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Manual no. RV*Sentry* Rev. A
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WARRANTY

Intek, Inc. warrants each *RheoVac*® product to be free from defects in material and workmanship under normal use and service, Intek's obligation under this warranty being limited to making good any part or parts thereof which shall, within one (1) year after delivery of such product to the original purchaser, be returned to Intek with transportation charges prepaid and which Intek's examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties, express or implied and all other obligation or liabilities on Intek's part. The purchaser will assume all responsibility and expense for removal, decontamination and reinstallation of equipment.

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SECTION 1 — GENERAL INFORMATION

1.1 INTRODUCTION

In 1994, Intek Inc. introduced the *RheoVac*® air in-leak monitor for continuously measuring condenser air in-leakage. This monitor was the first and only instrument to measure all of the necessary fluid properties in the condenser exhaust line to provide an accurate, reliable air in-leakage measurement:

— the *RheoVac*® Air In-Leak Monitor*

*USPNs 5,485,754; 5,752,411

The next generation instrument, the *RheoVac SENTRY*, uses the same proven sensor configuration, but brings new capabilities consistent with the industry's need for local as well as centralized and remote monitoring.

The *RheoVac* technology was developed with the help of power plant engineers, to overcome the deficiencies of existing air in-leakage and condenser performance measurement instrumentation and to create a powerful, complete condenser system analysis tool. No single product provides power plant engineers with as much diagnostic information related to the condenser as the *RheoVac SENTRY* System. In addition to providing reliable, real time indication of condenser air in-leakage, the *SENTRY* System provides valuable information that can be used to analyze problems associated with vacuum system components, thereby improving plant efficiency, reducing downtime and increasing maintenance effectiveness.

1.2 BENEFITS

The following are some of the unique benefits of the *RheoVac SENTRY* System:

- Distinguishes between air flow and water vapor flow
- Measures exhauster capacity
- Measures vacuum quality
- Allows operators to distinguish between air in-leakage and pump failure
- Continuous monitoring provides event time stamp
- Provides high resolution, range and accuracy of data
- Retrievable on-board data storage
- Provides data for condenser performance diagnostics
- Provides centralized access to the data from all of the *RheoVac* probes installed in the system
- Provides easy access to individual probe's data as well as on-screen review of selected common data from all of the probes for performance analysis
- Graphic representation of monitored data gives visual indications of performance changes
- Provides easy review of "before" and "after" data through the diagnostics screen to evaluate the effect of system changes
- Portable remote measurement (optional feature) of air-in-leak changes through the use of a hand-held display unit – used to locate leaks

1.3 USES

The *RheoVac SENTRY* System can be used for a multitude of performance related subjects, such as:

- Continuous air in-leak monitoring
- Vacuum pump performance testing
- Operating with zero excess back pressure
- Load dependent air in-leak isolation
- Optimizing condenser performance
- Scheduled preventive maintenance
- Leak detection during hogging operation
- Minimizing heat rate
- Optimizing condensate/water chemistry
- Understanding condenser performance

1.4 PRINCIPLE OF OPERATION

The *RheoVac* technology utilizes multiple primary sensors configured in a single probe head and an electronic signal conditioner and digital signal processor unit. The sensing probe is installed in the vacuum line between the condenser and the exhauster. The *RheoVac* instrument makes no assumptions about the dynamic condenser and vacuum line environment. The sensor head employs the patented Rheotherm® technology to provide an accurate flow measurement. Additionally, temperature, pressure and water vapor relative saturation measurements are made using a high accuracy platinum resistance temperature detector (RTD), a strain gauge pressure sensor and a specially configured and calibrated water vapor saturation sensor. The principal features of the *RheoVac* sensor are shown in Figure 1.

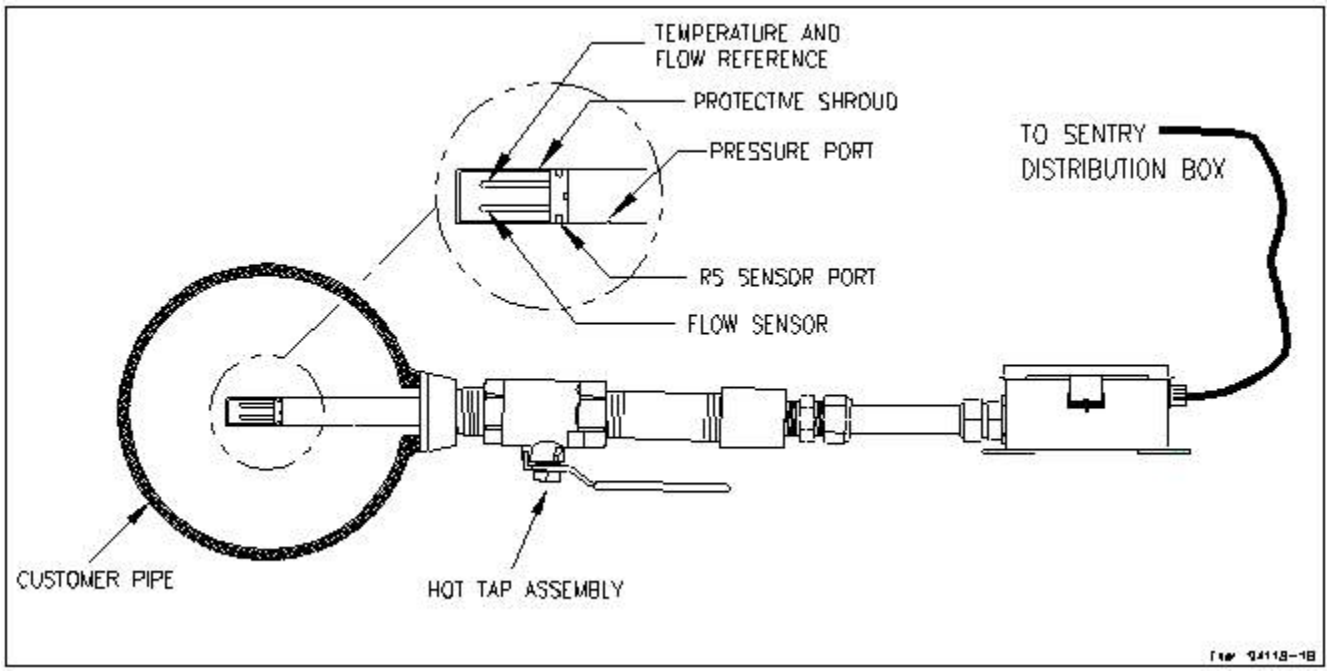


Figure 1 *RheoVac* Probe Sensor Monitor

At the heart of the *RheoVac* probe is the Rheotherm flow transducer, which uses the same patented thermal sensing technique employed in all precision flow instruments manufactured by Intek. Two temperature sensors are used; one sensor is in thermal equilibrium with the flow medium and provides a temperature and flow signal reference, while the second sensor is located near a constant power heater so that its temperature is always above that of the fluid. The temperature of the heated sensor will vary with the stream velocity of the fluid. Hence, the measured temperature differential between the reference sensor and heated sensor is a function of flow rate, which is approximately proportional to the logarithm of mass flow rate (USPN 4,255,968).

The Rheotherm flow sensor is calibrated to measure the total mass flow of the water vapor/air mixture. From the other three measurements, the *RheoVac SENTRY* electronics converts the total mass flow signal from the probe into two components, air mass flow rate and water vapor mass flow rate. This unique measurement method is disclosed in two separate patents (USPN 5,485,754 & 5,752,411). The *RheoVac* probe is fully calibrated at the factory under dynamic fluid conditions identical to those within the power plant vacuum line. No field adjustments are required.

In the *RheoVac SENTRY* System, multiple *RheoVac* probes are installed at pre-determined condenser vacuum line locations to provide the most appropriate measurement data for the condenser system. Depending on the plant configuration, sometimes a single *SENTRY* System can be configured to monitor more than one generating unit. The probes are connected to the *SENTRY* CPU, which processes the measured data and provides the system output data. The *SENTRY* System, in addition to data processing, display and graphing, also communicates the data, through 10Base-T Ethernet, to the plant control room, engineer's office, and/or Intek via modem or internet.

1.5 TECHNICAL SPECIFICATIONS

Primary Calibration Accuracy:
±1% of reading
Repeatability:
±0.5% of reading
Operating Temperature:
Electronics: 32 to 100°F
Probe: 40 to 160°F
Never subject probe to temperatures above 210°F
Operating Pressure:
0 to 10 inches Hg absolute
Process Connection:
Hot tap assembly
(1½" thread-o-let must be welded to pipe for hot tap installation)

Wetted Surface:
300 Series SS and engineering plastic
NEVER allow *RheoVac* probe heads to be immersed in liquid water or be exposed to live steam
Local Display:
touch screen display of all parameters from each probe, with graphing capability
Input Power:
115 Vac, 50/60 Hz (+10%/–20%)
Signal Output:
Ethernet (10Base T) RJ45
4-20mA (optional)
Storage Temperature:
–20 to 120°F
Storage Pressure:
15 psig (maximum)
Maximum number of probes/*SENTRY* CPU: 12

1.6 PRECAUTIONS

- Read the entire manual before installing and operating the *RheoVac* probes and *SENTRY* System.
- Carefully select the best location for installation of the sensing probe. Adequate straight run and freedom from standing water in the line are vital to achieving optimal performance from the *RheoVac* system (See Figure 2).
- Use reasonable care in handling the sensing probe(s) — the sensing components are delicate. Take care not to bend the probes, damage the tips, or otherwise obstruct the sensing ports. When a probe is taken out of line, always place it in the protective sheath which is shipped with probes from the factory.
- Use proper input power.
- Check the probe maximum temperature and pressure ratings — never operate a probe at or subject it to temperatures or pressures beyond its specified limits.
- Keep moisture out of the enclosures — once all service connections are made, make sure the enclosure lids are tightly closed and all gaskets are in place. Seal conduit lines at the instrument.

