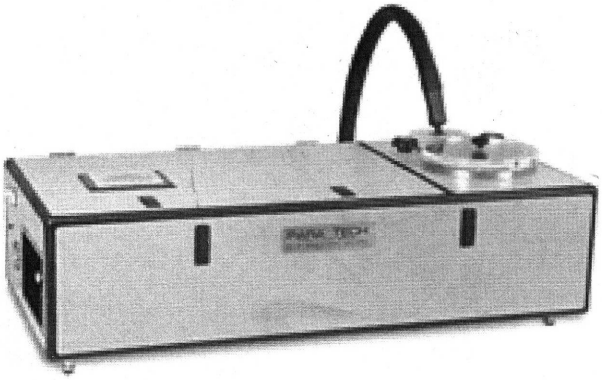
Para Tech Coating Inc.



LabTop 3000 Operator's Manual

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System Configuration

Model: **LabTop 3000** Serial # **3105**

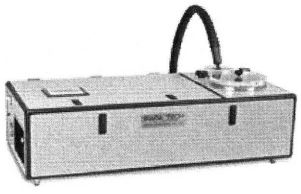
Chamber Size: **8"x9"**

Electrical Requirements: **208 Volt/60Hz/3 Phase/20 Amps**

Vacuum pump: **TrivacE2**

Cold Trap: **Mechanically Refrigerated Chiller**

System fittings: **Electro-Pneumatic**



System Description

The Para Tech Coating, Inc. portable Model 3000 coating system is designed for processing small substrates or modules in both laboratory and production settings. This bench-top coating system is a scaled-down version of the full-size Para Tech production units, with equivalent automated process features and vacuum-coating precision, It is suited for coating application research and development as well as short run production coating of printed circuit boards, medical components, electronic sensors and other small substrates. Tangential entry and exiting of the polymerizing monomer results in an low coating thickness gradient and superior film uniformity. Pressure and temperature values are pre-programmed and automatically controlled, providing operators the ability to achieve precise, repeatable results.

Key Features

- Patented tangential flow coating technology for film uniformity and production efficiency
- Baffle-free chamber design for optimal capacity and deposition efficiency
- Pre-programmed automated process computer with flat panel display

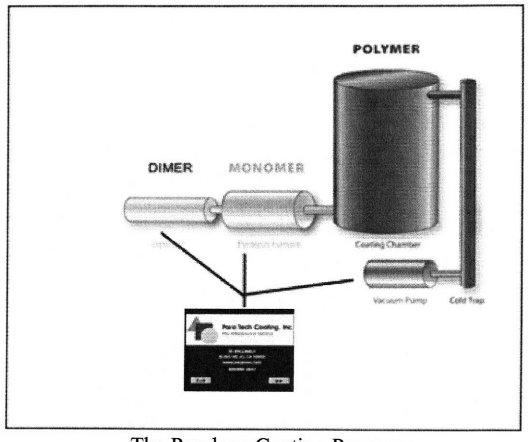
Commented [EL1]: How do you assure even distribution / circulation then?

The Coating Cycle

Para Tech Coating, Inc. uses a proprietary process for controlling temperature and pressure during Parylene coating. Control of the coating cycle is based on time and temperature, and does not depend on chamber pressure fluctuations related to the flow of monomer gas. As a result, thermal excursions and coating bursts are avoided, and cycle times are predictable and controllable.

The coating cycle begins with vaporization of the powdered raw material (dimer) at 130°C, creating a dimeric gas. Gas molecules are subsequently cleaved to the monomer form in a second stage by heating to 650°C. The active monomer gas is then introduced to an evacuated coating chamber where it disperses and polymerizes spontaneously on substrate surfaces at room temperature to form Parylene film.

The LabTop 3000 is fully microprocessor controlled. Utilizing a user-friendly touch-screen HMI display (Human Machine Interface), the LabTop 3000 comes pre-programmed to cover a wide range of Parylene coating applications. The HMI also collects critical coating-run process data that can be viewed on the HMI screen and can also be exported (in .CSV format) so that process values may be reviewed and analyzed off-line using a personal computer. Process settings can be modified if necessary by qualified PTC personnel.



The Parylene Coating Process

Operating Instructions

System Recommendations

Read and understand the information in this manual and in all accompanying system documentation before operating or maintaining the 3000 LabTop system.

All electrical connections to the 3000 Lap Top must be made by qualified and experienced personnel to ensure operational safety.

While this Deposition System incorporates appropriate safety features, it must be stressed that some components operate at elevated temperatures and pose the danger of serious burns – particularly the dimer loading door and pyrolysis furnace. Use protective gloves when working around these high-temperature components.

Keep the control panel closed whenever the system power switch is turned on. Maintenance is to be performed only by a qualified technician.

System Pre-Coating Preparations

Treat the coating chamber and the coating fixtures used to hold substrates with a suitable release agent before operating the 3000 Laptop Parylene Deposition System to simplify removal of Parylene residue after the coating cycle. Para Tech does not recommend silicone-based release agents as they may contaminate substrates and compromise coating quality. Long experience shows that a light application of carnauba-based wax is an effective means of preventing Parylene adhesion to chamber surfaces. Apply the wax sparingly to all surfaces and buff with a soft cloth. Treat the chamber o-ring seal with a vacuum grease. All system o-rings are made of Viton or silicone, and can be used at elevated temperatures.

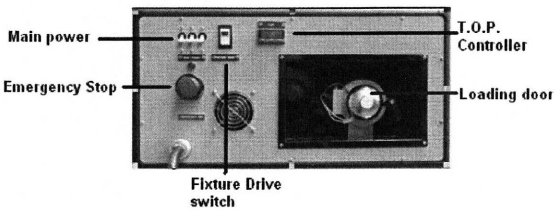
Commented [EL2]: Carnuba Wax instead? How about mineral oil?

Commented [EL3]: Any particular spec for Vaccuum grease?

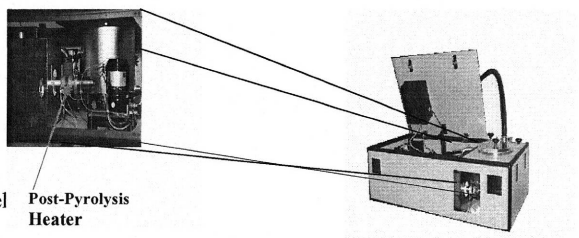
Equipment Overview and Materials Requirement

The 3000 Labtop Parylene Deposition System is composed of:
Microprocessor
Vacuum pump
Heated zones (Door, Vaporizer, Pyrolysis furnace, Post-Pyrolysis)
Deposition chamber with fixture motor drive
Cold trap
Mechanical chiller
Foreline vacuum gauge
Substrate fixture

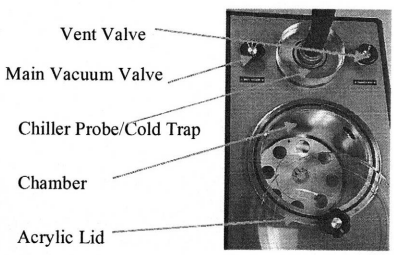
The Main Power switch, Fixture Drive switch and Thermal Override Protection controller are visible when facing the left side of the system. Main Power sends power to the entire system, including the microprocessor, the vacuum pump and ventilation fans around the system cabinet. The Fixture Drive switch activates the motor that maintains a constant rotation of the substrate fixture.



Two quick-release latches on the top of the unit allow the top panel to hinge open. System electronics, vacuum pump, heater zones, and fittings can all be accessed with the panel open. The right-side end panel opens with quick-release latches to expose cold trap, chamber, and fixture-drive rotary seal fittings for easy maintenance. The removable front panel provides access to the Post-Pyrolysis heater and thermocouples, and reveals the clamp and o-ring connection between the Pyrolysis tube and vacuum coating chamber.



The deposition chamber is covered with an acrylic lid and sealed with an o-ring. This allows for convenient viewing as substrates are coated. Adjacent to the chamber are the Cold Trap, Main Vacuum Valve, and Vent valve. The Main Vacuum Valve connects the vacuum pump to the system, and initiates system evacuation. The manual Vent Valve opens the system to atmospheric pressure to allow system venting and removal of substrates after the conclusion of a coating run.



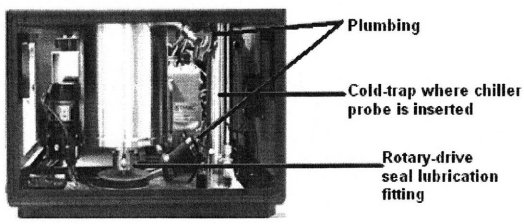
The Cold Trap is the chamber where the mechanical chiller probe is inserted. Excess Parylene reactive monomer is condensed around the cold probe to prevent it from entering and contaminating the vacuum pump.

Note: The Manual Vent valve **MUST** remain closed during a coating cycle to allow for system evacuation. During initial system warm-up and chiller cooling phase, both the Main Vacuum Valve and Vent Valve should remain closed until after dimer is placed into the vaporizer. During a coating run the valves will be in opposite positions: the Main Vacuum Valve **MUST** be opened to evacuate the system and the Vent Valve **MUST** remain closed. During system venting, at the conclusion of a coating run, the Main Vacuum Valve **MUST be closed before the Vent Valve is opened** and must remain closed during the venting process to prevent blow-back through, and damage to, the pump.

"Do not apply excessive torque to the manual valves since this can damage the internal mechanism and potentially create vacuum leaks over time".

Commented [EL4]: How do you check the Vaccuum Pump or Vent Valve? How can you tell if they are good or bad? Can you tell just by looking at them?

The right side end panel opens with quick-release latches to expose cold trap-to-chamber fittings and the rotational drive mechanism for easy maintenance.



