MODEL 2000 SERIES DEWPRIME DEW POINT HYGROMETER OPERATOR'S MANUAL

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We want you to be entirely satisfied with your instrument. The information in this manual will get you started. It tells you what you need to get your equipment up and running, and introduces its many features.

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Introduction

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1.1 GENERAL

The EdgeTech Model 2000 Series DewPrime Dew Point Hygrometer (Figure 1-1) is a microprocessor based, programmable dew point instrument with many built-in features. It has a measurement range of -50 to+100°C. Two sensor types are available for a depression of either 45 or 60°C.

The DewPrime Series is presented in two major configurations. The first, the Model 2001, is a dew point only measurement instrument. The second, the Model 2002, is a dew point, relative humidity, and ambient temperature measurement instrument.

This instrument has been designed to include the most desirable I/O options in the standard configuration. By "building in" these options, the cost is reduced significantly when compared to "added in" options.

Using a primary measurement technique, including provisions for self-checking and automatic balancing, the Model 2000 Series verifies its own performance on a timed sequential basis, and is ideally suited for process control and continuous unattended operation. Developed primarily for industrial process use, the Model 2000 Series is also useful for laboratory, scientific, and research applications, and can be equipped with a mirror microscope when used as a calibration standard. It is designed to meet reliability requirements of high temperature, high dew point process drying and curing, and the Model 2000 Series is finding broad applications in areas where energy conservation is a major consideration.

1.2 DESCRIPTION

The Model 2000 Series consists of a Control Unit and either a single or dual stage dew point Sensor and a built-in cooling jacket (S2 Sensor only). The Model 2000 Series is equipped with a timed, electronic, automatic self-standardization circuit; a Track or Hold output; mode indicators; and an Alarm Set. A platinum resistance thermometer (PRT) continuously measures the mirror temperature, directly displayed in °C or °F on the front of the 4-digit Digital Panel Meter, with a resolution of 0.1°C. Standard outputs of 0 to 5 VDC and 4-20 ma are available directly on the rear panel connector (Figure 1-2).

The Model 2000-S2 is also equipped with (1) a mirror overtemperature protection circuit, which shuts down the thermoelectric cooler at a mirror temperature over 100°C; and (2) an additional overtemperature circuit, which also shuts down the cooler if base temperatures exceed 100°C.

The Sensor incorporates an inert Rhodium (nickel electroplate-based surface) mirror that has a hard, bright surface to provide superior abrasion resistance, and an inherent antiwetting characteristic to enhance dew and frost formation. The Rhodium mirror was developed as a result of on-going material evaluation studies coupled with applied research in the physics of dew and frost formation on a mirrored surface. Extensive field tests in harsh industrial applications show that the Rhodium mirror provides significant advantages over conventional mirrors, especially gold-surfaced mirrors.

The S2 Sensor has a depression capability of 60°C (108°F) at an ambient temperature of 25°C and the S1 Sensor has a depression of 45°C (81°F). Depression decreases approximately 1° for every 3° drop in ambient temperature and increases approximately 1° for every 3° rise in ambient temperature from 25°C. Depression capability is sufficient at any temperature to permit dew point measurement corresponding to less than 1% RH. The S2 Sensor has a built-in cooling jacket that should be used when the dew point to be measured exceeds the cooling depression of the Sensor itself. When the jacket is used, Sensor cooling is based on the temperature of the coolant, which can be water, ethylene glycol, etc. Response is 1.7°C (3°F)/second at dew points above 0°C (32°F). Below 0°C, less water is available for condensation, and the response is governed by both the frost point and the sample flow rate.

The Sensor is usually mounted on the instrument's rear panel; however, it can be mounted remotely up to 75 meters (250 feet) from the instrument by using the optional Remote Mounting Cable Kit.

The Model 2000 Series is equipped with convenience features such as: (1) a Sensor spin-off cover that permits

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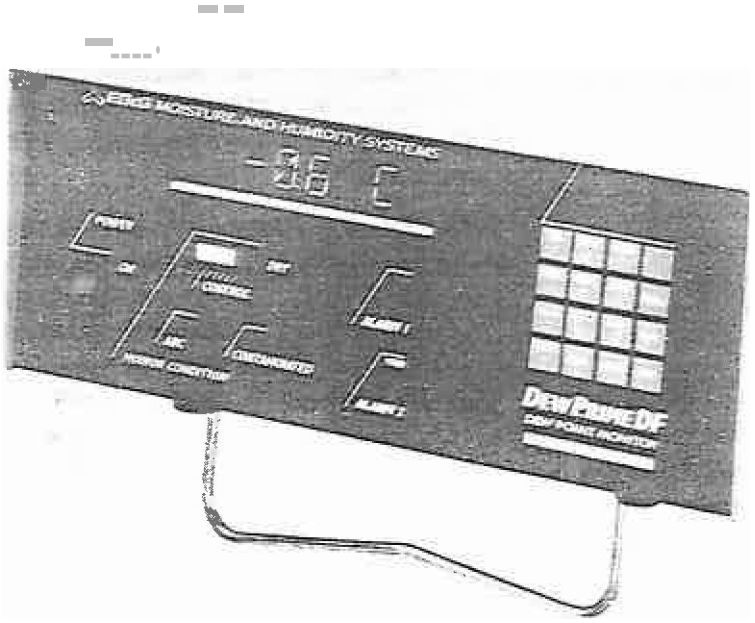

Figure 1-1. EdgeTech Model2000 Series DewPrime Dew Point Hygrometers.

Figure 1-2. Rear Panel, EdgeTech Model 2000 Series DewPrime Dew Point Hygrometers.

easy access to the mirror for cleaning without disconnecting sample lines and connections (S2); (2) the logic level front panel Automatic Balance Control (ABC) LED is "ON" steady when the instrument is standardizing, and "ON" flashing when the standardization cycle is completed and the instrument is depressing (cooling) to the dew point; (3) Alarm set points that are programmable over the entire Sensor range; and (4) a "CONTAMJNATED" LED and logic level olllput that signals *when and if* the Sensor miJror needs cleaning.

1.3 AUTOMATIC BALANCE CONTROL (ABq

The Model2000 Series incorporates an all-electronic, timed, Automatic Balance Control (ABC) circuit To correct for changing "dry mirror' reflectance as a fimction of contamination, the mirror is heated periodically to a temperature in excess of the dew point, and the optical bridge output is balanced electronically for the present reflectance. This heating is accomplished by reversal of the voltage across the th.mnoelectric cooler inside the Sensor.

The ABC cycle in the Model2000 Series can be programmed to start at a specific time and at any interval thereafter. The cycle can also be initiated manually by a pushbutton on the front panel or via the serial port This feature increases the time interval between sensor and sample-line cleanings without adversely affecting overall performance.

Sensitivity to particularly troublesome impurities, such as salts and other soluble contaminants, is negligible with EdgeTech hygrometers because the compensation circuit and the low thermal mass of the Sensor design permit use of a heavy condensate layer on the mirror surface without need for a coalescence precool cycle or other gimmickry to offset the servo instability, drift, and loss of accuracy often enco1.mtered in other chilled mirror hygrometers.

1.4 PROGRAMM.ABn.JTY

The Model 2000 Series' fimctions can be programmed via the front panel keypad or the RS-232 serial port.

- **ABC** Cycle. This cycle can be programmed to start at any specified time and repeated at programmed intervals. This feature allows the user to program the ABC cycle to occur at off-hours such as late at night or early morning when the restandardization will cause the least interruption of the sampling process.

- **8erial** Port. The serial port is RS-232C compatJ.'ble and can be used to remotely program setup paxameters, initiate an ABC cycle, or output data to a terminal, printer, or computer.

- **The** Setup Parameters include time plus date, units (°F or °C), ABC start time, ABC interval, alarm limits, analog outputs, baud rate, automatic data output interval, and digital averaging interval (0-16).

- **The** Data Output Function sends the date, time, dew point, and a1mn status to any serial device such as a computer, printer, or data logger equipped with an RS-232C input. The data can be sent either on command from the external device or automatically at programmed intervals.

- **The** Control Function allows the user to start an ABC cycle, initiate xoaximmn cool/heat, and send the status such as alarm condition, ABC cycle, or maximmn heat/cool. All commands are listed on a Help menu that can be printed or displayed on a terminal.

- **Aualog** Outputs. Two outputs, *0-5* VDC and 4-20 ma, are available simultaneously at the rear terminal connectors. They can be scaled electronically to correspond to any dewpointnmge. For instance, 0 V/4 ma can be set to -40°C and *5* V/20 ma can be set to +10°C. Any combination of dew points within the measuring range can be used This feature allows the user to customize the range for a particular strip chart recorder or to expand the scale for greater precision. Scaling can be programmed easily via the front panel keypad or the remote serial port

- **Alarm** Relays. Two programmable Form C relays are provided to control valves, anmmciators, etc. Each alarm relay can be set independently for high or low, latching or unlatching, and at any dew point

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1.5 OPTIONS/ACCESSORIES

1.5.1 Remote Mounting

When it is desired to mo\Dlt the Sensor in a location different from the location of the Model2000 Series Control Unit, use the Remote Mounting kit. The Remote Mounting kit allows for distances between Sensor and Control Unit to be as much as 250 feet (75 meters). Instructions for installing the Remote Mounting kit are included with the kit. If a Remote MountiDg kit is ordered with the Model 2000 Series Control Unit, the Control Unit and Remote MountiDg kit and Sensor are checked out and calibrated at the *factory* as a system. However, if a Remote Mounting kit is ordered separately for field instaJJation, then field calibration of the PRT Resistance-to-Voltage converter will be necessary to compensate for the slight resistance changes introduced by the change in cable length.

1.5.2 Panel and Rack Mounting

The Panel and Rack Mounting option allows the Model 2000 Series to be converted from a bench-mounted model to one tbat can be mounted in either a panel or rack. When mounting in a panel, a template included with the kit provides for ease in locating the cutout and mounting holes. Once installed in a panel, the hole cutouts are covered by the front panel of the kit.

1-5.3 Sample System Module

The Sample System consists of a Neptune Dynapump Model No.2, a Brooks *0-5* SCFH flowmeter, eight feet of tubing, and allhardware and fittings necessary for attaching to a Model S1 or S2 Sensor.

1.5.4 Mirror Microscope (S2 Sensor)

A Mirror Microscope option is offered for applications requiring a view of the actual dew layer esta lished on the Sensor mirror surface. This is particularly useful when attempting to obtain an NIST certified calibration when it must be determined if the system is controlling on the actual frost point at temperatures below 0°C, or on supercooled dew.

Since the relationship between dew point and frost point for temperatures below 0°C is 11known, it is easy to convert from one to the other <mce it is verified that control has been established on dew or frost below 0°C. This can be determined by visually observing the mirror surface using this Minor Microscope option.

To incorporate this option, it is only necessary to remove the S2 Sensor housing provided with the standard instrument and replace it with the one provided in the Mirror :Microscope kit. Use the same screws that were removed from the original Sensor housing to retain the new microscope Sensor housing, since these screws are especially strong and will ensure that the pressure integrity of the Sensor is maintained.

IwARNING!

The microscope provided for this option has been pressure-tested to 1800 psi, six times the allowable workiDg pressure of the Seasor, to eDSDI'e its integrity. However, with the microscope installed, it is recommended that maximum SeDSOr internal pressure not exceed 25 psi, since a gas under pressure could cause the JDi. c:roscope to become dislodged aad bec:ome a projectile thatmightiDjlll"e someone observinl the dew layer at the time of dislodgement.

1.5.5 Explosion-Proof Housing (S2 Sensor only)

The Explosion-Proof Housing is comprised of components designed for Class 1, Division 1, Groups C & D hazardous enviomments vmere high accuracy, long-term reliability, and NIST traceable dew points are required. Power is supplied to the chilled mirror Sensor through a remote cable from the controller, enabling the Sensor to be mounted at a distance of up to 250 feet. The housing assembly is not agency-In in-

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1.5.6 Isolated 4-20 ma Output

The4-20 maoption isavailable for applications requiring . complete isolation between the Model2000 Series and the 4-20 rna output. As with the standard 4-20 rna output, the range matches the 0-5 V output set on the Model2000 Series. Maximum loop resistance is 1000 ohms.

1.57 In-Line Filter

An in-line filter can be added to the sampling system in orderto provideadditional protection to the chilled mirror and associated optics. The filter assembly is a combination particulate and coalescing filter rated for 250 psi. The filter head assembly is anodized aluminum. Filter efficiency is rated at 99.99% for particulate and droplet sizes ofO.l micron and greater.

