CANNON INSTRUMENT COMPANY

TE-3000

Thermo Electric Temperature Bath

Instruction & Operation Manual

CONTENTS

CHAPTER 1

INTRODUCTION

A. Scope

Manual

The intent of this manual is to assist the user of the TE-3000 in the general installation, operation, maintenance, and simple field repair of the unit. This operations manual contains sections dealing with descriptions of equipments, unpacking and installation, general front panel operations, remote control/response operations, preventative maintenance, and simple failure analysis and fault isolation.

Diagnostics/repair

Detailed diagnostics and repair should be performed in conjunction with or solely by ***CANNON***® Instrument Company. Please consult ***CANNON***® Instrument Company for further assistance beyond the content of this manual.

B. Overview

TE-3000 features

The TE-3000 is a state of the art, microprocessor controlled and thermoelectrically cooled, constant temperature liquid bath. It is totally self-contained in two stackable bench-top units which together occupy a foot print less than 15 by 20 inches. The TE-3000 does not contain any fluorocarbons or refrigeration components and the only moving parts are four ball-bearing cooling fans and a long-life vibratory air pump. It can obtain any temperature between +30 degrees to -30 degrees Celsius and remain stable at that temperature within .01 degrees under normal operating conditions.

Figure 1: The TE-3000

Temperature control

The principals of operation for this instrument are the latest in science and technology. Custom-developed Peltier Cells are arranged on the back and sides of the bath vessel. Newly designed high density air heat sinks on the outer surfaces (hot side) of these Peltier Cells are cooled by muffin fans running at half of their rated voltage. The bath liquid (2.5 liters) is constantly circulated by recycled bath vapors to ensure uniform temperature distribution and stability. The temperature is controlled (both heating and cooling) with a custom designed 16 bit digital pulse width modulator running at a very high frequency.

Calibration

The TE-3000 can be calibrated to any temperature reference standard for any desired Celsius or Fahrenheit temperature. The controls for entering the target (desired) temperature and the calibration at this temperature are very simple and straight forward. The instrument remembers these calibration corrections for every possible temperature as well as the latest desired temperature so that upon power-up, the bath will adjust to these last known and entered parameters.

Networking/communication

The TE-3000 was designed for the future with built in capability for remote control and networking with a new family of instruments. With this remote interface capability, it is now possible to obtain quality assurance data via a computer network. The TE-3000 was also designed to ensure that its capabilities may be easily changed or updated with new operating firmware via a remote download over this same network.

CHAPTER 2

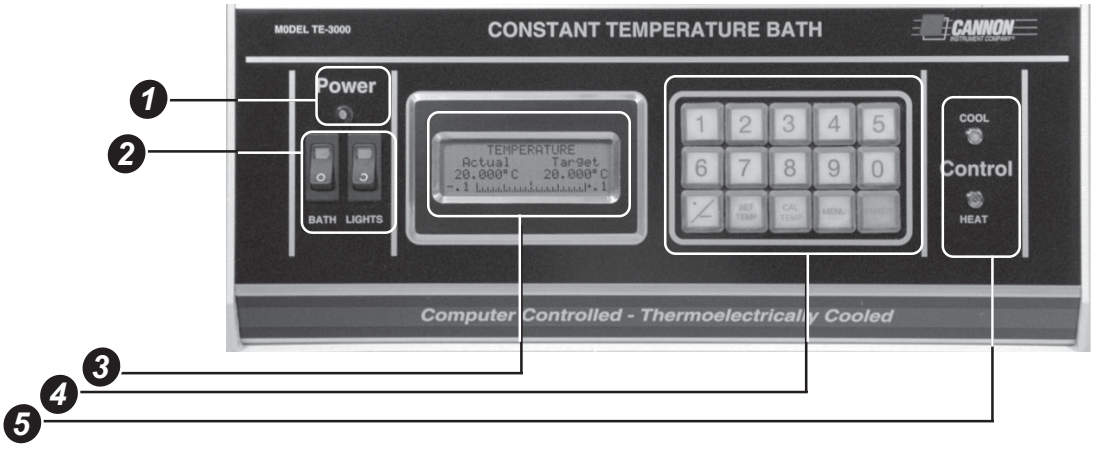
ITEM DESCRIPTIONS

A. Lower Control Chassis

The Control Chassis for the TE-3000 is the base unit of the instrument upon which the Upper Bath Vessel Housing sits.

The Control Chassis contains all of the power conditioning and supplies, air pump, and electronics needed for the operation of the TE-3000. The mains power input, two power connectors to the Upper Bath Vessel, communication (RS-232 and RS-485) connectors, address selection switch, download demand switch, two air pump connections to the Upper Bath Vessel, and the bath fluid pump switch reside on the rear panel of the Lower Control Chassis.

Figure 2: TE-3000 Front panel



The front panel contains:

1 DC power indicator lamp
2 two lighted power switches (bath & lighting)
3 liquid crystal display
4 15-keypad switch array
5 two LED indicators (heating and cooling)

B. Upper Bath Vessel Housing

The Bath Vessel Housing for the TE-3000 sits on top of the Lower Control Chassis. It contains a rectangular aluminum bath vessel with a four pane, specially designed glass window attached to the elongated front surface.

The Bath Vessel Housing also contains the thermoelectric modules, finned heat sinks, fans, and fluorescent lamps with ballasts. The rear panel has two power connectors from the Lower Control Chassis, two air pump connectors from the Control Chassis, and the bath fluid overflow jar along with integral pump and tubing connections.

C. Cables & hoses, etc.

The TE-3000 system includes several cables, hoses, and accessories which are necessary for operation of the system.

Power cables

1.) Two large diameter power cables (AC and DC) with circular connectors on their ends are provided to take power from the lower Control Chassis up to the upper Bath Vessel Housing. The sex and type of these connectors constrain their use in only one way - the proper configuration.

Air hoses

2.) Two small diameter silicon air hoses (tube assemblies) with twist and lock pneumatic connectors on their ends are provided to supply and return recirculated bath vapors from/to the upper Bath Vessel to/from the lower Control Chassis. The sex and type of these connectors constrain their use in only one way - the proper configuration.

Overflow jar

3.) One glass jar with lid is provided to catch the bath overflow liquid and is to be mounted on the rear overflow jar support along with three pieces of small diameter silicon tubing and an in-line pump with connector. For instructions on assembling the overflow jar support and connecting the Reciprocating Pump, see page 7. The plastic lid for the jar has a hole into which the 3" tubing is inserted. The other end of the 3" tubing is connected to the bath overflow outlet. The 6" tube connects the fitting at the bottom of the jar to the bottom of the air pump, and the top of the air pump is connected to the 11" tubing which then rises to the top of the Bath Vessel housing and mates to the bath fluid return pipe.

RTD sensor

4.) One Platinum RTD sensor assembly is provided, with the probe and part of the cable contained under the top plate of the upper Bath Vessel Housing. This cable has a metal, bayonet style, connector on one end to be plugged into the back of the lower Control Chassis.

Miscellaneous accessories

5.) Two hole covers, one 1/4-20 cap nut, and one mercury thermometer holder are provided.

CHAPTER 3

UNPACKING AND INSTALLATION

A. Unpacking

The TE-3000 should be inspected immediately upon arrival. If the shipping containers have been damaged externally, the shipping company should be advised of this condition *immediately*.

The contents should be carefully removed and placed on a stable bench or table for further inspection. Retain all original shipping materials and containers which will be needed if the return of the instrument is necessary for warranty repair/replacement.

B. Checking for damaged/missing items

After all items have been removed from the shipping container and placed on a bench or table, the items should be compared to the packing list.

Inspect each component for signs for damage. Report damages to the shipper and to the ***CANNON***® Instrument Company immediately.

Damaged items

Retain all packing materials until the instrument is connected and functioning properly. If any component(s) must be returned to ***CANNON***® Instrument Company, the damaged item(s) should be packaged in the original shipping container. Refer to the final chapter of this manual for instructions on returning defective equipment. Customers outside the United States should contact the local ***CANNON***® agent for procedures on returning products to ***CANNON***® .

If an item is missing, please notify ***CANNON***® Instrument Company immediately.