The primary items utilized in for the Parylene coating process are:

Substrate Fixture
Fixture spacers
Hand tools for Fixturing
Heat-resistant gloves for handling the heated loading door on the vaporizer
High vacuum grease for seals
Calibrated scale for weighing Parylene raw material (powdered dimer)

Additional recommended items include:

Masking materials
Parylene Dimer (C, N or D)
Primer
Witness coupons
Coating thickness measuring equipment
Glassware and/or stainless steel containers used for cleaning and priming/promoting

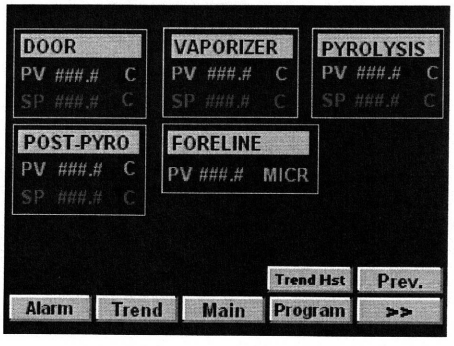
Operator Panel Operation Overview

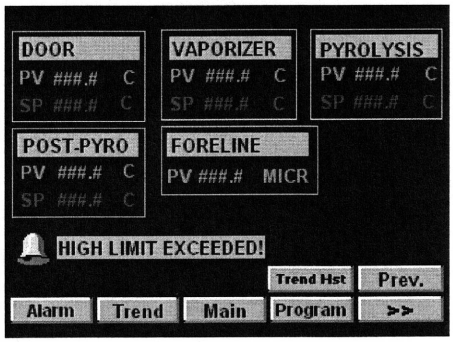
Screen and button function definitions

***Note** – buttons appearing on multiple screens will be defined only once. A list of all button functions resides at the end of this section.

- **Main** application screen – visible at start-up

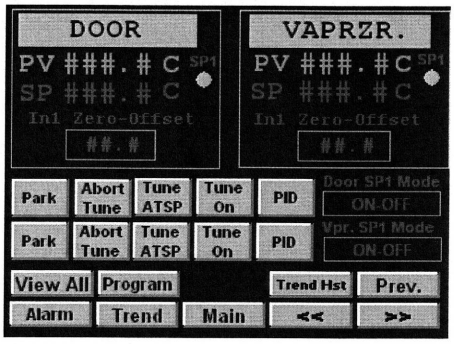
>> Takes you to the View All screen





- **View All** screen – Displays the Setpoint the Process Value for all heat and vacuum zones and also displays a "High Limit Exceeded" alarm ***if*** the Pyrolysis furnace exceeds it's upper band limit as explained in the "Thermal Override Protection" section of this manual. The "High Limit Exceeded" indication will not be displayed during normal operation (see above pictures showing the View All screen with and without the High Limit alarm indication.

Alarm	Displays the **Alarm** screen for viewing of system alarm conditions
Trend	Displays the process **Trend** screen for viewing of process parameters
Main	Calls up the **Main** application screen
Trend Hst	Displays the Trend History screen where specific coating-run data can be exported in .csv format for charting
Program	Displays the Program screen where programs are selected, initiated, turned off, and monitored
Prev.	Displays the Previously Viewed screen
>>	Displays the next screen

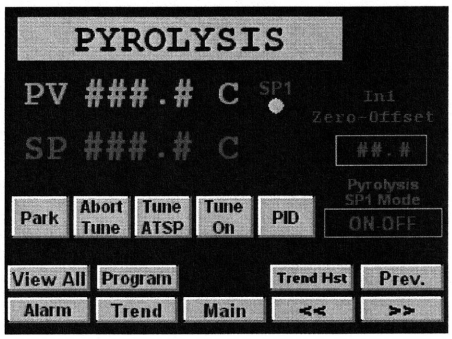


- **Door and Vaporizer** screen – Displays Setpoint and Process values for the Door and Vaporizer heater zones as well as their heater thermocouple calibration offset value (In1 Zero-offset), and allows for zone tuning as well.

Commented [EL5]: Where are these sensosr (Thermocouples?) located on the equipment?

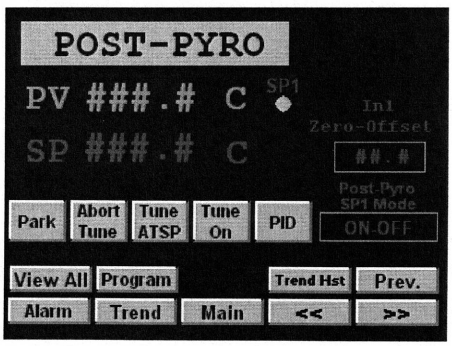
***CAUTION – See the "Tuning" section of this manual before using the tuning feature or pressing any of the associated buttons. Tuning must be performed correctly and ONLY WHEN NECESSARY to avoid unnecessary down-time.

Park	Parks the associated zone at Setpoint (SP) by disabling the output to the controller
Abort Tune	Aborts the tuning process
Tune ATSP	Initiates the "Tune At SetPoint" (ATSP) process
Tune On	Initiates the tuning process from ambient temperature
PID	Returns the associated zone to PID mode (Proportional, Integral, Derivative) where the zone is controlled by the system process controller.
View All	Returns to the **View All** screen where all zones can be monitored
<<	Returns to the previous screen



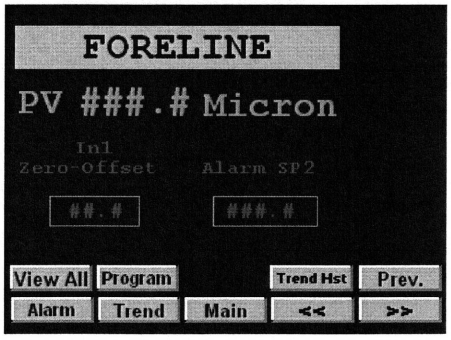
- **Pyrolysis** screen – Displays Setpoint and Process values for the pyrolysis furnace zone as well as the heater thermocouple calibration offset value (In1 Zero-offset), and allows for zone tuning as well.

***CAUTION – See the "Tuning" section of this manual before using the tuning feature or pressing any of the associated buttons. Tuning must be performed correctly and ONLY WHEN NECESSARY to avoid unnecessary down-time.

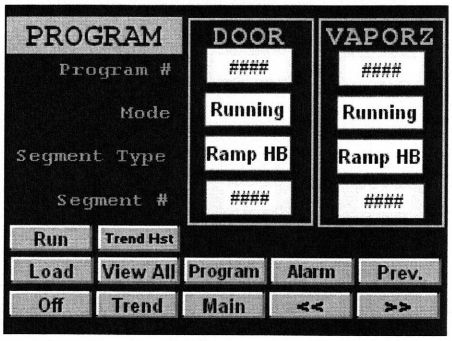


- **Post-Pyro** screen – Displays Setpoint and Process values for the post-pyrolysis heater zone as well as the heater thermocouple calibration offset value (In1 Zero-offset), and allows for zone tuning as well.

***CAUTION – See the "Tuning" section of this manual before using the tuning feature or pressing any of the associated buttons. Tuning must be performed correctly and ONLY WHEN NECESSARY to avoid unnecessary down-time.



- **Foreline** screen – Displays the Process value for the Foreline vacuum zone as well as the Foreline vacuum calibration offset value (In1 Zero-offset) and the vacuum Alarm Setpoint (SP2).



- **Program screen** – the desired coating program is selected, loaded, and initiated. The program mode, segment type, and segment # can be viewed at anytime during the process.

Run	Starts the selected coating program
Load	Loads the selected coating program
Off	Stops the coating program
Program #	Displays the selected program

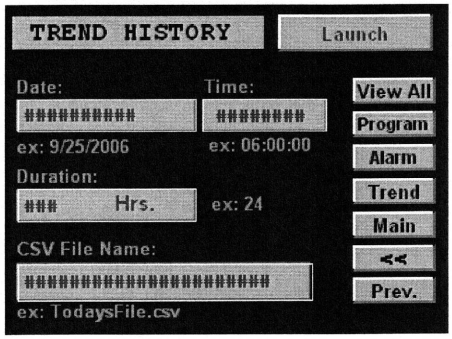
Mode Mode will display **Off**, **Running**, **Hold**, **Stop**, or **Holdback**.

Off	Off button pushed or alarm condition exists
Running	Program is running. Run button pushed, no active alarms
Hold	If a power failure occurs and the program is configured to go into Hold mode
Stop	Displayed when the selected program has completed. The Stop button should be pressed once a program has completed and **must** be pressed before the next program can be started.
Holdback	Will hold back the moving Setpoint of the Door and/or Vaporizer during temperature ramping if the Process Value (PV) exceeds the holdback band (+ 6°C) set within the program. Once the process value falls back within the specified band the moving Setpoint will resume ramping at the specified rate.

Segment Type Displays the current segment type as **Off**, **Ramp**, **Ramp HB**, or **Soak**

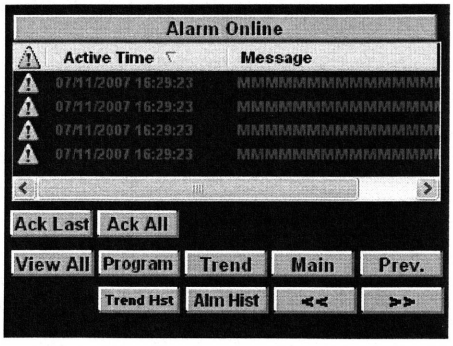
Off	Off button pushed or alarm condition exists
Soak	Indicates a Soak (segment) at a specific temperature
Ramp HB	Indicates that a Ramp segment is in process and that the system's HoldBack feature is enabled (see Holdback under mode settings above). ***Note** - The ***system*** is in HoldBack mode ***only*** when the program mode field displays "Holdback", otherwise Ramp HB indicates a normal ramp sequence (mode is Running).

Segment # Displays the current program segment number



- **Trend History** screen – this screen allows previous coating-run process data to be exported in .csv format so that it can be charted and analyzed. (See the **Trend History Data Export Procedure** section of this manual). All data must be entered in the exact format as indicated below each field.

Launch Pressing this button after entering the correct data in the **Date**, **Time**, **Duration**, and **CSV File Name** fields saves the file for exporting and charting.

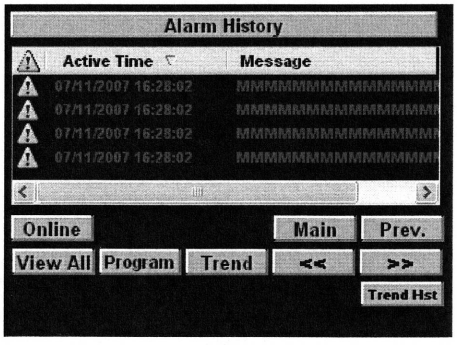


- **Alarm Online** screen – "Active" System Alarms can be viewed and acknowledged. The zone header will be flashing red on any zone that's experiencing an alarm condition. Zone headers display a gray background under normal conditions.

