BUCK RESEARCH INSTRUMENTS L.L.C.

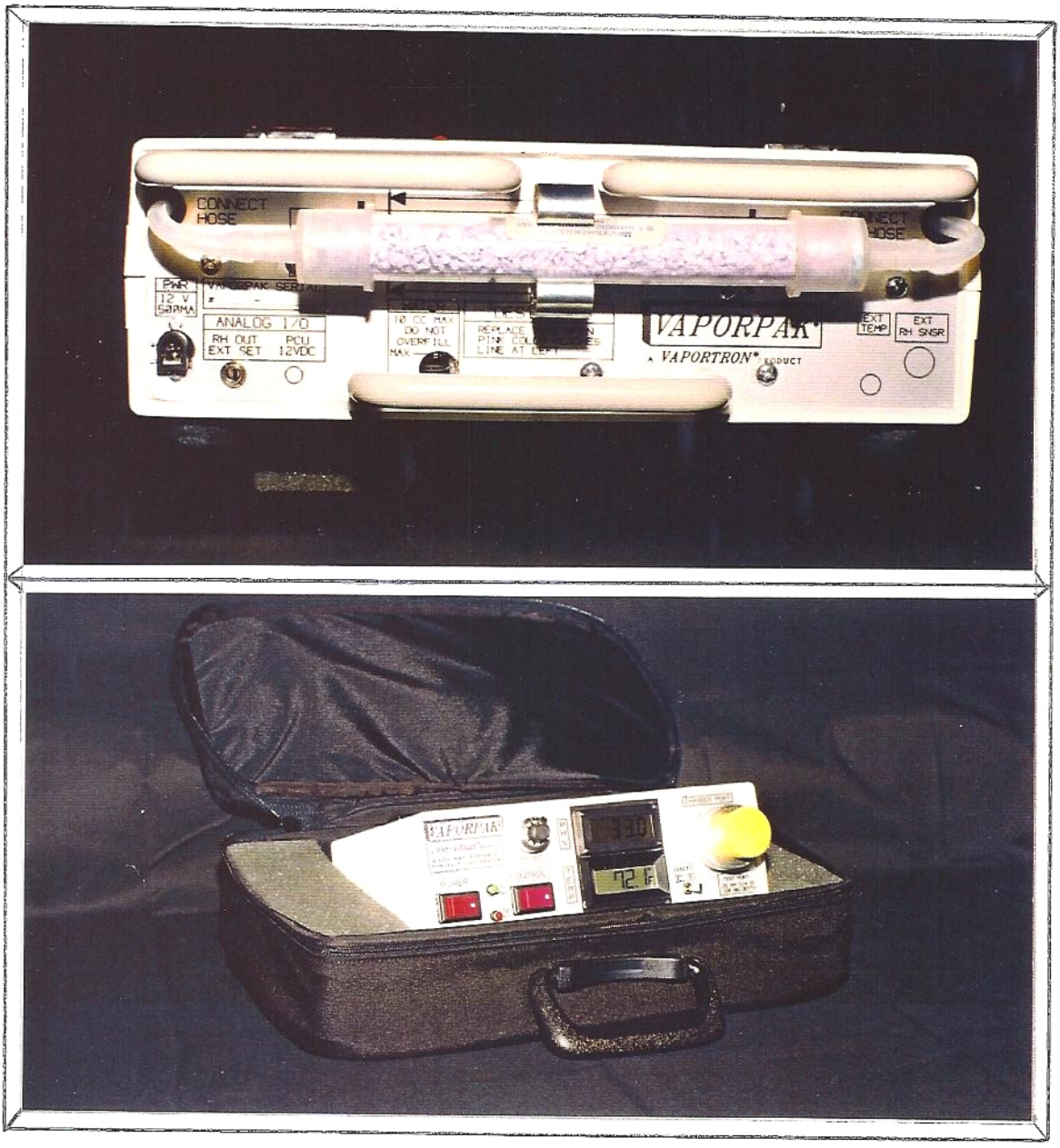
VAPORPAK H31 PORTABLE HUMIDITY CALIBRATOR
Users Manual 3/93

The H-31 humidity calibrator is intended for rapid determination of a field sensor temperature and/or humidity functionality. It can also be used for sensor linearity tests as well as probe drift studies. We certify this system using ASTM methods for a temperature accuracy of +/- 1.0 Deg F or better from 68 Deg F to 90 Deg F. The RH section is calibrated to an average accuracy of better than 1% RH from 11% RH to 97% RH (7 points taken). Over this range, a maximum error of 1.5 % RH is possible at any given point.