1.7 SPECIFICATIONS

The following specifications refer to the Model2000 Series. Those specifications that apply to the Model2002 only are highlighted by an(*).

Dew/Frost Point Range

-40 to +100°C (-40 to 2l2°F)- Sl, Ds1 Sensor
-50 to +100°C (-50 to 212°F)- S2, Ds2 Sensor
-75 to+100°C (-103 to 212°F)- S3 Sensor

Accuracy

Dew Point/Frost	::1::0.2°C (±0.36°F)
Ambient Temperature*	::1::0.2°C (::1::0.36°F)
Relative Humidity*	:::1::0.5% RH, nominal

Dew/Frost Point Temperature Sensor

3-wire Platinum Resistance Thennometer (PRT), 100 ohms at 0°C, nominal

Depression

45°C (81°f), nominal- S1, Ds1 Sensor
65°C (ll7°F), nominal- S2, Ds2 Sensor
95°C (171°f), nominal- S3 Sensor

Relative Humidity Range

5 to 100%, nominal-S1, Ds1 Sensor
1 to 100%, nominal-52, Ds2 Sensor
<I% to 100%, nominal-53, Sensor

Ambient Temperature Range*

-50°C to 130°C (-58°F to 266°f)

Auxiliary Coolant

Water (or other)-2liters/minute (0.5 gallon/ minute) at 100 psig maximum, to augment depression capability of Sensor when necessary

S1 Sensor- Coolant port standard
S2 Sensor- Coolant port standard
S3 Sensor- Coolant port standard

Sensor Material

Rhodium or Nickel Chromium mirror, glass, epoxy, isofoam insulation, anodized aluminum sensor body.

Remote Sensors

Up to 75 meters (250 feet)

Depression Slew Rate

1.7°C (3°F)/second max., above 0°C

Repeatability

±0.010C (0.2°F)

Hysteresis

None

Sample Flow Rate

0.25-2.5 liters/minute (0.5-5.0 SCfH)

Sample Pressure

0-21 kglcm:t (0-300 psia)- S1, S2, S3
0-63 kg/cm^2 (0-900 psia)- SIP, S2P

Operating Temperature

0 to +50°C (+32 to+122°f)- Control Unit
-50 to +70°C (-58 to +158°f) Sl Sensor
-50 to+I000C (-58 to +2 I2°F) 52 Sensor
-75 to +75°C (-103 to +167°F)- S3 Sensor

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Operating Temperature

o to +sooc (+32 *to* +l22°F)- Control Unit
-50 *to* +70°C *(-58 to* +158op)- SI Sensor
-50 to +l00°C (-58 to+212°F)- S2 Sensor

Display

4-digit LED alphanumeric data display
0.6 in. high digits
O.lºC/O.I°Fresolution, (-) xxx.x *CIF*

Keypad

16 keys, *to* provide programming for Model 2000 Series functions:

ºCfOF toggle
View/change time, date, digital averaging, baud rate
Manual Auto Balance Control initiate
Programmable Auto Balance Control for start time, interval, output Track/Hold
Maximum Heat toggle
Maximum Cool toggle
View/change high and low limits for analog outputs
View/change A.l.amJ. parame higbllow limits, high and/or low alarms, latched or unlatched relays
Reset front panel Alarm indic:alors (la!ched only)

Outputs

Track or Hold

Outputs (analog, digital, ala:rm.s) can be set to Track or Hold while in Auto Balance or Programming mode

Allalog

Voltage (Standard)

0 to +5 VDC, scalable from -100 *to* +100°C (-148 to +2I20f), I K minimum impedance

Current

Imemal or Extema1Power(Standard)

4 *to* 20 ma, scalable from -100 *to* +l000C (-148 to +212Gf'), 1000 ohms maximum loop resistance

Isolated (Optional)

4 to 20 ma, scalable from -100 to +IOOOC
(-148 *to* +21,2C'F), 1000 ohms maximum loop resistance

Digital

RS-232

300/1200/2400/4800/9600/19200 Baud N8I
25-pin D-subminiarure connector (female)
Output of time and dew/frost point during operation.
Output interval is user proglB'••mahle.
Progm_nming of all keypad functicms plus poll dew/frost point, OUipUI imervaJ.s, plus on-line Help menu.

Mirror Condition (Conmminated)

Rear panel TIL output and front panel LED

Two Alarms

Two Fmm C, SPDT alarm relays rated for 3 amps at 24 VDC, 120 VAC
Alarm mode (high and low) programmable from keypad or RS-232
Alarm set point programmable from -99.9 to +99.(-148 *to* 212Gf) from keypad or RS-232 port.
Alarms can be latched or tmlatched.

Auto Balance Control

Manual initiate of ABC at any time.
Automatic ABC with start time and interval programmable from keypad or RS-232 port

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Outputs programmable for Track or Hold during ABC.

Weight

7.0 kg (15.5 pounds), desk-top version
Rack mount available

Dimensions

28.2 (W) x 13.0 (H) x 45.7 (D) em
(11.1 (W)x 5.1 (H)x 18 (D) in.),
desk-top with S2 Sensor motmted

Mounting

Desk-top (standard)
Panel/Rack (optional)
NEMA 4 Enclosure (optional)

Power Requirements

100/115/230 VAC, ±10%, 50-60 Hz,
75 "Watts max:imlDil

Fuses

240 VAC Operation-
1A, 3 AG, 250 VAC, Slo-Blo

120 VAC Operation-
2A, 3 AG, 250 VAC, Slo-Blo

Installation Procedures

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2.1 UNPACKING

Remove the Model2000 Series DewPrime Dew Point Hygrometer from its shipping carton and remove any shipping ties, clamps, and packing material. Save the Certificate of Traceability shipped with this manual. Locate and save the small box containing the Cleaner Kit included in the shipping carton. The Model S1 or S2 Sensor normally is attached to the Model2000 Series Control Unit, except when the optional Remote Mounting Kit is ordered.

2.2 MOUNTING

2.2.1 General

The standard Model2000 Series is designed primarily for desk-top operation. However, an optional Panel/Rack Mounting Kit is available for mounting the instrument in either a panel or rack that is at least 19 inches wide. The Sensor may be mounted remotely from the Control Unit by means of the optional Remote Cable Mounting Kit

2.2.2 Desk-Top Operation

For bench-mounting the Model2000 Series Control Unit, place the instrument on a clean, flat surface. Ensure there are no obstructions to the free convection of air on the sides of the instrument.

2.2.3 Panel/Rack Mounting

For panel or rack mounting, the optional Panel/Rack Mounting Kit must be used. This kit includes a 19-inch rack panel that can be attached directly to a standard EIA 19-inch cabinet. The Model2000 Series attaches to the front panel and sits on the support plate, and the Sensor is then attached to a support bracket behind the rack panel. A template is provided to be used to position the hole cutouts to which the Panel Mounting Kit will be fastened. Ensure there are no obstructions around the instrument, whether mounted in a panel or rack configuration, that would impede the free convection of air around the instrument. Installation instructions for the Panel/Rack Mowting Kit are included with the kit.

2.2.4 Remote Sensor Mounting

When it is desired to mount the Sensor remotely from the Control Unit, the optional Remote Mounting Kit must be used. This kit consists of the mounting hardware, connectors, and cable necessary for locating the Sensor up to 75 meters (250 feet) from the Control Unit. The actual length of cable required should be specified in the Purchase Order since the instrument must be calibrated for the specific length of cable used. Installation instructions for the Remote Mounting Kit are included in subsection 1.5.1 of this manual.

2.3 COOLANT CONNECTIONS

For most applications, the Model S1 or S2 Sensor can be operated without the need for auxiliary cooling of the Sensor base. The Sensor measures the dew point of gases where the dew point is as much as 40°C (S1) or 60°C (S2) below ambient temperature when the Sensor is attached to the control unit. Since the depression is relative to the base temperature of the Sensor, cooling the base will lower the minimum dew point attainable. This can be accomplished by providing coolant to the integral brass coolant jacket (optional on S1) that forms the base of the Sensor. This coolant can be ordinary tap water, chilled water, or even a chilled antifreeze solution such as ethylene glycol or methanol. For instance, a coolant temperature of 50°F will permit dew point measurements at -55°C for the S2 and -35°C for the S1. Coolant flow rates of 0.5 GPM (2 LPM) are adequate, and the coolant pressure maximum rating is 100 psia (70 kg/cm^2). Connections for the coolant are made to the brass coolant jacket of the Sensor by means of 1/8-27 NPT fittings.

NOTE

When the coolant temperature is below the dew point temperature of the atmosphere surrounding the instrument and Sensor, the Sensor should be mounted from the rear of the instrument and allowed to attain the temperature of the coolant by itself. This prevents condensation from forming on the rear portion of the instrument as would normally happen if it were colder than the dew point of the surrounding atmosphere. Use of the optional Remote Mounting Kit allows the Sensor to operate at temperatures lower and higher than the instrument.

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2.4 TEMPERATURE LIMITS

Install the inst:n.:onent in locations where the ambient temperature will not exceed the range 0 to +50°C (32 to 122°F).

The Model S1 Sensor will operate over the range of -50 to +70°C. The Model S2 Sensor tempeiature range is -50 to +100°C. When the anticipated operating range of the Sensor is expected to be outside the operating temperature range of the instrument, the Sensor should be removed from the instrument and e<mneeted to the instrument by means of the Remote Mounting Kit. Always maintain the Sensor temperature at least 5°C above the dew point tcmperarure of the gas beiDg measured.

2.5 WIRING CONNECfiONS

The instrumemrequires a power source of 1151230 VAC, 50-400Hz. When the Model2000 Series is received and before attaching it to a power source, examine the priDted circuit card behind the window on the A.C. Power Module on the rear of the unit. The card should show "120" *CTr* "240," dependiDg on the intended usage. Also, confirm that the corresponding fuse is inserted in the A.C. Power Module: 2 amp 250V, 3 AG, Slo-Blo for 115 VAC or 1 amp 250V, 3 AG, Slo-Blo for 230 VAC.

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Removing the ModellOOO Series Control Unit cover uposes the user to liDe operating voltages when the 1llli t is plaged into the power source. If the instrument is plugged in when perform.iDgaDY circuit adjustmena or tests, take extreme care not to come in contact with the high voltage present on. the transformer, the A.C. line filter, and the front panel power switch.

2.6 AMBIENT TEMPERATURE PROBE (Model2002 only)

The Model2000 Series can be configured to measure ambient temperature (AT) and calculate relative hmnidity (RH). This configuration, which includes several other unique features, is refened to as the Model2002.

The AT probe iDstallation is made by coDD.ecting the appropriate leads to the terminal strip on the Model 2002 controller back panel labeled "AMB.1EMP. PROBE". Attach the wires (flying leads) to the correct temrinal screw in the following manner:

Attach this lead •••	To this terminal -•-
Bear wire	Sbld
White teflon coated wire	Wbt
Black teflon coated wire	B1k
Red teflon-coated wire	-Red

2.7 PLUMBING CONNECfiONS

A basic requirement of accurate dew point measurements is the proper design of the gas sampling system. In order that the Model2000 Series measures the actual moisture content of the gas, it is essential that the sampling components neither comnoute to nor absorb moisture from the gas UDder study. Also, the sampling componems must not modify the pressure or temperature parameters of the gas such that they would affect the moisture content of the sample. When dew point measurements are made, it is essential tbat the temperature of sampling components not be allowed *to* drop below the dewpoim temperature of the sample. This prevents condensation from occurring within. the line, causing an erroneous measurement Sampling lines and the Sensor must be properly preheated when measuring dew points above ambient atmospheric temperature. (Refer to Preheating Sensor and Sample Lines, subsection 2.9).

Generally, for dew point temperatures above -l8°C (about 800 ℙ at 1.02 lqVcm ^{2} (14.7 psia)), no special precautions need be taken in the selection of sampling line materials, other than ensuring that they have tempenl!Ure and pressure ratings necessary to handle the sample and that all coDD.eCtions are gas tight. The problems associated with the hygroscopic nature of sampling hardware worsen as the absolute moisture content decreases; that is, as the dew point lowers. For dew point temperatures below -l8°C, some attention

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must be given to the selection of nonhygroscopic sampling materials. (Refer to Selection of Components at Low Dew Points, subsection 2.10).

