

PDS 2010 LABCOTER™ 2 Parylene Deposition System Operator's Manual

System Serial Number: _____

Prepared for: _____

**Make certain that everyone associated with this instrument
becomes knowledgeable about the material contained in this manual
before using the equipment.**

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SPECIALTY COATING SYSTEMS™

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MODEL NO. SERIAL NO.

VOLTS AMPS PHASE HZ

INT. CAPACITY AMP MFG. DATE

SCHEMATICS

Specialty Coating Systems



DECLARATION OF CONFORMITY

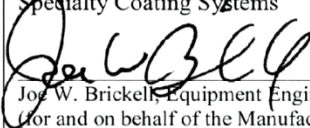
Manufacturer:	Specialty Coating Systems 7645 Woodland Drive, Indianapolis IN 46278, USA
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Low Voltage Directive & Standards	<p>DIRECTIVE 2006/95/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 December 2006 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (codified version)</p> <p>BS EN 61010-1:2001 IEC 61010-1:2001 - Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements</p>
Electromagnetic Compatibility Directive & Standards:	<p>DIRECTIVE 2004/108/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC</p> <p>EN 61326-1:2006 Electrical equipment for measurement, control and laboratory use — EMC requirements — Part 1: General requirements (IEC 61326-1:2005)</p>
Signature:	<p>Specialty Coating Systems</p>  <p>Joe W. Brickell, Equipment Engineering Manager (for and on behalf of the Manufacturer)</p>
Date:	

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1 SAFETY

This equipment is designed to be used in the specific manners designated. Key elements in the design promote operator safety and assure that there will be no damage to the product being coated. The equipment complies with all applicable sections of NFPA Article 79 of the National Electric code (NEC). All commercially standard components used in this machine have a minimum of UL and/or CSA ratings. Components built to CE standards have been used wherever possible. Any local or regional certifications required above and beyond the aforementioned are the responsibility of the customer. Efforts are also continuously made to include CE compliant components wherever possible.

1.1 GENERAL INFORMATION

The following warning symbols are used throughout this manual:



HOT SURFACE



ELECTRICAL SHOCK



FREEZING HAZARD



GENERAL WARNING

This equipment is designed to be used in the specific manners designated. The equipment complies with all applicable sections of NFPA Article 70 of the National Electric Code (NEC). Any local or regional certifications required above and beyond the aforementioned statement are the responsibility of the buyer.



WARNING: Safety pays. Improper operation or service of the 2010 can result in serious injury or death. Read and understand this entire instruction manual before operating or servicing this equipment.

- Think before you act. If you have any doubts regarding how to use this equipment safely, contact SCS Technical Support.
- The 2010 is not intended nor recommended for extended periods of unattended operation.
- Follow normal industrial safety practices with respect to 100-220 volts AC and moving parts.
- Use of this machine for anything but its intended purpose may create a safety hazard and void the equipment warranty.



CAUTION: The 2010 is equipped with a grounding-type power plug, which must be connected to a grounded outlet to prevent electrical shock.

General Hazards posed by the 2010 include:

- Electric shock
- Thermal burns
- Contact freeze injury by cryogenic apparatus
- Catastrophic loss of vacuum

If any Safety Labels are damaged, defaced, removed, or are otherwise unreadable, replace the labels.

1.2 MSDS

Material Safety Data Sheets (MSDS), included on the CD inserted inside of the back cover, are *for user reference only*. Contact your Material Safety Manager for complete updated MSDS sheets. The most up-to-date Parylene MSDS's are available on the SCS website (www.scscoatings.com) in the technical library.

The Material Safety Data Sheets cover the following topics:

- Parylene C Dimer, D Dimer, and N Dimer
- Edwards Super Grade A Pump Oil
- Ceramic Fiber Heaters
- Micro Liquid Laboratory Cleaner
- Vacuum Grease & Oil
- A-174 Silane

1.3 VAPORIZER AND PYROLYSIS SECTION



Under normal operating conditions, the vaporizer, pyrolysis furnace and gauge tube are maintained at high temperatures and are powered from 100-110 volts AC. These areas are enclosed within the PDS 2010 cabinet and should not be touched when the machine is powered or during cool down after a coating cycle.

1.3.1 Pyrolysis Furnace



The pyrolysis furnace is composed of a material called Refractory Ceramic Fiber (RCF). This material has been classified as a possible carcinogen. The furnace is rigidized on the surface and therefore much less likely to cause loose floating particles.

The main concern to our customers arises if there is ever a need to remove the furnace. During normal operation of the equipment, no particles of dust would be developed. If removal is necessary, use safety glasses, gloves, and a dust half-mask for handling and shipping activities. This will provide protection in case the rigid skin is breached and the interior material becomes airborne.

If any of the material, most likely next to the heating elements, reaches 1000°C, a chemical change takes place that forms cristobalite. This material can cause a respiratory disease called silicosis. Again, the risk of dust exposure to the customer is minute under normal operation, because normal furnace operating temperature is substantially lower than 1000°C.

1.4 DIMER LOAD DOOR



The load door heating element is controlled as a part of the vaporizer. A metal shield covers the heating element to protect against electric shock. When the vaporizer is enabled, this shield becomes hot. This part of the coating unit should not be touched during heat-up, deposition, or cool down after a coating cycle. *Wear protective gloves if it becomes necessary to open the load door when the door is hot.*

1.5 DEPOSITION CHAMBER VACUUM SENSOR



The chamber vacuum sensor must be heated to prevent deposition of Parylene on the sensing elements. *Wear protective gloves if it becomes necessary to handle the heating element or the sensor itself when they are hot.*

1.6 INLET BAFFLE



Wear protective gloves when removing the inlet baffle from the deposition chamber after a coating run. This baffle may become heated to temperatures in excess of 200°C via radiation from the pyrolysis furnace during deposition.

1.7 GLASS VIEWPORTS

Glass viewport(s) are provided to allow viewing of the substrate and fixture during the coating process. A viewport that is damaged or improperly installed poses a potential implosion threat while the chamber is under vacuum. Such an implosion would likely damage the substrate and/or the coating equipment, and could possibly cause personal injury.



CAUTION: Do not operate the 2010 if one of the viewports is cracked or improperly installed. Avoid impacts to the viewport surfaces while the system is under vacuum.

1.8 SERVICING

Follow the Serial Number Label for voltage, frequency, phase, and current requirements. See the schematic for proper connections. When connecting power, supply a secure and adequate ground. Failure to do so creates a potential electrical shock hazard.

Before servicing, remove all power. If it becomes necessary to perform diagnostic service with certain areas of the machine powered, only qualified personnel should perform the service. Follow all normal industrial safety practices when dealing with electrical systems. Review and understand the electrical schematic before attempting any electrical diagnostic service.

Extensive electrical grounding has been provided throughout the machine to reduce shock and explosion hazards. If any ground wire is found to be damaged or disconnected, **do not operate the machine** until this condition has been corrected.



CAUTION: Unless service is being performed by qualified and authorized personnel, close all access panels to the 2010 cabinet whenever the machine is powered.

1.9 NITROGEN

Nitrogen is a colorless, odorless, and tasteless gas that makes up about 78% of the atmosphere.



WARNING: Nitrogen can cause rapid asphyxiation and death in confined, poorly ventilated spaces. Nitrogen, as a liquid or gas, may cause severe frostbite to the eyes or skin. Do not touch frosted pipes or valves. If exposure occurs, restore tissue to normal body temperature (37°C/ 98.6°F) as rapidly as possible, followed by protection of the injured tissue from further damage and infection. Call a physician immediately. Rapid warming of the affected part is best achieved by using water at 42°C/108°F. Under no circumstances should the water temperature be over 44°C/112°F, nor should the frozen part be rubbed, either before or after re-warming. The patient should not smoke or drink alcohol. Keep warm and at rest.

KEEP THE EQUIPMENT AREA WELL-VENTILATED.

Nitrogen cannot be detected by the human senses. If adequate ventilation is not provided, this gas may displace normal air and develop a life-depriving atmosphere without warning. If there is doubt about the adequacy of the ventilation, use an oxygen analyzer with a 0 to 25% scale to check for oxygen. Any atmosphere that does not contain enough oxygen for breathing (at least 18%) can cause dizziness, unconsciousness, or even death. Store Nitrogen containers outdoors or in other well-ventilated areas. Never enter a tank, pit, or other confined area where these gases may be present until the area is purged with air and tested for a breathable atmosphere (of at least 18% oxygen) using a gas analyzer.

LIQUID NITROGEN IS EXTREMELY COLD. COVER YOUR EYES AND SKIN.



WARNING: Accidental contact of Nitrogen, as a liquid or gas, with the eyes or skin may cause severe frostbite. Handle liquid carefully to avoid a splash or spill. Protect your eyes with safety goggles and face shield, and cover skin to prevent contact with the liquid, cold gas, or with cold pipes and equipment. Protective gloves, without gauntlet, that can be quickly and easily removed and long sleeves are recommended for arm protection. Wear cuffless trousers outside of boots or over high-top shoes to shed spilled liquid.

Consult with your supplier for safe disposal and other safety information concerning the use and handling of Liquid Nitrogen.



CAUTION: The 2010 is available with an optional mechanical chiller unit. The surface of the probe with this configuration can reach temperatures below negative 120°C. Exercise caution to avoid direct skin contact with the probe of a mechanical chiller cold trap when it is cold.

2 EQUIPMENT SPECIFICATION

2.1 PDS-2010

Dimensions (Nominal)	Width 19.5 in (49.5cm) Height 50.5 in (128.3cm) Depth 23.75 in (60.4cm)
Operating Environment	An ambient temp or 60–80°F is desired. Temperatures above 90°F will decrease coating efficiency and may cause electronic equipment to shut down. Relative Humidity should be kept between 5%–95%.
Weight	170 lb. (77 kg)
Chamber Size	12 inch dia. X 12 inch high (8.5"/31.5cm Dia. X 11.19"/28.4cm H, useable size) Other chamber designs available
Power	110/220 VAC, single phase, 50-60 Hz, 20/12 A (Specified at time of purchase)
Dimer Capacity	125 grams
Vacuum Pump	8.5 CFM, two-stage, direct drive
Exhaust	Approx. 8.5 CFM @ 0.1 Inch Water (14.5M ³ /H)
Cold Trap	Optional Mechanical Chiller, LN ₂ (connect with 3/8" O.D. tube), or Manual Fill Probe
Controls	Computerized sequencing using microprocessor temperature and process controllers. Automatic and semi-automatic operation with fault condition and end-of-run monitoring for controlled shutdown sequence.

2.2 TUMBLER OPTION

Dimensions	Attaches to Optional Chamber with Removable Lid No additional floor space required
Weight	12 lb. (5.4 kg)
Canister Size	6 inch dia. x 6 inch long
Power	0–130 VDC, 0.3A (Supplied by Labcoter™)
Load Capacity	68 Cubic Inches (1.1L) [At 40% fill]
Controls	Controlled from Labcoter™

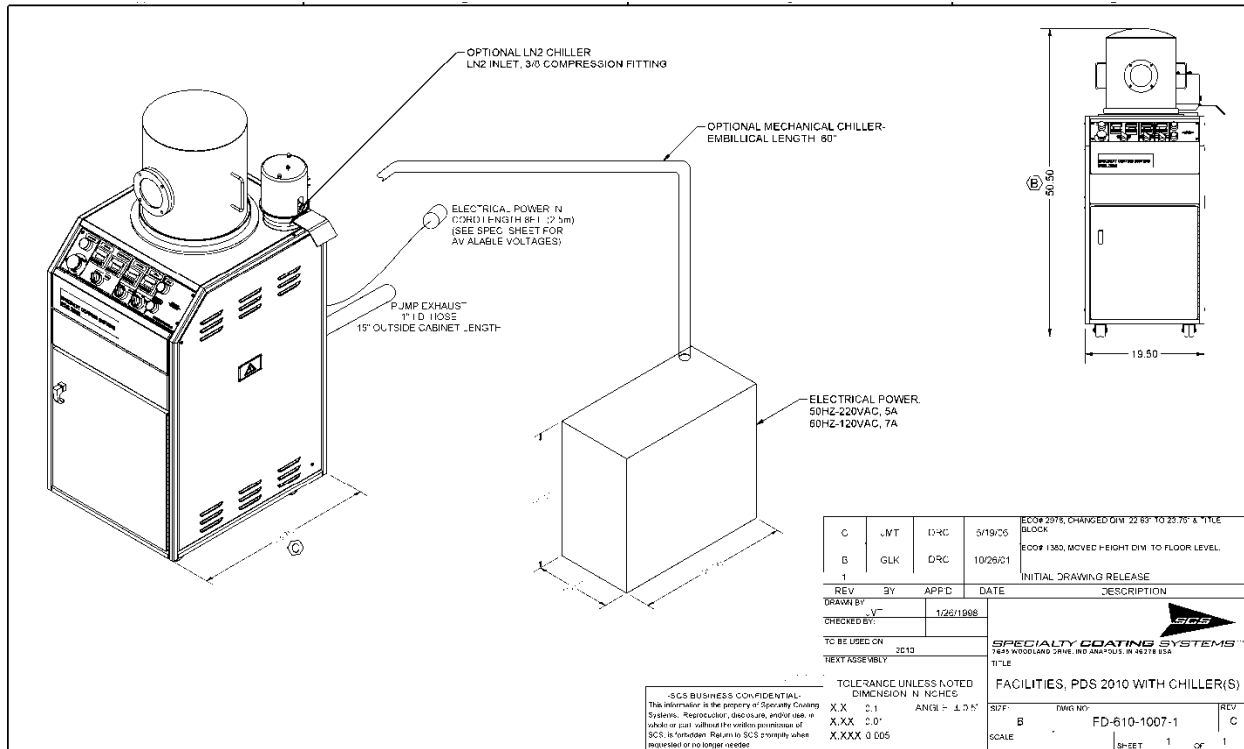


Figure 2-2 Facilities Drawing

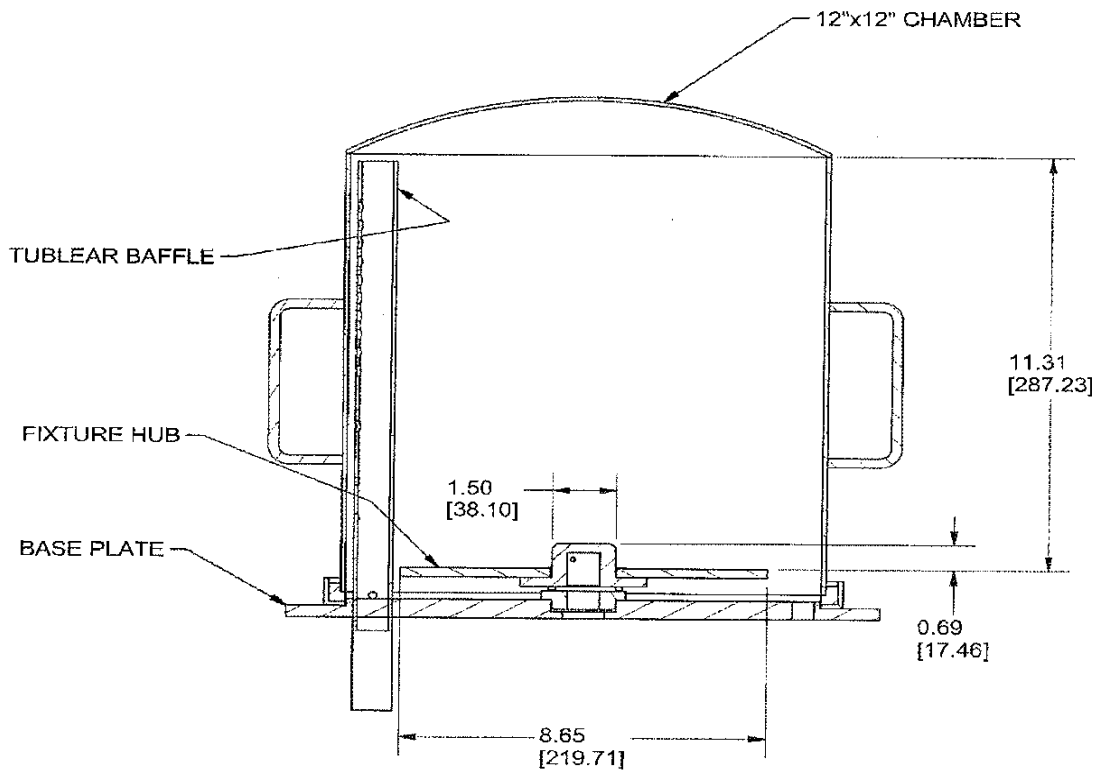


Figure 2-2 Useable Chamber Size

3 OVERVIEW

The Labcoter™ 2 (PDS 2010) is the first portable Parylene Deposition System of its kind. It is designed for the occasional Parylene user, and is ideal for experimentation and small production runs.

