TITLE: **SLR 700 Series User's Manual**

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A		Preliminary release.	6/5/95	C. Jackson
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Section Information	**Document Information**

Section	*Section Title*	*Document Number*	*Document Revision*
0	Cover Sheet	4185572d01	A
0	Foreword	4185573d01	C
0	Table of Contents	4185574d01	B
1	General Information	4185575d01	A
2	Installation	4185576d01	C
3	Operation	41xxxxxdxx	
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3.2	Utilities	4185577d02	A
3.3	Service	4185577d03	A
3.4	Display	4185577d04	A
3.5, 3.6, 3.7	Process, Help, Windows	4185577d05	A
4	Cold Start / Shut Down	4185578d01	A
5	Maintenance	4185579d01	A
6	System Configuration	4185580d01	
A	Appendix A	4185581d01	A
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C	Appendix C	4185583d01	A

1 General Information

1.1 Revision A - Preliminary release of SLR 700 Series User's Manual set per procedure ENG0014A. This includes SLR 700 installation, operation and maintenance information.

SHUTTLELOCK® READY SERIES

PLASMA PROCESSING SYSTEM

USER'S MANUAL

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FOREWORD

The intent of this manual is to provide descriptive information and procedures to be used in the operation of Unaxis, Inc., equipment.

Initial start-up of Unaxis systems will be performed by Unaxis, Inc., Customer Service personnel who will concurrently provide instruction on system operation.

Violation of this start-up policy may void the Unaxis, Inc., Warranty.

IMPORTANT NOTICE TO CUSTOMERS WITH CE MARKED SYSTEMS!

In order to maintain CE directive compliance, the customer is responsible for ensuring that all add-on systems, components and their replacements are equipped with shielded cabling excluding AC power supply lines. Furthermore, all OEM complaint equipment must be replaced with CE compliant equivalent components. Any deviations from or modifications of the system must comply with CE directives in order to maintain CE compliance or the system must be re-evaluated by a qualified EMC or safety engineer.

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SECTION ONE: GENERAL INFORMATION

1.1 INTRODUCTION

This manual contains information on the Unaxis, Inc., SLR Series plasma processing systems. Model variations are highlighted either by dedicated text, tables, charts or illustrations where appropriate. The documentation of this system is comprised of three volumes which are called the: (1) User's Manual, (2) Service Document, and (3) Equipment Manual. The User's Manual describes the equipment in general and specific terms and provides: (a) installation information, (b) step-by-step instruction on system operation from start-up to shut-down, and (c) a suggested system maintenance schedule. The Service Document is a compilation of all schematics, assembly drawings and parts lists which are germane to the system as delivered. It provides service personnel with information required for maintenance and repair work as may become necessary. The Equipment Manual is a compilation of all manuals provided by manufacturers of the various components which may be found in SLR Series systems.

1.2 GENERAL INFORMATION

Unaxis' SLR Series systems are designed to provide a flexible and cost effective platform for load locked parallel plate processes including Reactive Ion Etching (RIE), Plasma Etching (PE), Plasma Enhanced Chemical Vapor Deposition (PECVD), Inductively Coupled Plasma (ICP) and Electron Cyclotron Resonance (ECR). The specification of an SLR Series system includes a Primary Module and options which are appropriate for current and anticipated process requirements and budget.

The SLR base unit or Primary Module (PM) contains the RF Generator and matching network, power distribution circuitry, fluid distribution panel, gas handling system enclosure, 80486-based control computer and a vacuum connection with a 100 mm, 160 mm (ICP) or 250 mm (ECR) diameter at the pump connection flange. The SLR Docking Module (DM) provides the platform for a second process chamber and may be added with the initial purchase or as a field retrofit. The DM normally shares the RF, computer control and, in most cases, the vacuum system associated with the Primary Module.

The SLR Series systems are controlled by an 80486-based PC which runs MS-DOS® in conjunction with Windows®. The control system is discussed in Section Three of this manual. For now, it is sufficient to say that the Windows Graphical User Interface (GUI) provides an easy and familiar environment for machine operation and control. The control system is compatible with all commonly used DOS applications. During periods of machine idle, the Unaxis system control mode can be exited and the controller then behaves like any other DOS-based PC. This feature may be useful for data analysis, trending, archiving results or other uses associated with a PC.

The available process chamber types are:

- **SLR-720 RIE** (Reactive Ion Etch) - The substrate electrode is RF powered and temperature is controlled by a circulating liquid medium.
- **SLR-730 PECVD** (Plasma Enhanced Chemical Vapor Deposition) - The top electrode is RF powered and the substrate is temperature-controlled by means of an embedded resistance heater. The temperature range is 80º C to 400º C.
- **SLR-734 PECVD/RIE** (Plasma Enhanced Chemical Vapor Deposition/Reactive Ion Etch) - A combination in which RF power may be switched between the top and bottom electrodes. The substrate is temperature-controlled by means of an embedded resistance heater. The temperature range is 80º C to 400º C.
- **SLR-740 PE/RIE** (Plasma-Etch/Reactive Ion Etch) - In this case, the RF power may be switched between the top and bottom electrodes as the process requires. Temperature is controlled by a circulating liquid medium.
- **SLR-770 ICP** (Inductively Coupled Plasma) - The top coil is supplied 2MHz RF at 1000 Watts maximum and the bottom electrode is supplied 13.56 MHz RF at 500 Watts maximum. This allows separate control of the plasma bias at the top coil and the sheath bias at the lower electrode.
- **SLR-770 ECR** (Electron Cyclotron Resonance) - This is a combination in which the lower electrode is RF powered and temperature controlled. The ECR source consists of a tuner, a high density source with an electromagnet, and a microwave power supply.

NOTE: Please check the System Configuration sheets in Section Six to verify your system chamber configuration and option packages.

In addition to a choice of chamber types, there are many other standard options available on the SLR Series systems, some of which are listed below:

- Standard vacuum pumping packages include mechanical vane, "roots" type blower and turbomolecular pumps which may be combined to provide pumping performance commensurate with process requirements.
- Heat exchanger options circulate a liquid thermal transfer medium and, depending upon the model chosen, can provide temperature control ranging from -50º C to 200º C.
- Electrode cover plates and custom fixturing allow configuration of the chamber exactly as required by the process and substrates.
- Up to sixteen (16) process gas channels under mass flow control (up to eight per chamber). Other gas panel options include MFC flush, in-line and point-of-use filtration and customization as required by the end user.
- Endpoint detection systems include emission spectroscopy and LASER-based systems.

ASTEX® sources are used for ECR applications in many configurations within an Instrument Cabinet (see Figure 1-6). The ASTEX 4400 source consists of a 750 Watt, 1000 Watt or 1500 Watt microwave power source, manual three-stub tuner or automatic microwave tuner, circulator, water cooled dummy load, 5kW magnet/regulated switching power supply and associated wave guide.