Alm Hist Causes the **Alarm History** page to be displayed
Ack Last Acknowledges the most recent/last alarm message
Ack All Acknowledges all active alarm messages

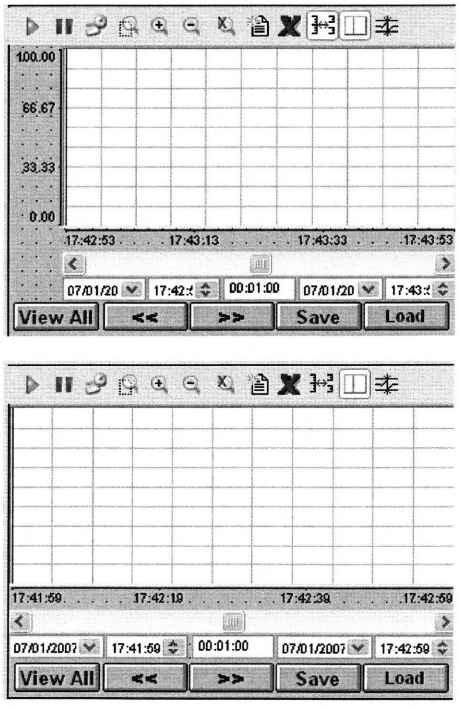
Alarm Status indications:

- **Active** alarms will be displayed in **Red text**
- **Acknowledged** alarms will be displayed in **Green text**
- **Normalized** (condition no longer exists) **and Unacknowledged** alarms are displayed in **Blue text**



➢ **Alarm History** screen – displays historic alarm messages from the history database file. The Alarm History is automatically purged after 2 days.

Online Causes the **Alarm Online** screen to be displayed



➢ **Trend** screens – display active trending information of coating run in-progress.

Two trend screens are used to provide adequate display of all five zones (Door, Vaporizer, Pyrolysis, Post-Pyro, and Foreline). Toggle between the two screens using << and >>. **One screen displays Door and Vaporizer and the other displays Pyro, Post-Pyro, and Foreline.**

Save Saves the current settings of the Trend Object

Load Loads the saved settings and applies them to the Trend Object during run-time

Toolbar: The commands available in the embedded Toolbar are described in the following table.

***Note **Not all buttons will apply to every display.**
Reference **on-screen** buttons for your particular display (see table below)

Command	Icon	Description	Activation Tag
Run		Set the Trend to the *Play* Mode. In this mode, the X axis is continuously updated (Online Mode). This option is disabled (grayed out) when the trend is already in *Play* Mode.	0 = Play Mode on 1 = Play Mode off
Stop		Set the Trend to the *Stop* Mode. In this mode, the X axis is not continuously updated (*History* Mode), so the user can visualize history data in a frozen period of time. This option is disabled (grayed out) when the trend is already in *Stop* Mode.	0 = Stop Mode on 1 = Stop Mode off
Period		Launches an embedded dialog, where the user can modify the X axis scale main settings	When the Activation Tag changes value (e.g. toggles), this command is executed.
Window Zoom		Allows the user to click on the Trend area and drag the cursor to select the area that must be visible when the cursor is released. This option is disabled (grayed out) when the **Multiple Section** option (for the Y scale) is active.	
Horizontal Zoom		Allows the user to click on two points on the Trend area, defining the Horizontal scale that must be available	
Vertical Zoom		Allows the user to click on two points on the Trend area, defining the Vertical scale that must be available. This option is disabled (grayed out) when the **Multiple Section** option (for the Y scale) is active.	
Zoom In		Allows the user to zoom in (display half of the current X and Y scales) each time they click on the Trend area.	0 = Zoom In on 1 = Zoom In off
Zoom Out		Allows the user to zoom out each time they click on the Trend area.	0 = Zoom Out on 1 = Zoom Out off
Cancel Zoom		Cancel the *Zoom In* or *Zoom Out* mode	When the Activation Tag changes value (e.g. toggles), this command is executed.
Legend Properties		Launches an embedded dialog, where the user can modify the Legend main settings	
Pen Style		Launches an embedded dialog, where the user can modify the style of the selected pen.	

Add Pen		Launches a dialog, where the user can add a new pen to the Trend object	
Remove Pen		Removes the selected pen from the Trend object	
Multiple Sections		Switches the Y scale to Multiple Sections (a section for each pen) or Single Section (all pens share the same Y scale section).	0 = Multiple Sections on 1 = Multiple Sections off
Cursor		Turns the cursor (ruler) to visible or hidden	0 = Cursor on 1 = Cursor off
Auto Scale		Changes the Y axis scale to fit all values from the pens that are currently being monitored.	When the Activation Tag changes value (e.g. toggles), this command is executed.

◆ **Legend**: The commands available in the embedded Legend are described in the following table:

Command	Icon	Description
Selection		Launches a dialog, where the user can replace the data point associated with the selected pen on the legend
Remove		Removes the selected pen from the Trend object
Hide		When checked, the selected pen is visible; otherwise, it is hidden.
Pen Style		Launches an embedded dialog, where the user can modify the style of the selected pen.
Scale		When this box is checked, the Y axis scale is visible; otherwise, it is hidden. The scale can be hidden only when each pen is using an individual scale (not sharing the same scale), and the Multiple Sections option is off.

- **Scroll bar**: Using the Scroll bar, the user can slide through the X axis values, according to the period configured for this scale.
- **Time bar**: Using the Time bar, the user can modify the Duration, as well as the Start Date/Time and/or the End Date/Time, for the data displayed on the object. Changing these values will affect the tags associated with the X axis scale (if any).

Consolidated button functions list:

>>	Takes you to the next screen
Exit	Exits the application from the **Main** screen
Alarm	Displays the **Alarm** screen for viewing of system alarm conditions
Trend	Displays the process **Trend** screen for viewing of process parameters
Main	Calls up the **Main** application screen
Trend Hst	Displays the Trend History screen where specific coating-run data can be exported in .csv format for charting
Program	Displays the Program screen where programs are selected, initiated, turned off, and monitored
Prev.	Displays the Previously Viewed screen
<<	Displays the previous screen in the screen sequence
Park	Parks the associated zone at Setpoint (SP)
Abort Tune	Aborts the tuning process
Tune ATSP	Initiates the "Tune At SetPoint" (ATSP) process
Tune On	Initiates the tuning process from ambient temperature
PID	Returns the associated zone to PID mode (Proportional, Integral, Derivative) where the zone is controlled by the system process controller.
View All	Returns to the **View All** screen where all zones can be monitored
Run	Starts the selected coating program
Load	Loads the selected coating program
Off	Stops the coating program
Launch	Pressing this button after entering the correct data in the **Date**, **Time**, **Duration**, and **CSV File Name** fields saves the file for exporting and charting.
Alm Hist	Causes the **Alarm History** page to be displayed
Ack Last	Acknowledges the most recent/last alarm message
Ack All	Acknowledges all active alarm messages
Save	Saves the current settings of the Trend Object
Load	Loads the saved settings and applies them to the Trend Object during run-time

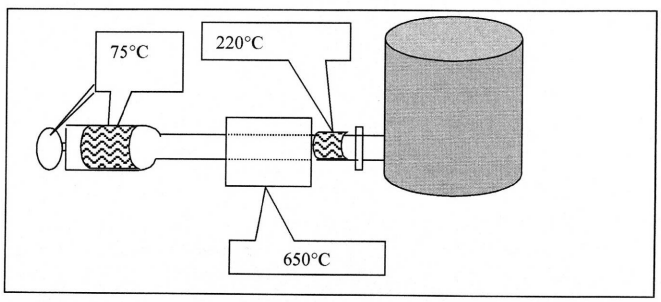
Indicates that a pyrolysis furnace over-temperature condition has occurred.

Coating Application

(***After reading and thoroughly understanding this section***, see the "Performing a coating run overview" section of this manual for an overview showing actual screen-shots and controls)

First deposition cycle

a. Ensure the system is in a clean condition
b. Confirm that a clean quartz liner tube has been inserted into the Pyrolysis tube
c. Check that the Main Vacuum Valve is closed
d. Check that the Vent Valve is closed
e. Turn on the Main Power Switch, wait approximately 10 seconds, turn on the HMI switch
f. The Set-Point (SP) and Process Value (PV) for each zone will be displayed and the SP values will move toward the PV values as the system heaters and vacuum pump are now operating
g. Turn on the mechanical chiller (target chiller temperature is -60°C to -70°C) and insert the chiller probe into the cold-trap. **USE EXTREME CARE WHEN HANDLING THE CHILLER PROBE FLEX LINE, ESPECIALLY WHEN COLD AS IT IS VERY FRAGILE.**
h. While the vacuum pump warms up, check the internal chamber surfaces for cleanliness, the chamber o-ring, o-ring groove, and the loading door o-ring. All surfaces should be clean and the o-rings should be in good condition and lightly greased with vacuum grease.
i. Turn on the fixture drive switch and confirm that the drive shaft at the bottom of the chamber is rotating in the counterclockwise direction.



j. Approximately 30-40 minutes after activation, the system will reach default settings in the following five zones:
    i. Door default temperature: 75°C
    ii. Vaporizer default temperature: 75°C
    iii. Pyrolysis furnace default temperature: 650°C
    iv. Post pyro default temperature: 220°C
    v. Foreline vacuum level: 5-10 µin Hg (depending on pump condition)

Commented [EL6]: Is this the long tube that has to be cleaned and replaced every few runs?

Commented [EL7]: Is Foreline sensor attached to vacuum pump? What is meant by Foreline?

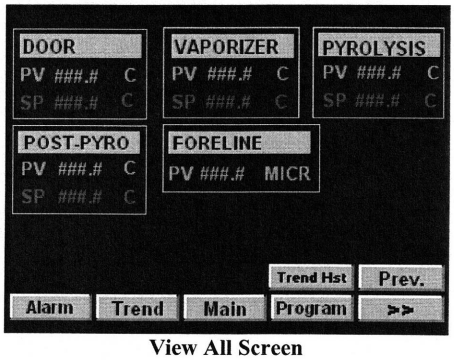
Does the Foreline sensor measure Coating Thickness or Pressure?