In general, the most common problem areas that affect the moisture of a sampled gas are:

1. Length of process line and sample line.
2. Leaks in the process line and sample line.
3. Adsorption or absoxption of moisture in the process and sample lines due to the materials of construction.
4. Excessive elbows, tees, valves, or other fittings used in the sample lines.
5. Back diffusion of moisture into a pressurized system, particularly at low dew points.
6. Condensation within the process line and sample line at high dew points.
7. Diffusion through the sampling materials.

The procedures and parts recommended in *this* manual should be used only as a guide in selecting and designing sampling systems. If your application is of a special nature, call EdgeTech's Sales Application Engineers for assistance in selecting sampling components.

2.8 SAMPLING CONFIGURATIONS

A suggested sampling system for use with the Model 2000 Series DewPrime Dew Point Hygrometer is shown in Figure 2-1. A portion of the gas line to be sampled is brought to the hygrometer location from a pressure tap, either by using a suitable vacuum pmnp or by returning the sample to a lower pressure point. The flow rate through this main sampling line should be sufficient to ensure continuous flushing of the lines in order to provide fast response times for the sampling system. Usually, a flow rate of O.S to 5.0 SCFH (14 to 142 LPH) in a 1/4-inch line is adequate; however, this number must be adjusted with the length of the line, the level of absolute moisture content of the sample, and the desired response time of the sampling system.

A bypass line may be used to increase the main sampling line velocity and to improve the overall response time. It is necessary that the main sampling line be equipped with a valve for adjustixlg the sample flow rate. The hygrometer's gas sample is obtained from the pressure drop across the bypass as shown in Figure 2-1. It is desirable to provide the hygrometer input with a filter, especially if the gas sample contains particulate contaminants. Several sintered stamless steel types of suitable filters are listed tmder Recommended Hardware, in subsection 2.13. The filter is considered a hygroscopic element that will contribute some lag to the sampling system. In the design of hygrometer sampling systems, minimize the number of components, such as valves, tees, and filters, prior to the Sensor's input The Sensor output should be connected to a suitable flow measuring device, such as a rotameter or valve to adjust the flow rate to the recommended range of 0.5 to 5.0 SCFH (14 to 142 LPH).

NOTES

Excessively high sample flow rates may cause a loss in the depression capability and unstable operation of the system.

Considerable savings can be obtained by recognizing that the sample exhaust lines and related components need not be of as high a quality and as nonhygroscopic as those prior to the hygrometer.

The gas to be sampled must be furnished to the 1/8-27 NPT male ports on the Sensor. Flow may pass through the Sensor in either direction. A sample shut-off valve may be used on the input side of the Sensor to extract the sample. Such a valve is especially useful when working 'With samples at high pressures (300 psia max or 211 kg/cm^2) and when opening the Sensor for periodic minor cleaning.

2.9 PREHEATING SENSOR AND SAMPLE LINES

If the dew point of the gas lmder measurement is above the ambient temperature of the installation and sampling lines, both the lines and the Sensor must be preheated. The sample lines must be furnished with some type of heater tape, so that condensate will not form on the optical components or other parts of the Sensor. The approach used will vary widely with the specific nature of

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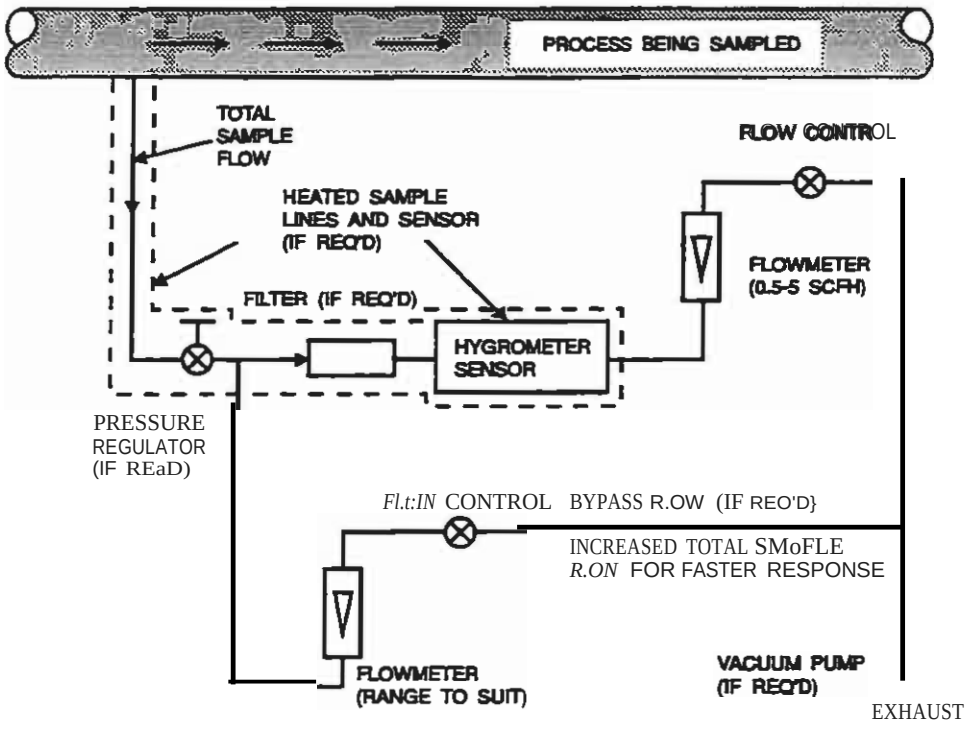

Figure 2-1. Suggested sampliDgsystem.

the installation, and the user must ensure that no portion of the sample line is at a temperature lower than the highest dew point anticipated. If electrical heater lines are used, it is usually sufficient to connect them to a variable transformer to adjust the heating level. If the sample lines are long, it may be desirable to wrap them in insulation to minimize the amo1m.t of heat required for preheating. The Sensor temperature must always be maintained at least 5°C above the dew point temperature of the gas sample. The temperature of the Sensor must not exceed +100°C. Heating the Sensor and sample lines above the dew point of the gas sample does not change the dew point of the sample.

2.10 SELECTION OF COMPONENTS AT LOW DEW POINTS

When measuring dew-points below -18°C, increased attention to sampling details must be made as the dew point is lowered.

Rubber, neoprene, tygon, and most plastic tubing are lm.desirable for use in hygrometer systems as sample lines from the sampling system to the Sensor. Specifically, nonhygroscopic tubing, such as stainless steel, Teflon, or KEL-F, with a minimum of joints, fittings, and other plumbing, is recommended. The actual selection of the sample line material should be based on

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the degree of permanency of the installation, and the type of fittings and connections to be used. Generally, stainless steel is preferred for pennanent installations operating at low dew points. On stainless steel lines, either swage or flare-type fittings can be used. Leaks in the sampling system must be avoided, particularly for installations operating below atmospheric pressures, since leakage of ambient air into the sampling system will seriously offset the readings obtained.

2.11 MATERIAL MOISTURE PROPERTIES

All materials will absorb moisture to some extent. The adjacent curves shown in Figure 2-2 relate typical desorption properties of common sampling line materials after being exposed to a "wet" gas such as the ambient atmosphere. The curves illustrate the difficulty of obtaining a fast system response when switching from a high dew point sample to a low dew point sample. Even. if the instrument were to respond in.stmtly, the sampling lines would dictate the overall response.

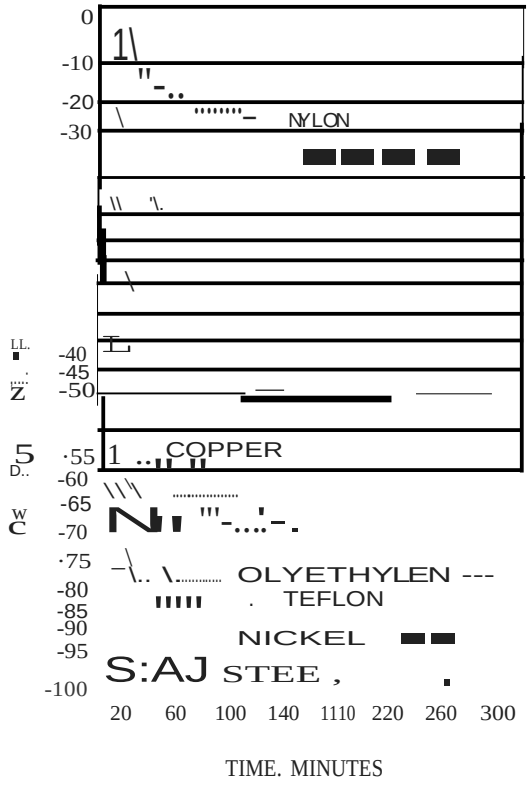

Figure 2-2. Typical sample line material response characteristics.

2.12 SELECI'ION OF SAMPLING PUMPS

Three types of pumps are generally suitable for hygrometric work. For iDstallations where the sample is not to be returned to the process, the Gas Manufacturing Co. vane pump is acceptable. This pump offers a reasonably high degree of reliability and can handle large volumes of air. The vane type of pump tends to contaminate the sample with minute amounts of pump-wear by-products (iron, carbon); therefore, it should be used on the output side of the Sensor.

For general-purpose use or for closed-loop sampling at atmospheric pressure, any one of several types of diaphragm pumps, such as the Neptune Dynapump, can be used. The Dynapump uses a neoprene diaphragm, and the pmnp housing is aluminum.

For most closed-loop sampling, where leak tightness is essential, the welded bellows type, such as the Metal Bellows MB-21, can be used. These pumps are available from EdgeTech as well as from their respective manufacturers. (The optional Sample System Kit uses the Neptune Dynapump Model No. 2.)

2.13 RECOMMENDED HARDWARE

2.13.1 Pumps

Cazbon Vane Type	Gast Mfg. Co. Model 0531-102B-347X (0.6 cfm) or equivalent
Diaphragm	Dynapump-Neptune Products, Model 2 (2.25 cu. inlmin.) or equivalent
Bellows Type	Metal Bellows Co. MB-21 or equivalent.

2.13.2 Filters (General Purpose, In-Line)

Stainless Steel	NUPRO 4F-316, with 60-micron filter element or equivalent
Brass	NUPRO 4F, with 60-micron filter element or equivalent.

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2.13.3 Flow Gauges (with valves)

Stainless Steel and Glass	Brooks Sho-Rate "50" No. 1350-V, or equivalent. Glass, range 0.2-4.5 SCFH
Brass and Lucite	Brooks-:Mite No. 2001V, 0.1-4.5 SCFH

2.13.4 Sample Tubing and Recommended Fittings

Stainless Steel, 1/4 in.	Flare or Swagelok
Teflon (or Kel-F) 1/4 in.	Swagelok
Stabilized Polyproplylc:ne, 1/4 in.	Swagelok

2.14 PRESSURE MEASUREMENTS

The dew point temperature of a gas is a measure of the absolute moisture content of the gas, at a given pressure, regardless of the temperature of the gas. Most conversion tables for dew point (or frost point), to parts-per-million, grains-per-pound, etc., are made at atmospheric pressure (14.7 psia or 1.03.kglcm^2); therefore, if accurate absolute moisture content measurements are to be converted to atmosphc:ric-pressure-referenced values, the pressure must be known. If dew points are to be measured at sample operating pressures other than atmospheric, the hygrometer Sensor should be fitted with an appropriate pressure gauge. (A dew point pressure conversion chart is shown in the appendix, Basic Hmnidity Definitions.)

2.15 CLEANING THE SAMPLING SYSTEM

Most types of metal tubing contain oil deposits on the interior walls due to the manu&cturing process. This residue must be removed before putting the lines into service in a gas sampling system. Trichloroethylene or similar degreasing solvent can be used to clean individual lines and components before assembly, with a final flushing after assembly. The lines should be purged dry with air or nitrogen before being placed into service. In addition to the initial installation, the process itself may constintte a source of coummination, and, in many applications, these are volatile hydrocarbons. An excellent fluid for pmging and cleaniDg the instrument 8nd! or the sample lines is Freon 114. This is a suitable solvent since it is capable of holdiug many hydrocarbons in solution, and it is highly volatile, nontoxic, nonexplosive, readily available, and will not attack comi:non sampling materials.

2.16 SAMPLE FLOW RATE

When setting sample flow rates at other than 1 atmosphere (1.03 kglcm^2 or 14.7 psia), or when gases other than air are ilivolv use Figures 2-3 and 2-4 to convert the indicated sample flow rate reading to the actual flow rate.