C. Physical arrangements

Sections A through C in the previous chapter dealing with item descriptions should be read prior to this section. The final placement for the TE-3000 should be a level, strong, and stable bench or table surface.

Occasional access to the rear of the unit should be conveniently permitted. The bath requires adequate ventilation for the integral cooling fans so a space of at least eight inches should be provided between the rear and both sides of the TE-3000 and any wall or other obstruction. A clearance

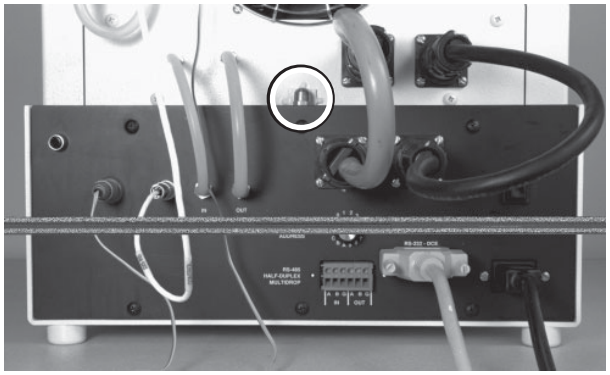


Figure 3:
TE-3000 rear view with alignment bolt highlighted

area on the right side of the unit is necessary to allow access to the rear pump switch. An electrical service MAINS power outlet must be located within nine feet of the TE-3000.

The lower Control Chassis should be placed on the table first followed by the upper Bath Vessel Housing which is placed on top of the Control Chassis. The rear mounted alignment bolt on the top rear of the lower Control Chassis must mate with the hole in the alignment bracket on the bottom rear of the upper Bath Vessel Housing (see Figure 3). A 1/4-20 hex nut is provided to secure this mating arrangement and should only be finger-tightened.

D. Liquid and pneumatic connections

The pneumatic connections on the TE-3000 provide the bath agitation and subsequent stirring by recirculating the bath vapors. Two silicon tube assemblies are provided which have plastic quick-connect bayonet style connectors on their ends. These tubes are connected from the air in/out connections on the bottom Control Chassis to the air out/in connections on the upper Bath Vessel Housing. There are female connectors on both ends of one hose and male (black o-ring visible) connectors on both ends of the other hose. The hose with the female connectors mates with a male connector on the lower chassis and a male connector on the upper housing. The hose with the male connectors mates with a female connector on the lower chassis and a female connector on the upper housing. They all secure with an insertion and a 1/8 turn lock.

E. Platform/pump assembly

The platform and pump assembly may be completed with the following items provided by ***CANNON***®:

Overflow Platform & assembly screws (2)
Reciprocating Pump
Pre-cut tubing (approx. 11", 6" & 3" lengths)

If the rear platform is not yet attached to the bath unit, you should attach it using the two 6-32 screws provided. The tabs which will hold the overflow jar in place should be facing upward.

Procedure

1. After the platform is securely in place, attach the 11" tubing to the bath intake at the top rear of the bath unit by pushing the tubing firmly over the intake nozzle. Then attach the other end of the tube to the top of the Reciprocating Pump (next to the electric connector cable) in the same way.
2. Remove the plastic nipple adaptor from the opposite end of the Reciprocating Pump and insert the pump end into the small hole on the Overflow Platform so the pump rests on the platform.
3. Reattach the nipple adaptor removed in Step 2 (this holds the unit in place).
4. Attach the electric connector cable from the Reciprocating Pump to the receptacle marked PUMP on the Control Unit. To connect the cable, make sure to align it correctly with the Bath Unit female connector (tab upwards), then push until the cable connection "clicks" into place.
5. Attach one end of the 6" tube to the bottom connection on the Reciprocating Pump.
6. Attach the 3" tube to the bath unit overflow outlet located above the Overflow Platform. Place the Overflow Jar on the platform, inserting the other end of the 3" tube through the lid of the jar.
7. Attach the other end of the 6" tube to the connector on the underside of the Overflow Jar. Make sure that all connections are secure.

Figure 4:
Positioning the overflow jar

F. Electrical connections

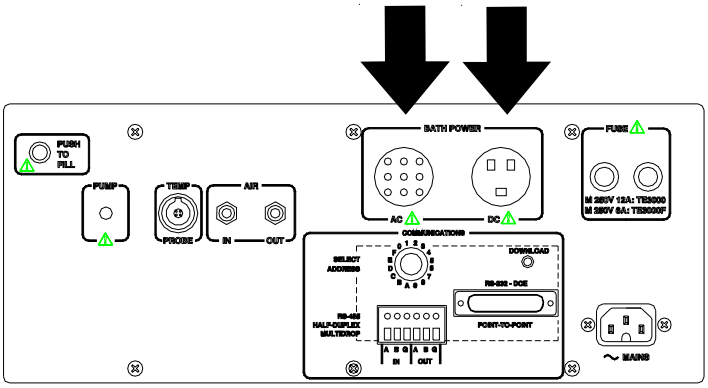


Figure 5: AC/DC cable connections

Two large diameter electrical cables deliver power from the lower Control Chassis up to the upper Bath Vessel Housing (see Figure 5). Both of these cables have circular plastic power connectors on their ends. The cable with three large rectangular pins carries DC power to the Bath Vessel Housing from the Control Chassis and the cable with nine smaller circular pins carries AC power to the Bath Vessel Housing. Both of these cables have a male connector on one end and its female counterpart on the other (see Figure 6). Determining which connector mates is fairly simple but ensure a good connection by turning the locking ring on every plug until a small "click" is felt.

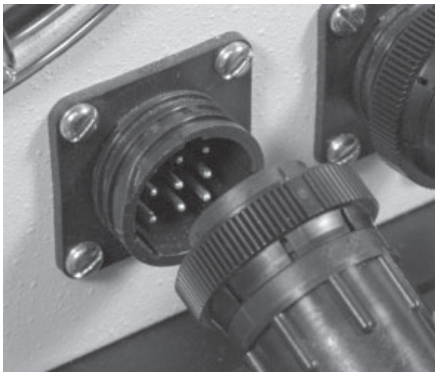


Figure 6: Cable locking mechanism

Sensor connections

The small black cable with a metal LEMO connector carries the temperature sensor signal from the upper Bath Vessel Housing down to the lower Control Chassis (labeled PROBE). This connection is keyed and it operates as a bayonet with a simple push in (*no twisting*). The red dot on the plug must be facing upward or insertion will not be permitted. When this connector is properly inserted, a small "click" can be felt. Removal is accomplished with a simple pull on the knurled section of the plug.

PUMP connections

The small wire cable from the liquid pump with a gray plastic REDEL connector mates with the connector on the lower Control Chassis labeled PUMP. This connection is keyed and it operates as a bayonet with a simple push in (*no twisting*). The keyway must be facing upward or insertion will not be permitted. When this connector is properly inserted, a small "click" can be felt. Removal is accomplished with a simple pull.

POWER connection

The MAINS power cord provided with the instrument will have an IEC connector on one end and the appropriate wall outlet connector on the other.

G. Selecting a bath liquid

The "Ideal" Bath Liquid

The "ideal" bath liquid would have a low viscosity, high heat capacity, and low vapor pressure over a wide range of temperatures. This liquid would also have a very high flash point and be relatively inexpensive. If the liquid were to be used in kinematic viscosity measurements where visual observation is important, it would be clear and colorless.

Unfortunately, there is no one "ideal" liquid to use when a wide temperature range is needed. No single liquid meets all of the above requirements.

Temperature Ranges

The kind of liquid used in the TE-3000 Temperature Bath depends upon the desired temperature range of the instrument. The table below lists several different operating ranges and the liquids suitable for use in those ranges:

TE-3000 BATH LIQUIDS	
TEMPERATURE RANGE	**SUITABLE BATH LIQUIDS**
-30°C to +10°C	Methyl Alcohol
-10°C to +20°C	Isopropyl Alcohol Ethyl Alcohol
+5°C to +30°C	Water, Low Viscosity Oils

CAUTION *Methyl alcohol (methanol) is very close to the "ideal" liquid; it can be used at all temperatures in the TE-3000 operating range. However, methanol may not be suitable for some laboratories because of its low flash point and degree of toxicity.*

Isopropyl alcohol is less toxic than methyl alcohol and somewhat less volatile. However, it becomes very viscous at low temperatures, making it difficult to maintain good temperature control.

