SPI SUPPLIES
PLASMA-PREP JR.™
MODELS 11001, 11002 and 11003

OPERATION AND MAINTENANCE MANUAL

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I. INTRODUCTION

You now own the SPI PlasmaPrep Jr. plasma etching system capable of performing many functions in the plant or laboratory. Typical applications are described in Section X.

The SPI PlasmaPrep Jr. system is manufactured from a microprocessor controlled microwave oven and uses the relevant digital control functions incorporated in the microwave oven. The SPI PlasmaPrep Jr. system also has an additional analog power control feature added to provide a wider control range of plasma power.

The SPI PlasmaPrep Jr. system operates by flowing a process gas (usually oxygen or argon) at reduced pressure (from 1 to 5 torr) through the process chamber and exciting the plasma discharge with the microwave energy from the microwave oven. This process produces ionized gas species and free radicals within the gas. These active species sputter and/or react with the work within the chamber. Since this process occurs in the gas phase at reduced pressure, little material is consumed or discharged. Reactions occur at the work surface (gas solid interface) and are subject to the geometrical constraints this arrangement introduces. For example, if two flat parts are bonded together, the area attacked is the narrow bond line exposed to the plasma.

Much of the plasma power eventually is dissipated as heat. For processing heat sensitive components, it becomes necessary to limit the average plasma power or to heatsink the work. The SPI PlasmaPrep Jr. therefore includes provisions to water cool the work.

We are confident that you will discover many applications for the SPI PlasmaPrep Jr. system in your work that you may not have considered before.

II. SPI PLASMAPREP JR. FEATURES

Reasonably Priced	Reduces Effluents
High Power to 700 Watts	Safety Designed
Electronic Digital Controls	Ease of Use
Duty Cycle Control	Simplicity of Maintenance
Analog Power Control	Reliability of Performance
Process Memory	Water-Cooled Base Plate
2.45 GHz Operation	Optional 50Hz 220V Power Available

III. SYSTEM SETUP: WATER COOLED REACTOR

Remove the bell jar and its contents from the inside of the SPI PlasmaPrep Jr. unit. The unit is shipped with its vacuum tube (3/8" O.D. tube) and water tubes (1/4" O.D. copper tubes with brass fittings) disconnected. Reconnect the vacuum tube and water tubes to

the appropriate fittings in the rear of the unit. If the unit was ordered without the SPI PlasmaPrep Jr. gas control panel, reconnect the flowmeter assembly to the gas inlet (the silver colored fitting on the lower right side when facing the rear of the water cooled unit). Screw the flowmeter brackets into the holes provided in the upper right side of the unit. Use one wrench inside the unit (5/8" for the brass water lines and 3/4" for the silver-colored vacuum line) and one outside the unit (9/16" for the brass water lines and 11/16" for the vacuum line) to tighten the fittings. Mount the bell jar, open side down, on the gasket and on top of the base plate.

Place the unit in location. Be sure to leave at least one inch of clearance at the top and three inches on each side to assure proper ventilation and access to the controls.

The SPI PlasmaPrep Jr. requires a vacuum pump with a capacity of at least 3.0 CFM (85 l/m), capable of pumping down to 50 μm. We recommend the SPI #10407-AB pump, manufactured by Edwards and precharged with FOBLIN Y-25 pump fluid; this is the unit provided if you ordered your SPI PlasmaPrep Jr. with a vacuum pump. In normal operation, the unit produces chemical radicals which may react with hydrocarbon vacuum pump oils. Therefore the vacuum pump must be properly prepared for use with a perfluorinated polyether pump fluid such as FOMBLIN Y-25 or Krytox 1525. Only a perfluorinated polyether pump fluid should be used to recharge the pump.

Set up the vacuum pump in accordance with the manufacturer's instructions. Connect one end of the long vacuum hose to the vacuum pump and the other end to the SPI PlasmaPrep Jr. control unit. Prior to use, check the pump oil level to be sure that the fluid level is between the "min." and "max." levels on the sight glass.

The SPI PlasmaPrep Jr. system is available in several different configurations, depending on the customer's specific needs. Which of the following steps to follow depends on the specific configuration of your system.

If your SPI PlasmaPrep Jr. does not include a controller unit, connect the process gas line to the fitting on the flowmeter. If it was purchased with a gas manifold, then connect a process gas to each of the manifold inlet fittings being used. Set each process gas regulator at 10 psi.