Secondary Collimating Magnet SCM4400 is equipped with a 2.5kW magnet. This magnet is positioned concentric to the lower electrode to allow control of incident ion current at the electrode (substrate/sample). This is accomplished by collimating the otherwise divergent lines of flux which emanate from the ECR source.

System modification and integration of non-standard equipment is performed by Unaxis, Inc. as required by our customers.

1.3 COMPONENT LOCATION

The SLR Series was developed in consideration of a variety of user environments. Ancillary equipment such as Heat Exchangers, Vacuum Pumps and the Main Power Disconnect can be located anywhere in close proximity to the Mainframe. This flexibility allows the SLR to accommodate most installation needs while providing good accessibility for maintenance personnel (see Section Two for system installation information).

This section illustrates the SLR system (single and dual chamber) and shows all major subsystem and component locations (see Figures 1-1 through 1-4).

1.3.1 MAIN CABINET

The Main Cabinet consists of the following units (see Figures 1-1 through 1-6):

- Process Chamber - The process chamber configuration is determined by the process to be performed and the throughput required.
- Emergency Power-Off Button (EPO) - This button will **shut down the entire system and should be used only under an emergency condition.** This button interrupts power to the main contacting relay in the Electrical Enclosure and turns off the entire system, including vacuum pumps and the heat exchanger.
- Pneumatic Access Panel - This panel houses the solenoids that operate air driven devices in the system.
- CSC - This is the 80486-based computer for system control.
- Fluid Input Panel - This panel contains the connections for all Primary Module fluid and pneumatic inputs and outputs.
- Valve Pack Panel - This panel houses the solenoids that operate air driven devices within the system. These solenoids are adjusted to provide smooth operation.
- Automatic Matching Network (AMN) - The AMN is used to match the chamber with the RF Generator. It consists of a fluid-cooled inductor, two variable capacitors and detection circuitry to monitor the quality of the match. In ICP systems there are two AMN units to match the two RF Generators (RF20 and RF5) required for the coil and electrode, respectively.

  Basically, it matches the impedance of the chamber to the output amplifier of the RF Generator, which must have a resistive load of 50 ohms to operate properly. This is done automatically via detection circuitry within the matching network, which monitors both the phase angle between the incoming RF voltage and current and the relative magnitudes of these two parameters as they arrive from the RF Generator.

  If these detectors find that the amount of reflected power indicates an impedance mismatch, then appropriate error signals are sent to the AMN Controller which in turn drives the variable capacitors of the AMN to eliminate the mismatch and reduce the reflected power.

  The quality of this match is displayed by the reflected power meter on the RF Generator and on the video monitor. Typically, a match of less than ten (10) Watts of reflected power is maintained and is considered nominal.
- AMN Controller - The AMN Controller is used to control the Automatic Matching Network.

- Gas Panel - The Gas Panel Enclosure has an access door which opens toward the rear of the system. Pressure regulated process gases are connected within the enclosure to VCR® type fittings. They are then piped through mass flow controllers and into a gas manifold for delivery under vacuum to the process chamber. As many as eight (8) process gases per enclosure may exist depending upon which options have been selected, and up to sixteen (16) process gases per system may be controlled (see Section 2.5.2.4 for detailed instructions on gas line connections).

NOTE: Please see the System Configuration sheets in Section Six to determine how many and which types of gases will be connected to your system.

- Electrical Enclosure - This unit serves as the distribution point for all system power requirements. Main power is connected to the wall-mounted System Disconnect Box from which it is delivered via flexible "Seal Tight" conduit to the Electrical Enclosure. Within the enclosure, primary power is transformed as required and distributed through individual circuit protectors to all components within and/or connected to the Mainframe which require it.
- Automatic Pressure Controller (APC) - The APC controls a 100mm throttle valve that varies the exhaust pipe conductance thereby maintaining a selected pressure within the process chamber independent of gas load. The pressure control system is a closed loop and consists of a capacitance manometer providing a scaled signal to the throttle valve controller which compares the incoming signal to a selected setpoint.
- RF Generator - The RF Generator is a 500 Watt solid-state 13.56 MHz generator. An additional 1000 Watt (limited) solid-state 2 MHz RF Generator is present in each ICP system for a separate plasma (coil) bias. All cables and services enter at the rear of the unit. It is interfaced to the computer. Power and voltage control is normally accomplished by choosing values which are then displayed on the video monitor. The unit may also be operated manually. RF Generator power is supplied by the electrical interface panel.
- Electric Heat Control - This unit is designed to control resistively heated elements such as those which control the PECVD substrate temperature.

1.3.2 REMOTE EQUIPMENT

Remote equipment consists of the following modules:

- System Disconnect Box - The System Disconnect Box is the single point to which primary electrical power is connected. The box consists of a NEMA enclosure, an electrical disconnect switch and transformers for the development of 115V and 24V power.
- Heat Exchanger (optional) - Usually some form of electrode and/or process chamber wall temperature control device is required. For temperatures below 200º C, the most common control device is a heat exchanger which circulates a temperature-controlled liquid medium. Unaxis offers a number of standard heat exchanger options which accommodate temperature control requirements from -50º C to 200º C.
- Vacuum Pumps (optional) - There are three types of vacuum pumps offered as optional equipment on SLR systems. They may be used alone or in combination to achieve pumping performance commensurate with process requirements. These are: (1) dual stage rotary vane, (2) "roots" type blower, and (3) turbomolecular.

NOTE: For specific information on the heat exchanger and vacuum pump options included with this system, please see the System Configuration sheets (Section Six) and the Equipment Manual.