!! !! WARNING !! !!

1. **Never allow live high temperature steam to flow in either direction in the exhauster line where the probe is located.**

2. **Never flood an exhauster line that has a *RheoVac* probe in it. Always remove the probe, or seal off that section of pipe before a hydrostatic leak test is performed.**

SECTION 2 — INSTALLATION

2.1 SYSTEM CONFIGURATION

The system provided consists of:

- a *RheoVac SENTRY* central processing unit (CPU) in a metal housing. The CPU includes a touch screen interface, uninterruptible power supply (UPS), modem (optional), interconnections and controls
- up to twelve (12) *RheoVac SENTRY* probes (see Custom Information Section)
- one (1) or more distribution box(s), and remote power supply boxes as required, (see Custom Information Section)
- RS485 cable for connecting the probes and electronics boxes.

A drawing is included in this manual illustrating the general layout of all the *SENTRY* components.

2.2 *RheoVac SENTRY* INSTALLATION/SITE SELECTION

2.2.1 Probe Site Selection **(IMPORTANT)**

➠ Select the installation site. The location should provide the probe's sensing area with well-established smooth flow, uniform system temperature and pressure, and consistent non-liquid phase flow medium. Refer to Figure 2 and select the most preferred location that fits your vacuum line configuration.

➠ DO NOT INSTALL THE PROBE DOWNSTREAM OF ANY "TRAP" SECTIONS AS SHOWN IN FIGURE 2, CONFIGURATIONS B AND D. Special installation instructions unique to your unit, where applicable, will be noted in SECTION 6.3 SPECIAL INSTRUCTIONS. Refer to this section now to review any special instructions.

➠ Check installation clearance. The probe is almost 3 feet long and the hot tap assembly is about 13" long, so allow 4 feet of clearance for probe installation. Be sure there are no obstructions around the vacuum line that will interfere with probe insertion or removal and that there is sufficient room for flexible conduit.

➠ OBSERVE the selected site. It should be convenient for removal and replacement of probe(s) at any time for service without building scaffolding or waiting for plant shutdown.

➠ Figure 3 shows the proper insertion angle. THIS ORIENTATION IS IMPORTANT FOR PROPER OPERATION.

➠ Check operating conditions. The temperature and pressure limits of the unit should be checked to ensure compatibility with your installation point, see Section 1.5.

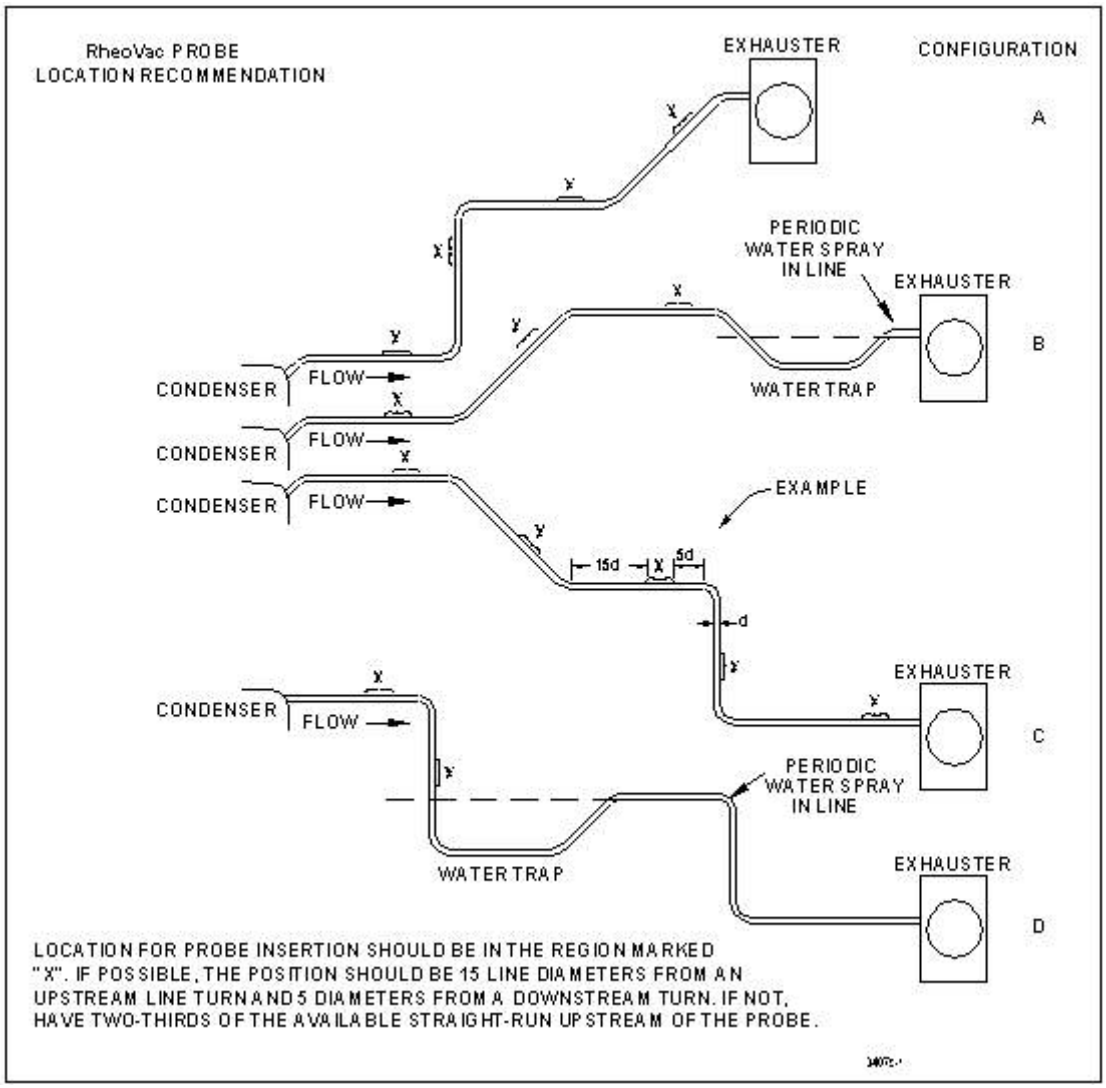


Figure 2 *RheoVac* Probe Insertion Recommendation

2.2.2 CPU/Distribution Box Site Selections

- Select the CPU installation site. The CPU should be located in a cool, dry area. The electronics are not protected against condensed liquid water inside the enclosure. The location should permit easy viewing and access to the touch screen display. Maximum temperature in the area should not exceed 100°F.

- Check for input voltage access. The electronics unit should be located in an area with access to a 115 Vac single phase, 50-60 Hz input power source.

- Consider the distances to all of the distribution boxes (located near the probes). Distances of 250 feet or more away from CPU may require a remote power supply (depends on number of probes).

- Distribution boxes are used to split off the RS485 signal to the probes. Distances from the distribution boxes to the probe, or probes, should be kept to 15 feet or less, if possible. Cable runs between distribution boxes can be hundreds of feet, although a remote power supply might be needed.

These instructions cover installation of the *RheoVac* probes and *SENTRY* CPU in its standard configuration. Additional information pertaining to your unit is covered in SECTION 6 — CUSTOM INFORMATION. Carefully read these instructions prior to installing the equipment.

2.3 HOT TAP INSTALLATION

① Check installation configuration. Make sure the probe is parallel to the floor (see Figure 4).

② Check installation clearance. Verify there is a minimum probe insertion clearance of 4 feet from the pipe surface.

③ Install the mounting hardware. Drill a 1½" through hole and weld the thread-o-let onto the condenser vacuum pipe (See Figure 4). Thread the hot-tap assembly into the thread-o-let. Use thread tape or pipe dope to seal the connection.

④ It should be convenient to apply a restrictive or pulling force of between 9 and 11 lbs to remove or replace the probes under plant operating conditions.

2.4 PROBE INSTALLATION

① Check proper installation direction. The probe has a directional arrow on the tag and/or etched into a metal part. Before installing the unit, note proper flow direction. This is important to instrument operation.

② Check serial number of the probe. Choose a location for each probe (always reinstall probe to same location). Custom labeling of the *SENTRY* screen with probe serial numbers or other I.D. is possible - see Section 3.3.

③ Verify stop clamp location (see Figure 3). A stop clamp is attached to each probe as an indication of its insertion depth. It is important this stay in place in order for the probe to be installed correctly and to ensure the end of the probe does not contact the opposing pipe wall. The clamp's location is determined based on the diameter of each pipe, as shown in SECTION 6.2, and is marked with a groove on the probe's shaft. Refer to this mark if the stop clamp is inadvertently moved.

④ Inspect the probe tips. Be sure wetted surfaces are clean before installing. If cleaning is needed, use a damp cloth wetted with alcohol and wipe dry using a soft, lint-free cloth. Do not immerse probe in liquid alcohol or any other liquids.

⑤ Install the probes. Each probe should be mounted through the pipe wall using a hot-tap assembly. The probe installs so that the two probe tips (visible in the probe head) are side-by-side across the gas stream. The probe has a flow directional arrow on the tag. When installing under vacuum, do not allow the clamp to "slam" against the seal nut upon opening the valve. Grasp the probe shaft firmly before opening the ball valve. Allow the probe to slide through the valve by controlling the amount of grip on its shaft. Special installation instructions, if any, will be noted in SECTION 6.