The unit can generate humidity in the range of 5 to 95% RH reliably, with a 0.2 % RH stability. Typical settling time is < 1 minute with a 5 minute maximum near the low and high RH limits.

The VAPORPAK H31 is configured with a standard port size of 25 mm diameter with a fitted compression gasket. For other, non-25 mm sensors and probes, split rubber stoppers and non-hygroscopic clay are supplied for sealing around the port opening

This unit is battery operable for around 3 hours with both POWER AND CONTROL switches enabled, and operates for approx 5 hours with the POWER switch on, and operated in "monitor mode".



VAPORPAK Model H31 Portable Humidity Calibrator

General Specifications:

Size: 10" wide X 10" depth X 3.75" height (255 X 255 X 95 mm)
Weight: 4.6 Lbs (2.1 Kg)
Power: 12 VDC at 5 Watts max. (internal 6 V Ni-Cad power)
Temperature Range: Operation; 10C to 40C Storage: 0C to 50 C
Accuracy: Temperature, +/- 0.5 C (20 to 32 C) Resol. 0.1 C
Accuracy: Humidity, avg < 1%RH (11 to 97 % RH) 1.5 % max
Humidity accuracy valid from 20C to 30C air temp

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Humidity Control System

Refer to following flow diagram on page 06. The VAPORPAK humidity control scheme is essentially a reference based, closed loop servo-demand flow network. The working volume (0.1 L or approx 6 cu in) is basically a highly turbulent mixed constant temperature atmosphere. The present relative humidity is sensed by a high grade, fast response polymer type reference sensor located approximately in the center rear 1/3 of the chamber. The RH signal is compared by an error amp processor to either a manually operable front panel adjustment knob setting (10 turns) or to an external 0-1 volt (presumably via computer) DC setpoint. Setpoint resolution is 0.1 % RH via the front panel dial-knob.

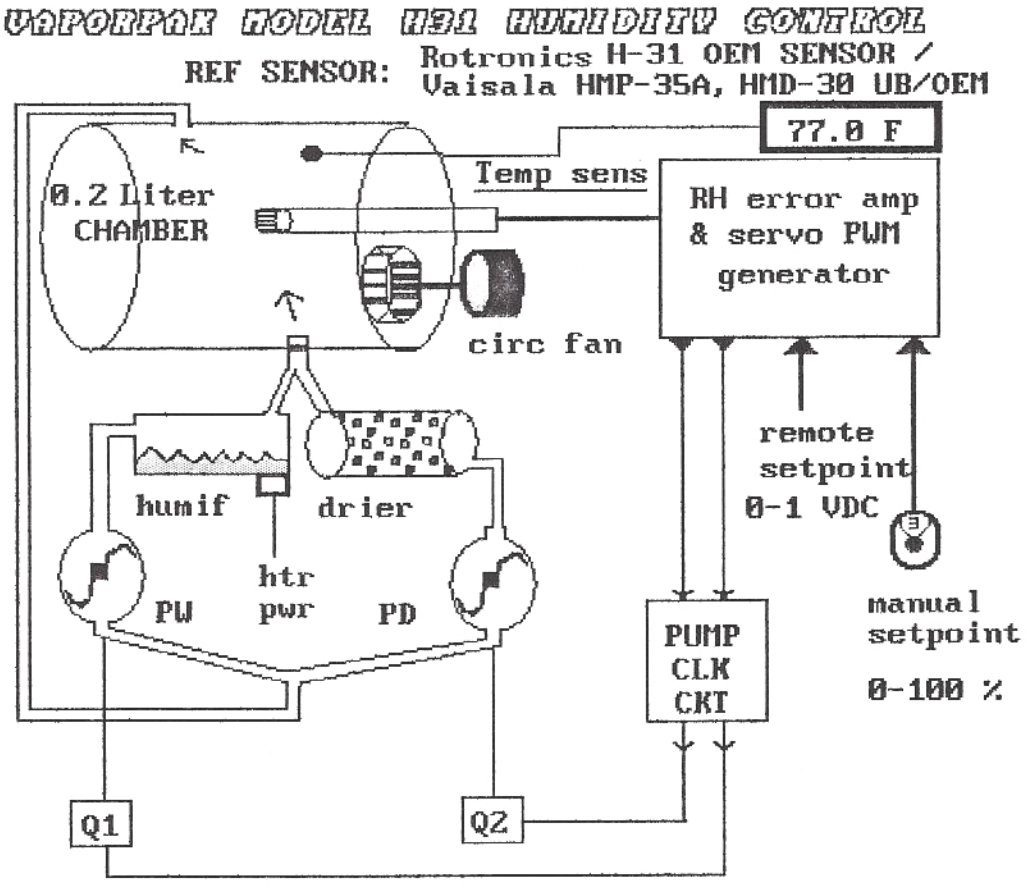
If the chamber RH compares lower than desired, a proportional PWM (pulse-width-modulation) signal is output by the controller to a power transistor which drives a small magnetic diaphragm pump (PW). The pump draws chamber air, pumps it through an air saturator vessel and outputs it back into the chamber. The output is vented directly into a 5 lpm internal circulator fan such that rapid molecular mixing occurs inside the chamber working volume.