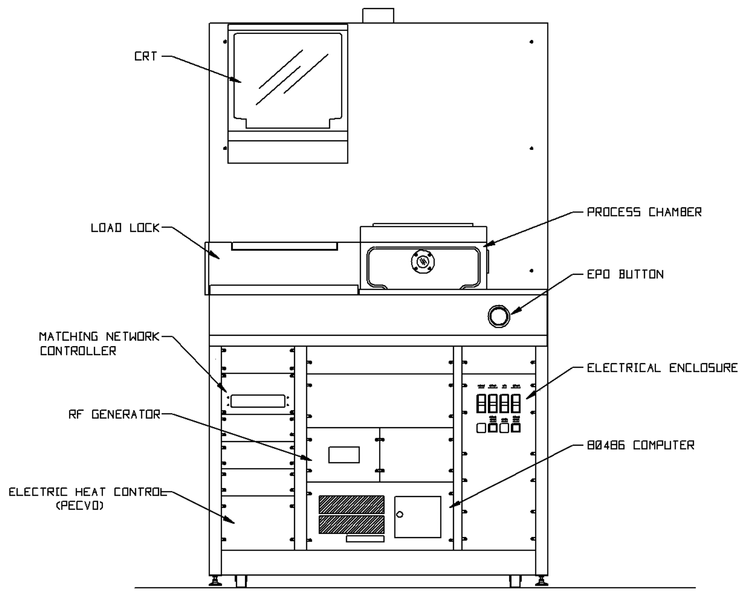

Figure 1-1. Standard SLR Process Module Front View

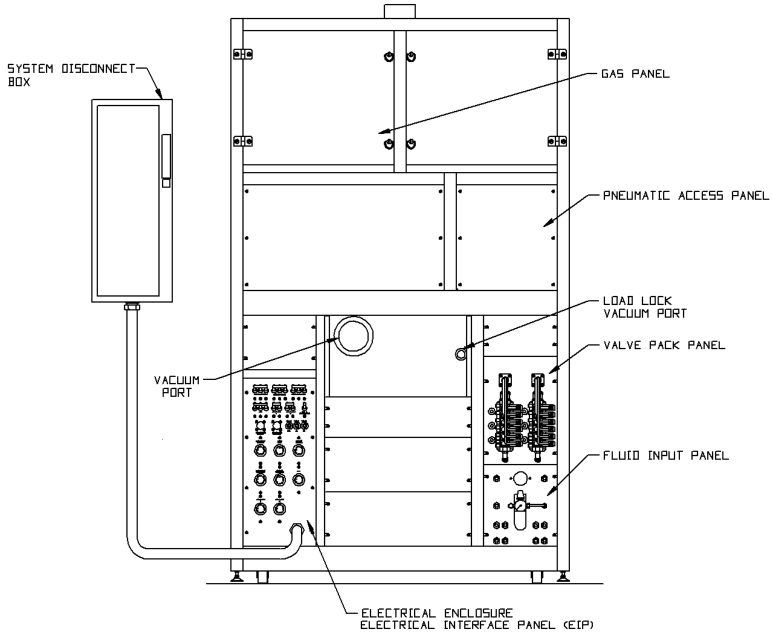

Figure 1-2. Standard SLR Process Module Rear View

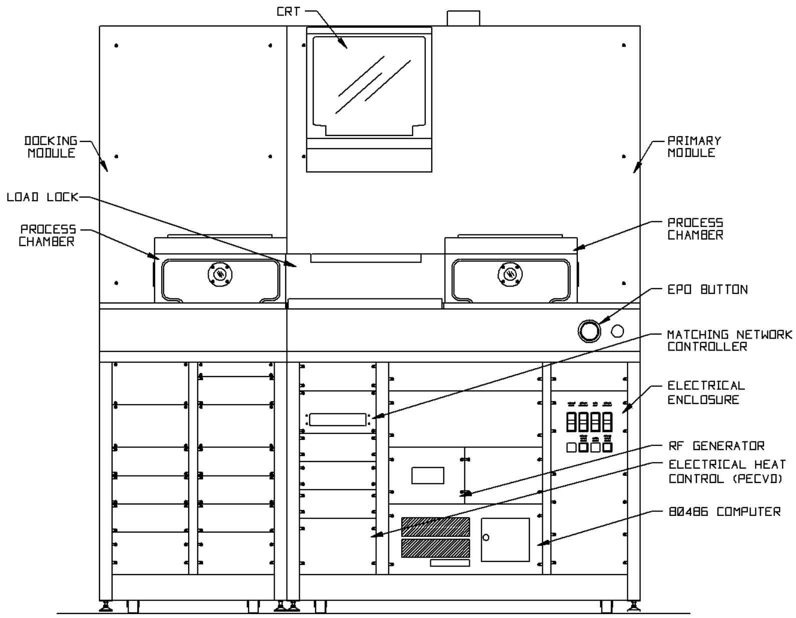

Figure 1-3. Dual Chamber SLR Process Module Front View

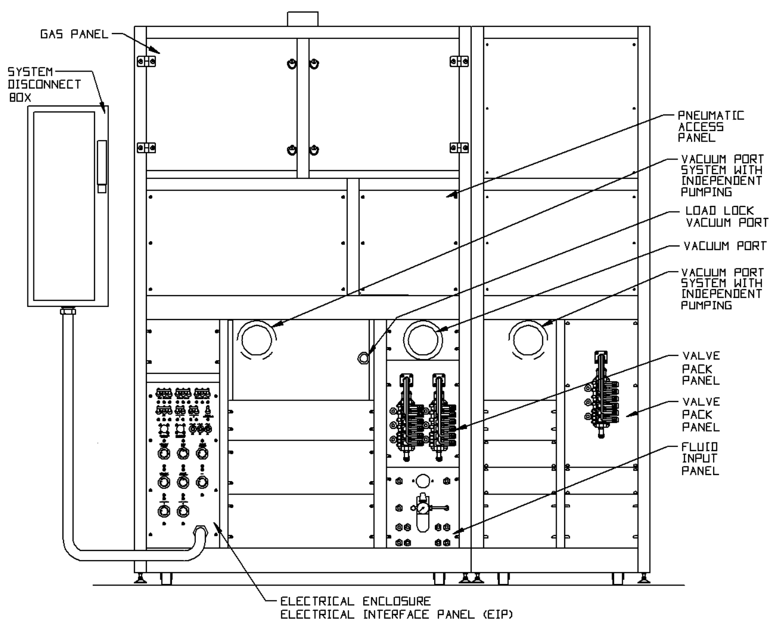

Figure 1-4. Dual Chamber SLR Process Module Rear View

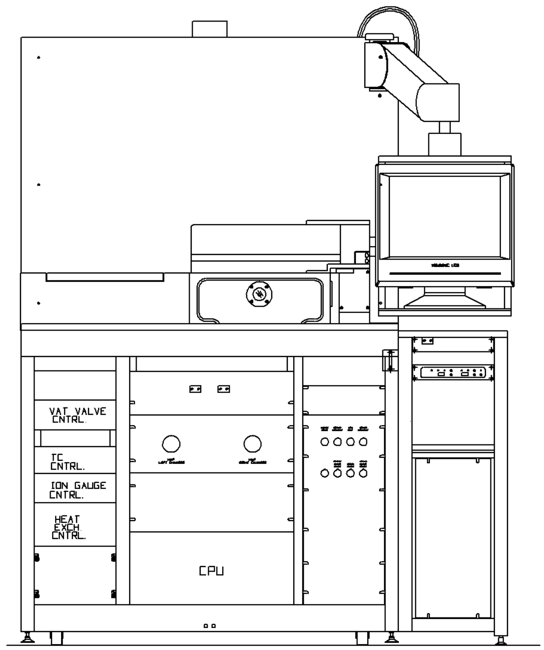

Figure 1-5. SLR-770 ICP Front View

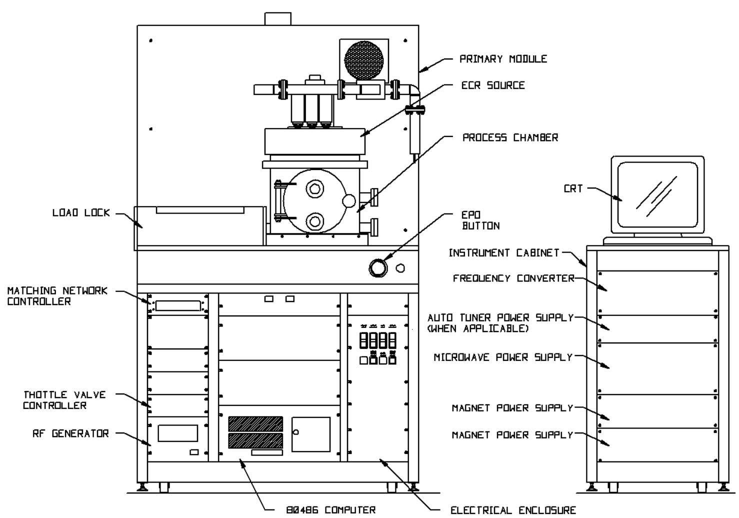

Figure 1-6. SLR-770 ECR Front View

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SECTION TWO: INSTALLATION

2.1 SITE SELECTION AND PLANNING

The Main Cabinet is designed to exist entirely within a cleanroom and all ancillary support equipment is designed to operate outside a cleanroom (see Figure 2-4, Section 2.5.1.2).

Ideally, the support equipment should be located as closely as possible to the Main Cabinet. However, if care is used when sizing, routing and connecting vacuum plumbing, the vacuum system may be located elsewhere as is compatible with your facility.

If there are any questions about the layout of your vacuum system, contact a Unaxis representative and provide a rough sketch of the following information:

1. A description of the proposed location of your vacuum system (i.e., basement, separate room).
2. Distance plumbing is to run.
3. Number of 90º bends in plumbing.
4. Plumbing size(s).

In addition to equipment proximity, other site planning considerations include available floor space for operation and maintenance, weight, lighting and air handling constraints, availability of utilities and flow of unprocessed and processed product.

Floor space must take into account the physical requirements of the equipment and space for access to the equipment. The following parameters should be used for site planning:

	(Inches)			(Pounds)
Item	**Width**	**Depth**	**Height**	**Approximate Weight**
Main Cabinet (Single Chamber)	44.10	41.00	72.62	1,000
Main Cabinet (Dual Chamber)	67.48	41.00	72.62	1,400
ECR Instrument Cabinet	22.38	32.00	38.38	
Heat Exchanger	See the Equipment Manual.			
Vacuum Pump(s)	See the Equipment Manual.			

Table 2-1. Equipment Dimensions

Recommended minimum clearances for equipment installation, operation and maintenance are:

	(Feet)		
Item	**Front**	**Side**	**Back**
Main Cabinet	3	2	3
System Disconnect Box	3	2	0
ECR Instrument Cabinet	3	2	3
Heat Exchanger	2.5	1	2.5
Vacuum Pump	2.5	1	2.5
Lock Pump	1	1	2

Table 2-2. Recommended Minimum Clearances

2.1.1 ENVIRONMENTAL REQUIREMENTS

	Room Temperature:
During Operation	26º C max, 15º C min

During Idle Time	26º C max, 15º C min
During Storage	26º C max, 7º C min
	Relative Humidity at 20º C:
During Operation	45% max
During Idle Time	45% max
During Storage	75% max

For the best processing results, wafer cassette sites should be provided with Class 10 air.

NOTE: If the system is to be stored for a long period, we recommend that all units be in a cool, dry area with the chamber under vacuum.

2.2 SITE PREPARATION

The customer is responsible for all water, air and gas lines, valves, pressure regulators, input power cables and overcurrent protection at the facility service panel. The following utilities should be available at the site prior to installation:

Main Cabinet	
Compressed Air	Clean, dry, 80-90 psig. Flow rate less than 1 slpm. Avg flow rate l scfm, oil free to 50 ppm. Max moisture content -60º F dew point, and filtered to max particle size of 3 microns
Machine Purge (Fluid Input Panel)	Nitrogen, 5-7 psig @ 1 slpm*
Flush Gas (Gas Panel)	Nitrogen, 15-20 psig @ 1 slpm*
Vent Gas	Nitrogen, 5-20 psig @ 10 slpm*
Process Gases	Up to 8 gases standard (per chamber), 5-25 psig
Gas Panel Exhaust	50/cfm min @ 0.5 inch H_2O, connection to 4-inch OD duct
Electrical *Please verify on your System Configuration sheets.*	Standard Domestic: — Interrupt Rating 208/240 VAC, 3 phase, 60 Amp, 5-wire, 60 Hz — 65kA Standard International: 200 VAC, 3 phase, 60 Amp, 4-wire, 50Hz — 50kA 380 VAC, 3 phase, 60 Amp, 5-wire, 50 Hz — 25kA 415 VAC, 3 phase, 60 Amp, 5-wire, 50 Hz — 25kA
Cooling *House Water*	Standard: 1 to 1.5 gpm @ 30 to 60 psig differential, supply temp. 20º C to 25º C. Heat load approximately 1kW
House Water	ICP: 40 psig @ 15 to 30º C, 1 MegOhm resistivity. RF-20M flow rate 2.5 GPM.
House Water	ECR: 1.25 GPM @ 60 psig differential, supply temperature 4 ºC (40ºF), maximum heat load approximately 7 kW.
Helium	20 psig @ 20 sccm, Helium Input connection at Fluid Input Panel.
Remote Components	
Pump Case Purge Gas	Customer supplied (see the Equipment Manual for pressure specification)
Pump Vacuum Exhaust	Piping must be compatible with effluent gases. All joints must be leak tight. Connections should be KF type (size is dependent upon pump configuration; see Section Six)
*Nitrogen purity as the process requires; 99.999% is recommended.	

Table 2-3. Required Utilities

Figures 2-1 (Single Chamber) and 2-2 (Dual Chamber) illustrate the center-to-center dimensions of utilities connections on system units. These are used to make air, water, gas and exhaust line pipes.

> **NOTE:** Pipe bends should conform to SAE standards to avoid kinking. All lines should be continuous without splices (where practical).

Particular attention should be paid to the leak integrity of all joints (welded or fitted), especially when plumbing process gas lines (see Section 2.7).