How do you clean it? Does it get coated with each cycle?

k. Prepare the raw material, load it into the vaporizer in an aluminum boat, and close the loading door, ensuring that the door o-ring is securely place in the groove
l. Prepare the loaded substrate fixture by loading the witness coupons and by protecting the bottom 3 inches with a layer of aluminum foil wrapped around the fixture plates as a barrier to protect the parts from overexposure to the dimer entering the chamber (see picture on page 55)
m. Insert the loaded fixture and make sure that it locks to the drive shaft at the bottom of the chamber
n. Install the o-ring into its chamber groove and seal the chamber with the lid
o. Insert the mechanical chiller cold probe into the cold trap chamber, making sure the o-ring is properly set around the probe, and that the probe's acrylic adaptor is perfectly flat against the cold trap o-ring
p. Prepare to evacuate the system by holding the cold-probe down against the cold trap O-ring
q. Slowly open the Main Vacuum Valve by turning its knob counterclockwise
r. Allow sufficient time for the vacuum level to reach the targeted value

s. Review the system condition by monitoring the View All screen on the HMI

NOTE: All set points (SP) must be reached before the operator can begin the coating deposition process

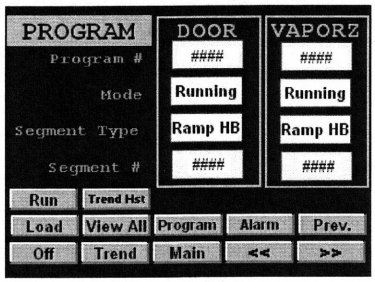


View All Screen

t. Open the Program page in preparation to initiate the coating process
u. On the Program page select the program desired by entering the number and pressing the Enter button on the keypad – Both zones must run the same program.

NOTE: Sixteen programs have been preset in the systems memory. Their parameters are outlined in Appendix A (Program number; duration of each program; quantity of segments in each program).

v. The program # will be displayed once it has been selected on the keypad.
w. Activate the coating program by pressing Load and then Run. If no alarm condition is present at this time, the program will start. Review the trouble-shooting guide in Appendix B if the program cannot be started.
x. Check the data logging on the Trend screen as desired – see the Trend History Data Export Procedure section of this manual for charting of the data once the run has completed.



Program Screen

y. Allow the system to run for the programmed time and monitor its condition periodically. If an alarm condition presents itself during the coating cycle, the program will be automatically terminated. In this event, the operator must close the Main Vacuum Valve, open the Vent Valve, wait for the system to ventilate, and pull the fixture, check the condition of the substrates, check the raw material in the vaporizer zone, and make a disposition. If the coating cycle has not been completed, the operator may possibly reload the system with the remaining raw material and reactivate the program by following the steps above.
z. After the program cycle has been completed, the mode will display OFF.

aa. Close the Main Vacuum Valve all the way. Do not apply excessive torque since this can damage the internal mechanism and potentially create vacuum leaks over time.
bb. Open the Vent Valve to ventilate the system, pull the chiller probe out of the cold trap, place it aside, and close the Vent Valve once again
cc. Open the loading door and with proper heat protection, remove the aluminum boat from the vaporizer zone
dd. Turn off the fixture drive, open the chamber acrylic lid, remove the substrate fixture and place it on the workstation for evaluation
ee. Clean the chiller probe in preparation for subsequent cycles
ff. Leave the system on if another cycle is to be immediately loaded

Last deposition cycle of the day:

a. Ensure the system is in clean condition
b. Ensure that a clean quartz liner tube has been inserted into the Pyrolysis tube
c. Check that the Main Vacuum Valve is closed
d. Check that the Vent Valve is closed
e. Check that the mechanical chiller probe is cold
f. Check the chamber internal surfaces for cleanliness and ensure that all o-rings are clean and properly greased
g. Check that the system is holding the default setting for all heated zones
h. Prepare the raw material, load it into the vaporizer in an aluminum boat and close the loading door, ensuring that the door o-ring is securely place in the groove
i. Prepare the loaded substrate fixture by loading the witness coupons and by protecting the bottom 3-inches with a layer of aluminum foil wrapped around the fixture plates

j. Insert the loaded fixture and make sure it locks in with the drive shaft at the bottom of the chamber
k. Install the o-ring into its chamber groove and seal the chamber with the lid
l. Insert the mechanical chiller cold probe into the cold trap chamber, making sure the o-ring is properly set around the probe, and that the probe's acrylic adaptor is perfectly flat against the cold trap o-ring
m. Prepare to evacuate the system by holding down the cold probe against the cold-trap O-ring
n. Slowly open the Main Vacuum Valve by turning its knob counterclockwise
o. Allow sufficient time for the vacuum level to reach the required level before activating the coating program.
p. Review the system condition by checking the operator panel View All screen
q. Open the Program screen in preparation to initiate the coating process
r. On the Program page select the program desired by entering the program number in both zones.
s. Activate the coating program by pressing Load and then Run. If no alarm condition is present, the program will start. Review the trouble-shooting guide on Appendix B if the program cannot be started.
t. Allow the system to run for the programmed time and monitor its condition periodically
u. After the program has been completed, the mode will display OFF. At this time the operator should press OFF on the Program Screen. OFF must be pressed after a program has been run in order for the next program to be able to be loaded.
v. Close the Main Vacuum Valve all the way. Do not apply excessive torque since this can damage the internal mechanism and potentially create vacuum leaks over time.
w. Open the Vent Valve to ventilate the system, and then close the Vent Valve
x. Open the loading door, and with proper heat protection remove the aluminum boat from the vaporizer zone
y. Turn off the fixture drive, open the chamber acrylic lid, remove the substrate fixture and place it on the workstation for evaluation
z. Allow sufficient time before the end of the work shift to activate the system for cleaning of the quartz tube liners before the system is powered down and cooled to room temperature
aa. Check that the chiller probe is still cold and close the chamber with the acrylic lid and o-ring
bb. Ensure the chiller probe is inserted into the cold trap and that the Vent Valve is closed
cc. Using protective gloves and tube tongs, pull the quartz liner inside the Pyrolysis tube out toward the loading door
dd. Close the loading door and lock it in place
ee. Immediately hold down the chiller probe aligned with the cold trap o-ring, and open the Main Vacuum Valve
ff. Allow a period of 15-20 minutes for the quartz line tube to be cleaned by heat from the Pyrolysis furnace
gg. NOTE: Residue accumulated inside the quartz liner during coating cycles will be burned off, the vapors drawn to the cold trap by the vacuum pump and condensed at the cold trap When the cleaning period is complete, close the Main Vacuum Valve and open the Vent Valve to ventilate the system
hh. Turn off the mechanical chiller and the Main Power switches

ii. Pull the chiller probe out of the cold trap
jj. Clean the cold probe under running warm water, remove all collected residue, dry the probe with paper towels, apply a light layer of wax, and set it aside for the next day
kk. The internal surfaces of the quartz tube should be cleaned with paper towels and/or lint free cloths

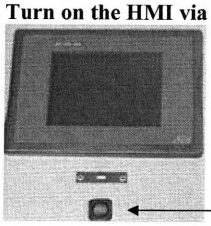
See "Coating Run overview" section below for more general information on performing coating runs

Performing a coating run overview

Before operating this machine ensure that you have read and understand all pertinent information contained in the **"3000 LabTop Operator Manual".**

Apply power to the machine in the following manner:

1) **Turn on the Main Power switch**
2) **Wait 10 seconds**
3) **Turn on the HMI via the HMI Switch**



HMI Power switch

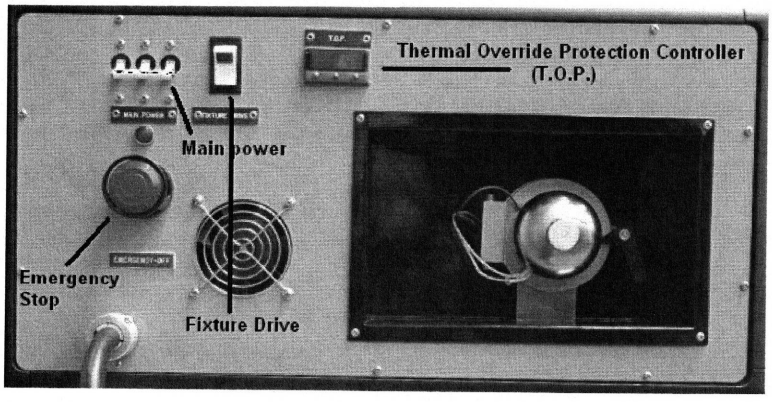
NOTE - When power is applied to this machine via the Main Power switch, all zone heaters will automatically heat up to set-point (**SP**) temperatures (**reference page 2 for SP temperatures**) and the vacuum pump will be powered on as well.

NOTE - If electrical power is interrupted during a coating cycle and is later restored, the machine will park all zones at SP (the program will terminate). Allow adequate time for the unit to cool down to SP before attempting to perform another coating run as the controller will not allow a program to begin until all zones have returned to SP temperatures.

NOTE - After a coating cycle program has ended, the machine will park all zones at SP. Allow adequate time for this to occur before loading dimer for the next run. Loading dimer at temperatures above SP can cause it to sublimate prematurely and will also cause higher than normal foreline vacuum readings due to the introduction of vapor into the system.

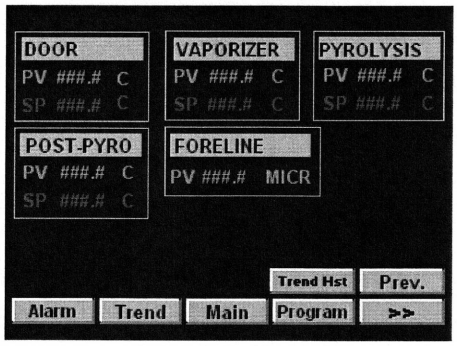
Emergency Stop Function (E-Stop) – This machine is equipped with a red-mushroom type Emergency Stop button. When pushed in it will cut power to all system components, however, there are still live circuits connected to line voltage at the power input. To remove power from the machine completely, unplug it from the power source.