The Labcoter™ 2 weighs 170 lbs. and is powered by either 100, 110, or 220 VAC with 20, 18, or 12 amp services. The 24" x 19.5" x 52" high cabinet is small enough to fit in almost any lab environment. The portable system is mounted on casters, making it easy to maneuver into place for operation or storage.

Operation of the system is simple. The operator only needs to place the parts to be coated in the fixture, load the Parylene charge, and set the machine for automatic operation.

In automatic operation, the system pumps down to a preset pressure while the furnace and chamber gauge cycle up to their operating temperature. When all temperatures and the pressure are within set operating parameters, the vaporizer will automatically begin sublimation of Parylene. The system will shut down after the process parameters indicate all the dimer has been vaporized.

Throughout the process, temperatures and pressures are continuously monitored. A deviation from the set point operating ranges will initiate an audio and visual alarm, at which time a fault timer will begin timing out. If the fault is not cleared within the time allowed, the process will be halted and secured. In the event of a power interruption, the process will secure itself while preserving the vacuum.

The PDS 2010 operates with any of the following cold trap options:

- Mechanical Chiller
- Manual-fill LN₂ cold trap
- Automatic-fill LN₂ control

3.1 PURPOSE OF EQUIPMENT

The PDS 2010 is a vacuum system used for the vapor deposition of Parylene polymer onto a variety of substrates. The clear polymer coating, formed on the substrate, provides an extremely effective chemical and moisture barrier, with high dielectric and mechanical strength.

The PDS 2010 sublimates Parylene dimer into a gaseous monomer. The monomer then polymerizes, at room temperature, onto the substrate. There is no intermediate liquid phase or separate cure cycle. At the vacuum levels employed, all sides of the substrate are uniformly impinged by the gaseous monomer, resulting in a truly conformal coating.

3.2 VACUUM CONCEPTS

An understanding of basic vacuum concepts and terminology is required prior to describing the Parylene deposition process.

3.2.1 Vacuum Pumps

A vacuum pump is a device that is used to reduce and maintain the gas pressure in a vessel below atmospheric pressure. The PDS 2010 uses the EDWARDS RV 8 (60 HZ) or EDWARDS RV12 (50 HZ) vacuum pump.

3.2.2 Vacuum

A vacuum is generally considered to be any closed system with a pressure less than atmospheric pressure. The weight of the Earth's atmosphere, pressing each unit of surface area constitutes atmospheric pressure, which is 14.7 psi at sea level. This pressure is called one atmosphere. Anything less than one atmosphere of pressure is a vacuum. In other commonly used units, one atmosphere equals 29.92 inches of mercury (inch Hg), 760 mm Hg, 760 Torr, and 1.013 bar.

The term "vacuum units" is used frequently in this manual to indicate a pressure reading on the equipment control panel. Vacuum units are essentially the same as milliTorr and are used to optimize accuracy in the 10 to 80 milliTorr range (the primary interest for processing/deposition). This choice facilitates the calibration procedure (to minus 4 using a zero pressure simulator).

3.2.3 Pressure

It is important to understand the term "pressure" when used to describe a vacuum. We are actually referring to absolute pressure, which is the pressure measured above a "perfect" vacuum (zero pressure). A perfect vacuum would be defined as any closed volume that contains absolutely no gas molecules. This perfect vacuum condition does not exist in the real world; every closed container contains at least some gas molecules, and therefore, has some pressure. It is helpful to think of a real world vacuum as an evacuated enclosure filled with a low pressure gas. This manual will use the units of Torr and milliTorr (1×10^{-3} Torr) to describe the pressure level above a perfect vacuum, and "vacuum units" to describe relative levels. **Table 3-1** relates commonly used terms for measuring the pressure of a vacuum to the percent of perfect vacuum. The Parylene deposition process typically takes place in the 10 to 100 milliTorr range, considerably lower than atmospheric pressure.

3.2.4 Vacuum Levels

Vacuum is usually divided into five levels, qualitatively labeled: Low, Medium, High, Very High, and Ultra High. A Low vacuum relates to having a relatively high pressure and a Very High vacuum having a relatively low pressure.

Low Vacuum represents pressure above 1 Torr absolute. Flow in this range is viscous, as represented by most common fluids. Mechanical vacuum pumps are used for low vacuum, and represent the large majority of pumps in industrial practice.

Vacuum	Torr	milliTorr	PSIA	Inches Hg	Atmosphere
Atmosphere	760	760 000	14.7	29.92	1.0
Low	100	100 000	1.93	3.94	0.132
Low	1	1000	0.019	0.0394	0.00132
Med.	0.100	100	1.93×10^{-3}	3.94×10^{-3}	1.32×10^{-4}
Med.	0.010	10	1.93×10^{-4}	3.94×10^{-4}	1.32×10^{-5}
High	$0.001 (10^{-3})$	1	1.93×10^{-5}	3.94×10^{-5}	1.32×10^{-6}
Very High	(10^{-6})	$0.001 (10^{-3})$	1.93×10^{-8}	3.94×10^{-8}	1.32×10^{-9}
Ultra High	(10^{-9})	(10^{-6})	1.93×10^{-11}	3.94×10^{-11}	1.32×10^{-12}

Table 3-1 Equivalence Table for Pressure/Vacuum Measurement

Medium Vacuum represents pressures between 1 and 1×10^{-3} Torr absolute. This is a transition range between viscous and molecular flow. Most pumps serving this range are also mechanical. The 2010 performs the Parylene deposition process in the medium vacuum range.

High Vacuum represents pressures between 1×10^{-3} and 1×10^{-6} Torr absolute. Flow in this region is molecular, with very little interaction between individual molecules. Many specialized applications for the semiconductor manufacturing industry fall in this range. Diffusion pumps, turbomolecular, and cryogenic pumps are typically used in this range.

Very High Vacuum represents absolute pressures between 1×10^{-6} and 1×10^{-9} Torr.

Ultra High Vacuum represents absolute pressure below 1×10^{-9} Torr.

3.2.5 Gas Flow

When a closed container at atmospheric pressure is evacuated by virtue of a vacuum pumping system, the flow of gas through the container will pass through one or more flow regimes. The flow regime in a container is determined by the mean free path of the enclosed gas molecules and the dimensions of the container or pipe diameter.

3.2.5.1 Mean Free Path

The mean free path is basically the average distance that a gas molecule will travel before colliding with another gas molecule. At atmospheric pressure, the mean free path is about 2×10^{-6} inch. The mean free path is inversely proportional to pressure. As the pressure is decreased, the average distance a gas molecule will travel before colliding with another gas molecule will increase.

3.2.5.2 Flow Regimes

In pumping down from atmosphere, the vacuum system may pass through all the different flow regimes from turbulent to viscous to transition and ultimately to molecular flow conditions.

Turbulent flow is usually short lived and associated with the very beginning of a vacuum system being pumped down. As the vacuum valve is opened, gas begins to flow from the system in a disorderly fashion. Swirling whirlpools of gas can appear briefly. As things settle down, the turbulence disappears and the gas leaves the system in an orderly fashion.

Viscous flow (laminar flow) is the flow of a gas through an enclosure under conditions such that the mean free path of the gas molecule is very small in comparison to the smallest dimensions of the enclosure. The character of the flow is determined by gas molecule-to-molecule collisions. The gas leaves the system as any viscous fluid would with the molecules striking each other and dragging other molecules along with them.

Transition flow is the flow of gas through an enclosure under conditions such that the mean free path is of the order as the dimensions of the enclosure. In this flow regime, the flow characteristics are determined by collisions of the gas molecules with surfaces as well as with other gas molecules. This is the "gray" area separating viscous flow and molecular flow.

Molecular flow is the flow of gas through an enclosure under conditions such that the mean free path is much greater than the dimensions of the enclosure. At these low pressures (high vacuum), the flow characteristics are determined by collisions of the gas molecules with the enclosure surfaces, and the flow effects from gas molecule to gas molecule collisions are insignificant. Molecular flow is not really a flow at all; but rather a random bouncing back and forth of the molecules from wall to wall, with the progress of molecules through the vacuum system a matter of statistical thermodynamics. The Parylene deposition process occurs between the transitional and molecular flow regimes.

3.2.5.3 *Throughput*

Throughput in the context of vacuum systems refers to the amount (usually expressed in volume) of gas that passes a certain point in a given time. The throughput of a vacuum pump at a particular operating pressure is referred to as pumping speed.

Another related topic to throughput is conductance. Similar to the term in electricity, conductance refers to the throughput of a gas in relation to the pressure drop across a particular segment of a vacuum system. The higher the conductance, the easier it is for a gas to flow.

3.2.6 *Outgassing*

If all the gases to be removed from a vacuum chamber were located exclusively in the free volume bounded by the vessel walls, system pump down would occur relatively quickly. However, in practice this will never be the case. Outgassing, the slow release of trapped gases and vapors from the interior surfaces and materials of the vacuum system and the substrate, will act to lengthen the actual pump down time.

Many gas molecules are attached to surfaces and are gradually released as the system pressure lowers. Other molecules may be imbedded in certain substrate materials (such as rubber, plastics, and fibrous materials) which, under vacuum, diffuse through the material toward its surface and are eventually released to the vacuum chamber. Minute cracks and spaces can trap molecules which will not release until lower pressures are achieved within the chamber. Extremely small leaks will also provide a steady stream of molecules into the vacuum vessel, which can be difficult to discern from true outgassing. Regardless of the cause, severe outgassing will result in longer pump down times, and can have detrimental effects on coating quality.

3.3 *Vacuum Pressure*

The pressure of the system is monitored inside the vacuum chamber. The chamber pressure is the most critical to the process. Unless otherwise specified, any references to pressure by SCS will mean the chamber pressure. The chamber pressure sensor (simply called “gauge tube” herein) is heated during processing so that Parylene does not deposit on it. This heating *does* change the tube’s response, but in a small, repeatable, and predictable way.

3.3.1 *Base Pressure*

Base pressure is defined as the lowest attainable steady state pressure of a given vacuum system. There is a practical limit to its value. Due to variations in vacuum components, monitoring equipment, and substrate composition, the base pressure of a particular vacuum system can vary over time and from machine to machine. Refer to section 3.11 of this manual for the procedures to determine the base pressure.

3.3.1.1 *Hot Base Pressure*

The hot base pressure of a system is the lowest attained pressure when all heaters, except the vaporizer, are heated to normal processing temperatures.

3.3.1.2 *Cold Base Pressure*

Cold base pressure means that NO component in the system is heated during the measurement; this does not normally occur except when special testing is being done.

The SCS convention is that whenever the term “base pressure” is used, it is understood to be hot base pressure. If other components in the system are heated, these conditions must be clearly explained and understood.

3.3.2 Coating Pressure

Coating pressure is generally defined as the desired chamber pressure to be maintained during a vacuum process. With Parylene deposition systems, coating pressure is the most important factor, affecting substrate coating quality. In general, a higher coating pressure will result in a shorter coating cycle, but excessive coating pressures will result in unacceptable coating quality- such as cloudiness, frosting, or formation of coating nodules. The process goal is to identify the highest coating pressure that results in an acceptable coating quality for each application.

3.4 PARYLENE

3.4.1 Parylene Types

Parylene is the generic name of members of a unique polymer series developed by Union Carbide Corporation. As the Parylene deposition process matured, a group eventually separated from the parent company, and SCS was formed.

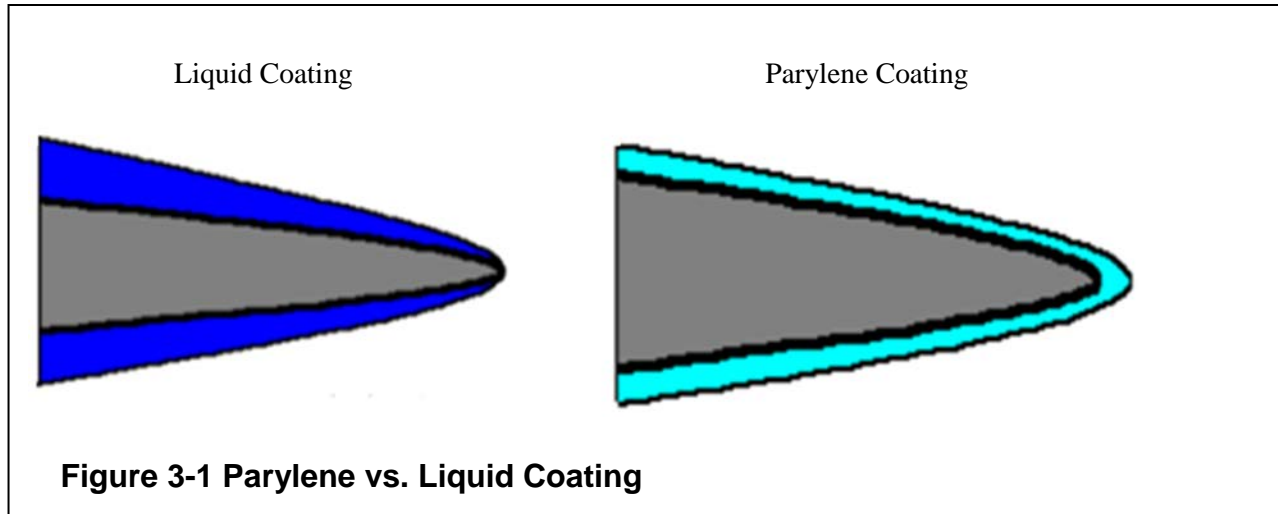
Parylene is applied, in a vacuum chamber, at room temperature. Deposition takes place at the molecular level as the chemical is converted, under vacuum and heat, from the powdered dimer form to a clear polymer film. Unlike liquid coatings, Parylene is deposited in equal thickness on all surfaces, including around sharp edges and in deep crevices see Figure 3-1.

Parylene has three primary variations—C, N, and D. The equipment settings and final product properties differ slightly for each variation. Detailed information on the properties is available upon request or at our web site, www.scscoatings.com.

Parylene N is the basic member of the series. Parylene N is poly-P-xylylene, a completely linear, highly crystalline material. Parylene N molecules are extremely elastic and will "bounce" around many times before depositing and polymerizing. This results in greater penetration, into small openings, than other types of Parylene. The expected increase of pressure in the deposition chamber during a coating run is controlled at a higher pressure than the other Parylene types. Parylene N deposits at a rate of approximately .00003" per hour, a much slower rate than Parylene C or D.

Parylene C is commercially available and is produced from the same monomer modified only by the substitution of a chlorine atom for one of the aromatic hydrogen atoms. Parylene C molecules are less elastic than N molecules and "bounce" around considerably less than N. The pressure in the Deposition Chamber is controlled at a value of approximately one half that for Parylene N. Deposition rates for Parylene C are in the order of .0002" per hour.

Parylene D is commercially available and is produced from the same monomer modified by the substitution of two chlorine atoms for two of the aromatic hydrogen atoms. Parylene D molecules are not very elastic. They will deposit and polymerize very quickly upon entering the deposition chamber. The associated pressure rise during deposition is quite low. If the use of Parylene D is required for your application, contact SCS Engineering for special process considerations involved with its use in the 2010.



3.4.2 Parylene Deposition

Parylene is formed (deposited) directly from a rarefied atmosphere of gaseous monomer. There is no intermediate liquid phase and no "cure" cycle. The deposition and formation of Parylene on a substrate can be viewed as a condensation process taking place, at room temperature, in a vacuum chamber.