Conversely, if the reference sensor senses a humidity that is moister than the present setpoint, a PWM error signal is output by the controller to another transistor which in turn powers a separate dry-pump (PD). The PD pump flow is essentially in parallel with the wet side, but they do not operate at the same time. The dry side pump feeds chamber air into a calcium carbonate cylinder (on back panel exterior) which dries the air to a 0.2 % RH or a dewpoint of approx -40 C. Finally the air is again mixed thoroughly with the chamber air upon its entrance.

Because of the servo nature of this system, the chamber responds rapidly to either a change in setpoint or a sudden change in chamber humidity loading. The servo pumps provide an ample overdrive capability such that only 1-2 minutes are required for most step changes in command value. At the extreme ends (<10 % and > 90 % RH) the system can take 5-10 minutes to reach the desired humidity. This is due to reduced drive differential and chamber container (and any contents) surface uptake/outgassing at each end of humidity extremes.

Typical control errors (deviation from setpoint) are +/- .5 % RH from 30 to 80 % RH setpoint to around 2 % error at the ends of the controlled range (3 to 97% RH). The control servo is an asymmetric proportional type with a cycle time of approx. 1 sec.

To allow for near 100 % RH at ambient chamber temperature the vapor saturator is electrically heated when the command setpoint exceeds 90% RH.



Humidity Flow Diagram

CONTROLS, SWITCHES AND OPERATION

IDENTIFICATION OF CONTROLS (left to right on panel)

1. Main POWER switch. Displays Temp and RH but no control.
2. ON AC green LED. Blinks when on AC adaptor (DC 12 V)
3. LOW BAT red LED. Glows near end of NI-CAD charge level.
4. CONTROL power switch. Enables humidity control servo.
5. RH SET dial. Setpoint for humidity range: 0 to 100% 10 turn.
6. RH% and TEMP LCD DISPLAYS. Display units and tenths units.
7. UNITS select switch. Deg C or F. Most accurate: 70 to 90 F.
8. CHAMBER PORT. 25 mm dia by approx 110 mm typical depth.
9. ANNUNCIATOR (internal) beeps when chamber arrives at setpoint.

General Operation

The VAPORPAK chamber is designed to generate an optimum environment for calibration of solid-state type polymer and other sensors that will physically fit inside the 25 mm diameter working cavity. By providing a high aspirating airflow past the internal reference sensor AND the sensor to be calibrated, an accelerated equilibrium of both temperature and humidity vapor can be realised.

It should be noted that due to the extremely fast and linear response of the internal polymer probe, the chamber can be made to very rapidly follow a new command that is dialed in. THIS CANNOT BE SAID FOR ALL SENSORS THAT ONE WILL ENCOUNTER DURING ATTEMPTED CALIBRATIONS. For this reason, we advise using caution -- especially when attempting calibration of a sensor or probe for the first time.