Panel interlock switches – are located on the top, front, and end panels. The machine is designed to be operated with all panels in place. When removed the interlock switches will cut-off system power. They can be bypassed for system maintenance by pulling them out to their extended position. **The panels must remain in place for the machine to operate properly.** (see appendix D for switch locations)



NOTE: Ensure that the "**Emergency Stop Button**" is pulled all the way out. The system unit will not power on unless it is.

Set-point temperatures are as follows:
Door: 75°C Vaporizer: 75°C Pyrolysis (oven): 650°C Post-Pyro: 220°C



Foreline vacuum reading - with the Main Vacuum valve closed will read approximately 4 microns and may rise as the vacuum pump ages.

NOTE: An alarm condition will occur if temperature zones exceed SP by +/- 5°C. If an alarm condition occurs, the system will terminate the current "in-process" program and all zones will return to SP. An alarm condition is displayed as a flashing red title bar in the offending zone. Alarms can be viewed by selecting the "Alarm" button, and can be reset by acknowledging them via the "**Ack Last**" and/or "**Ack All**" buttons on the "**Alarm**" page. See "Alarm Screen" section of this manual for more detailed information.

A Foreline alarm condition will occur when the Foreline reading is above 20 microns.

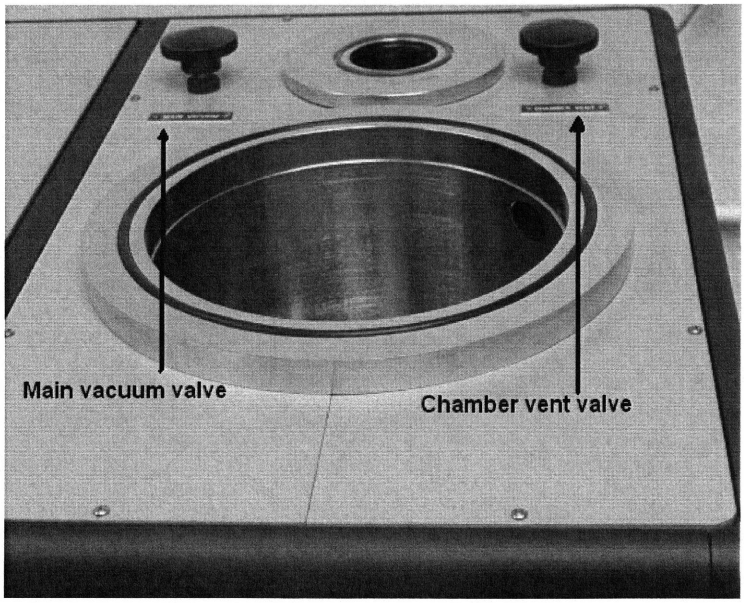
Commented [EL8]: Is this unit in Microns? Or in mmHg?

All zone screens can be accessed individually by touching the corresponding zone on the "**View All**" screen.

Performing a coating run

NOTE: Reference more in depth instructions in the 3000 LabTop Operator Manual :

1) Ensure that both the manually operated "**Main Vacuum**" valve and "**Chamber Vent**" valves are closed. Closed = Turned FULLY to the right.



"Do not apply excessive torque to the manual valves since this can damage the internal mechanism and potentially create vacuum leaks over time".

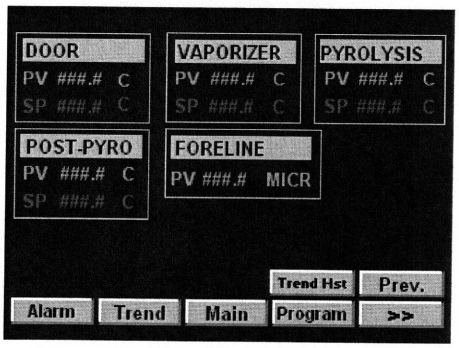
2) Apply power to the machine via the "**Main Power**" switch, wait approximately 10 seconds, turn on the HMI switch and allow all zones to reach SP temperatures.

3) Turn on the mechanical chiller, insert the chiller probe into the cold-trap, and allow it to run while the temperature zones reach SP. Ensure that a good seal is obtained where the chiller probe is inserted into the cold trap.

USE EXTREME CARE WHEN HANDLING THE CHILLER PROBE FLEX LINE, ESPECIALLY WHEN COLD AS IT IS VERY FRAGILE.

4) The HMI controller will power up and the main screen will be displayed:

5) Select the ">>" button to view the "**View All**" page and monitor all zones as they heat up to SP. (On consecutive coating runs, all zones will show an alarm condition (FLASHING RED zone label until they are back within their alarm band. This is normal and will prevent a coating run from being started until all zones back within the required range).



6) At this time measure the required amount of dimer into an aluminum-foil boat, prepare the test-coupons, and fixture the substrates to be coated. (***See the "Coating Program specifics and Test Run reference data" section of this manual for reference data concerning test runs performed on this machine). Protect the bottom 3 inches of the fixture with aluminum foil.

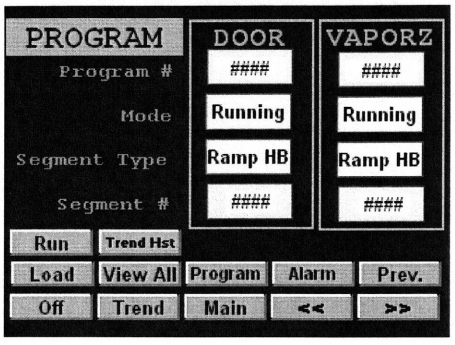
7) Once completed place the fixture into the chamber and close the chamber lid. Ensure that the fixture properly engages the drive shaft at the bottom of the chamber. Turn on the Fixture Drive and ensure that the fixture rotates freely and without interference.

8) Once all temperatures and vacuum have stabilized at SP, load the dimer into the vaporizer and close the vaporizer door taking proper precautions to avoid improperly handling a "HOT" door.

9) Open the "Main Vacuum" valve and allow sufficient time for the Foreline vacuum reading to come back to within its alarm band (below 20 microns). The program will be prevented from starting until the reading is within the alarm band. Make certain that the Vent Valve is fully closed.

Commented [EL9]: How does Vaccuum relate to Microns?

10) Once all zones are at SP (within their respective alarm bands) select "**Program**" from any page displaying the "**Program**" button and the "**Program**" screen will be displayed.



11) Enter the "**Program #**" in both the Door and Vaporizer "**Program** # " fields by touching each field and utilizing the on-screen keyboard that pops up. Select the desired program (there are 16 available).

12) Once the correct program #'s have been loaded into both fields, select "**Load**". The selected program # will be displayed. **The program #'s for both the Door and the Vaporizer (VAPORZ) *MUST* be identical.**

***NOTE** – When running programs consecutively, the "Off" button must be pressed between coating runs in order to "Load" the program for the next run.

13) Select "**Run**" to initiate the coating cycle. Mode, Segment Type, and Segment # information will be displayed (see more detailed information in the "Screen and button function definitions" section of this manual)

14) Once the coating cycle has ended the machine will park all temperatures back at SP. It may take some time for the Door and Vaporizer temperatures to return to SP.

NOTE: **DO NOT load dimer for another run until all zones have returned to SP.**

15) In order to open the chamber and remove the fixture **"FIRST CLOSE THE MAIN VACUUM VALVE FULLY"** and then open the "Chamber Vent" valve slowly to vent the system. The chamber lid can now be opened and the substrates removed.

CAUTION: Failure to **"FIRST CLOSE THE MAIN VACUUM VALVE FULLY" before opening the "Chamber Vent" valve can cause serious damage to the vacuum pump.**

16) NOTE – before another run can be initiated the operator must go to the "**Program**" screen and select "**OFF**".

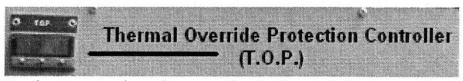
17) Follow all instructions in the **3000 LabTop Operator Manual** for additional information on performing consecutive coating cycles **(see item 5, page 28)**

NOTE: **See the "Trend History Data Export Procedure" section of this manual for information on exporting and charting coating run parameters.**

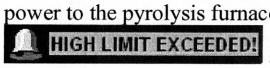
Thermal Override Protection (T.O.P) Safety Feature

The LabTop is equipped with an Industry Standard *independent* **T**hermal **O**verride **P**rotection feature designed to ensure personnel and equipment safety in the event of a Pyrolysis Furnace over-temperature condition.

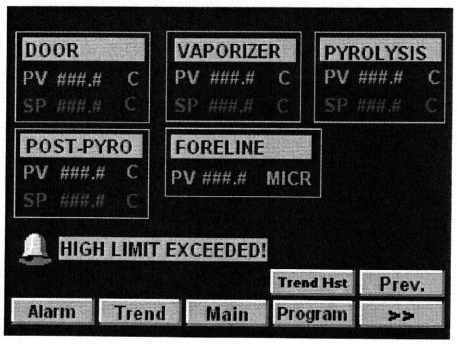
A separate pyrolysis controller temperature readout is located on the end panel containing the Main Power switch. It's temperature indication will closely match the Pyrolysis temperature displayed on the HMI. The temperature displayed during normal operation may not be exactly the same as the Pyrolysis temperature displayed on the HMI since it's a completely independent circuit, but it will be reasonably close.



In the event that the pyrolysis furnace temperature exceeds the factory-set high-limit (700°C), the power to the pyrolysis furnace will be shut off, the coating program will halt, and the



alarm will be displayed on the View All screen.



In the unlikely event that this does occur, the following steps should be taken as soon as possible:

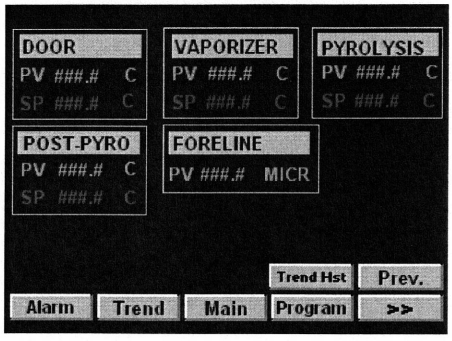
- Close the Main Vacuum Valve
- Open the Vent Valve
- Wait for the system to ventilate
- Remove fixture from the chamber
- Check the condition of the substrates and the raw material in the vaporizer zone, and make a disposition.
- If the coating cycle has not been completed, the operator may possibly reload the system with the remaining raw material and reactivate the program by following the appropriate steps.

