BUCK RESEARCH INSTRUMENTS L.L.C.

VAPORTRON® H100BL/H100CL Series Precision Humidity Lab

Users Guide – January 2012

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Table of Contents

Appendix

Watlow Controllers

Material Safety Data Sheets

Sample Certificate of Conformance

Humidity Related Tables

Product Line Description

1. INTRODUCTION

Overview

The VAPORTRON series calibration system is a high-performance, stand-alone temperature/humidity reference generator. It features a thermal servo system to stabilize temperature in the range of 15 to 60°C at ± 0.2°C stability. Relative humidity is rapidly generated in range of 3 to 95%RH at ± 0.2% RH stability. RH accuracy is ±1.5% at maximum between 20-90% RH At temperatures near ambient, a typical accuracy of +/- 1% RH is achieved. The chamber volume is 2 liters in a 12 cm (5 inch) diameter by 34 cm (7 inch) cylindrical space.

A thermoelectric cooler provides a means of stabilizing the chamber working temperature at a differential centered near the ambient air conditions in the room..

The servo based humidity control provides a system with the precision needed for laboratory and research needs. It also provides the overdrive required for production operations where large surface area or multiple sensor calibrations are processed. Due to the design of VAPORTRON, the typical settling time to a 1% RH stability is only 2-3 minutes.

Specifications

MODEL #	OPTIONS
H-100BL	15-60°C at ±0.2°C stability,
H-100CL	as above with Watlow 96 PID, serial data link, RH & Temp, & software

2. THEORY OF OPERATION

Philosophy of Design

The VAPORTRON system was developed around a solid-state capacitive polymer sensor. This philosophy differs somewhat from conventional humidity generators as we rely on a carefully calibrated transfer-standard (the polymer) instead of "first principal" methods, i.e. gravimetric, two-pressure, divided flow, dewpoint referenced feedback, etc. The VAPORTRON system excels for the following reasons:

- We generate relative humidity directly (via servo action against the reference), thus no calculations or conversions are required to read out the chamber humidity. The chamber environment is AT the humidity displayed on the readout panel.
- The reference sensor output is monotonic. There is no secondary control system to hamper or distort the sensor response to changes in moisture. This provides for a controlled, rapid approach to the desired humidity and a stable humidity output thereafter.

- There is no phase change ambiguity or oscillation introduced when the dewpoint, measured or generated, goes below 0 °C.

- A wide dynamic range of chamber output is possible. The 2-98% RH range corresponds to a -24 to +24 ºC dewpoint range.

- The polymer is immune to dust and salt contamination and requires little maintenance. A six month to one year service period is typical for 1% accuracy.

- The polymer reference sensor is approximately $1/10^{th}$ the cost of a chilled mirror hygrometer of similar sensing accuracy. It is compact, rugged, and produces no waste heat in the chamber. This allows us to offer a complete temperature controlled generator package for a price comparable to our most affordable chilled mirror hygrometer.

- The VAPORTRON system takes advantage of the high stability and physical durability of the world's best polymers. Only ROTRONIC premium sensors meet the stringent standards required for use in the VAPORTRON.

- This system was designed with generation of ***relative humidity*** as a major concern. For this reason, it excels at development, calibration and evaluation of other RH sensors. The great speed and precision of the VAPORTRON servo type generator saves both time and cost.

- VAPORTRON is ideal for industrial or commercial transmitter calibrations where multiple sensors can be calibrated at once, with exceptionally low unit-to-unit variation.

As standard final certification, we verify each VAPORTRON output RH using a CR-4 chilled mirror hygrometer and a Rotronic Hygropalm. Both hygrometers support better than 1% RH accuracy in this range. This comparison allows NIST traceability for our systems.

Relationship between Dewpoint and Relative Humidity

Figure 1 was calculated from the Clasius-Clapeyron general equation with the Goff-Gratch equivalent integration, and used in a computer program developed at Buck Research. Shown is the exponential dependence of dewpoint when RH is used as the reference input (or vice versa). This curve should be consulted when trying to cross -reference humidity measuring instruments of different types.

As can be seen, when generating high RH levels, a corresponding high accuracy should be realized in dewpoint (due to the shallow slope). Conversely, a small RH change at the dry end can result in large dewpoint changes.

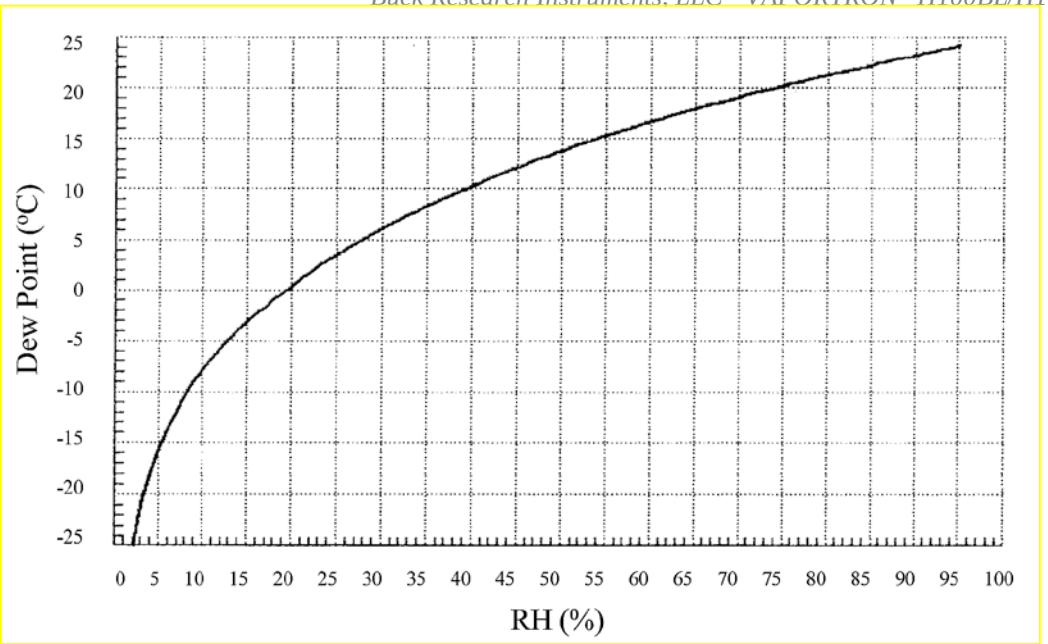


Figure 1. Relative humidity vs. dewpoint at a fixed air temperature of 25 °C

3. INSTRUMENT DESCRIPTION

Figure 2 shows the 2.0 L working volume of the chamber. It consists of a 12 cm diameter by 34 cm long insulated plastic cylinder. The chamber is designed as an isothermal mixing vessel with a small turbo-axial fan stirring air inside it. A high-efficiency heat sink is situated near the main cabinet fan (outside of chamber) for thermal exchange of heat to/from the outside. Located between the chamber internal heatsink and the cabinet heat-sink is a high capacity Peltier cooler (Model -Ll single stage, -L2 dual stage) which is operated conservatively at 5 volts and approximately 2.5 to 5 Amps (15 to 30 watts).

Figure 2 Photo of inside of the 2 liter workspace. RH reference sensor is on top, PT-100 sensor is on the bottom

Thermal Control System

The thermal design of the VAPORTRON is depicted in Figure 3. The chamber temperature is maintained by a Watlow series 965 (for -BL models) and Watlow 96 (for -CL models) micro-processor based PID controller (see Appendix for details on Watlow controllers). The controllers measure a platinum resistance sensor element that is placed in the chamber vessel near the rear center. Chamber setpoint is made via the controller digital front panel, which has a 0.1 °C resolution. The PID controller maintains the chamber internal air temperature at a +/- 0.1 °C stability.

The PID controller applies PWM (pulse-width-modulation) signals to the bases of a power MosFET driver transistor array. The FETS operates as current switches to the Peltier module attached to the chamber heat-sink. The Peltier module's heat-pumping is automatically bi-directional in polarity. That is, either heating or cooling is possible, depending on environmental conditions. This configuration allows the maximum thermal efficiency as well as fastest chamber temperature rate of change when needed.

The PID controller can be set from 0 to +50°C (60°C for –L2) by simply pressing the up or down arrows to change the setpoint. The chamber will typically arrive at a new stable temperature within 3 to 5 minutes after changing the command value. Up to 20 minutes should be allowed at the coldest and warmest program temperatures. The "M" and "A/M" buttons are disabled and have no function in this configuration.

The temperature output of the temperature sensor in the Rotronic probe is amplified and scaled to degrees celcius ranges and is available at the rear panel as a recordable analog output The range is 0-5 V for 0 to 100°C