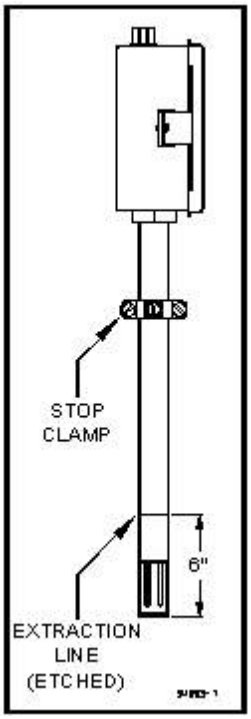
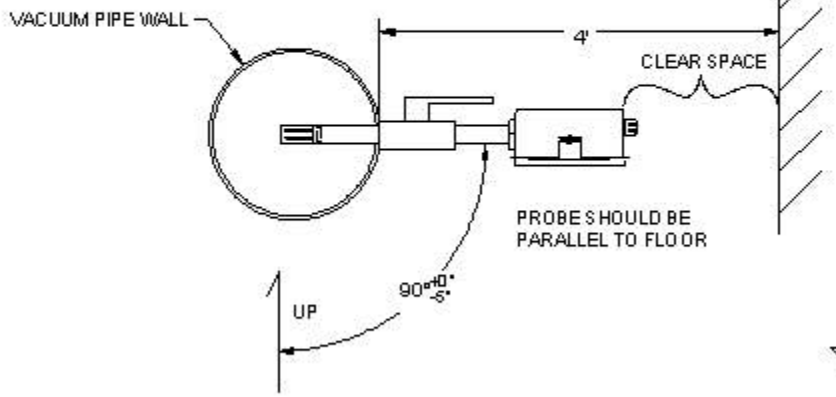


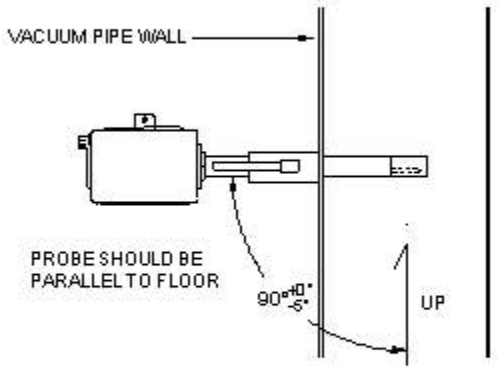
Figure 3 Transducer Stop Clamp

REVISIONS			
REV	DESCRIPTION	DATE	APVD
A	EDITING CHANGES	11/18/97	MH
B	Changed installation angle	11/15/99	BC
C	Edited Hot Tap Installation	12/04/00	BC

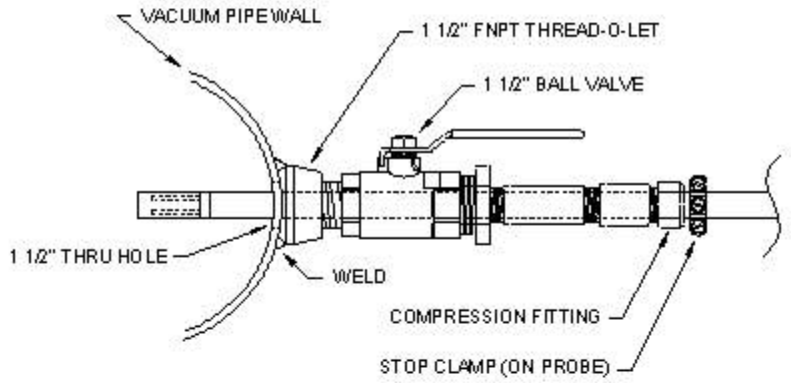
REQUIRED INSTALLATION ANGLE
FOR HORIZONTAL PIPE RUN



REQUIRED INSTALLATION ANGLE
FOR VERTICAL PIPE RUN



RHEOVAC HOT TAP INSTALLATION



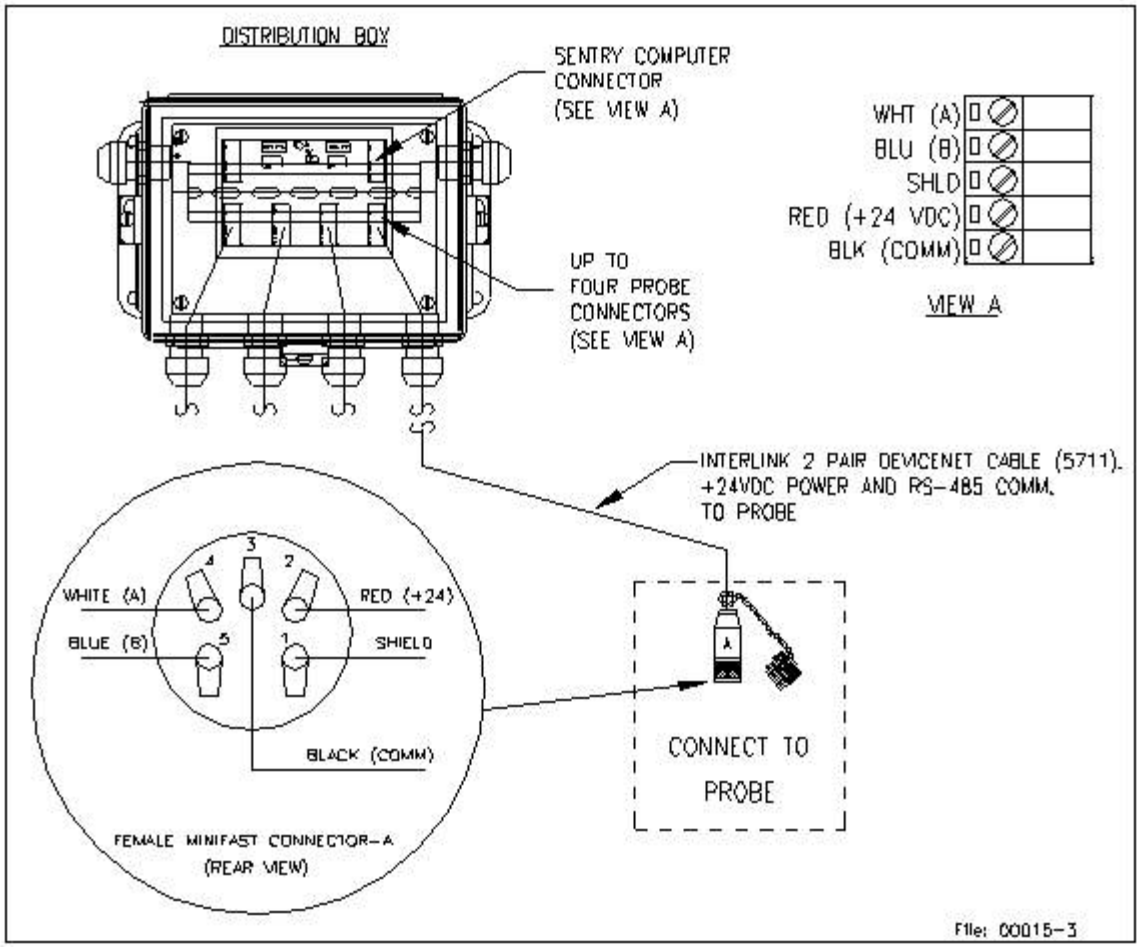
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES FRACTIONS = ± N/A DECIMALS = ± N/A ANGLES = ± N/A	DATE 10/03/95 DRAWN JVR CHKD APVD PROGRAM	Intek, Inc. 751 Intek Way Westerville, Ohio 43082	
		RheoVac© PROBE INSTALLATION DETAIL	
		SIZE A	CAGE CODE 59936
		DRWG NO. 94078-3	
FILE 94078-3	COMTR	SCALE NTS	SHEET 1 OF 1

Probe Installation Detail

2.5 ELECTRICAL CONNECTIONS **(Make all hardware & plug-in connections with power *off*)**

A. Distribution Box
   1. Contents
      a. Connection point for the RS485 wires (Blue and White), +24vdc power (Red), ground (Black), and shield.
      b. Connection point for the input from and output to other distribution enclosures.
      c. Connection points for up to four devices (probes or transmitters).
      d. Power "*on*" LED.
   2. Connections
      a. Mount the probe distribution enclosure(s) centrally among the devices for which it is supplying power and communications.
      b. Install ¾" liquid-tight flexible conduit between the distribution enclosure and the probes unless ¾ rigid conduit is used for long distance runs.
      c. The probe connector has an adapter, which allows the attachment of the ¾" flexible conduit connector.
      d. Connect the probes to the distribution enclosure using the manufacturer supplied four conductor shielded cable. Probe cable connections are shown in Figure 5.
      e. A termination resistor is required in the last distribution box (farthest point out from CPU). This resistor is accessed via a jumper at JP7 in the last distribution box. The jumper should be set on "EN" on JP7 to enable that resistor.

!!**IMPORTANT** !! Inspect and **VERIFY** these connections carefully. Improper connection could damage the RS485 IC in the probe assembly as well as the other probes.



B. Electronics Unit (CPU) (See Figure 6)

1. Sensor Power and Communication Line: Connect the RS485 Communications/Power cable, which connects the first distribution enclosure to the CPU.
2. Main Power: Connect main power terminals to a dedicated 120Vac, single phase, 15 amp circuit. An external disconnect switch should be used for disconnecting power to the system. (There is an internal circuit breaker located behind the display panel, but it is not easily turned off in the event of a problem.) The Uninterruptible Power Supply (UPS) in the CPU housing will continue to supply 120Vac power to the computer until the battery runs out of power or its main switch is turned off. The CPU will "beep" if main power is off. However, the UPS does not supply power to the probes, so disconnecting system power will turn off all probes.
3. Modem: (If supplied) A telephone modem connection is provided at the rear of the UPS, which has a transient protected RJ11 jack. DO NOT CONNECT DIRECTLY INTO THE MODEM.
4. LAN Connection: A LAN may be connected to the rear of the touch screen display. This connection is via an RJ45 plug using CAT 5 straight Ethernet high noise immune cable installed from the customer's LAN system to the *SENTRY* CPU.