CAUTION *Silicone fluids* CANNOT *be used in the TE-3000 Constant Temperature Bath.* NEVER *place a silicone liquid in the TE-3000.*

CAUTION *Do not attempt to use water as a bath fluid for operation at temperatures of 2°C or lower.*

Bath Liquid Guidelines

When selecting a liquid for use in the TE-3000, keep the following guidelines in mind:

VISCOSITY	Viscosity should be very low at bath operating temperature so that moderate stirring can effectively eliminate temperature gradients in the bath.
HEAT CAPACITY	Temperature changes in the bath are less rapid with a high heat capacity. Water has about twice the heat capacity of most organic fluids. Most other choices for bath fluids will have about half of the heat capacity of water. (Do NOT attempt to use water as a bath fluid for operation at temperatures of 2°C or lower.)
VOLATILITY	A liquid which is relatively volatile will require frequent replenishment. Furthermore, rapid evaporation at the bath surface produces a cooling effect, making temperature control more difficult.

CHAPTER 4

GENERAL OPERATIONS

A. Filling the bath with liquid

Prior to filling the TE-3000 with liquid, you should ensure that the bath overflow liquid reservoir, pump, and hoses are properly in place. For detailed installation procedure, please see the previous Chapter 3.D

The TE-3000 should be filled through one of the top instrument holes with a clear, alcohol type, liquid. This alcohol may be either wood or grain based.

⚠ ***CAUTION*** *Do **not** use silicone fluid!*

The dilution of this alcohol should be such to permit adequate stirring at the lowest operating temperature. Excessive water dilution will cause the liquid to appear cloudy at cold temperatures and thus impair the visibility in the bath.

Using room temperature alcohol, carefully pour the liquid into a funnel sitting in one of the instrument holes at the very top of the Bath Vessel Housing. As the bath liquid approaches the very top of the bath vessel, the overflow liquid will spill down the overflow tube into the jar.

Bath volume changes

The amount of "extra" liquid available in the overflow jar will depend upon what temperatures you will be operating the bath. Also, some bath liquid will be displaced by the addition of instruments and thermometers into the bath - and thus cause the level to rise.

The bath liquid will *expand* if *warmer* than room temperatures are desired. An empty jar at room temperature will fill up with the expanded liquid as the temperature rises. In this case, you would only install enough bath liquid to have the level just below the bath top edge and no liquid in the jar. *Do not overfill the bath.*

The bath liquid will *contract* if *colder* than room temperatures are desired. An almost full jar at room temperature will be depleted with the compressed liquid as the temperature falls. In this case, you would fill the bath and about half of the over flow jar with the room temperature liquid and after the insertion of the instruments, the jar would be almost full.

The purpose of the previous explanations is to illustrate that the steady state room temperature condition of the bath must be such that you should never spill any liquid and this level should be maintained with time after some of the alcohol evaporates.

Experience will further define the necessary levels to be maintained in the overflow jar. *But in all cases, for proper temperature control the level of the liquid inside the bath should be about 1/2" above the top edge of the white baffle.*

B. Application of power

Prior to the application of mains power to the TE-3000, ensure that all tubing and power connectors are properly installed between the upper Bath Vessel Housing and the lower Control Chassis. The bath liquid should be in place along with the overflow jar and tubing. Also be certain that the mains voltage and frequency specified on the rear identification label matches your mains voltage.

The power cord should have the appropriate power plug to permit plugging the cord into the mains power outlet on the wall. The other end contains an IEC connector which plugs into the power inlet receptacle on the rear of the lower Control Chassis. Be CERTAIN that you are plugging into the correct mains voltage as defined on the rear panel identification label. Both front panel power switches should be OFF while this power cord is being installed.

Turning on the TE-3000

Turn on the main BATH power switch. The LIGHTS switch is operable only if the BATH power is on. You should hear a long "beep" followed by a short "beep" and the bath electronics will enter one of two possible start-up procedures.

1. Cold start

This is the normal start-up mode for the bath and it occurs when the power was previously off for a period greater than about two seconds. The five LEDs in the lower row of keys will turn on and then off, a short "beep" tone will be heard, and the display on the front panel will initially and briefly show the following:

```
        TE-3000

Cannon Inst. Co., USA
Ver. X.XX   MM/DD/YY
```

Following this display, the bath will indicate that it is executing a cold start, thus:

```
       POWER UP
      Cold Start

  Initiating Self Test
```

After this display the bath will automatically enter the self-test sequence as specified in the following Section 4.C.

2. Warm start

This is the abnormal start-up mode for the bath and it occurs only if the power was previously off for a period less than about two seconds, or if a fault was detected in the microprocessor. The display will show the following and the lights on the bottom row of the keyboard should flash alternating.

```
POWER UP
Warm Start

Consult User's Guide
```

If this condition is ever discovered, the BATH power switch should be turned off. After waiting several seconds, turn the BATH power switch to the ON position and wait for the display to indicate either a warm or cold start again. If the bath comes up in a cold start condition and starts its normal self-test sequence, it is possible that a momentary power interruption caused the warm start condition and no further action is required. If the bath continues to enter the warm start condition, the user should consult ***CANNON***® Instrument Company for further assistance.

C. Self-test sequence

The self-test sequence is entered immediately after the TE-3000 powers up in a cold start condition. The tests performed in sequence and the accompanied displays are as follows:

```
Testing Display
■■■■■■■■■■■■■■■■■■■■
■■■■■■■■■■■■■■■■■■■■
■■■■■■■■■■■■■■■■■■■■
```

```
Testing 32k RAM ...

■■■■■■■■■■■■■■■■■■■■
■■■■ Test Passed ■■■■
```

```
Testing Pulse Width
Modulator.....
■■■■■■■■■■■■■■■■■■■■
■■■■ Test Passed ■■■■
```

```
Testing A/D .....
Calibrating ....OK
Consistency ....OK
```

```
Testing Voltage Levels......
    Positive Supply..OK
    Negative Supply..OK
```

```
     Diagnostic Report
     All tests PASSED
     Entering Normal
        Operation
```

Following this "all tests passed" report, the TE-3000 will enter into the normal display condition (see the following Section D) provided that the RTD temperature sensor is in place. If the RTD sensor is unplugged at any time after the completion of the self-test routine, the following display will be shown.

```
  The RTD sensor has
  been disconnected.
  Please reconnect it
  to reset the Bath.
```

If any test fails during this power-up self-test sequence, it will be noted on the display for that particular test. The displays will resemble the previous sequence shown above but if any failure is encountered, the OK will be replaced by BAD and PASSED will be replaced by FAILED!. All test sequences will be activated, however at the conclusion of the test sequence, the ENTER key will flash and the final screen will show:

```
     Diagnostic Report
     Some tests failed!
     SEE OWNER'S MANUAL
   Press ENTER to go on
```

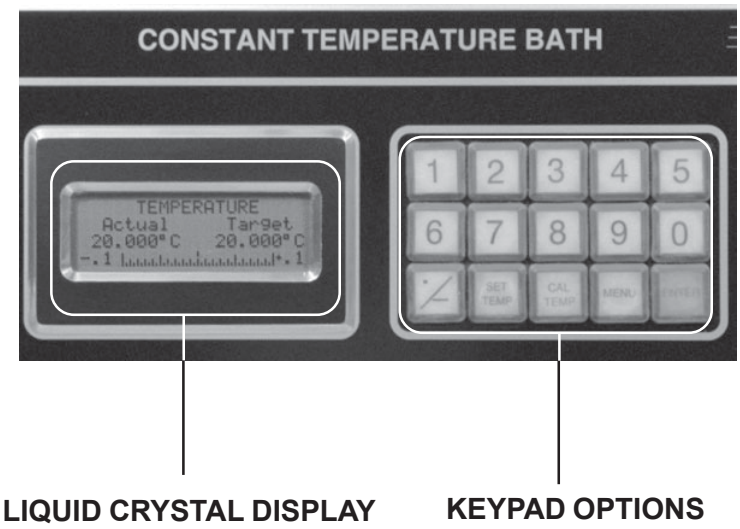
If you wish to continue with the operation of the bath even though the report issued states that a failure was encountered, you may press the ENTER switch. The following display will be briefly shown and the bath will enter the normal display condition (see the following Section D).

```
     Attempting Normal
        Operation.

   PROCEED WITH CAUTION
```

D. Normal display and keypad indications

Figure 7: TE-3000 Control Chassis front panel



The normal or "quiescent" LCD (liquid crystal display) for the TE-3000 bath is shown in the following example:

```
      TEMPERATURE
   Actual    Target
12.340°C  -20.000°C
      Cooling
```

Cooling indication

In the above example, the target temperature is much colder than the actual temperature of the bath so the display indicates that it is cooling. The COOLING indicator (green LED) on the right side of the front panel should be fully illuminated.