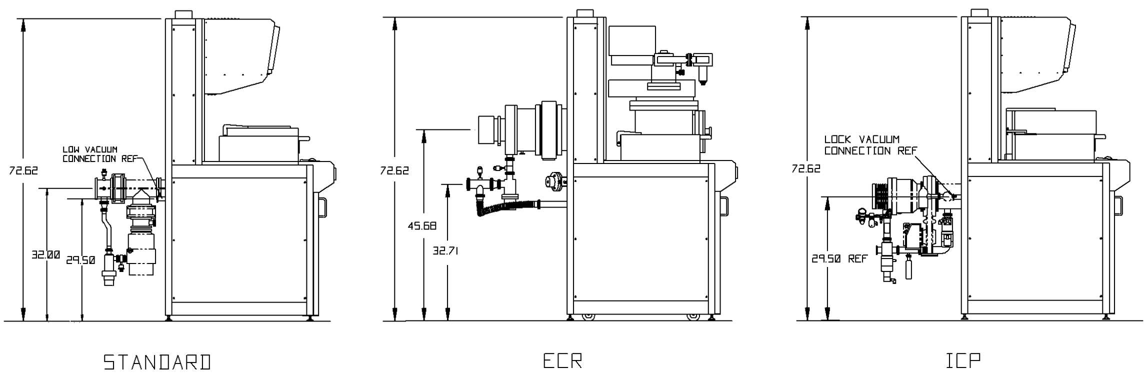
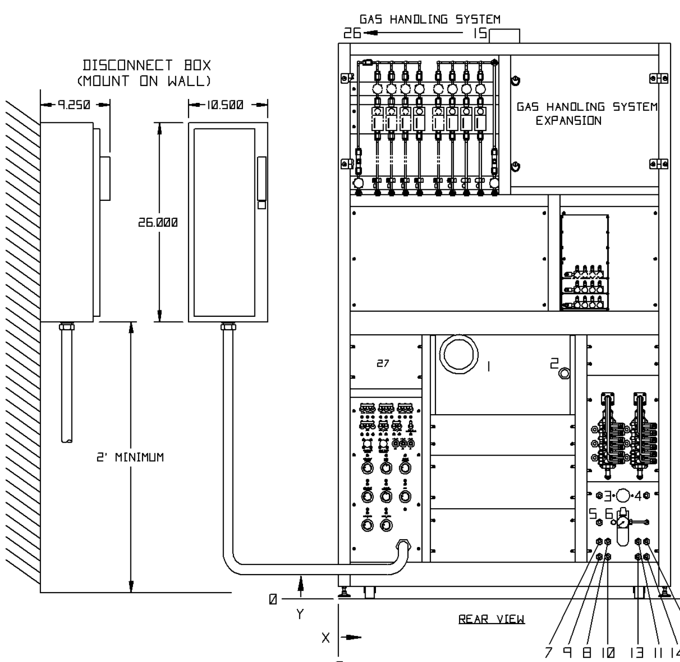
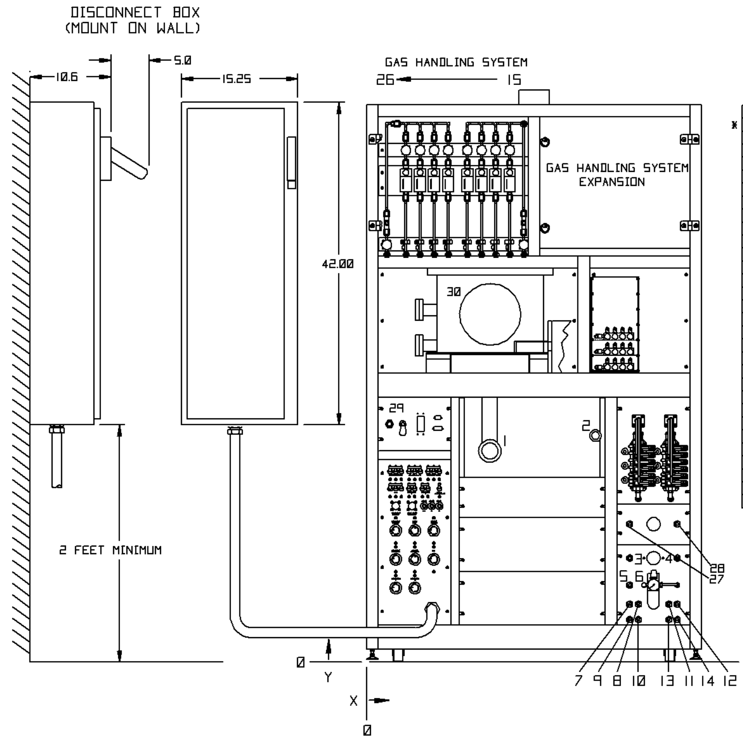


Figure 2-1a. Sample System Utilities Connections (Single Chamber)



REF	X	Y	FLANGE/FITTING	DESCRIPTION
1	15.97	32.00	100MM ISO	MAIN VACUUM CONN
2	30.00	29.50	25MM ISO-KF	LOCK VACUUM CONN
3	34.62	13.54	1/4 SWAGELOK	WATER IN
4	40.86	13.54	1/4 SWAGELOK	WATER OUT
5	34.62	10.04	1/4 SWAGELOK	N2
6	36.49	10.04	1/4 SWAGELOK	COMP AIR
7	34.62	7.54	3/8 SWAGELOK	RIGHT CHAMBER IN
8	35.74	7.54	3/8 SWAGELOK	RIGHT CHAMBER OUT
9	34.62	5.54	3/8 SWAGELOK	RIGHT ELECT IN
10	35.74	5.54	3/8 SWAGELOK	RIGHT ELECT OUT
11	39.74	7.54	3/8 SWAGELOK	LEFT CHAMBER IN
12	40.86	7.54	3/8 SWAGELOK	LEFT CHAMBER OUT
13	39.74	5.54	3/8 SWAGELOK	LEFT ELECT IN
14	40.86	5.54	3/8 SWAGELOK	LEFT ELECT OUT
15	20.43	53.34	1/4 VCR	CHAMBER VENT
16	18.58	53.34	1/4 VCR	PROCESS GAS 1
17	16.72	53.34	1/4 VCR	PROCESS GAS 2
18	14.87	53.34	1/4 VCR	PROCESS GAS 3
19	13.01	53.34	1/4 VCR	PROCESS GAS 4
20	11.75	53.34	1/4 VCR	FLUSH 1
21	10.49	53.34	1/4 VCR	PROCESS GAS 5/PURGE
22	8.64	53.34	1/4 VCR	PROCESS GAS 6
23	6.78	53.34	1/4 VCR	PROCESS GAS 7
24	4.93	53.34	1/4 VCR	PROCESS GAS 8
25	3.67	53.34	1/4 VCR	FLUSH 2
26	2.41	53.34	1/4 VCR	MANIFOLD PURGE

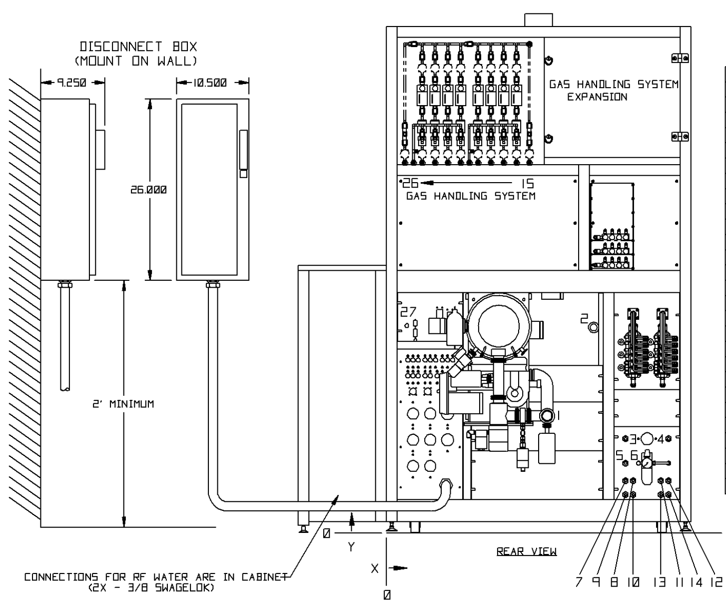
Figure 2-1b. Sample System Utilities Connections (Standard Single Chamber)