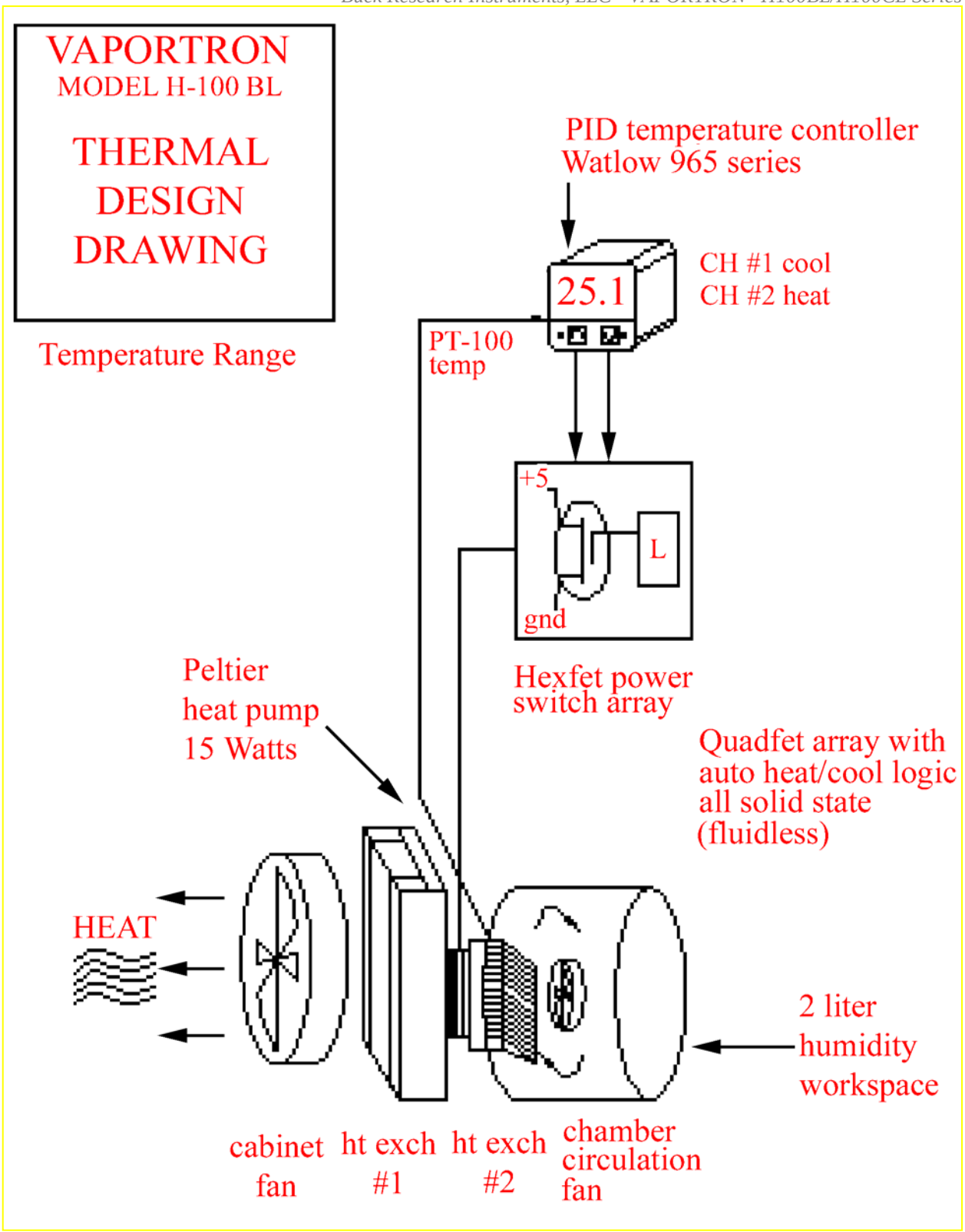


Figure 3. Thermal design concept diagram for VAPORTRON.

Humidity Control System

The VAPORTRON humidity control scheme is essentially a reference based, closed loop servo-demand flow network (see Figure 4). After being thermally stabilized by the system described in Figure 4, the working volume (2.0 Liters) is essentially a continuously stirred 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 third of the chamber. The RH signal is compared by an error amp processor inside the RH PID controller to its LED indicated set-point (command) as input by the user.

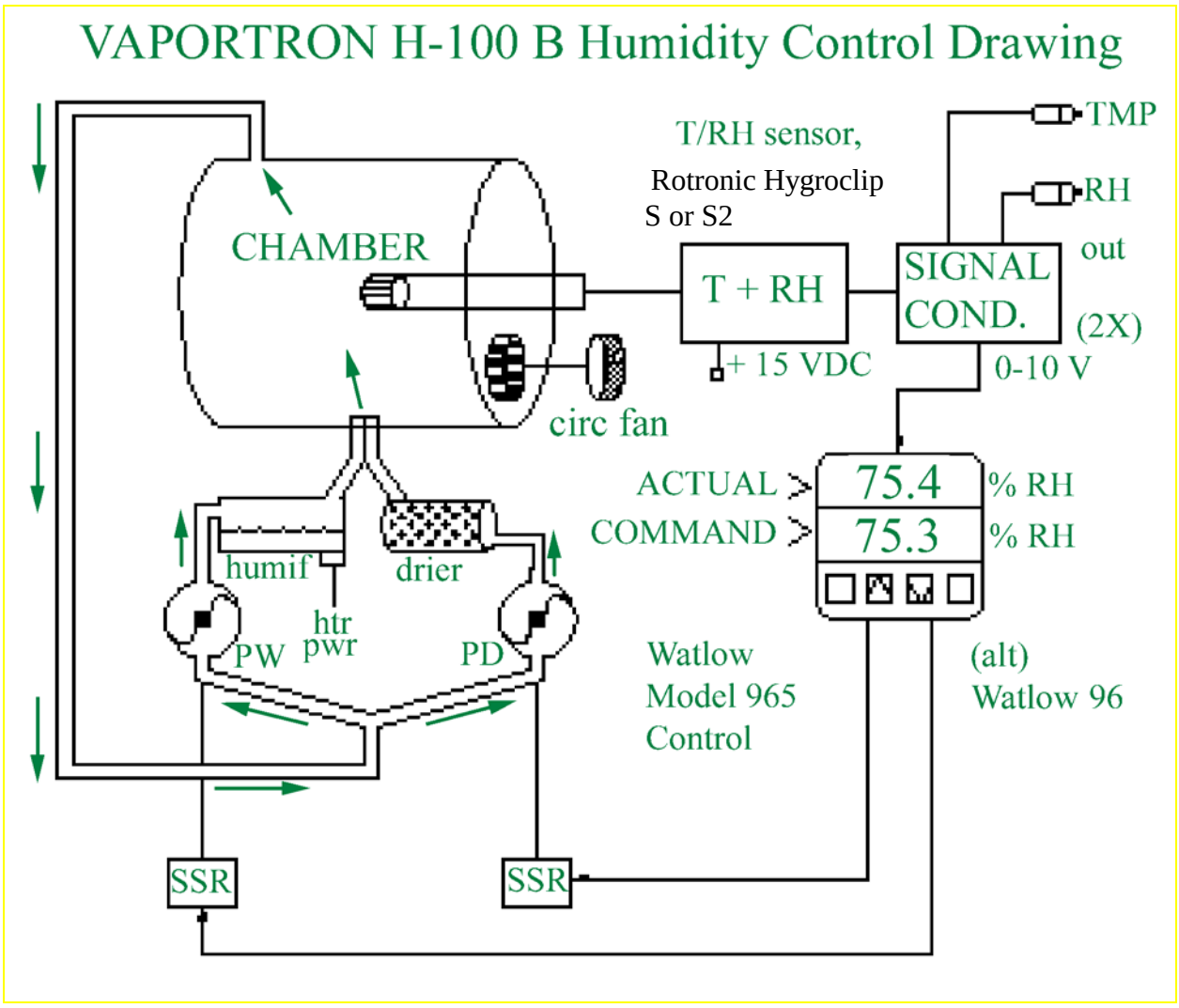


Figure 4. VAPORTRON H-100 B Humidity Control Drawing.

If the chamber RH compares lower than desired, a proportional PWM signal is output by the controller to a solid state 120 VAC (or 230 VAC for non-US models) relay which in turn feeds a small AC type diaphragm pump (PW). The pump draws chamber air, pumps it through the specially designed saturator vessel and outputs it back into the chamber. The output is vented directly into a 20 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 SSR which in turn powers a separate pump. 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 Sulfate filled cartridge which dries the air to a 0.2% RH or a dewpoint of approximately -40 C. Molecular sieves can also be used in the cylinders for better dry-end performance. Silica-gel, while slightly less efficient, can be used for minimum particulate generation when feeding Raoult-sensitive sensors. 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 2-3 minutes are required for most step changes in command value. At the extreme ends (<10% and > 90% RH) the system can take 10-15 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 +/- 0.1% RH from 10 to 90% RH setpoint to around 1% error at the ends of the controlled range (3 to 98% RH). To allow for near 100% RH at chamber temperatures of 25 C and above, the vapor saturator is electrically heated. Additionally, a very low heat is maintained on the saturator delivery plumbing to ensure that condensation limits are above ambient temperature.

4. SET UP AND VERIFICATION

The VAPORTRON control functions are shown in Figure 5. A description is listed roughly from Left to Right in Table 2. See Appendix (pages A-1 and A-2) for detailed description of temperature and RH controllers.

1. Unpack the VAPORTRON from the shipping carton and protective carrying case.
2. Remove the power cord and desiccant cartridge from side pouch and make sure the line voltage is correct. Plug power cord into power outlet.
3. Unfold desiccant holder hooks at rear panel, install fresh cartidge and connect plastic hoses to each end of the cartridge. (Place silver cap to INSIDE end of machine).
4. Switch on POWER (lower left). Both "RH DISPLAY" (green upper digits) and "TEMPERATURE" display (red upper digits) should read the approximate room conditions. Open white chamber for a few seconds. The RH reading should rise a few percent as the internal reference sensor responds to your skin humidity.
5. Replace door and install rubber stopper in aluminum port fitting (a test sensor may be inserted instead; seal around any cracks using the clay as provided in the kit).
6. Switch on "CONTROL". A muffled, high pitched sound should indicate proper operation of air circulator fan inside the chamber. The command or setpoint is read and adjusted in the lower displays. Press the UP and DOWN ARROWS to change the command humidity – set the RH command between 20 and 80% RH and allow 5 seconds for the new command to be updated. The setpoint for temperature is similarly adjusted using the UP and DOWN ARROWS. Set point is read off the lower display. Use a set point of 25.0 C to start out (i.e. use a value close to ambient temperature).
7. The VAPORTRON displays should begin to ramp toward the values that were set. Normally, the RH reading will stabilize within 10-60 seconds when the value desired is within 10% to 90% RH. The red L1 and L2 LEDs (right side or top of each controller) will indicate when moist or dry air is pumping into the chamber.
8. The temperature control may take from a few minutes up to approximately 15 minutes near the extreme range ends. At room temperature, normal achievable control control range in the chamber is 15 to 50^{o}C (L1), 10 to 60^{o}C (L2).
9. The VAPORTRON has been filled with an adequate supply of distilled water for approximately 1 month of normal operation. However, check the rear panel reservior window weekly.

Figure 5. VAPORTRON H-100BL front panel.