C Initial Power Up

1. Verify power connections to prevent damage to the electronics in the probes.
   a. Prior to powering up the system for the first time, remove the connector from each probe.
   b. Leave the UPS power off. Apply power only to the 24Vdc power supply inside of the CPU (See Figure 6).
   c. Verify voltage at each disconnected probe for PIN 2 (red) = (+24) and PIN 3 (black) = (Comm). If proper voltage is not at the connector, recheck wiring back through distribution box to the CPU.
   d. Turn off all power.
   e. Install each connector at the probe head, then at each distribution box.
2. Power Up
   a. Turn on the probe 24 Vdc power supply.
   b. Check each probe, one at a time, to see if they are working (power LED "*on*")
   c. Turn on the UPS.
   d. The *SENTRY* computer will then power up, going directly into the *SENTRY* Program.

The *SENTRY* program will check for all the probes that are connected to it and list any that are missing (not being seen by *SENTRY* CPU). If any are missing, there is probably a wiring problem. Turn off the probe power supply and check the missing probe's wiring connections.

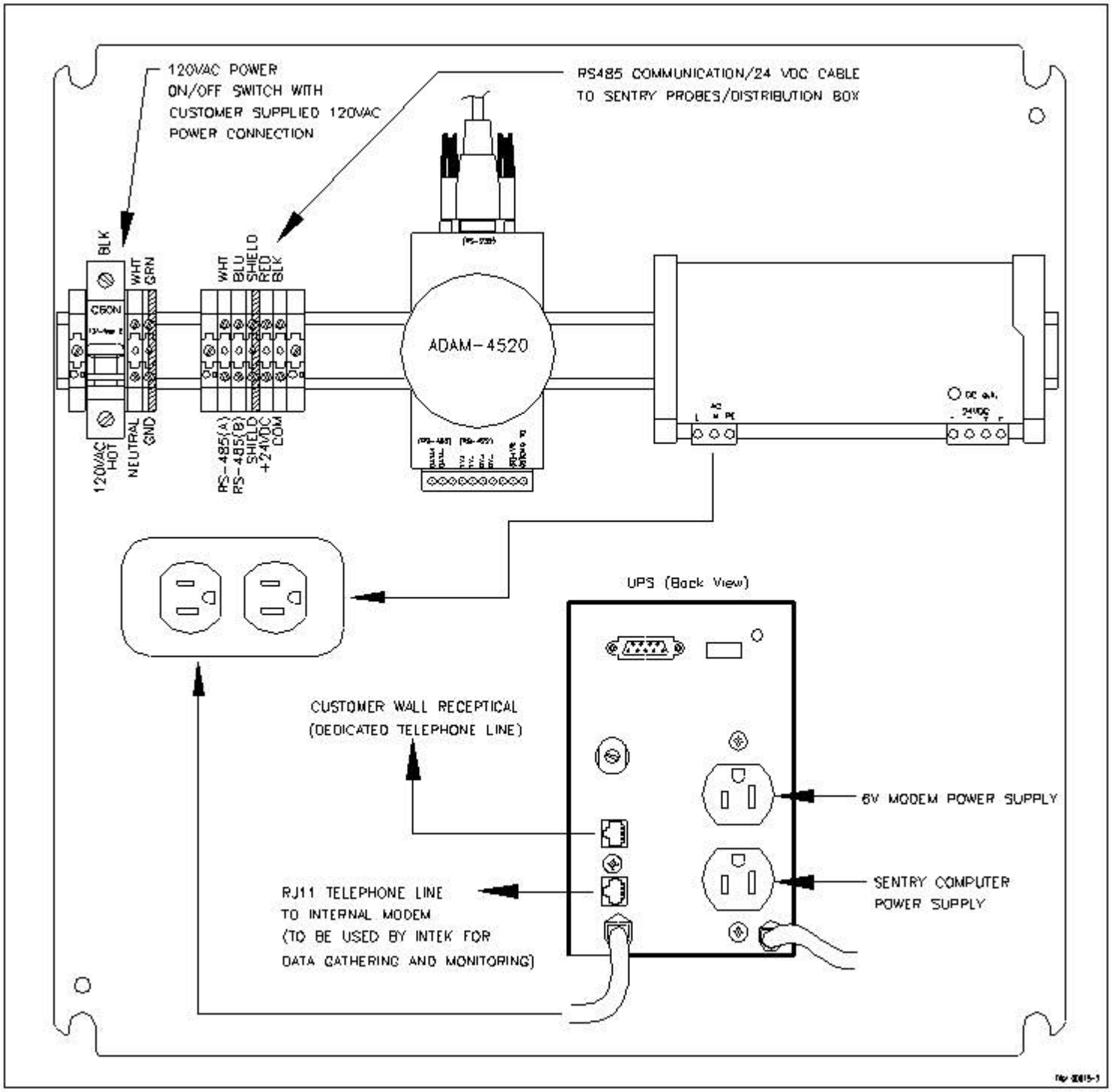


Figure 6 CPU Wiring - Part 1

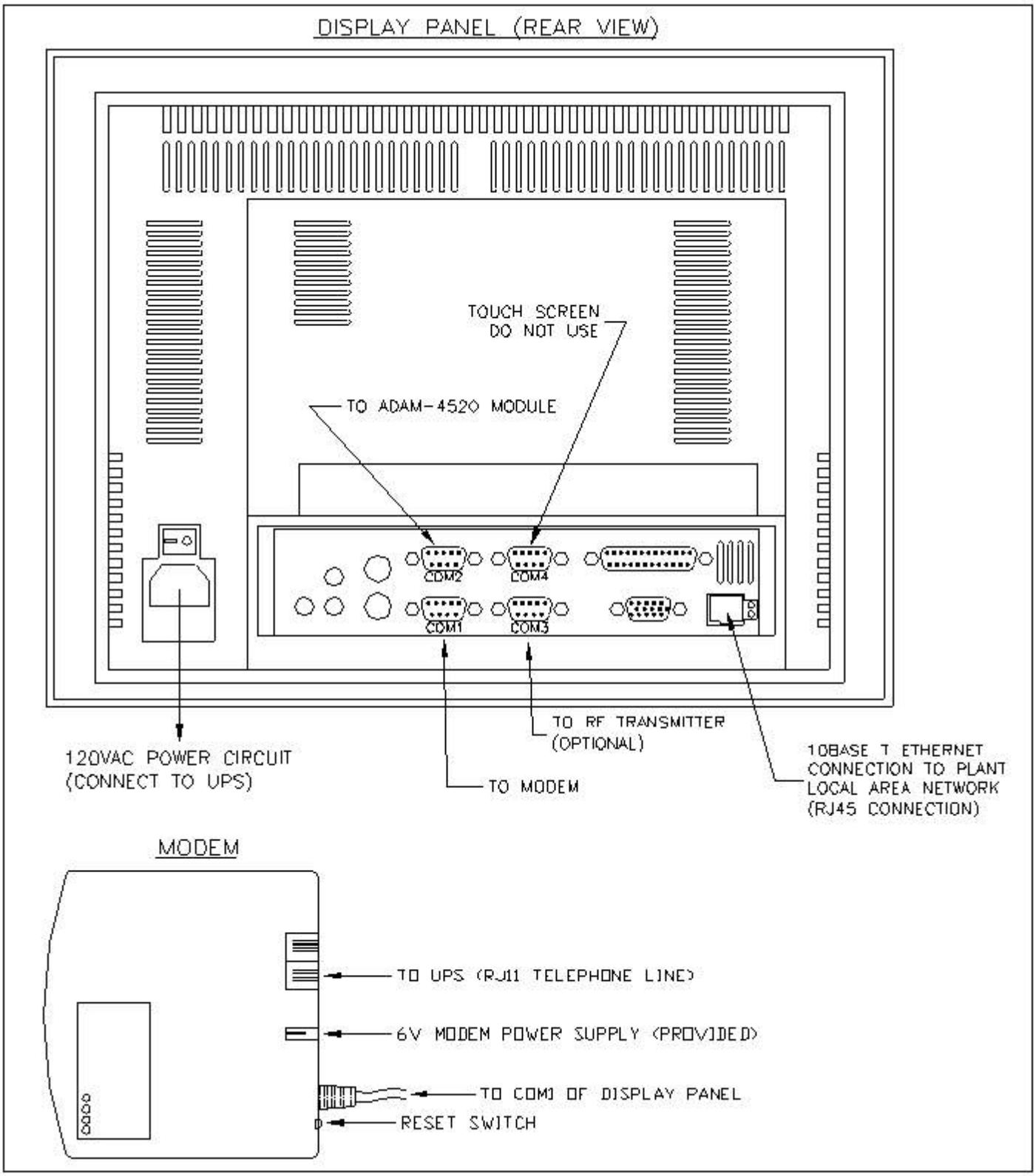


Figure 7 CPU Wiring - Part 2

SECTION 3 — OPERATION

3.1 GENERAL INFORMATION

The *RheoVac* probe outputs are compensated and linearized for a wide range of flowing media temperatures, pressures, and water vapor contents. However, abrupt changes in these parameters can cause the instrument to temporarily read the flow rate improperly, which could lead to transient spikes in the flow indication. In particular, if liquid (water) hits the probe tips, there will be high flow indications until all the water vaporizes. This is a rare occurrence that should not happen if the probe is properly installed per instructions in SECTION 2 — INSTALLATION.