If your SPI PlasmaPrep Jr. does include a controller unit, refer to Figure 2. Connect one end of the short piece of vacuum tubing to the controller fitting on the rear of the control unit and the other end to the large fitting on the left (facing the front of the unit near the brass water lines) of water cooled units or the bottom fitting of the barrel unit. The longer piece of vacuum hose connects the vacuum

pump to the controller at the fitting marked "TO VACUUM PUMP". The gas inlet tube is connected to the top center rear gas fitting marked "MIX GAS OUT", and the large right fitting of the water cooled unit or the top fitting of the barrel unit. Do not connect the vacuum pump to any of the outlets in the rear of the controller.

The process gases are connected to the rear fittings marked "GAS A" and "GAS B" on the controller, one on the right side and the other on the left side. The flowmeters are marked to show which meter measures the flow of which gas. Confirm that the regulators on the front panel of the controller are set for 5 psi. If one gas is not being used, it should be shut off using the needle valve.

Connect the water lines to an appropriate water source and return, or drain. The unit will operate properly with water flowing in either direction. Required water flow is about 0.3 gal/min.

If the unit has been stored under extremely cold conditions, wait a few hours before proceeding.

Plug the unit into an appropriate power source. Grounded power circuits are required.

IV. SPI PLASMAPREP JR. CONTROLLER FRONT PANEL CONTROLS

When the left most electrical switch is in the "up" position, it turns on any accessories which are plugged into the rear of the system. THIS CIRCUIT DOES NOT PROVIDE SUFFICIENT CURRENT TO OPERATE THE VACUUM PUMP. The vacuum pump must be plugged into a separate outlet.

When the center electrical switch is in the "up" position, it turns on the gas flow into the SPI PlasmaPrep Jr.

When the right electrical switch is in the "up" position, it opens the solenoid in the control box that connects the chamber to the vacuum pump. When this switch is in the "down" position, it closes the connection between the vacuum pump and the chamber and simultaneously opens a solenoid that bleeds gas into the chamber. The rate of flow of the bleed gas is controlled by a needle valve on the rear of the unit, between the two vacuum lines. Control of gas flow during bleed is a good idea in general, and it is essential to prevent small work pieces from blowing around during the vent cycle.

V. SYSTEM SETUP BARREL REACTOR

Open the front door of the SPI PlasmaPrep Jr. and remove the literature inside. Locate the inner chamber and place it inside the outer chamber, within the unit. Connect the vacuum line to the bottom connector on the left side of the unit in the rear. Set up the

vacuum pump according to the manufacturer's instructions. Connect the process gas line to the bottom fitting on the flowmeter. The top of the flowmeter connection or the "MIXED GAS OUT" of the controller should be connected to the top gas inlet connection on the left hand (facing the front) of the unit.

Plug the unit in to an appropriately grounded circuit. Electrical requirements are 110 to 120 V 15 A/60 Hz or 220 V 50 Hz, depending on the model purchased.

Do not remove the feet on the bottom of the unit; they are there to ensure proper air flow.

Note the cautions in Section VII concerning vacuum pump fluids and allowing the unit to reach room temperature before plugging in.

VI. SAFETY INFORMATION

Any microwave appliance must meet rigid safety performance standards established by regulatory authorities; in the United States, these regulations are established by the United States Department of Health and Human Services. The following precautions will reduce the risk of burns, electrical shock, fire, injury to persons or exposure to excessive microwave energy.

Read all instructions before using this equipment.

Read and follow the microwave energy precautions in Section VII.

Install the unit so that sufficient air circulation is possible around all of the unit, particularly the back. Install the unit on a stable base where it will not fall or get wet. Be sure that all water connections on water cooled units are tight and secure.

THIS UNIT MUST BE ELECTRICALLY GROUNDED.

Do not run the unit with the bell jar at atmospheric pressure or without gas flowing through the reaction chamber (no load condition) unless the unit is being controlled by the timer. While short periods of no load operation will not damage the unit, this procedure is not recommended.

Do not operate the unit if it has a damaged electrical cord or plug, if it is not functioning properly or if it has been damaged or dropped. Electrical shock, fire or other hazard may result.

The unit should only be serviced by qualified personnel.

There are various openings to allow air to circulate to the internal components; do not cover or block these openings, or fire may result.

Do not use the unit outdoors, to avoid damage or electrical shock.

Do not immerse the electrical chord or plug in water, or electrical shock may result.

Keep the electrical chord and plug away from heated surfaces, or electrical shock may result.

Carefully follow the door cleaning instructions in Section VIII.

If materials inside the unit catch fire, keep the door closed, turn the unit off and disconnect the electrical power by pulling out the plug or disconnecting the main power at the fuse or circuit-breaker box.

The SPI PlasmaPrep Jr. is not a storage cabinet. Do not leave anything inside it, particularly not combustible materials. If the unit is accidentally turned on, a fire could start.

Do not operate the unit with any metal component outside the vacuum chamber.