The VAPORPAK system will produce a short, high-pitched beep when it has first arrived to a new setpoint as dialed in (or programmed in -- via the rear-panel connector). This means that the internal reference sensor is stabilized within 1% RH.

Depending on the type, condition, and temperature of the sensor that is being calibrated, we advise allowing a period of time from 2 minutes up to 30 minutes before either adjustment or recording output of the Device Under Test (D.U.T.).

Typical Calibration Procedure for RH sensors

Initially, place the sensor to be calibrated inside the VAPORPAK chamber port and seal the opening such that it is leak-tight. Use the sealing clay, a rubber stopper which has been bored to the correct probe diameter, or plastic electrical tape etc. Allow approximately 5 to 10 minutes for sensor temperature stabilization, with only the POWER switch active on the VAPORPAK.

Normally, it is advised to establish the zero or offset value at a low RH such as 20 to 30 % RH. (CONTROL on and SETPOINT adjusted on VAPORPAK) Once the zero is made on the D.U.T., proceed to an upper RH of 75 to 90 % and allow a sufficient time for the D.U.T. to stabilize in output -- then adjust the "gain" or "span".

Since practically all sensor/electronic combinations exhibit a degree of zero-span interaction, it is advisable to repeat the "zero-span" steps at least once to ensure a proper transfer of calibration. If the amount of either "zero" or "span" adjustment is small, then reiteration of the calibration steps can be minimised or dropped.

HIGH RH CONDITIONS

For maximum accuracy, avoid operating the VAPORPAK system for more than a few hours above 90 % RH continuously. A temporary bias condition can result which may affect the internal reference polymer by approx +1 % RH for the following 1 to 2 hours.

Operating Information

When operating the system at very high RH levels (>90 %), it is important to realize that gradients in temperature (ie cold surfaces) can cause condensation of liquid water on that surface. When this occurs, attempting to maintain or increase the RH setting will only cause more condensation and the actual air-volume humidity will remain the same. If there are no problems with temperature gradients etc, a VAPORPAK chamber will typically achieve a 94 to 97 % RH level within about 5 to 7 minutes.

Condensation problems can be verified by commanding a -10% or more RH step setting temporarily, and watching if the RH display freezes or holds at the previous high RH reading for a long time before responding to the new setpoint (evidence of liquid puddling, as the system waits to evaporate liquid water from the walls etc).

Shut off the CONTROL switch temporarily, when opening chamber door to minimize mixing with ambient air and RH over/underload.

Water Level and Service

Normally a visible water-line should be seen when observing the round sight-glass at the rear panel. If no liquid can be seen, then water should be added. The water tank is accessed by removal of RED RUBBER CAP NEAR TOP REAR CENTER. Add distilled water slowly with a small syringe. Typically, add only 10 cc of water. * WARNING * IF THE WATER LEVEL IS OVERFILLED (SEE ROUND WINDOW AT BOTTOM REAR PANEL) LIQUID WATER CAN BE INADVERTENTLY PUMPED DIRECTLY INTO THE CHAMBER WORKING VOLUME! BE CAREFUL!

Desiccant Service

The desiccator cartridge on the rear panel is filled with a commercial Calcium-Sulfate granule charge. A colbalt-chloride indicator is used to visually show when the desiccant is depleted (blue=dry, pink or grey=spent). Replenish desiccant when edge of pink color approaches 2 cm (1 inch) from the LEFT end of drying tube (line on rear of instrument); use only DARK BLUE, ultra dry desiccant (see attached desiccant product data sheet for re-charging instructions, page 14). When re-filling the dryer tube, use a small funnel -- pack desiccant down to avoid large air-pockets.

The rate of desiccant usage is HIGHLY dependent upon type of operation encountered. A typical range could be a cartridge used each day under continuous VAPORPAK up/down cycling up to a month operating time under steady-state setpoints, with no chamber leaks).

Basically, it should be remembered that desiccant is ONLY used when the VAPORPAK is CHANGING the humidity in its' chamber cavity. To preserve the maximum desiccant life, avoid VAPORPAK operation (CONTROL switch on) with the chamber door open -- except for short peroids when changing sensors. Keep covers on desiccator cartridge if it is stored while NOT connected to the VAPORPAK system hoses.