3.4.2.1 The Deposition Process

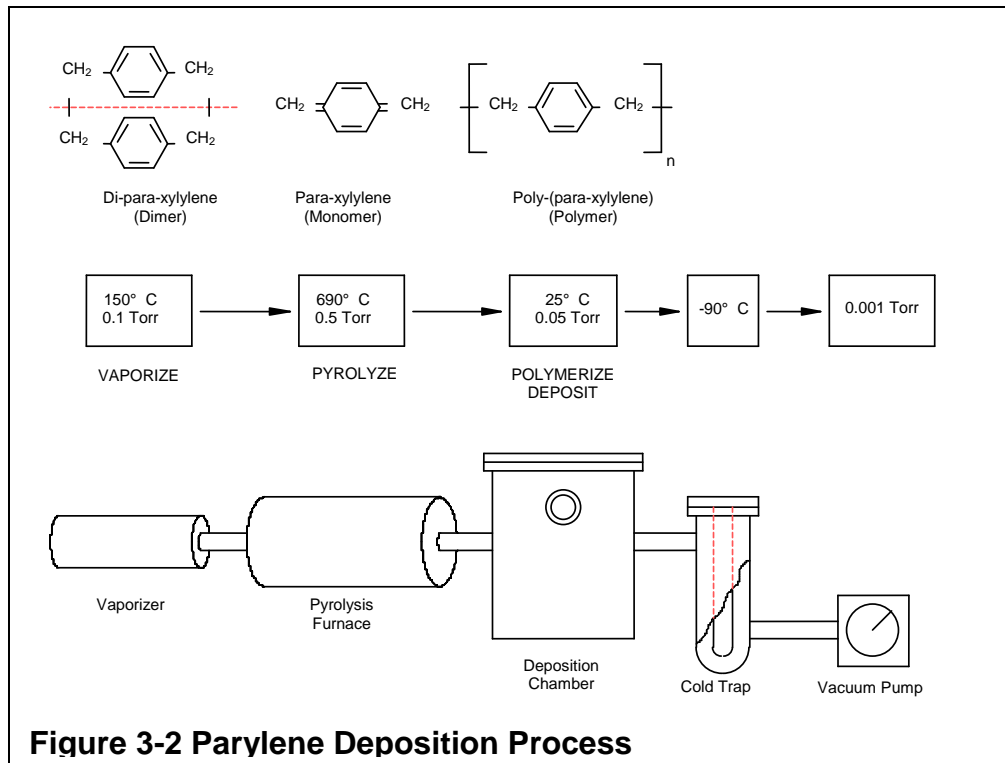
Parylene polymers are deposited from the vapor phase by a process that resembles vacuum metallizing. Unlike vacuum metallization, which is conducted at a pressure of 1×10^{-5} Torr or below, Parylene is formed at around 1×10^{-2} Torr. Also, Parylene deposition is not line-of-sight; all sides of an object, to be encapsulated, are uniformly impinged by the gaseous monomer. This results in the truly conformal nature of the coating.

The deposition process consists of the following steps done in the presence of a medium vacuum:

1. **Vaporization:** Parylene is vaporized from its solid dimer form. This is accomplished by the application of heat under vacuum.
NOTE: The appropriate term for passing directly from a solid to a gas is sublimation. However, the industry has conventionally used the term vaporization in conjunction with the Parylene process. This convention is maintained throughout this manual.
2. **Pyrolysis** (cleaving) of the gaseous form of the dimer into a monomer is achieved by using a high temperature tube furnace.
3. **Polymerization** of the gaseous monomer occurs at room temperature as the Parylene deposits as a polymer onto the substrate in the vacuum chamber.

3.4.2.2 Deposition Equipment

All Parylene deposition equipment must be able to accomplish these three steps. **Figure 3-2** depicts the block diagram of a typical Parylene deposition system consisting of the five main components, connected in series. The Parylene coating system is a sealed system consisting of tubes and chambers that allow gas to flow from the vaporizer section, through the pyrolysis zone, into the deposition chamber, past the cold trap, and then through the vacuum pump (which exhausts to the atmosphere).



3.4.2.3 Typical Coating Cycle

1. The substrate to be coated is loaded on the fixture base plate and the chamber is placed over it.
2. Parylene, in its dimer form (similar in appearance to powdered laundry detergent), is loaded into the ambient temperature vaporizer zone through the load door. The door is then sealed. The amount of dimer loaded is dependent upon the required coating thickness, total surface area of substrate, and deposition chamber size.
3. The sealed system is pumped down by the vacuum pump to a steady state pressure of 1-100 milliTorr, as indicated by a vacuum sensor connected to the deposition chamber. This is the base pressure as described in Section 3.11.



NOTE: In this example the pyrolysis zone has been preheated to approximately 690°C and the chiller probe has been cooled to less than -90°C.

4. Once system base pressure has been reached in step three, the vaporizer zone begins to heat to 120-180°C. The vaporizer heater is cycled On/Off by the chamber pressure controller in order to maintain the pressure in the chamber. As the pressure reaches the chamber pressure set point, the power to the vaporizer heater is reduced to prevent the chamber pressure from overshooting. The vaporizer heater is then maintained at a temperature where the chamber pressure is at the pressure set point. This causes the Parylene dimer to slowly vaporize/sublime (go directly from a solid to gas).

5. The pumping action of the vacuum pump causes the dimer gas to flow "downstream" through the pyrolysis zone. The high temperature pyrolysis furnace cleaves the dimer gas to form the Parylene monomer gas. The monomer is very reactive at this point and upon exiting the pyrolysis zone will immediately seek a place to deposit and polymerize.
6. As the reactive monomer gas exits the pyrolysis zone and enters the chamber containing the substrate material, deposition takes place. The monomer will deposit and polymerize on all the ambient temperature surfaces within the deposition chamber; this includes the loaded substrate, fixture, chamber walls, baffles, and any other extraneous surface within the deposition chamber.
7. It is important to note that as the monomer gas flows into the deposition chamber it causes the pressure in the chamber to rise. Typically, the desired pressure rise is 15-30 milliTorr above base pressure for Parylene C. The growth rate of the Parylene film in the deposition chamber is proportional to the partial pressure of monomer gas. In practice, a feedback control system is used to maintain the desired pressure within the deposition chamber by controlling the rate at which dimer is vaporized.
8. Because of the gas flow dynamics associated with the vacuum pump, any monomer gas that flows into the deposition chamber that does not deposit there will tend to flow through the cold trap and toward the vacuum pump. However, because the cold trap is maintained at a sufficiently cold temperature, any monomer gas that enters the cold trap will condense and deposit on the chilled probe surface and not flow into the vacuum pump.
9. When the dimer has been completely vaporized, the pressure in the deposition chamber will decrease and approach the base pressure that was observed in step 3. Once the pressure reaches the base pressure a 5 minute timer will begin counting down to assure that all the dimer has been vaporized. At this point, the deposition cycle is complete; the system can be brought back to atmospheric pressure and the substrate can be removed.

3.5 CONTROL PANEL

This section explains the function and operation of control panel components.

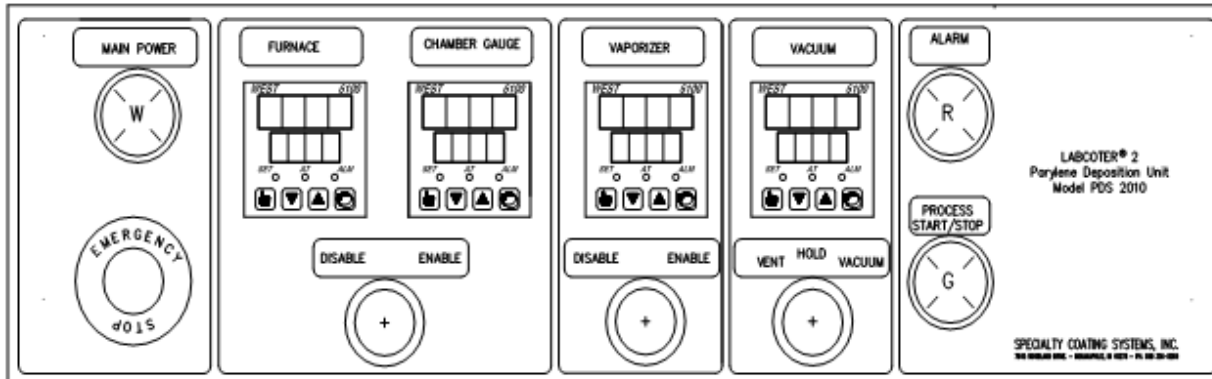


Figure 3-3 Control Panel

3.5.1 Emergency Stop

The Emergency Stop is a rotary type pushbutton. Depressing the Emergency Stop will stop the process. The PDS 2010 will not operate with the Emergency Stop button engaged. To release rotate the button clockwise.

3.5.2 Power

If main power is applied, the white Main Power pushbutton light will illuminate. To energize the machine, depress the white Main Power pushbutton. This will initialize the computer for operation and power the process controllers.

3.5.3 Alarm

If a fault is detected the red pushbutton light will begin to flash and there will be a series of audible beeps. It only illuminates in the case of a system fault during a deposition cycle. The fault code can be determined by counting the beeps or the alarm light flashes (see below). The red alarm light will continue to flash the code every 5 seconds. If the fault condition is not rectified within 5 minutes, shutdown will occur. The audible alarm can be disabled by pressing the Alarm pushbutton.

Code number Cause

- 3 Furnace temperature out of range.
- 2 Gauge tube temperature out of range.
- 1 Vaporizer temperature too high.

3.5.4 Furnace / Chamber Gauge Switch

If the PROCESS START/STOP button is depressed and active (the green button is lit), the Furnace/Chamber Gauge switch provides power to the furnace and chamber gauge controller outputs, which in turn provide power to the actual heater elements. When the switch is in the ENABLE position, the switch lever light illuminates. This switch can always be used to defeat power to these heaters. Also, when either of the computer's fault or end-of-run shutdown timers has elapsed, these heater outputs are disabled until the PROCESS START/STOP pushbutton is pressed.

3.5.5 Vacuum Switch

The Vacuum switch three-position switch controls the action of the vacuum system. In the VACUUM position, the vacuum pump will engage and begin to pump the system down. When the pump is running, the switch lever light illuminates. In the HOLD position, the pump will be disengaged and the integral isolation valve in the pump will immediately close to preserve most of the vacuum already established in the system. In the VENT position, the pump will remain off, and the vent solenoid valve will open to purge the system to atmosphere.

NOTE 1: **Do not** use the HOLD position to test the system for leaks. Under normal operating conditions it is possible that contamination of the seat of the integral pump isolation valve that will allow air back through the pump into the system. Consult the Edwards manual, specifically Section 10.

NOTE 2: There is no override provision for the vacuum control switch. Opening the vent during deposition would be possible, but would immediately initiate the fault shutdown timer and will have a detrimental effect on coating quality.

NOTE 3: If the 2010 is supplied with the LN₂ option, the LN₂ solenoid is enabled when the vacuum switch is in the evacuate position. The LN₂ option is not available in the European Community.

3.5.6 Vaporizer Switch

The Vaporizer switch permits the vaporizer heater elements to be energized as enabled by the sequencing computer. When switched is in ENABLE position, the switch lever light illuminates, but the heater control output will not be enabled until the pre-coating conditions have been met. As with the furnace and chamber gauge heaters, when the fault or end-of-run shutdown timer of the computer has elapsed, the vaporizer heaters are disabled until the computer is reset.



CAUTION: If the 2010 is supplied with the rotation option, the fixture rotation is controlled with the vaporizer switch. Whenever the vaporizer switch is on, the fixture rotates.

3.6 PROCESS CONTROLLERS

A copy of the "Installation and Operation" Manual for the WEST 6100+ controller is included in Section 6. The discussion here is limited to the settings and indications of each controller as they relate to the process.

When a controller comes on, the digital display indicates the present process value (SP lower display) and the present value (upper display). To change the displayed parameter, refer to Section 6.4.

3.6.1.1 Furnace Temperature Controller

The furnace controller displays and controls the temperature of the pyrolysis tube heater. The furnace set point is 690°C for Parylene C dimer. Other types of dimer may require different settings. The output '1' at the upper right corner of the lower display light is on when the furnace is cycling heat. It will be on continuously during warm-up and begin to cycle when it nears set point. A 20°C deviation from the set point either high or low will trigger the red alarm (ALM) light.

The alarm indicator must be off as one of the preconditions before the vaporizer can be enabled. If the red alarm light comes on for at least 20 seconds after the furnace has reached its operating range, the fault alarm detection sequence will be initiated.

3.6.1.2 Chamber Gauge Temperature Controller

The chamber gauge controller displays and controls the temperature of the vacuum gauge tube. The gauge tube heater set point is 135°C and should not be changed. Higher settings could damage the sensor and lower settings could permit Parylene formation on the sensor elements. The indicators operate as described for the furnace, with the output '1' light indicating heat cycling and the alarm (ALM) light indicating a high or low 10°C deviation from set point.

The alarm indicators must be off as one of the preconditions before the vaporizer can be enabled. If the ALM light comes on for at least 20 seconds after the chamber gauge has reached its operating range, the fault alarm sequence will be initiated.

3.6.1.3 Vacuum Pressure Controller

The vacuum controller displays a process value indicating the degree of vacuum in the system and keeps the chamber pressure within the set points by controlling the vaporizer temperature. The chamber pressure transducer used on the 2010 provides a non-linear voltage input to the vacuum controller. To provide for optimum coating process control, the span and offset parameters of the vacuum process controller have been configured to display a value that very nearly represents absolute pressure (in milliTorr) for the process range of 10 to 100 units. As the pressure in the chamber rises above this range, the display reading is increasingly lower than actual milliTorr values. For example, when the display reads 500 units, the actual pressure in the chamber is approximately 2.2 Torr (2200 milliTorr).

For more information regarding the vacuum controller values, refer to the WEST controller and Granville-Phillips gauge documentation provided in Section 6. **Remember:** The displayed process value is very near the actual milliTorr value while in the range of process control (10 to 100 milliTorr).

The vacuum controller set point value is factory-set at 15 units above base pressure. By changing this setting up or down, the process will speed up or slow down respectively. Take care not to set this value too high, as it will result in cloudy coatings.

Background gasses from previous runs can contaminate the vacuum pump oil making the pump less effective which will result in a slight rise in the system base pressure. To compensate for this, the set point value can be incremented up. Doing this will readjust the coating cycle timing back to normal.

The output '1' light indicates that the vacuum controller is attempting to cycle the vaporizer to maintain the pressure set point value. This indicator must come on as one of the preconditions before coating begins. When the red ALM light comes on, it indicates the end of the run.

The quality of the coating depends heavily on the rate of deposition. Lower pressure or lower vaporization temperature will slow the deposition rate and result in better distribution and better quality of film.

3.6.1.4 Vaporizer Temperature Controller

The vaporizer controller displays the vaporizer temperature. The vaporizer set point value is 175°C. Do not change this—this value protects the vaporizer from overheating at the end of a run. The output '1' light is always on except when the vaporizer is above its set point value.

In some applications, the initial rise (or overshoot) in chamber pressure may be unacceptable. These applications include very thin round substrates (fine wire, needles, etc.). In these instances, the lower set point on the vaporizer temperature controller (PhA2) automatically starts the vaporizer at a lower set point, usually in the range from 110° – 120°C. After a sufficient amount of time (30 minutes) to allow the chamber pressure to settle at its set point, the vaporizer is then automatically allowed to rise above the lower set point, and will finish the run at 175°C. If your process does not require the lower set point, simply set PhA2 on the vaporizer at 174°C (See Section 6.4 for instructions on how to adjust the lower set point). This is part of the end-of-run condition: vaporizer *temperature* must be above PhA2 and *pressure* must be below base to trigger end-of-run.

Parylene	vaporizer Set Point	Pressure Set Point	Furnace Set Point
Type N	160 C	Base + 55 Vacuum Units	650 C
Type C	175 C	Base +15 Vacuum Units	690 C

Table 3-2 Typical Set Point Values

3.7 SEQUENCING COMPUTER

The sequencing computer is located on the electrical panel behind the front access panel. The ladder logic program is installed at the factory and provides overall control of the system heating elements and alarm status monitoring, based on inputs generated by other control system components. Changes in the factory-loaded control program could affect machine safety and deposition quality; do not alter them.

Protracted Pump Down (Optional)

Some substrates continue to emit gas even after the system has been pumped down below the base pressure setting. In this case, the operator may wish to extend the chamber evacuation time with a protracted pump down. This can be achieved by lowering the set point (See Section 5.5.3).

The **vaporizer temperature monitor** is enabled immediately after the 10-second start-up delay of the sequencing computer. A vaporizer temperature fault is identified when the vaporizer controller ALM light is ON.

The **chamber gauge temperature monitor** is enabled after the chamber gauge has been within its deviation limits ($\pm 10^{\circ}\text{C}$ of set point) for at least 20 seconds after the PROCESS START/STOP pushbutton is depressed (or after main power is turned on). After the chamber gauge monitor is enabled, any deviation from the gauge tube heater set point, as indicated by the chamber gauge controller red ALM light, will initiate the fault shutdown timer.

The **furnace temperature monitor** is enabled after the furnace has been within its deviation limits ($\pm 20^{\circ}\text{C}$ of set point) for at least 20 seconds after the PROCESS START/STOP is depressed (or after main power is turned on). After the furnace monitor is enabled, any deviation from the furnace set point, as indicated by the furnace controller red ALM light, will initiate the fault shutdown timer.

If the fault timer elapses after a temperature fault has been detected, a system shutdown will be executed. All heater control outputs will be disabled and the fault alarm will sound.

In addition to temperature fault monitoring, the sequencing computer is provided with a process alarm that indicates a possible pressure control problem during deposition.