Be certain that the vacuum chamber is at atmospheric pressure before attempting to open the outer door.

The plasma generating process of the SPI PlasmaPrep Jr. generates ultraviolet light. The built-in light filter takes away 90% of this light, but it is still a good idea not to look at the glowing plasma at close range for extended periods of time, since eye strain may result from doing this.

The vacuum chamber is made of glass. It is fragile, and it should be treated with the same care you would give to any other piece of glass.

Do not use incompatible gas mixtures (such as hydrogen and oxygen) in the reaction chamber; an explosion could result from doing this.

Do not run the water-cooled unit at full power in the CW mode for more than 15 minutes at a time without water flow to prevent overheating of the baseplate and gasket.

The glass vacuum chamber can become very hot during full power, 100% duty cycle operation. Hot glass must be handled with extreme care and appropriate safety precautions.

To prolong the life of the analog power control unit, avoid operating at analog power control settings between 80 and 99 (100 or full power is OK).

VII. AVOIDING POSSIBLE EXPOSURE TO EXCESSIVE MICROWAVE ENERGY

The front door of the SPI PlasmaPrep Jr. is an integral part of the shielding system which protects you and your colleagues from excessive exposure to microwave energy. The safety interlocks are there to protect you. Do not attempt to operate the unit with the door open.

Do not place any object between the unit front face and the door or allow soil, cleaner or residue to accumulate on sealing surfaces.

Do not operate the unit if it is damaged. It is particularly important that the front door close properly and that there is no damage to the door (bent), the hinges and latches (broken or loosened), the door seals and sealing surfaces or the fittings in the rear of the unit (removed or loosened).

The unit should not be adjusted or repaired by anyone except a properly qualified service person.

VIII. GROUNDING INSTRUCTIONS

The SPI PlasmaPrep Jr. system must be electrically grounded and connected to the same ground as the vacuum pump. In the event of an electrical short circuit, grounding reduces the risk of electrical shock by providing an escape route for electric current. The power cord which we provide is equipped with an appropriate grounding wire with a grounding plug. The plug must be plugged into an outlet that is properly installed and grounded.

WARNING: Improper use of the grounding plug can result in risk of electrical shock. If there is any doubt about the grounding instructions, or any question about whether the unit is properly grounded, consult a qualified electrician or service technician.

If it is necessary to use an extension cord, use only a 3-wire extension cord that has a 3-blade grounding plug and a 3-slot receptacle that will accept the plug on the unit. The marked rating of the extension cord must be equal to or greater than the electrical rating of the unit.

CAUTION: The glass vacuum chamber can become HOT when the unit is in operation, particularly at full power at 100% duty cycle. Take proper precautions when handling the hot glass, especially when it is under vacuum. Do not open the door when the bell jar is under vacuum. The possibility of implosion always exists with glass under vacuum, especially if the glass is hot.

When the run is finished, shut off the vacuum pump and vent the bell jar immediately by turning the vent valve toward the back of the unit. If the bell jar is not vented immediately, oil may suck up from the vacuum pump and contaminate the system. SPI PlasmaPrep Jr. units shipped without the Control Panel are equipped with a vent valve. The vent valve has a 0.013" diameter flow-constricting orifice to prevent small parts from flying around inside the bell jar during the venting operation. The gas flow is automatically shut off when the vent valve is in the vent position.

After the system reaches atmospheric pressure (about 20 seconds), open the door and the bell jar may be lifted.

Load the system with the specimens to be treated and repeat the above steps. Adjust the time, duty cycle, analog power and thermal resistance to the heat sink based on the effects of the plasma on the work.

IX. CARING FOR YOUR SPI PLASMAPREP JR. SYSTEM

Do not use abrasive cleaners, cleaning pads or steel wool to clean the door, because they might scratch or dull it.

Clean the interior and exterior of the unit with a damp cloth. Do not use solvents because they might damage or discolor the plastic components.

Make certain that nothing is blocking the door and the sealing surfaces.

The bell jar may be removed and cleaned as you would any glass object. Soap and water works well. Be sure to rinse thoroughly, as traces of soap on the inside could cause the glass to weaken in an oxygen plasma. Avoid solutions containing hydrofluoric acid, which may weaken the glass.

The rubber gasket can also be cleaned with a damp cloth. Do not use sharp objects as they might cut the rubber and prevent the formation of the vacuum seal. Should the unit become contaminated, it can be cleaned by operating it empty, at full power, for 15 minutes, preferably using oxygen as the process gas.

X. TROUBLE SHOOTING GUIDE

Unit stops by itself--Line voltage too low, or the unit is improperly grounded.