	REF	X	Y	FLANGE/FITTING	DESCRIPTION
*	1	16.22	27.50	50mm ISO	MAIN VACUUM CONN
	2	30.10	29.50	25mm ISO-KF	LOCK VACUUM CONN
	3	34.62	13.54	1/4 SWAGELOK	WATER IN
	4	40.86	13.54	1/4 SWAGELOK	WATER OUT
	5	34.62	10.04	1/4 SWAGELOK	N2
	6	36.49	10.04	1/4 SWAGELOK	COMP AIR
	7	34.62	7.54	1/4 VCR	HELIUM "IN"
	8	35.74	7.54	3/8 SWAGELOK	-
	9	34.62	5.54	3/8 SWAGELOK	FLUID IN
	10	35.74	5.54	3/8 SWAGELOK	FLUID OUT
	11	39.74	7.54	3/8 SWAGELOK	FLUID IN
	12	40.86	7.54	3/8 SWAGELOK	FLUID OUT
	13	39.74	5.54	3/8 SWAGELOK	FLUID IN
	14	40.86	5.54	3/8 SWAGELOK	FLUID OUT
	15	20.43	53.34	1/4 VCR	CHAMBER VENT
	16	18.58	53.34	1/4 VCR	PROCESS GAS 1
	17	16.72	53.34	1/4 VCR	PROCESS GAS 2
	18	14.87	53.34	1/4 VCR	PROCESS GAS 3
	19	13.01	53.34	1/4 VCR	PROCESS GAS 4
	20	11.75	53.34	1/4 VCR	FLUSH 1
	21	10.49	53.34	1/4 VCR	PROCESS GAS 5/PURGE
	22	8.64	53.34	1/4 VCR	PROCESS GAS 6
	23	6.78	53.34	1/4 VCR	PROCESS GAS 7
	24	4.93	53.34	1/4 VCR	PROCESS GAS 8
	25	3.67	53.34	1/4 VCR	FLUSH 2
	26	2.41	53.34	1/4 VCR	MANIFOLD PURGE
	27	34.62	18.125	3/8 SWAGELOK	MAGNET WATER "IN"
	28	40.86	18.125	3/8 SWAGELOK	MAGNET WATER "OUT"
	29	3.03	29.37	1/4 SWAGELOK	COMP AIR
	30	16.22	45.31	250 mm (12"CF)	VAC PORT

* SIZE DEPENDENT UPON
CONFIGURATION AND OPTIONS AVAILABLE

Figure 2-1c. Sample System Utilities Connections (ECR Single Chamber)



REF	X	Y	FLANGE/FITTING	DESCRIPTION
1	23.247	16.827	40mm ISO-KF	MAIN VACUUM CONN
2	30.00	29.50	25mm ISO-KF	LOCK VACUUM CONN
3	34.62	13.54	1/4 SWAGELOK	WATER IN
4	40.86	13.54	1/4 SWAGELOK	WATER OUT
5	34.62	10.04	1/4 SWAGELOK	N2
6	36.49	10.04	1/4 SWAGELOK	COMP AIR
7	34.62	7.54	3/8 SWAGELOK	RIGHT CHAMBER IN
8	35.74	7.54	3/8 SWAGELOK	RIGHT CHAMBER OUT
9	34.62	5.54	3/8 SWAGELOK	RIGHT ELECT IN
10	35.74	5.54	3/8 SWAGELOK	RIGHT ELECT OUT
11	39.74	7.54	3/8 SWAGELOK	LEFT CHAMBER IN
12	40.86	7.54	3/8 SWAGELOK	LEFT CHAMBER OUT
13	39.74	5.54	3/8 SWAGELOK	LEFT ELECT IN
14	40.86	5.54	3/8 SWAGELOK	LEFT ELECT OUT
15	20.43	53.34	1/4 VCR	CHAMBER VENT
16	18.58	53.34	1/4 VCR	PROCESS GAS 1
17	16.72	53.34	1/4 VCR	PROCESS GAS 2
18	14.87	53.34	1/4 VCR	PROCESS GAS 3
19	13.01	53.34	1/4 VCR	PROCESS GAS 4
20	11.75	53.34	1/4 VCR	FLUSH 1
21	10.49	53.34	1/4 VCR	PROCESS GAS 5/PURGE
22	8.64	53.34	1/4 VCR	PROCESS GAS 6
23	6.78	53.34	1/4 VCR	PROCESS GAS 7
24	4.93	53.34	1/4 VCR	PROCESS GAS 8
25	3.67	53.34	1/4 VCR	FLUSH 2
26	2.41	53.34	1/4 VCR	MANIFOLD PURGE
27	2.95	29.75	1/4 VCR	HELIUM INPUT

Figure 2-1d. Sample System Utilities Connections (ICP Single Chamber)