3.2 OUTPUT PARAMETERS

The *RheoVac SENTRY* System measures and calculates ten output parameters. These are accessible on the touch screen display, through ethernet, or modem connection. These output parameters are:

Table I - Output Parameters

PROCESS VARIABLE	PROCESS VARIABLE DEFINITION
ACTUAL VOLUME FLOW [ACFM]	The actual volumetric flow rate of gases leaving the condenser. It is a measure of pump capacity. Decreased capacity means pump degradation.
TOTAL MASS FLOW [lbs/hr]	The total mass flow rate of the flowing gas. Note: this value is not a measure of air in-leak. It is a measure of steam jet air ejector capacity.
WATER VAPOR MASS FLOW [lbs/hr]	The water vapor component of the flowing gas being removed from the condenser.
RheoVac PRESSURE [" Hg]	Absolute pressure at the *RheoVac* probe head. Should be equal to or less than turbine back pressure.
WATER VAPOR SPECIFIC VOLUME [cu. ft/lb]	The inverse density of the water vapor present in the line.
WATER to AIR MASS RATIO	Ratio of water vapor flow rate to dry air flow rate. Defines "vacuum quality."
RELATIVE SATURATION [%]	The percent concentration of water vapor in the extraction line relative to saturation.
PARTIAL PRESSURE, WATER ["Hg]	The partial pressure of water vapor in the vacuum line.
AIR IN-LEAK [SCFM]	Actual measure of air volume flow rate passing the *RheoVac* sensor head, normalized to standard conditions (70°F, 29.9" HgA).
RheoVac TEMPERATURE [°F]	Temperature of the flow media at the *RheoVac* probe head.

3.3 *RheoVac SENTRY* PROBES

In the *RheoVac SENTRY* System, multiple probes are installed in strategic locations of the condenser system. Sometimes the locations will be labeled on the screen by Intek during manufacture or by the customer after installation. As the *SENTRY* CPU only recognizes the probe's identity (via its unique serial number), and does not recognize physical locations, it is important that the assigned location for

a given probe remain unchanged. To custom label the *SENTRY* screen with actual probe locations, you will need to plug a PS-2 style computer keyboard into the back of the *SENTRY* touchscreen. After plugging in the keyboard, reboot the *SENTRY* (cycle power off, then on). Press the button labeled 'Recal/Repair' on the *RheoVac SENTRY* front panel. When the Recal/Repair options panel appears, press the button labeled 'Probe Labels.' The Probe Location/Information panel will appear. A space is provided for an eight-character description to be added to each probe label (this eight-character limit is set due to space constraints on the *SENTRY* front panel). After you have input your custom labels, press the Save button. Changes will take effect when you exit back to the front panel.

Complete evaluation of a typical condenser and exhauster system is accomplished using a multiple probe *RheoVac SENTRY* configuration. A multi-probe installation provides centralized data collection for all flow paths in the air extraction system, which will aid in locating leaks and identifying exhauster malfunction. Each *SENTRY* CPU is capable of supporting up to twelve *RheoVac* probes. Therefore, it is possible that the configuration chosen for your plant may have the *SENTRY* CPU monitoring probes installed on more than one generating unit. Accordingly, it is imperative that the serial number of the probes and their installed locations, as shown on the original factory configuration, be clearly retained and readily accessible.

3.4 CPU TOUCH SCREEN

The *RheoVac SENTRY* System CPU touch screen provides operator access, interface and control of the components of the system. This section discusses the data and diagnostic information available to engineers and operators via this touch screen.

Main Screen — System Diagram

The CPU main screen will show a general layout of your *SENTRY* System. The drawing here is a generic example. Touching a probe "button" or icon brings up the display screen associated with that probe. The light at the lower left of the screen indicates communication status — when data is transmitting, the light flashes red; when no data is being transmitted, the light is a steady green. At the bottom of the screen are the "buttons" that provide access to the next level of data detail. These buttons access the **Plot, Diagnostic Tool, Disk Info, Recal/Repair,** and **Errors** functions. The **Recal/Repair** function is not used in the field except as described above.

The **STOP** button should only be used to stop program execution and all communications with the probes. This is necessary only for factory personnel to perform software updates and system service.

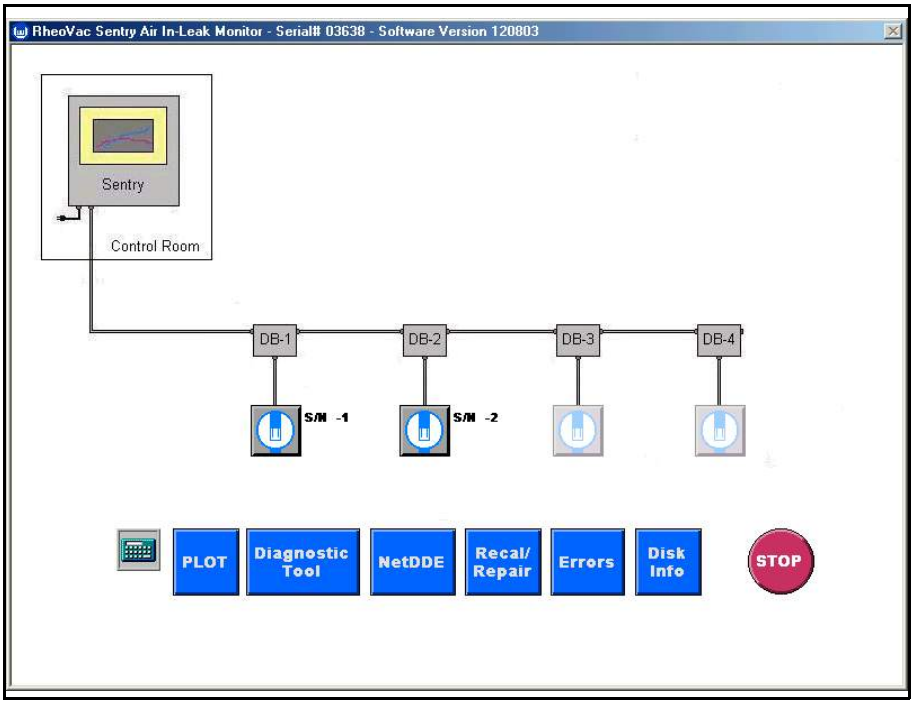


Figure 8 - System Diagram

Probe Data

To view the data monitored by the *RheoVac SENTRY* probes, select the appropriate probe icon on the main touch screen display. This brings up the following data screen:

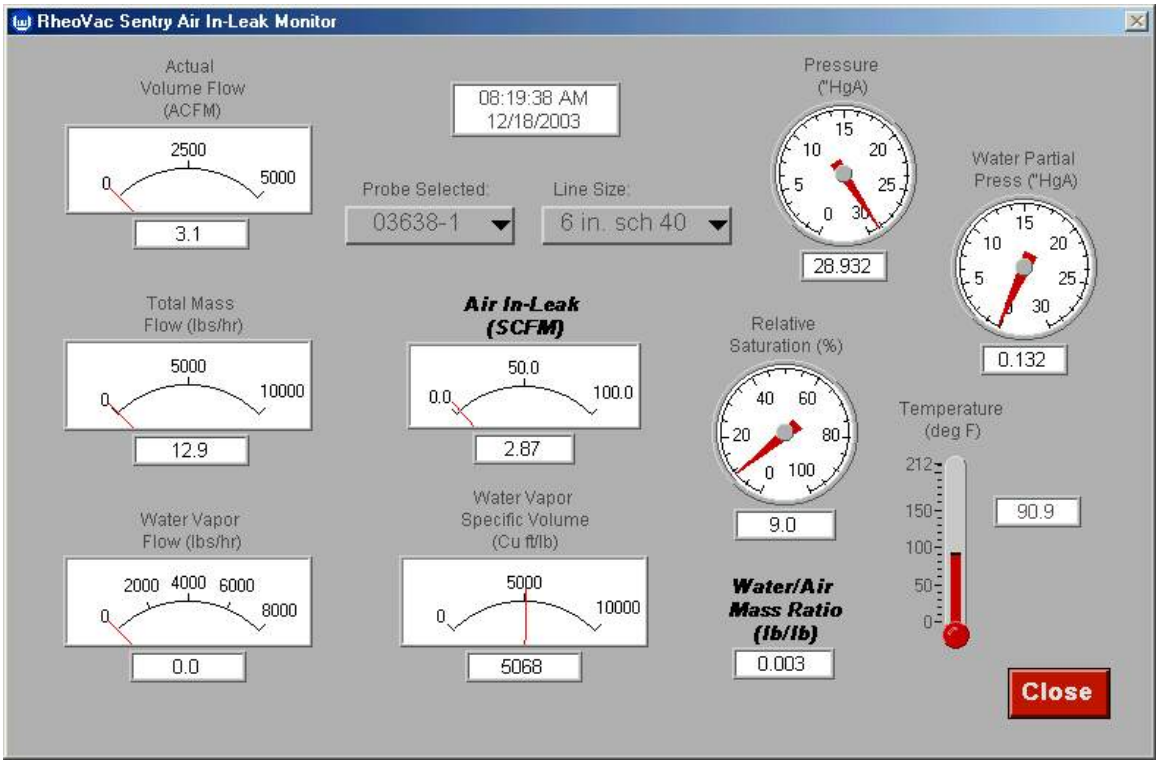


Figure 9 - Ten Parameter Probe Display in Meter/Gauge Format

The data from all ten parameters monitored by the probe is updated continuously. From this screen, one can check the same parameters from each probe by selecting another probe serial number in the "Probe Selected" field. This screen is also used to change the pipe size setting for each probe. Always make sure the pipe size setting is correct for any probe being monitored.