Nothing happens when the numbers are pushed--Remember to press the pads firmly and to press CLOCK before entering the time setting. Press CLEAR PAD and start over.

Plasma appears concentrated in one corner of the bell jar--check the vacuum connections and the vacuum tubing for leaks. Check the vacuum pump oil for contamination.

Vacuum pump starts noisily--This is normal operation when the pump oil is cold and has a high viscosity.

Vacuum pump does not "settle down" or gas can be felt exiting from the pump--The vent valve is in the vent position (for SPI PlasmaPrep Jr. systems without the Control Panel) or the bell jar is not fitting snugly against the rubber gasket. Vent the system, readjust and try again.

Specimens are getting too hot--Heat sink the specimens better (water cooled unit only) and/or reduce the power or duty cycle.

No reaction is occurring or the reaction is very slow--Increase the specimen temperature by placing a piece of glass between the specimen and the heatsink (water cooled unit only) and/or increase the analog power or duty cycle.

Solder on the work is sputtering or smearing--Reduce the process temperature, use the ion trap (Section XVI) and/or reduce the power.

The vacuum baseplate is getting hot--Check the water flow and water temperature (water cooled units only).

XI. SPI PLASMAPREP JR. APPLICATION GUIDE

INDUSTRY	FEATURE	BENEFIT
Electronic	Argon Plasma Cleaning Without Ion Trap (Between 5 and 10 min.)	Wire Bond Pads Pd-Ag Dia Attach Pads Gold Plated Parts Solder Preforms Epoxy Bleed Preparation for Soldering Photoresist Removal Oxidizable Metal Surfaces Gold or Aluminum Wire Removal of Some Metal Oxides
	Argon Plasma Cleaning With Ion Trap (~15 to 30 min.)	Devices with Sensitive Chips Laser Diode Facets Ceramics with Soft Solder P.C. Boards with Soft Solder
	Oxygen Plasma Cleaning (5 min. @ full power)	Photoresist Removal Bare Ceramic Substrates Removal of Plastic Encapsulants for Failure Mode Analysis Glass Parts Metal Oxide Parts Gold Plated Parts Silicon Gallium Arsenide Indium Phosphide Preparation of Plastics for Gluing
Optical	Oxygen Plasma Cleaning (5 to 15 min.)	Glass, Si or GaAs Optics Finger Prints Epoxy Residues Oil Residues Lapping Compound Binders Parts will Pass the "Water Break Test" After Cleaning

XII. SPI PLASMAPREP JR. SYSTEM SPECIFICATIONS

The SPI PlasmaPrep Jr. system comes in three versions. The first is the barrel type reactor. The other two have water cooled reaction chambers, the smaller 8" x 6" x 2" and the larger 9" x 7" x 3". Each system is described below:

Barrel Reactor System	SPI PlasmaPrep Jr. SPI#11001-AB
Chamber	Barrel
Diameter	4.1"
Length	6.0"
Material	Pyrex (Quartz on Special Order)
Small Water Cooled System	SPI PlasmaPrep Jr. SPI#11002-AB
Chamber	Rectangular
Dimensions	8" x 6" x 2"
Cooling Along	8" x 6" side
Material	Pyrex and aluminum
External w x h x d	28" x 12" x 13"
Shipping Weight	65 pounds
Large Water Cooled System	SPI PlasmaPrep Jr. SPI#11003-AB
Chamber	Rectangular
Dimensions	9" x 7" x 3"
Cooling Along	9" x 7" side
Material	Pyrex and aluminum
External w x h x d	28" x 12" x 13"
Shipping Weight	80 pounds

Specifications for all units:

Electrical Power	115 V ac 15 A 60 Hz grounded or 220 V ac 50 Hz
Plasma Power	Variable 100 to 750 watts
Frequency	2.45 GHz
Duty Cycle Adjustment	Variable from 10% to continuous
Flow Meter Standard	5 cu. ft./Hr. @ STP
Utilities Required	Vacuum pump, water and drain
Gas Supply	Oxygen and Argon

XIII. SUGGESTED MAINTENANCE

Change the vacuum pump oil on a regular basis to remove accumulated contamination.

Keep the unit clean, especially around the front door seal area.

If the bell jar becomes dirty, clean in any manner appropriate for glassware. If soap is used, thoroughly remove all traces; interaction of soap with plasma will weaken the glass.

Additional bell jars and gaskets are available by contacting SPI Supplies Customer Service at 1-800-242-4774 in the U.S. and Canada.

XIV. SPI PLASMAPREP JR. CONTROLS

The ANALOG POWER CONTROL KNOB is located on the right hand side of the unit. It is equipped with an indicator dial, where 100 corresponds to 100% power and 0 corresponds to about 100 watts of power. Avoid operating with the analog control knob set between 80 and 99 (100 or full power is OK). This will prolong the life of the analog control unit.