Heating indication

In the following example, the target temperature is much warmer than the actual temperature of the bath so the display indicates that it heating. The HEATING indicator (red LED) on the right side of the front panel should be illuminated.

```
      TEMPERATURE
   Actual    Target
-23.450°C   -20.000°C
      Heating
```

Temperature scale

In the following example, the target temperature is within .1 degrees of the actual temperature of the bath so the display indicates a scale on the bottom line and the actual temperature is shown on this scale with a dark marker. For target temperatures colder than +10 degrees Celsius, the COOLING indicator (green LED) on the right side of the front panel will indicate various intensities and the HEATING indicator (red LED) will be extinguished. For target temperatures warmer than +10 degrees Celsius, the COOLING indicator (green LED) on the right side of the front panel will indicate various intensities and the HEATING indicator (red LED) will flash on and off with a one second interval.

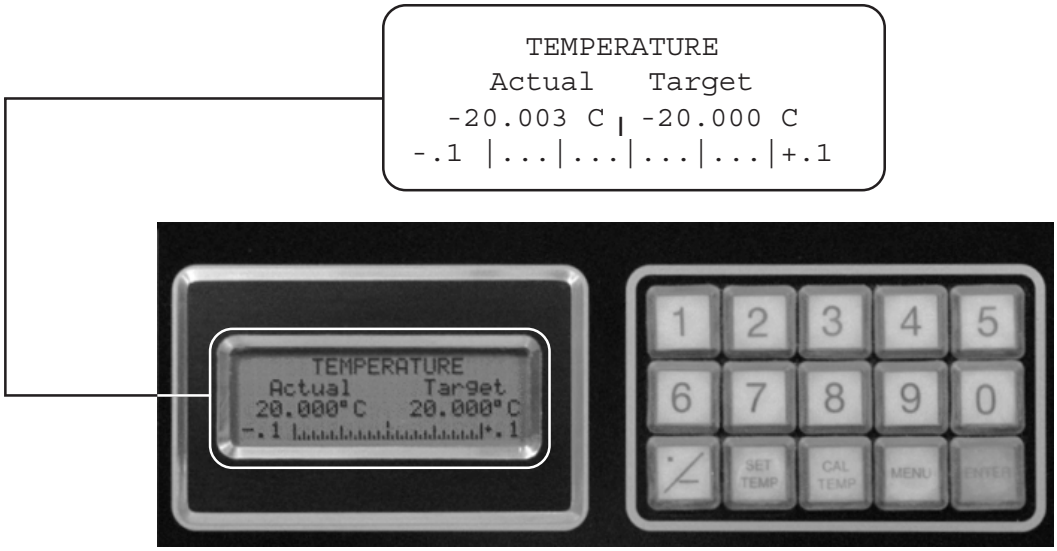


Figure 8: TE-3000 LCD display when controlling at target temperature (dark marker at midpoint of scale)

Keypad

The keypad on the front panel of the TE-3000 (see Figure 8) consists of fifteen keys - white numbers 0 through 9, a white combination "minus sign" and "decimal point" key (**-/.**), a yellow SET TEMP[erature] key, a yellow CAL[ibrate] TEMP[erature] key, a yellow MENU key, and an orange ENTER key. The bottom row of five keys (non-numerical keys) have the capability of being illuminated to assist the operator by indicating possible key entry choices.

All keypad lights are off during normal operation of the bath. The only key entry possibilities at this time are the yellow keys. Depression of any key other than a yellow key will result in a long "beep" to indicate an improper entry. If any yellow key is depressed, the appropriate instructions are provided on the LCD and are discussed in later sections of this manual. If no further action is taken by the operator in any menu or other screen mode within five minutes, the display will automatically revert back to the normal (quiescent) display as shown above.

Selecting/canceling options

To access any of the primary keypad options, press the appropriate keypad button once. If you make a data entry error and wish to cancel your input sequence, press the same keypad option button again.

The ENTER *key*

The ENTER key is the most-used feature on the TE-3000 keypad. You must confirm each submenu choice and numeric input by pressing this key.

E. LED indicators

The two LED indicators on the right side of the front panel signify the actual control signals commanding the temperature control of the bath. The COOLING indicator (green LED) may be viewed as a multiple intensity light with brightness directly proportional to the degree of cooling power applied to the solid state coolers (thermoelectric modules). The HEATING indicator (red LED) is more simply on or off and at warmer temperatures it will blink at one second intervals to signify that power is applied to the internal heating element in the bath. The HEATING indicator will be fully illuminated if the bath is commanded to go to a temperature much warmer than the current temperature.

F. Adjusting the liquid level in the bath

Assuming that the bath has already been filled according to the instructions as provided in Chapter 4-A, the user must adjust the level of the bath liquid as the bath temperature is decreased. Since the bath liquid decreases in volume as the temperature decreases, the operator must add liquid to the bath vessel to maintain proper circulation.

Maintaining bath liquid level

The level of the liquid inside the bath vessel must be maintained at a level approximately 1/2 inch above the top edge of the rear (white) baffle. When the liquid is adjusted to the proper level, a large number of bubbles will be visible rising behind the baffle and causing some turbulence at the surface of the liquid. A push-button switch is provided on the upper rear right hand side of the lower Control Chassis which when depressed, activates the small pump next to the overflow jar which returns the liquid from this jar back into the bath vessel.

Adequate expansion volume is provided in the expansion jar so that you may operate at -35° Celsius with the bath liquid maintained at approximately 1/2 inch above the top edge of the baffle with the expansion jar empty. When the bath is powered-off from this condition, the liquid will expand in the bath vessel and overflow into the jar. The jar is of sufficient size to accommodate all of this expansion liquid without overflowing as the temperature slowly rises up toward room temperature.

G. Setting the target (desired) bath temperature

The setting of a new desired temperature for the bath is accomplished by depressing the yellow SET TEMP key. The display will be changed to the following:

```
Enter Target Bath
   Temperature:
        +_____ °C
SET TEMP to Cancel
```

With the cursor (dark underline character) in the first position, the user has the option of setting a negative temperature by depressing the combination **-/.** key. If any numerical key is depressed in this first position, the temperature is assumed to be positive. After this first character entry, there are only two restrictions which apply prior to depression of the ENTER key and they are:

1. A decimal point MAY be included as an entry. It should be preceded by at least one number or a "0".
2. The entered temperature must be within the operational temperature range of the bath.

Incorrect settings

If a temperature is entered which is outside of the operational temperature range of the TE-3000, the following display will be shown on the LCD and the ENTER key will flash.

```
*** RANGE ERROR! ***
Range is -43 to 33° C
   or -45 to 91° F
ENTER to continue...
```

High-temp adjustments

If the bath was previously operating at a temperature below +20° Celsius and a new temperature is entered which is above +20° Celsius, the operator will be instructed to remove one of the air circulation tubes on the rear of the instrument. By disconnecting the air input hose on the rear of the Control Chassis, the alcohol vapors cannot condense inside the air return hose and subsequently impede the air circulation/stirring of the bath. For this condition, the display issued to the LCD will be:

```
DISCONNECT AIR INPUT
  HOSE ON BOTTOM OF
   CONTROL CHASSIS.
ENTER to continue...
```

Low-temp adjustments

If the bath was previously operating at a temperature above +20° Celsius and a new temperature is entered which is below +20° Celsius, the operator will be instructed to replace one of the air circulation tubes on the rear of the instrument. By reconnecting the air input hose on the rear

of the Control Chassis, the alcohol vapors will be contained within the air return hose and permit the operation at low temperatures. For this condition, the display issued to the LCD will be:

```
RECONNECT AIR INPUT
HOSE ON BOTTOM OF
CONTROL CHASSIS.
ENTER to continue...
```

H. Calibration at a given target temperature

The TE-3000 temperature control system permits the calibration of the bath temperature to agree with any user supplied temperature reference standard. The bath can be calibrated by the user whenever the bath temperature is stable for any given TARGET temperature in degrees Celsius or Fahrenheit.