The **pressure control monitor** observes the amount of time between any two-output requests by the vacuum controller for vaporizer heat. If this time interval ever exceeds 10 minutes, it is a likely indication that the chamber pressure has been somewhat above its set point for several minutes. This would indicate a vacuum leak or a run-away vaporizer heating element.

Unlike the temperature fault monitors, the pressure control monitor will not initiate a fault shutdown sequence. It merely provides the fault alarm that provides operator notification of the detected condition. The control sequence is not affected.

Power Failure

The vacuum pump is equipped with an isolation valve that immediately seals the system upon power failure. Once power has been restored and the PROCESS START/STOP button has been depressed until the green light is lit, the computer will re-check the pre-coating conditions (following the same criteria as an automatic coating cycle). When these conditions are again satisfactory, the coating process will resume.

NOTE: If the power interruption occurs during deposition then the vaporizer heaters will not be immediately re-enabled upon power-up.

3.8 COLD TRAP OPERATION



CAUTION: Operation of cryogenic devices poses the threat of severe freeze injury.

3.8.1 Mechanical Chiller (option)

The 2010 is equipped with a mechanical chilling unit; this includes a cold trap probe that is inserted into the cold trap housing. For operation of this unit, follow the manufacturer's instructions.



IMPORTANT: The mechanical chiller is equipped with a "T" type thermocouple that measures the temperature of the probe. This thermocouple may be used to monitor the cold trap temperature during a coating cycle. If this temperature is being monitored, the vaporizer heaters should not be enabled until the cold trap probe is below -75°C . If this temperature is not being monitored, the mechanical chiller should be allowed to operate for at least 45 minutes before initiating the vaporizer heaters. This is done to make sure that the cold trap is cold enough to adequately capture Parylene process by-products so the vacuum pump is protected.

3.8.2 LN₂ (option)

Outside the European Community, the 2010 may be equipped with a LN₂ (Liquid Nitrogen) chilling unit; this includes a cold trap probe that is inserted into the cold trap housing. The option consists of an electronic control card, sensors, solenoid valve, cable, and a fitting for connecting the supply of LN₂ to the 2010. A LN₂ supply regulated at 20-25 PSIG is recommended for auto control of the LN₂ into the cold trap probe.

The Auto LN₂ low level-sensor opens the solenoid valve to allow LN₂ to flow into the probe. When the LN₂ level reaches the high level-sensor, the solenoid valve is closed. As the LN₂ evaporates, the level drops once again to activate the low level-sensor. This cycle will continue throughout the coating run. The LN₂ solenoid is enabled when the vacuum switch is in the VACUUM position. This allows the cold trap probe to be chilled to -196°C almost immediately.



WARNING: Industrial safety rules require the wearing of both safety glasses and protective gloves when working with or handling liquid nitrogen. Adhere to these rules at all times when working in the vicinity of the liquid nitrogen cold trap and control elements. Keep face and hands clear of the discharge area. Wear protective gloves when removing the cold trap probe for cleaning after a deposition cycle has been completed. Use the handles of the cold trap probe when removing the probe from the cold trap housing. Do not touch the probe surface with any exposed skin; doing so will immediately freeze unprotected areas, causing serious frostbite injury.



WARNING: In addition to the frostbite potential, use of liquid nitrogen will release gaseous nitrogen into the atmosphere in the equipment area. Nitrogen is non-toxic, but can cause rapid asphyxiation in a confined area that does not provide adequate ventilation. Keep the 2010 equipment area well ventilated during cold trap operation.

3.9 TUMBLER (OPTION) SPEED CONTROL

The Amber/Orange pushbutton lets you check rotation prior to coating, making sure the tumbler can rotate the load and that there are no obstructions to hinder rotation in the chamber.

The Amber/Orange light will illuminate when the tumbler is enabled through PLC logic.

NOTE: In order to enable rotation, the Vaporizer switch must be set to ENABLE.

The tumbler can only be activated by pressing the Amber/Orange pushbutton or through PLC logic.

PLC logic:

The tumbler will be enabled when the conditions below are satisfied in this sequence:

1. Vaporizer switch is set to the ENABLE position.
2. All process heaters are within limit (furnace and gauge tube heaters)
3. Chamber pressure has reached below the base pressure set point.
4. Chamber pressure then rises above the base pressure set point.

The tumbler will stop after the end of the run.

3.9.1 Adjustments:

1. Read "Installation and Operation Instructions for KBWS Whisper Drive" located in the Technical Literature section.
2. Disconnect the main power from the PDS 2010.
3. The tumbler drive assembly uses a 130VDC motor. For the 130VDC motor, set Jumper J1 to the "90V" position.

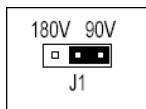


Figure 6: Jumper

4. Reconnect the main power and power up the unit.
5. Set tumbler speed to 2 RPM at 0% and 10 RPM at 100% by adjusting the MIN and MAX trimpot.
 - a) Disconnect the tumbler motor cable from the connector located on the top of the 2010 unit.
 - b) Set the voltmeter to DC voltage and plug positive to pin #2 and negative to pin #4.
 - c) Set speed control trimpot to 0. Depress and hold the amber pushbutton. Adjust the MIN trimpot until Voltmeter reads 18.5 VDC.

NOTE: You may not be able to reach the exact voltage.
 - d) Set speed control trimpot to 100. Depress and hold the amber pushbutton. Adjust the MAX trimpot until Voltmeter reads 92.8 VDC.

NOTE: You may not be able to reach the exact voltage.
 - e) Release the amber pushbutton and reconnect the tumbler motor with the 2010 tumbler connector.
 - f) Verify tumbler operation and calibration.

For more adjustment information (Acceleration, Deceleration, etc.) see the operation instructions for the KBWS Whisper Driver in the Technical Literature section.

3.10 BASE PRESSURE

The base pressure for the 2010 is defined as the lowest obtainable pressure reading (under the specific conditions described in the next section, as indicated by the vacuum gauge). *It is imperative for efficient and quality deposition that you **know** the base pressure, and check it frequently.* The base pressure reading is repeatable—significant deviation from previously established readings (more than 3 vacuum units) can indicate vacuum leaks, vacuum pump problems, calibration errors, and other deficiencies that degrade system performance.

A base pressure check is recommended:

- before the first coating run with a new machine.
- after extended periods of non-use.
- after every 5 to 10 coating cycles during regular use.
- as warranted by changes in coating quality.

3.10.1 Determining Base Pressure

The following procedure should be used to check the base pressure of an *unloaded* 2010 system (clean, dry, empty chamber).

1. Make sure all vacuum system O-rings and gaskets, and their mating surfaces, are clean and free of Parylene film.
2. Lower the chamber over the base (it is not necessary to install the baffle into the chamber inlet), insert the cold trap probe into the housing, turn on mechanical chiller or LN₂, close and seal the vaporizer load door.

NOTE: If the unit is equipped with a LN₂ Chiller, it will come on in Step 6.

3. Press the Main Power pushbutton. The computer will initialize and the process controllers will illuminate.
4. Verify that the process controller set points are at their normal operating values (see Section 6.4.5 for factory settings and Section 6.4.6. for parameter descriptions).

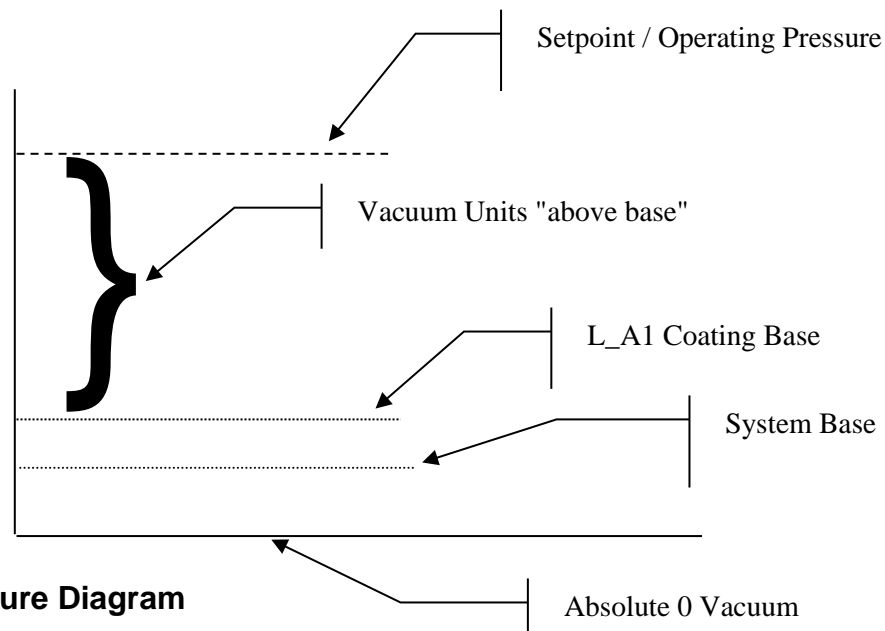


Figure 7: Pressure Diagram

5. ENABLE the Furnace / Chamber Gauge switch. Place the Vacuum switch in the HOLD position. Do not ENABLE the Vaporizer control switch.
6. Press the PROCESS START/STOP pushbutton and turn on the chiller. After 45 minutes, place the vacuum switch in the VACUUM position. Allow the system to pump down until the pressure reading has stabilized for at least 15 minutes.
7. Record the pressure reading. This is the System Base pressure. The expected base pressure reading for a properly functioning 2010 system should be less than 15 vacuum units. A base pressure above this value generally indicates a vacuum system problem.
8. The Coating Base is normally set to System Base plus 2–3 vacuum units. Base Pressure as used in this manual refers to the Coating Base. The Coating Base is a level that is adequate for the process and is more easily and rapidly reached.

4 OPERATION

4.1 Dimer Boat Construction

It has been shown that the best pressure control with the 2010 happens when there is maximum heat transfer between dimer vessel and the vaporizer walls. A simple, inexpensive way to achieve this is to use a dimer boat fabricated from standard aluminum foil, shaped to match the curvature of the vaporizer walls. The 2010 is shipped with a 2" x 7.5" tube (called the boat form) which you can use to make disposable dimer boats from an ordinary aluminum foil sheet. By shaping the boat so it touches as much of the heater walls as possible, the heat transfer is optimized.

To create a dimer boat:

1. Cut a rectangular piece of aluminum foil to 11 inches by 5 inches.
2. Form the aluminum piece lengthwise along the outside diameter of the boat form. Face the shiniest side of the foil toward the boat form.
3. Fold in the ends of the foil so it will not spill the dimer charge used in your application. Remove the dimer boat from the form.

NOTICE: *Keep your aluminum foil boat shorter than 7.5 inches. A boat longer than this will stick out directly under the pyrolysis furnace. This could result in premature vaporization caused by heat from the furnace section.*

When loading the boat, place it only as far into the vaporizer as necessary to close the load door. This keeps the dimer charge as far away as possible from heat generated by the pyrolysis furnace. The maximum amount of dimer is 125g; typical amounts may be much less.

It is not necessary to use the boat form when shaping an aluminum foil boat, but it is imperative to keep the dimer vessel no more than 7.5 inches long. The boat form is recommended because it provides the largest possible volume for retaining powdered dimer in the vaporizer. Also, by forming a cylindrical boat that closely matches the contour of the inside diameter of the vaporizer, the surface contact between the vaporizer wall and the dimer boat is maximized, providing the best heat transfer path to the dimer.

Discard the aluminum foil dimer boat when the dark residue, which tends to accumulate during vaporization, becomes moderately thick.

4.2 System Preparation

1. Load the dimer boat, containing a pre-measured amount Parylene dimer, into the vaporizer by opening the load door located in the lower front compartment. The maximum amount of dimer is 125g; typical amounts may be much less.
2. Treat all surfaces of the baffle, chamber interior, cold trap probe, and cold trap housing with a release agent (2% *Micro*® soap solution). See Section 6.1, Parylene Deposit Removal.
3. Insert the inlet baffle over the chamber inlet port. The baffle installs with the holes pointing toward the chamber wall. Use high-temperature tape at the base to retain the baffle straight upright, and to seal the other (top) end of the baffle. Refer to Section 5.13.7. **Make sure the baffle clears the fixture if the rotation option is installed.**

NOTICE: Be sure to tape any gaps that may exist at the baffle/inlet port interface. Failure to do so results in a monomer gas leak that bypasses the baffle. This could be detrimental to coating quality.

4. Fixture the parts on the chamber base within the confines of the chamber; avoid direct contact between the baffle and the fixture/parts.
5. Make sure O-rings and gaskets and their matching surfaces are very clean. Insert the cold trap probe into the cold trap housing, close the vaporizer load door, and lower the chamber over the base.

The chamber/base split line has some tolerance to allow for easy fit of the chamber onto the base. For most coating applications, it is desirable to place the chamber as far to the right of the base as possible in order to minimize the gap between the chamber wall and the lower portion of the inlet baffle. This will provide for the best Parylene distribution during deposition.

6. Provide/maintain liquid nitrogen for the cold trap probe, or start the mechanical chiller.

4.3 Start-Up

1. Release the Emergency Stop by turning it clockwise, or pulling it out.
2. Depress the MAIN POWER pushbutton. The computer will initialize and the vacuum and temperature controllers will illuminate.
3. Check all the controller set point values. If a protracted pump down is desired to eliminate anticipated outgassing, set it at this time (refer to Section 5.7). If a lower initial vaporizer set point is desired, it should also be set at this time (see Section 5.5).
4. ENABLE the Furnace/Chamber Gauge and Vaporizer switches. Enable the mechanical chiller.
5. After the chiller has been on 45 minutes for the mechanical chiller or 5 minutes for the LN₂ chiller, turn the Vacuum Pump switch to the VACUUM position.

4.4 Computer Control Sequence

After completing the above, depress the PROCESS START/STOP button. The computer will automatically control the deposition process in the following sequence:

1. Chamber gauge and furnace heaters come on and heat up to set point value.
 - Vaporizer is disabled.
 - Vaporizer temperature fault monitor is enabled.
 - Rotation (if installed) comes on.
2. When the chamber pressure is below Base Pressure (indicated by the flashing output ALM light on the vacuum controller) and the furnace and chamber gauge temperatures are in limits (indicated by the ALM light on both controllers not flashing), the vaporizer is enabled and begins to ramp up.
3. When the vaporizer exceeds 90°C, coating begins.
4. If a temperature fault is detected, a fault shutdown will be initiated:
 - The Red Alarm light will begin to flash.
 - An audio alarm will sound (this can be silenced by depressing the Alarm pushbutton).
 - The 5 minute fault alarm timer will initiate. If the fault does not clear before the timer elapses, then a shut down will initiate as described in the next step.
5. When the coating run has completed, the vaporizer will hold at set point temperature and the chamber will return to base pressure. The 5 minute end-of-run timer begins timing out before initiating a shut down as described in step 6.

6. Shut down occurs when the end-of-run or a fault timer has elapsed. The PROCESS START/STOP (green) light will start to blink. The furnace, gauge tube, vaporizer, and load door heaters will be disabled. If the shut down was caused by a fault, the red alarm will be turned on. The pump will remain on to secure the process by preserving the vacuum.

4.5 End-Of-Run



CAUTION: The system will maintain vacuum until the PROCESS START/STOP button is depressed or the VENT switch is moved to the VENT position.

1. Disable chilling of the cold trap.
2. Depress the PROCESS START/STOP button to turn off the blinking green light. Vent the chamber by turning the Vacuum switch from the VACUUM to the VENT position. After the system pressure is at atmospheric pressure, you must determine when to remove the probe from the cold trap for routine cleaning.

WHEN MOVING THE COLD TRAP PROBE:

There are two opposing needs to consider when moving the cold trap probe:

- The flex line and its junction to the probe need time to warm a little so they are not damaged by flexing.
- The probe needs to be removed promptly so the frozen material on the probe does not drip or fall into the cold trap.

Try to allow enough time for the flex line and junction to warm before moving, but do not wait so long that the frozen material on the probe begins to melt.



IMPORTANT:

- **Avoid unnecessary flexing of the flex line to the probe. Do not pull or twist on the flex line. Do not yank, drop, or handle the probe roughly. Mechanical shock to the probe can cause hairline fractures resulting in failure of the chiller. A holder is provided for supporting the probe when it is not in the cold trap, and for cleaning.**
 - **If you must coil the flex line, form a coil at least 6 inches in diameter and allow the line to rotate as it is coiled. The inner core is axially rigid and may rupture if not allowed to rotate while coiling.**
 - **Minimize handling of the probe while it is chilled and handle the probe carefully at all times to avoid mechanical damage to the probe. Do not allow the probe to warm to room temperature while under vacuum—trapped material may separate from the probe surface and scatter through the vacuum system when venting. Note that corrosive compounds are produced (in small amounts) as a byproduct of the Parylene deposition and are condensed on the probe surface.**
 - **Regular cleaning is imperative to prevent corrosion and pitting of the probe. See Section 6.**
3. The chamber is now ready to be unloaded.