******* TROUBLESHOOTING *******

In normal operation, the control system will respond quickly to bring the RH reading to very close to the dial (or COMMAND) setting. If the pumps run for a long time and/or the RH reading does not quickly settle in, it could be caused by the following:

========== CHAMBER TOO MOIST OR TOO DRY ==========

1. Leaks in or near the chamber door or through rubber port gland or rubber stopper. (check and apply clay or tape shut)

2. Abnormally cold or hot chamber temperatures. (bring chamber close to ambient temperature, see if control improves)

========= CHAMBER TOO MOIST -- NO CONTROL ==========

3. Condensation on chamber walls. (open chamber, wipe walls with dry cloth, allow to air-dry for 5-10 minutes)

5. Desiccator cartridge used-up (all pink or grey in color) or has become physically disconnected from the chamber hoses.
   * Note that the system can actually work without the dryer connected, but the chamber will be limited to around whatever the prevailing room humidity is, and above.

6. Hygroscopic load! Some materials have TREMENDOUS water capacity in the vapor phase, eg; Nylons, PVC plastics, and woods etc.
   (remove any objects you suspect could be too hygroscopic)

========== CHAMBER TOO DRY -- NO CONTROL ==========

7. No liquid water in saturator vessel (check back sight glass and tilt cabinet front to back to confirm the water level)

8. Cabinet of VAPORPAK unit too cold. (Allow system to run in the power-on only (no control) for a period of time.)

9. Hygroscopic load! See item # 6. (remove suspect material)

==== NO CONTROL ====

10. "CONTROL" switch not activated. (check that it's pressed on)

11. Low battery condition, connect charger or other 12 VDC, .3 A

12. Electronic failure. (consult technical documents or factory)

CALIBRATION OF INTERNAL REFERENCE PROBE

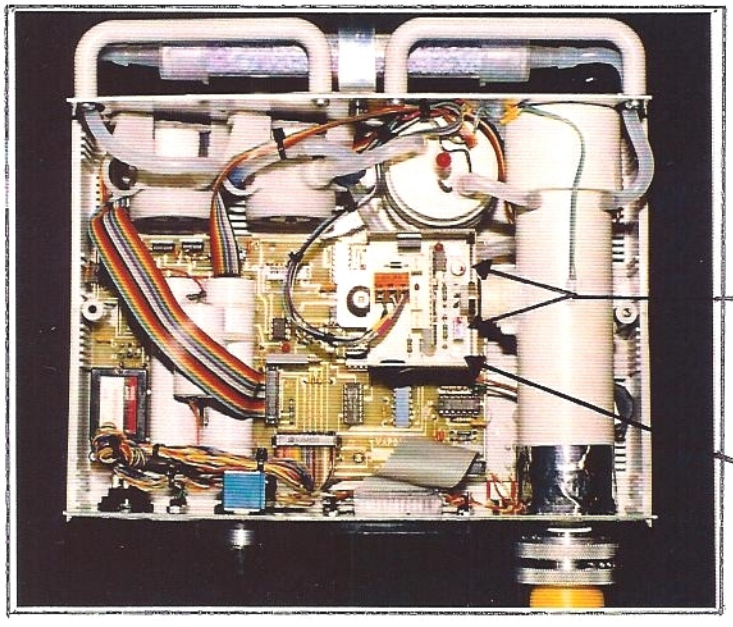
The VAPORPAK internal reference probe has been initially factory calibrated against ASTM and possibly NIST referenced standards. See details in appendix. If it is desired to provide another prime calibration or reference check, several possible avenues are possible:

1. Calibrate against a trusted reference probe using the VAPORPAK as a mixing/calibration vessel. (Use only Rotronics/Vaisala)

2. Calibrate against a reference chamber by placement of the entire VAPORPAK inside the reference and operate passively.

3. Remove the reference sensor and calibrate against either a primary standard or reference salt in an external chamber.

To access the reference sensor, remove the top cover and locate the sensor using the picture below (see arrow). To remove reference sensor probe, remove phillips holdown screw/grommet assy and gently pull out on probe and/or sensor case housing.



The calibration pots will be labeled as either "Z" and "S" or "D" and "W" for the respective dry and wet adjustments.

