temp in deg C of sensor bar/ISO avg
0,1,2,3 (n1) and sensor/WBGT 0,1,2,3,4,5
(n2)
response: degree C of appropriate sensor combination

&U 6 n1 n2<cr> send Temp in deg F of sensor bar/ISO avg
0,1,2,3 (n1) and sensor/WBGT 0,1,2,3,4,5
(n2)
response: degree F of appropriate sensor combination

```

**Print Rate Control:**

```

&V<cr> Get current print rate.

&VS n1<cr> Set new print rate.

where : n1=print rate
0 = 30 seconds
1 = 1 minute
2 = 2 minutes
3 = 5 minutes
4 = 10 minutes
5 = 15 minutes
6 = 30 minutes
7 = 60 minutes

response: (same for both commands)
M15 Print Rate= n1

```

**Wake-up Alarm control:**

```

&W<cr> Get current wake-up alarm setting
response: M22 Automatic Wake-up Disabled
or
M23 Date Wake-up Enabled for mm/dd at hh:mm:ss

&W 0<cr> Disable wake-up alarm.
response: M22 Automatic Wake-up Disabled

&W 1 mm dd hh mm ss<cr> Set date & time wake-up
alarm.

where: mm = month (1-12)
dd = day of the month (1-31)
hh = hours in military time (0-23)
mm = minutes (0-59)
ss = seconds (0-59)

response: M23 Date Wake-up Enabled for mm/dd at hh:mm:ss

&W 2 wd hh mm ss<cr> Set days of the week wake-up alarm.

where: wd = which days of the week
1 = Sunday
2 = Monday 6 3 1
4 = Tuesday 4 2 6 8 4 2 1
8 = Wednesday
16 = Thursday X X X X X X X
32 = Friday (0-7) (0-F)
64 = Saturday
Add these numbers and send the result in Hexidecimal to
set multiple days of the week. I.E. 05= Sunday &
Tuesday, 0E= Monday, Tuesday & Wednesday 3E= Monday
thru Friday

hh = hours in military time (0-23)
mm = minutes (0-59)
ss = seconds (0-59)

response: M24 Week Days Wake-up enabled for Days wd at
hh:mm:ss

&W 3 hh mm ss<cr> Set daily wake-up alarm.