If the 2010 is to be powered down, first pump it down to keep the interior clean. If another coating cycle is to be performed, continue with the next section.

4.6 SUCCESSIVE RUNS

If another run is desired, take the following preparations:

1. After the cold trap probe has been cleaned, re-apply the release agent.
2. Place the fixture on the chamber base.

WARNING: The chamber base inlet and baffle may be hot.

3. After the Vaporizer has cooled below 40°C, load a new charge of Parylene dimer. If you load the vaporizer before it cools, the Parylene dimer will begin to vaporize immediately; this will lead to pump down problems and likely degradation of the subsequent coating run. Wear protective gloves if the vaporizer is hot.
4. Reseal chamber, cold trap probe, and vaporizer door.
5. Re-start chilling the cold trap (for 45 minutes or to a temperature of -75°C or below).
6. Press the PROCESS START/STOP button to start the process.

4.7 SEMI-AUTOMATIC OPERATION

Semi-automatic operation may be utilized for operator-controlled sequences and paced start-ups. All system components except for the vaporizer may be controlled independently. The vaporizer will illuminate when enabled but will not begin heating until:

- the furnace/gauge tube heaters are within the allowable deviation of their set points
- the pump output "1" light is on (indicating base pressure has been achieved)
- the optional protracted pump down time (if used) has elapsed.

As during automatic operation, the ALARM pushbutton can be used to silence the audio alarm after an alarm has been acknowledged. The operator has 5 minutes to resolve an alarm situation before the system will automatically secure itself by shutting off all the heaters.

4.8 OPERATING CONSIDERATIONS

The purpose of the 2010 Parylene Deposition System is to provide the user with a means to apply a clear, uniform, and smooth Parylene coating to the required thickness on a substrate. The machine operator must understand the coating variables that affect this and choose the controlling parameters that will achieve the desired results. It is essential to be familiar with the variables that affect the deposition process. This section discusses the coating variables that can affect deposition.

4.8.1 Deposition Rate

How fast Parylene deposits onto a substrate is of primary concern. The proper deposition rate will give an acceptable coating in the shortest possible time. Generally, the slower the deposition, the more uniform and clear the Parylene will be. From the standpoint of coating quality, you cannot coat too slowly, but coating too quickly can cause cloudy or whitish Parylene and uneven coating thickness. For Parylene C, the deposition rate will typically be about .0002" per hour; for Parylene N, .00003" per hour. The deposition rate is indirectly controlled by regulating the pressure in the deposition chamber during the deposition process.

Parylene Type	Recommended Pressure Over System Base Pressure
C	15 vacuum units over System Base
N	50 vacuum units over System Base
D	5 vacuum units over System Base

4.8.2 Amount of Substrate

Consider the total amount of coating surface area when determining the amount of Parylene dimer needed to achieve a given coating thickness. In addition to the substrate, the chamber walls, baffle, and fixturing are part of the total surface area. *Therefore, doubling the amount of substrate in the deposition chamber does not double the area being coated.* The total surface area within the Deposition Chamber is the primary consideration when calculating the amount of dimer needed to achieve a required coating thickness.

EXAMPLE: The chamber surface area = ~678 in²; baffle and rotating plate = 188 in², and assume that the fixture = 34 in², for a total area of 900 in². **If the substrate is doubled** from 40 in² to 80 in², that actually is an increase in total area from 940 in² to 980 in² (or **only** about 4.25%).

4.8.3 Type of Substrate

The type of substrate being coated has little effect. Parylene will coat onto any type of substrate that is vacuum compatible. However, if the material to be coated exhibits abnormally high *outgassing*, a protracted pump down will be required to reduce the number of interfering gas molecules that could affect the even deposition of Parylene onto the substrate surface.

4.8.4 Orientation of Substrate

It is best to distribute the substrate evenly within the Deposition Chamber. Relatively large spaces with little or no surface area will tend to result in Parylene coating that is cloudy. This is most evident when the upper half of the Deposition Chamber is not loaded with any substrate. Substrate coating near these large empty volumes can be cloudy while substrate with more surface area nearby will have a clear coating.

When a large amount of substrate is to be coated, use care to position the substrate to minimize the shadowing effect that individual parts may have on one another. Also, maintain a minimum spacing requirement of 1/2" between parts in dense loads.

Rotation of the fixture helps distribution, and rotation is standard for the 2010. Using rotation helps distribute any non uniformity of the coating over the entire fixture; however, it will not typically help distribution variances from the top to bottom of the chamber.

4.8.5 Pump Down Time

The time necessary to pump the Deposition Chamber to a low enough pressure to initiate deposition will vary greatly depending on the amount of substrate and the outgassing associated with the substrate. The pump down time can vary from less than 15 minutes to 4 hours or more.

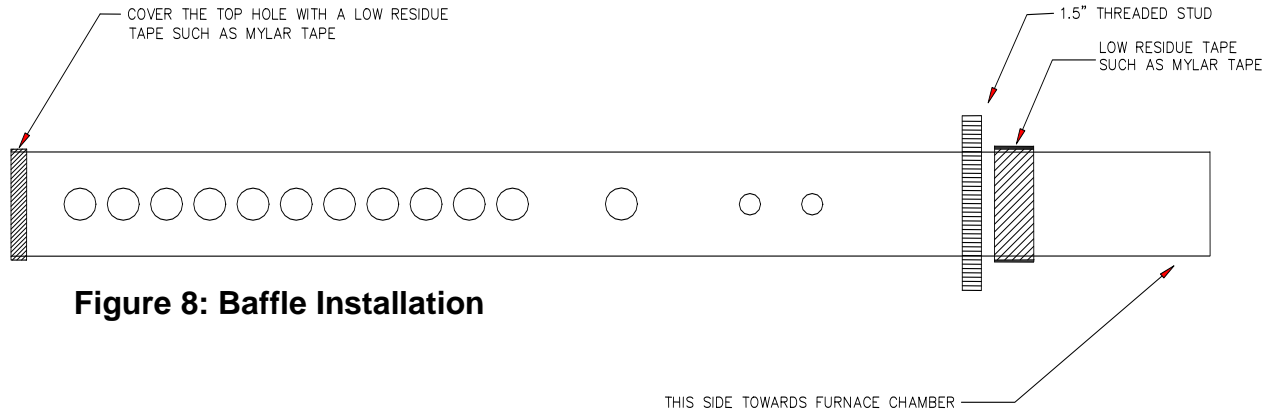
4.8.6 Vacuum System Leaks

Small leaks in the vacuum system will increase the pump down time and lower the overall efficiency of the 2010. Relatively large leaks can affect the quality of the Parylene coating.

4.8.7 Baffle

The chamber inlet baffle is extremely important for the even distribution of monomer gas in the deposition chamber. A warped, damaged, poorly installed, or heavily coated baffle can cause coating thickness variations and distribution anomalies within the chamber. Use a standard taping scheme in order to provide a consistent, repeatable method of installing the baffle.

To install a flute baffle, insert a 1.5" long threaded stud (PP-578-1002-0) in the first hole as shown in the figure below. Use a low residue tape (e.g., Mylar or glass cloth tape) around the area just below the stud in order to increase the thickness so that the baffle will fit in the furnace chamber. When installing the baffle in the chamber, make sure that the holes face towards the chamber wall.



4.9 ADHESION PROMOTION (WET PROMOTION)

Silane A-174 is available for adhesion promotion if improved Parylene adhesion is desired. Two types of AP are possible: 1)Wet Promotion, which is a treatment process that is performed on the product **before** it is loaded in the coating machine, and 2)In-Chamber Promotion, which is an option offered on some of the SCS coating machines, and is incorporated AP in the coating process. Sections 5.15.1–5.15.3 deal with wet adhesion promotion.

4.9.1 Making the Promotion Solution

The promotion solution is made of 99% pure isopropyl alcohol (IPA), deionized water (DI), and A-174 solution.

1. Mix equal parts of IPA and DI, then add 0.5% (1 part to 200, by volume) of the A-174. **The shelf life of the solution is 24 hours**, so mix only the amount that will be used during that time.
2. Stir the solution with a clean stirring rod for 30 seconds and allow the solution to stand for at least 2 hours (to allow adequate chemical reaction) before using it.

Remember: Storage life of the promotion solution is 24 hours. Discard all solution after this time has elapsed and mix a new batch.

4.9.2 Quality Check, Disposal

1. Use a pipette or dropper to place 6-10 ml of the promotion solution into a clean, dry 100-ml beaker.
2. Carefully add 3-4 grains of potassium permanganate to the 100-ml beaker.
3. Agitate the sample by gently swirling the beaker contents for 15-30 seconds. **DO NOT** mix the sample in any other way.
4. Observe the color of the sample:
 - A good solution will turn yellow-brown (much like apple cider). This color indicates that the solution is ready for production use.
 - A bad solution will turn bright pink. This color indicates that a fresh batch of promotion solution is required.
5. Dispose of the old/bad test solution properly (see MSDS and local regulations for proper disposal of alcohol plus silane). Rinse the test items and all containers thoroughly in IPA before conducting another test.

4.9.3 How to Use the Promotion Solution

1. Submerge the parts in the prepared promotion solution for 15-30 minutes.
2. Remove the parts from the solution and allow them to air dry for 15-30 minutes.
3. Submerge the parts in IPA for 15-30 seconds. Agitate the basket of parts up and down several times.
4. Remove parts and drain adequately (approximately 30-60 seconds).
5. Dry parts per requirement before you start the coating operation.
6. Parts should be coated within 30 hours, maximum. If parts are not coated within this time, parts must be re-promoted, repeating this process.

5 MAINTENANCE

5.1 PARYLENE DEPOSIT REMOVAL

The nature of the Parylene coating process necessitates the periodic removal of the Parylene that is deposited on the interior surfaces of the coating chamber and related components.

5.1.1 Applying Release Agent

To aid the removal of the deposited film it is imperative that a release agent be applied to all surfaces that will be coated and subsequently stripped. A 2% mixture of "*Micro*® Laboratory Cleaning Solution" (manufactured by International Product Corp.) with deionized water is an effective release agent. Application is most effectively performed with a spray bottle and a lint-free cloth. Components for application include:

- interior of coating chamber and base
- inlet baffle
- cold trap probe and housing
- piping between coating chamber and cold trap
- any other items that appear in the coating chamber that will be stripped of film (reusable fixturing, witness strips, etc.)

Once Parylene has been deposited, a *Micro*® soap interface between the Parylene film and the coating chamber interior has been established. This *Micro*® soap interface will remain until the Parylene film has been removed. It is not necessary to apply the release agent to the Parylene film itself, but only to the bare, uncoated surfaces that will receive a coating during the first deposition cycle after cleaning.

5.1.2 Parylene Coating Removal

The following items should be cleaned when the coating becomes excessively heavy, blisters, or separates from the surfaces:

- Deposition Chamber
- Viewing Port
- Inlet Baffle
- Chamber Ports, inlet, and exit
- Cold Trap Housing internal surfaces

Parylene deposits thicker than .001 inch on the chamber interior walls, base, and baffle should be stripped.

NOTE: Avoid using sharp tools for removing deposits, or use extreme care; you could be injured and could nick the surfaces. Such nicks could make it more difficult to remove deposits the next time and damage the sealing surfaces, causing leaks.

Do not attempt to remove very thin coatings, as they tend to break during removal. However, sections of coating that pull away from the surfaces can cause problems if they are not removed. The main problem which can occur is collapsing (or pulling completely away) of the coating when the system has been loaded for a run. When the system is placed under vacuum, air entrapped under the coating will migrate, possibly pulling the coating away completely. If this happens in the deposition chamber, the coating will surround the fixture, preventing the dimer from depositing properly. If this happens in the pump out port, the collapsed coating could reduce or eliminate the vacuum needed to achieve an acceptable quality coating.

5.1.3 Cold Trap Probe (Thimble)

To achieve the coldest possible cold trap probe surfaces and to preclude the separation of trapped deposits, remove and clean the cold trap probe promptly* after each run. Set the probe in the holder provided on the machine. Corrosive compounds are produced (in small amounts) as a byproduct of Parylene deposition and are subsequently condensed on the probe surface. Therefore, regular cleaning is imperative to prevent corrosion and pitting of the cold trap probe. See the MACHINE SAFETY Section for precautions required when handling cryogenic apparatus. See End-of-Run in Section 5 for handling of mechanical chiller probe.

*There are two opposing needs to consider when moving the cold trap probe:

- The flex line and its junction to the probe need time to warm a little so they are not damaged by flexing.
- The probe needs to be removed promptly so the frozen material on the probe does not drip or fall into the cold trap.

Try to allow enough time for the flex line and junction to warm before moving, but do not wait so long that the frozen material on the probe begins to melt. **Use special care** to minimize stress on the line and junction when moving the probe to the holder.

To remove the thin layers of polymer that deposit on the lower portion of the probe, spray liberally with Microsoap solution and use a non-metallic abrasive pads such as Scotch Brite.

5.1.4 Vacuum Integrity

Vacuum leaks are usually due to contamination of sealing surfaces and O-rings. The contamination, in most cases, has been found to be small particles of trapped polymer. It is good operating practice to check the sealing surfaces of the vaporizer access door, chamber ring, and cold trap probe flange before pumping the system down. For leak detection, the use of solvents is NOT recommended. Solvent flammability and noxious vapor creation could result in serious injury or equipment damage. Use of a helium leak detection system is the approved method.

5.1.5 Vacuum Pump

For optimum performance, the pump's oil should be kept free from foreign particles and excessive condensable vapors. Parylene vapors in particular can have a significant negative effect. The oil in the vacuum pump provides lubrication and wear-protection for the pump internal components and also performs a critical role in the pump's ability to reach its ultimate pressure. The 2010 includes both a cold trap and a wire mesh inlet screen to protect the pump from most contaminants. However, as with any oil-lubricated device, the pump will require routine oil changes. Refer to the documentation supplied by the manufacturer for a complete description of operation and service to the vacuum pump.

Schedule oil changes for the 2010 vacuum pump based upon the following events, *whichever comes first*:

- After 10 coating runs.
- After a process throughput of 120 grams of Parylene dimer.
- Anytime that the cold trap has exceeded (been higher than) -75°C during deposition
- Whenever the oil appears cloudy, dirty, or otherwise contaminated.
- When, after a coating cycle has been performed, the machine is scheduled to be idle for more than one week. (Change the oil before periods of non-use to prevent corrosion of pump components during storage.)

NOTE: The system base pressure should be regularly monitored. Increases not attributed to vacuum leaks or outgassing usually indicate a deterioration of the pumping system. Deterioration is usually due to the passage of process by-products that are not effectively trapped by the cold trap probe. In some instances, lower cold trap temperatures will alleviate this condition. Normally, the lower system base pressures can be restored by cleaning the inlet screen at the pump inlet and/or changing the pump oil.

5.1.6 Vacuum Gauge Port

The vacuum gauge is heated to 135°C to protect it from Parylene build-up. However, the small port in the chamber base to which the gauge is connected is subject to build-up. This port should be regularly inspected and stripped because polymer build-up could interfere with the vacuum readings.

5.1.7 Vaporizer

The vaporizer and load door are subject to build-up of Parylene dimer film and ash. These areas should be cleaned whenever a build-up is noted in order to prevent coating contamination.

5.2 LONG TERM INSPECTIONS AND MAINTENANCE

The regularity of these inspections and maintenance is dependent on the amount of use and dimer throughput encountered by the 2010.

5.2.1 Pyrolysis Tube

After several runs, a yellowish, brittle deposit will be found in the pyrolysis tube. This deposit will be most prevalent near the inlet port of the chamber base. Typically, this deposit will need to be removed after a dimer throughput of 300 to 400 grams.

To remove deposit from the pyrolysis tube:

1. Place a tool under the deposit to separate it from the tube.
2. Peel or scrape out the deposit.
3. After removing the build-up, work a wire brush or equivalent through the inside diameter of the pyrolysis tube to dislodge any remaining debris.
4. Use a vacuum cleaner to remove any material that may have fallen down the pyrolysis tube. (Access to the bottom of the pyrolysis section is best achieved through the vaporizer load door.)

5.2.2 O-Rings, Vacuum System Seals

The O-rings at the vaporizer load door and the pyrolysis tube connection at the base of the chamber are significantly susceptible to high temperature fatigue. The chamber gasket and cold trap O-ring are subject to abuse from normal day-to-day cleaning and handling. These O-rings and gaskets should be inspected frequently and replaced as necessary.