Figure 2-3 gives the actual flow rate of air at pressures other than 1 atmosphete (14.7 psia). For example, the actual flow rate of air at 30 psia is 3.3 SCFH when the sample flow rate reading is 2.3 SCFH.

Figure 2-4 gives the actual flow rate of six different gases. The actual flow rate of helium, for example, when the sample flow rate indicates 1.2 SCFH is 3.3 SCFH (at 1 atmosphere). When gas pressures other than 1 atmosphere are used, use Figure 2·3 to convert the "actual" flow rate reading obtained from Figure 2-4 to the true flow rate. Using 30 psia, rather than 1 atmosphere in the helimn gas example above, apply the 3.3 SCM "actual" flow rate obtained from Figure 2-3 as the Flow Gauge Reading on Figure 2-4, and read 4.8 SCFH as the actual flow rate of helium at 30 psia.

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3.1 KEYPAD IDENTIFICATION

able 3-1 sts each fthe keys othe Model 2000 Senes DewPrime Dew Pomt Hygrometer front.panel (Figure 3-1) and gives a brief description of their functions. A detailed description of the keypad operation *is* presented in subsection 3.3.

Table 3-1. Identification of keys on front panel keypad.

Key		Function
MODE		Toggle temperature units.
Fl'JNC	I TIME	View and/or change time.
	I DATE	View and/or change date.
	IAVE	View and/or change number of temperature readings to be averaged.
	I BAUD	View and/or change the baud rate. (300,1200,2400,4800,9600,19200).
	I OT.JT JNT	View and/or change R.S-232 ourpm interval (sees).
VIEW		View the numeric value of the parameter on the LED display.
MABC		Start manual ABC cycle.
PABC	i·ABC ST	View and/or change Amo ABC start time.
	1 ABC JNT	View and/or change Auto ABC time interval.
	j-HOLD	Toggle hold on/off.
HEAT		Tum on/off MAX HEAT.
COOL		Tum on/off MAX COOL.
>,+and<,-		>,< used as initial entry for setting a.larms. +,-used as second a1ar.m entry and for initial entry for setting output r.mge.
OUT	[HI	View and/or change temp of analog 5 volt (20 ma) output.
	jLO	View and/or change temp of analog 0 volt (4 ma) output.
ENT		Enter a new value for any of the above.
RSET		Cancel flashing alann lights in latch mode.
ALMI	J ALARM 1	View and/or change Alarm 1 temperature setting.
	IL 1	View and/or change Alarm 1 latch status.
ALM2	I ALARM 2	View and/or change Alarm 2 tempemure setting.
	[L 2	View and/or change Alarm 2 latch status.
ESC		Use to cancel a mistake or leave parameter without making any change.

3.2 KEYPAD LOCKOUT SECURITY

The Model 2000 Series has a digital security code that can lock out tmauthorized or casual users. In applications where the Model 2000 Series is on a control loop, security of instrument setup is critical. Initially, the instrument is shipped from the factory in the UNLOCKED status. The user must proactively LOCK the instrument, if desired.

When the keypad is locked, all keys are rendered inoperative. Once locked, each time any key is pressed, the display will indicate LOCKED for a few seconds, and then return to the nonnal display. IfLOCKED, the keypad will remain LOCKED even if the instrument power is switched on or off.

The lock/tmlock status is similar to a toggle switch, where the same operation will tum on or off the digital lock. To LOCK or UNLOCK the keypad, press the following four keys in sequence:

"BLANK","MABC/4","ENT",then "RSET/0"

----------Operating Instructions----------

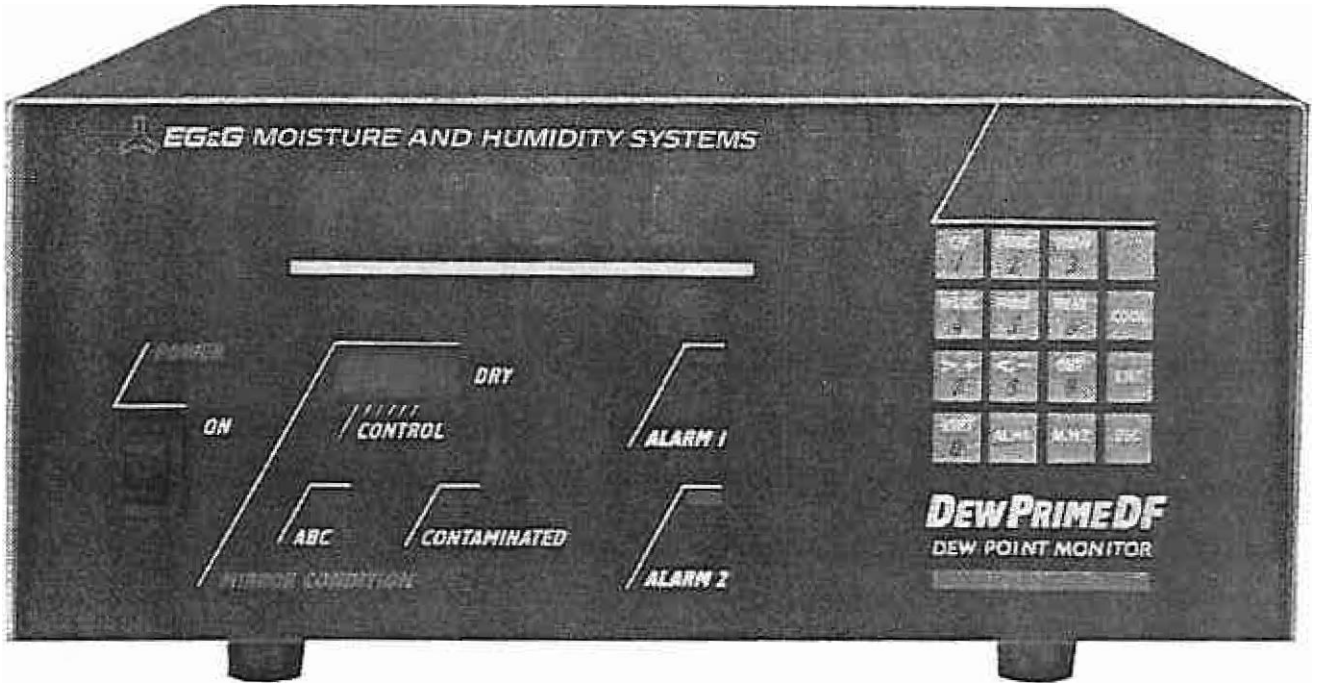

Figure 3-1. Front paneEdgeTech Model2000 Series DewPrime Dew Point Hygrometers.

Operating Instructions

3.3 FRONT PANEL KEYPAD OPERATION

MODE: The MODE key controls the panel display. Pressing the MODE key will indicate various measurement parameters, depending on the model configuration and selected options. The (*) indicates a measurement parameter available only on the Model 2002. Selecting a particular display does not change the output on the analog or digital signal.

If the display indicates ...	The measurement is ...
xxx.x C D	Dew/frost point °C
xxx.x F D	Dew/frost point Of
xxx.x GR	Grains per pound
xxx(.)x PM	Parts per million, by volume
xxx.x C T	Ambient Temperature OC*
xxx.x C T	Ambient Temperature VF*
xxx.x RH	Relative Humidity, %*

FUNC: This key allows the viewing and changing of a number of eters. The first press of this key displays TIME. The VIEW key shows the time and allows the user to change it. Pressing FUNC instead of VIEW accesses the next ftmction and displays DA1E. Press VIEW to view/change the date or press FUNC again to go to the next function, AVE. This represents the nmnber of temperature readings to be averaged in order to compensale for short-term changes in temperature. The next ftmction after AVE is BAUD, in which the baud rate for RS-232 communication is set. Allowable values are 300, 1200, 2400, 4800, 9600, 19200. The final parameter IDlder FUNC is our INT, which sets the output interval, in seconds, between RS-232 outputs. A value of 0 for our INT results in no RS-232 data output.

MABC: Begins a manual ABC cycle. If the Model2000 Series is already in an ABC cycle, this key restarts the ABC cycle.

PABC: This key is multifunctional, allowing viewing and changing of three parameters related to the ABC cycle. The first press of the key displays ABC ST. Pressing VIEW allows viewing or cban Png the ABC start time, displayed in hours and minutes (e.g., 08 45). If PABC is pressed again, instead of VIEW, ABC n-IT is displayed. This is the interval, in hours and minutes, between ABC cycles. If ABC ST = 00 00 and ABC n-IT = 00 00, ABC is not performed. If only ABC INT = 00 00, then there is one ABC at ABC ST time. The next function of the PABC key is the HOLD ftmction.. Pressing PABC after ABC INT displays the status of hold (HOlD ON or HOLD OFF). Pressing VIEW toggles the status of HOLD. If HOLD is ON, the temperature just before the beginning of an ABC is output on the RS-232 port and the analog output port, and held until the ABC cycle is completed. The front-panel LED display shows the true temperature during the entire ABC cycle. If HOLD is OFF, the front panel LED, the RS-232 output, and the analog output continue *to* reflect the true temperature during the cycle.

HEAT: This key toggles the MAX HEAT mode, during which the control loop is bypassed and the minor is heated. The front panel LED flashes a letter "H" and the RS-232 output indicates MAX HEAT. During an ABC cycle, MAX HEAT (MAX COOL) does not fimction..

COOL: *As* above, but toggles the MAX COOL mode and flashes a letter *"C'* on the LED display.

NOTE

Turning on MAX HEAT turns off MAX COOL and vice versa; both cannot be activated simultaneously.

OUT: This key allows the user *to* view and change the scaling range of the *0-5* VDC and 4-20 ma analog outputs. The user can simultaneously output any *one* of the available measurement parameters on *both* analog outputs. If the instrument has more than one measurement parameter available (such as the Model2002), only *one* of those parameters can be assigned *to* each of the outputs. The user selects the measurement parameter and dedicates both ouputs *to* that parameter. (Remember, the RS-232 serial commlDlication will output *all* measurement parameters at the same time.)

To scale the analog outputs:

1. Press the OUT key until the desired measurement parameter is displayed on the front panel. The instrmnent must be configured with a particular

measurement parameter in order to select it for output.

2. Press VIEW key. The display key will read: XX IDGH, the upper limit of the selected measurement parameter.

3. Press VIEW key again to display the *present* high setting.

4. Enter the desired high value. Press ENT to store the high value. (Note: for positive numbers, including zero, a "+" must preceed the number, otherwise an ERROR message will appear on the display.) The display will now read XX LOW, the lower limit of the measurement panuneter.

5. Press VIEW key again to display the *present* low setting.

6. Enter the desired low value. Press ENT to store the low value number. (Note: for positive numbers, including zero, a "+" must preceed the IDmlber, otherwise an ERROR message "9.'ill appear on the display.)

ENT: If a change is being made to any parameter, this key enters the new value shown on the LED display to the memory nonvolarile. If a mistake is made, the ESC key can be pressed instead to cancel any changes in process. If the proposed change is not valid (e.g., hour >24), the LED displays ERROR after ENT is pressed and returns to normal operation.

RSET: This key tums off the flashing Alann LEDs. A flashing alarm light indicates that the temperature value has exceeded the a1mn values and the Alarm is in the Latched mode.

ALMl, ALMl: These keys allow viewing and/or changing the type (high or low) and the temperature of the two a.lm:ms. The two *alarms* are completely independent of each other. The first press of one of these keys displays ALARM x. Pressing VIEW shows the type and temperature of that alarm and enables a change to be entered, if desired. All alarm entries must begin with a > or < key, followed by a + or - key, followed by the temperature value. The decimal point is fixed on the LED display and the digits scroll to *the:* left. If the above order is not followed, the system returns to normal operation. After ALARM x is displayed, pressing the ALM key again will display the status of that Alarm's latch. Pressing VIEW will then toggle the Latch mode.

ESC: This key is used to return to normal operation after viewing any parameter or setting, with no changes made.

NOTE

If ESC is not pressed, the Model 2000 Series automatically returns to normal operation after about 10 seconds of no keypad activity.

3.4 FRONT PANEL INDICATORS

Table 3-2 lists each of the indicators on the Model 2000 Series front panel (Figure 3-1) with a brief description of their :functions. A detailed description of the indicators is presented in subsection 3.5.

Table 3-2. Identification of front panel indicators.