where: hh = hours in military time (0-23)
mm = minutes (0-59)
ss = seconds (0-59)

```

response: M25 Daily Wake-up enabled at hh:mm:ss

#### Auto-Execute control:

This command controls the execution of the commands stored in the auto execute buffer by the &E commands. The buffered commands can be executed every time the unit is powered on, or only when powered on by a clocked automatic wake-up alarm (controlled by the &W commands).

**&X<cr>** Get Auto-execute Status.

**&X 0<cr>** Disable Auto-execute

**&X 1<cr>** Enable Auto-execute for all power-up.

**&X 2<cr>** Enable Auto-execute for alarm wake-up only

response: (same for all commands)  
M26 Enable Auto Execute = n1,  
Auto Wake-only = n2

where: n1 = Auto Execute Flag  
0 = disabled  
1 = enabled

n2 = Auto Execute on Auto Wake-up Only  
0 = disabled  
1 = enabled

**Timed Delay:** During autoexecute (only functions while autoexecuting)

**&Y n1 n2 n3<cr>** where: n1 = hours, n2 = minutes,  
n3 = seconds  
response: none

#### Unit Reset:

**&Z<cr>** Reset (clear) logging data memory.

response: M16 Unit Reset

#### Alarms:

When a temperature alarm occurs, the QT-15 will send a message over the RS-232 port if the RTS signal is present.

A01 05-23-1991 13:12:05 \*\*\*\* Temp. Alarm TRIGGERED \*\*\*\*

A02 05-23-1991 16:23:45 \*\*\*\* Temp. Alarm RESET \*\*\*\*

#### Command Errors:

If the QT-15 receives a command that it does not understand, it will respond with the following message:

M99 \*\*\* Command Error \*\*\*

#### RS-232C CABLE CONNECTIONS

The pinout for the DATA PORT connector is shown in Figure 4. All other pins are used for connection to a parallel printer and must not be connected for serial operation.

When connected to a serial printer the Questemp<sup>o</sup>15 is DTE and the printer is DCE. When connected to a personal computer the Questemp<sup>o</sup>15 is DCE and the computer is DTE.

The data word has 8 data bits, 1 stop bit and no parity. To set the baud rate, refer to the PRINT key section of this manual.

An RTS signal will always turn power to the unit ON.

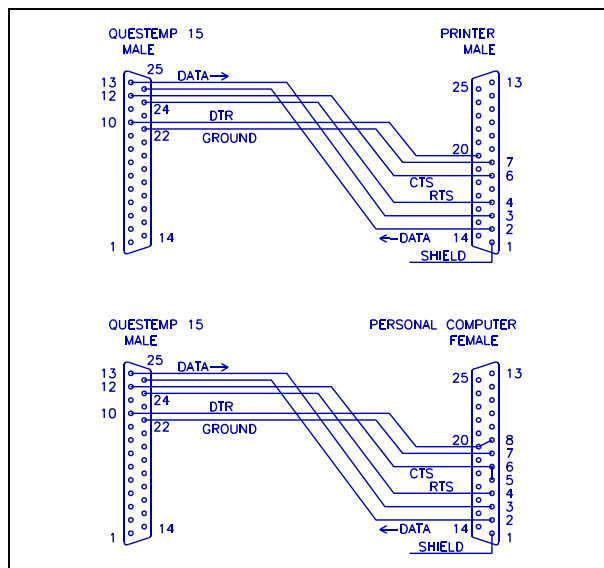


Figure 16 RS-232 CABLE CONFIGURATIONS



### XIII. SPECIFICATIONS

Size: Width: 6.5" (165mm); Height: 10" (254mm); Depth: 2" (51mm)  
Dimensions include a mounted sensor assembly.

Weight: 28 oz. (800 g) with mounted sensor assembly.

Temperature Sensors : 1000 ohm platinum RTD, 3.85 ohm/°C

Temperature Sensor Accuracy: +/- 0.5 degree C from 0°C to 100°C  
+/- 1.0 degree above 100°C

Ambient Operating Temperature Range:

Questemp<sup>®</sup>15 : 0 to 60 degrees C  
Sensor Assembly : 0 to 100 degrees C

Operating Humidity Range:

Electronics : 0 to 95% non condensing.  
Sensor Assembly : 0 to 100% (non submersible)

Response Time (typical): Dry Bulb : 2 minutes  
Globe : 12 minutes  
Wet Bulb : 10 minutes

Power Requirements : One 9 volt alkaline battery (NEDA #1604A) or  
optional AC adapter. [2-3mA typical current  
drain without using RS-232C, 20mA typical  
while using the RS-232C port.]

Battery Life : 100 hours minimum (using RS-232C decreases life)

Effects Due To External Fields : Tested for RF susceptibility with less than  
0.3°C error at field strengths to 10V/m over the frequency range of  
10MHz to 500MHz.

### XIV. ACCESSORIES

|  |         |
|--|---------|
| SC-25 25 foot shielded remote sensor cable   | 056-924 |
| SC-5 5 foot shielded remote sensor cable     | 056-944 |
| Model 920 AC adapter                         | 056-067 |
| TP-1 Tripod                                  | 059-045 |
| RWS-1 Replacement wicks (10) and sponges (3) | 056-056 |
| WB-1 Water Bottle, 2 oz.                     | 056-068 |
| CSM-1 Calibration sensor module              | 056-937 |

|  |         |
|--|---------|
| SA-2 Sensor array with 2 inch diameter globe   | 056-941 |
| SA-6 Sensor array with 6 inch diameter globe   | 056-945 |
| RS-232C cable for serial printer (25 pin male)   | 056-922 |
| RS-232C cable for personal computer (25 pin female)                                    | 056-936 |
| Parallel printer cable (36 pin Centronics)   | 056-019 |
| Carrying Case for Questemp <sup>®</sup> 15 and accessories                             | 056-939 |
| Carrying Case for QT-15M-3 3 sensor option kit<br>(includes tripod, brackets with rod) | 056-940 |
| Quest Suite for Windows PC support software  |         |

### XV. APPENDICES

#### **Appendix A : CONVERSION FORMULAS**

$$^{\circ}\text{C} = 5/9(^{\circ}\text{F} - 32)$$

$$^{\circ}\text{F} = 9/5^{\circ}\text{C} + 32$$

#### **Appendix B : HEAT EXPOSURE TABLES**

Permissible Heat Exposure Threshold Limit Values  
(Values are given in °C WBGT)

| <u>Work-Rest Regimen</u>          | <u>Work Load</u> |          |       |
|-----------------------------------|------------------|----------|-------|
|                                   | Light            | Moderate | Heavy |
| Continuous Work                   | 30.0             | 26.7     | 25.0  |
| 75% Work -<br>25% Rest, each hour | 30.6             | 28.0     | 25.9  |
| 50% Work -<br>50% Rest, each hour | 31.4             | 29.4     | 27.9  |
| 25% Work -<br>75% Rest, each hour | 32.2             | 31.1     | 30.0  |

*from "American Conference of Governmental Industrial Hygienists - Threshold  
Limit Values and Biological Exposure Indices for 1990-1991"  
Reprinted with permission from ACGIH*

## XVI. SERVICE AND WARRANTY POLICY

### **Service Policy**

The Quest product you have purchased is one of the finest instruments available. It is backed by our full one year warranty which seeks complete customer satisfaction. This is your assurance that you can expect prompt courteous service for your equipment from the entire Quest service organization.

Should your Quest equipment need to be returned for repair or recalibration, please contact the Service Department at 1(800)245-0779 (USA) or Fax (262)567-4047 for a Return Authorization Number. The RA number is valid for 30 days, and must be shown on the shipping label and purchase order/cover letter. If you are unable to return instruments in that time call for a new RA number. Send it prepaid and properly packed in the original shipping carton directly to Quest Technologies, 1060 Corporate Center Dr., Oconomowoc, WI 53066 U.S.A.

Repair or replacement work done under warranty will be performed free of charge, and the instrument will be returned to you prepaid. Your copy or a photocopy of the Quest Registration Card will serve as proof of warranty should the factory require this information.

If for any reason you should find it necessary to contact the factory regarding service or shipping damage, please direct your calls or letters to the attention of the Service Manager, Quest Technologies, (262) 567-9157 or (800) 245-0779. Office hours are from 8 AM to 5 PM (Central Standard Time) Monday through Friday.

### **Warranty Policy**

Quest Technologies warrants our instruments to be free from defects in materials and workmanship for one year under normal conditions of use and service. For U.S.A. 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 Quest Technologies. Microphones, sensors, printers, and chart recorders may have shorter warranty periods. This warranty states our total obligation in place of any other warranties expressed 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 U.S.A., a minimum of one year warranty applies subject to the same limitation and exceptions as above with service provided or arranged through the authorized Quest sales agent or our Quest European Service Laboratory. Foreign purchasers should contact the local Quest authorized sales agent for details.