A new precision-made system will not ordinarily require grease on its O-rings. As a system ages however, the accumulation of minute scratches and bits of material in the groove make it harder for the O-ring to maintain an excellent seal. In such times, it may be helpful to apply *very small amounts* of silicone grease (pn 20117) to non-heated O-rings. An additional advantage of using the grease on the chamber rings is that removing parylene deposits will be much easier.

5.2.3 Vacuum Hose

Over time, the vacuum hose tubing will acquire a compression set. If the system develops a leak associated with this tubing, we recommend that the tubing be replaced.

5.2.4 Rotary Feed-Thru Maintenance

Refer to Figure 6-1. This process requires rotary feed-thru maintenance kit SA-285-1118-1.

1. Vent the vacuum from the chamber.
2. REMOVE POWER FROM THE GENERATION UNIT.
3. Remove the fixture hub from the feed-thru shaft inside the chamber.
4. Remove the drive belt and pulley, remove the 4 bolts holding the feed-thru to the chamber, and then remove the feed-thru.
5. Clean the shaft and the outside of the feed-thru of all accumulated dirt.
Work on a clean surface; do not allow dirt or dust to contaminate clean parts.
6. Remove retainer A from the housing and press the shaft assembly out. DO NOT HAMMER the shaft out of the housing—this could damage the shaft.
7. Clean the housing, shaft, and spacer with solvent.
8. Liberally coat the shaft and housing bore in the marked A with APIEZON-K vacuum oil.
9. Coat the new O-rings and spacer with APIEZON-K vacuum oil and install in the housing.
10. Press the shaft assembly in the housing and install new retaining ring A.
11. Clean the face and O-ring groove on the feed-thru and install a new O-ring on the feed-thru. Reinstall parts in the chamber in the reverse order of removal.

5.2.5 Feed-Thru Rebuild

Refer to Figure 6-1. This process requires rotary feed-thru rebuild kit SA-285-1119-1.

1. Vent the chamber vacuum.
2. REMOVE POWER FROM THE GENERATION UNIT.
3. Remove the fixture hub from the feed-thru shaft inside the chamber.
4. Remove the drive belt and pulley, remove the 4 bolts holding the feed-thru to the chamber, and then remove the feed-thru.
5. Clean the shaft and the outside of the feed-thru of all accumulated dirt.
Work on a clean surface. Do not allow dirt or dust to contaminate clean parts.
6. Remove retainer A from the housing and press the shaft assembly out. DO NOT HAMMER the shaft out of the housing—this could damage the shaft.
7. Remove retainer B from the shaft and remove both bearings and spacers.

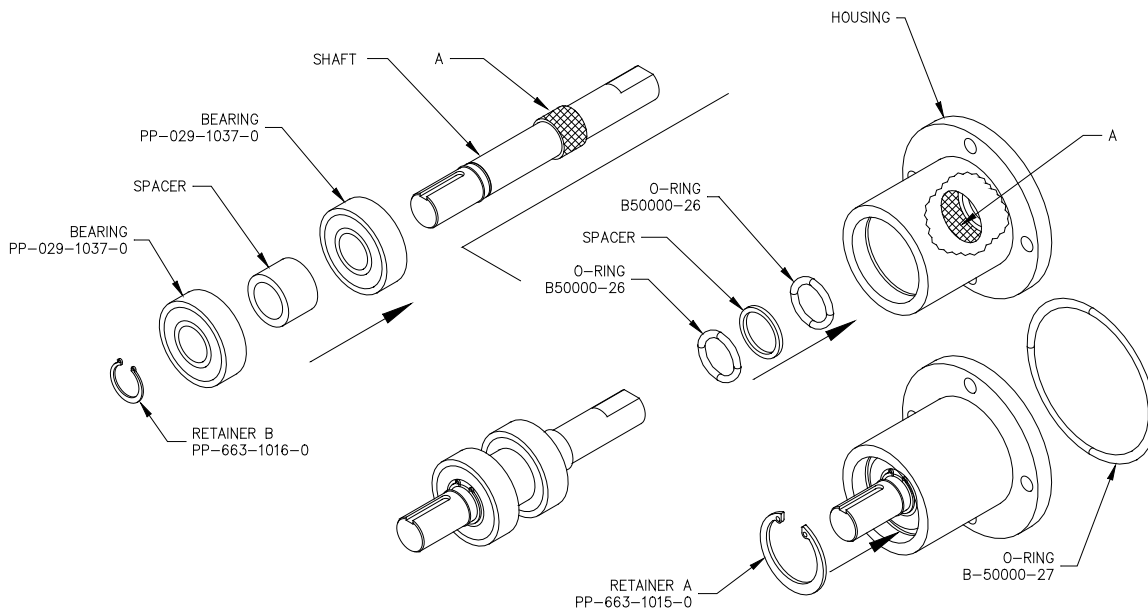


Figure 4-1 Rotary Feed Thru

8. Clean the housing, shaft, and spacers with solvent.
9. Install new bearings on the shaft, reuse the spacer removed in step 7, and secure with new retainer B.
10. Liberally coat the shaft and housing bore in the areas marked A with APIEZON-K vacuum oil.
11. Coat the new O-rings and spacer with APIEZON-K vacuum oil and install in the housing.
12. Press the shaft assembly in the housing and install new retaining ring A.
13. Clean the face and O-ring groove on the feed-thru and install a new O-ring on the feed-thru. Reinstall in the chamber in the reverse order of removal.

5.3 PROCESS TEMPERATURE CONTROLLERS

The WEST process controllers used on the 2010 continually recalibrate themselves throughout operation and are not subject to drift caused by ambient temperature variations. To verify the temperature controllers (furnace, gauge tube, and vaporizer), follow section 6.3.1.



CAUTION: Procedures for verifying WEST 6100+ controllers on the 2010 require powering the machine with one or more of the cabinet panels removed. This exposes high voltage conductors and creates an electrical shock hazard. Calibration should be performed by qualified and authorized personnel only.

5.3.1 Verifying the WEST Model 6100+ Temperature Controller

1. Remove all power to the machine. Open the front door of the 2010.
2. Disconnect the J-type thermocouple connector above the load door. Connect a male connector to a qualified thermocouple simulator. Plug the male connector into the female connector of interest.
3. Re-install the panel and turn on the Main Power.
4. Simulate the input to the subject controller per the following chart:

TEMPERATURE CONTROLLER	REFERENCE TEMPERATURE	REQUIRED ACCURACY
Furnace	690°C	± 3°C
Gauge Tube	140°C	± 3°C
Vaporizer	140°C	± 5°C

5. If the process value set point reading of the subject controller is out of the specified accuracy range, replace the controller. (This should be a very rare occurrence.)
6. If the controller reading is within specification, remove machine power, remove the panel, disconnect the thermocouple simulator, re-install the subject thermocouple connector, and close the front door. Verification is complete.

5.3.2 Vacuum Controller

The 2010 chamber pressure is monitored and controlled by a combination of three (3) components:

- Pirani-type pressure transducer housed within the gauge tube
- Amplifier circuit board which amplifies the gauge tube signal
- WEST Model 6100+ process controller which accepts the amplified (0-10VDC) signal, calculates the chamber pressure reading, and then uses this information to control the vaporizer heaters.

As with the WEST temperature controllers, the 0-10VDC input process controller continually recalibrates itself throughout operation and is not subject to drift caused by ambient temperature variations. The gauge tube does not require nor provide the ability for field calibration. Therefore, the only component which will normally require calibration will be the amplifier circuit board.

In order to provide the ability to fully calibrate the vacuum monitoring circuit, the procedures will be included to verify all pressure monitoring components. For a comprehensive calibration, perform each of the following procedures in sequence. However, in most cases, performing the Amplifier Circuit Board Calibration procedure exclusively will be sufficient.

5.3.3 Calibrating the Granville-Phillips Zero Pressure Simulator

Calibration of the amplifier circuit board requires the use of a Convectron Zero Pressure Simulator, SCS Part No. 20232. This simulator may be calibrated by following the instructions provided with the unit.

NOTE: The simulator calibration does not require a Model 275 Convectron controller as described in the instructions. Energizing the simulator with the 2010 amplifier circuit board instead of the Convectron controller will achieve identical results.

5.3.4 Verifying the WEST Model 6100+ Vacuum Process Controller

To verify proper calibration of the vacuum process controller, perform the following:

1. Remove all power to the machine.
2. Remove the cabinet side panels.
3. Replace the lead wires at terminals 4 and 5 of the controller with leads from a qualified variable voltage source capable of 0-10 volts output and accurate to ± 0.001 volt. Pin 5 of the controller is the positive (+) terminal.
4. Re-install the control panel and turn on the Main Power.
5. Provide voltage input to the process controller per the following chart:

INPUT VOLTAGE	REFERENCE PROCESS VALUE	REQUIRED ACCURACY
0.000 V	-4	± 3 units
10.000 V	1112	± 5 units

6. If a process value set point reading of the controller is out of the specified accuracy range, then the controller requires re-calibration (this should be a very rare occurrence). Contact WEST or your local service provider.
7. If the controller reading is within specification, remove machine power, disconnect the voltage source, re-install the machine input leads, and re-install the control panel. Verification is complete.

5.3.5 Vacuum Amplifier Circuit Board Calibration

To locate the vacuum amplifier circuit board, remove the left side panel from the machine. The circuit board is located inside the frame of the 2010, below the fuse blocks.

The vacuum zero adjust setting (labeled "VAC") for the amplifier circuit board is of primary concern for proper operation of the 2010. The atmospheric setting (ATM) has little effect on the calibration of the sensor in the vacuum range utilized during the Parylene deposition process.

5.3.5.1 Vacuum Zero Adjust (VAC)

1. Remove all power and remove the cabinet side panels
2. Remove the blue circular connector from the gauge tube and install the Convectron Zero Pressure Simulator.
3. Turn on the Main Power.
4. View the process value set point on the vacuum controller display.
5. Locate the vacuum potentiometer (labeled "VAC") on the amplifier circuit board.
6. Press and hold the red button at the end of the zero pressure simulator. Adjust the VAC potentiometer to achieve a reading of "-4" on the display. (Turning the potentiometer clockwise will raise the displayed value, and turning it counterclockwise will lower it.)
7. The zero adjust calibration is now complete. Turn off the Main Power, reconnect the gauge tube cable, re-install the side panels, and then turn the Main Power on again.

5.3.5.2 Atmosphere Adjust (ATM)

1. Assure that the chamber is at atmospheric pressure by removing the cold trap probe or the chamber lid. The chamber gauge tube should be at room temperature.
2. View the process value set point on the vacuum controller display.
3. Locate the atmospheric potentiometer (labeled "ATM") on the amplifier circuit board.
4. Adjust the ATM potentiometer to achieve a reading of "1000" on the display. (Turning the potentiometer clockwise will raise the displayed value, and turning counterclockwise will lower it.)

NOTE 1: The value of "1000" correlates to a standard atmosphere, defined as 29.92 inches of mercury, or 760 Torr. For the most accurate calibration, a barometer could be used to determine exact atmospheric conditions at the time of calibration. Then the corresponding atmospheric reading could be calculated. For the purposes of calibrating the 2010, this is not required.

NOTE 2: The amplifier circuit board should be re-calibrated any time the pressure gauge tube is replaced.

5.4 PROCESS CONTROLLER PARAMETERS

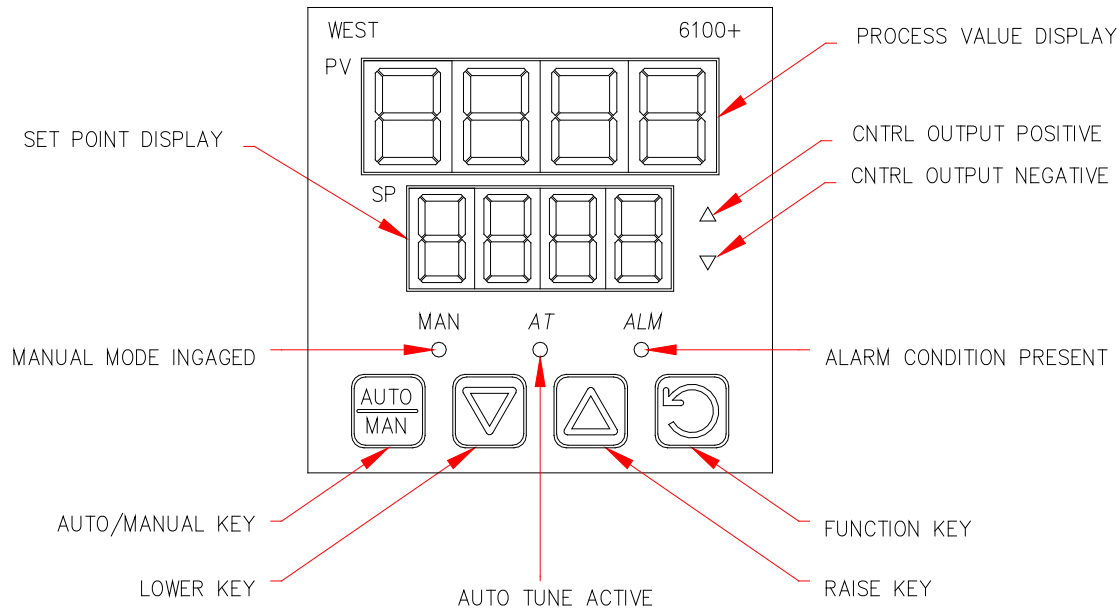


Figure 4-2 WEST MODEL 6100+ CONTROLLER

Note: New controllers must complete Configuration and Setup first.

5.4.1 To Enter the Configuration Mode:

1. Depress and hold the Function key and depress the Raise key to access Select Mode. The upper display will read OPtr and the lower display will read SLCT.
2. Depress the Raise key once. The upper display will show Conf.
3. Depress the Function key once. The lower display will show Uloc.
4. Use the Raise key to increment the PV value until the controller shows the proper Unlock code (the default code is 20), and then depress the Function key. The display will show the first parameter in the Configuration Mode and the menu will appear on the lower display.
5. Use the Function key to scroll through the menu. Use the Raise and Lower keys to scroll through parameters.
6. Press Auto/Manual key to accept the change.

5.4.2 To Exit the Configuration Mode:

1. Depress and hold the Function key and depress the Raise key to return to Select Mode.
2. Use the lower key to select Optr and depress the Function key to return to Operator Mode.

5.4.3 To Enter the Setup Mode:

1. Depress and hold the Function key and depress the Raise key to access Select Mode. The upper display will read OPtr and display will read SLCT.

2. Press the Raise key once. The upper display will show SetP.
3. Press the Function key once. The lower display will show Uloc.
4. Use the Raise key to increment the PV value until the upper display shows the proper Unlock code (the default code is 10), and then depress the Function key. The MAN light will come on and display the first parameter in the Setup Mode menu.
5. Use the Function key to scroll through the menu. Use the Raise and Lower keys to increment and decrement the values of each parameter.

5.4.4 To exit the Setup Mode:

1. Depress and hold the Function key and depress the Raise key to return to Select Mode. This will also cause the MAN light to go off.
2. Use the Lower key to select Optr and depress the Function key to return to Operator Mode.

5.4.5 Factory Settings

Configuration Mode (with hardware definition code ₁)

Parameter	Furnace	Chamber Gauge	Vaporizer	Vacuum
inPt	JC	JC	JC	0_10
ruL	761	761	761	1112
rLL	0	0	0	-4
dPoS	---	---	---	0
CtyP	SnGL	SnGL	SnGL	SnGL
CtrL	rEv	rEv	rEv	rEv
ALA 1	bAnd	bAnd	P_Hi	P_Lo
bAL 1	---	---	---	---
PhA 1*	---	---	---	---
PLA 1*	---	---	---	---
AHY 1*	1	1	1	1
ALA 2*	nonE	nonE	P_Hi	nonE
PhA 2*	---	---	---	---
AHY 2*	---	---	1	---
LAEn	diSA	diSA	diSA	diSA
Inh i	nonE	nonE	nonE	nonE
USE 1	Pr i	Pr i	Pr i	Pr i
USE 2	---	---	A2_d	---
USE 3	A1_d	A1_d	A1_d	A1_d
diSP	1	1	1	1
Cloc	20	20	20	20

* Not applicable if a DC linear input is fitted. Requires internal jumper change.