BIN settings

For every whole degree Celsius and Fahrenheit, a calibration "BIN" exists in nonvolatile memory within the temperature control system. The "reference actual temperature" is entered by the user as the actual temperature of the bath according to the user's temperature reference standard and is stored by the bath in this memory and will be used whenever that particular target temperature is entered. Fractional degrees will use the closest whole number bin. In the following example, the target temperature is -20 degrees Celsius and the bath temperature is stable and controlling well within +/- .01 degrees. When the CAL TEMP key is depressed, the display will show:

```
Enter Actual Bath
Temp. for Bin Offset
at -20 C: +_____ °C
CAL TEMP to Cancel
```

With the cursor (dark underline character) in the first position, the user has the option of entering a negative temperature by depressing the combination **-/.** key. If any numerical key is depressed in this first position, the temperature entered is assumed to be positive. After this first character entry, there are three restrictions which apply prior to depression of the ENTER key and they are:

1. A decimal point MAY be included as an entry. It should be preceded by at least one number or a "0".
2. The entered temperature must be within the operational temperature range of the bath.
3. The entered actual temperature must not cause a correction in temperature greater than +/- 2.5 degrees.

Multiple corrections

Multiple or successive entries of correction for any temperature are permissible. A newly entered corrected temperature is mathematically

compensated with the previously entered correction and is stored as the latest correction.

Data entry errors

If a temperature is entered which is outside of the operational temperature range of the TE-3000 plus or minus the allowable correction factor, the following display will be shown on the LCD:

```
*CALIBRATION ERROR!*
Range is -45 to 35°C
   or -49 to 95°F.
ENTER to continue...
```

If an actual reference temperature is entered which is within the operational temperature range of the TE-3000 BUT the amount of the correction (delta to displayed temperature) is too large, the following display will be shown. The user should check his reference thermometer to verify the actual temperature. If the user cannot correct the error, contact ***CANNON***® Instrument Company for further assistance.

```
*CALIBRATION ERROR!*
 Calib amount is too
 large. Can't store.
ENTER to continue...
```

I. Menu selections

Whenever the bath is in the normal or quiescent mode, the MENU key may be depressed. The MAIN MENU will be entered and the following display will be shown:

```
      MAIN MENU
  1. Change to °F
  2. Bath Temp Offsets
  3. Comm Setup   :_
```

From this MAIN MENU, the user may enter any number from 1 to 3 followed by the ENTER key or the MENU key will return back to the normal display. The following sections describe any subsequent menus or action taken by the TE-3000 control system.

1. Celsius or Fahrenheit operation

The TE-3000 is capable of being operated in either degrees Celsius or Fahrenheit. If the user is presently operating in Celsius degrees, depressing a **1** in the MAIN MENU followed by the ENTER key will cause the bath to operate in degrees Fahrenheit. If the user is presently operating in Fahrenheit degrees, depressing a **1** in the MAIN MENU followed by the ENTER key will cause the bath to operate in degrees Celsius. The normal display will then return after this entry.

2. Bath temperature calibrations and offsets

The previous Section H dealt with the setting of individual temperature correction bins for temperature calibrations at any given set temperature. When the user enters a **2** in the MAIN MENU, the following display is shown. It is possible to clear (or zero) ALL bin calibration data or enter the GENERAL BATH OFFSET menu.

```
BATH TEMP OFFSETS
1. Clear Bin Offsets
2. Set Gen Bath Ofs.
 (Protected)  :_
```

a. Clearing all temperature calibrations/offsets

Whenever a **1** is entered in the BATH TEMP OFFSET menu, the following screen is shown. This command will clear ALL of the temperature correction "bins" for degrees Celsius AND Fahrenheit which may have previously been set. This command is usually used prior to adjustment of the "general bath offset". This command may also be used if significant differences become apparent between the user supplied reference temperature and the displayed temperature of the bath or if CAL TEMP entries were made when the bath was not stable. Once this "clear" command is issued, new calibration entries may be made in the CAL TEMP menu.

```
ABOUT TO CLEAR ALL
CALIB. CONSTANTS!
  ARE YOU SURE?
ENTER-Yes  MENU-No
```

b. Setting the bath general offset

Whenever a **2** is entered in the BATH TEMP OFFSET menu, the following screen is shown. The setting of the BATH GENERAL OFFSET mathematically compensates all temperature readings displayed as "Actual Temperature". This function is normally performed at the factory prior to shipment of the instrument and is accomplished at a temperature near the midpoint of operation of the TE-3000. This function is password-protected so the user must contact ***CANNON***® Instrument Company if access to this capability is required.

```
This is a protected
function. Enter the
passkey to continue.
Press MENU to Cancel
```

Once the correct password is entered, the user will be presented with the following display. The current "general bath offset" is displayed as a delta in degrees and two choices are permissible.

```
GEN. OFFSET CORRECT
 Offset: 0.000 °C
 1. Set Gen. Offset
 2. Clear Offset  :_
```

If a **1** is entered in the GEN. OFFSET CORRECT menu, the following display is shown. The user is prompted to enter the correct "reference" actual temperature of the bath. At this point the temperature of the bath should be stable or no entry should be made.

```
  Enter Actual Bath
Temperature for Gen.
 Offset:  +_____ °C
   MENU to Cancel
```

With the cursor (dark underline character) in the first position, the user has the option of entering a negative temperature by depressing the combination **-/.** key. If any numerical key is depressed in this first position, the temperature entered is assumed to be positive. After this first character entry, there are three restrictions which apply prior to depression of the ENTER key and they are:

1. A decimal point MAY be included as an entry. It should be preceded by at least one number or a "0".
2. The entered temperature must be within the operational temperature range of the bath.
3. The entered actual temperature must not cause a correction in temperature greater than +/- 2.5 degrees.

If a **1** is entered in the GEN. OFFSET CORRECT menu, the general offset will be zeroed in value and the normal display will then be shown.

3. Communication options

The "Communication Setup" menu is entered from the Main Menu by selecting item **3** and the following is presented on the display. The user may enter a **1** or a **2** followed by enter or else the MENU key may be depressed to return to the normal display.

```
  COMMUNICATION SETUP
  1. Change Port Speed
  2. Change Mode
                    :_
```

a. Changing the port speed

If the user selects to enter a **1** from the COMMUNICATION SETUP menu, the COMM PORT SPEED menu will display five baud rate options: 1200, 2400, 9600, 19.2K, and 38.4K BAUD. The baud rate selected will be effective on *both* the RS-485 interface (polled) and the RS-232 interface (point-to-point). The user may enter a number from **1** through **5** followed by ENTER or else the MENU key may be depressed to return to the normal display.

```
    COMM PORT SPEED
1. 1200  4. 19.2K
2. 2400  5. 38.4K
3. 9600           :3
```

NOTE *The number shown after the colon denotes the present baud rate.*

b. Configuring the mode of operation

If the user selects to enter a **2** from the COMMUNICATION SETUP menu, one of the two following submenu screens will be shown. If the TE-3000 was previously configured to operate in a polled (RS-485) environment, the first display will be provided - showing that timed reports are disabled and the present mode is polled (:1). If the user wishes to operate in a point-to-point environment with or without timed interval reports, a **2** should be entered now.

```
COMMUNICATION MODE
1. Polled
2. Point to Point
(Reports Disabled):1
```

If the TE-3000 was previously configured to operate in a point-to-point (RS-232) environment, the following display will be provided - showing that timed reports may be utilized and the present mode is point-to-point (:2). An entry of **1** at this time will place the bath in a polled environment. For an entry of **3**, please see the next section (5.D.) for the response to a TR command.

```
COMMUNICATION MODE
1. Polled
2. Point to Point
3. Config Reports :2
```

c. Configuring reporting periods

Selecting a report interval

If a **3** is entered in the COMMUNICATION MODE menu, the system was previously configured for point-to-point operation and therefore the following display is shown. The user may select any reporting interval in "seconds" or NO reporting interval which is OFF. The **:1** in the bottom right hand corner indicates the presently selected period. A number entry from 1 to 8 is acceptable.

```
SELECT REPORT PERIOD
1. OFF   4. 5     7. 60
2. 1     5. 10    8.120
3. 2     6. 30       :1
```

NOTE *These reports are only issued if the mode of communications is configured as* POINT-TO-POINT*.*

If the bath is configured in the point-to-point mode of communication operations, then the controller has a full-duplex communication link (RS-232) and can therefore issue these unrestricted timed reports. If the bath is re-configured in the polled mode of communication operations, the controller has a half-duplex communication link (RS-485) and cannot issue timed reports. The report option will be automatically disabled and a message indicating the report status will be displayed on the LCD screen. Press the blinking ENTER key to return to the normal screen display.