If using a transfer probe, operate the VAPORPAK for at least 10 minutes at each cal point, shut off "CONTROL" when making the pot adjustments to avoid confusion.

If calibrating against salts, follow ASTM guidelines and allow at LEAST 30 minutes at each point for stabilization. In all cases, set the "dry" or zero first, then the "wet" or gain. See text on page 07 above about calibration procedures in general.

If the VAPORPAK reference probe is removed, re-tape with teflon thread tape when re-installing in chamber and/or ensure that sealing "O" ring is seated against probe base! Always calibrate in very stable temperatures or in a calibration room.

PROGRAM CONTROL UNIT (PCU) Description and Operation
(Model PCU and PCU-RS232 described)

The PCU is an interface and automatic step controller for automating the RH commands of any model VAPORTRON/VAPORPAK chamber. The -RS232 option when installed allows computer control via an RS-232 data-conversion module.

The PCU plugs into the rear panel of a VAPORPAK chassis VIA a micro and stereo mini male plug-pair. The PCU is powered from the VAPORPAK 12 VDC adaptor/charger. When the PCU is connected to the VAPORPAK rear connector, RH command data is automatically routed into the chamber (front panel dial settings are ignored). NOTE: THE VAPORPAK MUST BE LINE-POWERED FROM THE 12 VDC BATTERY CHARGER WHEN OPERATING THE PCU ACCESSORY!

Controls (left to right)

First set DATA SOURCE switch to "AUTO-STEP" (If RS-232 optioned)
Next flip RUN/STOP switch from RUN to STOP to reset to STEP 1.

1. STEP DURATION — Allows selection of duration at each step level. Intervals are 3.75 m, 7.5 m, 15 m, 30m, 1hr, 2 hr

2. MAN ADVANCE — Push button to increment to next step level.

3. CLOCK — Green Flashing LED, lit when STEP clock is running.

4. RUN/STOP — Toggle Switch, "STOP" resets to STEP #1, "RUN" activates timer clock according to DURATION knob.

5. STEP 1-8 — LED shows active STEP, 3 digit LCD shows what the COMMAND RH is set to. A 20 turn adjustment via small screwdriver (supplied in kit) allows adjustment of each step from 0-100 % RH. (Insert above each LED)

6. DATA SOURCE — Switch selects between Auto-Step and Computer Interface for VAPORPAK and LCD COMMAND RH display.

PROGRAM CONTROL UNIT-- UNDER COMPUTER OR RS-232 SERIAL CONTROL

The PCU must be set to "COMPUTER" on "DATA SOURCE " switch setting. This allows the serial D/A, A/D system to read and output its signals to the VAPORPAK (and the PCU LCD display also). When in this mode, the VAPORPAK current internal RH probe reading is read into the computer as "channel 1" and up to 3 each 0-5 volt user channels are also available to plot and/or log to disk. This configuration enables a totally automated calibration platform exist for up to 3 customer sensors.

The PCU has a power-off memory system that "remembers" most of the previous setup configuration as well as the last RH command value. When the PCU is powered on, (even if it is not connected to a computer) the last used RH will appear on the LCD readout on the front panel.

PCU DEMO-UTILITY PC SOFTWARE OPERATION

To operate under serial interface, do the following:

1. Connect the DB-25 female connector to the Host computers' COM 1 or COM 2 port. (Use a 25 pin to 9 pin adaptor for a laptop etc)

2. Insert 3.5 inch 720 K "DIGILOG" diskette with "PCU" label.

3. The software package will run on IBM compatible PC, XT, AT, 386 or 486 machines.

4. Log onto the correct drive, type "ADLOGR <any file name> <Com n>" and enter. You must use a file name (for logging any output you might want to record from the chamber, or the analog inputs). The default COM port is #1 so the <COM n> entry is optional.