Setup Mode

Parameter	Furnace	Chamber Gauge	Vaporizer	Vacuum
FiLt	2	2	2	2
OFFS	0	0	0	0
PPLJ	read only	read only	read only	read only
Pb_P	1.0	1.0	5.0	0.5
ArST	2.37	0.41	2.00	3.00
rAtE	0.39	0.10	0.30	1.40
biAS	25	25	25	25
SPuL	720	140	180	100
SPLL	0	0	0	-4
OPuL	100	100	100	100
Ct 1	32	32	32	32
bAL 1	20	10	----	----
PhA 1	----	----	200	----
PLA 1	----	----	----	15
AHY 1	1	1	1	1
PhA 2	----	----	174	----
AHY 2	----	----	1	----
APt	diSA	diSA	diSA	diSA
PoEn	diSA	diSA	diSA	diSA
SPr	diSA	diSA	diSA	diSA
rP				
SP	690	135	175	35
Sloc	10	10	10	10

Parameter Description (Configuration)

Parameter	Description	West Factory Default
inPt	Input Type and Range	JC
ruL	Scale Range Upper Limit	1200
rLL	Scale Range Lower Limit	-200
dPoS	Decimal point position	1
CtyP	Control Type	SnGL
Ctrl	Primary Output Control Action	REv (reverse acting)
ALA 1	Alarm 1 Type	P_Hi
PhA 1	Process High Alarm 1 value*	Range Max.
PLA 1	Process Low Alarm 1 value*	Range Min.
bAL 1	Band Alarm 1 value*	5
AHY 1	Alarm 1 Hysteresis *	1
ALA 2	Alarm 2 Type	P_Lo
PhA 2	Process High Alarm 2 value*	Range Max.
PLA 2	Process Low Alarm 2 value*	Range Min.
bAL 2	Band Alarm 2 value*	5
AHY 2	Alarm 2 Hysteresis*	1
LAEn	Loop Alarm Enable	diSA
Inhi	Alarm Inhibit	nonE
USE 1	Output 1 Usage	Pri
USE 3	Output 3 Usage	A1_d
diSP	Display Strategy	1
Cloc	Configuration Mode Lock Code	20

Parameter Description (Setup)

Parameter	Description	West Factory Default
FiLt	Input Filter Time constant	2.0 sec.
OFFS	Process Variable Offset	0
PPLJ	Primary (Heat) power	*read only
Pb_P	Proportional Band	10
ArST	Automatic Reset (Integral Time)	5
rAtE	Rate (Derivative Time)	1.15
biAS	Manual Reset (Bias)	25
SPuL	Setpoint Upper Limit	Max. Range
SPLl	Setpoint Lower Limit	Min. Range
OPuL	Output Power Limit	100%
Ct 1	Output 1 Cycle Time	32 sec.
bAL 1	Band Alarm 1 value	5
PhA 1	High Alarm 1 value	Max. Range
PLA 1	Low Alarm 1 value	Min. Range
AHY 1	Alarm 1 Hysteresis	1
PhA 2	High Alarm 2 value	Max. Range
AHY 2	Alarm 2 Hysteresis	1
APt	Auto Pre-tune	diSA
PoEn	Auto/manual Control selection	diSA
SPr	Setpoint ramping	diSA
rP	SP Ramp Rate value	Off
SP	Setpoint	Min. Range
Sloc	Setup Lock Code	10

NOTE: The Vacuum controller set point is set for an operating pressure of 15 units above base pressure (PLA1), as established during the factory test procedure. You can adjust it as warranted for a specific coating application and to accommodate changes in system base pressure.

5.4.6 Detailed Description of Parameters

5.4.6.1 *AHY_1 & AHY_2 - Alarm Hysteresis*

An adjustable band on the safe of an alarm point through which the process variable must pass before the alarm will change state. The high alarm hysteresis band is below the high alarm value, and a low alarm hysteresis is above the low alarm value.

5.4.6.2 *ALAI & ALA2 - Alarm Type*

Up to three alarms are possible on some models. The alarm types may be set as process high or low, deviation (active above or below controller set point), band (active both above and below set point), or control loop type. These alarms can be linked to any suitable output

5.4.6.3 *APt - Auto Pre-Tune*

This parameter determines whether or not the controller's pre-tune facility is activated automatically on power-up or not (diSA = Disabled, EnAb = Enabled).

5.4.6.4 *ArST - Automatic Reset (Integral Time Constant)*

This parameter is adjustable in the range of 1 second to 99 minutes 59 seconds or OFF (value greater than the maximum). This parameter is not applicable if the Proportional Band is set to 0 (On/Off control).

5.4.6.5 *bAL_1 & bAL_2 - Band Alarm Value*

5.4.6.6 This parameter, applicable only when Alarm is selected to be a Band Alarm, defines a band of process variable values, centered on the set point of the value. If the process variable value is outside this band, the alarm will be active. This parameter may be adjusted to be within +/- input span from set point.

5.4.6.7 *biAS - Bias (Manual Reset)*

This bias to the output power is expressed as a percentage of output power and is adjustable in the range 0% to 100%. This parameter is not applicable if the Proportional Band is set to 0 (On/Off control).

5.4.6.8 *Cloc, Sloc, and tLoc -Lock Codes*

This parameter defines the four-digit code required to enter Set Up Mode. It may be adjusted in the range of 0 to 9999.

These parameters define the four-digit codes required to enter Configuration (20), Set-Up (10), and Auto Tuning (0) modes. The default values are shown in brackets.

5.4.6.9 *Ct1 - Output 1 Cycle Time*

The cycle time value required is dependent upon the process being controlled and the type of output being used for Output 1. For a Relay Output, the cycle time should be as large as possible (while remaining compatible with the process control requirements) in order to maximize relay life. For an SSR Output, the cycle time may have a lower value (and thus satisfy the requirements of a fast changing process variable e.g. flow or pressure). The permitted range of value is: .5, 1, 2, 4, 8, 16, 32, 64, 128, 256, 512 seconds. This parameter is not applicable if Proportional Band 1 is set to 0 or if Output 1 is a DC linear output.

5.4.6.10 *diSP - Display Strategy*

This is a controller parameter; it allows the user to alter the parameters displayed in normal operator mode. These parameters can be PV + SP, PV + adjustable SP, PV + Ramping SP, PV only, or SP only. Display strategy 6 will allow read only access to the set point values in Operator Mode; Setup Mode must then be entered to change the set point.

5.4.6.11 *dPOS - Decimal Point Position*

This parameter, applicable only if a linear input is fitted, defines the position of the decimal point in values of the process variable, set point, alarm levels, and recorder output as follows:

<u>VALUE</u>	<u>DECIMAL POINT POSITION</u>
0	XXXX
1	XXX.X
2	XX.XX
3	X.XXX

5.4.6.12 *Filt - Input Filter Time Constant*

The controller input is equipped with a digital filter that is used to filter out any extraneous impulses on the process variable. This filtered process variable is used for all process variable dependent functions. The time constant for this filter may be adjusted in the range 0.0 seconds to 100.0 seconds in .5 second increments.



NOTICE: If this parameter is set to an excessively high value, the control quality may be significantly impaired. Choose a value that is sufficiently large to attenuate stray noise on the process variable signal, but no larger.

5.4.6.13 *Inhi - Alarm Inhibit*

This inhibits an alarm at power-up, or if a controller set point is switched, until that alarm goes inactive. The alarm operates normally from that point onwards.

5.4.6.14 *InPt - Input Range*

This is the overall input range and type as selected by the Inpt parameter in Configuration Mode.

5.4.6.15 *LAEn - Loop Alarm*

This is a controller parameter; it is the means by which the user can enable or disable the loop alarm. The loop alarm is a special alarm that detects faults in the control feedback loop by continuously monitoring process variable response to the control output(s). The loop alarm can be tied to any suitable output. When enabled, the loop alarm repeatedly checks if the control output(s) are at the maximum or minimum limit. If an output is at the limit, an internal timer is started. Thereafter, if the high output has not caused the process variable to be corrected by a predetermined amount 'V' after time 'T' has elapsed, the loop alarm becomes active. Subsequently, the loop alarm mode repeatedly checks the process variable and the control output(s). When the process variable starts to change value in the correct sense or when the output is no longer at the limit, the loop alarm is deactivated.

5.4.6.16 *OFFS - Process Variable Offset*

This parameter is used to modify the actual process variable value (measured at the Controller's input terminals) in the following manner:

Offset Process Variable Value = Actual Process Variable Value + Process Variable Offset Value.

5.4.6.17 *OPuL - Output 1 Power Limit*

This parameter is used to limit the power level of Output 1 and may be used to protect the process being controlled. If no protection is required, this parameter may be set to 100%. The parameter may be adjusted between 0% and 100%.

5.4.6.18 *Pb_P - Proportional Band*

This parameter is the portion of the input span of the Controller over which the Output power level is proportional to the displayed process variable value. It may be adjusted in the range 0.0% to 999.9%.

5.4.6.19 PhA_1 & PhA_2 - Process High Alarm Value

This parameter, applicable only when Alarm is selected to be a Process High alarm, defines the process variable value at or above which Alarm will be active. Its value may be adjusted between Input Range Maximum and Input Range Minimum.

5.4.6.20 PLA_1 & PLA_2 - Process Low Alarm Value

This parameter, applicable only when Alarm is selected to be a Process Low alarm, defines the process variable value at or below which Alarm will be active. Its value may be adjusted between Input Range Maximum and Input Range Minimum.

5.4.6.21 PoEn - Auto/Manual Control

This parameter determines whether operator selection of manual control is enabled or disabled (diSA = Disabled, EnAb = Enabled).

5.4.6.22 PPLJ - Output Power

This parameter is the current Output power level. It is a read-only parameter and is not adjustable.

5.4.6.23 rAtE - Rate (Derivative Time Constant)

This parameter is adjustable in the range of 00 seconds to 99 minutes 59 seconds. This parameter is not applicable if the Proportional Band is set to 0 (On/Off control).

5.4.6.24 rLL - Scale Range Lower Limit

For a linear input, this parameter can be used to display the process variable in engineering units. It defines the displayed value when the process variable input is at its minimum value. It is adjustable between -1999 to 9999 and can be set to a value more than (but not within 100 units of) the Scale Range Upper Limit, in which case the sense of the input is reversed.

For thermocouple and RTD inputs, this parameter is used to reduce the effective range of the input. All span related functions work from the trimmed span. The parameter can be adjusted within the limits of the range selected by the Configuration Mode parameter, InPt. It is adjustable to within 100 degrees of the Scale Range Upper Limit. The default value is 0 for linear inputs or a range minimum for temperature inputs.

5.4.6.25 rP - Set Point Ramp Rate

This is a controller parameter; it is the rate at which the actual set point value will move towards the target value if Set Point Ramping is enabled. The default setting is OFF.

5.4.6.26 rUL - Scale Range Upper Limit

For a linear input, this parameter can be used to display the process variable in engineering units. It defines the displayed value when the process variable input is at its maximum value. It is adjustable between -1999 to 9999 and can be set to a value less than (but not within 100 units of) the Scale Range Lower Limit, in which case the sense of the input is reversed.

For thermocouple and RTD inputs, this parameter is used to reduce the effective range of the input. All span related functions work from the trimmed input span. The parameter can be adjusted within the limits of the range selected by Configuration Mode parameter, InPt. It is adjustable to within 100 degrees of the Scale Range Lower Limit. The default value is 1000 for linear input or a range maximum for temperature inputs.

5.4.6.27 SP - Setpoint

This is a controller parameter; it is the target value at which the controller will attempt to maintain the process variable by making adjustments to the power output level.

5.4.6.28 *SPLL - Set Point Low Limit*

This is the minimum limit for set point adjustment. It should be set to a value that avoids causing damage to the process being controlled. The Set Point Low Limit may be adjusted between the Input Range Minimum and the current set point value.

5.4.6.29 *SPr - Set Point Ramp*

This parameter enables/disables use of the set point ramping feature at user level (diSA = Disabled, EnAb = Enabled).

5.4.6.30 *SPuL - Set Point High Limit*

This is the maximum limit for set point adjustment. It should be set to a value that prevents the set point being given a value that will cause damage to the process being controlled. The Set Point High Limit may be adjusted between the current set point value and the input Range Maximum.

Note: For more information see the Manufacturer's Literature.

5.5 OPERATION AND MAINTENANCE LOGS

The 2010 is a robust piece of equipment, but the Parylene process requires periodic maintenance to be performed. Cleaning of the Parylene from the chamber and cold trap probe is essential to avoid coating build-up that otherwise would eventually destroy the performance of the system

Logs should be maintained on Daily Operation, Daily Maintenance, and Periodic Maintenance. Example logs are shown below. Using and following the recommendations in these logs will maximize trouble free operation of the PDS 2010 coating process.

DAILY OPERATION LOG

Date	Film Thickness	Load Size Sq. Inches	Dimer Usage		Base Pressure		Base Pump Down Time	Run Time	Vaporizer Parameters	Chamber Parameters	
			Run	Total	Cold	Hot				Set Point	SP

DAILY MAINTENANCE LOG

(Inspect, Check Condition, Remove, Replace, Clean or Apply)

Date	O-Rings and Sealing Surfaces	Vaporizer and Dimer Boat	Chamber, Baffle Turntable, Sight Glass	Cold Trap and Probe	Vacuum Pump Oil
	Load Door Chamber Gasket Cold Trap	Remove Residuals	Remove Parylene Build-up Apply Release Agent on Bare Surfaces Only	Thoroughly Clean After Every Run Apply Release Agent	Check Replace

PERIODIC MAINTENANCE LOG

Date	Daily Maint. Items	Pyrolysis Tube	Dimer Boat	Tubing	Temperature Pressure Readouts	PUMP OIL
		Scrape/Peel Build-up at Ends	Replace	Inspect. Replace as Needed	Verify. Calibrate as Needed	CHANGE

5.6 SUPPLIES FOR SERVICING

Lint Free Paper Towels	Spray Bottle for Micro-Soap	Allen Wrench Set
Scotch Brite™	2% Micro-Soap/Water Solution	Pliers
Single Edge Razor Blades	Hi-Temperature O-Ring Grease	Tweezers
Screwdrivers	Non-Flammable Solvent	Flash Light
SA-285-1119-1 2010 Rotary Feed Thru Rebuild Kit	SA-285-1216-1 2010 Cleaning Kit	

5.7 COATING PROBLEMS AND SOLUTIONS

The following table lists Parylene coating problems and solutions. The solutions offered are general guidelines and should resolve most problems.

Each specific coating application will have its own requirements for coating thickness, substrate configuration in the Chamber, rate of deposition, and other criteria. The customer must optimize the process for each coating application.

COATING PROBLEMS AND SOLUTIONS

PROBLEM	CAUSE	SOLUTION
No significant pressure rise and the run takes too long.	Chamber SP too low.	Increase Chamber SP. 25 vacuum units above Base is typical for Parylene C.
	Blocked chamber - Inlet port.	Remove and Clean Inlet Baffle.
Cloudy coating or high dimer content.	Chamber SP too high.	Lower Chamber SP.
	Initial pressure overshoot.	See next entry.
Initial pressure overshoot more than 2-3 vacuum units.	Vaporizer temperature ramp up to fast.	Increase Vaporizer Pb1 by 10%.
	Chamber loop too aggressive.	Increase Chamber Pb1 by 10%.
	Vaporizer temperature not controlled.	See next entry.
Vaporizer temperature not controlled.	Check for possible malfunction of heater or thermocouple.	If temperature overshoots, increase Vaporizer Pb1 by 10%.
Uneven coating distributions in the chamber.	Parts not uniformly loaded in the chamber.	Load parts as recommended in "Orientation of Substrate".
	Chamber baffle warped, clogged or loose fitting.	Correct inlet baffle problem.
	Fixture rotation not operating.	Check that FIXTURE DRIVE is On. Observe rotation through the chamber view port.
Coating too thick.	Too much dimer powder in the boat.	Decrease the dimer load.
Coating too thin.	Too little dimer powder in the boat.	Increase the dimer load.
High Parylene dimer content in the coating.	Insufficient Pyrolysis.	Check that the Furnace Set Point and Vaporizer Set Point are set according to the Process Control Parameters Table.
	Too high a coating set point.	Lower Chamber Set Point.
Impurities in coating.	Too high dimer content.	Reduce Chamber SP.
	Vacuum leaks introducing other gasses.	Fix vacuum leaks.
	Black flecks from dirty Pyrolysis Tube.	Clean out Pyrolysis Tube, brush out all ash.

6 SPARE PARTS

6.1 SPARE PARTS KITS

The following Kits provide a convenient means to order the recommended spare parts for your unit.

The **Basic** Kit contains the minimum recommended parts to cover 85% of expected failures plus normal operational expendable items.

The **Comprehensive** Kit contains everything in the Basic Kit plus recommended parts to cover 98% of expected failures.