Resetting the Thermal Override Protection "High Limit" Alarm

To reset the system and turn off the 

alarm indication, go to the Alarm screen, Acknowledge the alarm, and then cycle the machine's "Main Power" switch to OFF and the back to ON.

Once the condition has been cleared and the system power has been reset, the High Limit warning will disappear from the View All screen.



System Preventive Maintenance Schedule

Commented [EL10]: Is there a recommended way to clean up /remove the coating buildup (aside from pre-treating with Carnuba)?

Performance of the Parylene deposition system is highly dependent on preventive maintenance. This maintenance program includes four categories:

Daily	Partial maintenance after each coating cycle, with minor disassembly and cleaning
Weekly	Monitoring of vacuum pump and pump oil, replace oil after 200 hours running time
Monthly	Periodic inspection and maintenance of the vacuum sensor
Quarterly	Periodic calibration checks and maintenance of electronic components
Semi-Annually	Periodic check and maintenance of mechanical components

Document completion of these maintenance steps regularly using the five worksheets provided in Appendix C of this manual

System Calibration

Commented [EL11]: Do you have a Chart / Pictures showing where all the Thermocouple sensors go? How about where the Vaccuum Gage is?

Instruments and measuring devices used in the Parylene coating operation shall be subject to calibration by an approved calibration laboratory according to National Institute of Standards and Technology (NIST) specifications, per MIL-STD-45663. The instruments and measuring devices shall be submitted for calibration on a quarterly schedule. Calibration labels showing the date of last calibration and expiration date are to be attached to instruments and measuring devices in use.

Instruments recommended for calibration inspections include a Teledyne calibrated gauge tube and a temperature simulator for thermocouples, type K. Recommended calibration intervals have been established as follows:

Temperature measuring devices & indicators.....90 days
Vacuum Gauges.....90 days

Thermocouple and Vacuum Calibration procedure:

PID Controller Calibration Procedure

****IMPORTANT – **Read through this entire procedure before beginning the process**

Necessary Equipment:

1. A Thermocouple (TC) Simulator with the correct type of thermocouple (K, J, T, etc.)
2. An appropriate thermocouple extension wire with male plug attached at one end, and bare, stripped leads at the opposite end (approximately 4 feet in length)
3. A data log sheet to record readings
4. A reference vacuum tube (3 milli-Torr/micron and/or 4.9 milli-Torr/micron are recommended)

Preparation:

1. Unplug the machine's main power-cord and turn OFF the main power circuit breaker.

2. Unplug and label each white terminal block from the top of each PID module. **Cover the white terminal block with a piece of electrical tape to prevent accidental connection to the system.** Repeat this step for all heater modules at this time.

   Heater modules can be identified as those having red and yellow thermocouple wires inserted in the connector at the bottom of the module in terminal 1 and 2 locations.

3. Carefully remove the thermocouple wires at terminals 1 & 2. Label them accordingly. For type K thermocouples, the yellow wire must be attached to terminal 1, and red wire must be at number 2. Isolate each wire using electrical tape to ensure that the red and yellow wires do not come into contact with each other or any other conductive material. Repeat this step for all heat modules at this time.

4. Insert the thermocouple wires from **the thermocouple simulator** into terminals 1 (yellow) and 2 (red) of the terminal block of the module that is to be calibrated and then plug the terminal block into the respective PID module.

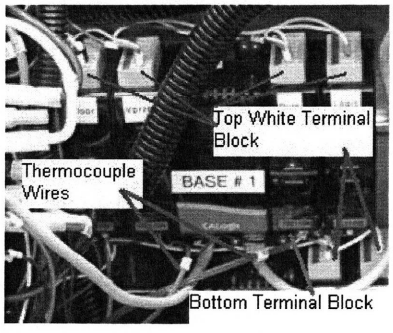


Figure 1

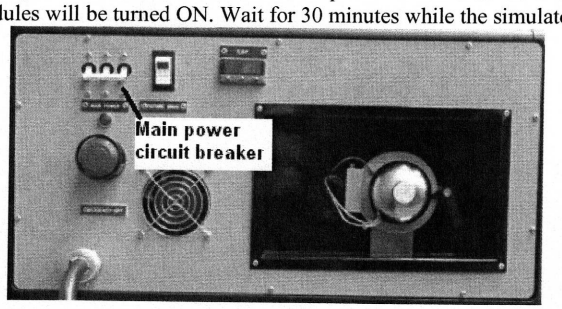
Heat Zone Calibration :

1. Check that the PID module is correctly prepared (as indicated above) and then turn on the simulator. **The warm-up time of the simulator is approximately 30 minutes.** Adjust the simulator to the Sample # 1 reading (50°C). Prepare a data sheet to record temperature readings during the calibration process.

Data sheet example :

Data Collection							
Data in: ^{o}C	Tolerance: $\pm 3^{o}C$						
		Calibration			2nd run after Actions		
Sample #	Simulator Value ^{o}C	HMI Display Reading			HMI Display Reading		
		1	2	3	1	2	3
1	50						
2	70						
3	90						
4	110						
5	130						
6	150						
7	170						
8	190						
9	200						
10	300						
11	400						
12	500						
13	600						
14	700						
15	800						

2. Plug in the main-power cord and turn ON the main power circuit breaker. The HMI and all associated modules will be turned ON. Wait for 30 minutes while the simulator stabilizes.



3. Check the stability of the simulator, and adjust it to the Sample # 1 Simulator value if it has changed. Record the reading of the simulator value on the data log sheet. Record the reading of the HMI display. The reading on the HMI display for that module should be within ±3°C of the simulator nominal value as set on the simulator.

Repeat this step for all other nominal values. If the reading is out of the tolerance, proceed to the **Zero Offset procedure** below.

4. Turn OFF the main power circuit breaker **and unplug the power cord from the electrical outlet.** Turn OFF the simulator and then move the thermocouple wires of the simulator to the next module to be calibrated. **CAUTION: The power cord must be unplugged from the electrical outlet to avoid any possible contact with dangerous voltages inside the system.**

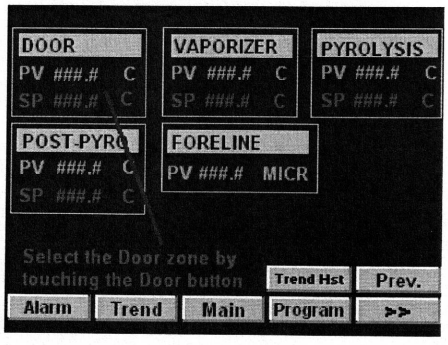
5. Plug the main power cord to the electrical outlet. Turn ON the main circuit breaker. Turn ON the simulator and repeat step 3 and step 4 above.

6. After all modules have been calibrated, turn OFF the main power circuit breaker. Unplug the main power cord and then **return the system to its original configuration.**

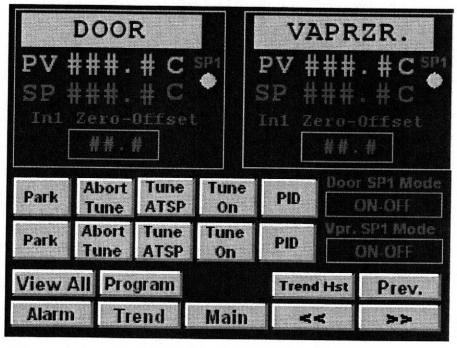
Zero Offset Procedure:

This procedure must be performed very carefully. It affects the accuracy of the module over the temperature range of the measurement. For type K thermocouples the temperature range is 0 °C to 1200 °C.

1. Turn on the main-power circuit breaker. The HMI and all modules are powered on. On the HMI, touch the associated zone to display the reading for that zone. For example, to calibrate the DOOR module the operator touches the DOOR zone as shown here.



The HMI now shows the next screen.



2. Touch the box under In1 Zero-Offset to enter the offset value for the DOOR module. The Offset Value = Reading on the Simulator – Reading on HMI (whether positive or negative). After the offset value has been entered, the PID will store the new value in its memory. After setting the offset value, perform the entire calibration sequence again.

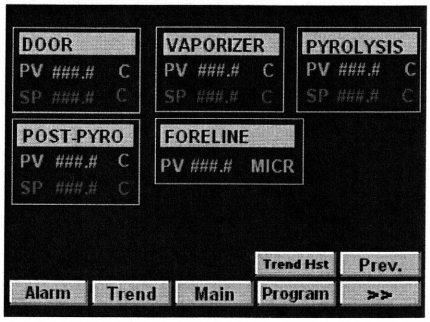
   IMPORTANT - wait until the simulator and the module readings have stabilized before calculating the offset value.

3. Proceed to the next heater module as necessary.

Vacuum Zone Calibration (Foreline):

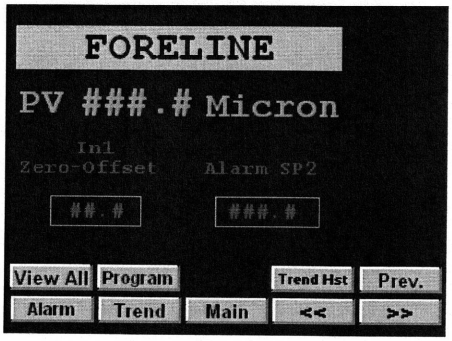
- A calibrated vacuum reference tube is required as specified above.

1. Turn on the main-power circuit breaker. The HMI and all modules are ON. On the HMI, touch the Foreline zone. Locate the Foreline sensor and unplug the black octal socket from the sensor. Insert the reference tube in the octal socket. Record the calibrated value which is printed on the tube's case.



2. Touch the Foreline zone

3. The HMI now displays:



4. Touch the box under In1 Zero-Offset to enter the offset value for the FORELINE module. The Offset Value = the Reading on the Reference tube – Reading on HMI. After the offset value has been entered, the PID will store the new value in its memory.