5. A Screen similar to the one shown below should appear.

DIGILOG INSTRUMENTS VAPORTRON HUMIDITY SYSTEM
Serial Program Control Unit Display Screen

Average 1 Reads Send Data Every 1 Seconds NOT Logging to Disk

TIME	COMMAND A	INPUT 1	INPUT 2	INPUT 3	INPUT 4
21:36:32	0510	0497	0004	0004	0004
21:36:33	0510	0502	0004	0004	0004
21:36:34	0510	0502	0004	0004	0004
21:36:35	0510	0502	0004	0004	0004
21:36:36	0510	0502	0004	0004	0004
21:36:37	0510	0502	0004	0004	0004
21:36:38	0510	0502	0004	0004	0004
21:36:39	0510	0507	0004	0004	0004
21:36:40	0510	0502	0004	0004	0004
21:36:41	0510	0502	0004	0004	0004
21:36:42	0510	0502	0004	0004	0004
21:36:43	0510	0502	0004	0004	0004
21:36:44	0510	0502	0004	0004	0004
21:36:45	0510	0502	0004	0004	0004
21:36:46	0510	0502	0004	0004	0004
21:36:47	0510	0502	0004	0004	0004

F1:COMMAND VALUE F2:SAMPLE F3:AVERAGE F4:CHANNELS F5:DISK LOG F10:EXIT

6. Note that "Command A" is the D/A output to the VAPORPAK (the units are in millivolts on the display screen, 0 to 5000 millivolt range).

PCU DEMO/UTILITY SOFTWARE continued

7. To change a command value to the chamber, hit F1, then type the voltage you want. Example .5 is 50% RH, .842 is 84.2 % RH.

8. Note that Input # 1 is the actual chamber RH value expressed in millivolts. 1000 mv on screen equals 100.0 % chamber RH.

9. The other Commands (Function Keys) are similar and fairly self-explanatory.

10. Consult the available PCU support guide for programming details.

AVAILABLE PC DRIVER PACKAGES

At present, two IBM, PC based logging and control packages are offered. Described above is the Utility called "ADLOGR". It is a Pascal program for which we provide source code for customer modification etc.

Also provided is an advanced driver called "PCU" which allows up to 21 programmable command RH steps to the VAPORTRON/ VAPORPAK system. Various plotting, plot scaling, signal averaging and logging options are featured.

START UP

1. Unpack unit from carrying case & inspect it for an intact (and mostly blue) desiccator tube on the back. Make sure the hoses going to the tube are not pinched or restricted. Move the tube left or right as needed.

2. Using a syringe, or attached plastic filler, add about 10 or 15 cc/ml of distilled water to the water tank. Recap the rubber top when done. Verify that the water line is visible in sight glass in rear of Vaporpak. Exact level is not critical, but water in the lower to mid glass range is best.

3. Plug in the charger/adaptor into the rear connector and ensure that the green "ON AC" lamp is lit on the front panel. You can leave the charger on for lab use, or just leave it connected overnight for next day's offline use.

4. Turn on the POWER switch & listen inside the test chamber for a whirring sound from the rear. This is the circulating fan and it MUST be operating.

5. Let the unit run for a few minutes with the front port open. See that the Temp and RH readings are approximately right for the room conditions... abnormally high RH means that liquid is in the chamber and it must be blown out with dry air or wicked with a paper towel very gently, until the RH comes to what “room RH” should be.

6. Next, put a rubber stopper in the front fitting, and turn on the CONROL switch. Set the RH command dial for a low reading... like 20% RH. You should hear the pumps run and the chamber should drop to 20% and hold it within 0.5 % or better.

7. Similarly, test the high range by dialing the Command knob several turns to say... 70 to 75 % RH. The chamber should rise up to near the command and within a few minutes, be again within about 1/2 % of the command. If the reading is off, simply adjust the command a little to get the exact RH you want.

8. If all this goes well, then insert a RH/Temp probe to be tested/calibrated and do the same thing as before. The chamber might take a bit longer to stabilize since the DUT or probe might have some hygroscopic surface or residual moisture.

9. Don’t expect the Temperature readings to move or converge very quickly, because the thermal mass of the DUT or test probe will limit how fast the small circulator fan can equilibrate the probe tip to the actual chamber temp. It might take 5 or 10 mins to converge, but this is important due to the RH/Temperature relationship of the water vapor physics. For nominal accuracy, you should have no more than 0.2 Degree(C) difference or gradient between the DUT and the chamber Temperature display... (Discounting, of course the static error between the two thermometers).

10: If all these steps can be reached, then the rest of the calibration process can be followed from the operation & usage section of the user’s manual.