The layout of the SPI PlasmaPrep Jr. touch pad control panel is shown in Section XV. In order to provide the advantages of a sophisticated plasma cleaning system at minimum cost, the SPI PlasmaPrep Jr. is based on a commercially made microwave oven. Some of the controls of this oven are not used in the operation of the unit, and these controls are marked with an asterisk (*) below.

DISPLAY--Displays time of day, time during processing functions, power level being used, process mode and instructions.

*popcorn

*reheat

MICRO COOK--Energizes the SPI PlasmaPrep Jr. system for a selected amount of time using the 100% duty cycle.

EXPRESS COOK--Touch the number 1 through 5 pad for 1 to 5 minutes of processing time at 100% duty cycle. For example, touch 2 then START for 2 minutes of processing time.

NUMBER PADS--Touch these pads to enter process time, time of day and power level.

POWER LEVEL--Touch this pad before changing to another duty cycle.

SOUND--Touch the SOUND pad to turn the beeper on or off.

TIMER--Uses no microwave energy functions as a timer.

*beverage

*cook

*time defrost

*auto defrost

START--After all selections are made, touch this pad to start the microwave power.

DELAY START/REMINDER--Allows you to program the SPI PlasmaPrep Jr. system to begin operation at a present time of day up to 12 hours

later OR the REMINDER feature can be used as an alarm clock.

CLEAR/OFF--When touched, this control shuts off microwave energy and erases all settings except time of day. When held for 3 seconds, the LOCK-OUT feature will be activated. To deactivate the LOCK-OUT feature, press and hold the CLEAR/OFF pad for 3 seconds.

ADD 30 SECONDS--Press this pad to add 30 seconds of process time, to add 30 seconds to the process time as it is counting down or for an "instant on" for 30 seconds.

CLOCK--Touch this pad to enter the time of day or to check the time of day during processing. To set the clock, first touch CLOCK pad, and then enter the time of day. For example, if the time is 1:30, touch number pads 1, 3 and 0 and "1:30 will appear in the display. Then touch the START pad. To reset or change the time of day, simply repeat this process.

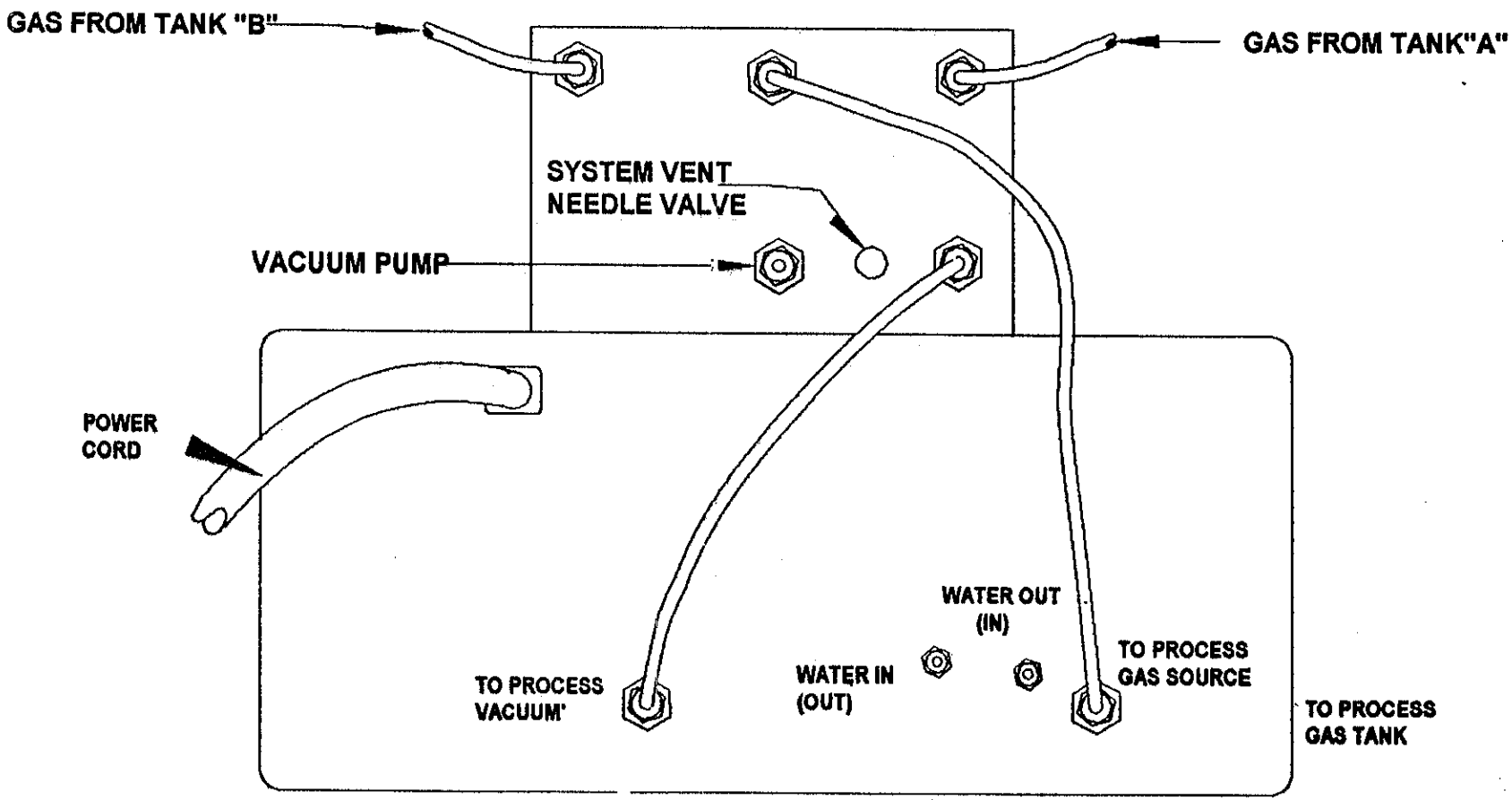
POWER LEVEL or DUTY CYCLE--To reduce the duty cycle, depress the POWER LEVEL pad and the proper numeric pad. The duty cycle is based on a 30 second time interval, i.e. a 50% duty cycle is 15 seconds on and 15 seconds off.