Basic Spare Parts Kit	SCS P/N SA-285-1028-3
Comprehensive Spare Parts Kit	SCS P/N SA-285-1033-2

6.2 SA-285-1028-3 BASIC SPARE PARTS KIT

Material	QTY	U/M	Material Description
269-037	1	EA	FUSE,1/2AMP,250VAC, BUSSMAN MDA-1/2
20060	1	EA	T'COUPLE,J-TYPE WATLOW #75XJFGA024A
20061	1	EA	T'COUPLE,J-TYPE WATLOW #75XJFGA048A
20062	1	EA	T'COUPLE,J-TYPE GORDON AF-2025531
20077	1	EA	GASKET,12" BUNA-N, LG12B LESKER
20079	1	EA	CENTERING RING W/SCRN,QF25-SRV-SM LESKER
20080	2	EA	O-RING,VITON,SZ.231,2-231-V884-75 PARKER
20081	1	EA	O-RING,SILICONE, 2-234-S604-70
20084	2	EA	O-RING, SZ.240 NITRILE,2-240-N674-70PARK
20091	1	EA	O-RING, VITON, 2-225-V884-75 PARKER
B50000-46	1	EA	O-RING,SZ.380,NIT.,#2-380-N674-70 PARKER
9589	2	EA	FUSE,2A,250VAC, MDA-2 BUSSMAN
537-1001	4	LT	OIL, PUMP,ULTRA 19, H110-250-012 EDWARDS
20165	2	FT	HOSE,VACUUM 1.0" PVC,LESKER PT100-1
20166	1	FT	HOSE,VACUUM 1.5" PVC,LESKER PT150-1
20139	1	EA	CLAMP PAK,S/S, 5540K22 MACARCO MCMMASTER
9591	2	EA	FUSE,5A,250VAC, MDA-5 BUSSMAN
SA-018-1044-1	2	EA	BAFFLE ASSEMBLY, 2010
SA-269-1057-1	2	EA	THERMAL FUSE ASSY, 121 C (GAUGE TUBE)
SA-269-1058-1	2	EA	THERMAL FUSE ASSY, 144 C (VAPORIZER)
SA-269-1059-1	2	EA	THERMAL FUSE ASSY, 229 C (FURNACE)
9572	1	EA	FUSE,10A,250V AC, MDA-10 BUSSMANN
9595	1	EA	FUSE,20A,250VAC,MDA-20 BUSSMAN
269-044	1	EA	FUSE,12AMP,BUSSMAN MDA-12
PP-660-1000-0	1	EA	RELAY,SSR 25A 3-32VDC C-G RM1A23D25
20057	1	EA	VALVE,SOLENOID,115V,NC,
20048	1	EA	GAUGE TUBE 275071 G/P

6.3 SA-285-1033-2 COMPREHENSIVE SPARE PARTS KIT


Material	QTY	U/M	Material Description
SA-285-1028-3	1	EA	KIT, BASIC SPARE PARTS, PDS2010(120/220) (SEE ABOVE)
823-1007	1	EA	CONTROLLER, WEST 6100+ SERIES (3 OUTPUTS)
OM-285-1200-1	1	EA	MANUAL, RETROFIT WEST 6100+ CONTROLLER
PP-374-1046-0	1	EA	HEATER, VAP 2010, WATLOW B02G09LC-3000
20109	1	EA	PYREX GLASS, 4.25"DIA X .25"THK,
PP-858-1001-0	1	EA	TAPE 1/2"GLASS CLOTH MMCAR 75885A675
PP-660-1000-0	1	EA	RELAY, SSR 25A 3-32VDC C-G RM1A23D25
20195	1	EA	BRIDGE AMP W/CABLE #275239 G-P
20052	1	EA	HEATER, BAND, 240V/500W #STB1J3A2-A12 WAT
20056	1	EA	HEATER, 150W RING, A-00 135247 CHROMOLOX
20058	1	EA	FAN, AXIAL, 235CFM
20065	1	EA	ALARM, SONALERT, #SC110 MALLORY
PP-859-1000-0	2	EA	CONTROLLER, WEST 6100+ SERIES (2 OUTPUTS)
PP-744-1043-0	1	EA	OPERATOR PUSHBUTTON GREEN AB 800FP-LFA3
PP-744-1042-0	1	EA	OPERATOR PUSHBUTTON CLEAR AB 800FP-LF7
PP-744-1044-0	1	EA	OPERATOR PUSHBUTTON RED AB 800FP-LFA4
PP-757-1004-0	1	EA	MOUNTING LATCH - PLASTIC AB 800F-ALP
PP-744-1047-0	1	EA	LED POWER MOD 120V WHITE AB 800F-N5W
PP-107-1007-0	1	EA	CONTACT, SELECT SWITCH, NO, A/B 800F-X10
PP-107-1008-0	1	EA	CONTACT, SELECT SWITCH, NC, A/B 800F-X01

7 STEP BY STEP PROCEDURE FOR PARYLENE COATING

7.1 PREPARING TO COAT


The ideal and simplest condition for starting would be one where the unit had been unloaded and cleaned, and had set overnight to reach room temperature. This is seldom the case. Therefore, the following does not assume these ideal conditions. If your system does not need venting, cooling, etc., skip the unneeded step.


STEP	OPERATOR ACTION	PDS 2010 ACTIONS
1	Power on the PDS 2010 with the MAIN POWER ON button. The process controllers will be on when main power is on (The MAIN POWER ON button will be illuminated when power is applied to the machine).	
2	Vent the system. Switch the VACUUM SWITCH selector to VENT.	Vent the CHAMBER to atmosphere.
3	When the CHAMBER PRESSURE controller reads approximately '999', the CHAMBER is at atmosphere. The chamber will be removed from its base in step 5.	
4	Make sure that all temperature, pressure and alarm settings are correct.	Refer to Section 6.4 for setup procedure.

<p>5</p>	<p>Remove the CHAMBER.</p> <p>A good method for removing the chamber is to twist it before lifting. This is easy and creates a nice clean break in the Parylene coating.</p> <p>If Parylene coating build-up from previous coating runs is blistering or separating from the machine surfaces, the Parylene film must be removed at this time.</p> <p>If cleaning is necessary:</p> <ul style="list-style-type: none"> ◆ The fixture base should be removed for cleaning. ◆ Strip all the film from the Chamber, Viewport, Furnace Port, and any other surfaces of the fixture that are coated. ◆ Apply the RELEASE AGENT (Microsoap Solution) to the interior of the CHAMBER. <p>With a spray bottle and a lint-free cloth, apply a 2% solution of Micro Soap and water release agent to all the bare stainless steel surfaces from where the Parylene coating must later be stripped after several coating runs.</p> <p>Apply release agent to :</p> <ul style="list-style-type: none"> <input type="checkbox"/> the interior of the coating chamber; <input type="checkbox"/> the interior of the chamber lid and sight glass; <input type="checkbox"/> the inlet and outlet ports of the chamber; <input type="checkbox"/> the inlet and outlet baffles; <input type="checkbox"/> the turntable and fixturing; <p>Do not apply a release agent over deposited Parylene coating from previous runs. The sequential runs make the Parylene thicker and easier to remove as sheets, rather than in small pieces.</p> <p>The System internal surfaces must be clean. All O-rings and seals must be in good condition and all sealing surfaces must be clean. Even small strips of Parylene film on the O-rings will cause vacuum leaks that will impair the process.</p>	
<p>6</p>	<div style="display: flex; align-items: center;">  <p>Avoid Freeze Burns! Wear protective gloves when working with a Cold Trap.</p> </div> <p>Expose and, if required, clean the COLD TRAP PROBE.</p>	

	<p>NOTE (HOW SOON TO MOVE THE COLD TRAP PROBE): There are two opposing needs to consider. 1) The flex line to the probe, and its junction, need time to warm somewhat so they are not damaged by the flexing. 2) However, the probe needs to be removed promptly so the frozen material on the probe does not drip or fall into the Cold Trap and eventually cause damage. Allow 10 minutes for the flex line (and its junction to the probe) to warm before moving; do not wait so long that the frozen material on the probe begins to melt. Then use special care to minimize stress on the line and junction when moving the probe to the fixture.</p> <p>Use a cloth wrapped around the probe to twist and remove the deposits. Remove the cloths and vacuum the base of the probe to remove all deposits. If necessary, use Scotch Brite™ abrasive pad to remove the rest of the deposits.</p>	
7	Apply RELEASE AGENT to the COLD TRAP PROBE.	
8	Reinsert the COLD TRAP PROBE into the COLD TRAP HOUSING.	
9	Secure parts in fixture for coating.	

7.2 AUTO MODE OPERATION

STEP	OPERATOR ACTION	PDS 2010 ACTIONS
1	 <p>Caution - The steps of Section 9.1, Preparing to Coat, must be completed. This is critical, because the chamber must be prepared to assure good coating and also to enable later stripping of the film.</p>	
2	Turn on machine by depressing Main Power ON.	Process controllers come on when.
3	Turn on MECHANICAL CHILLER Ref. Section 5.8.1	Wait 30 - 45 minutes before pumping down
3b	LN ₂ OPTION Ref. Section 5.8.2 NOTE: Do not enable the LN ₂ at this time-See step 8.	
4	Depress PROCESS START/STOP	After depressing this pushbutton, the button will be illuminated green. None of the heaters can begin to heat unless this button is depressed and illuminated.
5	Switch FURNACE and CHAMBER GAUGE selector to ENABLE. (Do not wait for heaters to reach set point, but continue with the next step. The PDS 2010 will assure proper temperatures before beginning coating.)	When switched On, this enables PROCESS TEMPS. This will allow all the PROCESS TEMPS, including Chamber Gauge Heat, Furnace Heat ...to heat to set point. These zones of heat must reach set point before coating begins.

STEP	OPERATOR ACTION	PDS 2010 ACTIONS
6	Load fixtured parts on to turntable. Switch Vaporizer selector to ENABLE. The turntable we begin to rotate the fixtured parts. Insure that the fixture does not hit the baffle or the fixture could become stuck during the run. Place chamber on chamber base.	The VAPORIZER selector enables the turntable. Rotating the parts insures even distribution of the Parylene coating. The VAPORIZER selector also allows the Vaporizer to come on when the PLC program allows. The Vaporizer heater will not come on unless the VAPORIZER selector is enabled.
7	 <p><i>Allow the Vaporizer Load Door and Dimer Boat to cool before handling them and wear protective gloves when removing the Dimer Boat</i></p> <p>Load the measured amount of Dimer in a Dimer Boat. Close the LOAD DOOR.</p>	
8	Switch the VACUUM selector to VACUUM. NOTE: If a Mechanical Chiller is being used, be sure that it has been running at least 30-45 minutes before proceeding with this step. Ref. Step 3	Turns on VACUUM PUMP when enabled. If LN ₂ cold trap is being used in place of the Mechanical Chiller, the LN ₂ will be enabled when the VACUUM selector is switched to VACUUM.
9		Chamber pumps to base pressure. If Process Temps (Chamber Gauge and Furnace temperatures) are in limits, the Vaporizer heater is enabled.
10		If using the Lower Vaporizer Set Point, the Vaporizer will heat to that temperature and remain there for 30 minutes, as long as the chamber pressure remains below the Vacuum set point. 30 minutes is the minimum run time.

STEP	OPERATOR ACTION	PDS 2010 ACTIONS
11		After the minimum 30 minute timer is complete, the Vaporizer will try to heat to its standard set point being limited by the Vacuum controller. Also, after 30 minutes, the PLC program is waiting for the chamber pressure to achieve base pressure again, indicating complete vaporization of the dimer, before proceeding to step 12.
12		After base pressure has been achieved again, a 5 minute Bake Out timer is enabled. This ensures all parylene dimer gets vaporized.
13	<p>Press the PROCESS START/STOP button to stop it from blinking continuously.</p> <p>Turn the VACUUM selector to VENT.</p>	<p>After the 5 minute Bake Out time is complete, the run is over and the following will occur.</p> <p>The PROCESS START/STOP button will blink continuously.</p> <p>All heaters will be disabled.</p>
14	Turn off Mechanical Chiller	
15	Remove chamber and unload parts.	
16	As soon as possible, remove and clean Cold Trap probe. See Section 6.1.3	

8 LIMITED WARRANTY POLICY

- I. Subject to the limitations hereinafter set forth, SPECIALTY COATING SYSTEMS ("SCS") warrants that all component parts manufactured by SCS are free from defects in materials and workmanship for a period of twelve (12) months from the date of shipment. SCS will replace materials for a period of twelve (12) months from the date of shipment, and provide labor, if required, for a period of six (6) months from the date of shipment to correct warranty defects.
- II. Components such as gauges and meters, controllers, pumps, motors and valves are warranted by their respective manufacturers and these warranties are extended to the end user. Alcohol solutions and D.I. columns are not warranted.
- III. If, within the warranty period, any equipment or components manufactured by SCS shall prove to SCS's satisfaction to be defective, such equipment or parts shall be replaced or repaired, at SCS's option, at SCS's expense. Installation of replacement equipment or parts shall be at the Purchaser's expense.
- IV. The foregoing warranty shall be limited with respect to parts which are subject to wear or chemical reactions or which have a variable life expectancy, including but not specifically limited to, protective coatings, thermocouples, heaters, seals, o-rings, drive belts, relays, lamps and bearings (but not including filters) to a period of ninety (90) days from the date of shipment. Test cells are warranted for six (6) months from the date of shipment.
- V. SCS's obligation hereunder shall be limited to repair or replacement, F.O.B. SCS's factory, and shall be conditioned upon receipt of written notice of such defect within ten (10) days after its discovery. Prior written approval is required, for return shipment of equipment or components to SCS at SCS's expense.
- VI. This warranty shall not apply to equipment or parts which have been repaired or altered by any party other than SCS as, in SCS's judgment, adversely affects the same, or which shall be subject to negligence, accident, damage or circumstances beyond SCS's control (including fire, earthquake, flood or other acts of God), or improper installation, operation, maintenance, or storage, or to other than normal use of service. Improper operation of equipment or any part thereof shall include, without limitation, operation under loads, speeds, pressures or electrical current characteristics, or with supplies not complying with SCS's specifications.
- VII. SCS will not accept responsibility for repairs or the cost of any work done without specific written SCS authorization.
- VIII. This warranty does not apply to used or second-hand equipment, nor does it extend to any person other than the original Purchaser.

- IX. This warranty does not apply to equipment which is broken or damaged in transit. In no event shall SCS be responsible for any liability, loss or damage of such equipment delivered in good order and condition to a carrier or carriers at any point of shipment.
- X. This warranty shall not cover, and SCS shall not be liable for, losses of supplies or time, damages to materials, or consequential damages of any nature, arising from or attributable to equipment sold to the Purchaser by SCS. This warranty is strictly limited to the replacement or repair of the equipment or parts purchased.
- XI. SCS's liability to the Purchaser arising out of the supplying of this equipment or its use, whether based on warranty, contract, or negligence, shall not in any case exceed the cost of correcting defects in the equipment as herein provided, and upon expiration of the applicable warranty period as aforesaid, all such liability shall terminate.
- XII. EXCEPT AS OTHERWISE SET FORTH IN THIS LIMITED WARRANTY, THE EQUIPMENT AND PARTS SOLD BY SCS TO PURCHASER ARE SOLD "AS IS" AND "WHERE IS" AND "WITH ALL FAULTS," AND SCS DOES NOT MAKE AND SHALL NOT BE DEEMED TO HAVE MADE, AND SCS HEREBY DISCLAIMS, ANY REPRESENTATION OR WARRANTY, EXPRESSED OR IMPLIED, REGARDING THE DESIGN, CONSTRUCTION OR CONDITION OF, OR THE QUALITY OF MATERIAL OR WORKMANSHIP IN, THE EQUIPMENT OR PARTS, AND SCS MAKES NO WARRANTY OF MERCHANTABILITY OR FITNESS OF THE EQUIPMENT OR PARTS FOR ANY PARTICULAR PURPOSE.

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9 TECHNICAL LITERATURE

The Assembly Drawings, Electrical and Pneumatic Schematics, MSDS' and technical literature is provided on a CD, placed in a pocket in the back cover of this manual.

The literature is provided in Adobe Acrobat™ (PDF) form. You need Acrobat Reader™ to open the files*. The disk should start automatically; if it does not start, begin by opening the file `AccessPage.PDF`. From it you can easily elect to view any of the manufacturers' manuals.

(more files may be available on CD-ROM)

*Adobe Acrobat Reader is available free from many web sites, in addition to www.Adobe.com

10 INDEX

NOTE: Refer first to the Table of Contents; major subjects and activities are listed there. If you do not find what you are looking for there, come back to the Index for smaller and more specific items.

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