Indicator	Function
8-cbaracter alpha-nmneric display	Nonnally displays the dew display temperature but can be used to view all operating p8I3Dleters stored within the Model 2000 Series.
10-LED BARGRAPH CONTROL	Indicates status of the Sensor control.
ALARMl and ALARM2 LEDs	Indicates status of alarms. ON=latched
ABC LED	Indicates status of Automatic Balance Control cycle. ON= in ABC mode.
CONTAMINATED LED	Indicates inability of ABC cycle to balance system and clean the mirror.

Operating Instructions

3.5 FUNCTIONS OF FRONT PANEL INDICATORS

The CONTROL indicator represents the current that is controlling the heating or cooling of the Sensor. All lights on represents high cooling current; no lights on represents high heating current.

During normal operation. the number ofbars lit will be roughly indicative of the dew point. For a low dew point, more cooling current will have to be supplied continually, so more bars will be lit (6 - 8 bars). At high dew points, little current may be used so that five or fewer lights will be on. If the system needs to servo to maintain the dew point, one or more bars may temporarily illuminate.

During the begjm;ng (heating) phase of an ABC, the CONTROL bars first indicate the imbalance caused by entering the ABC mode by having 0 or 1 bar lit. Then. as the Sensor dries out, the indicator should move toward the center (4-6 bars). If it does not, then an intemai balance adjustment must be made (see subsection 5.6.1). The adjustment is made using the bar display. At the end of a successful balance cycle, all bargraph LEDs will ilbnninate. indicating a heavy cooling current, and then stabilize as the dew point is found.

The ALARM LEDs are on when an alarm condition is satisfied. In a Latch mode, if a satisfied a1arm condition becomes unsatisfied, the LED begins to flash, indicating that there was an alann condition. Depressing the RSET key turns off the flashing LED. If a satisfied alann condition exists when an ABC is started, the almm is cancelled, but the LED flashes. If an alarm LED *is* flashing when an ABC is started, the flashing will be cancelled.

NOTE

The alann relays are never energized during an ABC cycle.

The ABC LED comes on when an ABC cycle starts, whether amomatic or manual. It remains on steady during the heat phase and the balance phase. After a successful balance, the ABC LED flashes for the duration of the ABC hold time. If Hold is on, the analog outputs are held until the LED is out.

The CONTAMINA'IED LED comes on if an ABC is unsuccessful After the heat phase of an ABC, attempt to :find an acceptable balance point. If the mirror is badly contaminated and balance is impossible, then the LED indictaes a need to clean the Sensor mirror.

3.6 R.S-232 SERIAL PORT

The Model 2000 Series serial port on the rear panel can be used to operate the unit, program parameters, or output data to a printer, data terminal, or personal computer. To be effective, the RS-232 must be connected to a computer equipped with an appropriate communication software. At the factory, we use PROCOMM and PROCOMM+.

3.6.1 Computer Connection

Connect an RS-232 cable between the Model 2000 Series 25-pin D-Type connector and the RS-232 serial port of a PC, terminal, or printer. All handshaking lines are available at the connector; however a 3-wire XON/XOFF cable is all th.al: is nOimally required. The serial port is wired as a DTE device (Data Temrinal Equipment); i.e., Transmit (TxD) is pin 3 and Receive (RxD) is pin 2. For connection to a DCE device (Data Communications Equipment) such as a PC, a direct pin-to-pin cable is necessary. For connection to another DTE device such as a printer, a null modem is required.

3.6.2 'PC Setup

Set the Model 2000 Series to the preferred baud rate via the :front panel The available baud rates are 19.2K., 9600, 4800, 2400, 1200, and 300.

Set up the PC's communication program for a baud rate to match the Model2000. The protocol should be 8 data bits, 1 stop bit, and no parity (N81).

Once communication is established, the available commands can be viewed by accessing the HELP menu. Press the ENTER key on the computer keyboard.

Enter Command (H for Help): Type the letter "H" and press ENTER.

The HELP menu shovvn. in Table 3-3 will be displayed on the computer's screen. NOTE: If no actions are taken, the Model 2000 Series will revert to data mode in 15 seconds.

Table 3-3. HELP menu.

Options	Example (Max Entries ShoWD)
Display the HELP Menu	H <CR>
Enter New Time (HH::MM: SS)	T <CR> 23:59:59
Enter New Time (MM:DD:YY) 12:31: 99	D <CR>
Temperature Units (F,C)	U <CR.> C <CR.>
ABC Start TJmc (HH:MM)	AS <CR> 23:59<CR>
ABC Interval (HH:MM)	AI <CR.> 23:59<CR>
Alarm!(>.<)(±)(Deg)	A1 <CR> < 100.0<CR>
A1arm2 (>.<) (±) (Deg)	A2 <CR> <-100.0 <CR>
Analog Output (Min) (Max)	AO <CR.> -100 100 <CR>
Baud Rate (Baud)	B <CR> 19200<CR>
Output Interval RS-232 (Sec Gap)	O <CR> 3600<CR>
Poll for Dew Point	P <CR>
Start a Manual ABC Cycle	AB <CR.>
Average (Number of Data Points)	AV <CR> 16<CR>
Max Heat Toggle ON/OFF	MH <CR>
Max Cool Toggle ON/OFF	MC <CR>
La hAbmmlTo eON/OFF	Ll
h Alarm2 Toggle ON/OFF	L2

In the data mode, the screen will display dew point data at intervals as set by the "'utput Interval" setting.

3.7 RS-232 COMMANDS AND PARAMETER SETTING

3.7.1 Time

Press the ENIER key on the computer keyboard. The "Enter Command (H for Help):" is displayed. Type the letter "T" and press ENTER.

The time format is: Hours:Minutes:Seconds. Hours is expressed in 24-hour military time.

Enter the desired time with colon delimiters:

00:00:00 = 12 midnight
23:59:59 = 11:59:59 p.m.

N01E: Two digits must be used for each entry field.

3.7.2 Date

Press the EN1ER key on the computer keyboard. The "Enter Command (H for Help):"' is displayed. Type the letter "D" and then press EN1ER.

The DAJE format is: MONTH:DAY:YEAR

01:01:00 = January 1, 2000

12:31:99 = December 31' 1999

N01E: Two digits must be used for each entry field.

3.7.3 Units (F,C)

The Model2000 Series can display temperature in either Degrees C or Degrees F. The front panel and the RS-232 data will reflect the selection.

Press the ENTER key on the computer keyboard. The "Enter Command (H for Help):"' is displayed. Type the letter "U" and press ENTER. Type "C or F"' and press ENI'ER.

3.7.4 ABC Start Time

Press the ENTER key on the computer keyboard. "Enter Command (H for Help):" is displayed. Type the letters "AS" and press the ENTER key. Enter the time "Hours:Mmutes," and press the ENTER key.

37.5 ABC Interval

Press the "Enter" key on the computer keyboard. The "Enter Command (H for Help:" is displayed. Type the letters "AI" and press the EN1ER key. Type the time in "Hours:Mmutes" and press the ENTER key.

Example: If the ABC Start Time is 08:00 (8 o'clock in the moming) and the ABC Interval is 2:00, the first .ABC cycle would occur at 8:00 AM and every two hours thereafter.

3.7.6 Alarm 1 and Alarm 2

These are the relays that can be set to operate at predetermined dew point limits.

Each relay can be set as a high or low set point by use of the greater than ">" and less than "<., symbols.

Each can also be set to latch when a limit is exceeded. In the latch mode, the a1aim will remain active even if the alarm condition returns to nonna.l. To cancel the alarm, the operator must press the RESET button on the keypad. If the latch mode is not set, the relays will deactivate when the a1ann condition is COlTeCted.. In this case, however, the front panel a1aim indicators will flash to alert the operator of an alarm that has occurred, but has been corrected The RESET button on the keypad will reset the indicators.

To enter the alarm limits:

Press the ENIER key on the computer keyboard

The "Enter Command (H for Help):" is displayed

Type the letters "A1" for alarm 1 or "A2" for alarm 2 and press ENIER.

Enter the set point beginning with the > or < symbol followed by the sign and value of the a1.ann limit. When completed, press the ENTER key.

3.7.7 Analog Output (Low) (High)

This parameter sets the 0-5 volt and 4-20.ma (analog) lower and upper output range. The instrmnent range is -50to+lOOOC.

NOTE

A plus (+) sign is not needed for positive temperature entries, but a negative (-) sign is necessary.

If programming a positive temperature via the *front panel*, a plus (+) sign is required.

Press the ENTER key on the computer keyboard The "Enter Command (H for Help):" prompt is displayed. Type the letters "AO" and press the ENTER key. Enter the limits with a plus or minus sign first, then the lower temperature, a space, and the positive or negative upper temperature.

Press the ENTER key to record the values.

Example: -33[sp]45 gives a low value of -33°C and a high value of +450C.

37.8 Baud Rate

The available baud rates in the Model 2000 Series are:

19200, 9600, 4800, 2400, 1200, or 300

NOTE

Both the Model2000 Series and the computer must be set to the same baud rate for communication to take place. If the unit is not communicating properly, check the Model2000 Series' baud rate setting via the front panel and set the communications software to match the Model2000 Series. Also verify that the data fOimat is correct (i.e., Data Bits = 8, Stop Bits = 1, Parity Bit= N).

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37.9 RS-232 Output Interval

This is the interval in seconds between automatic data output transmissions of the RS-232 data output. The time range is from 0 to 3600 seconds.

NOTE

An entry of zero will stop RS-232 data from being output.

Press the ENTER key on the computer keyboard The "Enter Command (H for Help):" prompt is displayed Type the letter "0" and press the EN1ER key. Enter the desired interval in seconds and press ENTER

3.7.10 Poll for Dew Point

This command requests the Model 2000 Series to send data. It is independent of the automatic interval.

Press the ENTER key on the computer keyboard. The "Enter C()!Timand (H for Help):" prompt is displayed Type the letter "P"and press the ENlER." key.

37.11 Start an ABC Cycle

lbis command initiates an ABC cycle and can be issued at any time. The cycle is the same as a programmed ABC cycle.

Press the EN1ER. key on the computer keyboard. The "Enter Command (H for Help):" prompt is displayed Type the letters "AB" and press the ENTER key.

3.7.12 Number of Points to Average

This command sets the number of temperature readings to average between display updates. The limits are 1 to 16.

Press the ENIER key on the computer keyboard. The "Enter Command (H for Help):" prompt is displayed Type the letters "AV" and press the ENTER key. The Model2000 will respond with "Enter SETTING=.,., Type in the two-digit value and press the EN1ER. key.

3.7.13 Max Heat

This command toggles the Sensor's heater on or off. It can be initiated at any time and can be used to clear excessive moisture from the mi.rror in flooding situations.

Press the EN1ER key on the computer keyboard. The "Enter Command (H for Help):" prompt is displayed Type the letters "MH" and press the ENTER key. The Model2000 display will show a flashing H and the temperature will rise. To turn off the HEAT mode, enter "MH" again.

3.7.14 Max Cool

This command toggles the Sensor's cooler on or off. It can be used to test the maximum depression of the Sensor.

Press the ENTER key on the computer keyboard. The "Enter Command (H for Help):" prompt is displayed Type the letters "MC" and press the EN1ER key. The Model2000 Series temperature will decrease and the display will show a flashing "C."

To tum off the COOL mode, enter "MC" again.

NOTE

After an extended period of time in the cool mode, excess moisture or frost will form on the mirror. It may be necessary to "Heaf' the mirror to shorten the drying time.

3.7.15 Alarm 1 and Alarm 2 Latches

The alam1s can be set to latch on an alarm condition by typing "Ll" for a1ann 1 or "1..2" for alarm 2 from the HELP menua. The Ll and L2 commands toggle the latch on or off.

3.7.16 Status Report

This command gives the user a report of all the Model 2000 Series settings. To get a status report, do the following.

Press the ENTER key on the computer keyboard. The "Enter Command (H for Help):" prompt is displayed. Type the letters "ST" and press the EN1ER key. The display will show:

NOTE

The X's represent user entered data.

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Model2000 Series-Status Report

Current Time:	:XX:XX:XX
Current Date:	XX:XX:XX
Temp Units:	X
ABC Start Time:	:XX:XX ABC
Interval:	:XX:XX
Alarm 1 Temp:	XXXXX.X:X
Alarm 2 Temp:	X XXXX.X:X
A1ann !latch:	XXX
Alarm 2 latch:	XXX
Analog out:	XXXX to :X:XXX
Average:	XX
Baud:	XXXXX
Out Interval:	XX
Hold:	XXX

3.8 PROGRAMMABLE INPUT PARAMETER LIMITS

Table 3-4 is a chart of the data input limits for the programmable parameters. If data fall between these listed ranges, the Model2000 Series will respond with a front panel display of "OKAY."Data outside these ranges will cause the unit to respond with the word "ERROR" on the front panel display and an "INVALID ENIRY" message on the RS-232 display.