Table 2. VAPORTRON control functions

POWER SWITCH	Powers up all measuring and readout displays. All control systems are disabled. Chamber is "floating" and is allowed to reach equilibrium with ambient air.
CONTROL SWITCH	Enables both temperature and RH Controllers. Turns on internal chamber fan.
RH CONTROL	(Watlow model 965A) TOP GREEN LED; 0-100% RH display of chamber RH LOWER GREEN LED: RH command or setpoint value UP/DOWN ARROWS: press to raise or lower RH command DRY AIR; is on when red L2 led blinks on WET AIR; is on when red Ll led blinks on
TEMPER-ATURE CONTROL	(Watlow model 965A) TOP RED LED; 0-50 ºC (L1) air temperature BOTTOM RED LED; 0-50 ºC air temp COMMAND VALUE UP/DOWN ARROWS: press to increase or lower temperature COOLING: is on when red Ll led blinks on HEATING: is on when red L2 led blinks on DISPLAY RANGE: limited to 0 to 50 (or 60) ºC. ACTUAL CONTROL RANGE: 15 TO 50 ºC (L1), 10 TO 60 ºC (L2)
CHAMBER DOOR AND PORTS	The main circular door is approximately 5 inches on the inside. The door is normally fitted with a single 25 mm (actually 26 mm clearance) gland sealed type access fitting. optionally, two ports can be supplied on the door. Port fitting size adaptors are available for most commonly available sensor probes, typically; 12, 13 mm; TESTO and VAISALA small diameter 3/8 inch; Hy-cal probes 15, 16 mm; Rotronic small probes 18 mm ; Vaisala large (HMP-35 series) 20, 21 mm; TESTO large diameter

5. USE AND CALIBRATION

General Practices

For best dewpoint accuracy, the user is urged to use the output from the air-immersed PRT temperature sensor that is co-located with the RH sensor. This allows for actual AIR temperatures to measured from the place where the RH level is slaved.

Some general practices to observe include:

- To minimize mixing with ambient air and RH over/underload, temporarily shut off the Control Switch when opening chamber door.

- Keep RH setting low (20-30%) when changing chamber temperatures ESPECIALLY WHEN COOLING DOWN.

- Before chamber shutdown, set RH to a low value (20-30%) to avoid condensation inside chamber during storage.

- Replace humidifer level with distilled water as required (typically once per month is adequate).

- Use LAB ALGAECIDE or 1 DROP of Clorox (chlorine bleach) per filling to inhibit mold. The water tank is accessed by removal of red rubber cap at the center of the rear panel.

- Add water slowly with a small syringe. Typically, add only 20 cc of water. * WARNING * IF THE WATER LEVEL IS OVERFILLED (SEE ROUND WINDOW AT BOTTOM REAR PANEL) LIQUID WATER MAY BE INADVERTENTLY PUMPED DIRECTLY INTO THE CHAMBER WORKING VOLUME! ** BE CAREFUL**

Calibration

CALIBRATION OF SENSORS AND TRANSMITTERS WITH THE VAPORTRON

In the past, the most widely used method for RH calibration has been with saturated salts. With salts, it is possible to attain sub 1% RH accuracies but usually at the expense of a lot of time spent on the slow equilibration times, especially above the 75% RH level.

An additional related problem is that most sensor/electronic combinations exhibit interactions between the calibration adjustment points. When long times are needed for the salt and the sensor to stabilize, it is not usually time-efficient to properly address the interaction problem (i.e. through iteration).

With the VAPORTRON system, we have chosen to accept slightly less final generation accuracy, (circa 1.5%) but to greatly accelerate the time to change RH values and associated settling times.

The VAPORTRON stabilizes to a new RH value from 10 to 100 times faster than most salt derived methods. The benefit of this is that the product of calibration throughput and final accuracy is greatly enhanced.

In addition, due to the speed of generation, it is possible (and normally expected in metrology practice) to provide an “as found-as left" record of sensors tested, so that post-deployment corrections can be applied if needed to the sensor data.

One other advantage is that (especially through automated ramp and soak option) it is easier to identify faulty or non-linear sensor output and deal with it BEFORE a lot of *personnel time* is wasted on attempting calibration of a malfunctioning sensor!

RECOMMENDED CALIBRATION PROCEDURE (OR TRIAL-RUN)

For a typical "as found" or exploratory run, we advise to start at low RH (typically 20 or 30% RH). Allow the Devices Under Test (DUT's) to sit in the VAPORTRON chamber for 2 minutes for every Deg C difference between room temperature in the lab and the VAPORTRON chamber temperature. As a rule of thumb -- 5 minutes is usually enough at low RH. Once the temperature is fully stable (use the readings of the DUT's temperature output if available) follow the procedure below:

1. Note or log sensor readings at the low RH
2. Command a mid-range RH value of 50% RH and after 5 minutes (minimum) and record sensor readings.
3. Command a high-scale or "span-check" of 70 to 80% RH and allow another 5 minutes, again record the sensor values.
4. Finally, set the VAPORTRON for an RH of 90 or 95% and allow the sensors approximately 10-15 min to "soak". Record the sensor readings after 5 minutes and again at 15 minutes. Most normal RH polymers will show a small upward "creep". However, this change in RH should be less than 0.5% RH.
5. Return the VAPORTRON RH to the initial low RH and allow 10 minutes for full stabilization.

SENSOR RESPONSE ANALYSIS

Plotting the four recorded measurements from the calibration procedure on a linear-linear graph will make it easier to determine if sensor adjustments are necessary. The lines behavior and suggested adjustments are as follows:

If a DUT output shows a constant "offset" to a perfect 1:1 line (curve A on Figure 6) - adjust the DUT’s "zero" or "low RH" potentiometer.

If a DUT shows an output that crosses the straight line but is either flatter or steeper than 1:1 (curve B on Figure 6) – adjust both the DUT’s "zero" and "span" (or "HIGH") potentiometer.

If a DUT shows a "hump", “sag”, or severe non-linearity through the middle of the range (or excessive slope above the 75% to 95% range) then an iterative/compromise set of adjustments

will need to be made to get a best fit. If it is necessary to have the ideal sensor response at a restricted RH range, the non-linearity may be ignored.

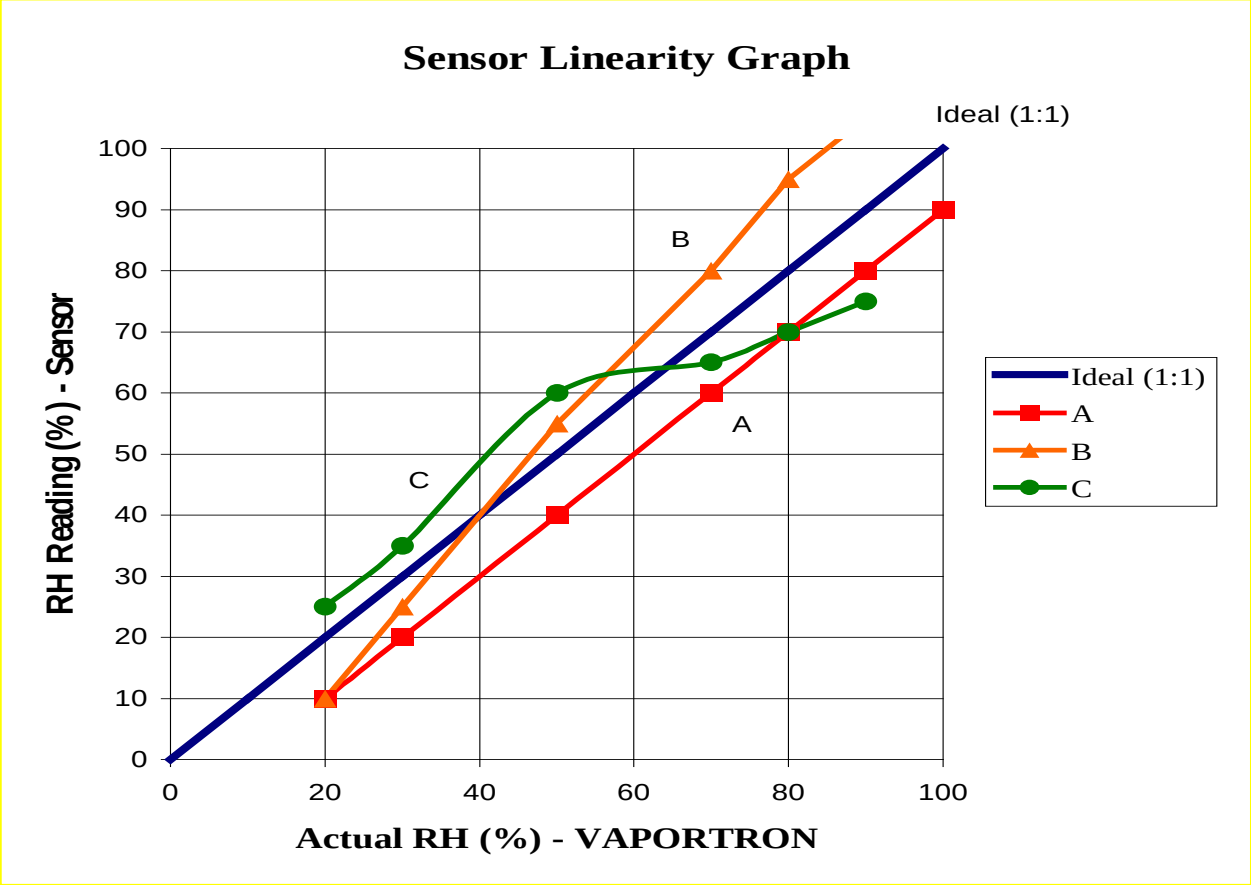


Figure 6. Sensor linearity curves. Sensor curve A can be corrected by adjustment of "offset" only. Sensor curve B can be corrected by both "offset" and "span" adjustment. Sensor curve C linearity cannot be corrected, however closer average agreement to "ideal" can be made by lowering "offset" and raising the "gain" setting slightly.