See Section D of Chapter 5 for more information on the structure of these reports, which are identical to the response to a TR query.

CHAPTER 5

COMMUNICATIONS

The TE-3000 is equipped with a full-duplex RS-232C point-to-point interface as well as a half-duplex RS-485 network interface. Commands and Queries may be sent to the TE-3000 via either interface and Responses and Reports received by a master controlling computer. This interface is configured as 8 data bits with no parity and one stop bit. The Baud rate of the interface is configured only via the front panel menu system and can be set at 1200, 2400, 9600, 19.2k, or 38.4k Baud. The mode of operation, point-to-point or polled (multi-drop), can only be configured via the front panel menu system. Time interval reports of the actual and desired bath temperature can only be enabled if the TE-3000 is configured in the point-to-point mode of operation.

A. Downloading firmware updates

The TE-3000 is capable of receiving new operational software via either the RS-232 or RS-485 interface. If this software is updated and a new release is issued by ***CANNON***® Instrument Company, a diskette will be sent to the users along with instructions on how to perform this upgrade.

Download button

A "download" push-button is provided on the rear panel of the TE-3000 which places the instrument into the download mode. When this mode is entered, the front panel display will show the version number of both the resident download hardware code and the version of the present operational firmware. A computer will then be required to send the new firmware to the TE-3000.

B. Full duplex (POINT-TO-POINT) operations

The RS-232 interface is furnished for a direct connection from one TE-3000 to one computer. A DB-25 connector, configured as Data Communication Equipment (DCE), is provided on the rear panel of the TE-3000. This configuration permits a direct connection (straight through cable - pins 1 through 8, & 20) from the TE-3000 to virtually any computer. Most present day computers have a DB-9 connector which requires the use of an adaptor or a cable with a DB-25 male connector on one end and a DB-9 female connector on the other end. For a complete description of the Commands, Queries, Responses and Reports on this interface, please refer to the section D which follows.

C. Half duplex and polled (multi-drop) operations

The RS-485 interface is provided to permit a network connection from one computer to multiple instruments. A three-wire (with feed-through) screw terminal connector is furnished on the rear panel of the TE-3000 which allows the use of any three conductor cable (two wire shielded, preferred) to be connected into and out of the instrument. The computer must have an RS-232 to RS-485 adaptor plugged into the computer serial port.

Network capability

The network is capable of supporting up to 16 instruments at distances of up to 4000 feet. If the network is configured for more than three occupants and/or if the network spans a long distance (>100 feet) then it may be required that termination resistors be added to the first and last occupant on the network. Contact ***CANNON***® Instrument Company for further assistance about the configuration of your particular network needs.

For a complete description of the Commands, Queries, Responses, and Reports on this interface, please refer to section D which follows.

D. Commands, queries, responses and reports

The protocol on the serial interfaces includes commands and queries which are sent by a master controlling computer, and responses which are sent by the TE-3000 in reply to every command or query it receives. The TE-3000 may also issue timed interval reports automatically if it is configured to operate in the point-to-point mode. If the TE-3000 is configured to operate in the multi-drop mode, reports will only be issued in response to a specific query.

Protocol

All Commands and Queries sent to the TE-3000, *regardless of which interface*, must be preceded by a **/** and a **#**. The **#** is the selected address (rear address switch) of the TE-3000 and must be 0-9 or A-F while the **/** is a simple slash character denoting the beginning of an addressed command or query.

All Commands must then be identified with the letter **C** and all Queries must be identified with the letter **Q**. Commands and Queries have various types which are always defined with two letters - $$. Some command and query types have arguments which may be associated with it to further define the action which must be taken - &..&.

And finally, all Commands and Queries must end with a carriage return (Enter ↵).

Format examples

Therefore, the format for a typical COMMAND line is:

```
/#C$$&..&
```

And the format for a typical QUERY line is:

```
/#Q$$&
```

On the following pages is a table of *Command* types with possible arguments along with a description of the action taken by the TE-3000 and its subsequent response.

Command Type "$$"	Possible Argument "&..&"	Description of Action Taken by TE-3000
AD	none	Calibrates the 16 bit A to D converter. When done the response is **AD_NO** if the calibration failed, or "ADYES" if the calibration was successful. If the command is not recognizable, an **ERR** is returned. As an example, if this command was sent to a TE-3000 with an address of 5: **/5CAD** The response might look like this **-5CADYES**
RT	none	Runs a complete self-Test like the one that is run on power up. A response is returned immediately indicating receipt of command **RTYES** or else the command is not recognizable and a **ERR** is the response. As an example, if this command was sent to a TE-3000 with an address of 6: **/6CRT** The response might look like this: **-6CRTYES**
DC	none	Display all temperature in degrees Celsius on the LCD and in all reports. This command places the bath in the Celsius mode for all temperature references. A response is returned immediately indicating receipt of command **DCYES** or else the command is not recognizable and a **ERR** is the response. As an example, if this command was sent to a TE-3000 with an address of 1: **/1CDC** The response might look like this: **-1CDCYES**
DF	none	Display all temperature in degrees Fahrenheit on the LCD and in all reports. This command places the bath in the Fahrenheit mode for all temperature references. A response is returned immediately indicating receipt of command **DFYES** or else the command is not recognizable and a **ERR** is the response. As an example, if this command was sent to a TE-3000 with an address of 2: **/2CDF** The response might look like this: **-2CDFYES**
SR	&&&	Sets the Reporting interval to the value of half-seconds as defined by the three character argument &&& which is in HEXADECIMAL. Only arguments from 000 to FFF will be accepted where 000 turns all reports off and any other numbers permit reports to be issued on any half-second interval from .5 seconds up to 2,047.5 seconds (ONLY IF THE TE-3000 IS IN THE POINT-TO-POINT MODE OF OPERATION). If the command is accepted, the instrument will return with a **SRYES** response and the new report interval will take effect. If an invalid hex field is seen, the response will be **SR_NO**, and anything else will result in a **ERR** as the response. As an example, if this command, requesting reports at five-second intervals, was sent to a TE-3000 with an address of 3: **/3CSR00A** The response might look like this: **-3CSRYES**

Command Type "$$"	Possible Argument "&..&"	Description of Action Taken by TE-3000
ST	+&&&.&&& or -&&&.&&&	Sets the target (desired) Temperature of the bath as defined by the argument ± &&&.&&& which is in degrees Celsius or Fahrenheit as previously set. Only fixed point numbers will be accepted and they must be within the operating range of the bath. If the command is accepted, a**STYES** will be the response, otherwise a **ERR** will be returned. As an example, if this command was sent to a TE-3000 with an address of 4: **/4CST-020.000** The response might look like this: **-4CSTYES**
CB	C|F	Clears all of the calibration offset Bins as defined by the argument in Celsius or Fahrenheit. This command is performed immediately and there is no response. This command is usually used prior to sending the SB type commands. But in all cases, it should eventually be ended with an EE type command. As an example, if this command was sent to a TE-3000 with an address of 9: **/9CCBC** (There is no response)
SB	C±@@±&.&&& or F±@@±&.&&&	Sets the calibration offset Bin for the specified whole degree temperature @@ as defined for C or F with the offset as defined in degrees &.&&&. The Celsius or Fahrenheit bin must be defined along with a plus or minus for this whole degree. The value of the offset must be defined as plus or minus and can be defined to the thousandths of degrees with &.&&&. If the command is accepted, a **SBYES** will be the response, otherwise a ERR will be returned. After a series of these command types are issued, the EE type command should follow. As an example, if this command was sent to a TE-3000 with an address of 3: **/3CSBC-20-0.123** The response might look like this: **-3CSBYES**
EE	none	Copies the contents of volatile RAM to non-volatile EEprom memory. This command should be used to end any sequence of CB and SB type commands which update the contents of the bins. After the memory transfer has completed successfully, a **EEYES** will be sent. If the transfer fails, a **EE_NO** will be the response; otherwise a **ERR** will be issued. As an example, if this command was sent to a TE-3000 with an address of 8: **/8CEE** The response might look like this: **-8CEEYES**

The following is a table of *Query* types with possible arguments along with a description of the response given by the TE-3000.