Plot

The 'Plot' button brings up the strip chart display of all data monitored by the probes. The information is arranged so that the user selects a variable, such as 'Air In-Leak,' or 'Temperature' (see bottom left for parameter selection), and the data for that parameter from all the probes in the system will be displayed. The data is shown as a graph in the top half of the screen, and in measured values in the bottom half of the screen. The data is color keyed for each probe.

For the graph display, the y-axis minimum and maximum values are controlled by the buttons on the left side of the chart. Pressing the 'Y-max' or 'Y-min' button will bring up a keypad, which is used to enter the desired value. If 'auto' is pressed, the display will select Y-axis values based on the data values being graphed. The x-axis range can be similarly controlled by the dials below the plot or by the pre-defined increment buttons situated between these two dials. The slide bar below the chart is used to control what point on the chart is displayed in the boxes at the bottom part of the screen. If the slide bar is set in the far right position, as is shown, the most recent data will be displayed.

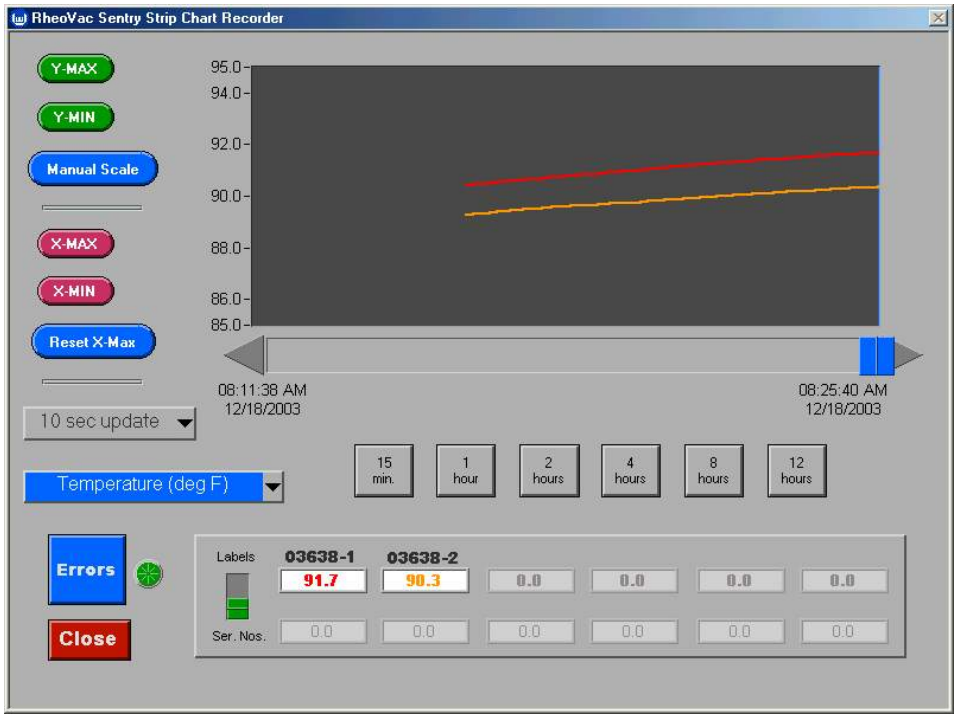


Figure 10 - Plot or Strip Chart Screen

Diagnostic Tool

The 'Diagnostic Tool' button leads to the display screen shown in Figure 11.

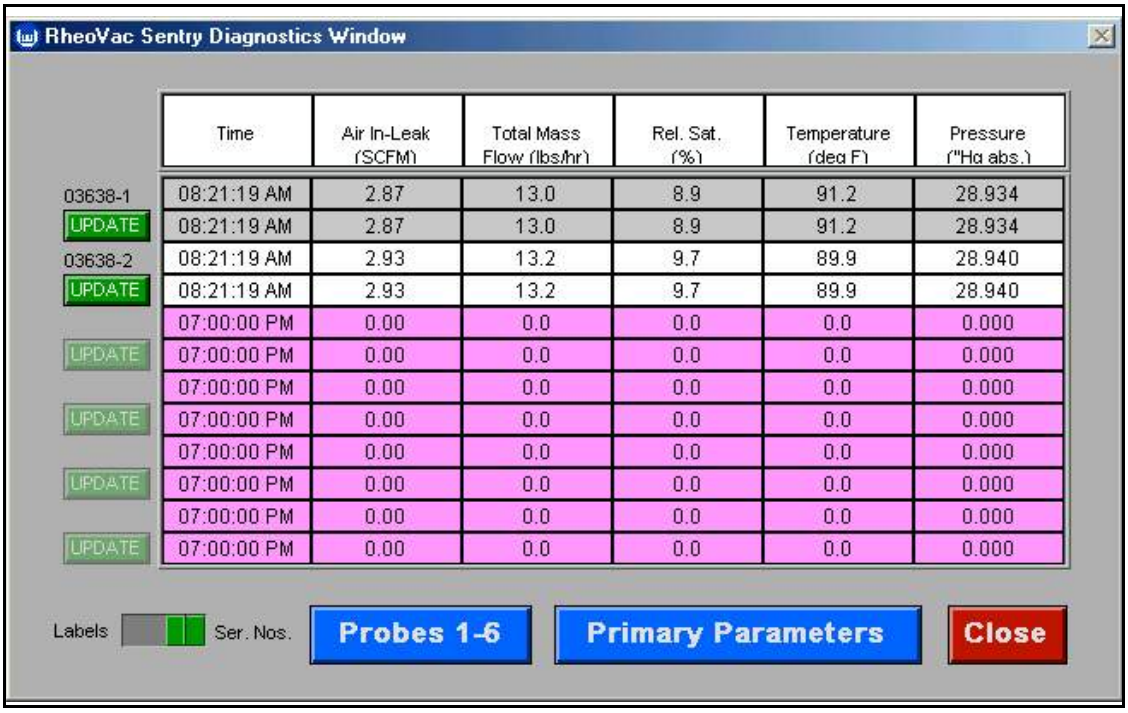


Figure 11 - Diagnostic Screen

While this illustrative display only shows the data for two probes, the actual screen will show the data from all probes in the *SENTRY* System. The data for each probe is displayed on two lines – the top line,

with the probe serial number, is always the current set of measured data for that probe. The bottom line of the data pair, whose button shows UPDATE or HOLD at the left side, can be user selected and placed on 'HOLD' to capture the measurements of a given moment (or set of system conditions.) This is a most unique capability of the *RheoVac SENTRY* System, allowing the engineer/operator to capture a "before" set of measured parameters and then evaluate the monitored parameters "after" a known set of operating conditions have changed. For example, when one of two exhausters is taken down for maintenance; capture data by placing the second data line on HOLD before the exhauster removal. The live data after removing the exhauster (the top line) can be compared to the held data to quantify the change.

Disk Info

Selection of the 'Disk Info' button on the main screen brings up the screen shown in Figure 12. This screen shows how much space is used by the data stored in the CPU, and the amount of free space available for storing additional data on the system's hard drive.

Generally, it will not be necessary to remove stored system data to archive files in order to make room on the hard drive. Viewing this information aids the plant in determining a suitable archive schedule.

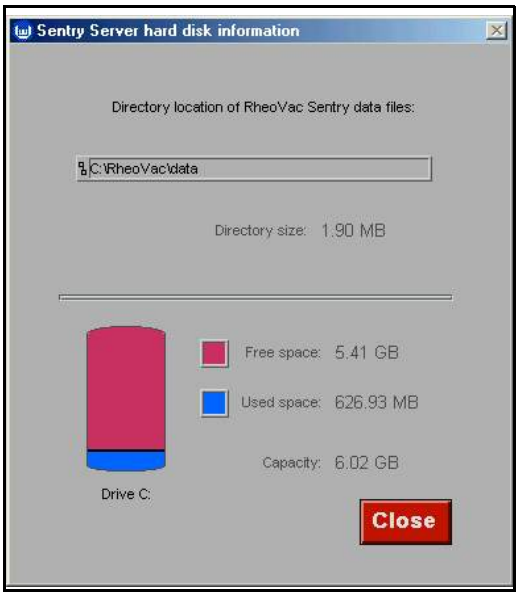


Figure 12 - Data Storage availability

Recal/Repair

This selection on the main *RheoVac SENTRY* screen is mostly used by Intek factory service representatives.

Errors

The 'Errors' button on the main screen will flash if there are current, unresolved errors detected by the system. Pressing this button brings up two error screens so that the nature of the error can be seen:

The detected error is identified by a red light in the display panel shown in Figure 13. The light will indicate the nature of the error and the probe which is affected. The table of error messages, shown in Figure 14, provides a historical log of all error messages detected, with the latest error shown at the bottom of the list. This log provides the operator a clear description of the error noted and the date and time of the error for resolution. See Section on Trouble Shooting Guide.