Table 3-4. Programmable limits.

Function	Limits Min	Max	Units
ABCST	0000	23 *59*	TIME (HRSIMINS)
ABCINT	0000	23 *59*	TIME (HRSIMINS)
OUTHIGH	±100	±100	DEGREES
OUT LOW	±100	±100	DEGREES
ALARM!	>-100.0	<+100.0	DEGREES
ALARM2	>-100.0	<+100.0	DEGREES
AVE	01	16	READINGS TO AVERAGE
BAUD	300	19200	BAUDRA1ES
OUTINT	000	3600	TIME (SECONDS)

3.9 DEFAULT PROGRAMMABLE PARAMETERS

If a fault is detected in the parameter memory, or the nonvolatile memory chip is replaced, the instrument will replace all the user entered parameters with the default parameters listed in Table 3-5.

Ta le 3-5. Default programmable parameters.

FDDc:tion	Default Parameters
ABCST	08 00 (HOURS MINUTES)
ABCINT	12 00 (HOURS MINUTES)
OUTIUGH	+60 DEGREES C
OUT LOW	-40 DEGREES C
ALARM ▮	*>+50.0* DEGREES C
ALARM2	>+50.0 DEGREES C
AVE	01
BAUD	2400
OUTINT	60

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4.1 SYSTEM OPERATION

4.1.1 Main Control Loop

be EdgeTech Model2000 SeriesDewPrime Dew Point Hygrometer accurately measures the dew point of a gas by cooling a su:rf3ce over which the gas flows until a layer of dew forms on the surface, then maintaining the temperature of that surface such that the layer of dew remains uniform. This control loop operates according to the method shown in the block diagram, Figure 4-1. The surface is a mirror, with an LED light source shining on it and reflecting to an optical sensor. Another LED light source shines directly on a second optical sensor. The system is set up so that when the miiror is dry, a positive voltage is output from amplifier Al. This positive voltage results in positive current from amplifier A2, a voltage-to-current converter, into the thermoelectric heater/cooler to cool the mirror .surface. When the dew point temperatme is reached, a layer of dew begins to form on the mirror, resulting in decreased reflectance of the LED light and a positive signal at the input snmming point of amplifier Al. Since Al is an inverting amplifier, the voltage output of A1 will reduce (possibly become negative) and result in a decrease in cooling current (or poSSioly a reversal, causing heating to occur). The temperature of the mirror surface is maintained closely in this manner, and the temperalUre of the mirror is monitored by means of a Platinum Resistance Thermometer (PRT), embedded beneath the miiror surface.

4.1.2 Temperature

The PRT is part of a bridge, and the bridge output, proportional to the temperature of the mirror smface, is amplified by A3 and converted into a digital value approximately once per second, which is used for display of the dew point, analog output (via a digital-to-analog converter), monitoring of alarm. levels, and RS-232 digital outputs.

4.1.3 Automatic Balance Control (ABC)

At programmable intervals, the Model 2000 Series can be forced into an Automatic Balance Control (ABC) cycle to compensate for the buildup of contaminants on the mirror surface, which may change the optical balance of the system. When an ABC is begun, the control loop is intem.Jpted, the mirror is heated so that the dew is evaporated, and a new balance point is found that compensates for the contaminants that may have accumulated and caused a change in the reflectivity of the mirror. The control loop is then reconnected, and, after some time, normal control operation is attained.

4.1.4 Microprocessor Control

All timing fimctions, such as when and how often ABCs occur, parameter setting such as alarm levels, and outputs, both analog and 232, are under microprocessor control. All parameters can be viewed and/or changed via the front panel keypad. All parameters can also be viewed/changed via the RS-232 port. The keyboard menu system is arranged with the user in mind. All functions can be acussed by at most four key presses, some by two. When a key is pressed, the microprocessor stops its normal routine of temperature measurement to service the user. No:rmal operation is resmned when the user is finished with the task, or when a time-out of about 10 seconds between key presses occurs. When using the RS-232 port to communicate with the Model2000 Series, normal operation is interrupted.

4.2 CIRCUIT DESCRIPTIONS

4.2.1 Thermoelectric Dew Point Tempenture Control Circuits

The thennoelectric dew point temperature control circuit heats and cools the mirror surface of the dew point Sensor to the temperature necessary to have a layer of dew on the mirror that is in equilibrium with the moisture in the sample gas in the Sensor. It also maintains that equilibrium even though the temperature necessary to do so may vary. To accomplish this, an LED light source shining on the mirror surtace of the Sensor is driven from a constant current source. This circuit maintains the LED current constant regardless of changes in cable resistance, cable length, temperature, etc. The light reflected from the miiror surface in the Sensor is detected by a direct phototransistor. A separate LED and phototransistor are also located in the Sensor and serve as bias controls on the effects of temperature changes on the LED output intensity and

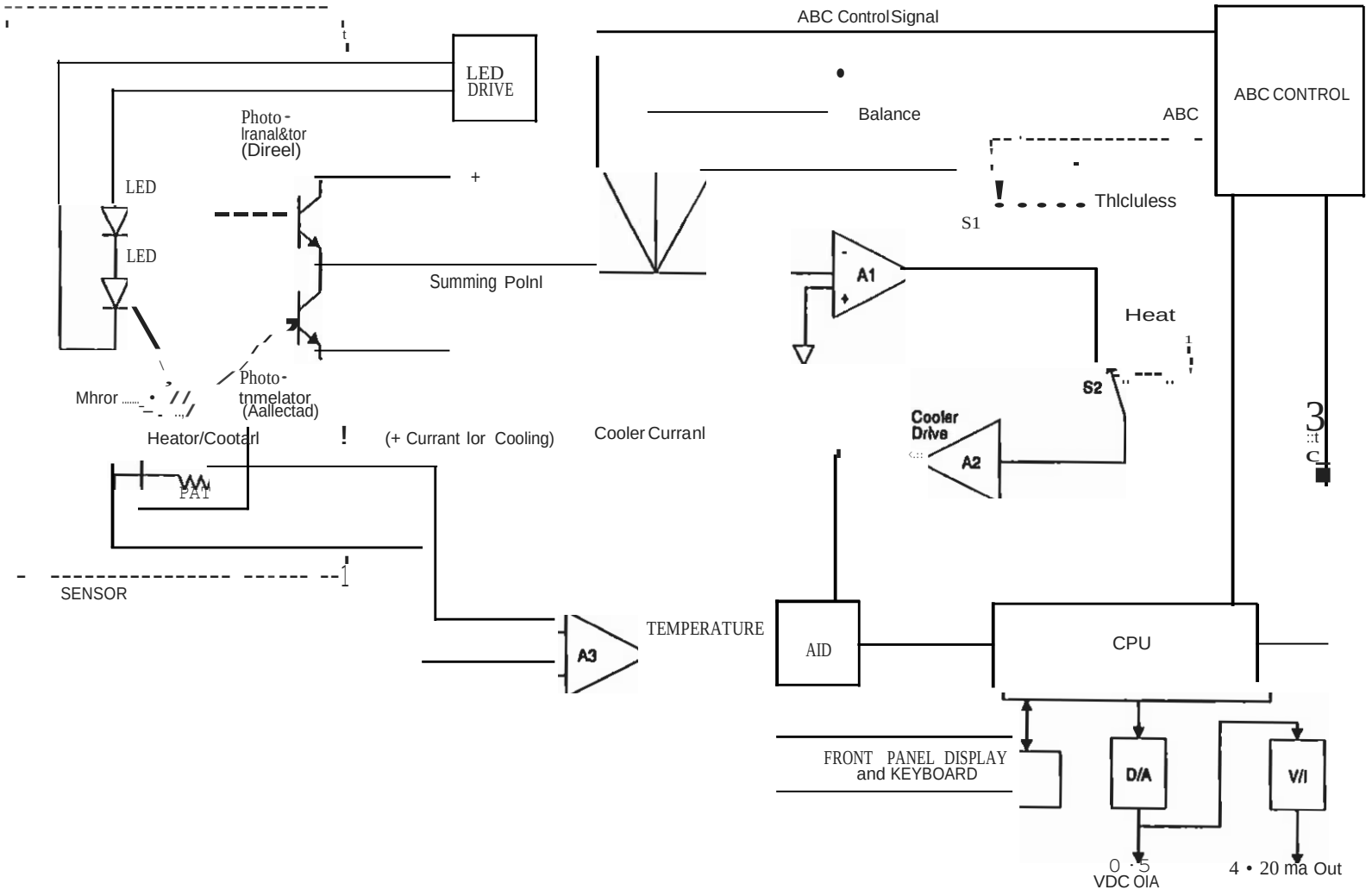

Figure 4-1. Block diagram ofEdgeTecb ModellOOO Series DewPrlme Dew Point Hygrometers.

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phototransistor gain. The combined outputs of the direct and bias phototransistors are used to drive the Control Amplifier circuit. If the mirror surface is dry, this Control Amplifier circuit instructs the Cool/Heat Power Amplifier to cool the mirror surface. When too much dew forms on the mirror surface, the Cool/Heat Amplifier reduces the cooling level to heat the minor surface, if necessary. This circuitry, i.e., the phototransistor sensing the reflectivity of the Sensor mirror surface, the Control Amplifier circuit, and the Cool/Heat Amplifier, is connected to form a servo-controlled loop. When operating, it adjusts itself automatically to control the Sensor mirror surface at the temperature required to maintain a layer of dew on the mirror surface in equilibrium with the gas sample around it.

When the Model 2000 Series is in the Automatic Balance Control (ABC) cycle mode, the servo loop described above is interrupted, and the Cool/Heat Amplifier is forced to heat the mirror surface to evaporate any dew or frost present so that the circuitry may automatically compensate for changes in mirror reflectivity, should they occur. Once this compensation has been achieved, the loop is reconnected and allowed to control on the dew point temperature once more.

4.2.2 Sensor PRT Resistance-to-Voltage Converter

The temperature of the mirror surface is measured by means of a Platinum Resistance Thermometer (PRn embedded beneath the mirror surface. The resistance of the PRT device varies almost linearly with changes in temperature. The circuitry in this section interfaces with the PRT with adjustments for ZERO, SPAN, and LINEARITY.

4.2.3 Automatic Balance Control Circuits[1]

The Model2000 Series automatically verifies its own performance on a timed sequential basis by means of an automatic self-standardization circuit. This circuit adjusts for changes in the condition of the mirror surface, or for changes in any of the circuitry associated with the Sensor optical system and control loop. The Automatic Balance Control (ABC) cycle is initiated upon instrument tum-on. In addition, the ABC cycle can be initiated automatically at programmable intervals.

An ABC cycle may also be initiated manually at any tiJne by depressing the MABC (Manual Automatic Balance Control) key on the Control Unit front panel keypad, or remotely via the RS-232 port.

Associated with the ABC cycle is the tiJne required to complete the cycle. The bulk of the cycle tiJne is made up of a period of time when the dew point Sensor mirror sur:&ce is being heated above the ambient tempeiature to remove any condensate on it, either dew or frost. 1bis heat time is preprogrammed in the Model 2000. At low temperatures, greater time is needed to evaporate the condensate. Jf the temperature aithe beginning of the ABC cycle is greater than 0°C, the heat time is 1.0 minute. If the temperature is 0°C and -25°C, the heat time is 2.0 minutes. At temperatures below -25°C, the heat time is 4.0 minutes. At the end of the selected tiJne period, the circuit automatically balances the optical bridge and control loop and returns to normal operation.

4.2.4 Alarm Set and Protection Circuits

With the Model 2000 Series Control Unit, it is possible to establish set points for operation of each of two alann relays. Once the set point has been established, between -50 and+100°C, the alarm relay remains de-energized as long as the actual dew point does not satisfy the alann set point, and energizes as soon as the actual dew point satisfies the alarm set point. The outputs of each relay-a single pole, double throw (SPOT) contact-are aU brought to the rear panel connector for use in customer-provided alarm indicator ciJ:cuits.