This chart gives the percent duty cycle assigned to each numerical value:

Automatic = 100%	5 = 50%
9 = 90%	4 = 40%
8 = 80%	3 = 30%
7 = 70%	2 = 20%
6 = 60%	1 = 10%

FIGURE 2

PLASMA PREP JR WITH BARREL REACTOR REAR PANEL CONNECTIONS



PLASMA PREP JR
REAR PANEL CONNECTIONS

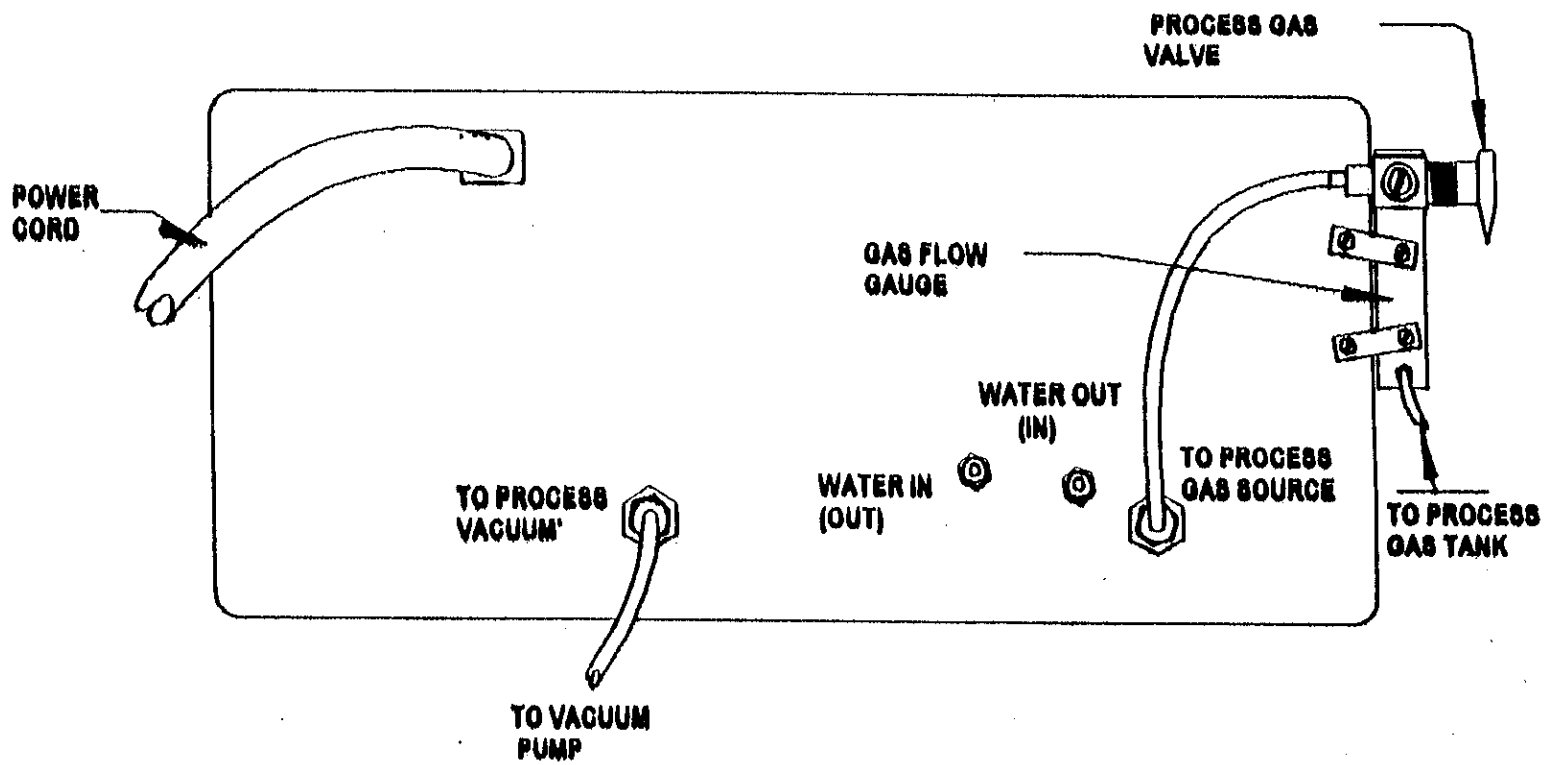
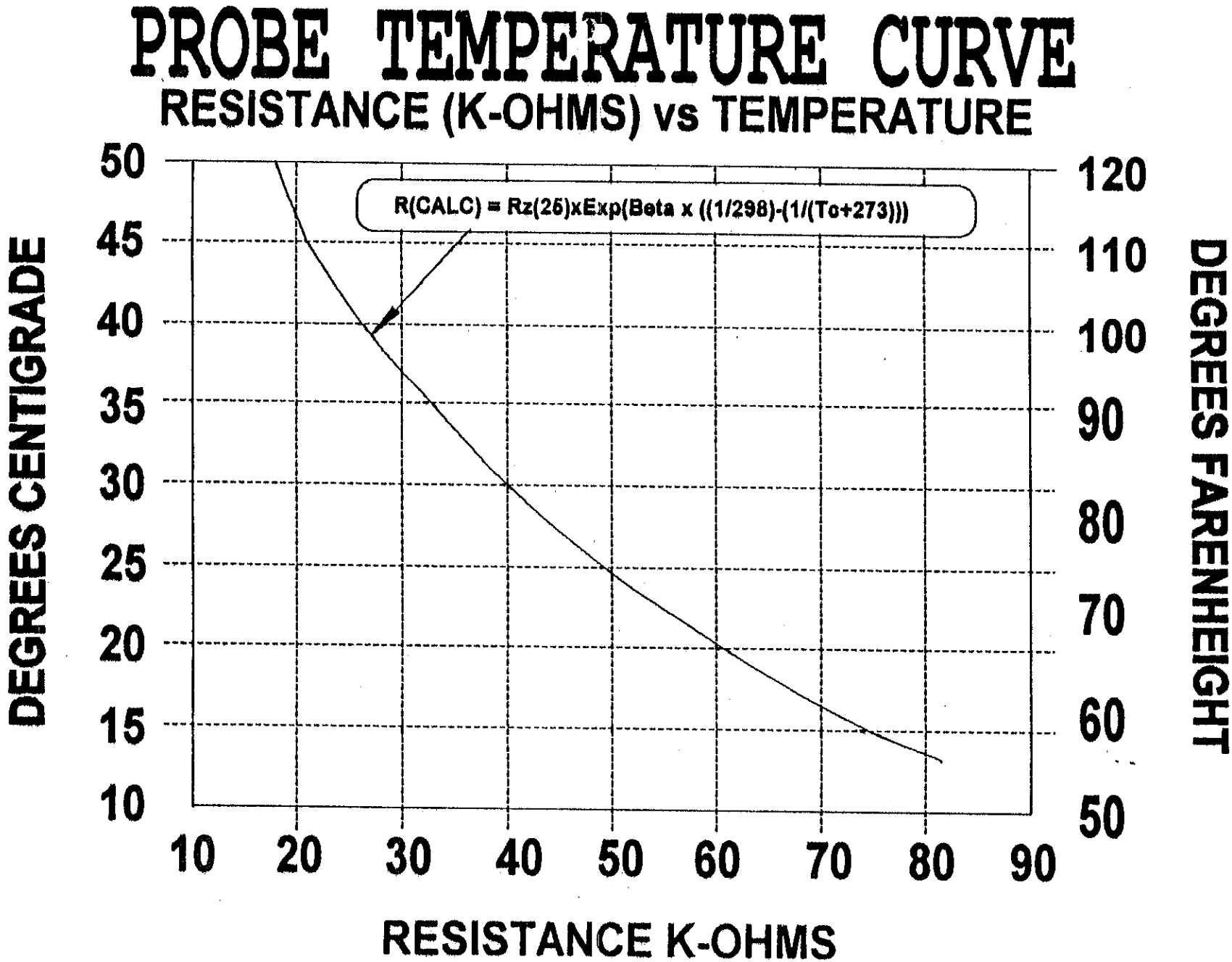
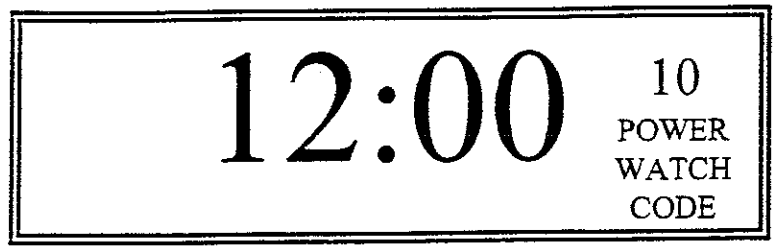