SENSOR/TRANSMITTER ADJUSTMENT PROCEDURE

Once a preliminary analysis is made through the pre-calibration and exploratory runs, use the following steps to calibrate the sensor/transmitter:

1. Adjust each DUT's "low" or "zero" to within 1% of the actual VAPORTRON RH. (Assuming you are still at the 20-30% RH step)
2. Set the VAPORTRON to the "high" end point where you want to optimize the slope or "span" of the sensor (i.e. 75 to 80% RH), allow 10 minutes soak time, then adjust the "gain" or "span" potentiometer of the DUT for within 1% of actual RH.
3. Return to the dry end, wait 5 minutes and make a final (usually < 0.5%) adjustment to the "zero" adjustment.
4. If necessary, return to the High RH and make a final trim to the span.

5. Set the VAPORTRON to mid-scale (50%) and allow sensors to stabilize. It is at this point that true sensor linearity can be tested and any compromise adjustments can be contemplated. Usually the "low" or "zero" adjustment is may now be trimmed to allow for a "split-the-difference" trade-off deviation to be made for the low and high-end RH regions.

SPECIAL LOW-END TRIMS

Some sensor/transmitters, especially for industrial ovens or dryers will have an additional adjustment for the very dry end of the RH spectrum (usually in the 5 to 10% RH range). Once the general output is adjusted as per the above sequence, it is safe to make minor adjustment trims by setting the VAPORTRON to approximately 10% RH and allowing 15 minutes for dryout, then adjusting the special "LOW" or "DRY" potentiometer. If a total change is 5% or more in this region, it is advised to again return to the normal 20-30% range to verify that circuit interaction is not excessive (> 0.5 to 1%).

Other Guidelines

OPERATING AT HIGH RELATIVE HUMIDITY

This calibration chamber is designed for optimum performance near or slightly above the ambient air temperature. The unit will generate RH at cooler and warmer temperatures but at some sacrifice in the range of humidity output. (The RH range that is possible will be narrowed at both the moist and dry ends by 10% or more.)

When operating the system at very high RH levels (>90%), it is important to realize that gradients in temperature (i.e. 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.

In other words, the limits of high RH operation will depend on how much cooling is being demanded of the heat-exchanger. The most reliable way to get RH values above 90%RH is to set the chamber temperature a little above ambient (1-2 ºC) and start by increasing the RH command by 1%RH intervals. Each time after the %RH value stabilizes, decrease the %RH value by 1%RH. If the chamber responds quickly, then increase the RH command by 1%RH and continue increasing the %RH value by 1%RH increments. When the chamber no longer quickly responds to a decrease of 1%RH, then it is at or near physical saturation. It is also wise to make sure the chamber is stable and not oscillating or ramping in temperature when running at high RH levels.

Verify that a problem with condensation is occuring by commanding a -5 to -10% RH step setting temporarily. Watch the RH display. If it freezes or holds at the previous high RH reading for a long time before responding to the new setpoint there is a condensation problem. The slow response is evidence of water puddling as the system waits to evaporate liquid water from the walls.

DESICCANT/DRIER CARTRIDGE SERVICE

The plastic desiccator tube holds enough material to run the VAPORTRON typically for one month. (See Figure 7). The dryer material gradually turns from **dark blue** when dry to **pink** or greyish white when depleted. Normally a sharp contrast is seen when using granular CALCIUM SULFATE material between the depleted and fresh section (depletion is from left to right from back view).

Replenish desiccant when edge of pink color approaches 2 cm (1 inch) from the right end of drying tube (on rear of instrument); use only DARK BLUE, ultra dry desiccant (approx. 1 month operating time is normal service per charge). Keep covers on desiccator cartridge if it is stored while NOT connected to the VAPORTRON system hoses.

For VAPORTRONs with the dew point option (-DP), we normally supply the desiccator tube filled with ½ molecular sieve and ½ calcium sulfate . The molecular sieve dries the air by a mechanical method as opposed to chemical and is less “dusty”. This allows longer use of chilled mirrors before mirror contamination occurs. We advise to change the desiccant at 1 inch to left of the red line when using the molecular sieve filled drier cartridges.

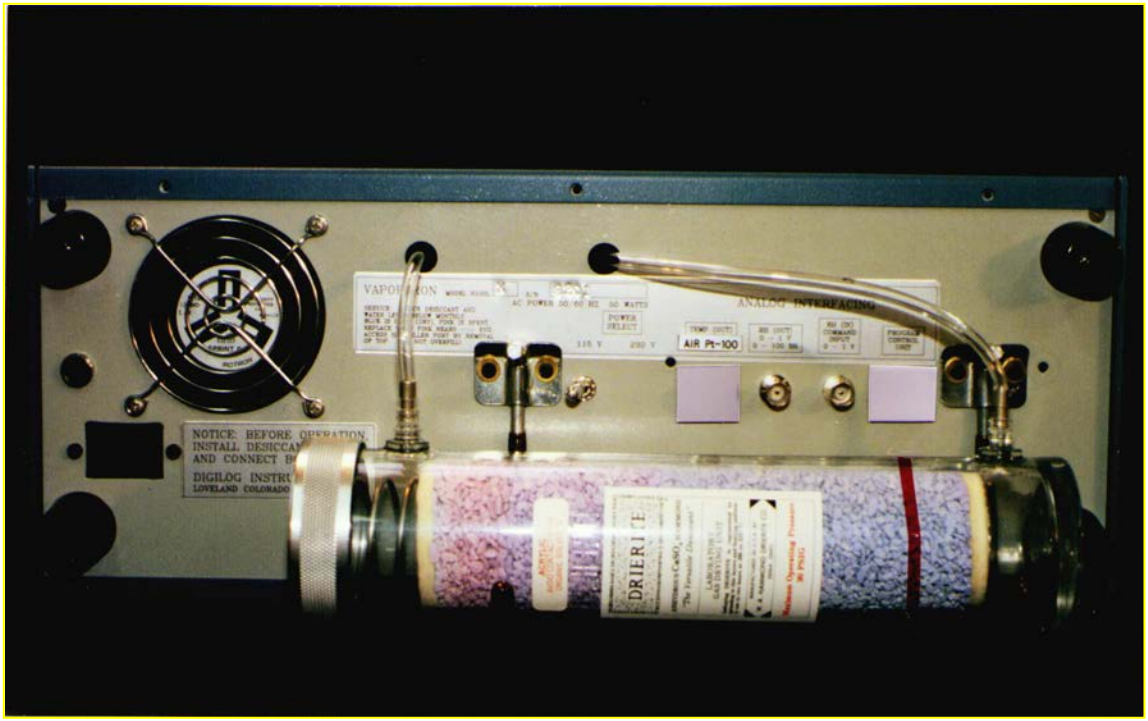


Figure 7. Rear panel with desiccant cartidge correctly installed.

WATER RESERVIOR CHECK AND WATER SERVICE PROCEDURE

The VAPORTRON internal vapor saturator/ water reservior is designed for long service between re-fills. Depending on the amount of use, the normal refill of water should last from 4 to 6 weeks to only to 1 week for continuous use or heavy cycling from hi to low RH levels.

To check the water level, remove the desiccant cartridge and look into the large window near the left desiccant hangar hook (see Figure 8). Use the small inspection lamp supplied in the service kit. If necessary, tilt the VAPORTRON chassis fore/aft or left/right about 20 degrees. This may help to visually locate the water level.

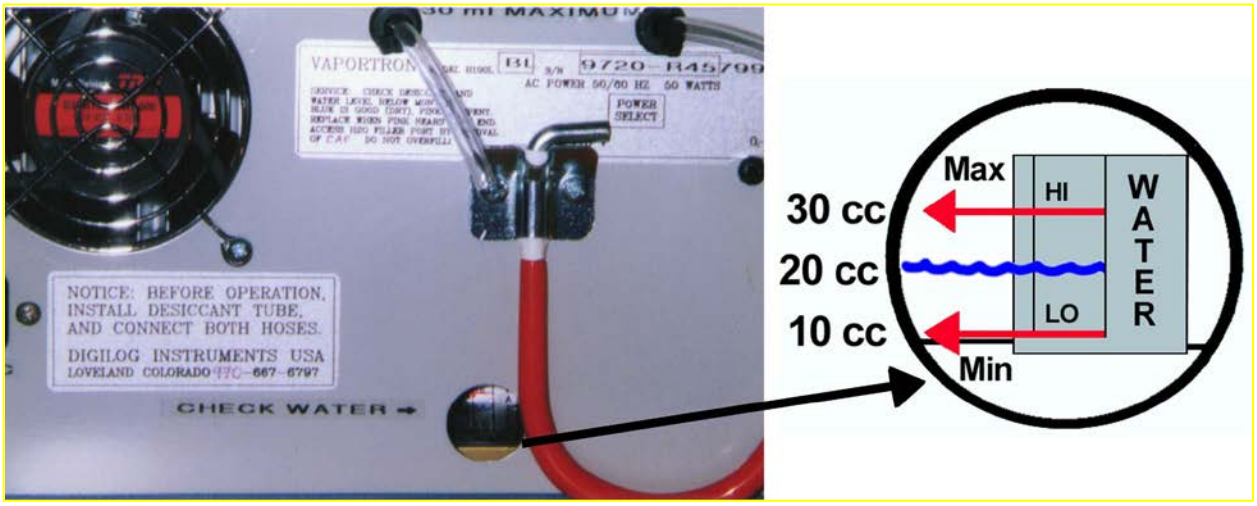


Figure 8. Water guage window location (left). Detailed figure of guage window decal (right).

The water level must be between to lower and upper red lines on the fill level decal. NEVER ADD MORE THAN 30 CC OF WATER. When available, use distilled water, otherwise use clean tap water or bottled water. A blunt-needle syringe was included in the service kit to aid in filling the reservior. Always re-install the small cap after adding water.

6. TROUBLESHOOTING

In normal operation, the control system will respond quickly to bring the RH reading to very close to the digital command LED 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: (First, shut off main power for 1 second, then back on. This action assures immediate re-entry of correct setpoints in case the system has been left idle with the CONTROL switch off.)

CHAMBER TOO MOIST OR TOO DRY

Possible Cause	Suggested Action
Leaks in or near the chamber door or through rubber port gland or rubber stopper.	Check and apply clay or tape shut.
Open return fitting (no cover or hose on fitting) on "SAMPLE RETURN".	Replace cover or tape the fitting shut.
Abnormally cold or hot chamber temperatures.	Bring chamber close to ambient temperature, see if control improves.