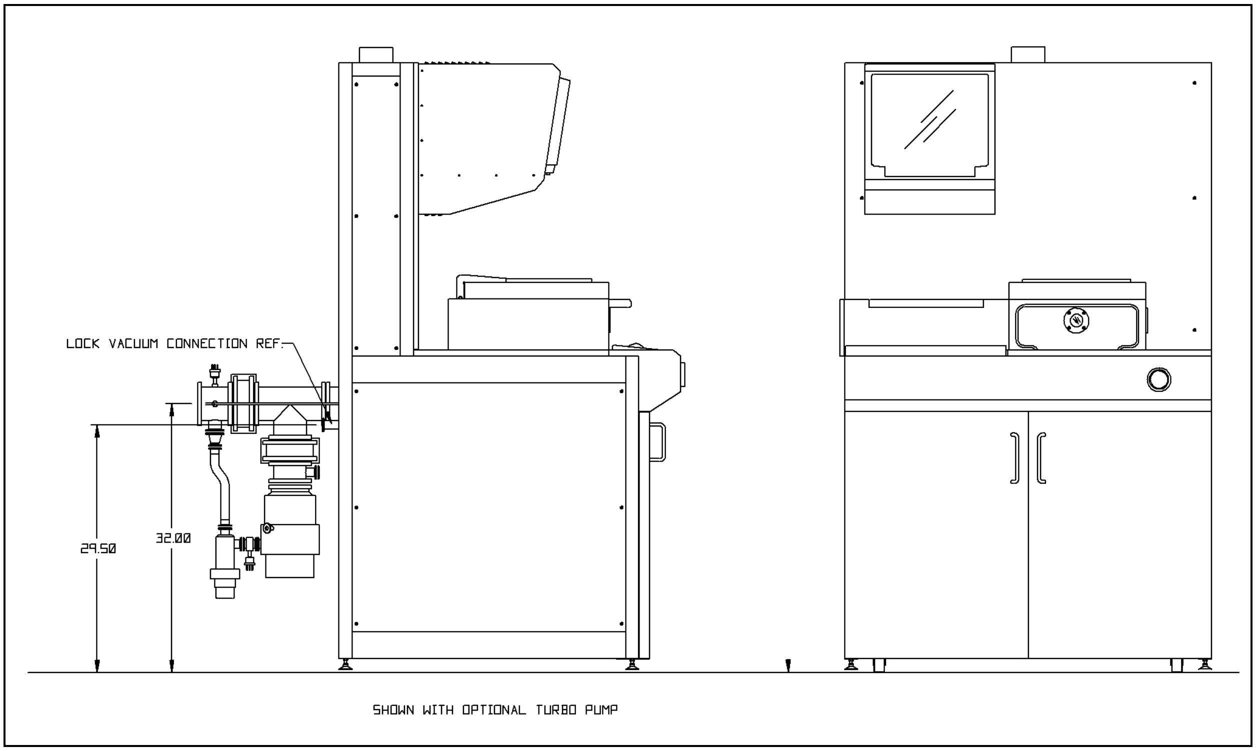
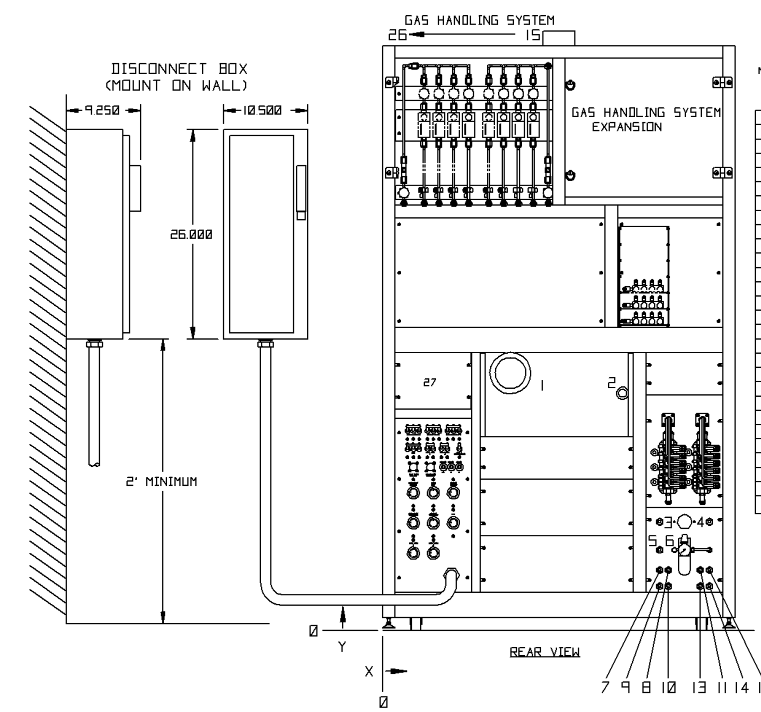


Figure 2-2a. Sample System Utilities Connections (Standard Dual Chamber)



NOTE: THE VALUES FOR REF 1, MAIN VACUUM CONN. ARE FOR STANDARD SYSTEMS.
FOR ICP X= 16.25, Y= 29.50 & FLANGE= 160mm ISO.

REF	X	Y	FLANGE/FITTING	DESCRIPTION
1	15.97	32.00	100mm ISO	MAIN VACUUM CONN
2	30.00	29.50	25mm ISO-KF	LOCK VACUUM CONN
3	34.62	13.54	1/4 SWAGELOK	WATER IN
4	40.86	13.54	1/4 SWAGELOK	WATER OUT
5	34.62	10.04	1/4 SWAGELOK	N2
6	36.49	10.04	1/4 SWAGELOK	COMP AIR
7	34.62	7.54	3/8 SWAGELOK	RIGHT CHAMBER IN
8	35.74	7.54	3/8 SWAGELOK	RIGHT CHAMBER OUT
9	34.62	5.54	3/8 SWAGELOK	RIGHT ELECT IN
10	35.74	5.54	3/8 SWAGELOK	RIGHT ELECT OUT
11	39.74	7.54	3/8 SWAGELOK	LEFT CHAMBER IN
12	40.86	7.54	3/8 SWAGELOK	LEFT CHAMBER OUT
13	39.74	5.54	3/8 SWAGELOK	LEFT ELECT IN
14	40.86	5.54	3/8 SWAGELOK	LEFT ELECT OUT
15	20.43	53.34	1/4 VCR	CHAMBER VENT
16	18.58	53.34	1/4 VCR	PROCESS GAS 1
17	16.72	53.34	1/4 VCR	PROCESS GAS 2
18	14.87	53.34	1/4 VCR	PROCESS GAS 3
19	13.01	53.34	1/4 VCR	PROCESS GAS 4
20	11.75	53.34	1/4 VCR	FLUSH 1
21	10.49	53.34	1/4 VCR	PROCESS GAS 5/PURGE
22	8.64	53.34	1/4 VCR	PROCESS GAS 6
23	6.78	53.34	1/4 VCR	PROCESS GAS 7
24	4.93	53.34	1/4 VCR	PROCESS GAS 8
25	3.67	53.34	1/4 VCR	FLUSH 2
26	2.41	53.34	1/4 VCR	MANIFOLD PURGE
27	2.95	29.75	1/4 VCR	HELIUM INPUT (ICP)

Figure 2-2b. Sample System Utilities Connections (Standard Dual Chamber)

2.3 SAFETY PRECAUTIONS

IMPORTANT NOTICE TO CUSTOMERS WITH CE MARKED SYSTEMS!
In order to maintain CE directive compliance, the customer is responsible for ensuring that all add-on systems, components and their replacements are equipped with shielded cabling excluding AC power supply lines. Furthermore, all OEM complaint equipment must be replaced with CE compliant equivalent components. Any deviations from or modifications of the system must comply with CE directives in order to maintain CE compliance or the system must be re-evaluated by a qualified EMC or safety engineer.

2.3.1 OVERVIEW

Unaxis, Inc. designs and manufactures its equipment in accordance with two major criteria: (1) that it meets or exceeds established performance specifications, and (2) that it satisfies stringent operator safety requirements. Wherever personnel hazards exist, all possible precautions have been integrated into the equipment and appropriate warnings noted.

Voltages in certain areas of the system are potentially dangerous and can cause injury to personnel. Many gases are toxic and hazardous, and vacuum pump outgases may harm personnel if proper exhaust precautions are not taken. Other cautions and warnings are provided where applicable.

Voltage interlocks should not be overridden or by-passed except by competent maintenance personnel.