FIGURE 1


PROBE TEMPERATURE CURVE
RESISTANCE (K-OHMS) vs TEMPERATURE
R(CALC) = Rz(25)xExp(Beta x ((1/298)-(1/(To+273)))
DEGREES CENTIGRADE
50
45
40
35
30
25
20
15
10
DEGREES FARENHEIGHT
120
110
100
90
80
70
60
50
10
20
30
40
50
60
70
80
90
RESISTANCE K-OHMS

PLASMA-PREP JR. CONTROL PANEL



*2.time defrost

3. TIME COOK	TIME COOK I & II	time defrost	Temp cook & hold
4.POWER LEVEL 5.MIN/SEC TIMER	POWER LEVEL	MIN/SEC TIMER	ADD 30 SECONDS

*13. Auto Defrost

14. ADD 30 SECONDS

*6.auto cook; *7auto cook
*8. popcorn

auto cook	auto def.	auto roast
popcorn		auto reheat

*15. auto roast
*16. auto reheat

9. NUMBER PADS	1	2	3	4	5
	6	7	8	9	0

17. EXPRESS COOK

10. MINUTE	MINUTE		CLOCK
11.AUTO START 12. START	AUTO START	START	CLEAR / OFF

18. CLOCK

19.CLEAR/OFF

* denotes functions not used in the Plasma Prep Jr. System

XVI. FUNCTION AND USE OF THE ION TRAP

The ion trap is made from perforated aluminum sheet. Specimens to be processed are surrounded by the ion trap within the vacuum chamber. This has two effects: First, the ionic portion of the plasma is neutralized. Second, the ion trap acts as a Faraday cage to shield the specimen from residual microwave radiation. The use of the ion trap results in less damage to the specimen, milder reaction conditions and reduced (~50%) process reaction rates. The use of the ion trap is called for when process power and temperature reduction are not enough to prevent damage to the specimen.

XVII. DIRECTIONS FOR SETUP AND USE OF THE SPI#11001WC-AB WATER RECIRCULATING SYSTEM

Locate the water tank in a convenient position near the SPI PlasmaPrep Jr. system. A typical location is on the floor under the bench on which the unit sits.

Fill up the tank to within 1 inch (2.5 cm) of the top. An algicide such as those used in swimming pools (~1 teaspoon) may be added to suppress the growth of algae.

Attach one of the water lines of the recirculating system to one of the copper tubes of the SPI PlasmaPrep Jr. system and the other water line to the other copper tube. Water may circulate in either direction. Fit the top onto the water tank.

Plug the water pump into an appropriate outlet (115 V/60 Hz or 220 V/50 Ha, depending on model); the water recirculating system is ready for operation.

XVIII. WATER TEMPERATURE MEASUREMENT

Attach a digital ohm meter capable of measuring to 100 K-ohms to the probe in the center of the water tank.

Read the resistance of the probe and convert the reading to temperature using Figure 1 (next page).

Under no circumstances should the water temperature exceed 120°F(48°C) to prevent damage to the water pump and/or the gasket.

When the water tank is initially at 70°F, the system can operate continuously for about 2 hours without exceeding 120° F. The water in the tank serves as the system heatsink; the water must be given an opportunity to cool between runs.

CAUTION: Check the water level periodically; refill when the level drops to 2 inches (5 cm) below the top of the water tank.