CHAMBER TOO MOIST - NO CONTROL

Possible Cause	Suggested Action
Condensation on chamber walls.	Open chamber, wipe walls with dry cloth, allow to air-dry for 5-10 minutes.
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 = or > than whatever the prevailing room humidity is!	Check desiccator cartridge. Replace if all pink or grey. Reconnect hose if disconnected.
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

Possible Cause	Suggested Action
No liquid water in saturator vessel	Check back sight glass and tilt cabinet front to back to confirm the water level
Cabinet of VAPORTRON unit too cold	Allow system to run in the power-on only (no control) for a period of time.
Hygroscopic load! Some materials have TREMENDOUS water capacity in the vapor phase, eg; Nylons, PVC plastics, and woods etc.	Remove suspect material

NO CONTROL -- L1, L2 PUMP LEDS LIT, BUT NO REGULATION

Possible Cause	Suggested Action
"CONTROL" switch not activated.	Check that it is pressed on
Electronic failure.	Consult technical documents or the factory

WATLOW CONTROLLER OPTION (Series 965)

How to Use the Keys and Displays

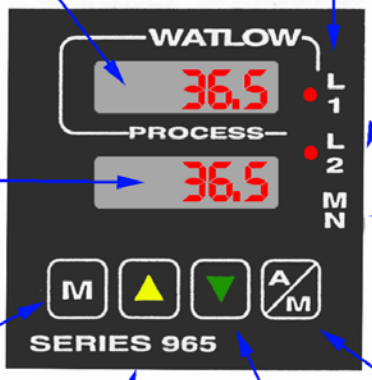
The new Vaportron H-100B configuration now uses digital process controllers (PID's) for BOTH temperature and relative humidity. The setpoints and actual chamber values are displayed in the lower and upper LED readouts respectively.

Upper Display
Red or green, 0.3" (8 mm) high, seven segment
RED = Actual temperature (^{O}C)
GREEN = Actual RH (%)

L1
L1 = Cooling
L1 = Moistening Air

L2
L2 = Heating
L2 = Drying Air

Lower Display
RED = Setpoint (^{O}C)
GREEN = Setpoint RH (%)
Setpoints are active when the H-100L "control" switch is on



MN *(Note: Not used in normal operation).*
Lit when in Manual operation mode. To enter Automatic operation, press the A/M key twice. While blinking, pressing the A/M key toggles between Auto and Manual. After five seconds LED stops blinking, and returns to its previous state.

Mode Key
Unused for Vaportron H-100BL

Up-Arrow Key
Increases the value of the displayed setpoint. A light touch increases the value by one. Holding the key down increases the value at a rapid rate. New data is self entering in five seconds.

Down-Arrow Key
Decreases the value of the displayed setpoint. A light touch decreases the value by one. Holding the key down decreases the value at a rapid rate. New data is self entering in five seconds.

A/M Key
Pressed once, it clears any latched alarms and toggles between Auto and Manual mode. If pressed again within five seconds it will change from Auto to Manual or vice versa. While in Manual mode, percent power is in the lower display.

WATLOW CONTROLLER OPTION (Series 96)

How to Use the Keys and Displays

The new Vaportron H-100C configuration now uses digital process controllers (PID's) for BOTH temperature and relative humidity. The setpoints and actual chamber values are displayed in the lower and upper LED readouts respectively.

L1
L1 = Cooling
L1 = Moistening Air

L2
L2 = Heating
L2 = Drying Air

L4
RS-232
Information Activity

Upper Display
Red or green, 0.3" (8 mm) high, seven segment
RED = Actual temperature (^{O}C)
GREEN = Actual RH (%)

Up-Arrow Key
Increases the value of the displayed setpoint. A light touch increases the value by one. Holding the key down increases the value at a rapid rate. New data is self entering in five seconds.

Lower Display
RED = Setpoint (^{O}C)
GREEN = Setpoint RH (%)
Setpoints are active when the H-100L "control" switch is on

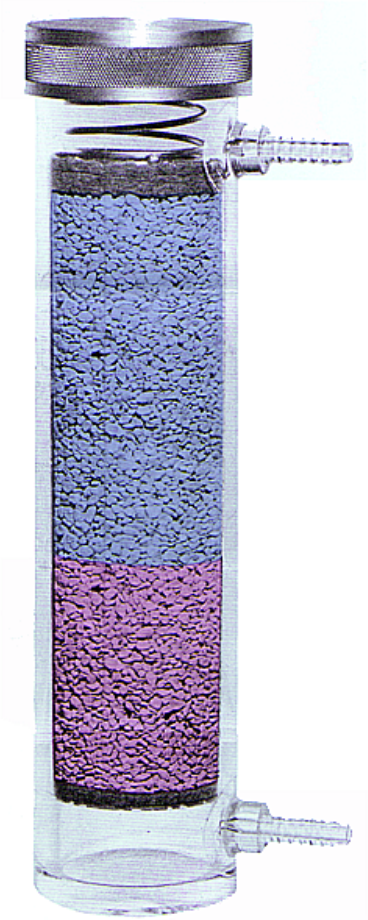
Down-Arrow Key
Decreases the value of the displayed setpoint. A light touch decreases the value by one. Holding the key down decreases the value at a rapid rate. New data is self entering in five seconds.

Drying Column for Air and Gases

. . . pressures up to 90 psig

DRIERITE®

INDICATING DRIERITE IN THIS ACRYLIC UNIT DRIES AIR TO A DEW POINT OF —100°F AND PROVIDES INDICATION OF DESICCANT CONDITION.



Size: 2⅝" x 11⅜"
Laboratory Gas and Air Drying Unit
STOCK NO. 26800

The Laboratory Air and Gas Drying Unit will completely dry air at atmospheric pressure or pressures up to 90 psig. A simple connection by rubber hose from the compressed air line or gas cylinder to the bottom inlet of the dryer provides an immediate flow of dry gas. Flow rate may be 200 liters per hour or 0.1 scfm.

Continuous flows are possible with two units in the line and the necessary valves so that the exhausted column may be refilled while the alternate column remains in use.

COLOR CHANGE

Indicating DRIERITE is a distinct blue color. When exhausted it turns to a rose red or pink. The zone between the two colors in the column may be a purple color and this zone should be a sharp narrow band when the flow rate is at equilibrium. Regeneration will restore the blue color.

The Indicating DRIERITE gives constant visual assurance of active desiccant. The progress of this color change upward through the column is very informative. It shows the drying zone as a narrow color band when the correct flow rates are used. The band widens when optimum flow rates are exceeded.

SUGGESTED USES

1. Drying laboratory systems and apparatus prior to distillation, refluxing, etc.
2. Pressurization of electronic enclosures where electrically dry atmospheres are imperative.
3. Vent drier on 55 gallon storage tanks or venting any instrument compartment that will breathe in moist air.
4. Supply small flows of instrument air.
5. Drying airborne optical instruments, wave guides, and electronic enclosures subject to pressure and temperature changes.
6. Moisture indicator for compressed air and gases.
7. General purpose absorption column that can be refilled with Ascarite for CO_2 removal or charcoal and other physical adsorbents for specific separations.
8. The unit may be used for gravimetric determination of water vapor in air and gases by weighing the complete assembly.
9. Applications in chromatography.

SPECIFICATIONS

1. Column is molded acrylic plastic.
2. Dimensions: 2⅝" O.D. x 11⅜".
3. Anodized aluminum cap is fitted with "O-Ring" gasket.
4. Safe for working pressures to 90 psig.
5. Desiccant supports and coil spring are of cadmium-plated steel.
6. DRIERITE is held firmly in place between felt filters.
7. Connections are for rubber tubing. Tubing should be held with hose clamps when used under pressure.
8. Filled with approximately 1¼ lbs. of 8 mesh Indicating DRIERITE.
9. Capacity for water vapor up to 50 grams.
10. Flow rate should be 200 liters per hour or 0.1 scfm for maximum efficiency.
11. Air and gases dried to —100°F dew point.
12. Indicating DRIERITE is non-toxic and non-explosive.

REGENERATION

DRIERITE granules should be removed from the column and spread evenly, one granule deep, on a tray. Heat for one hour at about 200°C or 400°F. The desiccant should then be cooled in a tight container before refilling the acrylic unit. Felt filters should also be pre-dried at 100°C for about 30 minutes before assembly.

Specify the acrylic model of the LABORATORY GAS DRYING UNIT.

For Sale by the Manufacturer and
LEADING LABORATORY SUPPLY DEALERS
UNITED STATES AND CANADA

BULLETIN NO. 68

W. A. HAMMOND DRIERITE COMPANY
138 DAYTON AVENUE
XENIA, OHIO 45385
(513) 376-2927

MATERIAL SAFETY DATA SHEET
IDENTITY: INDICATING DRIERITE DATE PREPARED: 7-9-96
DESCRIPTION: 1/16" TO I/4" BLUE GRANULES

SECTION I

MANUFACTURER'S NAME: W. A. HAMMOND DRIERITE CO., LTD
ADDRESS: P. 0. BOX 460, 138 DAYTON AVE. XENIA, OH 45385
EMERGENCY PHONE NUMBER: (513) 376-2927
INFORMATION PHONE NUMBER: (513) 376-2927

SECTION II
INGREDIENTS

CHEMICAL IDENTITY	%	OSHA PEL	ACGIH TLV	UNITS	C.A.S. #
CALCIUM SULFATE	97	15	10	mg/m3	7778-I8-9
COBALT CHLORIDE	3	0.05*	0.05*	mg/m3	7646-79-9

*(AS COBALT METAL)

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM (HMIS)

HEALTH	FLAMMIBILITY	REACTIVITY	PROTECTIVE EQUIPMENT
1	0	1	E

SECTION III
PHYSICAL/CHEMICAL CHARACTERISTICS

SPECIFIC GRAVITY: (H20=1): 1.87
SOLUBILITY IN WATER: 0.25 GRAMS PER LITER
MELTING POINT: 1450 ^{o}C DECOMPOSES
APPEARANCE: BLUE GRANULES; NO ODOR