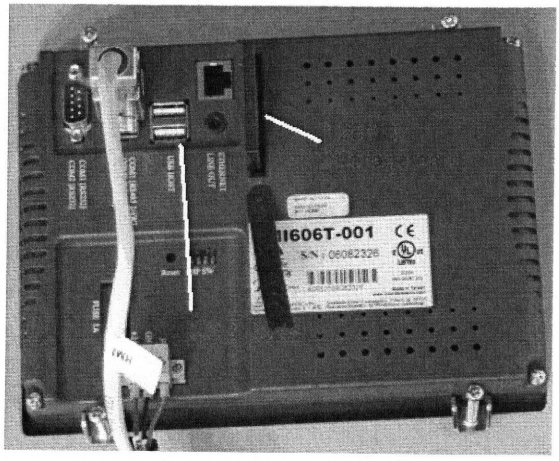
End of Calibration and Zero-Offset

Trend History Data Export Procedure

Overview

Basically you'll be creating a .CSV file (comma separated values) using the HMI (Human-Machine-Interface) touch-screen controller, copying it to a flash-memory device, transferring it to a computer, pasting it into a spreadsheet template, and charting it.

You can use the touch screen to maneuver around ***or*** you can attach a USB mouse into one of the USB ports on the back of the HMI.



Windows CE works best if you plug in the mouse ***before*** you power up the HMI. The same goes for the flash-memory device.

NOTE** - Some flash memory devices will ***not be recognized by Windows CE.
Flash memory devices that *are* recognized can sometimes take up to 30 seconds to show that they're active.

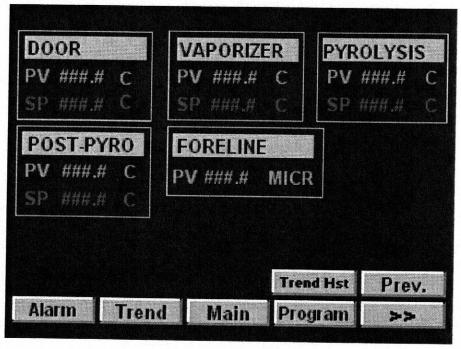
It is recommended that you read through this entire procedure before beginning.

Procedure

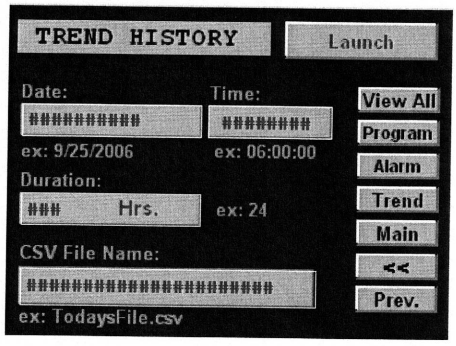
Ensure that the Windows CE clock is set to your time-zone.

Then, from the **"Main Screen"** hit the ">>" button

which takes you to the **"View All"** screen.



Select **"Trend Hst"** from the **"View All"** screen (or from any other screen that has the "Trend Hst" button)



Enter the data into each field. When you touch or click your mouse in each field, a small on-screen keyboard will pop up. You'll have to scroll back and forth to access the characters you need. **Enter the data in the exact format shown beneath each field** and hit the check mark ✓ to enter the data into that field.

Once all of the data is entered, hit the "**Launch**" button in the upper right hand corner of the screen.

Next, hit the "**Main**" button and once you're at the "**Main Screen**" hit the "**Exit**" button (or you can pull up the menu bar at the bottom of the screen and hit the "**desktop**" icon if you're using a mouse).

From the desktop open "**My Computer**". Open the "**Storage Card**" folder, and then the "**TrendHstCSV**" folder (My Computer\Storage Card\TrendHstCSV).

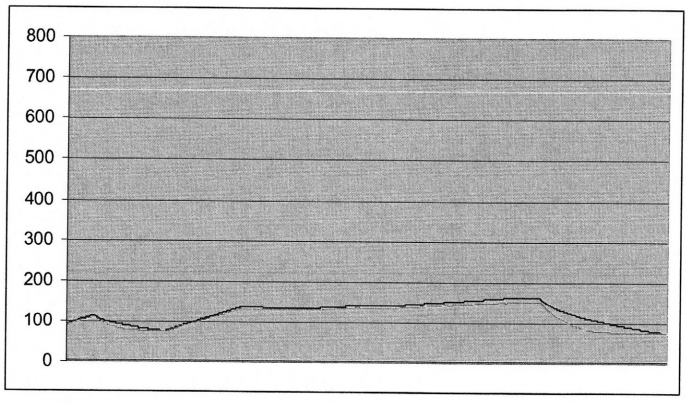
You'll see the file that you created listed twice, once as a .CSV file and once as a .hdr or header file (you may need to change the view to "details" to see the file type extensions).

Copy the .CSV version of the file and paste it onto the flash-memory device. The flash-memory device will show up as "**Hard Disk**" in the "**My Computer**" folder. **DO NOT paste the file into the Storage Card folder.**

The Storage Card folder contains application files and the Trend History files. The Storage Card capacity is 128MB.

It's recommended to occasionally remove your Trend History files from the storage card so that you don't max out its capacity which could possibly effect the running of the application.

Paste the data into Excel and use the Chart Wizard to chart it, which should display results similar to the sample chart below for a *successful* run (you may wish to include labels for each parameter).



You can create a simple template to use with Microsoft Excel™ as follows:

Date	Time	Door	Vaporizer	Pyrolysis	Post Pyro	Foreline

PID Module Tuning procedure

****IMPORTANT – Read through this entire procedure before beginning the process**

- Tuning should ONLY be performed when any heater will not stabilize at setpoint or when a failed heater has been replaced.
- TUNE ONLY WHEN AND IF NECESSARY

Auto-tune:

The Auto-tune procedure matches the controller to the process. Auto-tune can performed as either "Tune" (from ambient temperature) or "Tune at Setpoint" (already at setpoint temperature).

The "recommended" tuning method is determined by the following criteria:

- **Tune ("Tune On" button is used)**
  a. Used when the setpoint is greater than100°C and is started at *ambient* temperature. (Pyrolysis and Post-Pyro zones)

- **Tune at setpoint ("Tune ATSP" button is used)**
  - Used when the **setpoint** is less than 100 °C (Door and Vaporizer zones)
  - When **setpoint** control is poor (unstable with large oscillations)

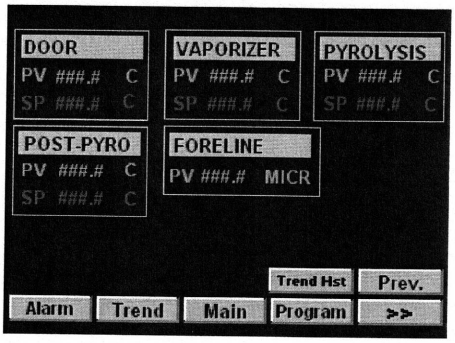
Tuning Procedure:

4. Determine whether "Tune" or "Tune at setpoint" will be performed. If "Tune at Setpoint" will be performed, heat all zones to setpoint before continuing.

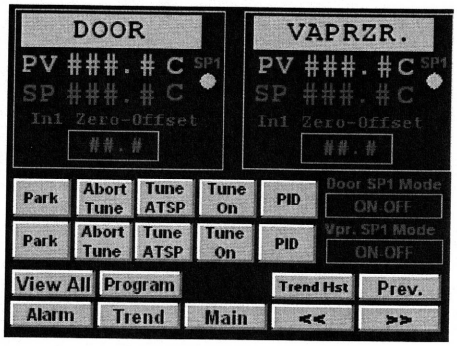
   If "Tune" will be performed, ensure that all zones are first at ambient temperature and then proceed.

5. Turn the main power circuit breaker switch to the ON position. At the main Screen,

hit >> which will cause the "View All" screen to be displayed.



6. On the display, select (touch) the zone to be tuned. For example, touch the DOOR zone to tune the DOOR heater. The following screen will then be displayed.



Press the "**Tune On**" button to "**Tune**" **the zone** or press **Tune ATSP** to **Tune at setpoint**.

The **Auto-tune** program is now activated. **Tune or ATSP will appear in the box underneath "Door SP1 Mode"**.

7. When tuning has completed, (approximately 45 minutes for Door and Vaporizer **heaters** and approximately 30 minutes for Pyrolysis and Post-Pyro **heaters**) the display underneath **"Door SP1 Mode"** should indicate **"PID"** which indicates that the Auto-tune program has successfully completed.

   Otherwise, the program will return a **"FAIL"** indication in the box under **"Door SP1 Mode"**.

8. The common causes of a failed **Auto-tune** are shown under the **Error Messages** section below.

9. Repeat step 1 to step 4 for auto-tuning the other heat zones (either **Tune** or **Tune at Setpoint**). **The FORELINE vacuum zone cannot be Tuned. Only heated zones are Tuned.**

10. Once the Auto-tune program exits successfully, a new set of parameters gets loaded into the memory of the PID controller. The process value will be stable (very small oscillations about the setpoint).

Error Messages

Failures during the **Auto-tune** cycle can be caused by the thermal characteristics of the load (heaters) exceeding the **Auto-tune** algorithm limits.

Recommended actions:

1. Try "Tune At Setpoint" instead of "Tune"
2. Make sure the Tune program starts when the load is at ambient temperature (not above)
3. **Change the condition:** raise the setpoint (see Tune or Tune at Setpoint criteria above)

Appendix A

Coating Program Parameters

Program #	Program Duration	Number of segments
1	35 minutes	4
2	65 minutes	4
3	120 minutes (2 hours)	12
4	150 minutes (2.5 hours)	7
5	165 minutes (2.75 hours)	16
6	180 minutes (3 hours)	7
7	195 minutes (3.25 hours)	7
8	225 minutes (3.75 hours)	16
9	240 minutes (4 hours)	7
10	300 minutes (5 hours)	16
11	330 minutes (5.5 hours)	16
12	360 minutes (6 hours)	16
13	390 minutes (6.5 hours)	16
14	420 minutes (7 hours)	16
15	450 minutes (7.5 hours)	16
16	1485 minutes (24.75 hours)	15

Appendix B

Parylene Deposition Troubleshooting Guide

This troubleshooting guide outlines corrective actions to be considered for resolving common Parylene Deposition System malfunctions. In the event of a conflict with work instructions specified by the end-user, the approved Para Tech work instructions will govern.