Figure 13

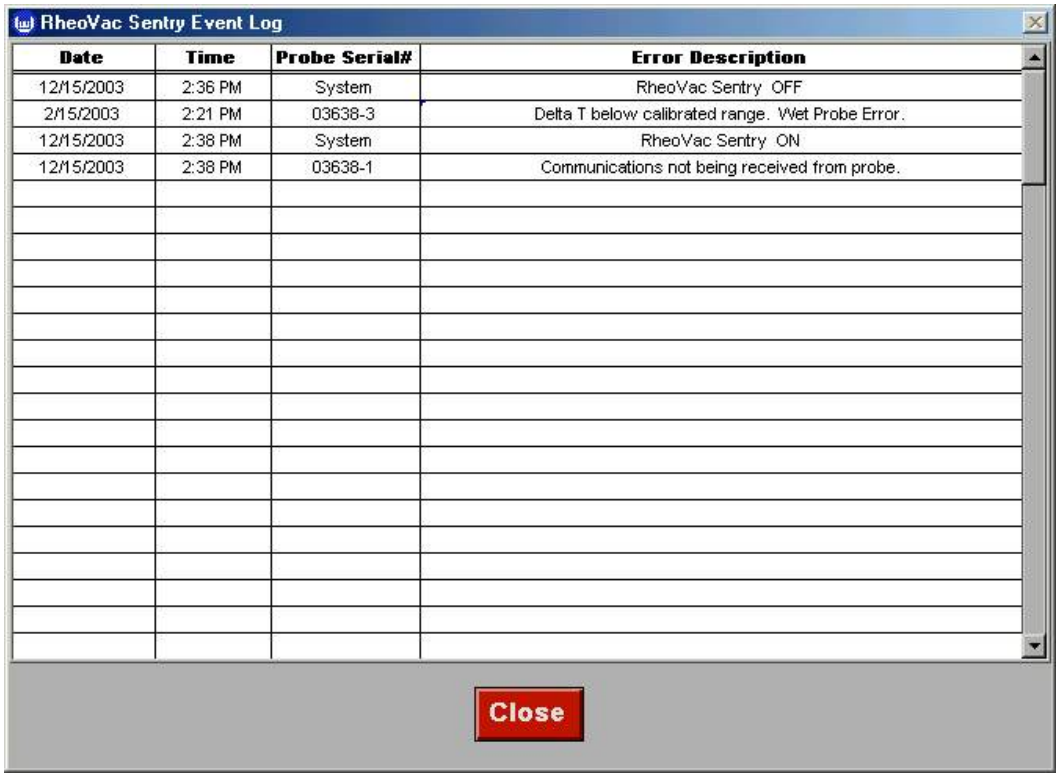


Figure 14

3.5 ETHERNET or MODEM OUTPUT

The *RheoVac SENTRY* data and stored files are accessed via an Ethernet (10Base-T) connection. The connection is made through an RJ45 port, shown in Figure 7. The line is brought into the *SENTRY* box through conduit hubs in the bottom of the enclosure.

Historical data files for each probe in the *RheoVac SENTRY* System are stored on the hard drive of the *SENTRY* CPU. A directory for each probe serial number is created in the directory named:

C:\RheoVac\data

Each file contains 24 hours of data and is named for the date on which the data was gathered. For example, data gathered on September 14, 2000 by a probe with the serial number 99261-5 would be located by using the file path:

C:\RheoVac\data\99261-5\091400.dat.

Note that the filename will always be six characters plus the file extension. Two digits each are used for the month, day, and year. If you are accessing the data files from a remote location via Ethernet or modem connection, the above file path would be modified to the following:

\\computer_name\c\RheoVac\data\99261-5\091400.dat

where "computer_name" is the Network Identification of the *SENTRY* CPU on your network. Each data file is arranged in tab-delimited spreadsheet format, which can be viewed using any common spreadsheet software application.

RheoVac SENTRY data is made available to all computers on the same network as the *SENTRY* CPU via Network Dynamic Data Exchange (NetDDE). Any program running on the network that can act as a NetDDE client, such as Microsoft Excel, can access *RheoVac SENTRY* data. By using this method, *SENTRY* data can be accessed directly using the Plant Information Network.

Data available under NetDDE includes Probe Serial Number, Time Stamp, Air In-leak, Total Mass Flow, Water Vapor Flow, Pressure, Water Partial Pressure, Actual Volume Flow, Relative Saturation, Water Vapor Specific Volume, Water/Air Mass Ratio, and Temperature.

This data is arranged in a table as shown in Figure 15 so that the NetDDE client can request information from each cell of the table using the provided NetDDE Service Name, Topic Name, and the corresponding row and column as the NetDDE Item Name.

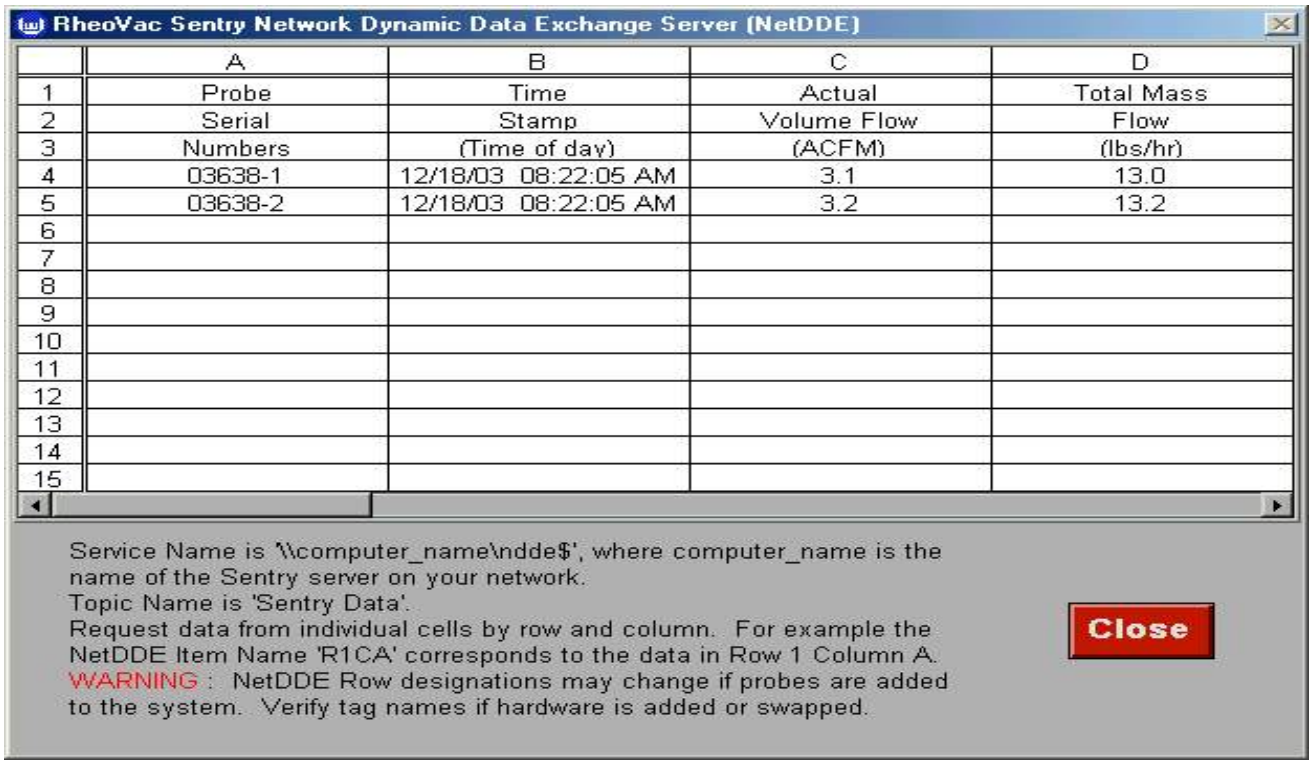


Figure 15 - NetDDE Available Data

3.6 SEARCHING FOR LEAKS WITH MULTI-PROBE SYSTEM

The next figure shows typical recommended installation locations for probes in a condenser system where five probes are desirable and for hands free remote condenser system diagnostics. The location for each of the five probes is identified by a number which is used in the subsequent discussions with respect to identifying performance information.

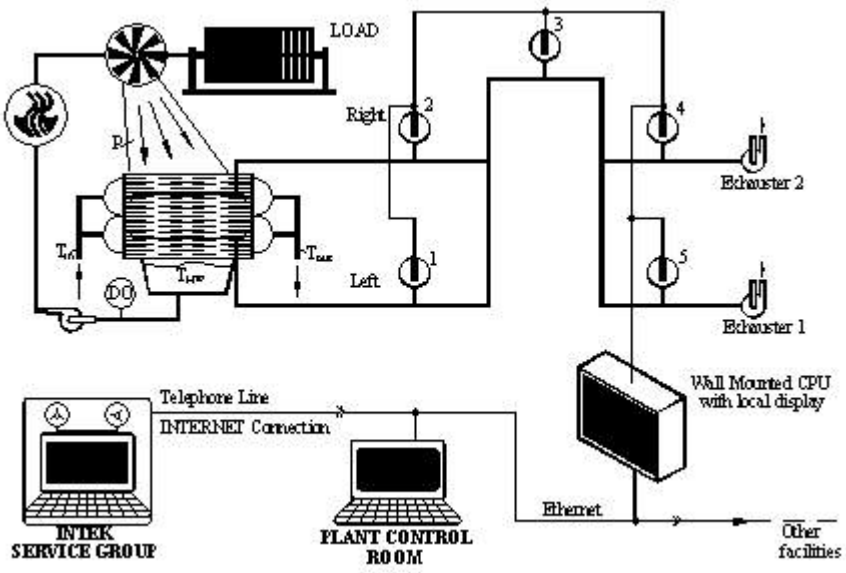


Figure 16 - A *RheoVac SENTRY* System Configuration

As examples of the performance data provided by the *RheoVac* probe, note that it measures the flow rate into the vacuum pump (or air ejector) and distinguishes between air flow and water vapor flow, making it possible to quantify the performance of the condenser's exhausting equipment. A measurement at the pump (or air ejector) discharge cannot provide this information.

Additionally, the *RheoVac* system provides recordable, real-time air in-leak measurements and will respond to changes of air in-leak flow within 1 minute. Therefore, it can be used to quantify each source of air in-leakage as repairs are made.