Protection circuits have been incorporated into the Model2000 Series electronics to prevent damage to the Sensor from overheating caused by normal circuit operations. The first of these protection circuits is a thermostat installed in the base of the Sensor to shut down Sensor thermoelectric current in the event that the Sensor base temperature exceeds +105°C. Since the Sensor is designed to operate in ambient temperatures up to +100°C, it is possible, if attempting to read vezy low dew points under these conditions, that the energy

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dissipated in the thermoelectric cooler can raise the temperature of the Sensor base above +100°C, if it is not attached properly to an appropriate heat sink. If this should occur, the thermostat in the Sensor base will open rather thanrisk damaging the Sensor.

The second of these protection circuits also relates to the high temperature operation for which the Model2000 Series bas been designed. This protection circuitty monitors the Sensor mirror temperature continuously and automatically shuts off any current flow to the Sensor thcnnoelectrics should the mirror temperature exceed+100°C. This can occm primarily when the Sensor is at a high ambient temperature, +50°C to +100°C, and an automatic self-standardization cycle is initiated which heats the mim>r surmce. This heating could ca1lSe 1he mirror temperature to exceed+1000C and damage the Sensor. However, this circuitry protects against this possibility.

4.2.5 Display Cireoitry

The Model2000 Series is equipped with an 8-character alphanumeric LED display allowing presentation of numeric and alphanumeric information.

4.2.6 Track or Hold Circuitry

The Track or Hold circuitry provides (1) an analog dew point temperature oUlpUt identical to the direct dew point temperature output as l<mg as the system is controlling on the actual dew point temperature, and (2) a steady output coriesponding to the actual dew point value *just prior* to an ABC cycle, during the entire cycle. The time when the two outputs are identical is called the Track mode; the time spent during the ABC cycle is called the Hold mode. By attaching process control instrumentation to the output of the Track or old circuitry, rather than to the direct output of the Sensor mirror PRT readout ci:rcuitty, the mirror t.empelamre increase and decrease that occur during the ABC cycle can be effec-- tively "lnaskedduring this period. This feature can be disabled by turning HOLD off.

During the ABC cycle, initiated automatically at power tum-on, the output of the Track or Hold circuitry will be the ambient temperature at the time of power tum-on.

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5.1 ROUTINE MAINTENANCE

To ensure the maximum in accurate and reliable operation ofthe Model2000 Series, a periodic m.al:D.tenance program should be established. The first area of interest is to avoid impeding the normal flow of air by natural convection around the instrument by ensuring that items do not get placed near or mder the Model2000 Series Control Unit.

5.2 MIRROR CLEANING SCHEDULE

Contrazy to what might be expected, the mirror sur:filce in the Sensor need not be spotless for proper operation. In fact, mirror surface contnninants act as nuclei for the condensate, thus hastening formation.

The buildup of contamination on the mirror surface normally occurs very slowly. Dust and other matter borne by the sample gas adhere to the mirror surface as they are collected by the dew layer present on the mirror. Also, particulate matter that may be passed by system line filters can also be deposited on the mirror's surface. The net result of the buildup of contaminants on the mirror surface is reduced reflectivity. This is the same effect caused by the presence of dew on the mirror. Therefore, it is necessary to compensate the circuitry occasionally to account for the change in reflectivity of the mmor sur:filce due to coiJtaminants.

This compensation for change in miiror reflectivity is accomplished automatically in the Model 2000 Series with each Automatic Balance Control (ABC) cycle. This patented feature adjusts the circuitry automatically for any reduction in mirror surface reflectivity that occurs when the mirror is dry, and ensures that normal operation of the Model 2000 Series will be proper, even after long periods of continuous tmattended operation.

Eventually, however, buildup of contaminants on the Sensor mirror su:rbce may become so great that it is necessary to clean the mirror surface. Normally, intervals of 90 days between routine mirror cleanings can be easily achieved. However, if gas sample operating conditions are particularly severe, more frequent mirror cleanings will be required. Whenever the instrument cannot electronically adjust for conrnm__inarion, the ABC cycle cannot be completed. This is indicated by the illumination of the CONTAMINATED LED. When this occurs, clean the mirror surface and optical parts. Then depress the MABC key on the Model2000 Series front panel to allow the circuitry to readjust for the clean mirror surface before retuming to normal operation.

5.3 MIRROR CLEANING

To clean the mirror surface in the S2 Sensor, remove the spin-off cover from the Sensor to expose the mirror. For the S1, remove tbree hex head screws.

CAUTION

When operatmg with a pressurized sampliDg system, be sure to remove pressure from the Seusor prior *to* removing the Sensor cover.

When the cover has been removed, lightly dampen a Q-tip with isopropyl alcohol. Q-tips and cleaner are provided in the Cleaning Kit shipped with the Model 2000 Series. Do not use an excessive amount of cleaner on the Q-tip. Shake the Q-tip to remove all excess fluid prior to cleaning tlie mirror surfuce.

After cleaning the mirror surface, remove all traces of the cleaning fluid with the dry end of the Q-tip. To remove particulate matter present around the mirror surface, use a clean, dry Q-tip, not isopropyl alcohol.

For those applications where the isopropyl alcohol is ineffective in removing hard deposits or varnishes, a polishing paste-Simichrome Polish (Competition Chemicals, Iowa Falls, Iowa 50125)--may be used sparingly. To prevent excessive ero<li:ng of the mirror surface, avoid using this material unless necessary.

5.4 CALIBRATION OF PRT

A Platinum Resistance Thennometer (PRT) is used in the dew point Sensor. To measure the temperature, the PRTresistance is converted to a voltage by aPRT amplifier. This amplifier contains controls for ZERO, SPAN, and LINEARITY. By adjusting these controls, the PRT amplifier produces a linear output voltage proportional to the temperature sensed by the PRT.

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These adjustments are made at the factory and nonnally do not have to be changed. However, changes in cable lengths used to mount the dew point Sensor remotely may require readjustment (there is approximately a 0.10C change in output for a 50-foot change in cable length). Factory adjustments are made based on cable lengths specified at time of purchase. If it becomes necessary to check the operation of the PRT amplifier, or if the remote cable length is changed significantly after shipment from EdgeTech, then the procedures descdbed in subsection 5.5 should be followed. A precision cah'brated resistance decade box with a ±().01% accuracy is required for making these adjustments.

55 CALIBRATION OF THE PRT AMPLIFIER

When recalibration is attempted for the reasons *dis*-cussed above, the following procedure is recommended:

1. Remove the Sensor from the end of the cable (either long or short) and prepare a precision resistance decade box to be used to simulate the PRT in the Sensor.
2. Tum on power to the Model 2000 Series and wait 1/ 2 hour to ensure that all electronics have reached an equilibrium condition.
3. Remove the top cover by removing the six retaining screws.
4. SettheresiSWice decade box to 100.00 ohms.
5. Use three equal length and gauge wires to connect pins 4 and 10 of the connector removed from the Sensor to each other and to one terminal of the decade box. Connect the other terminal of the decade box to pin 9 of the Sensor cable connector.
6. The front panel digital meter should be reading 00.0°C at *this* time. Adjust the ZERO potentiometer, R76, on the Main Board um:il this readmg is attained.
7. Set the resiSWice decade box to 119.40 ohms and adjust the SPAN potentiometer, R69, on the Main Board for a display of +50.0°C.
8. Set the resistance decade box to 13.4.70 ohms and adjust the LIN (Linearity) potentiometer, R83, on the Main Board for a display of +90.0°C.
9. Repeat steps 6,7, and 8 as often as required to bring each temperature reading to within ::!;().10C of the values given. Each adjustment interacts slightly with the others so it may be necessary to repeat these steps several times.
10. By setting the resi.stmce decade box to 88.22 ohms, a lower value of -30°C can be checked.
11. Once calibration has been completed, remove the resistance decade box and reattach the Sensor to the end of the cable. After the Sensor is reconnected, press the MABC key and reattach tbe Coo1rol Unit cover to the chassis. The resistor values to be used for cahlmltion purposes (listed in the above procedure) are nominal values that serve for most Model 2000 Series Sensors. This allows for interchangeability of Sensors without recalibration. However, if the cah'bration values for a particular Sensor are different from those listed here, the COirect values will be included on a separate docmnent shipped with the Sensor and the certificate of cah'"bration.

5.6 OPERATING ADJUSTMENTS

The Model2000 Series is designed to operate without operator control. Although there are several potentiometers on the PC boards, all are &.ctory set, and nonnally it is not necessary to adjust them. Ho er, certain adjustments may be made by the user after a knowledge of the instrument and its capabilities bas been achieved, and when familiarity with the instrument bas been gained. These adjustments are BALANCE, TmCK-NESS, GAIN, and COMPENSATION. The BALANCE adjustment affects the static setup of the instrument, and the other three affect the dynamic response of the instrument to changes in the dew point temperature of the gas sample in the Sensor.

5.6.1 Balance for S2 Sensor

Move the selector switch on the main board to the "660" position. The BALANCE control, potentiometer R52, is used to make the CONfROL LED (10-LED bargraph)

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read near center scale when the ABC LED is steadily illuminated. It performs the same fimctions as the ABC circuitry and determines a starting point for the ABC. It is particularly useful to adjust this BALANCE control when a new Sensor is attached to the Model2000 Series Co ol Unit

After the Model2000 Series Control Unit has been on for more than one hour, depress the manual ABC (MABC).key on the front panel This causes the ABC indicator to light steadily. Jf there is a dew layer on the Sensor miiror, the 10-LED bargraph CONTROL indicator will show the imbalance by being completely unlit or by having one LED lit *As* the dew evaporates, more LEDs will light, moving the bargraph toward the center. 'When the bars stop illuminating and the ABC light is on in a steady condition, BALANCE potentiometer R52 can be adjusted to ma.ke the CONTROL bars indicate as close to the center of the scale as poSSiole (4-6 LEDs lit). It is preferable to make this adjustment after the Sensor mirror surface has been cleaned (subsection 5.3). Once set, and as contaminants build up on the Sensor mirror surface, the CONTROL barn begin to indicate more to the left of center whenever the instrument is in its automatic self-standardization (balance) mode, and whenever the ABC lamp is on steadily and the Sensor mirror is dry. If the lJli:lror surface is knovm to be clean, and the CON1ROL bar LEDs indicate to the far left or right with a dry miiTor and a steady ABC light, then R52 should be adjusted. After R52 is adjusted, and contaminant buildup causes the CONTROL bars to indicate to the far left1Dlder the same conditions of dry miiror ABC lamp is on steady, the mirror should be cleaned in accordance with the standard practice outlined in subsection5.3.

5.6.2 Balance for Sl Sensor

Move the selector switch Sl on the main board away from the "660"position. Follow the directions in subsection 5.6.1 using Rlll (Bal2) instead ofR52.

5.6.3 Thickness

TI:UCKNESS control potentiometer R64 varies the thickness of the dew layer on the Sensor mixror surface when the dew layer on the miiTor surface is in equili'b-rium. with the moisture in the air sample passing over the mirror. The 1HICKNESS comrol has only a minimal effect on the dew point temperature. Any setting of this control represents a compromise between fast dynamic response of the Sensor and insensitivity to contaminants on the miiror surface. The Model2000 Series, as shipped, has been set for optimmn response with mirror cleaning intervals in excess of 90 days for nonnal gas sample environments. (The time between mirror cleaning periods is determined largely by the quality of the filtering of particulate matter from the gas sample.) If a faster response to changes in dew point temperatures is required, the dew layer thickness can be reduced. Conversely, iflonger periods between mirror cleanings is required for the operating conditions being experienced, the TID:CKNESS comrol can be increased..

TinCKNESS control potentiometer R64 is a single-tum device. Before changing this control, always record its factoxy-set position for ease in returning to the original position at a later date. Use Test Points 1P12 and 1PDGND for this measurement.

If the TI:UCKNESS control is set too thin, i.e., few bars illuminate on the CONTROL indicator, the Sensor mirror temperature will not depress to the dew point temperature. If set too thick, the Sensor will not control on the dew point temperature, but will continue to cool UDtil a dew point temperature, approaching the *maxi*-mum Sensor miiror depression from ambient temperature capability, is reached.

Whenever the TinCKNESS comrol is adjusted, always depress the PABC key on the front panel to perform an ABC cycle before returning to nonnal operation.