Query Type "$$"	Possible Argument "&..&"	Description of Response given by TE-3000
TB	C|F	Transmits all of the whole degree temperature Bins for either Celsius or Fahrenheit or else **ERR** is transmitted. This response has the bin number in the first five columns followed by two spaces, and then the sign (if any or space if none) and the offset. As an example, if the following query is sent to a TE3000 at address 9: **/9QTBC** This queries the Celsius bins. The following report will be received: **-043C 0.000** **-042C +0.123** **- - - - - -** (continues in order **with ...)** **+032C -0.456** **+033C -0.789** **-9QTBYES** (end of report identifier) As another example, if the following query is sent to a TE3000 at address 9: **/9QTBF** This queries the Fahrenheit bins. The following report will be received: **-045F 0.000** **-044F +0.123** **- - - - - -** (continues in order with ...) **+090F -0.456** **+091F -0.789** **-9QTBYES** (end of report identifier)
TR	none	Transmits a Report of key bath parameters. This is a single line report with the network address being in the first column followed by one space and then a C or F to indicate what the temperature scale is followed by at least one space and then one or two digits to indicate hours, followed by a colon, two digits for minutes, a decimal, and two digits for seconds which is the time elapsed since the last affected temperature entry. This is followed by at least one space, a possible minus sign, and then the desired temperature to the thousandth of a degree. This is followed by at least one space, a possible minus sign, and then the actual temperature of the bath to the thousandth of a degree. As an example, if the following query is sent to a TE3000 operating in Celsius with a target temperature of -20 degrees and residing on the network at address 3: **/3QTR** This queries the temperature report. The following report will be received: **3 C 12:34.56 -20.000 -20.002** **-3QTRYES** (end of report identifier)
MT	none	This queries the Machine Type and firmware version. A single line report is issued indicating the model and number designation of the instrument at this address along with the firmware revision level. As an example, if the following query is sent to a TE3000 at network address 7: **/7QMT** This queries the machine type. The following report will be received: **-7QMTMTTE3000 FV01.01** (firmware release # may vary)

CHAPTER 6

MAINTENANCE

The TE-3000 was designed for minimal care and maximum reliability. By following a few basic rules of preventative maintenance, the TE-3000 should provide years of trouble free operation.

Additionally, the TE-3000 provides an automatic built-in self test which examines the operation and performance of the instrument. These diagnostic routines assist the user by presenting the results of all tests and a determination of what is wrong if any test fails. This gives the user a high level of confidence that the instrument is functioning properly or if not, exactly where the problem is located.

A. Preventative (scheduled) maintenance

The TE-3000 requires a minimum amount of maintenance at intervals that are entirely dependent upon the environment and the degree of usage. In the typical situation of an average modern laboratory performing a dozen tests daily, the following items should be performed every six months. If the bath is located in a dirty environment and/or is heavily used, the preventative maintenance listed below should be scheduled on a monthly basis.

Cleaning of painted surfaces and front panel

The finish of the TE-3000 is a baked-on epoxy enamel in colors of almond and black. This paint is virtually immune to most solvents, however, if acetone is rubbed on the painted surfaces, the paint will be removed. A good quality household cleaner may be used on all painted surfaces and the front panel. Do *not* spray the cleaning fluid directly on any surface, especially the area where the fans and heat sinks are located. The liquid will harden dust particles and cause an accumulation of dust to be imbedded into the heat sinks and make removal very difficult. Instead, a soft cloth should be sprayed with the cleaning solution and the cloth should be used to transfer the solution to the surface of the instrument.

Cleaning the fans and heat sinks

Cleaning fans

Dust and dirt will accumulate with time in the small gaps of the air heat sinks and around the blades of the fans. These deposits will affect the cooling effectiveness of the thermoelectric cells and will ultimately affect the ability of the bath to go to cold temperatures. The easiest and most effective way to clean these heat sinks and fans is by using a compressed air source and blowing the dust away. This should be accomplished by moving the upper Bath Vessel Assembly outside or away from any clean environment, apply the blasts of clean air through the fans on the sides

and the rear, and alternately apply blasts of air directly into the heat sinks. This can be accomplished without removal of any panels surrounding this upper Bath Vessel Housing.

Cleaning heat sinks

If the bath is operating in a high humidity environment, the dirt may become very hard and encrusted on the fins of the heat sinks. When this condition is noticed while attempting to blow out the dust, remove the left and right side panels to gain access to the heat sinks.

Removing side panels

Each side panel is attached with four screws and should be removed by moving the detached side panel outward for a small distance and then upward to avoid striking the fluorescent lamp.

Using a soft, long bristled brush (available in automotive departments for cleaning wire wheels) loosen the encrusted dust and then blow it away with the compressed air source. Care should be taken to not bend or crush the fins of the heat sinks.

Assemble the side panels back onto the Bath Vessel Housing by reversing the removal procedure.

Compressed air cleaning

If a central or self-contained air compressor line with a blow gun is not available, compressed air (aerosol) cans may be obtained from most computer supply dealers. These cans may be used in conjunction with a long nozzle to facilitate directing most of the air into a confined area.

Cleaning the bath window

The viewing window on the TE-3000 is constructed with four panes of low emissivity glass with all panes tempered for safety. The space between these panes are filled with a gas and sealed to provide a frost-free viewing window. The outside (front) surface of this window may become smudged and dirty and should be cleaned with common household window cleaner. Apply window cleaner to a soft cloth and wipe on the front window of bath.

NOTE *Do not spray cleaner directly on front face of glass.*

Draining the bath liquid

Remove all power from the TE-3000 and remove all instruments from the bath prior to the draining operation.

The bath liquid in the TE-3000 must be removed by siphoning action (see Figure 9). A general purpose siphon is available wherever kerosene heaters are

Figure 9: Siphoning bath liquid

sold. This simple plastic device has an integral squeeze pump to start the siphoning with a long, straight input hose and a flexible output hose.

A more effective method is a vacuum system with a container trap for containment of the bath fluid. The continuous vacuum in such a system provides an easy means to remove any solid dirt particles and completely empty the bath.

Using a siphon or vacuum hose placed into one of the two instrument holes at the top, transfer all of the bath liquid into another container. Briefly turn on bath power and energize the fluid return pump by depressing the push button on the rear of the Control Housing.

⚠ ***CAUTION*** *Do **NOT** leave TE-3000 power on without liquid in the bath!*

Once it is apparent that most of the liquid has been removed from the overflow jar and hoses and transferred back into the bath, remove the power from the TE-3000 again and continue to siphon or vacuum the bath liquid.

After the bath has been drained as much as possible, remove the overflow jar and associated hoses from the rear of the Bath Vessel Housing and empty their contents into this container.

Cleaning the inside of the bath vessel

Depending on the grade of alcohol being used as a bath liquid, the frequency of replacing the bath liquid may vary greatly. The contaminants contained in solution with the alcohol will remain as sediment in the bath after the alcohol evaporates. If the bath temperature is always maintained at a cold temperature and the holes at the top are always covered, the rate of evaporation of the alcohol will be at a minimum. Conversely, if the bath is maintained in the power off condition and the top holes are uncovered, the room temperature alcohol will evaporate quickly.