SECTION IV
FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: NONE
EXTINGUISHING MEDIA: NOT COMBUSTIBLE
SPECIAL FIREFIGHTING PROCEDURES: NONE
UNUSUAL FIRE AND EXPLOSION HAZARDS: NONE

SECTION V
REACTIVITY DATA

STABILITY: STABLE
INCOMPATIBILTY (MATERIALS TO AVOID): STRONG ACIDS
HAZARDOUS DECOMPOSITION BYPRODUCTS: CL_2 AT 318^{o}; $S0_3$ @ 1450 ^{o}C
HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

SECTION VI
HEALTH HAZARD DATA

EYES: PARTICLES MAY CAUSE IRRITATION.
SKIN: THIS MATERIAL IS NOT TOXIC. MAY DRY OR IRRITATE SKIN
INHALATION: MAY CAUSE AN IRRITATION OF RESPIRATORY ORGANS OF SENSITIVE PERSONS RESULTING IN THE OBSTRUCTION OF AIRWAYS WITH SHORTNESS OF BREATH.
INGESTION: MAY CAUSE VOMITING, DIARRHEA AND SENSATION OF WARMTH
SIGNS AND SYMPTOMS OF OVER EXPOSURE: EYE, NOSE, THROAT, OR RESPIRATORY IRRITATION

CARCINOGENICITY OF INGREDIENTS:

MATERIAL	IARC	NTP	OSHA
CALCIUM SULFATE,	NOT LISTED	NOT LISTED	NOT LISTED
COBALT CHLORIDE	YES*	NO	NO

*(COBALT & COBALT COMPOUNDS ARE CLASSIFIED AS GROUP 2B)

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE:
PRE-EXISTING UPPER RESPIRATORY AND LUNG DISEASE SUCH AS, BUT NOT LIMITED TO, BRONCHITIS, EMPHYSEMA & ASTHMA

EMERGENCY AND FIRST AID PROCEDURES:
EYES: FLUSH WITH WATER. IF IRRITATION CONTINUES OBTAIN MEDICAL ATTENTION.
DUST: INHALATION: REMOVE TO FRESH AIR
SKIN: WASH WITH WATER
INGESTION: IF PATIENT IS CONSCIOUS, INDUCE VOMITING. OBTAIN MEDICAL ATTENTION.

SECTION VII
SPILL AND LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: SWEEP OR VACUUM MATERIAL INTO APPROPRIATE WASTE CONTAINER FOR DISPOSAL. AVOID DUSTING CONDITIONS.
WASTE DISPOSAL METHOD: THIS MATERIAL MUST BE DISPOSED OF IN ACCORDANCE WITH PROCEDURES ACCEPTABLE UNDER. FEDERAL, STATE AND LOCAL REGULATIONS.
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: KEEP CONTAINER CLOSED STORE IN A COOL DRY PLACE AVOID GENERATING DUST

SECTION VIII
CONTROL MEASURES

RESPIRATORY PROTECTION: MASK NIOSH/OSHA APPROVED FOR DUST
VENTILATION: TO MEET TLV REQUIREMENTS
EYES: SAFETY GLASSES OR GOGGLES
OTHER PROTECTIVE EQUIPMENT: GLOVES OR PROTECTIVE CLOTHING ARE NOT USUALLY NECESSARY BUT MAY BE DESIRABLE IN SPECIFIC WORK SITUATIONS.

SECTION IX
REFERENCES

U.S. DEPARTMENT OF LABOR - OSHA FORM APPROVED OMB NO.1218-0072. OSHA HAZARD COMMUNICATION STANDARD - 29 CFR 1910.1200 U.S GYPSUM CO. & SOGEM-AFROMET INC.

BUCK RESEARCH INSTRUMENTS L.L.C.

CERTIFICATE OF CONFORMANCE

Customer Name	Model #	Serial #	Date
	VAPORTRON	2K-0104-TD100XXXXX Hygroclip S 11XXXX	05/03/2006

NIST TRACEABLE STANDARD %RH	CUSTOMER UNIT %RH	DIFFERENCE	SPECIFICATION OF UNIT
11.4	11.0	-0.4%RH	± 1.5%RH
32.7	32.2	-0.5%RH	± 1.5%RH
48.2	48.4	+0.2%RH	± 1.5%RH
57.7	58.0	+0.3%RH	± 1.5%RH
75.3	74.5	-0.8%RH	± 1.5%RH
84.2	83.2	-1.0%RH	± 1.5%RH

NIST TRACEABLE CALIBRATION EQUIPMENT

Humidity Standard

Manufacturer	Model	Cal Due	Serial #
Buck Research Instruments	CR-3	2/1/2006	301

Temperature Standard

Manufacturer	Model	Cal Due	Serial #
Logan	PlatinumRTD	3/15/2006	9251-12

Voltage Standard

Manufacturer	Model	Cal Due	Serial #
Agilent Hewlett Packard	34401A 34401A	5/27/2006 5/27/2006	US36112687 US36043947

Pressure Standard

Manufacturer	Model	Cal Due	Serial #
Druck	DPI-740	2/12/2006	740 01260

TESTED BY: _____

PO Box 19498, Boulder, CO 80308
main: 303.442.6055
fax: 303.443.2986
1.800.HUMIDITY
WWW.HYGROMETERS.COM