Examination of the measured air in-leak data from the installed probes will provide information on the likely location(s) of the leaks which give rise to the measured air in-leak values. The following chart shows indications that can be expected for the locations of different leaks. This table is prepared based on a five-probe installation, as shown in the figure above.

Leak Location	Probe Indications of Air In-Leak (SCFM) and Plant DO
Below water line, left side of condenser	Much higher than normal DO, 1 > 2, 1 + 2 = 3 = 4 + 5, 4 = 5 This implies pumps are working identically.
Above water line, right side of condenser	Slightly higher or normal DO, 2 > 1, 1 + 2 = 3 = 4 + 5, 4 = 5 (Identically working pumps)

Leak Location	Probe Indications of Air In-Leak (SCFM) and Plant DO
Small leak or faulty exhauster down stream of probe 4	Slightly higher or normal DO 1 = 2, 1 + 2 = 3 = 4 + 5, 4 < 5
Large leak or failed exhauster down stream of probe 4	Slightly higher or normal DO 1 = 2, 1 + 2 = 3 = 4 + 5, 5 < 4 (Back flow at 4)
Center joint seal, LP bearing seal, or other central location	Slightly higher or normal DO 1 = 2, 1 + 2 = 3 = 4 + 5

Some examples of observed *RheoVac* monitor measured data and corresponding identification of leak presence and leak location determinations are:

Leak Location	Probe Indications of Air In-Leak (SCFM)
Normal tight system	1 = 2.5 SCFM 2 = 2.5 SCFM 3 = 5 SCFM 4 = 0 SCFM (exhauster 2 not in service) 5 = 5 SCFM
Abnormal, need to locate and fix leaks (central joint seal)	1 = 15 SCFM 2 = 18 SCFM 3 = 33 SCFM 4 = 16.5 SCFM 5 = 16.5 SCFM
Abnormal, need to locate leaks and fix Nash pump shaft seal in exhauster 2	1 = 20 SCFM 2 = 20 SCFM 3 = 40 SCFM 4 = 20 SCFM (air back flow through exhauster past probe 4) 5 = 60 SCFM
Abnormal, Nash pump shaft seal leaks in exhauster 2, but not totally failed	1 = 7.5 SCFM 2 = 7.5 SCFM 3 = 5 SCFM 4 = 1 SCFM 5 =4 SCFM

SECTION 4 — MAINTENANCE

4.1 GENERAL MAINTENANCE

Precautions should be taken to insure proper performance of all sensors. Since the quantification technique involves signal measurements, care should be exercised to prevent build-up of dirt on the probe, or corrosion on terminal strip connections in the electronics box. Periodic checks with necessary cleaning should be performed to insure clean terminals. The probes should be regularly inspected for corrosion or presence of moisture or dirt; the probe tips (where the sensing components are housed) should be carefully cleaned (see Section 2.4 PROBE INSTALLATION).

4.2 CALIBRATION

The *RheoVac SENTRY* System is calibrated at the factory in a calibration system which replicates the condenser and vacuum line environment. The system is designed to calibrate the temperature, pressure, water vapor relative saturation and mass flow under the gaseous fluid conditions found within the power plant vacuum line.

In general, calibrations should be valid over a two to five year period. Should the unit require re-ranging or recalibration, note the serial number of the *RheoVac* instrument and contact the factory concerning recalibration cost and turn around times. Refer to SECTION 5 — CUSTOMER SERVICE of this manual for additional information.

4.3 SPARE PARTS

There are no normally recommended spare components to stock. However, it is desirable and usually cost effective to order and stock a spare sensor probe. Should a probe become damaged or require factory service, the spare probe can be readily installed in its place. (This will require installing a new data file into the CPU.)

Spare fuses should be available for replacement of blown fuses. Appropriate fuse to stock is:

> Slow blow 500mA Wickmann fuse, part number 3720500041 or equivalent, for the *SENTRY* probe electronics.

4.4 TROUBLE SHOOTING

The *RheoVac SENTRY* error screen displays diagnostic messages to aid operators in identifying potential causes of instrument problems and malfunctions. The following table provides a list of the fault modes identified by the instrument and the corresponding appropriate remedial actions. The last two items in the table do not show up in the error log, but are obvious symptoms that might be encountered.

Table III - Trouble Shooting Guide

Error Log Description/Symptom	Probable Cause	Action
Communications not being received from probe(s)	1. Improper cable hookup 2. Blown main fuse 3. Failed RS-485 circuit 4. Damaged flow sensor	1. Verify cable hookup is correct 2. Check cable connections 3. Contact factory
Invalid checksum received from probe(s)	1. Failed RS-485 communications component	1. Contact factory
Invalid checksum received from probe(s)	1. Failed RS-485 communications component	1. Contact factory
Relative saturation sensor power 'OFF"	1. Failed sensor or other electronic component	1. Contact factory
Relative saturation sensor heater 'OFF"	1. Failed electronic component	1. Contact factory
Flow sensor heater 'OFF''	1. Blown heater fuse (F3) 2. Failed electronic component	1. Replace heater fuse 2. Contact factory
Pressure sensor heater 'OFF''	1. Blown heater fuse (F2) 2. Failed electronic component	1. Replace heater fuse, contact factory 2. Contact factory
Temperature above specified maximum limit	1. Temperature above 210˚F 2. Possible sensor damage	1. Remove sensor from flow stream and contact factory 2. Contact factory
Wet probe	1. This usually indicates a condenser design or operation problem that requires corrective action.	1. Contact factory
RS sensor problem	1. RS sensor or circuit has failed.	1. Contact factory
*Mass flow output saturates **high**, will not respond to flow changes*	1. Flow rate is not within range of calibration 2. Blown heater fuse 3. Failed electronic component	1. Contact factory about re-ranging instrument 2. Replace fuse 3. Contact factory
*Mass flow output saturates **low**, will not respond to flow changes*	1. Flow rate is not within range of calibration 2. Failed electronic component	1. Contact factory about re-ranging instrument 2. Contact factory

If the *RheoVac SENTRY* is operating without error indications but output readings from one or more probes are questionable, please send to Intek by telefax or e-mail the following plant data: turbine back pressure, hot well temperature, load, and inlet and outlet circulation water temperatures, along with a minimum of 4 hours of concurrent data from all *RheoVac* probes on that generating unit. You may also contact the factory to transmit *RheoVac SENTRY* probe data via modem to the factory for analysis and problem resolution.

SECTION 5 — CUSTOMER SERVICE

Intek's corporate philosophy is to help solve our customer's difficult flow measurement problems. When you purchase a *RheoVac* instrument you also receive Intek's outstanding customer service. For sales or product service, call your local representative or Intek directly at (614) 895-0301, 8AM to 5PM EST/EDT weekdays, or fax us anytime at (614) 895-0319. E-mail inquiries should be sent to techsupport@intekflow.com. Our customer service staff will provide assistance promptly.

5.1 QUESTION ON EXISTING HARDWARE

To allow us to help you more quickly, please have the serial number of the equipment available before you call.

5.2 TROUBLE SHOOTING

If you have reviewed SECTION 4.4 TROUBLE SHOOTING and have questions, please call our experienced engineers for assistance.

5.3 FACTORY AND FIELD SERVICE

If you request field service, Intek has experienced engineers available to meet your needs. The *RheoVac* instrument is complex and most repairs or re-calibrations will require returning the instrument to the factory. If a problem cannot be solved over the phone, with your help, we will determine if factory service or field service will be the best solution.

To request factory service, a Return Material Authorization (RMA) or purchase order is required. Our customer service staff will assist you with the required information to return instruments for service.

5.4 QUESTIONS ON NEW EQUIPMENT

For a new *RheoVac SENTRY* application or any liquid or gas flow measurement need, contact the Intek technical sales department at the above phone/fax numbers. E-mail inquires should be sent to sales@intekflow.com. Our staff will be pleased to answer all questions and provide quotations.

SECTION 6 — CUSTOM INFORMATION

6.1 UNIT IDENTIFICATION

Model No.: _____

Serial No.: _____

Customer Identification: _____

6.2 CONFIGURATION

The marked (X) items denote the configuration of this unit, as originally shipped from the factory.

☒ *RheoVac SENTRY* CPU with touch screen panel, Serial No.: _____
☒ Microsoft Windows ME software Software: Microsoft Windows _____
☒ Modem Model: _____ Serial No.: _____
☒ _____ *RheoVac SENTRY* probes

probe serial no: _____, assigned location/identification: _____, Pipe size _____
probe serial no: _____, assigned location/identification: _____, Pipe size _____
probe serial no: _____, assigned location/identification: _____, Pipe size _____
probe serial no: _____, assigned location/identification: _____, Pipe size _____
probe serial no: _____, assigned location/identification: _____, Pipe size _____
probe serial no: _____, assigned location/identification: _____, Pipe size _____
probe serial no: _____, assigned location/identification: _____, Pipe size _____
probe serial no: _____, assigned location/identification: _____, Pipe size _____
probe serial no: _____, assigned location/identification: _____, Pipe size _____
probe serial no: _____, assigned location/identification: _____, Pipe size _____
probe serial no: _____, assigned location/identification: _____, Pipe size _____
probe serial no: _____, assigned location/identification: _____, Pipe size _____
probe serial no: _____, assigned location/identification: _____, Pipe size _____

☒ _____ Distribution boxes; I.D. numbers :_____, :_____, _____

Pipe Connection for probes: ☒ Hot tap with 1½" MNPT connection
Input Power: ☒ 115 Vac, 50/60 Hz

Output: ☐ Ethernet 10Base-T

6.3 SPECIAL INSTRUCTIONS