5.6.4 Gain

GAIN control potentiometer R57 is a s:ingle-tum control similar to the TillCKNESS control. The GAIN control adjusts the overall gain of the Model2000 Series control loop that controls the proper dew point temperature. The overall gain of the control loop is dependent on the electric gain of the control loop circu:itry, and the gain of the condensation phenomenon on the dew point Sensor mirror surface. The gain of the condensation phenomenon is related to the mobility of the condemate, which is both a ftmction of the absolute temperature and the state of the condensate (water or ice), being high for

high temperatures and water deposits, and low for low temperatures and ice deposits. The GAIN adjustment compensates for this change in gain of the condensate phenomenon.

The GAm control is set at the fi!.ctory to provide stable operation over the range of operation of the instrument. Before making adjustments to the GAIN conttol, always record the bctory-set position to aid in returning to the original position at a later date. However, if dynamic performance must be optimized for a particular operating dew point, the GAIN control may be adjmted clockwise as far as possible until unstable operation is experienced, as noted by oscillations in the dew point temperature and in the operation of the CONIROL indicator. When oscillation occurs during this adjustment, slowly turn the control coUDterclockwise umi1 stable operation is achieved at a higher gain setting.

Before returning to normal operation, depress the MABC key on the front panel of the Model2000 Series after making changes to the GAm control to cause the instrument to perfonn an ABC cycle.

5.6.5 Compensation

COMPENSATION control potemiometer R88 is provided to introduce phase lead into the a:zni,lifier circuit to compensate for the thermal phase lag cha:ra.ctc:ristics of the thermoelectric cooler in the dew point Sensor. Introduction of this phase lead into the optical system and mirror temperature control loop pemrits the loop to be operated at a higher gain setting without oscillation, resulting in improved dynamic perfonnance. The frequency response of this compensation network is such that it is effective only at dew points of 0°C and above.

The COMPENSATION control has been set at the factory for optimum dynamic response when operating at high dew points and should not have to be adjusted. Before making adjustments to the COMPENSATION control, always record the factory-set position to aid in renJTTJing to the original position at a l.at.er date. However, proper adjustment of the COMPENSATION control may. be achieved by introducing a gas sample into the Sensor at the highest dew point anticipated. With the instrument operating nomWly on *this* dew point, rotate the COMPENSATION control fully counterclockwise and advance the GAIN control until a steady oscillation is obtained If oscillation occurs, rotate the COMPENSATION control clockwise slowly, noting the change in zesponse for each increment of change until the oscillation ceases. If no oscillation occurs, it is permisSible to operate at maximum GAIN.

5.7 WEITED PARTS

Since the sensor comes in contact with the sample, it :aright be important to know sensors material of construction of these wetted parts. The wetted parts of the S1 and 82 include;

Rigid polyurethane isofoam (closed cell) securing mirror

Plastic mylar foam protector

- Silicon rubber adhesive (RTV)

Glass plate optics protector (S2 only)

- Non-anodized aluminmn inside sensor cap
- Brass (standard) or stainless steel (optiorial) compression with teflon tape

5.8 SUGGESTEDSPAREPARTS

EdgeTech recommends that equipment be returned to the factory for repairs and part replacements. However, it is recogoized that some users are trained to make repairs and part replaceme:ms in the :field. In these cases, EdgeTech can suggest spare parts that may be needed in infrequent circumstances.

Part Number	Description
C9057-00007	Front PCB with switch matrix
C9057-00038	Rear PCB
D9057-00036	Main PCB
A31966	EPROM, customized
2000-Sl	Sl Sensor, 1-stage, 450C depression
2000-S2	S2 Sensor, 2-stage, 600C depression
Dl6118-16	Cleaning kit with fuses
B24264	Cover, bolt-on, for 2000-Sl sensor
C23585	Cover, screw-on, for 2000-S2 sensor
C24359	Ambient Temperature PCB, Model 2002only
B24461	Ambient Temperature probe, Model 2002only

Troubleshooting and Repair

EdgeTech

Troubleshooting and Repair

6.1 LOCATING TROUBLE

In some cases of faulty instrument operation, the source of trouble will be immediately apparent.

In others, this will not be the case since a given symptom may often be due to any one of several causes. In locating and eliminating such faults, two methods are recommended:

1. When trouble arises, a number of simple preliminary checks, listed in Table 6-1, should be made before proceeding with more elaborate tests. These checks, which can be performed without disturbing any components of the system, are designed to detect or correct those troubles most likely to occur.

2. If the trouble is not located or remedied by the preliminary checks, a series of tests, described in Table 6-2, can be used to isolate the fiwlt to one of the major sections of the system. When this is done, the faulty section can then be replaced or checked systematically to locate the particular component causing trouble.

6.2 TEST POINTS

The following test points are available on the main PC board:

TPl	The SJJDlming point of the main servo amplifier.
TP2	Output of servo amplifier. This voltage ultimately controls the Sensor currem and is also the voltage represemed by the CONI'ROL LEDs.
TP3	Can be used to measure Sensor current by measuring the voltage between TP3 and TPAGND (analog ground) and dividing by 0.1.
TP4	TP3 and TP4 represent both sides of the Sensor.
TPS	Represents the output of the PRT amplifier and is approximately lOV/lOOOC.
TP6	Output ofD/A converter that generates the balance voltage.
TP7	- The shifted balance voltage as presented to the SlJDlming point.
TP8,9	The differential inputs of the PRT amplifier.
TPIO	The junction between the +ISV and the phototransistors in the Sensor
TPll	The junction between the -lSV and the phototransistors in the Sensor
TP12	The voltage generated by the thickness potentiometer (R64).
TPVCC	The +SV supply.
TPAGND	Analog ground.
TPDGND	Digital ground.

Troubleshooting and Repair

Table 6-1. Troubleshooting clw1: preliminary ehecks.

Symptoms	Corrective Action
Instrument is completely inoperative with no LEDs lit.	Check the 120/240 voh PC card for proper position for input AC voltage being used If the fuse is good, check for line voltage across the AC terminals.
Line voltage and fuses are good, but still no indication of equipment operation.	Unplug the power cord and slide the clear plastic door to the left to check the AC voltage select card and fuse. Check that the cables connecting to the PWB are intact.
Replaced fuse blows when power is turned on again.	Check that the proper fuse is being used. The fuse value should have a 2-amp rating for 120 VAC operation and a l-amp rating for 240 VAC operation. Both fuses should be rated 250V, 3 AG, Slo-Blo.
CONTROL indicator is too far left or too far right daring the time the ABC indicator is on steady.	This indication can occur if the Sensor is not plugged in, if the Sensor has been changed, or if the Sensor mirror sur:W:e is very dirty. A dirty mirror causes the CONTROL indicator to indicate more to the left. Adjustment of BALANCE potentiometer RS2 can usually bring this indication back. to center scale if a new Sensor has been attached. Cleaning a dirty Sensor mirror has a similar effect.
Control indicator and dew point temperature output do not settle out to a steady reading.	First check that the dew poiut sample flowing through the Sensor is under a constant pressure and does not vuy, and that there are no plmnbing leaks. If these inputs to the Seusor check out, then either the GAIN or COMPENSATION control may be set too high, or the sample flow rate may be too high.
Sluggish response to changes in dew point.	TIDCKNESS setting may be too high or GAIN setting may be too low.
Dew point reading is always too high.	THICKNESS setting is too low or GAIN setting is too low.
When operating at high Sensor ambient temperatures near +IOOOC, the instrument indicates ambient temperature rather than dew point temperature.	If the Sensor base temperature has been allowed to exceed +1OSOC, the thermostat in the Sensor will open, preventing the mirror from cooling to the dew point The mirror temperature will now rise to ambient. Reduce the Sensor temperature to +800C or below to reset the Sensor thermostat

Troubleshooting and Repair

Table 6-2. Fault isolation.

Symptoms	Recommended Checks and Replacement
Not all three power supply voltages, +5V, +lSV, and -ISV, are present.	This is probably caused by a failme in one of the power supplies or a poor cable connection from the transformer to the main PCB (connector J2). It can also be caused by an overload on one of the power supply regulator circuits. Tum the equipment off and, in a few minutes, tum it back on. This causes the overload protection circuits on the power supplies to reset and, if the overload was temporary, the fault will clear.
Sensor mirror does not heat above ambient temperature during a self-standardization cycle, but operates on dew point readings.	Measure the voltJlge at TP2 during the Automatic Balance Control (ABC) cycle and while the ABC LED indicator is on steady, as during the self-standardization cycle. This voltage should be ±0.5 volt.
Mirror temperature cools below the actual dew point and large amounts of dew or frost builds up on the mirror surface.	Press the MABC key to place the instrument in the self-standardization mode and clean the mirror surface with isopropyl alcohol. Make sure no detergents are allowed on the mirror surface. If trouble persists, it may be caused by dirty optics. Clean the optics with isopropyl alcohol and a pipe cleaner. Clean optics are indicated by a voltage drop of greater than 5V across R51.

Procedure for Returning Material

EdgeTech

Procedure for Returning Material

All Returned Material

It is necessary to obtain a Returned Material Authorization (RMA) number prior to returning any equipment to EdgeTech. This is to assist EdgeTech to recognize your equipment when it arrives at our Receiver dock, and to assist us in tracking your equipment while it is at our facility.

Factory Location

EdgeTech, 19 Brigham Street, Unit 8, Marlborough, MA 01752
TEL: (800) 276-3729 or (508) 263-5900; FAX (508) 486-9348

Inside Continental United States

Simply contact Customer Service and request a Return Material Authorization number (RMA#). Securely pack all material being returned. Shipping documents must be clearly marked with factory destination and RMA#. Once the material is received, we will send you a Return Acknowledgment card.

Outside Continental United States

The following steps apply only to material being returned from outside the Continental United States. These steps should be followed carefully to prevent delays and additional costs.

I. All shipments must be accompanied by two copies of your commercial invoice, showing the value of the material and the reason for its return. Whenever possible, please send copies of original.export shipping documents with the consignment.

2. If the value of the equipment is over $1,000, the following shipper's oath must be sent with the invoice. This oath can be typed on the invoice, or on a separate sheet of letterhead.

"I, declare that the articles herein specified are the growth, produce, or manufacture of the United States; that they were exported from the United States from the port of. —— —— -------"on or about ; that they are returned without having been advanced in value or improved in condition by any process of manufacture or any other means; and that no drawback, bounty, or allowance has been paid or admitted hereof."

Signed---------- ——

3. If there is more than one part per consignment, a packing list must accompany the shipment. It is acceptable to combine the commercial invoice and packing list as long as the contents of each carton are clearly numbered and identified on the commercial invoice.
4. Consign all air freight shipments to EdgeTech in care oflntercontinental Transport Services, Inc., Logan International Airport, East Boston, MA 02128
5. If the equipment is the property of EdgeTech, please insure for full value.
6. Route via Logan International Airport only as the final destination.
7. Mail one invoice, packing list, and copy of airway bill to EdgeTech upon shipment.
8. Please refer to the issued RMA number on all documents and correspondence.
9. Airfreight must be paid on all returns.

WARRANTY STATEMENT

All equipmem JDanJJDctured by EdgeTech is wanaut.ed against defective components and wmianansbip for repair at their plmt free of charge, for a period of twelve momhs. Malfunction due to iuij:Jwper use is not covered in this wanauty and EdgeTech disclaims any liability 1br CODSeqDCDtial damage resnffing 1iom defects in the pedo• ••umce of the equipment. No pmdoct is wma uted as beiDg :fit for a particular pmpose and there is no wanauty of merchantability. Ibis waaanty applies only if (i) the items are used solely under theopetatiugconditionsaodinthemiiJDtl;lteco••••••endedintheinstructianmamml,specifications, or o1her literature; ("n}the items have not been misused or abused in any manner or repairs attempted thereon; ("Iii) wtittm notice of 1he failure within the wananty period is forwarded to EdgeTechand1hedirectiQDS received:tbrpiopedyidemifyingitemsn!fm•edunderwanautyare followed; and (iv) the returnnotice authorizes EdgeTech to examine and ctisassemble mumed products *to* the extem EdgeTech deems necessaey to ascertam the cause for :failure_ The wananties expressed herein ate exclusive. There are no other wananties, either expressed or implied, beyond those set forthhere:in, and EdgeTech does not assume any other obligation or liability in COlllla.."1ion with the sale or use of said products.

Equipment not manufilctured by EdgeTech is supported only to the extent of the original manufacturer's wananties.

IMPORTANT

When requesting information about this instrument, always furnish the serial numbers of the Control Unit and the Sensor. The Control Unit serial number is marlced on a sticker on the rear panel. The Sensor serial number is stamped into the top swface of the metal base of the Sensor housing.