TABLE OF RELATIVE HUMIDITY VS. DEWPOINT at 1% RH STEPS IN DEGREES C

	AIR TEMPERATURE:										
	20 C	21 C	22 C	23 C	24 C	25 C		26 C	27 C	28 C	29 C	30 C
% RH	DEWPOINT	DEWPOINT	DEWPOINT	DEWPOINT	DEWPOINT	DEWPOINT		DEWPOINT	DEWPOINT	DEWPOINT	DEWPOINT	DEWPOIN
5	-18.700	-18.048	-17.398	-16.750	-16.104	-15.459	MOST COMMON	-14.816	-14.175	-13.535	-12.897	-12.260
6	-16.760	-16.103	-15.444	-14.786	-14.129	-13.475	USE RANGE	-12.821	-12.170	-11.520	-10.872	-10.226
7	-15.110	-14.436	-13.768	-13.101	-12.436	-11.773	FOR	-11.111	-10.451	-9.793	-9.136	-8.481
8	-13.650	-12.974	-12.298	-11.624	-10.951	-10.280	OPERATION:	-9.611	-8.943	-8.277	-7.613	-6.950
9	-12.350	-11.670	-10.988	-10.307	-9.627	-8.949	25 C	-8.273	-7.599	-6.926	-6.255	-5.586
10	-11.180	-10.493	-9.804	-9.117	-8.432	-7.748		-7.065	-6.385	-5.706	-5.029	-4.353
11	-10.120	-9.419	-8.725	-8.032	-7.341	-6.651		-5.963	-5.277	-4.592	-3.909	-3.228
12	-9.130	-8.431	-7.731	-7.033	-6.337	-5.642		-4.949	-4.257	-3.567	-2.879	-2.193
13	-8.220	-7.516	-6.811	-6.108	-5.406	-4.707		-4.009	-3.312	-2.618	-1.924	-1.233
14	-7.370	-6.662	-5.953	-5.245	-4.539	-3.835		-3.132	-2.432	-1.732	-1.035	-0.339
15	-6.580	-5.863	-5.149	-4.437	-3.727	-3.018		-2.312	-1.606	-0.903	-0.201	0.565
16	-5.830	-5.110	-4.393	-3.677	-2.963	-2.250		-1.539	-0.830	-0.122	0.661	1.461
17	-5.120	-4.400	-3.679	-2.959	-2.241	-1.524		-0.810	-0.096	0.697	1.503	2.309
18	-4.450	-3.727	-3.002	-2.278	-1.557	-0.836		-0.118	0.678	1.491	2.302	3.113
19	-3.820	-3.087	-2.358	-1.631	-0.906	-0.183		0.611	1.429	2.246	3.063	3.879
20	-3.210	-2.477	-1.745	-1.015	-0.286	-0.499		1.322	2.145	2.968	3.789	4.610
21	-2.630	-1.894	-1.159	-0.425	0.346	1.175		2.003	2.831	3.658	4.484	5.310
22	-2.080	-1.336	-0.598	0.156	0.990	1.823		2.656	3.488	4.320	5.150	5.981
23	-1.540	-0.800	-0.059	0.770	1.608	2.446		3.283	4.119	4.955	5.790	6.625
24	-1.030	-0.286	0.518	1.361	2.204	3.045		3.886	4.727	5.567	6.406	7.245
25	-0.540	0.237	1.084	1.931	2.777	3.623		4.468	5.312	6.156	7.000	7.842
26	-0.060	0.779	1.630	2.481	3.331	4.180		5.029	5.878	6.725	7.573	8.419
27	0.450	1.303	2.158	3.012	3.866	4.719		5.572	6.424	7.275	8.126	8.977
28	0.950	1.810	2.668	3.526	4.384	5.241		6.097	6.953	7.808	8.662	9.516
29	1.440	2.301	3.163	4.025	4.886	5.746		6.606	7.465	8.324	9.182	10.039
30	1.910	2.778	3.643	4.508	5.372	6.236		7.099	7.962	8.824	9.685	10.546
31	2.370	3.240	4.109	4.977	5.845	6.712		7.578	8.444	9.310	10.175	11.039
32	2.820	3.690	4.562	5.433	6.304	7.174		8.044	8.913	9.782	10.650	11.518
33	3.250	4.127	5.002	5.877	6.751	7.624		8.497	9.370	10.241	11.113	11.984
34	3.670	4.553	5.431	6.309	7.186	8.062		8.938	9.814	10.689	11.563	12.437
35	4.090	4.968	5.849	6.730	7.610	8.489		9.368	10.247	11.125	12.002	12.879
36	4.490	5.373	6.257	7.140	8.023	8.905		9.787	10.669	11.550	12.430	13.310
37	4.880	5.767	6.654	7.540	8.426	9.311		10.196	11.080	11.964	12.848	13.731
38	5.260	6.153	7.042	7.931	8.820	9.708		10.596	11.483	12.369	13.256	14.141
39	5.640	6.529	7.422	8.313	9.205	10.095		10.996	11.876	12.765	13.654	14.543
40	6.000	6.898	7.792	8.687	9.581	10.474		11.367	12.260	13.152	14.044	14.935
41	6.360	6.155	6.155	9.052	9.940	10.845		11.740	12.636	13.531	14.425	15.319
42	6.710	7.610	8.510	9.410	10.309	11.207		12.106	13.004	13.901	14.798	15.695
43	7.050	7.955	8.858	9.760	10.861	11.563		12.463	13.364	14.264	15.163	16.063
44	7.390	8.293	9.198	10.103	11.007	11.911		12.814	13.717	14.619	15.521	16.423
45	7.720	8.625	9.532	10.439	11.345	12.252		13.157	14.063	14.968	15.872	16.776
46	8.040	8.950	9.859	10.769	11.677	12.586		13.494	14.402	15.309	16.216	17.123
47	8.360	9.268	10.180	11.092	12.003	12.914		13.825	14.735	15.645	16.554	17.463
48	8.670	9.581	10.496	11.409	12.323	13.236		14.149	15.061	15.974	16.885	17.797
49	8.970	9.888	10.805	11.721	12.637	13.552		14.468	15.382	16.297	17.211	18.124
50	9.270	10.190	11.109	12.027	12.945	13.863		14.780	15.697	16.614	17.530	18.446
51	9.570	10.486	11.407	12.328	13.248	14.168		15.088	16.007	16.926	17.844	18.763
52	9.850	10.778	11.701	12.624	13.546	14.468		15.390	16.311	17.232	18.153	19.073
53	10.140	11.064	11.989	12.914	13.839	14.763		15.687	16.610	17.534	18.457	19.379
54	10.420	11.346	12.273	13.200	14.127	15.053		15.979	16.905	17.830	18.755	19.680
55	10.690	11.623	12.552	13.481	14.410	15.338		16.267	17.194	18.122	19.049	19.976
56	10.960	11.896	12.827	13.758	14.689	15.619		16.549	17.479	18.409	19.338	20.267
57	11.230	12.164	13.098	14.031	14.963	15.896		16.828	17.760	18.691	19.623	20.554
58	11.490	12.429	13.364	14.299	15.234	16.168		17.102	18.036	18.970	19.903	20.836
59	11.750	12.689	13.626	14.563	15.500	16.436		17.372	18.308	19.244	20.179	21.114
60	12.010	12.946	13.885	14.824	15.762	16.700		17.639	18.576	19.514	20.451	21.388
61	12.260	13.199	14.140	15.080	16.021	16.961		17.901	18.840	19.780	20.719	21.658
62	12.500	13.448	14.391	15.333	16.276	17.218		18.159	19.101	20.042	20.983	21.924
63	12.750	13.694	14.638	15.583	16.527	17.471		18.414	19.358	20.301	21.244	22.186
64	12.990	13.936	14.882	15.828	16.774	17.720		18.666	19.611	20.556	21.501	22.445
65	13.230	14.175	15.123	16.071	17.019	17.966		18.914	19.861	20.808	21.754	22.701
66	13.460	14.411	15.361	16.310	17.260	18.209		19.158	20.107	21.056	22.004	22.953
67	13.690	14.643	15.595	16.547	17.498	18.449		19.400	20.350	21.301	22.251	23.201
68	13.920	14.873	15.826	16.780	17.733	18.685		19.638	20.590	21.543	22.495	23.446
69	14.140	15.100	16.055	17.010	17.964	18.919		19.873	20.827	21.781	22.735	23.689
70	14.370	15.323	16.280	17.237	18.193	19.150		20.106	21.061	22.017	22.973	23.928
71	14.590	15.544	16.503	17.461	18.419	19.377		20.335	21.293	22.250	23.207	24.164
72	14.800	15.763	16.723	17.683	18.643	19.602		20.562	21.521	22.480	23.439	24.397
73	15.020	15.978	16.940	17.902	18.863	19.824		20.785	21.746	22.707	23.668	24.628
74	15.230	16.192	17.155	18.118	19.081	20.044		21.007	21.969	22.932	23.894	24.856
75	15.440	16.402	17.367	18.332	19.296	20.261		21.225	22.189	23.153	24.117	25.081
76	15.640	16.610	17.577	18.543	19.509	20.475		21.441	22.407	23.373	24.338	25.303
77	15.850	16.816	17.784	18.752	19.720	20.687		21.655	22.622	23.589	24.556	25.523
78	16.050	17.019	17.989	18.958	19.928	20.897		21.866	22.835	23.804	24.772	25.741
79	16.250	17.221	18.192	19.163	20.133	21.104		22.075	23.045	24.016	24.986	25.956
80	16.450	17.419	18.392	19.365	20.337	21.309		22.281	23.253	24.225	25.197	26.169
81	16.640	17.616	18.590	19.564	20.538	21.512		22.486	23.459	24.433	25.406	26.379
82	16.840	17.811	18.786	19.762	20.737	21.713		22.688	23.663	24.638	25.613	26.587
83	17.030	18.003	18.980	19.957	20.934	21.911		22.888	23.864	24.841	25.817	26.793
84	17.220	18.194	19.172	20.151	21.129	22.107		23.085	24.063	25.041	26.019	26.997
85	17.400	18.382	19.362	20.342	21.322	22.302		23.281	24.261	25.240	26.219	27.199
86	17.590	18.569	19.550	20.532	21.513	22.494		23.475	24.456	25.437	26.418	27.398
87	17.770	18.754	19.737	20.719	21.702	22.684		23.667	24.649	25.632	26.614	27.596
88	17.950	18.937	19.921	20.905	21.889	22.873		23.857	24.841	25.824	26.808	27.792
89	18.130	19.118	20.103	21.089	22.074	23.060		24.045	25.030	26.015	27.000	27.985
90	18.310	19.297	20.284	21.271	22.258	23.244		24.231	25.218	26.204	27.191	28.177
91	18.490	19.475	20.463	21.451	22.439	23.427		24.415	25.403	26.391	27.379	28.367
92	18.660	19.650	20.640	21.630	22.619	23.609		24.598	25.588	26.577	27.566	28.555
93	18.830	19.825	20.816	21.807	22.797	23.788		24.779	25.770	26.761	27.751	28.742
94	19.000	19.997	20.989	21.982	22.974	23.966		24.958	25.950	26.942	27.934	28.927
95	19.170	20.168	21.162	22.155	23.149	24.142		25.136	26.129	27.123	28.116	29.109