After all of the bath liquid has been removed and the bath vessel is at room temperature, the cleaning procedure can begin. The actual process of cleaning is difficult at best without the proper cleaning implements. A long handled brush, such as one available from Thomas Scientific (cat. No. 1929-M80), permits scrubbing the baffle, side walls, and the inside of the bath window. Again, a good quality household cleaning agent may be used. Spray the liquid cleaning agent through one of the top holes in the bath vessel and use the brush to scrub off the residue on the baffle, side walls, and bath window. Water should be used to rinse the vessel and a siphon or vacuum system for removing the remaining mixture from the vessel. Ensure that the vessel is clean and dry before refilling with clean alcohol. Use lint-free towels to wipe the vessel dry if a vacuum system is not available.

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CHAPTER 7

WARRANTY/RETURN INFORMATION

Products limited warranty

In addition to other manufacturers' warranties, ***CANNON***® Instrument Company ("the Company") warrants all products (other than reagents and chemicals) delivered to and retained by their original purchasers to be free from defect in material and workmanship for one year from the date of the Company's invoice to the purchaser. For a period of one year from the date of such invoice, the Company will correct, either by repair or replacement at the Company's sole election, any defect in material or workmanship (not including defects due to misuse, abuse, abnormal conditions or operation, accident or acts of God, or to service or modification of the product without prior authorization of the Company) without charge for parts and labor. The determination of whether any product has been subject to misuse or abuse will be made solely by the Company.

The Company shall not be liable for any special, incidental, or consequential damages, or any damage to plant, personnel, equipment or products, directly or indirectly resulting from the use or misuse of any product. Representations and warranties made by any person, including dealers and representatives of the Company, which are inconsistent, in conflict with, or in excess of the terms of this warranty shall not be binding upon the Company unless placed in writing and approved by an officer of the Company.

Reagent and chemical warranty

CANNON® Instrument Company ("the Company") warrants all reagents and chemicals sold by the Company and delivered to and retained by their original purchasers to conform to the weight, specifications and standards stated on the package. The Company will, at its sole option, either replace or refund the price (net of freight, handling charges and taxes), of any reagent or chemical sold by the Company which does not conform to such weight, specifications and standards upon the prompt return of the unused portion. Except for replacement or refund of the net price, the Company shall not be liable for any damages occurring as a consequence of the failure of any reagent or chemical sold by the Company to conform to the weight, specifications and standards stated on the package.

Returning a product to CANNON®

Procedure

Before returning a **CANNON®** product for repair or service, make every attempt to identify the problem. If, after careful checking, the problem remains unidentified or unsolved, telephone **CANNON®** Instrument Company (or the local service agent) to consult with a product specialist. If the specialist cannot recommend a simple solution or repair, **CANNON®** will authorize the return of the product through the issuance of a Return Authorization number (RA).

CANNON® Telephone Number	814-353-8000
CANNON® Fax Number	814-353-8007

Products returned to **CANNON®** must be carefully packed. Ship prepaid to the following address:

CANNON Instrument Company
ATTN: Return Authorization # _____
2139 High Tech Road
State College, PA 16803 USA

Please include the following:

Required information

- The Return Authorization number (RA).
- The name and telephone number of the person at your company to contact regarding the product.
- Shipping and billing instructions for the return of the product to your location.
- A detailed explanation of the reason for the return.

If the product is not covered by warranty, the customer will be provided with an estimate of the repair costs and asked for approval before any repairs are made. The customer will be required to issue a purchase order for the cost of the repairs.

Hazardous materials

Stringent government regulations restrict the shipment of mercury. Please contact **CANNON®** before returning a product that could possibly contain mercury.

Shipping notification

Products returned without prior notification (by either telephone or fax), or without Cannon's authorization, will not be accepted.

The customer may be billed a testing fee if a product is returned to **CANNON®** and found to be working properly.

CHAPTER A

APPENDIX A—REPLACEMENT PARTS LIST

PART #	DESCRIPTION
P28.6100	DC Power Cable Assembly
P28.0579	AC Power Cable Assembly
P28.0704	Tube Assembly, Air In
P28.0705	Tube Assembly, Air Out
P01.2060	Cap Nut, 1/4-20
P28.0695	Jar Assembly, Bath overflow
P51.1210	Silicon Tubing, 1/4" OD, 3 pieces with lengths: 3", 6", & 11"

The following parts represent those items in the TE-3000 which are believed to be either expendable or may exhibit a short lifetime. Other parts, possibly damaged by misuse or neglect, may not be included in this list but may be obtained by contacting ***CANNON***® Instrument Company directly.

PART #	REPLACEMENT PART DESCRIPTION
P25.2455	Fuse, M 12A 250V; 1¼"×¼" (for 120V model)
P27.1300	Lamp, Fluorescent, 7W
P28.0718	RTD Probe Assembly
P28.0851	Fuse, M 6A 250V; 1¼"×¼" (for 220/240V model)
P28.5710	Pump Assembly, Recirculating, Air
P28.0714	Pump Assembly, Return Liquid
P28.0695	Jar Assembly, Bath overflow

Accessories

PART #	DESCRIPTION
P28.8140	Hole Cover
P20.22	Thermometer Holder
P28.0990	Manual, Instruction & Operation

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CHAPTER B

APPENDIX B— TROUBLESHOOTING GUIDE

SYMPTOM	PROBABLE CAUSE	LIKELY FIX
The green indicator light on the power switches for "BATH" and "LIGHTS" do not illuminate.	The power cord for the bath is not plugged into the wall outlet and/or the back of the TE-3000.	Plug power cord into wall outlet and the IEC connector on the back of the TE-3000.
	The MAINS outlet on the wall is not energized.	Reset breaker or replace fuse in MAINS panel. Circuit may be overloaded by additional equipment on same breaker/fuse.
	A fuse has blown.	Replace fuse. If condition persists, call ***CANNON***®.
Green neon light under "POWER" is not lit but the other green lights on the power switches are.	Air heat sink temperature is greater than 35° Celsius. Cooling fans have stopped operating due to failure of the +15v power supply and/or some fans are not turning.	Replace faulty fan(s). Contact ***CANNON***® Customer Service for assistance.
	Air heat sink temperature is greater than 35° Celsius. Unit has been operating for some time with the cooling fans blocked against a wall or other obstruction.	Move unit away from obstructions at the rear and sides. Allow heat sinks to cool.
Unit is unable to obtain cold temperatures.	Ambient air temperature is too warm. TE-3000 cannot obtain temperatures colder than about 60° Celsius below ambient (room) temperature.	Move unit to an air conditioned room or lower ambient (room) temperature.
	Some cooling fans have ceased in their operation or some of the cooling air is blocked by an obstruction.	Replace faulty cooling fan or move unit away from air obstruction.
	Not enough liquid in bath to permit adequate cooling.	Add liquid to bath so that the surface of the liquid is about 1/2 inch above the top edge of the rear (white) baffle.
Unit is unable to obtain warm temperatures.	Air circulator is blocked by moisture condensed in air pump.	Remove "AIR IN" hose connection on Control Chassis and let room temperature air remove the moisture in pump.
	Heater element is burned out.	Return bath to ***CANNON***® for repair.

SYMPTOM	PROBABLE	LIKELY FIX
Temperature control /stability is poor.	Not enough liquid in bath to permit adequate stirring.	Add liquid to bath so that the surface of the liquid is about 1/2 inch above the top edge of the rear (white) baffle.
	Inadequate stirring of bath with bubbles. Air hoses on rear of bath are faulty or not connected.	The hose connecting the "AIR OUT" of the bottom Control Chassis must be connected to the "AIR IN" on the upper Bath Vessel Housing as a minimum. The other hose need not be connected for target temperatures above 10 degrees Celsius.
	Temperature probe is not properly installed in the bath vessel.	The bottom tip of the temperature sensor should be about 1/2 inch below the top edge of the white baffle and it should be in front of this baffle.
	Temperature probe is faulty.	Replace the faulty probe.
Visibility in bath is poor.	One or more of the fluorescent lamps are burned out.	Replace the faulty lamp.
	The bath liquid is dirty or dark colored.	Siphon old bath fluid from vessel and empty overflow jar, clean tank inside glass window and tank sides and bottom. Refill tank and jar with clean alcohol.

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