Trouble	Possible Cause	Corrective Action
Vacuum Leaks	O-ring damages	Check all o-rings between loading door and cold trap exit to ensure that no silicon o-ring damage occurred during maintenance.
	Frozen cold trap o-ring(s)	Determine if cold trap/mechanical chiller was activated before the system was evacuated. Disassemble cold probe and cold trap o-ring, remove condensation, re-grease and retry evacuation.
	Misplaced quick clamps	Inspect all quick clamps removed during maintenance and check that each is properly installed. The clamp should embrace both flanges with metal and silicon o-ring centered. No excessive pressure or torque should be necessary to tighten the quick clamps.
	Teflon tape seal at Foreline vacuum gauge sensor	Determine if Foreline vacuum sensor was properly re-installed with the use of Teflon tape (or equivalent) around the threads. No excessive pressure or torque should be necessary to tighten the sensor
	Faulty Manual Vent Valve	Inspect the Manual Vent Valve. Any malfunction of the internal mechanism when the valve is closed will permit air inflow to the system.
	Teflon tape seal at Manual Vent Valve	Determine if Manual Vent Valve has a good seal at its Teflon-taped joints. No excessive pressure or torque should be necessary to tighten the joints.
	Damaged vacuum hose	Inspect the orange hose(s) used as joints inside the deposition module. This hose is used to ease separation of tubing for maintenance, and excessive force used during maintenance could deform or damage the hose and jeopardize connections.
Heating	Defective thermocouples	Check that the heated zone in question has a

Appendix C

System daily preventive maintenance worksheets

Component/Location	Monday				Tuesday			
Run	1	2	3	4	1	2	3	4
Door								
Door O-ring								
Vaporizer Chamber								
Chamber entry tube								
Chamber inner surfaces								
Chamber lid o-ring								
Chamber lid								
Chamber fixture shaft								
Chamber exit fittings								
Chamber exit o-rings								
Chamber exit inner o-ring								
Chamber exit quick clamps								
Cold trap entry fittings								
Cold trap chamber								
Cold trap o-ring								
Chiller cold trap probe								
Cold Trap exit tube								
Cold trap exit adaptor fittings								
Manual main vacuum valve								
Manual vent valve								
Pyrolysis tube								
Quartz Tube								

Appendix C

System weekly preventive maintenance worksheets

Week ending on	MM/DD/YY	MM/DD/YY	MM/DD/YY
Component / Location	Friday	Friday	Friday
Vacuum pump oil level			
Vacuum pump oil condition			
Vacuum pump dirt trap			
Vacuum pump loading opening o-ring A			
Vacuum pump loading opening o-ring B			
Vacuum pump oil vent valve connections			
Vacuum pump oil vent valve			
Vacuum pump ballast valve			
Vacuum pump after filter display			
Comments and/or replaced components			

Appendix C

System monthly preventive maintenance worksheets

Component / Location	MM/YY	MM/YY	MM/YY	MM/YY	MM/YY	MM/YY
Foreline sensor tube						
Foreline sensor connections						
Foreline sensor						
Foreline gauge socket input connector						
Vacuum pump entry outer o-ring						
Vacuum pump oil ballast						
Comments and/or replaced components						

Appendix C

System quarterly preventive maintenance worksheets

Door heater fuse				
Door heater relay				
Vaporizer heater				
Vaporizer thermocouple				
Vaporizer heater fuse				
Vaporizer heater relay				
Pyrolysis furnace				
Pyrolysis furnace thermocouple				
Pyrolysis furnace fuse				
Pyrolysis furnace relay				
Post-pyro heater				
Post-pyro thermocouple				
Post-pyro heater fuse				
Post-pyro heater relay				
Chamber rotary seal				
Manual vent valve connections				
Manual main vacuum connections				
Operator panel				
PID Modules				
PID Modules electrical connections				

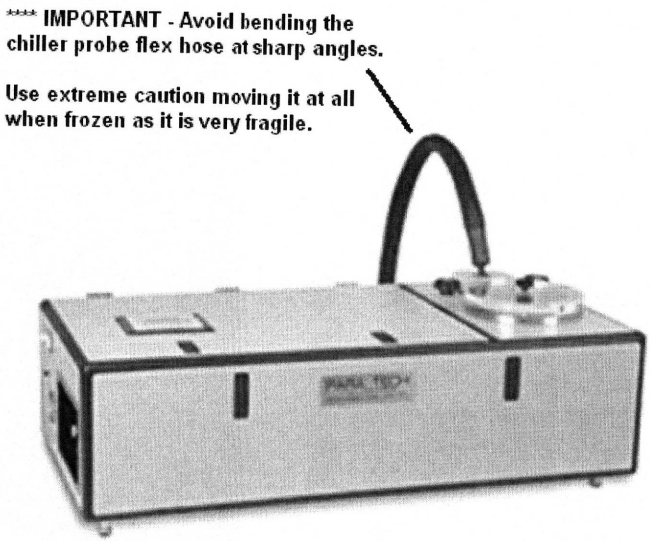
Appendix C

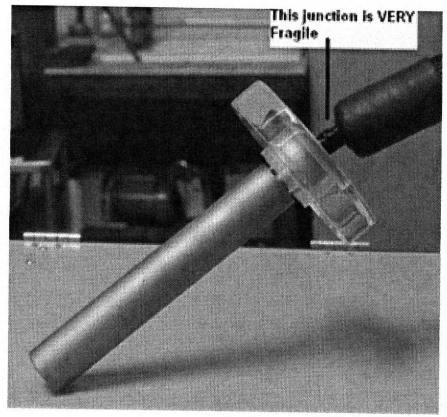
System semi-annual preventive maintenance worksheets

	MM/YY Friday	MM/YY Friday	MM/YY Friday	MM/YY Friday	**Comments and/or replaced components**
Chamber rotary seal o-ring					
Fixture drive gear					
Fixture drive Timing belt					
Fixture drive motor gear					
Fixture drive motor					
Fixture drive switch					
Cold trap-Pump fittings					
Cold Trap -pump o-rings					
Cold trap-pump quick clamps					
Manual main vacuum valve					
Manual vent valve					
Vaccum pump entry quick clamp					
Vacuum pump exit tube					
Vacuum pump exit o-rings					
Vacuum pump exit quick clamp					
Vacuum pump after filter chamber					
Vacuum pupm after filter inner cartridge					

Appendix D – Additional important information

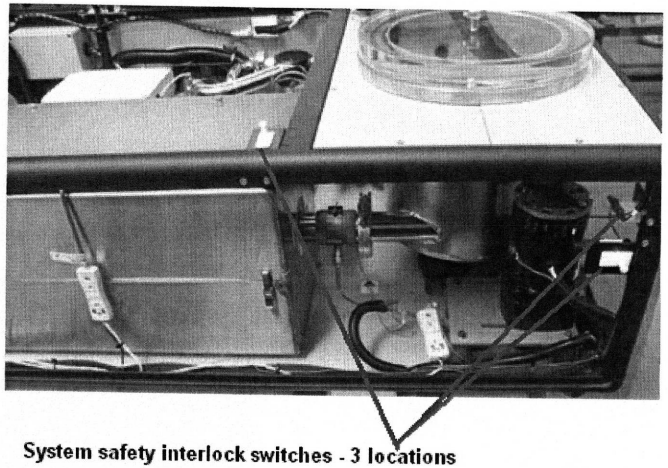
Important Chiller probe information





The cold probe houses RTD sensors that relay temperature feedback information to the chiller. The junction between the flex hose and the chiller probe must be handled with the utmost care.

System Safety Interlock Switches

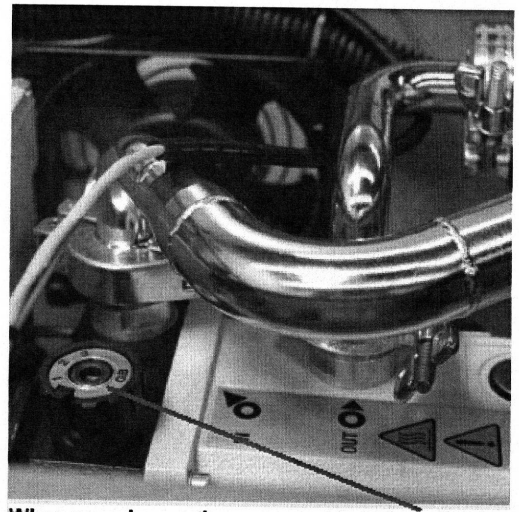


System safety interlock switches - 3 locations

These interlock switches prevent system operation when the panels are removed. They can be bypassed if necessary by pulling them out to their fully extended positions.

Coating runs SHOULD NOT be performed with the panels removed as system tuning may be adversely effected.

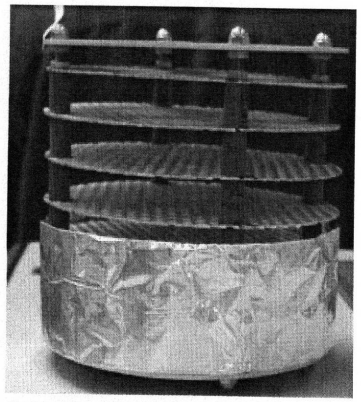
Vacuum pump ballast setting



When warming up the pump, set it to the ballast position for the first 20 to 30 minutes prior to pumping the system down.

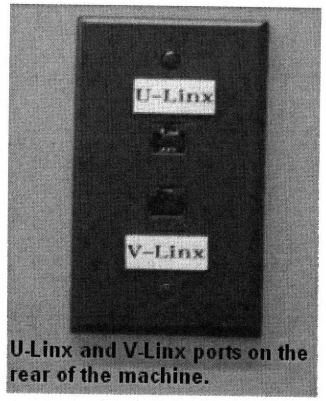
Commented [EL14]: Which setting is the "Ballest" setting? It just says 1,2,3 on the pump gage you are showing in your picture.

Substrate fixture with 3-inch aluminum foil barrier



Substrate fixture with 3 inch aluminum foil barrier

U-Linx and V-Linx ports



U-Linx and V-Linx ports on the rear of the machine.

The U-Linx and V-Linx ports are used for computer and internet access respectively, and are used when engineering technical support assistance is required remotely