TABLE OF RELATIVE HUMIDITY VS. DEWPOINT at 1% RH STEPS IN DEGREES F

	AIR TEMPERATURE: 68 F	69.8 F	71.6 F	73.4 F	75.2 F	77 F		78.8 F	80.6 F	82.4 F	84.2 F	86 F
% RH	DEWPOINT	DEWPOINT	DEWPOINT	DEWPOINT	DEWPOINT	DEWPOINT		DEWPOINT	DEWPOINT	DEWPOINT	DEWPOINT	DEWPOINT
5	-1.66	-0.49	0.68	1.85	3.01	4.17	MOST COMMON	5.33	6.48	7.64	8.79	9.93
6	1.83	3.01	4.20	5.39	6.57	7.75	USE RANGE	8.92	10.09	11.26	12.43	13.59
7	4.80	6.02	7.22	8.42	9.62	10.81	FOR	12.00	13.19	14.37	15.56	16.73
8	7.43	8.65	9.86	11.08	12.29	13.50	OPERATION:	14.70	15.90	17.10	18.30	19.49
9	9.77	10.99	12.22	13.45	14.67	15.89	77 F	17.11	18.32	19.53	20.74	21.95
10	11.88	13.11	14.35	15.59	16.82	18.05		19.28	20.51	21.73	22.95	24.16
11	13.78	15.05	16.30	17.54	18.79	20.03		21.27	22.50	23.73	24.96	26.19
12	15.57	16.82	18.08	19.34	20.59	21.84		23.09	24.34	25.58	26.82	28.05
13	17.20	18.47	19.74	21.01	22.27	23.53		24.78	26.04	27.29	28.54	29.78
14	18.73	20.01	21.28	22.56	23.83	25.10		26.36	27.62	28.88	30.14	31.39
15	20.16	21.45	22.73	24.01	25.29	26.57		27.84	29.11	30.37	31.64	33.02
16	21.51	22.80	24.09	25.38	26.67	27.95		29.23	30.51	31.78	33.19	34.63
17	22.78	24.08	25.38	26.67	27.97	29.26		30.54	31.83	33.25	34.71	36.16
18	23.99	25.29	26.60	27.90	29.20	30.50		31.79	33.22	34.68	36.14	37.60
19	25.12	26.44	27.76	29.06	30.37	31.67		33.10	34.57	36.04	37.51	38.98
20	26.22	27.54	28.86	30.17	31.49	31.10		34.38	35.86	37.34	38.82	40.30
21	27.27	28.59	29.91	31.24	32.62	34.12		35.61	37.10	38.58	40.07	41.56
22	28.26	29.60	30.92	32.28	33.78	35.28		36.78	38.28	39.78	41.27	42.77
23	29.23	30.56	31.89	33.39	34.89	36.40		37.91	39.41	40.92	42.42	43.93
24	30.15	31.49	32.93	34.45	35.97	37.48		38.99	40.51	42.02	43.53	45.04
25	31.03	32.43	33.95	35.48	37.00	38.52		40.04	41.56	43.08	44.60	46.12
26	31.89	33.40	34.93	36.47	38.00	39.52		41.05	42.58	44.11	45.63	47.15
27	32.81	34.35	35.88	37.42	38.96	40.49		42.03	43.56	45.10	46.63	48.16
28	33.71	35.26	36.80	38.35	39.89	41.43		42.97	44.52	46.05	47.59	49.13
29	34.59	36.14	37.69	39.25	40.79	42.34		43.89	45.44	46.98	48.53	50.07
30	35.44	37.00	38.56	40.11	41.67	43.22		44.78	46.33	47.88	49.43	50.98
31	36.27	37.83	39.40	40.96	42.52	44.08		45.64	47.20	48.76	50.32	51.87
32	37.08	38.64	40.21	41.78	43.35	44.91		46.48	48.04	49.61	51.17	52.73
33	37.85	39.43	41.00	42.58	44.15	45.72		47.29	48.87	50.43	52.00	53.57
34	38.61	40.20	41.78	43.36	44.93	46.51		48.09	49.67	51.24	52.81	54.39
35	39.36	40.94	42.53	44.11	45.70	47.28		48.86	50.44	52.03	53.60	55.18
36	40.08	41.67	43.26	44.85	46.44	48.03		49.62	51.20	52.79	54.37	55.96
37	40.78	42.38	43.98	45.57	47.17	48.76		50.35	51.94	53.54	55.13	56.72
38	41.47	43.08	44.68	46.28	47.88	49.47		51.07	52.67	54.26	55.86	57.45
39	42.15	43.75	45.36	46.96	48.57	50.17		51.77	53.38	54.98	56.58	58.18
40	42.80	44.42	46.03	47.64	49.25	50.85		52.46	54.07	55.67	57.28	58.88
41	43.45	46.68	46.68	48.29	49.91	51.52		53.13	54.74	56.36	57.97	59.57
42	44.08	45.70	47.32	48.94	50.56	52.17		53.79	55.41	57.02	58.64	60.25
43	44.69	46.32	47.94	49.57	51.19	52.81		54.43	56.06	57.68	59.29	60.91
44	45.30	46.93	48.56	50.19	51.81	53.44		55.07	56.69	58.31	59.94	61.56
45	45.90	47.53	49.16	50.79	52.42	54.05		55.68	57.31	58.94	60.57	62.20
46	46.47	48.11	49.75	51.38	53.02	54.65		56.29	57.92	59.56	61.19	62.82
47	47.05	48.68	50.32	51.97	53.61	55.25		56.89	58.52	60.16	61.80	63.43
48	47.61	49.25	50.89	52.54	54.18	55.82		57.47	59.11	60.75	62.39	64.03
49	48.15	49.80	51.45	53.10	54.75	56.39		58.04	59.69	61.33	62.98	64.62
50	48.69	50.34	52.00	53.65	55.30	56.95		58.60	60.25	61.91	63.55	65.20
51	49.23	50.87	52.53	54.19	55.85	57.50		59.16	60.81	62.47	64.12	65.77
52	49.73	51.40	53.06	54.72	56.38	58.04		59.70	61.36	63.02	64.68	66.33
53	50.25	51.92	53.58	55.25	56.91	58.57		60.24	61.90	63.56	65.22	66.88
54	50.76	52.42	54.09	55.76	57.43	59.10		60.76	62.43	64.09	65.76	67.42
55	51.24	52.92	54.59	56.27	57.94	59.61		61.28	62.95	64.62	66.29	67.96
56	51.73	53.41	55.09	56.76	58.44	60.11		61.79	63.46	65.14	66.81	68.48
57	52.21	53.90	55.58	57.26	58.93	60.61		62.29	63.97	65.64	67.32	69.00
58	52.68	54.37	56.06	57.74	59.42	61.10		62.78	64.46	66.15	67.83	69.50
59	53.15	54.84	56.53	58.21	59.90	61.58		63.27	64.95	66.64	68.32	70.01
60	53.62	55.30	56.99	58.68	60.37	62.06		63.75	65.44	67.13	68.81	70.50
61	54.07	55.76	57.45	59.14	60.84	62.53		64.22	65.91	67.60	69.29	70.98
62	54.50	56.21	57.90	59.60	61.30	62.99		64.69	66.38	68.08	69.77	71.46
63	54.95	56.65	58.35	60.05	61.75	63.45		65.15	66.84	68.54	70.24	71.93
64	55.38	57.08	58.79	60.49	62.19	63.90		65.60	67.30	69.00	70.70	72.40
65	55.81	57.52	59.22	60.93	62.63	64.34		66.05	67.75	69.45	71.16	72.86
66	56.23	57.94	59.65	61.36	63.07	64.78		66.48	68.19	69.90	71.61	73.32
67	56.64	58.36	60.07	61.78	63.50	65.21		66.92	68.63	70.34	72.05	73.76
68	57.06	58.77	60.49	62.20	63.92	65.63		67.35	69.06	70.78	72.49	74.20
69	57.45	59.18	60.90	62.62	64.34	66.05		67.77	69.49	71.21	72.92	74.64
70	57.87	59.58	61.30	63.03	64.75	66.47		68.19	69.91	71.63	73.35	75.07
71	58.26	59.98	61.71	63.43	65.15	66.88		68.60	70.33	72.05	73.77	75.50
72	58.64	60.37	62.10	63.83	65.56	67.28		69.01	70.74	72.46	74.19	75.91
73	59.04	60.76	62.49	64.22	65.95	67.68		69.41	71.14	72.87	74.60	76.33
74	59.41	61.15	62.88	64.61	66.35	68.08		69.81	71.54	73.28	75.01	76.74
75	59.79	61.52	63.26	65.00	66.73	68.47		70.21	71.94	73.68	75.41	77.15
76	60.15	61.90	63.64	65.38	67.12	68.86		70.59	72.33	74.07	75.81	77.55
77	60.53	62.27	64.01	65.75	67.50	69.24		70.98	72.72	74.46	76.20	77.94
78	60.89	62.63	64.38	66.12	67.87	69.61		71.36	73.10	74.85	76.59	78.33
79	61.25	63.00	64.75	66.49	68.24	69.99		71.74	73.48	75.23	76.97	78.72
80	61.61	63.35	65.11	66.86	68.61	70.36		72.11	73.86	75.61	77.35	79.10
81	61.95	63.71	65.46	67.22	68.97	70.72		72.47	74.23	75.98	77.73	79.48
82	62.31	64.06	65.81	67.57	69.33	71.08		72.84	74.59	76.35	78.10	79.86
83	62.65	64.41	66.16	67.92	69.68	71.44		73.20	74.96	76.71	78.47	80.23
84	63.00	64.75	66.51	68.27	70.03	71.79		73.55	75.31	77.07	78.83	80.59
85	63.32	65.09	66.85	68.62	70.38	72.14		73.91	75.67	77.43	79.19	80.96
86	63.66	65.42	67.19	68.96	70.72	72.49		74.26	76.02	77.79	79.55	81.32
87	63.99	65.76	67.53	69.29	71.06	72.83		74.60	76.37	78.14	79.91	81.67
88	64.31	66.09	67.86	69.63	71.40	73.17		74.94	76.71	78.48	80.25	82.03
89	64.63	66.41	68.19	69.96	71.73	73.51		75.28	77.05	78.83	80.60	82.37
90	64.96	66.73	68.51	70.29	72.06	73.84		75.62	77.39	79.17	80.94	82.72
91	65.28	67.06	68.83	70.61	72.39	74.17		75.95	77.73	79.50	81.28	83.06
92	65.59	67.37	69.15	70.93	72.71	74.50		76.28	78.06	79.84	81.62	83.40
93	65.89	67.69	69.47	71.25	73.03	74.82		76.60	78.39	80.17	81.95	83.74
94	66.20	67.99	69.78	71.57	73.35	75.14		76.92	78.71	80.50	82.28	84.07
95	66.51	68.30	70.09	71.88	73.67	75.46		77.24	79.03	80.82	82.61	84.40

PRODUCT LISTING

TABLE-TOP HUMIDITY LABORATORY - V*APORTRON® H-100* SERIES
(line powered portables 115/230V 50/60HZ)

H-100BL	Basic unit with manual set-points and no computer interface. RH range of 3-95 % RH, 10 to 60 Deg C
H-100CL	Advanced unit with manual/computer interface and PC operated ramp & soak with logging to disk- file.

INSTALLED OPTIONS: Available in "BL". or "CL" version:

-230	230VAC, 50Hz option (standard is 110VAC, 60Hz)
-DP	CiS dew point sensor with LCD readout and output
-DPR	LCD dew point display from Rotronic Sensor

VAPORTRON ACCESSORIES AND SUPPORT ITEMS:

DRIER H-100	Desiccant cartridge
DOOR-OSTD	Blank insulated door
DOOR-1	Standard single-port door; 25mm diameter fitting, insulated
DOOR-2	Standard dual-port door; 25mm diameter fitting, insulated
SPARES	Accessory kit for VAPORTRON
H-100 MAN	Operators' manual
DOOR-ESP	Heavy duty 3/8” machined polycarbonate door with face o-ring seal and thumbscrew lockdowns –blank –no holes -clear
DOOR-ESP-4	Same as above with 4 drilled ports at 12-25 mm dia – clear (customer specify each port diameter at order placement)
RECAL	NVLAP certified calibration with documents

APPENDIX 3:WARRANTY

Manufacturer warrants that the items delivered shall be free from defects (latent and patent) in material and workmanship for a period of one year after acceptance of the specific goods by Buyer. The Buyer's sole and exclusive remedy under this warranty shall be limited to repair or replacement. Defective goods must be returned to the Manufacturer promptly after the discovery of any defect within the above referenced one-year period. Transportation expenses to return unit to Manufacturer shall be borne by the Buyer. Return shipping to Buyer shall be borne by Manufacturer for valid warranty claims. This warranty shall become inapplicable in instances where the items have been misused or otherwise subjected to negligence by the Buyer

NOTWITHSTANDING ANY OTHER PROVISION OF THIS CONTRACT, NO OTHER WARRANTIES WHETHER STATUTORY OR ARISING BY OPERATION OF LAW, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THOSE OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE, SHALL APPLY TO THE GOODS OR SERVICES PROVIDED HEREUNDER, OTHER THAN THE REPAIR AND REPLACEMENT WARRANTY ABOVE . SELLER SHALL IN NO EVENT BE LIABLE TO BUYER OR ANY THIRD PARTY FOR ANY DAMAGE, INJURY OR LOSS, INCLUDING LOSS OF USE OR ANY DIRECT OR INDIRECT INCEDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND.