

READ AND SAVE THESE INSTRUCTIONS

CARNES®

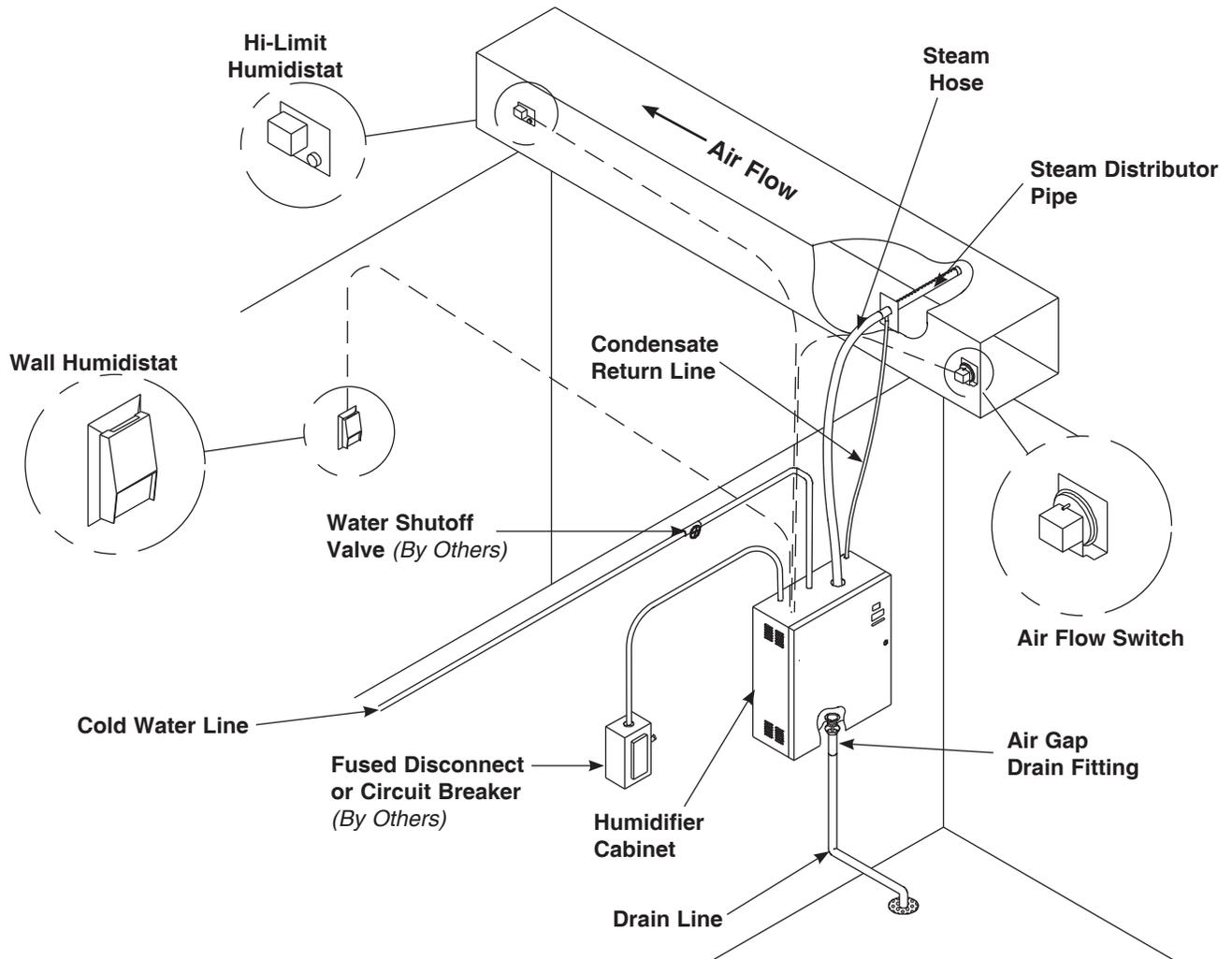
MODEL HRAB TECHNICAL MANUAL

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

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TYPICAL INSTALLATION

Figure A



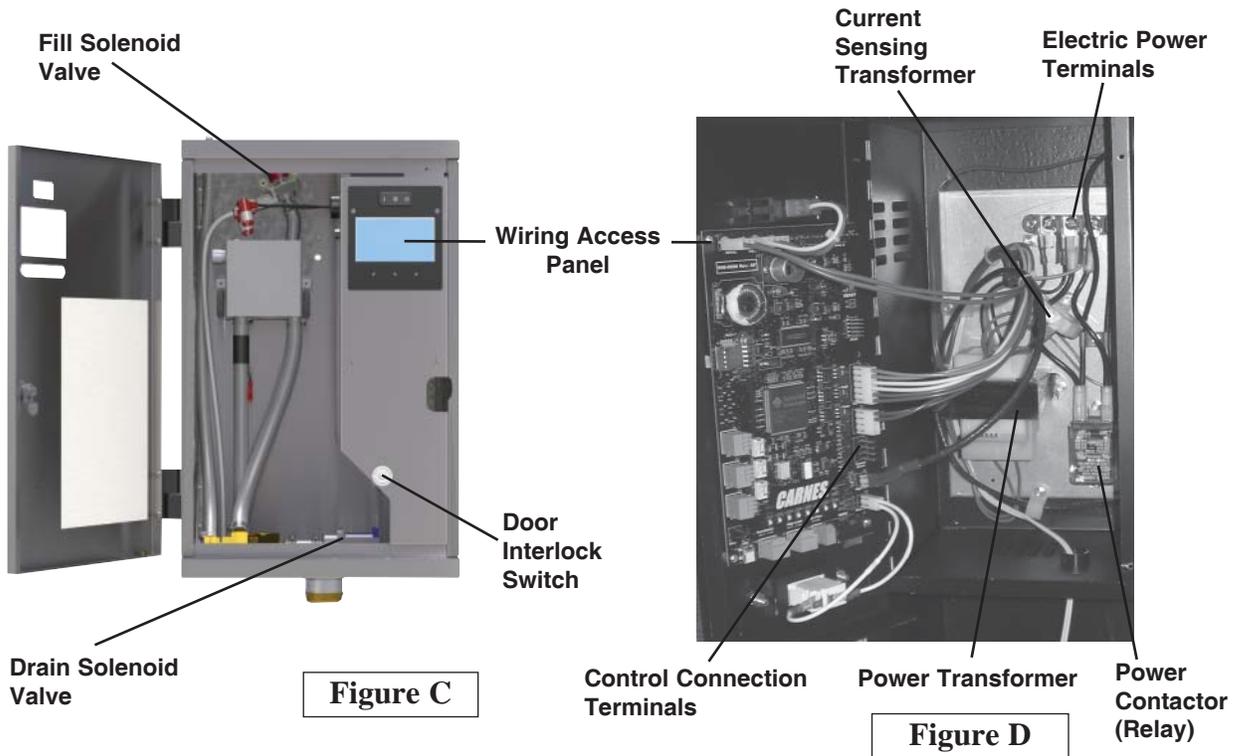
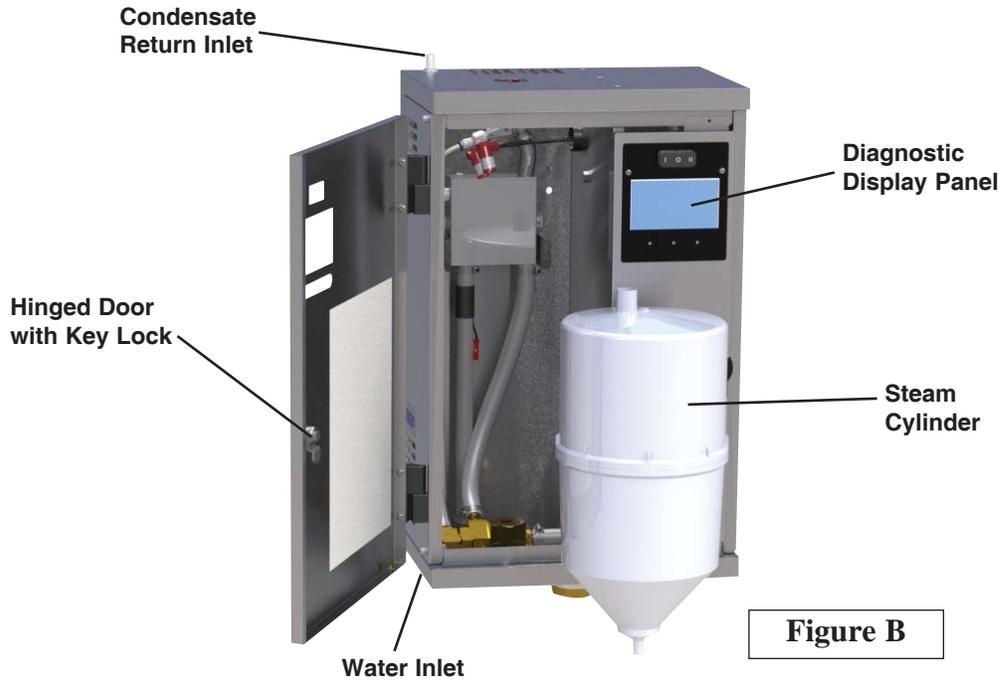
"B" Design Series



WARNING: THE HUMIDIFIER CABINET CONTAINS HIGH VOLTAGE WIRING AND HOT SURFACES. THE CABINET DOOR INCLUDES A LOCK AND ACCESS MUST BE LIMITED TO TRAINED AND QUALIFIED PERSONNEL ONLY. THE DOOR MUST BE LOCKED AND KEY MUST BE KEPT IN A SECURE LOCATION AWAY FROM THE HUMIDIFIER.



WARNING: INSTALLING AND SERVICING THIS EQUIPMENT CAN BE HAZARDOUS DUE TO ELECTRICAL COMPONENTS AND HOT SURFACES. ONLY TRAINED AND QUALIFIED PERSONNEL SHOULD INSTALL, REPAIR OR SERVICE THIS EQUIPMENT. INSTALLATION MUST BE MADE IN ACCORDANCE WITH ALL APPLICABLE CODES AND STANDARDS.



INSTALLATION

UNPACKING AND INSPECTION

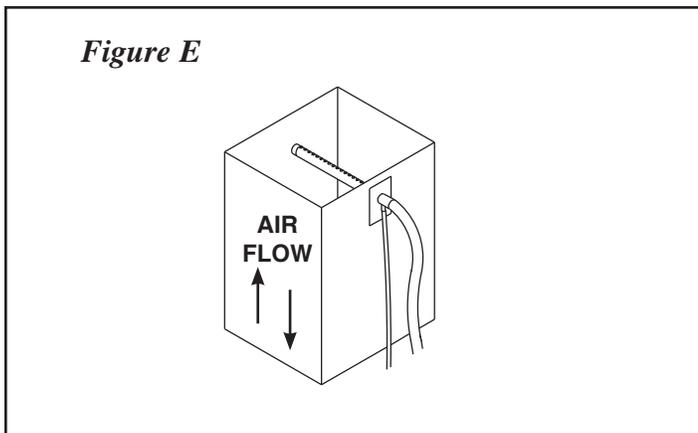
1. An envelope shipped with the cabinet contains the cabinet keys and Installation, Operation and Maintenance Instructions.
2. The following optional components are packed in a separate shipping carton for connection when installing the humidifier.
 - A. Steam Distributor Pipe.
 - B. Steam Hose.
 - C. Condensate Return Line.
 - D. Humidistats and Air Flow Switches.
 - E. Steam Hose Clamps.
 - F. Condensate Return Clamps.
 - G. Air Gap Drain Fitting.

STEAM DISTRIBUTOR PIPE LOCATION

In a typical installation the humidifier is located below a duct as shown in Figure A. The distance between the humidifier cabinet and the steam distributor pipe should be the shortest possible.

The maximum length of steam hose that may be installed is 10 feet.

In a vertical duct with either upward or downward air flow the distributor pipe should be installed horizontally.

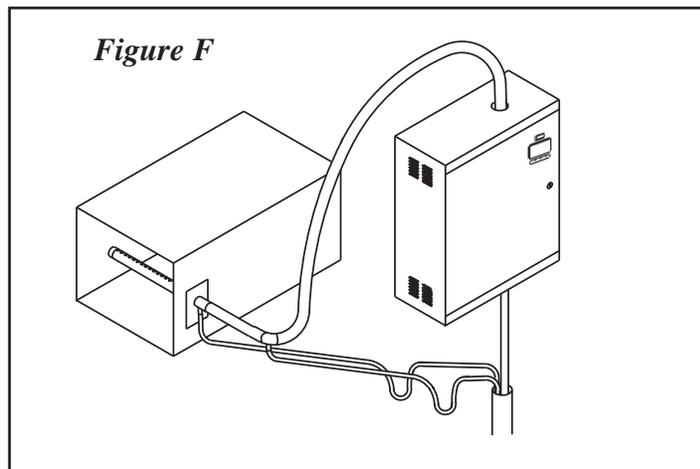


The distributor pipe should be located to insure best distribution of steam into the airstream. A minimum clearance of 4" must be maintained between the top of the duct and the distributor pipe.

The steam distributor pipe is usually located in the supply duct downstream of the fan. It is important to locate the distributor as far upstream as possible from any obstructions in the ductwork so that air can absorb the steam before it impinges on a surface and condenses. There must be minimum of three feet between the distributor and any fans, coils, filters, dampers, elbows or outlets downstream to reduce the possibility of condensation.

Duct air temperatures below 60°F may require a condensate drain pan, supplied by others, below the steam distributor pipe.

The distributor pipe may be located below the humidifier if the installation is made as shown in Figure F. A trap may be necessary to prevent steam from flowing back through the condensate return line.



INSTALL STEAM DISTRIBUTOR PIPE

The steam distributor pipe must be mounted on a plumb surface so that it is inclined upward. This is required so the condensate, which forms in the distributor pipe, will drain into the return line.

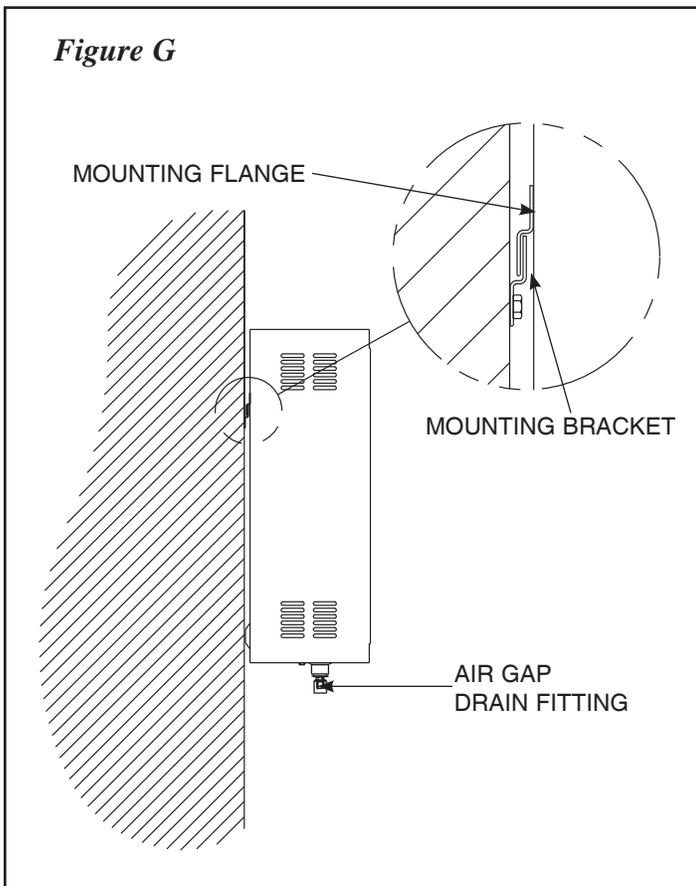
Insert the distributor pipe into duct and secure with four sheet metal screws, not provided.

MOUNTING THE HUMIDIFIER

Locate the humidifier cabinet level and plumb on a surface as close to the steam distributor as possible at a convenient height for servicing. Allow 1" or more on the sides for ventilation and 16" from the bottom to the floor to allow for drain connections. Allow at least 16" in front of cabinet for door opening. Consult local and national codes prior to installation and comply with any provisions they require.

The humidifier must never be located outside or where it may be exposed to freezing temperatures unless a heated, ventilated, weatherproof enclosure by others is provided. Do not mount humidifiers on a hot or vibrating surface.

Maximum operating weight is 70 pounds. Fasten the mounting bracket to wood studs or solid wood. Recommended fasteners: Four 1/4" x 1" long lag screws. Fasteners are not provided.



Place the mounting flange on the humidifier cabinet over the mounting bracket. A sheet metal screw should be installed through the back of the humidifier cabinet to secure the humidifier to the mounting bracket.

WATER SUPPLY CONNECTION

DO NOT use hot water, deionized water, or water that has been treated by a water softener without consulting the factory.

Use ordinary tap water (20 to 120 psi). A 1/4" FPT fitting is provided at the top of the humidifier. A shutoff valve, not provided, must be installed ahead of this fitting.

DRAIN LINE CONNECTION

1. Remove the large nut and plastic gasket located on the fitting on the bottom of the cabinet. The nut and gasket may be used with standard type drain fitting if an air gap fitting is not required by local codes.
2. Connect the air gap drain fitting to the cabinet drain connection. It may be necessary to cut off some of the air gap fitting depending on available space.
3. Connect the drain or air gap fitting to S or P trap or run piping to a floor drain. Use plumbing material capable of handling hot water, such as copper or CPVC.

CONNECT THE STEAM HOSE & CONDENSATE RETURN LINE

COPPERTUBE IS THE ONLY ACCEPTABLE SUBSTITUTE FOR STEAM HOSE OR CONDENSATE RETURN LINE.

1. The steam hose should be installed so there is a continuous rise from the humidifier to the distributor pipe. The rise should be 2" in 12" to allow proper condensate drainage.

Support the steam hose at intermediate points to prevent dips or pockets. It is very important that both the steam hose and condensate return line be installed so that sags are prevented. The steam is at very low pressure and it cannot overcome resistance caused by water standing in the steam hose. Water accumulating in sags in the return line will restrict the flow and may cause water to enter the duct from the distributor pipe.

If it is difficult to install the steam hose to prevent sags, it is recommended that copper tube be used as a substitute. Size 3/4" copper tube can be used. Any 90° elbows are approximately equivalent to three feet of steam hose.

If copper tube is used, a minimum of one inch of insulation must be applied to prevent excessive condensation and contact with the hot pipe. A short length of steam hose must be used to connect the cylinder in the humidifier to the copper tube. Another short length should be used to connect the copper tube to the distributor pipe. Any turns in the hose should have a minimum radius of 8" to prevent kinking.

2. Fasten the steam hose to the distributor pipe with one of the hose clamps provided.
3. Push the steam hose through the opening on the top of the humidifier cabinet and slip over the outlet stub on the top of the cylinder. Fasten with the hose clamp provided.
4. Fasten the condensate return line to the distributor pipe with the hose clamp provided. Connect the return line to the condensate return inlet with the hose clamp provided.

If it is impossible to maintain a drop to the top of the cabinet, it will be necessary to run the condensate return line directly to the air gap drain fitting or some other drain. A trap (usually 8" is sufficient) may be necessary to prevent loss of steam through the return line. Do **not** install a trap if condensate is returned to the top of the cabinet.

ELECTRICAL DATA

Model	Maximum Lb./Hr.	kW	Voltage	Phase	Line Amp Rating	Recommended Disconnect Size (Amps)	Steam Cylinder	Digital Display Code
HRABA U 005	5	1.7	120	1	14.4	20	HXCBAX220	0005
HRABD U 005	5	1.7	230	1	7.5	15	HXCBAX380	3005
HRABD U 010	10	3.4	230	1	15.0	20	HXCBAX380	3010

U = UL

C = cUL



ELECTRICAL CONNECTIONS



WARNING: BEFORE MAKING ANY ELECTRICAL CONNECTIONS SWITCH POWER OFF AT SERVICE PANEL, FUSED DISCONNECT OR CIRCUIT BREAKER AND LOCK THE DISCONNECTING MEANS TO PREVENT POWER FROM BEING SWITCHED ON ACCIDENTALLY.

Check unit electrical characteristics on label outside of cabinet. They must agree with power provided to the unit.

A fused disconnect or circuit breaker, not provided, must be installed per local and national codes.

1. Remove screws securing hinged panel for access to wiring.
2. An opening is provided on the top of the electrical section. Bring electrical power lines through this opening and connect to the electric power terminals as shown on wiring diagram.
3. Replace electrical cover panel.

CONTROLS

CONTROL HUMIDISTAT

Either a wall-mounted humidistat or duct-mounted humidistat in the return air may be used. The wall-mounted humidistat is the most common as it allows the setting to be easily adjusted to accommodate changing requirements or to lower the level of relative humidity in the space to prevent condensation on windows during extremely cold weather. Room humidity is usually set in range of 30-40% RH. Other settings may be necessary for certain conditions.

If an on-off humidistat is used the humidifier will generate steam at the preset output rate and cycle on or off as necessary to satisfy the conditioned area requirements.

If a proportional humidistat is used the humidifier will automatically vary the steam output rate in the range of 25-100% of the humidifiers maximum rating in response to the humidistat. Proportional control provides less on-off cycling of the humidifier.

AIR FLOW DETECTION

The humidifier control circuit should include some method to confirm air flow. If the steam distributor pipe were "located in a duct where there is no air flow and the control humidistat is calling for humidity, steam would be discharged into the duct where it would immediately condense.

Air flow may be detected by using a pressure differential switch that detects air flow by sensing static pressure in the duct.

CONDENSATION PROTECTION

An additional device may be used to provide condensation protection in the duct system. A hi-limit humidistat may be installed 10 feet downstream from the steam distributor pipe. This humidistat is normally set to 90-95% RH and opens the circuit if the humidity level in the duct exceeds the setpoint. Once the humidity level returns below the setpoint, humidifier operation will resume following a delay of several minutes after reclosure of the circuit. Use of this device is recommended particularly when the humidifier is used in applications where cooling air is being humidified.

Either an on-off or proportional hi-limit humidistat may be used. If a proportional humidistat is used the output of the humidifier will automatically be decreased to reduce the possibility of condensation. Two proportional humidistats may be used. One may be located in the area to be humidified or its return duct and another as a hi-limit in the supply duct. The humidifier will automatically select the lowest signal to control the humidifier output.

EXTERNAL MONITORING

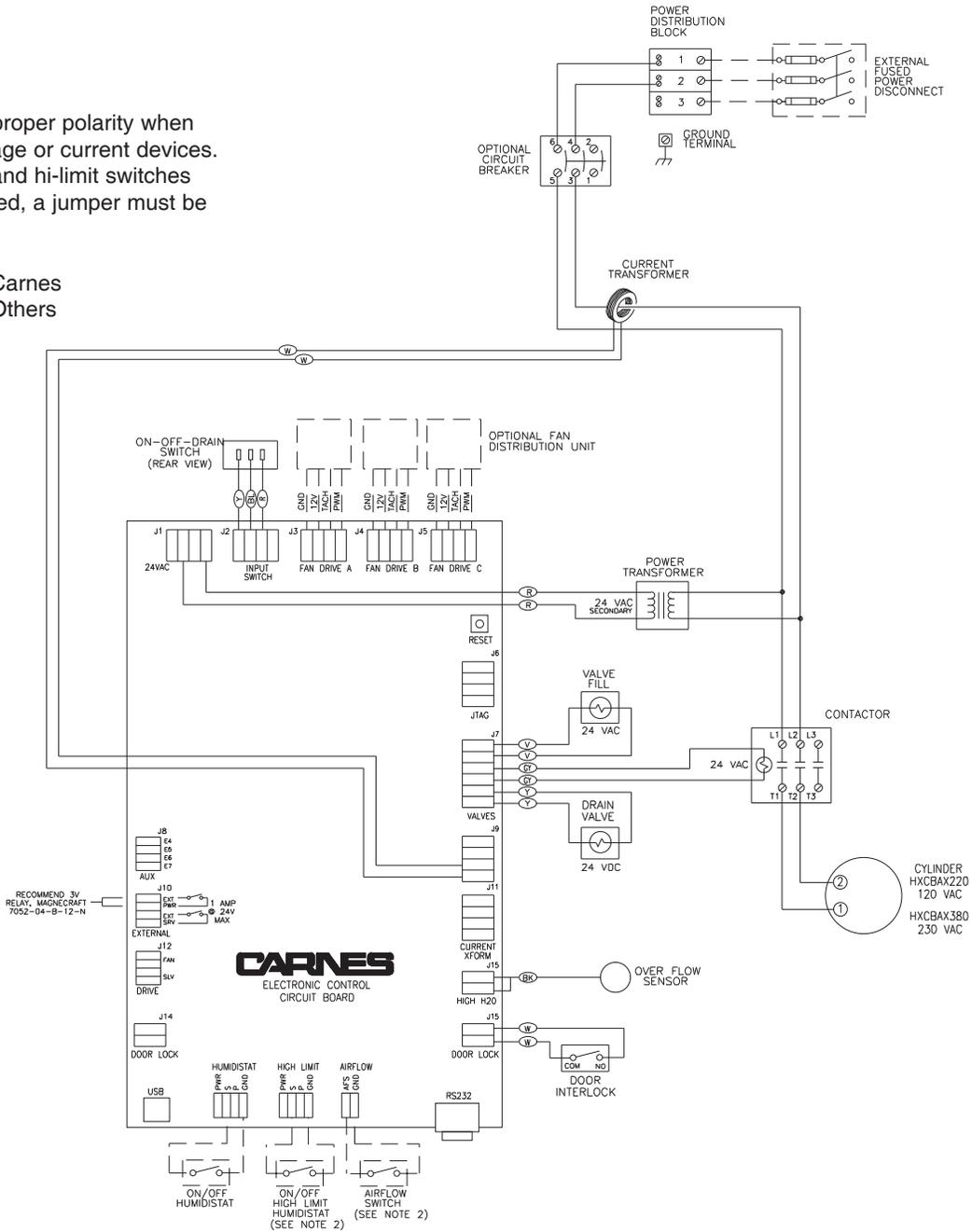
Terminals 11 and 12, shown in Figure H are provided for remote monitoring of the status of the humidifier if desired. When the unit is on terminals 11 and 12 are closed. When the output of the humidifier is less than 50% of setpoint terminals 13 and 14 are closed indicating a need for service. Each set of terminals is capable of switching 1/2 amp at 24 volt maximum.

Figure H

NOTES:

1. Observe proper polarity when using voltage or current devices.
2. If airflow and hi-limit switches are not used, a jumper must be installed.

————— By Carnes
 - - - - - By Others



CONTROL CONNECTIONS



WARNING: BEFORE MAKING ANY ELECTRICAL CONNECTIONS SWITCH POWER OFF AT SERVICE PANEL, FUSED DISCONNECT OR CIRCUIT BREAKER AND LOCK THE DISCONNECTING MEANS TO PREVENT POWER FROM BEING SWITCHED ON ACCIDENTALLY.

2. If an air flow switch or hi-limit humidistat is not used jumpers must be installed before the humidifier will operate.

Controls should be connected to the terminals on the electronic circuit board as shown Figure H using #18 AWG wire. Avoid running control wiring near high voltage wires.

1. A 7/8" opening is provided on top of the cabinet. The control wiring should pass through the opening to the terminal strip.

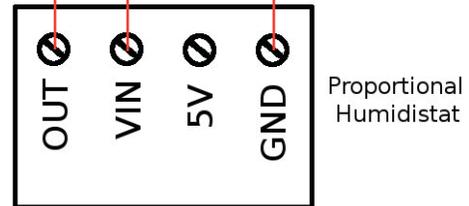
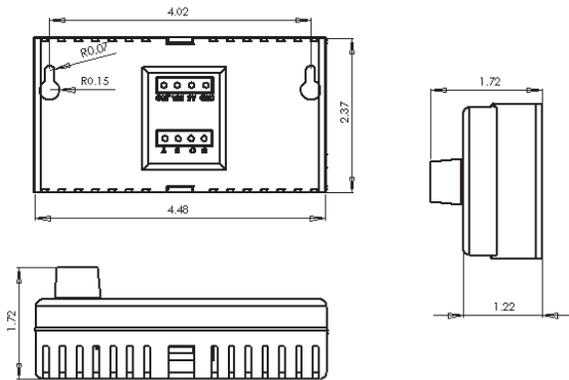
NOTE: A built-in transformer provides power for the control circuit. No outside power supply is required for the control circuit.

OPTIONAL ACCESSORY CONTROLS

WALL HUMIDISTAT, PROPORTIONAL CONTROL

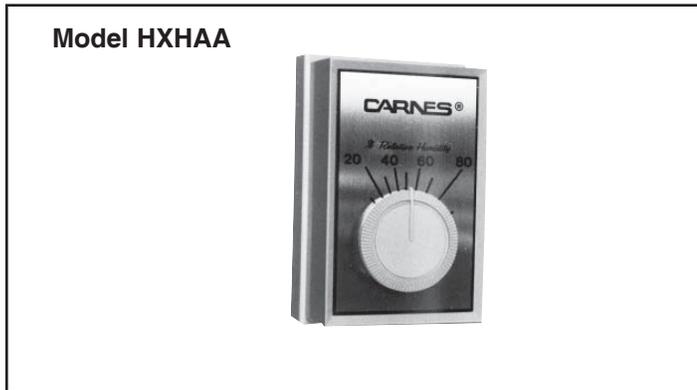


The Model HXHAM is a wall-mounted, microprocessor-controlled humidistat solution for cutting edge humidity control. The HXHAM employs a backlit LCD module, which displays both the ambient temperature and humidity of the surrounding air. The embedded software allows user navigation between temperature/humidity viewing mode and setpoint adjustment mode, and also outdoor temperature and humidity viewing mode.



Proportional Humidistat

WALL HUMIDISTAT, ON-OFF CONTROL



Unit may be installed on either a flush switch box, or a surface switch box, or directly on a wall.

Mount with Number 6 screws provided for switch box mounting. Different screws are required for wall mounting.

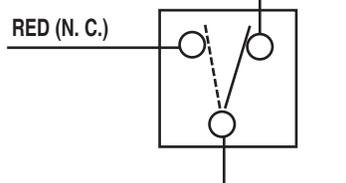
Mount this humidistat four or five feet above the floor in freely circulating air of the temperature and humidity about average for the entire space to be controlled. Avoid locations near hot or cold air ducts and discharge air from the humidifier. Scale range is from 10-90% RH. Differential is 5% non-adjustable.

RED MAKES TO ORANGE
on a R. H. Rise.

BROWN (N. O.) (To Terminal 2 or 4)

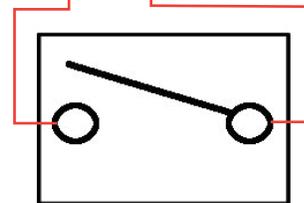
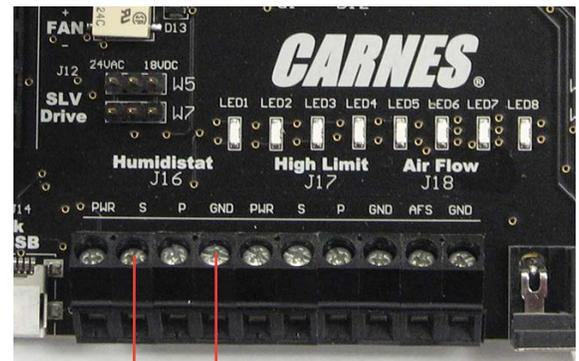
RED (N. C.)

BROWN MAKES TO ORANGE
on a R. H. Drop.



NOTE: The HXHAA has 6" (152mm) leads and a green grounding wire for use with non-conducting conduit.

ORANGE (COMMON)
(To Terminal 2 or 4)

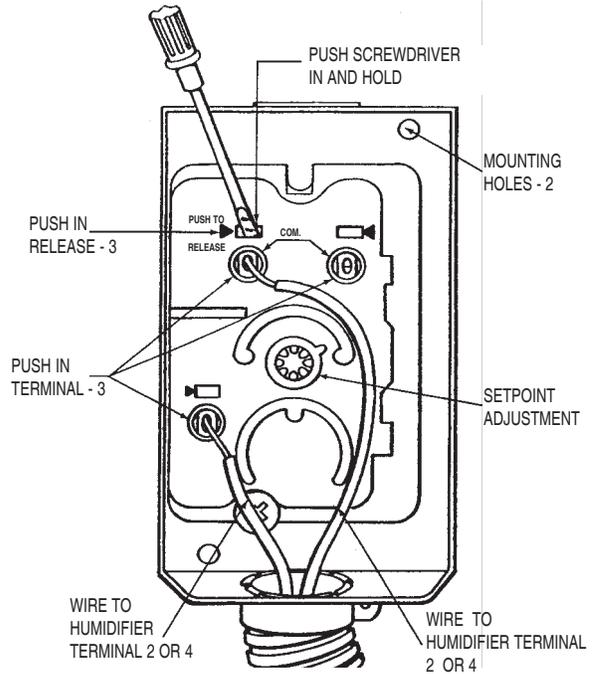
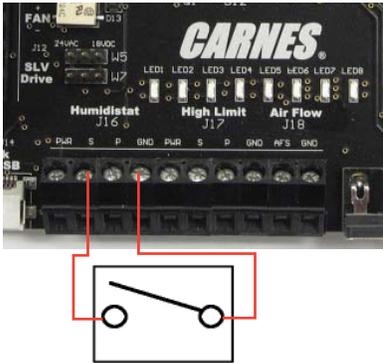


DUCT HUMIDISTAT, ON-OFF CONTROL

Model HXHAB



This duct mounted humidistat is installed in the return air duct to sense the humidity level in the area being served. Scale range is 15-50% RH. Differential is 4-6% non-adjustable.



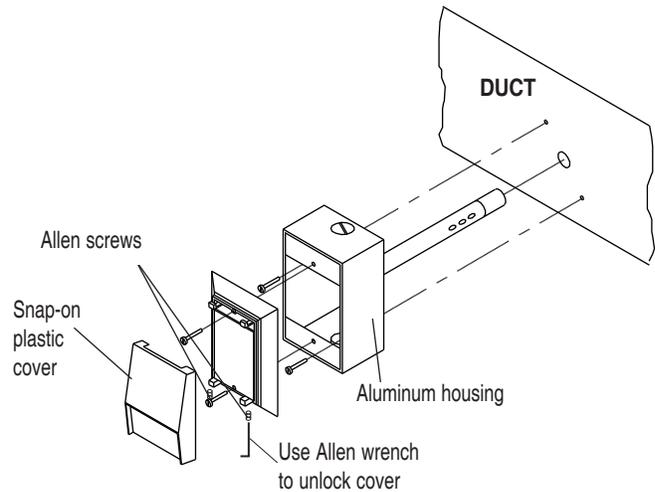
The control should be located in the duct where it will be affected by normal air flow. The control can be mounted in any position, but where possible locate it on the side of the duct to make the setpoint adjustment easily accessible.

DUCT HUMIDISTAT, PROPORTIONAL CONTROL

Model HXHAN



The Model HXHAN is an intelligent humidistat solution used exclusively for duct mounted installations. The humidistat is capable of providing both humidity and temperature measurements from inside the duct. The microprocessor control takes the temperature into consideration when calculating the humidity to provide an extra degree of precision.

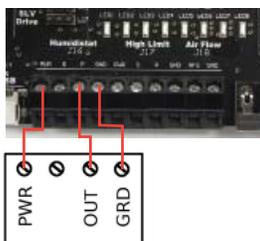


Remove any excess insulation from the duct that would prevent the probe from extending a minimum of 4" (106mm) into the air stream.

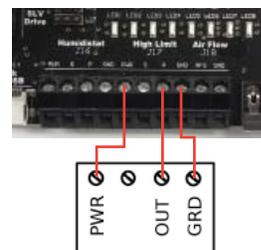
Make a 1-1/2" (38mm) hole in the duct for inserting the probe.

Use a gasket, sealer, or other means to seal the area between the unit and the duct to ensure proper operation.

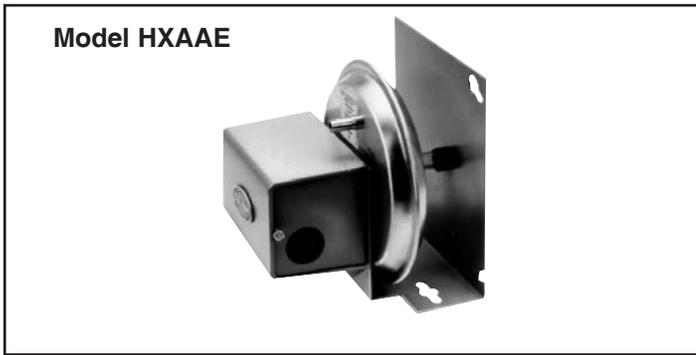
WHEN USED TO CONTROL ROOM RELATIVE HUMIDITY



WHEN USED AS HI-LIMIT HUMIDISTAT



AIR FLOW SWITCH, PRESSURE DIFFERENTIAL TYPE



Air flow in the duct may be sensed by using this differential pressure switch. The differential in pressure between the interior of the duct closes a switch when air is moving. Air pressure differential as low as .07 w.g. may be sensed with this switch.

Environment:

Ambient Temperature Limits,

Shipping -40 to 140°F (-40 to 60°C).

Operating 35 to 140°F (0 to 60°C).

Humidity, 5 to 95% R.H., non-condensing.

Locations, NEMA Type 1 indoor only.

Mounting: In vertical position on any surface free of vibration

On an increase of air pressure to above setpoint, common contact of switch is made to normally open contact. On a decrease of air pressure to below setpoint, common contact of switch is made to normally closed contact. Avoid locations where excessive moisture, corrosive fumes or vibrations are present.

Setpoint:

Factory Set, 0.07" (1.8mm) W.C.

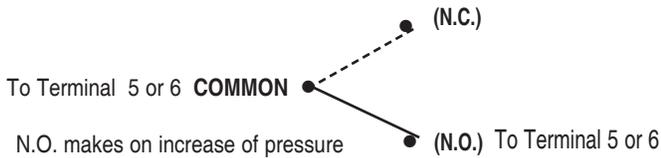
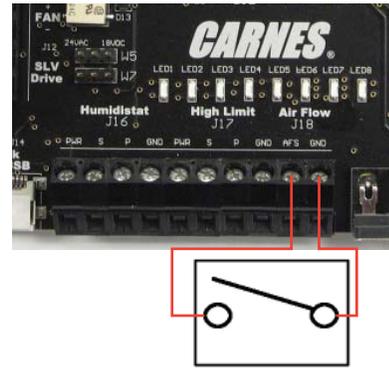
Field Adjustable, 0.07 to 1" (1.8 to 25.4mm) W.C.

Sensing Element: Neoprene diaphragm.

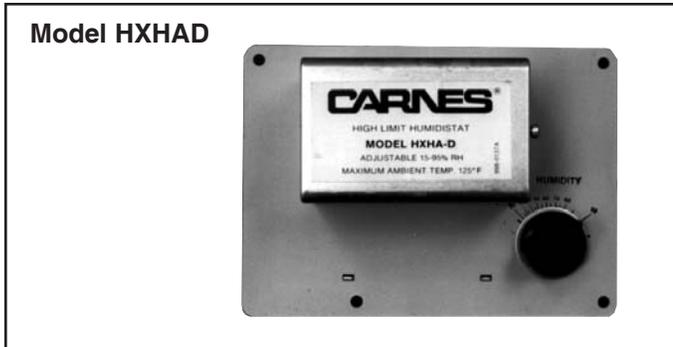
Adjustment

Note: Units are shipped at minimum setpoint.

To increase setpoint, turn adjustment screw clockwise. Adjustable 0.05 ±0.02" to 1.0" (1.25mm ±0.5mm to 25mm) W.C. To decrease setpoint, turn adjustment screw counterclockwise.



HI-LIMIT HUMIDISTAT



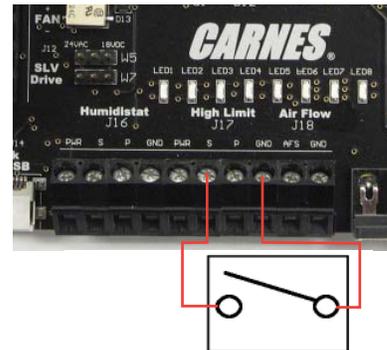
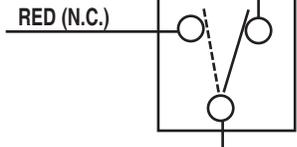
The Model HXHAD is available to reduce the potential of condensation occurring in the supply duct. The control must be mounted a minimum of 10 feet downstream of the steam distributor pipe. Setpoint range is 15-95% RH. Differential is 5% non-adjustable.

The HXHAD may be mounted in any position on the outside surface of the supply air duct where it is exposed to freely circulating air (horizontal mounting is preferred).

RED MAKES TO ORANGE
on a R. H. Rise

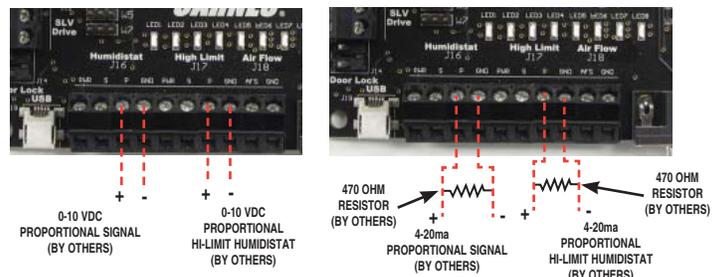
BROWN MAKES TO ORANGE
on a R. H. Drop.

BROWN (N.O.) To Terminal 8 or 10



EXTERNAL DDC CONTROL SIGNALS

The humidifiers can also accept a 0-10 volt DC signal to modulate the output of the humidifier. Polarity must be observed. Input impedance is 20K ohms. If a 4-20 mA input signal is provided to the humidifier a 470 ohm 1/4 watt resistor must be installed as shown.



OPERATION

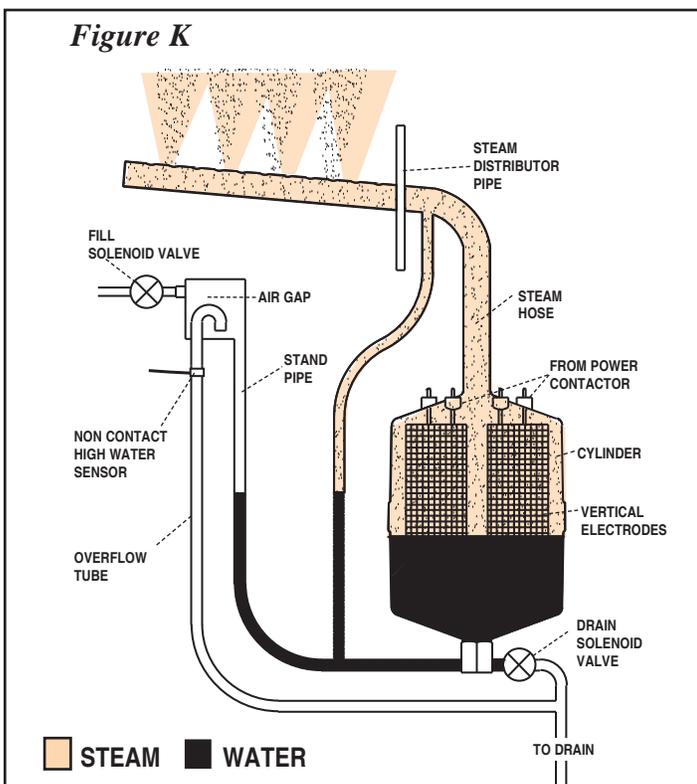
Upon a signal from external controls the circuit board opens a fill solenoid valve, allowing water to flow across an air gap into a standpipe. See Figure K. The standpipe provides a column of water to be fed into the cylinder using gravity. The air gap prevents back flow into the water supply and prevents the cylinder from becoming a pressure vessel. The steam cylinder operates at a pressure of less than 1/2 psi.

The circuit board also closes a power contactor allowing current to flow to vertical electrodes sealed inside the cylinder. Current flows between the electrodes using minerals in the water as a conductor. The water is heated to boiling and converted to steam, which leaves the cylinder through the flexible steam hose, which is connected to the steam distributor pipe.

The circuit board monitors current flow between the electrodes and automatically opens the fill solenoid valve when more water is required to maintain the desired output rate, and closes when the desired rate is reached.

The operation of the drain solenoid valve is automatically controlled by the circuit board, which responds to any changes in water conditions and drains the required quantity of water to provide stable operation and long cylinder life.

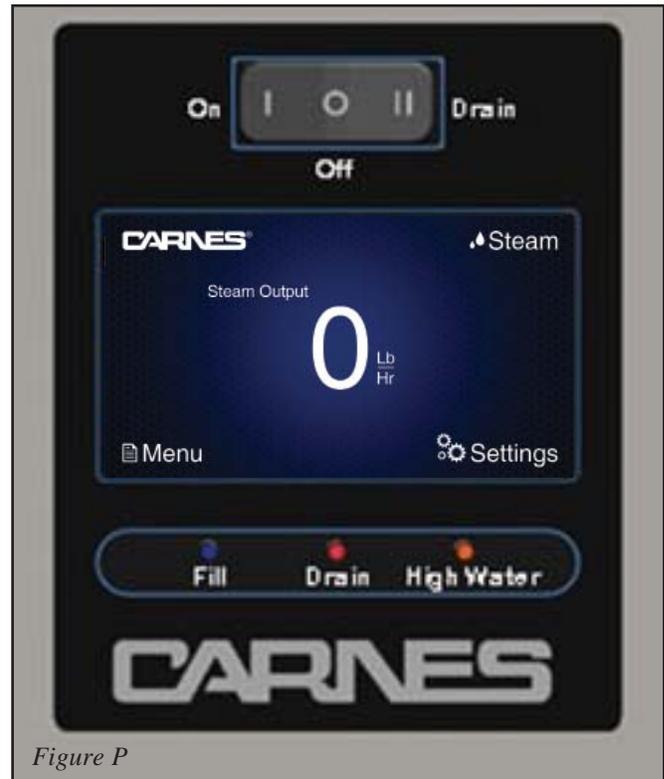
As mineral deposits build up within the cylinder the water level will slowly rise to uncovered electrode surfaces to maintain the desired steam output rate. When mineral deposits have covered all available electrode areas, current flow will be reduced to a level when the desired steam output cannot be reached and the service light will signal the need for maintenance. When the cylinder is filled with minerals it is easily changed to less than five minutes.



DISPLAYS AND INTERNAL CONTROLS

FRONT PANEL DISPLAYS & CONTROLS

The display on the front panel of the humidifier cabinet contains the “On-Off-Drain” switch, the LCD True Touchscreen display and the “Fill”, “Drain” and “High Water” LED’s.



“ON-OFF-DRAIN” SWITCH

In the “On” position the humidifier will operate if all controls are calling for humidity. The “Off” position is used for seasonal shut down if desired. The “Drain” position is used to drain water from the steam cylinder for maintenance. The fill solenoid valve will be on whenever the drain is activated to reduce the drain water temperature.

LCD TRUE TOUCHSCREEN DISPLAY

This LCD True Touchscreen display offers a user friendly interface to control and monitor many aspects of the humidifier. The screen uses pressure sensitive technology. Depressing on the labeled buttons on the designated area of the screen will allow you to navigate through the different menu pages.

“HOME SCREEN” PAGE

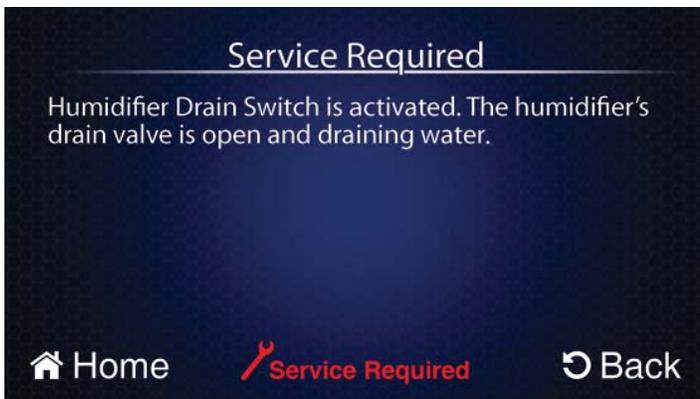
The “Home Screen” page is the main screen through which most other pages can be accessed. The “Home Screen” displays the current steam output in Lbs./Hr. (or Kg/Hr.). To select either is available under the “Setting” menu. The main “Home Screen” features four navigation buttons, Carnes Logo button (providing contact info to the factory and the company website), Steam Menu button, Menu button and a Settings Menu button. Tapping any of these buttons will show dialog explaining the subject or status of that button and display pictures. The “Home Screen” will also display a “Service Required” indicator when a current service issue is indicated. The “Service Required” and Steam Output number will illuminate “RED”. Tap on the

“Service Required” button, this will take you to the service required page and indicate what service issue is being detected.



“SERVICE REQUIRED” PAGE

The “Service Required” page outlines any service issues that are in need of being resolved. Many issues can be traced back to variability in water parameters, and often the solution can be dealt with through the changing of cylinders or modifying timer values within the “Settings” page. This page is used to alert the user and direct them on the right path towards resolution.



“FILL” LED

The FILL LED is a blue light illuminated when the Fill Valve is activated. An activated Fill Valve allows water to flow into the cylinder of the humidifier. An analogous indicator, and a description of its operation, is offered in the “Settings” menu, under “Component Activity”.

“DRAIN” LED

The DRAIN LED is a red light illuminated when the Drain Valve is activated. An activated Drain Valve allows water to drain from the humidifier. An analogous indicator, and a description of its operation, is offered in the “Settings” menu, under “Component Activity”.

“HIGH WATER” LED

The HIGH WATER LED is an orange light illuminated when the High Water Sensor is activated. An activated High Water Sensor indicates that the water has risen to the maximum allowable level in the cylinder. This can be a normal situation, particularly if the cylinder is being filled with mostly unconditioned water. An activated High Water Sensor can also be a sign that the cylinder is close to end-of-life and

needs replacing, or, in rarer cases, the cylinder is not conductive enough for the fresh water entering the humidifier. An analogous indicator, and a description of its operation, is offered in “Settings” menu, under “Component Activity”. More information on troubleshooting High Water situations can also be found under the “Help” button, on the “Menu” screen.

“CARNES” LOGO

The Carnes logo on the “Home Screen” will take you to a page that displays the Carnes Company contact information (address, phone number and company website). This feature is for the purpose of contacting the factory for any start-up questions, troubleshooting or service issues that may arise.

“STEAM” MENU



The “Steam” menu page will display the status of the four basic controls (Control Humidistat, Hi-Limit Humidistat, Air Flow Switch and Door Interlock). The humidifier will only produce steam when the unit is switched into the “ON” position, and if all four controls are satisfied.

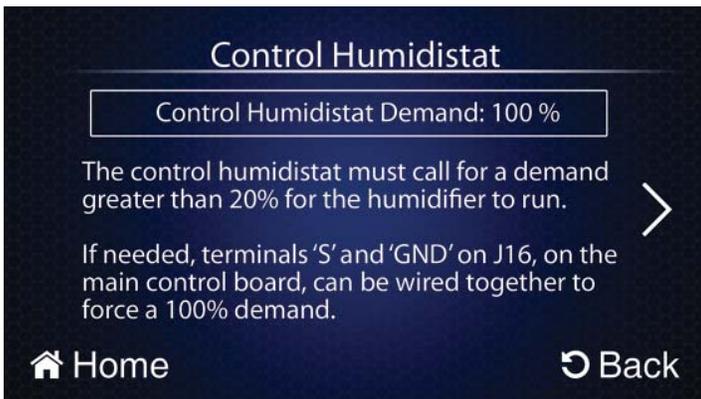
A green “✓” will be displayed to indicate if the control is sending a signal.



A Red “X” will be displayed to indicate if the control is not sending a signal. If any one component is not satisfied, the “Home Screen” will display an indicator when one or more controls are not satisfied. The Steam Output number and the “Steam” menu icon will illuminate in “RED”.



1. **Control Humidistat** - Explains the status of the Control Humidistat indicator light, and also shows the current demand of the Control Humidistat. The Control Humidistat must call for a demand greater than 20% for the humidifier to run. If needed, terminals 'S' and 'GND' on J16, on the main control board, can be wired together to force a 100% demand.



2. **Hi-Limit Humidistat** - Explains the status of the Hi-Limit Humidistat indicator light, and also shows the current demand of the Hi-Limit Humidistat. The Hi-Limit must call for a demand greater than 20% for the humidifier to run. If needed, terminals 'S' and 'GND' on J17, on the main control board, can be wired together to force a 100% demand.

The Control Humidistat, which provides the Control Demand, is normally the humidistat in the room being humidified. It is either installed in the room itself or the return air duct. The Hi-Limit Humidistat, which provides the Hi-Limit Demand, is a safe-guard humidistat is usually set to a high level (80-90%), and will shut down the humidifier if the humidity gets too high in the supply

duct. Without a Hi-Limit Humidistat properly installed, the supply duct could reach a humidity level where any steam entering the duct would readily condense. Both Control Humidistats and Hi-Limit Humidistats are wired in the same way, only Control Humidistats are wired to port J16 of the circuit board and Hi-Limit Humidistats are wired to port J17. Both ports have the same number of pins and connection layout.

When using an on/off humidistat, the percentage should be either 100% or below 20%. In this case, the control is either calling for full output or no output. On-Off humidistats are dry-contact switches. They will have two wires; each connected to pins 2 and 4 (in no particular order/polarity).

For a proportional humidistat, any percentage value is possible between 0% and 100%. In this case, the humidifier can be modified to output any fraction of its max output. If the proportional control falls to 20% or below, the humidifier is shut off. The input signal of a proportional humidistat must be of the 0-10V DC variety. Proportional humidistats will have three wires, with 'power' going to pin 1, 'signal' to pin 3 and 'ground' to pin 4. **In lieu of a humidistat**, a DDC signal from a building management system may also be used. Here, the 'signal' should be connected to pin 3, and 'ground' to pin 4. In this case, 'power' can be ignored. A DDC signal must be of a 0-10V signal by adding a 470 Ohm resistor between the 'signal' (pin 3) and 'ground' (pin 4).

3. **Air Flow** - Explains the status of the Air Flow switch. The Air Flow switch must sense proper air flow in order for the humidifier to activate. Insufficient air flow or an improperly installed air flow switch will cause the indicator to change to a red "X" and the unit not operate. If needed, terminals 'AFS' and 'GND' on J18, on the main control board, can be wired together to force activation of the switch.
4. **Door Interlock** - Explains the status of the Door Interlock switch. The Door Interlock needs to be engaged for the unit to operate. This can be accomplished by either locking the door shut or pulling out the plunger for temporary operation while servicing the unit.

MENU



The "Menu" page displays four features: Setpoint, Component Activity, Dim LCD and Help. Tapping any of

these buttons will show dialog explaining the subject or status of that button and display pictures.



“SETPOINTS”

The Setpoints page displays the Setpoints (the target steam output of the humidifier) associated with the unit. There are three different Setpoints, but only one Setpoint is active at any given time. Each Setpoint is accompanied by the current value of the Setpoint to the right, and an indicator that represents its status.

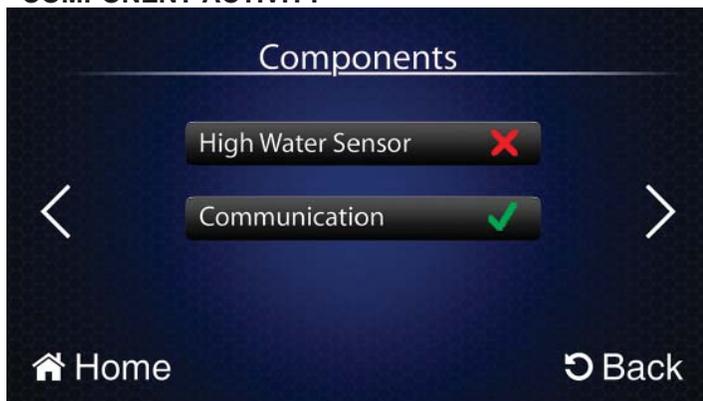
The **Max Setpoint** is the user-specified Setpoint active when no external controls or internal reduction is taking place. The Max Setpoint is always modifiable via the “Max Output Adjust” within the settings menu.

The **Controlled Setpoint** is the Setpoint when a humidifier (Control or Hi-Limit), reduces the target output of the humidifier due to changing room requirements.

The **Reduced Setpoint** is active when the unit requires a reduction in output due to a high water situation.

The Setpoints have the following priorities: The Reduced Setpoint has the highest priority and always overrides the Controlled Setpoint and the Max Setpoint when active. The Controlled Setpoint has the next highest priority, and always overrides the Max Setpoint. It should be noted that the Reduced Setpoint is always lower than or equal to the Max Setpoint (or Controlled Setpoint, if active) and the Controlled Setpoint is always lower or equal to the Max Setpoint.

“COMPONENT ACTIVITY”



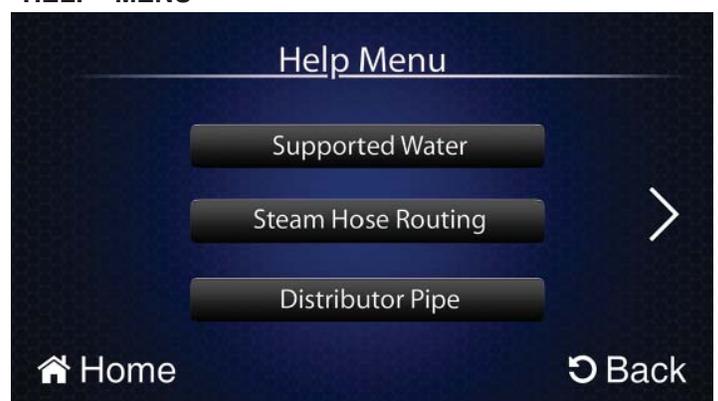
The Component Activity page lists all internal components that can switch on and off during operation. This includes the Fill Valve, Drain Valve, Contactor, High Water Sensor and Communication. Each component listed is accom

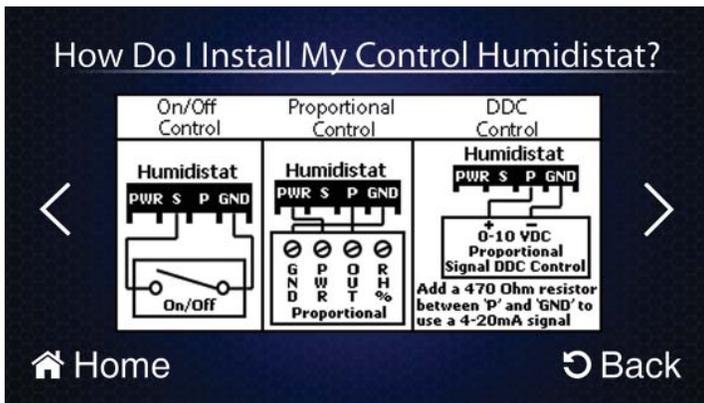
panied by a green “✓” or a red “X” indicator representing whether or not the component is currently ‘on’. The Fill Value is on when the unit is either filling or draining the cylinder. The Drain Valve is on when the humidifier is producing steam. The High Water Sensor is on when the humidifier has identified a high water situation. When in a high water situation, the fill valve is disabled for 5 minutes. At the end of 5 minutes the high water sensor light will go out, the fill valve will open, if there is a call for more humidity, and unit will continue normal operation. High water sensors can be cumulative depending on the condition of the water.

The other component in the “Component Activity” page is the Communication button. The Communication button represents whether the True Touchscreen controller on the circuit board is properly communicating with the microcontroller. The Communication indicator is a green “✓” when the LCD display is communicating properly with the control board. If there is a red “X”, the Touchscreen has likely lost communication with the control board, and the information on the screen may be inaccurate. For troubleshooting, contact Carnes Company at 608-845-6411.



“HELP” MENU





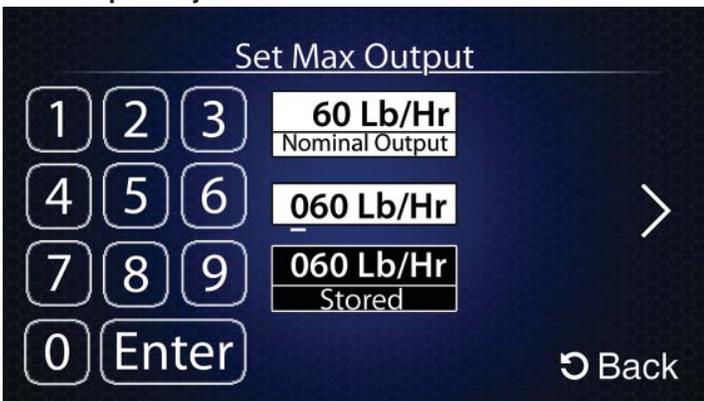
The help pages consist of buttons labeled with questions. When a button is pressed, information will be given answering and/or giving information about the subject in question. A basic help page consists of text and/or diagrams to help the user through basic problems. For example, in the pictures above, the question “How Do I Install My Control Humidistat?” is answered with a diagram and corresponding text. Some pages consist of more buttons to help guide a user through different processes. These buttons can be used and referenced as needed.

“SETTINGS” MENU



The “Settings” menu has pages where all operational values can be set. It is password protected by default, with a default password of ‘1212’. The default password can be changed or disabled under the “Change Password” page. See “Settings Password” page for more details.

Max Output Adjust



The maximum steam output of the unit can be set on this page. The maximum output value cannot exceed the nominal output value of the unit, and it cannot be set below 20% of the nominal output. The nominal output of the unit is listed on the nameplate and the previous screen.

Cylinder Life Counter



This page consists of a counter where the user can monitor the life, in hours, of the cylinder. When changing a cylinder, press the ‘Reset’ button on this page to reset the timer. The Cylinder Life Counter only counts the amount of actual runtime of the cylinder (the time when the contactor is pulled in). The counter value is saved even when the humidifier is powered down. The national average cylinder life is about 1150 hours, but this can vary greatly depending on individual water conditions.

Fan Speed Adjust



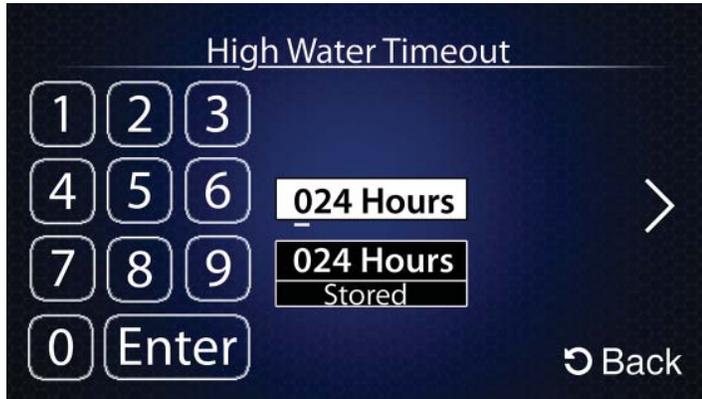
This page consists of a slider bar that can change the speed of the fans when the humidifier is connected to an optional blower box. This slider bar will not affect the operation of the humidifier if no blower box is attached. The bar can change the speeds of the fans from 0 to 100% of the max fan speed. Also displayed on this page is an estimate of the current fan air output, in Cubic Feet per Minute (CFM). This adjustment is particularly useful if the humidifier is of a smaller capacity, and less noise from the fans is appreciated.

Setpoint Timeout



This page is where the Setpoint Timeout value is set. The maximum amount of time allowed for the unit to reach Setpoint during a fill sequence is designated by the Setpoint Timeout. Its default value is 30 minutes, but can be set as high as 255 minutes. After the timer expires during a fill sequence, the humidifier assumes the drain valve is stuck open (due to sediment buildup), and begins pulsing the drain valve to attempt to unclog it. After the pulsing routine, the humidifier will attempt to reach Setpoint for a second and third time. After the third attempt without reaching Setpoint, the unit will shut down.

High Water Timeout



This page is where the High Water Timeout value is set. This is the maximum amount of time allowed for the unit to run in a "Reduced Setpoint" mode (see Setpoints page). The timeout has a range from 0 to 168 hours, with the default being 24 hours. If the humidifier Setpoint is artificially reduced due to a high water situation, the humidifier will continue to run. If the humidifier cannot work its way up the normal max/controlled Setpoint, the humidifier will shut down after the High Water Timeout value elapses.

Boil Down Timer

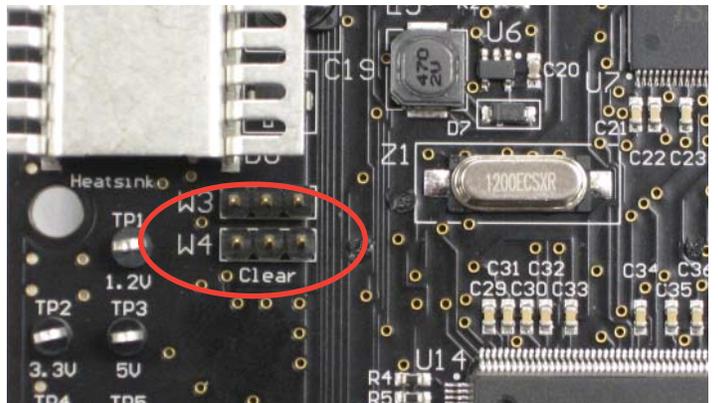


This page is where the Boil Down Timer is set. The Boil Down Timer is variable between 0 and 255 seconds, with a default value of 25 seconds. Setting the Boil Down Timer higher will result in an increased water level, and less-conditioned water. This may be helpful in reducing low water level induced arcing and corrosion of cylinders. More water is consumed by the humidifier when the Boil Down Timer value is increased.

Settings Password



This page is where the password for the settings menu can be changed or disabled. If the password for the Settings menu is forgotten, it can be reset. To do this, remove power to the humidifier, move the jumper on W4 from pins '1 and 2' to '2 and 3', and power the unit back on. Return the jumper to pins '1 and 2' afterward. Pins '1 and 2' are to the left, and pins '2 and 3' are to the right. The different yellow buttons on both setting pages allow for the changing of different values. Below is a brief summary of each, and more information can be accessed within the page itself.



Calibration Password

This page is where the Humidifier Unit Code, a four digit number identifying the humidifier, is programmed into the unit. This page is password protected, and the number should not be modified by the end user. Contact the factory if further information is needed.

Corrective Drain Length



This page is where the Corrective Drain Length is set. This value represents how much water should be drained from the cylinder when the humidifier senses a corrective drain is needed. As water boils from the humidifier, minerals increase in the cylinder causing the water to get more conductive. Increasing the length of the drain flushes more conductive material from the humidifier, decreasing the water conductivity. The input here is a percentage value. To set the Corrective Drain Length to drain 20% of the cylinder during a corrective drain, input 020. To drain all the tank, input 100. 30 is the default value, and only multiples of 10 between 20 and 100 can be entered.

ON/OFF Setting Buttons



There are a few operational options that do not need separate pages, and therefore are only enabled/disabled via the ON/OFF Buttons on the main “Settings” menu page. Their functionality is described as follows:

The **Drain Valve** option is enabled by default. This option allows the drain valve to pulse when the humidifier executes a corrective drain. This actuates the water within the drain piping, allowing for minerals buildup to be discharged more easily. Enabling this option will make the unit noisier whenever a corrective drain is executed.

The **72-Hour Drain** is disabled by default. This option, when enabled, allows the humidifier to drain the cylinder completely after 72 hours of idle operation.

The **LCD Auto-Dim** is disabled by default. This option, when enabled, will automatically turn off the backlight of the LCD after 15 minutes of idleness. This feature can save on energy consumed.

The **Kg./Hr. Readout** is disabled by default. This option, when enabled, will turn the steam readout on home page, and in the upper right hand corner of the pages, into Kg./Hr. instead of Lb./Hr.

HUMIDIFIER MANDATORY PRE-STARTUP CHECKLIST

Unit Serial #: _____	No. of Humidifiers: _____		
Model #: _____	Voltage: _____ V/ _____ ph	Steam Output: _____ lbs./hr.	
Customer/Job: _____	Address: _____		

WATER QUALITY:

Well Water _____ City Water _____ Softened Water _____
 Water Conductivity (if known): mhmos: _____ Hardness: _____ gr.

HUMIDIFIER MOUNTING:

<u>Clearances around the unit</u>		<u>Acceptable</u>
Front (door opens freely?)	yes <input type="checkbox"/> no <input type="checkbox"/>	18" (Residential/Commercial)
Top (steam lines)	yes <input type="checkbox"/> no <input type="checkbox"/>	38" (Dual Cylinder Cabinet)
Bottom (fill, drain, controls)	yes <input type="checkbox"/> no <input type="checkbox"/>	12" (Residential/Commercial)
Both Sides	yes <input type="checkbox"/> no <input type="checkbox"/>	16" (Residential/Commercial)

STEAM HOSE:

Sloping up 2 in. every 12 in. yes no
 Sloping down 0.5 in. every 12 in. yes no
 Lengths/Size _____/_____
 Material _____
 Runs of hose over 12 ft. yes no
 (if yes, drain T is needed, check IOM for details)
 Can condensate be trapped anywhere in the steam line or condensate line? yes no

CONDENSATE HOSE:

Sloping back to drain yes no
 Condensate routes to drain?
 Lengths/Size _____/_____
 Material _____
 Runs of hose over 12 ft. yes no
 (if yes, drain T is needed, check IOM for details)
 Can condensate be trapped anywhere in the steam line or condensate line? yes no

WATER SUPPLY LINE (do not use hot water):

3/8 in. connection at fill yes <input type="checkbox"/> no <input type="checkbox"/>	Water pressure 20-120 psi yes <input type="checkbox"/> no <input type="checkbox"/>
Water supply shutoff within 6 ft. yes <input type="checkbox"/> no <input type="checkbox"/>	PVC yes <input type="checkbox"/> no <input type="checkbox"/> Copper yes <input type="checkbox"/> no <input type="checkbox"/>

DRAIN LINE:

Connection pipe fitting to trap yes no Slope to drain yes no

CYLINDER:

Properly installed and secured yes <input type="checkbox"/> no <input type="checkbox"/>	Water pressure 20-120 psi yes <input type="checkbox"/> no <input type="checkbox"/>
Wire connectors pushed completely down on electrode rods?	yes <input type="checkbox"/> no <input type="checkbox"/>

WIRING:

No loose wiring connections and connectors yes no

CONTROLS:

Humidistat location: _____	Humidistat to Terminal J16 yes <input type="checkbox"/> no <input type="checkbox"/>
Hi-Limit location: _____	Hi-Limit to Terminal J17 yes <input type="checkbox"/> no <input type="checkbox"/>

POWER:

Voltage, amperage rating and fuse correspond to spec label yes no
 Disconnect switch located close to humidifier unit yes no

Started by: _____ Date of Startup: _____
 Company: _____

TROUBLE SHOOTING - SYMPTOM, CAUSE AND ACTION - Table 6

SYMPTOM	CAUSE	ACTION
Arcing	*Naturally very high conductivity water.	*Water may be too high in conductivity. Test water.
	*Drain lines restricted causing low water levels.	*Inspect & clean drain & tubing regularly.
	*Defective drain solenoid valve.	*Repair, clean or replace as necessary.
	*Insufficient flow of incoming water. Levels low.	*Maintain 20 psi or above. Clean strainer, repair, clean or replace fill solenoid as necessary.
	*High back pressure in steam line.	*Check kinks or severe bends in steam hose. Check system static pressure.
	*Excessive lengths of steam hose and/or high static pressure.	*Shorten distance between humidifier & dispersion, maintain proper incline in steam hose, eliminate as many 90° or 45° bends, insulate steam line as necessary.
	*Attempted cleaning of cylinder by flushing or banging producing flakes causing restricted lines.	*Do not use solutions to clean cylinders, dispose as necessary. Solutions could cause chemical reactions not conducive to good operation.
“Service” indicator on	*Various.	*See “Service Required” page for more information regarding the problem.
Water doesn’t fill into cylinder (gray fill valve indicator)	*All 4 basic control signals not satisfied.	*Make sure all control circuits are closed and the humidifier is ‘On’.
Water doesn’t fill into cylinder (green fill) valve indicator)	*Fill valve strainer is restricted.	*Remove strainer from fill valve assembly and clean.
	* Fill valve is defective.	*Repair or replace as necessary.
	*24 Volts AC not coming from circuit board.	*Consult factory, replace circuit board.
Humidifier drains continuously	*Piece of mineral is partially blocking drain so it will not close properly.	*Cycle drain. If it does not clear, clean as necessary.
	*Drain plunger is worn out, preventing drain valve from closing completely.	*Repair or replace as necessary.
Water in duct or spitting from distributor pipe	*Steam hose & condensate return hose do not have a continuous slope. Condensate accumulates and gets pushed out distributor.	*Improve routing of all hoses and/or install condensate drains as necessary. Add a trap in the steam hose in front of the distributor.
	*Condensate return is blocked, kinked and prevents proper drainage of condensate water and accumulates in distributor pipe and pushed out into duct.	*Eliminate restriction in hose and routes as required for proper flow of condensate water.
	*Distributor pipe not installed properly or manufactured properly, not allowing for a continuous backward slope to steam hose and condensate hose connection.	*Re-assemble, repair or replace as necessary.
	*If condensate return hose has a drop less than 12”.	*Route the condensate return to a common drain and include a trap.
	*Condensate return is connected to top of unit, but a trap was installed too close to elbow, split, turning vane, grille or diffuser.	*Whenever condensate hose is returned to top of unit a trap is not required, remove it. Distributor pipe must be a minimum of 6 ft. upstream from elbows, grilles, etc. If temp. in duct is 60°F or lower the distance should be 10 ft. If distance, as mentioned, is not possible, a drain pan may be required. If the air in the duct can not hold the volume of steam, the only recourse is to reduce the maximum output of the unit. If very short absorption distances are required, a short absorption manifold can be installed.

TROUBLE SHOOTING - SYMPTOM, CAUSE AND ACTION *(Continued)*

SYMPTOM	CAUSE	ACTION
No LCD display	*The LCD has been dimmed.	*Touch LCD screen.
	*Voltage to the humidifier is not that which is required per rating label.	*Change humidifier or make necessary changes to confirm compatibility.
	*3 phase voltage but not all legs have power.	*Check electrical connections and make necessary repairs or hook ups.
	*Internal or external circuit breakers are not closed.	*Close all circuit breakers.
	*24 VAC supply to circuit board is not available.	*Make sure the protection on the transformer is not tripped (fuse or breaker). Confirm the required 24 VAC is leaving transformer. Make sure connection to circuit board at J1 is intact. If situation does not resolve, replace circuit board.
Humidifier unable to reach maximum output or required setpoint	*Capacity of unit is too low.	*Determine proper load calculation & capacity of humidifier. Use properly sized unit.
	*Too high of a system static pressure.	*Supply air system must be evaluated if static pressure is too high. Located & correct issue.
	*Back pressure in steam hose too high.	*Too long of steam line runs, sags, dips, horizontal runs not allowing for proper condensate removal, improper sloping of steam lines & condensate line.
	*Foaming.	*Remove impurities inside the cylinder. If cleaning of cylinder was attempted, throw away.
	*Wrong cylinder.	*Make sure proper cylinder and configuration is used.

WATER CONTROL

The water contained in the cylinder must be controlled, in order for the humidifier to function properly. The fill and drain rates must be maintained. Filling too quickly can cause over-amping and automatic shutdown, circuit breaker tripping or blown fuses. Filling too slowly can cause insufficient steam output or insufficient humidity levels. Water supply pressure should be between 30 and 80 psig, ideally 55 to 60 psig. Draining too quickly can cause dangerous arcing and electrode corrosion. Draining too slowly can cause over-concentration and malfunction due to foaming. These are just some examples of what can go wrong if the fill and drain rates are not controlled and maintained.

TROUBLE SHOOTING

SYMPTOM: LCD NOT ON

1. Verify that voltage being supplied to the humidifier is the same as that listed on the rating label on the front left hand corner of cabinet.
2. If humidifier is 3-phase, verify that all legs have power.
3. If the humidifier has optional internal circuit breakers, they must be on.
4. Verify LCD is not in dimmed mode by touching it.
5. Verify that 24VAC is being supplied by the voltage transformer by taking voltage reading between TP6 and TP7 (*Photo O*). Check the connection at J1 (*Photo P*).
6. If 24V AC is not present reset the overload protection (breaker or fuse) located on the transformer.
7. If 24V AC is present, the circuit board may be defective.

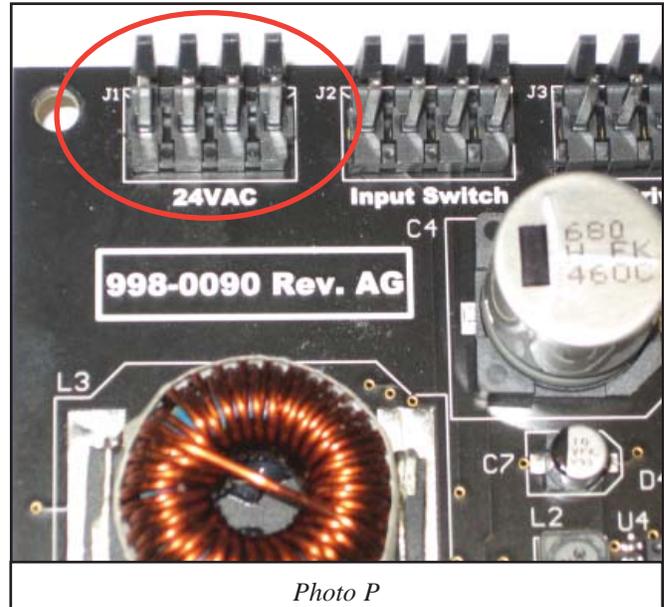


Photo P

SYMPTOM: WATER DOESN'T FILL INTO CYLINDER

1. Confirm that indicators for the four basic controls are all lit green, and the humidifier is switched 'On'.
2. If all four indicators are not green, consult the "Controls" section of the IOM.
3. If all four indicators are green, and the 'Steam' indicator is green, check the service required page for a possible shutdown scenario.
4. If no service required information is available, check the Fill Valve indicator (or the Blue LED on the front). If on, check for 24VAC at the coil of the fill valve. If 24VAC is present water should be flowing if water is available. Be sure all shut off valves ahead of the humidifier are open.
5. If water is available, check the fill valve strainer for sediment. Strainer may be checked by removing brass nut from input of valve and reaching inside housing and pulling out strainer.
6. If 24VAC is present and strainer is clean, the fill valve may be defective.
7. If the High Water Sensor is activated, the fill valve will not be allowed to open. In this case the green indicator (and blue LED on front panel) will be off.
8. Make sure the drain solenoid is not partially open due to blockage, restriction or malfunction.

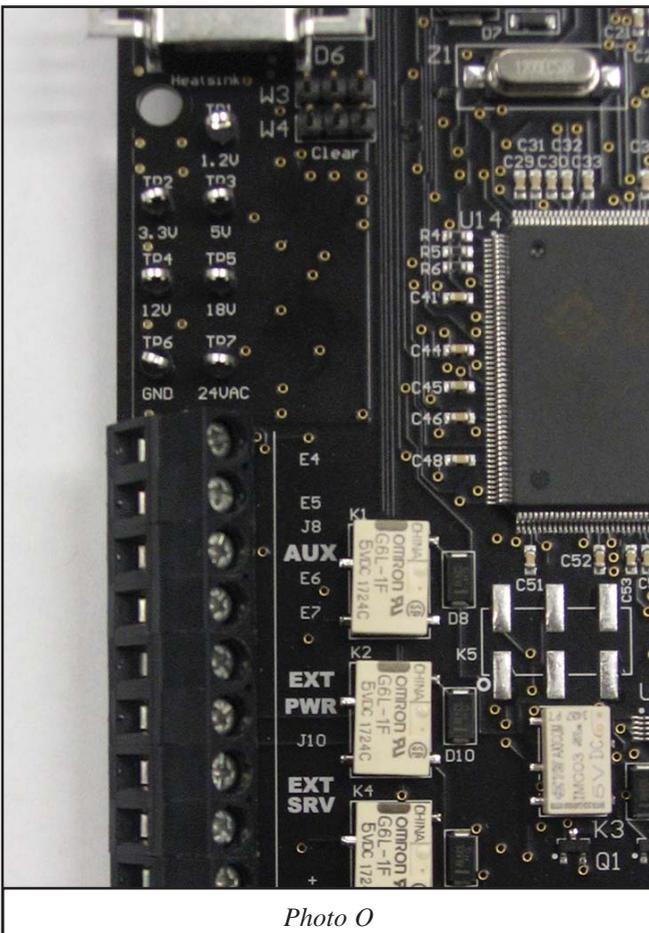
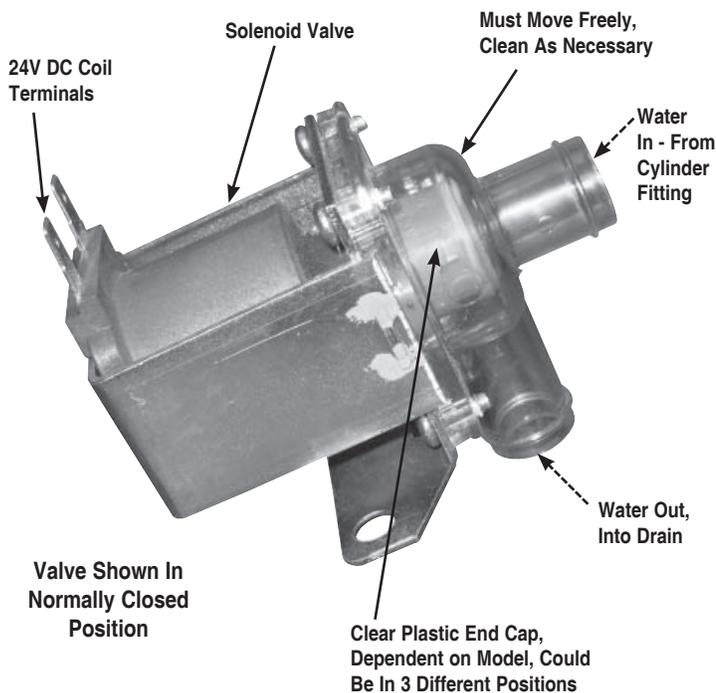


Photo O

SYMPTOM: DRAINS CONTINUOUSLY

1. The most common cause is to have a piece of mineral in the drain solenoid valve that prevents the valve from closing properly. Simply cycling the “On-Off-Drain” switch back and forth between “Off” and “Drain” may dislodge the sediment. In extreme cases it may be necessary to disassemble drain lines to clean them. If mineral buildup is re-occurring issue, make sure the “Repetitive Drain Valve” option is enabled in the settings menu.
2. Check movement of the solenoid actuator to verify that the plunger moves freely in the coil. If the coil has overheated so that movement of the plunger is restricted, it will require replacement of the valve.
3. When the Drain Valve” LED is lit, the circuit board is sending 24VDC to the drain valve. If the indicator is gray but 24VDC is present at the drain valve, the circuit board may be defective.



SYMPTOM: WATER IN THE DUCT

Note: This is usually an installation problem. The first step is to determine whether water is spitting from the steam distributor pipe or if steam is condensing on some object downstream from the steam distributor pipe.

If water is spitting from the steam distributor pipe there may be several causes.

1. The steam hose and condensate return line **MUST** have continuous slopes without any sags or low areas where water could accumulate. If water accumulates in the

steam hose it may be suddenly pushed into the distributor pipe and the condensate return line may be unable to handle the large volume.

2. Make sure that the condensate return line is not restricted anywhere. Areas where the hose bends or where it is tied using cable ties are often the problem.
3. The distributor pipe must be installed so that far end of the distributor pipe is higher than the incoming end where condensate return connection is located. The mounting plate on distributor pipes up through 36" should be mounted on a plumb surface to automatically provide proper pitch. On longer pipes, it is necessary to support the pipe using the bracket on the end of the pipe to insure that proper slope is maintained.
4. If the condensate return line has a drop of less than 12" from the distributor pipe to the top of the humidifier cabinet, it may be better to route the drain below the unit rather than connecting at the top of the cabinet.
5. If the condensate return line is connected to the fitting at the top of the humidifier cabinet, make sure that traps have not been installed in the return line. A trap is only needed if the return line is routed to a separate drain and it is necessary to prevent steam from being discharged from the line.
6. It may be beneficial, particularly on longer routes, to put a trap in the steam hose right before the distributor pipe. In this case, it is absolutely necessary to run the condensate at the bottom of the trap away to a separate drain.

If water is condensing on an object in the duct or on the duct itself it will be necessary to take other steps.

1. The distributor pipe must be a **minimum** of 6 feet upstream from any elbow, split, coil, turning vane, grille or diffuser. The lower the air temperature is in the duct the further upstream the pipe must be located. If the air temperature is 60°F it may be necessary to have 10 feet between the pipe and any obstruction.
2. If it is not possible to have the required distance from the distributor pipe to an obstruction a drain pan may be required to accommodate the water.
3. It may be that air in the duct simply can't hold the volume of steam that is being added. Normally the only practical solution is to reduce the steam output of the humidifier, as it is usually not feasible to increase the air temperature or quantity.

SYMPTOM: ARCING IN THE STEAM CYLINDER

An occasional arc is not a problem. When a cylinder is restarted after a long period of off time arcing may occur as pieces of mineral flake off the electrode surface. During a drain cycle, arcing may occur if water is very low in the cylinder. Arcing **is** a problem if it occurs frequently or if it causes dark brown or red discoloration in the cylinder. The dark deposits are caused by deterioration of electrode material and must be prevented. Arcing may be caused by several conditions:

1. Incoming water may have high conductivity. Conductivity, the ability to conduct current, is measured in "micromhos". In any electrode type humidifier there are maximum values of conductivity that may be used in the humidifier. It is very unusual for any naturally occurring water to have conductivity that is too high for operation. It is recommended that water conductivity be less than 900 micromhos. If water is treated by a water softener its conductivity will be higher than untreated water. As it is boiled away its conductivity also increases at a higher rate than untreated water. Softened water may be too high in conductivity to operate without arcing.
2. Drain lines within the humidifier that have become restricted by mineral deposits prevent proper drain rates. This causes minerals to concentrate inside the cylinder, which in turn causes low water levels. Low water levels cause arcing. Drain lines should be inspected when cylinders are changed and thoroughly cleaned if necessary.
3. A defective drain solenoid valve will prevent proper draining. The solenoid should be checked to verify that it moves freely when 24VDC is applied to the coil. When placed in the "Drain" position, both the drain and fill valves open and it is very important the water level falls in the cylinder.
4. Insufficient flow of incoming fresh water will cause arcing by causing low water levels. Since an automatic drain is not initiated until setpoint is reached a drain will not occur if the flow rate is too low. Therefore, if low water pressure at the humidifier (below 20 psi) or a clogged water strainer restricts the flow of water, arcing will result.
5. High back pressure, which can be caused by an obstruction in the steam hose, prevents fresh water from entering the cylinder and results in arcing. Care must be taken to prevent kinking of steam hose when making bends.
6. Excessive lengths of steam hose in conjunction with high duct static pressures cause low water levels and arcing.
7. Frequent cleaning of the steam cylinder by removing and flushing or by striking the side of the cylinder potentially dislodges flakes that can build up a "dam" in the drain lines. It is not recommended that the cylinder be removed except for replacement.

8. Chemicals should not be used to attempt to prevent mineral build up in the cylinder or to dissolve minerals that accumulate. Chemical treatment may affect conductivity. Only untreated tap water is recommended for use in the humidifier.

SYMPTOM: FOAMING

Foaming is usually due to foreign matter or impurities getting into the cylinder through normal water supply. Detergents, cleaning agents used to clean dirty cylinders (Cylinders are not to be cleaned, but to be disposed of at end of cylinder life), and water issues precipitated by very slow or fast drain cycles. It is important to note that when foam is generated it is as conductive as the conditioned water and could, if circumstances are right, force a high water level situation.

1. Clean all water lines, replace if necessary.
2. Replace cylinder.
3. Reduce softening mix or concentration.
4. Increase water volume by correcting drain issues.
5. Changing cylinder, but with a different electrode configuration to accommodate the water condition.

HUMIDIFIER OPERATIONAL SPECIFICATIONS:

1. Provide self-contained electronically controlled steam generating humidifiers of the size(s) shown on plans as manufactured by Carnes Company, Verona, WI.
2. Carnes Humidifiers shall have the capacity to operate at 115, 208, 230, 277, 380, 415, 460 and 575 volt (or nominal value), 60 or 50 hz (cycle), single or 3 phase power. Specific combination of maximum output, voltage and phase for order application determined by electrical data chart.
3. The humidifier(s) shall be UL and cUL listed.
4. The humidifier(s) shall have a total Color "True Touchscreen" user interface. Features:
 - a. True Touchscreen navigation for all aspects of operation and information access.
 - b. Cylinder life-counter (hours of operation. Found by accessing Settings button.
 - c. With Fan Distribution Unit, there is a fan speed Slide Bar control with CFM indication. Found by accessing Settings button.
 - d. "Help" screen button.
 - e. "Service Required" button and indicator and corresponding screen explaining service issues and possible troubleshooting tips.
 - f. "Dim LCD" feature button.
 - g. "Settings button - where all operational values can be set.
 - h. "Setpoints" button - target steam output of the humidifier.
5. Steam shall be generated from tap water or softened water (see factory representative) in a factory sealed cylinder containing electrodes. Cylinders shall not require setting of electrode spacing, cleaning or maintenance and shall be of the disposable type.
6. The humidifier(s) shall include an automatic drain cycle controlled electronically to maximize energy efficiency. Drain cycle shall adapt to variations in water conditions (high/low conductivity and high/low hardness) and not require manual setting. There is also a default setting for a pulsing drain action to assist in keeping drain lines open.
7. In the event of over-current, the humidifier shall signal that a fault condition exists by message on touchscreen. Replacement type fuses are not acceptable.

Option: Humidifier(s) shall also include secondary magnetic overload switches (circuit breakers) that shall be manually resettable and shall be of the type that positively disconnects power to the steam cylinder.
8. Humidifier(s) shall include a door interlock safety switch to disconnect power to steam cylinder(s) when cabinet door is opened.
9. The system shall include one steam distributor pipe for each steam generating cylinder mounting in the duct as shown on the plans. Steam distributing pipe(s) shall be of corrosion resistant design (copper or stainless steel) and be designed to provide uniform distribution over the entire length of the pipe.

Option: Supply and install remote (or humidifier mounted) fan distribution units to discharge steam directly into the conditioned space.

Provide the following components:

 - a. Three 12VDC fans operated by circuit board.
 - b. Integral steam manifold trap.
 - b. Remote mounted on/off, proportional control humidistat.

Option: When plans call for a specific short absorption distance from dispersion system, a multi-tube Short Absorption Manifold is available sized specifically to duct dimensions, with horizontal stainless steel cross tubes and vertical headers.
10. The system shall include flexible hose to connect the steam cylinder(s) to the steam distributor pipe(s). A separate condensate return line shall return condensate to the humidifier for reuse to minimize consumption. If due to specific routing issues or application of unit, condensate line can not run back to unit, the line can go directly to the common drain, and the addition of a "circle" or "U" trap will be required (see IOM). Long distances from unit to common drain can be accommodated with accessory option Water Pump (HXWA). Hard tubing can be used for Steam Hose and Condensate Return to prevent sags, restrictions or obstructions (see IOM), but it is recommended a minimum of 12 inches of flexible hose be used from unit and before distributor pipe. We recommend a maximum distance of 30 feet from unit to distributor pipe(s) or short absorption manifold and proper routing and inclination of hoses and hard tubing be adhered to for proper, overall consistent and dependable operation.
11. The humidifier(s) shall incorporate a 1" air gap on the fill water line to prevent backflow. It is recommended that a drain air gap fitting be installed by a non-Carnes contractor to prevent backflow of water. Carnes offers an air gap fitting as a purchased option.
12. The humidifier cabinet(s) shall be constructed of 304 B 20 gauge stainless steel and shipped with Novacel 4228 protective film. The cabinet door shall be hinged and provided with a lock and key. The main door is also provided with a quick release pin for removal to provide easy access to internals. The True Touchscreen Home Page will show a digital LCD steam output meter calibrated in pounds of steam per hour (kg of steam per hour selection is included as a built in option), fill cycle, drain cycle and high water indicator lights will be visible with the cabinet door closed.

Option: Humidifier cabinet(s) shall be constructed of 20 gauge steel with a stainless steel bottom pan, protected by a dipped electrostatic baked enamel undercoat with multi spec textured top coat with black accent architectural grade.
13. The humidifier(s) shall be controlled by a humidistat which operates through the solid-state circuit board. Humidifier(s) shall incorporate terminals for connection of humidistat, air flow switch and hi-limit control humidistat.

Option: Provide the following accessory controls:

 - a. Wall mounted humidistat, on/off control.
 - b. Wall mounted humidistat, w/ LCD combo (NEW).
 - c. Duct mounted humidistat, on/off control.
 - d. Duct mounted humidistat, proportional control.
 - e. Duct mounted humidistat w/digital humidity and temperature, combo (NEW).
 - f. Hi-limit duct mounted humidistat, on/off control.
 - g. Hi-limit duct mounted humidistat, proportional control.
 - h. Pressure differential type air flow switch.
 - i. Paddle type air flow switch.
 - j. Wall or duct mounted temperature compensated, on/off or proportional control, digital display humidistat.
14. External Control Signals - All Carnes humidifiers will accept external DDC control signals of 0-10 volt DC. Signal to modulate the output of humidifier. Polarity must be observed and input impedance is 20K ohms. If 4-20 mA signal is provided a 470 ohm, 1/4 watt resistor must be installed. Humidifiers will also accept internal (BMS) building management system or (BAS) building automation system signal.
15. The fill water line shall include a strainer to remove sediment from incoming water and a flow regulating control to automatically compensate for water pressures from 20-120 psi.
16. Humidifier(s) shall include a "Service Required" button (illuminated in RED) on the total "True Touchscreen" home page which shall explain service issues and possible troubleshooting tips. The light shall be visible with the cabinet door closed and terminals shall be provided for remote signal. Terminals are also provided to indicate normal operation to a remote location.
17. Dedicated buttons with indicator lights on the steam page of the total "True Touchscreen" shall indicate status of the control humidistat, hi-limit humidistat, air flow switch and door interlock switch. Operation of fill solenoid, drain solenoid, power contactor and high water sensor shall be shown after accessing the "Component Activity" button on the home page of the total "True Touchscreen".
18. The humidifier(s) electronic circuit board shall include automatic controls to compensate for varying water conditions without changing cylinders or electrode spacing. The control shall activate the fill and drain solenoid valves to automatically maximize efficiency. Unit will perform system self-correction procedures to assist in preventing unit shutdown due to any fault in operational sequence. A drain pulsing feature is included to assist in expelling any blockage that may occur during a self-correcting drain cycle. If self-correction procedures are unable to correct problems after specific cycles, unit will automatically shutdown.
19. The humidifier(s) shall include a non water contact capacitance proximity high water sensor to prevent overflowing and loss of water.
20. The fill solenoid valve shall open whenever the drain solenoid is activated, whether in automatic or manual operation, to prevent discharge of boiling water into drainage system. Drain light shall indicate the switch is in drain position.
21. Humidifiers, dependent upon capacity, will have one (1) or two (2) cylinders for operation. If a capacity is desired of 125, 150, 175 or 200 lbs./hr., the units will be equipped with two (2) cylinders, each independently and separately controlled by their own control signal.
22. Automatic Drain of cylinder water will take place when there is a demand signal loss for 72 hours. Unit will remain in stand-by in the event that a quick start-up is required.

HUMIDIFIER MAINTENANCE CHECKLIST:

Unit Serial #: _____	No. of Humidifiers: _____	
Model #: _____	Voltage: _____ V/ _____ ph	Steam Output: _____ lbs./hr.
Customer/Job: _____	Address: _____	

CYLINDER/SYSTEM CHECK:

- "Service Required" Warning (Cylinder Life Counter) yes no
 - Fault cylinder spent yes no
- (If panel displays "Service Required" Warning and the warning states "Cylinder near end of life" the cylinder will need to be replaced soon.)
- Orange LED on with High Water Warning yes no
- (If Orange LED is on with High Water Warning and cylinder is not new, cylinder may have to be replaced soon.)
- Other warnings or faults shown in display yes no
- (See Troubleshooting chapter for actions to address warnings and faults if present.)

REPLACE CYLINDER:

- Drain cylinder yes no
- Disconnect open, On/Off switch is Off, water shut off closed yes no
- Remove cylinder yes no
- Drain valve removed/cleaned/new o-ring yes no
- Drain valve installed/ground wire attached yes no
- New cylinder installed and hose clamps tightened yes no

New cylinder model # _____

(Should be same as removed cylinder.)

- Cylinder plug numbers match cylinder numbers yes no
- Cylinder plugs snug and in good condition yes no
- High water sensor plug snug and in good condition yes no
- Electrical wiring not loose and in good condition yes no
- Steam and condensate hoses in good condition/no kinks in hose yes no
- No signs of water leaking around humidifier, internal plumbing, steam line, condensate returns yes no
- Door replaced, water shut off valve opened, On/Off switch to on, disconnect closed yes no
- "Reset Cylinder Life Counter" in Settings. (Settings password: 1212) yes no

Started by: _____ Date of Startup: _____

Company: _____

PREVENTATIVE MAINTENANCE:

Unit Serial #:	_____	No. of Humidifiers:	_____		
Model #:	_____	Voltage:	_____ V/ _____ ph	Steam Output:	_____ lbs./hr.
Customer/Job:	_____	Address:	_____		

PREVENTATIVE MAINTENANCE: RECOMMENDED MONTHLY PREVENTATIVE MAINTENANCE FOR HUMIDIFIERS

Service contractor or maintenance agent - be prepared to:

1. Investigate and observe.
2. Recognize issues.
3. Determine procedures.
4. Implement solutions.
5. Inform customers.

Preventative maintenance is not intended to replace quality manufacturing and assembly from the company of origin. Products get older, wear and tear occurs, personnel changes and simple attention to detail sometimes become lax. Basic preventative maintenance for humidifiers should be required follow-up for continued proper operation of products. Preventative maintenance is a means to prevent future costly failures. The following are recommended preventative maintenance procedures for humidifiers on a monthly basis:

PLEASE FOLLOW ALL REQUIRED SAFETY PROCEDURES BEFORE WORKING ON HUMIDIFIER UNITS.

1. Visually inspect steam hose(s) and condensate hose(s) for proper routing and installation from humidifier unit. Prevent sags, dips or kinks in hoses. Eliminate horizontal runs. Make sure of adequate slope up for steam hose and slope down for condensate return. Correct as necessary. Recommend no hose lengths longer than 30 to 35 feet. Refer to early pages of this IOM.
2. Visually inspect steam hose and condensate attachment to dispersion pipe or short absorption manifold. Recommend periodic removal of dispersion systems for inspection (restricted dispersion holes, damage, plumb mounting and clamping tightness).
3. Humidifier unit - inspect internal hoses for sediment build up or degradation. Clean or replace as necessary. Also, check tightness of hose clamps. Tighten as necessary.
4. Inspect fill valve strainer. Industrial/commercial unit fill valve strainer is located at the connection point of the water inlet hose to valve. Strainer is located inside the valve at the threads. Pop out and inspect. Clean or replace as necessary. Residential unit - disconnect inlet hose to solenoid valve assembly, remove solenoid valve from unit and visually check filter screen inside inlet port. Clean as necessary.
5. Visually check operation of the drain solenoid valve, smooth operation and 100% seal when normally closed. If necessary, remove solenoid valve, disassemble and clean or replace as necessary.

6. Visually check cylinder for extreme amounts of residue on the inside surface. Very high level of water or unit unable to provide full capacity may be an indication of end of life cycle of the cylinder. Do not attempt to clean out with chemicals, do not stick screwdrivers or other objects into cylinder to clean out sediment. These cylinders are made to be replaced at end of life cycle. Life cycle of cylinder is more often than not determined by the condition of the water used in the unit, especially hardness, % of max output, or run time (24/7, 8 hr./day, etc.). Refer to this IOM or main humidifier catalog for more information.
7. Visually and manually check all wire and plus connections inside unit. Include the wire connections to the top of the cylinder. If a red 90° connector is used, be sure to check the inside of the connector for a set screw. This screw needs to be checked for tightness. Make sure control wires at the J16, J17 and J18 terminal connections, bottom of the circuit board, are tight.
8. Monthly - remove drain air gap and check for any sediment buildup that may block any free flow of water. These check points for the "H" series humidifier are basic, but significantly covers the entire unit.

Keeping a preventative maintenance record would be recommended to show maintenance performed and any observations made during inspection.

EXTENDED SHUTDOWN/STARTING AFTER EXTENDED SHUTDOWN:

Unit Serial #:	_____	No. of Humidifiers:	_____
Model #:	_____	Voltage: _____ V/ _____ ph	Steam Output: _____ lbs./hr.
Customer/Job:	_____	Address:	_____

EXTENDED SHUTDOWN

During long periods of humidification downtime, the cylinder should be completely drained and emptied.

1. Manually push the On/Off rocker switch to drain.
2. Wait until the humidifier is completely drained of water.
3. Turn the On/Off rocker switch to the "OFF" position.
4. Shut off the main external power to the humidifier unit.
5. Turn the supply water off at the shut-off valve.



NOTE:

CARNES RECOMMENDS THAT THE CYLINDER REMAIN EMPTY DURING EXTENDED SHUTDOWN PERIODS. THIS WILL PREVENT THE POSSIBILITY OF CORROSION OF THE ELECTRODES AND THE ACCUMULATION OF ALGAE AND BACTERIA GROWING IN THE CYLINDER.

STARTING AFTER EXTENDED SHUTDOWN

1. Inspect the humidifier for any damage. Check to make sure the mounting and installation has not been altered.
2. Turn on the main external power to the humidifier unit.
3. Turn the On/Off rocker switch to the "ON" position.
4. Review and follow the startup procedure in the IOM.

REPLACEMENT CYLINDER:

Unit Serial #: _____ No. of Humidifiers: _____
Model #: _____ Voltage: _____ V/ _____ ph Steam Output: _____ lbs./hr.
Customer/Job: _____ Address: _____

The label on the existing cylinder identifies the cylinder model. When ordering, please quote the 7, 8 or 9 digit model number from the cylinder label. You will also need to provide the humidifier model number and serial number (located on the sticker on the front of the unit).



NOTE:

CARNES RECOMMENDS THAT THE CYLINDER REMAIN EMPTY DURING EXTENDED SHUTDOWN PERIODS. THIS WILL PREVENT THE POSSIBILITY OF CORROSION OF THE ELECTRODES AND THE ACCUMULATION OF ALGAE AND BACTERIA GROWING IN THE CYLINDER.

REMOVING THE CYLINDER:

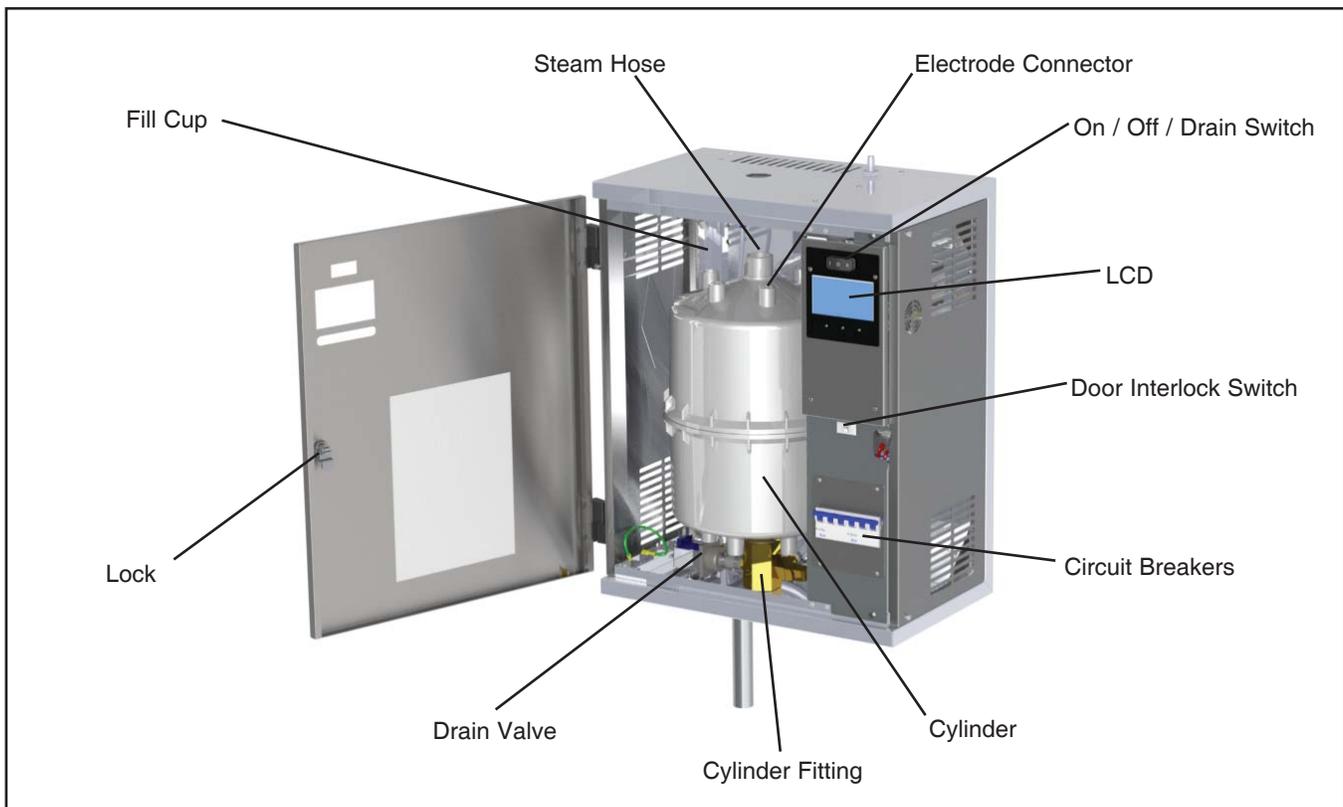
Unit Serial #: _____ No. of Humidifiers: _____
Model #: _____ Voltage: _____ V/ _____ ph Steam Output: _____ lbs./hr.
Customer/Job: _____ Address: _____



WARNING

- Disconnect power (external shut-off) before servicing.
- CAUTION: cylinder may be **hot**.
- Compartments contain high voltage wiring.

1. Completely drain the existing cylinder (flip On/Off rocker switch to "Drain").
2. Turn off water supply at the shut-off valve.
3. Turn the humidifier off (flip On/Off rocker switch to "OFF").
4. Turn main power "Off" at the external shut-off.
5. Remove all terminal plugs (red capped wires) from the cylinder.
6. Loosen the steam hose clamp and remove the steam hose from the cylinder.
7. (Using a flat head screwdriver) Remove the cylinder strap, keeping the cylinder in place.
8. A and B sized cylinders are threaded. Unscrew the cylinder (counter clockwise) and lift up and out.
9. C sized cylinders are seated into the brass plumbing with an "O" ring. Just lift up and out.



INSTALLING THE CYLINDER:

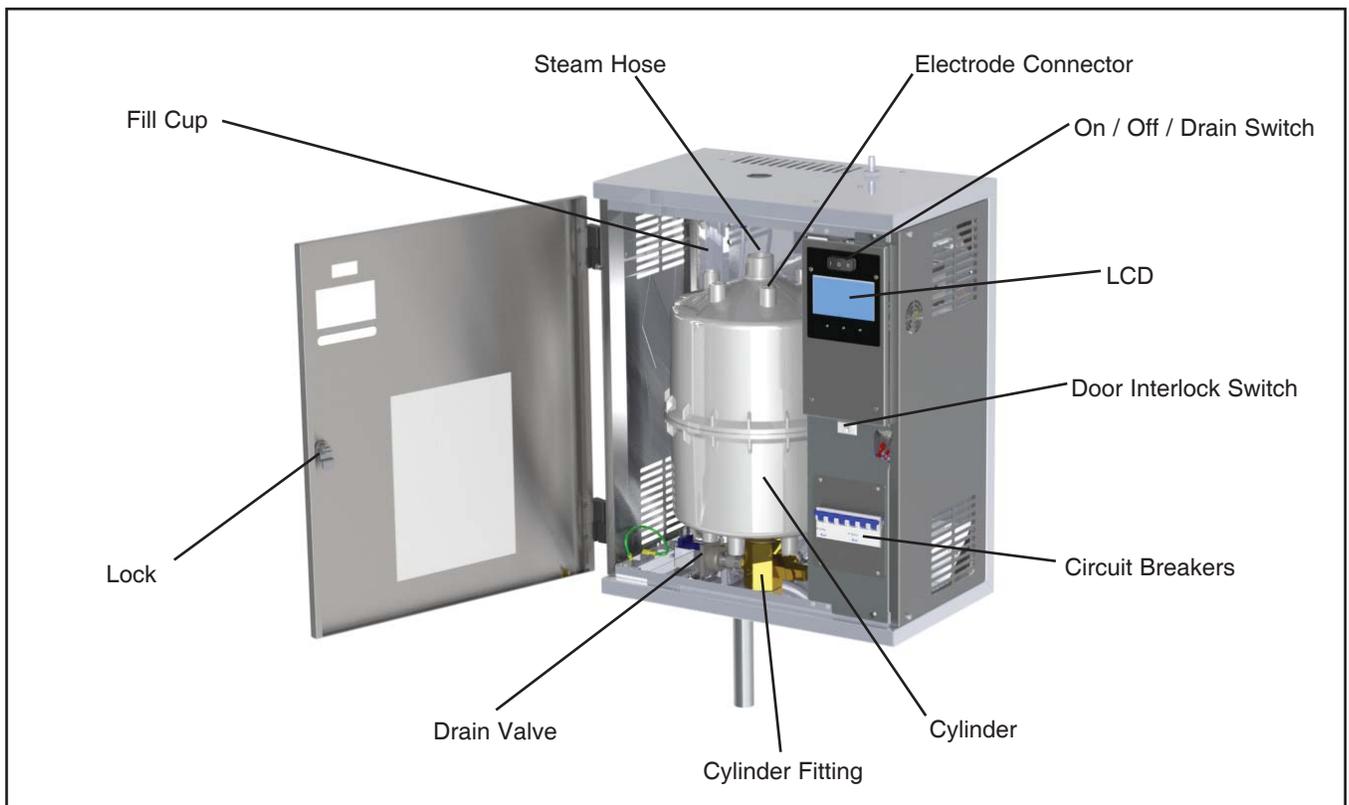
Unit Serial #: _____ No. of Humidifiers: _____
Model #: _____ Voltage: _____ V/ _____ ph Steam Output: _____ lbs./hr.
Customer/Job: _____ Address: _____



WARNING

- Keep power off (external shut-off) until cylinder is in place and reconnected.
- Compartments contain high voltage wiring.

1. Insert cylinder into brass cylinder fitting.
2. A and B style cylinders are threaded. Verify there is Teflon tape on the threads and do not over tighten.
3. C sized cylinders have no threading, verify the two "O" rings are present and set the cylinder fully.
4. Secure the cylinder with the white cylinder straps (not labeled).
5. Do not over tighten as this may damage the cylinder.
6. Connect the terminal wires to the electrodes so that the numbers match those on the cylinder. Push the plugs onto the pins to ensure the electrode plugs are firmly in place.
7. Place the steam hose onto the steam outlet and tighten the steam hose clamp.
8. Turn main power "On" at the external shut-off.
9. Turn on the water supply at the shut-off valve.
10. Turn the humidifier on (flip On/Off rocker switch to "ON").





WARNING

UNAUTHORIZED MODIFICATION OF THIS HUMIDIFIER OR USING UNAUTHORIZED REPLACEMENT PARTS MAY CAUSE MALFUNCTION WITH RISK OF SERIOUS PERSONAL INJURY AND WILL VOID ALL PRODUCT WARRANTIES.

REPLACEMENT CYLINDER ORDER FORM

Name: _____

Company: _____

Address: _____

City: _____ State/Province: _____ Code: _____

Phone: _____ Email: _____



"AX" Cylinder



"B" Cylinder



"C" Cylinder

Part #	Cylinder	Humidifier Specifications	Quantity
HXCBA145	"AX"	<i>Contact Carnes Rep for more info.</i>	
HXCBA220	"AX"	005/010 lbs./hr. 120V 1 ph.	
HXCBA380	"AX"	005/010 lbs./hr. 208-277V 1 ph.	
HXCBA500	"AX"	<i>Contact Carnes Rep for more info.</i>	
HXCBA600	"AX"	005/010 lbs./hr. 415-380V 1 ph.	
HXCBA700	"AX"	005/010 lbs./hr. 460-575V 1 ph.	
HXCBB380	"B"	<i>Contact Carnes Rep for more info.</i>	
HXCBB500	"B"	020/030 lbs./hr. 208-277V 1 & 3 ph.	
HXCBB600	"B"	020/030 lbs./hr. 380-415V 1 ph.	
HXCBB700	"B"	020/030 lbs./hr. 460-575V 1 & 3 ph.	
HXCBC12	"C"	080/200 lbs./hr. 380-575V 3 ph.	
HXCBC6F	"C"	<i>Contact Carnes Rep for more info.</i>	
HXCBC6X	"C"	<i>Contact Carnes Rep for more info.</i>	
HXCBC61	"C"	<i>Contact Carnes Rep for more info.</i>	
HXCBC62	"C"	030/100 lbs./hr. 208-277V 1 & 3 ph.	
HXCBC63	"C"	<i>Contact Carnes Rep for more info.</i>	
HXCBC64	"C"	<i>Contact Carnes Rep for more info.</i>	
HXCBC65	"C"	030/060 lbs./hr. 2380-575V 1 & 3 ph.	

MODEL	<input type="text"/>	LBS/HR	<input type="text"/>
SERIAL NO.	<input type="text"/>	CODE	<input type="text"/>
POWER SUPPLY	<input type="text"/>	VAC,	<input type="text"/>
		HZ,	<input type="text"/>
		PH,	<input type="text"/>
		AMPS	<input type="text"/>

← Requested information is located on a label on the outside of the humidifier cabinet on the lower left corner.

Cylinders can be ordered directly from your local agent. You can also fill out this form and email it directly to Carnes and carnes@carnes.com. We will have your agent contact you. Thank you for choosing Carnes Humidifiers.

"Due to ongoing research and development CARNES reserves the right to change specifications without notice."
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TERMS, CONDITIONS AND WARRANTY

1. ACCEPTANCE, GOVERNING PROVISIONS AND CANCELLATION.

This writing constitutes the complete and exclusive statement of the terms and conditions of sale of the products and/or services described herein, and Seller's obligation to sell is expressly conditioned upon assent to these terms and conditions. Buyer will be deemed to have assented to these terms and conditions unless Seller receives written notice of any objection within 5 days of the date Buyer receives this writing. No additional or different specifications will be binding upon Seller unless specifically agreed to in writing; failure of Seller to object to provisions contained in any purchase order or other communication from the Buyer shall not be construed as a waiver of these terms and conditions nor an acceptance of any such provisions. No order accepted by Seller may be cancelled or altered by the Buyer except upon terms and conditions acceptable to Seller, as evidenced by Seller's written consent. In the event of such an approved cancellation by Buyer, Seller shall be entitled to payment for all finished and in-process goods, as well as any costs incurred in the preparation of Buyer's order to the date of cancellation.

2. DELIVERY, CLAIMS AND DELAYS.

Delivery of products to a carrier at Seller's plant or other loading point shall constitute delivery to Buyer; and regardless of shipping terms or freight payment, all risk of loss or damage in transit shall be borne by Buyer. Seller reserves the right to make delivery in installments, unless otherwise expressly stipulated herein, all such installments to be separately invoiced and paid for when due per invoice, without regard to subsequent deliveries. Delay in delivery of any installment shall not relieve Buyer of his obligations to accept remaining deliveries. Further, use of the products by the Buyer shall constitute a waiver of any claim for delay.

Claims for shortages or other errors in delivery must be made in writing to Seller within 10 days after receipt of shipment and failure to give such notice shall constitute unqualified acceptance and a waiver of all such claims by Buyer. Claims for loss or damage to products in transit should be made to the carrier and not to Seller.

Seller shall not be liable for any damage as a result of any delay due to any factor or event beyond Seller's reasonable control, including, without limitation, an act of God, act of the Buyer, embargo or other governmental act, regulation or request, fire, accident, strike, slowdown, a war, riot, delay in transportation, inability to obtain necessary labor, materials, or manufacturing facilities. All such factors and/or events shall extend the delivery date for a period equivalent to the time lost by reason of such factors and/or events, plus thirty (30) days.

3. CHANGES.

Seller may at any time make such changes in design and construction of products as shall constitute an improvement in the judgment of Seller. Seller may furnish suitable substitutes for materials unobtainable because of priorities or regulations established by governmental authority or nonavailability of materials from suppliers.

4. PAYMENT.

Unless otherwise expressly stated on the face hereof, all prices are subject to change without notice; and the price of products on order but unshipped will be adjusted to the price in effect at the time of shipment. Products are sold f.o.b. Seller's plant unless otherwise stated.

Full invoice amount is due in 30 days from date of invoice ("due date") unless otherwise expressly indicated on the reverse side, and a late payment charge of one and one-half percent (1-1/2%) per month may be added to any invoiced amounts unpaid when due if not prohibited by law, otherwise at the highest lawful contract rate. Buyer shall reimburse Seller, upon demand, for any costs of collection incurred by Seller, including reasonable attorneys' fees. Invoices may be submitted as partial shipments are made. If during the period of the contract the financial condition of Buyer does not justify the terms of payment specified, Seller may demand full or partial payment in advance before proceeding with the contract. If shipment is delayed beyond the scheduled date by Buyer, payment shall be due in full when Seller is prepared to make the shipment. If Buyer defaults in any payment when due, then the whole contract price shall immediately become due and payable upon demand, or Seller, at its option without prejudice to other lawful remedies, may defer delivery or cancel this contract.

5. SECURITY INTEREST.

Buyer hereby grants to Seller a security interest in the products and the proceeds thereof, to secure payment of all sums to become due the Seller hereunder, and any other indebtedness owing at any time by Buyer to Seller. The Seller shall have, upon a default in payment, all of the rights and remedies of a secured party under the Uniform Commercial Code. Buyer shall execute and deliver upon Seller's request financing statements to perfect the security interest, and Buyer shall take such further action as shall be necessary or desirable to preserve and protect Seller's security interest.

6. TAXES AND OTHER CHARGES.

Any manufacturer's tax, retailer's occupation tax, use tax, sales tax, excise tax, duty, custom, inspection or testing fee, or any other tax, fee or charge of any nature whatsoever imposed by any governmental authority, on or measured by the transaction between Seller and Buyer shall be paid by the buyer in addition to the prices quoted or invoiced. In the event the Seller is required to pay any such tax, fee or charge, Buyer shall reimburse Seller therefore; or, in lieu of such payment, Buyer shall provide Seller at the time the order is submitted with an exemption certificate or other document acceptable to the authority imposing the same.

7. WARRANTIES.

Seller warrants products manufactured by it and supplied hereunder to be free from defects in materials and workmanship under normal use and proper maintenance for a period of twelve months from date of shipment. If within such period any such products shall be proved to Seller's reasonable satisfaction to be defective, such products shall be repaired or replaced at Seller's option. Seller's obligation and Buyer's exclusive remedy hereunder shall be limited to such repair and replacement and shall be conditioned upon Seller's receiving written notice of any alleged defects no later than 10 days after its discovery within the warranty period and, at Seller's option, the return of such products to Seller, f.o.b. its factory, when such return is feasible. Seller reserves the right to satisfy its warranty obligation in full by reimbursing Buyer for all payments it makes hereunder, and Buyer shall thereupon return the products to Seller. Seller shall have the right to remedy such defects.

THE FOREGOING WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS AND IMPLIED WARRANTIES (EXCEPT TO TITLE) INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, PERFORMANCE, OR OTHERWISE, and in no event shall the Seller be liable for claims (based upon breach of express or implied warranty, negligence, product liability, or otherwise) for any other damages, whether direct, immediate, incidental, foreseeable, consequential, or special.

8. NON-LIABILITY FOR DAMAGED APPARATUS.

Seller will not be responsible or liable for any damage resulting from improper storage or handling prior to placing the products in service and will not assume any responsibility, expense or liability for repairs made outside its works without proper written consent.

9. PATENTS.

Seller will, at its own expense, defend any suits that may be instituted by anyone against Buyer for alleged infringement of any United States patent relating to any products furnished by Seller hereunder, if such alleged infringement consists of the use of such products, or parts thereof, in Buyer's business for any of the purposes for which the same were sold, and provided Buyer shall have made all payments then due hereunder and shall give to Seller immediate notice in writing of any claim of infringement and of the institution of any such suit and transmit to Seller immediately upon receipt all processes and papers served upon Buyer and permit Seller through its counsel, either in the name of the Buyer or in the name of Seller, to defend the same and give all needed information, assistance and authority to enable Seller to do so. In case of a final award of damages in such suit Seller will pay such award but will not be responsible for any compromise made without its written consent. In addition to the foregoing, if at any time Seller determines that there is a substantial question of infringement or in the case any such product is judicially held to constitute infringement and the use of such product is enjoined, Seller may, at its expense, either procure for Buyer the right to continue using the product, or replace the product with non-infringing apparatus, or modify it so that it becomes non-infringing, or remove the product and refund the purchase price and the transportation and installation costs thereof. In no case, shall Seller pay any recovery based on Buyer's savings or profit through the use of the product, whether the use be special or ordinary.

The foregoing states the entire liability of Seller for patent infringement; and in no event shall Seller be liable if the infringement is based on the use of the product for a purpose other than that for which sold by Seller. As to any products furnished by Seller to Buyer manufactured in accordance with designs proposed by Buyer, Buyer shall indemnify Seller against any award made against Seller for any patent, trademark or copyright infringement.

10. CONSEQUENTIAL DAMAGES; INDEMNITY.

SELLER SHOULD NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL OR CONTINGENT DAMAGES WHATSOEVER.

Buyer shall indemnify the Seller against any and all losses, damages and expenses (including attorneys' fees and other costs of defending any action) that it may sustain or incur as a result of any claim of negligence, breach of implied warranty, strict liability in tort, or similar claims by Buyer, its successors and assigns and its customers whether direct or indirect, in connection with the use of products furnished hereunder, including, without limitation, such as may be caused by the negligence of the Seller.

11. SHIPPING WEIGHTS.

Seller shall not be responsible for the accuracy of shipping weights. Such weights are correct only within the limits necessary for estimating freight. For foreign shipments 20% should be added to approximate shipping weight.

12. STORAGE.

If the products are not shipped within 15 days after notification to Buyer that they are ready for shipping, for any reason beyond Seller's reasonable control, including Buyer's failure to give shipping instructions, Seller may store such products at Buyer's risk in a warehouse or yard or upon Seller's premises, and Buyer shall pay all handling, transportation and storage costs at the prevailing commercial rates upon submission of invoices therefor.

13. TECHNICAL INFORMATION.

Any sketches, models or samples submitted by Seller shall remain the property of Seller, and shall be treated as confidential information unless the Seller has in writing indicated a contrary intent. No use or disclosure of such sketches, models and samples, or any design or production techniques revealed thereby, shall be made without the express written consent of the Seller.

14. REMEDIES AND JURISDICTION.

Buyer agrees and understands that this agreement with the Seller shall be governed by and construed in accordance with the laws of the State of Wisconsin without giving effect to the conflict of law principles thereof. The Buyer irrevocably and unconditionally consent to submit to the exclusive jurisdiction of the courts of the State of Wisconsin and of the United States of America located in the State of Wisconsin for any action, suits or proceedings arising out of or relating to this agreement and the transaction contemplated hereby (and buyer agrees not to commence any action, suit or proceeding relating thereto except in such courts). Buyer agrees irrevocably and unconditionally to waive any objection to the laying of venue of any action, suit or proceeding arising out of this agreement or the transactions contemplated hereby, in the courts of the State of Wisconsin or the United States of America located in the State of Wisconsin and agrees not to plead or claim in any such court that any such action, suit or proceeding brought in any such court has been brought in an inconvenient forum.