WARNING! **POTENTIAL HAZARDS EXIST IN AN ELECTROMECHANICAL ENVIRONMENT. TO PREVENT INJURY TO PERSONNEL OR EQUIPMENT DAMAGE ENSURE THAT POWER IS OFF AT SERVICE PANEL. FOLLOW COMPANY AND GOVERNMENT SAFETY REGULATIONS. KEEP UNAUTHORIZED PERSONNEL OUT OF THE AREA WHEN WORKING ON EQUIPMENT.**

Utmost care should be taken to protect personnel and avoid equipment damage. The following paragraphs highlight potential areas of concern. If there are any questions, contact your Plant Safety Engineer or Unaxis, Inc.

2.3.2 HANDLING

Use the “two-person lift” for any unit weighing between 35 and 51 pounds.

Lift any unit weighing 51 pounds or more with a forklift. Ensure that: (1) the unit is lifted from the bottom, (2) the fork tines extend the full depth or width of the unit, and (3) the unit is balanced before moving.

Use the proper gas cylinder hand truck with safety chain when transporting standard gas cylinders. Ensure that cylinder caps are tightly in place.

Use lint-free gloves when working inside or around the Process Chamber. Fingerprints can cause contamination during processing.

2.3.3 ELECTRICAL

Care should be taken when making input power connections or interconnections between the System Disconnect Box and other devices.

WARNING! **VOLTAGE LEVELS WITHIN THE SYSTEM PRESENT A SHOCK HAZARD AND CAN BE LETHAL. DISCONNECT POWER BEFORE MAKING OR BREAKING POTENTIALLY LIVE WIRES. ENSURE THAT INPUT POWER WIRES ARE AT LEAST #6 AWG AND HOUSED IN ACCORDANCE WITH LOCAL CODES AND REQUIREMENTS. ENSURE THAT THE GROUND WIRE IS AT LEAST #8 AWG OR NOT LESS THAN TWO GRADES SMALLER THAN THE INPUT POWER LINES.**

The voltage used by this machine could cause injury or death. To avoid injury to personnel and damage to property, use of an approved lock out/tag out device equipped to accommodate three or more pad locks or tags is recommended when securing the main power disconnect switch during maintenance of the electrical system. This switch handle is located at the front of the main disconnect enclosure and is clearly marked with a lock out label.

RF power within the system is carried by coaxial cable. Do NOT: cut outer shield, bend less than a 10-inch radius or operate with loose or defective connectors at either end. Ensure that RF switch(es) (if applicable) and Matching Network covers are secure.

2.3.4 GASES

This system may use toxic and hazardous gases and can combine safe gases into toxic or hazardous compounds.

We highly recommend that all tubing for reactant gases be seamless Type 316L stainless steel with VCR® (or equivalent) compression connections.

All cut lines must be deburred. All joints must be helium leak tested to less than 4.9×10^{-9} scc/second.

Reactant gas lines must be cleaned before installation by flushing with a sequence of 1.1.1 trichloroethane, acetone and methyl alcohol. Lines should be dried with filtered dry nitrogen.

Supply lines should be free of mechanical joints except in well-ventilated areas. Fittings should not be installed in non-vented spaces or in trenches, ducts, or hallways if possible.

All trenches, ducts and hallways should be vented to avoid potentially dangerous gas pockets.

All gas lines should be marked at both ends and enroute where possible.

Avoid dead-end plumbing and gas lines.

Compressed gas cylinders should be stored in vented cabinets or in separate storage areas per OSHA regulations. The cylinders must be turned off at the tank when not in use or in the event of an emergency. Routine and emergency gas handling and shut-off procedures should be posted and practiced. A gas panel input chart (Figure 2-3) should be referenced and maintained with full-scale flows, calibration factors and specific gas listings for each channel.

Automatic shut-off of dangerous gases at the source, interlocked with the ventilation system and the system EPO, is recommended. Pressure regulators for dangerous gases should be a non-venting type and should only be used with a purge assembly. Install a pressure relief system to alleviate a pressure regulator failure, which could stress other gas control system components.

MASS FLOW METERS AS VIEWED FROM SYSTEM REAR

MFC 8	MFC 7	MFC 6	MFC 5	MFC 4	MFC 3	MFC 2	MFC 1

MASS FLOW METER			SOURCE GAS		
MASS FLOW CHANNEL	RANGE FULL SCALE (SCCM)	CALIBRATION GAS	GAS IN USE	GAS CALIBRATION FACTOR	REMARKS
#1					
#2					
#3					
#4					
#5					
#6					
#7					
#8					
PURGE					
FLUSH					

Figure 2-3a. Gas Input Chart (Single Chamber)

MASS FLOW METERS AS VIEWED FROM SYSTEM REAR

Primary Module								Docking Module							
MFC 8	MFC 7	MFC 6	MFC 5	MFC 4	MFC 3	MFC 2	MFC 1	MFC 16	MFC 15	MFC 14	MFC 13	MFC 12	MFC 11	MFC 10	MFC 9

	MASS FLOW METER			SOURCE GAS		
	MASS FLOW CHANNEL	RANGE FULL SCALE (SCCM)	CALIBRATION GAS	GAS IN USE	GAS CALIBRATION FACTOR	REMARKS
Primary Module	#1					
	#2					
	#3					
	#4					
	#5					
	#6					
	#7					
	#8					
	PURGE					
	FLUSH					
Docking Module	#9					
	#10					
	#11					
	#12					
	#13					
	#14					
	#15					
	#16					
	PURGE					
	FLUSH					

Figure 2-3b. Gas Input Chart (Dual Chamber)

WARNING! **HOUSE NITROGEN SUPPLIES MUST NEVER BE USED TO PURGE DANGEROUS GAS LINES. INCORRECT PROCEDURES OR MALFUNCTIONING CHECK VALVES COULD ALLOW HIGHLY DANGEROUS GASES TO INFILTRATE HOUSE NITROGEN LINES. UHP DRY NITROGEN (99.999% PURE) SHOULD BE SUPPLIED TO PURGE REACTANT GAS SUPPLY LINES.**

Separate purge cylinders are required to keep oxidizers from reducers.

CAUTION: The use of the purge gas channel for reactive gases is **not** recommended.

2.3.5 WATER/HEAT TRANSFER FLUID

It is recommended that all water lines contain a 120-micron sediment filter followed by a 10-micron filter, pressure gauge and shut-off valve.

2.3.6 EXHAUST

Although exhaust piping requirements permit some latitude in the type of material used, care should be taken to ensure a safe, correct installation. The material must be compatible with effluent gases. Joints and bends should be minimized.

If exhausted into an existing facilities exhaust system, be sure it can handle the additional SLR exhaust load. Additional precautions should be taken to prevent volatile gas mixtures.

2.3.7 VACUUM SYSTEM OIL

- Process Pump - Use pump fluids compatible with process gases used in the system. Perfluoropolyethers (i.e., Krytox, Fomblin) are recommended for most applications.

NOTE: Please refer to the System Configuration sheets (Section Six) and the Equipment Manual.

WARNING! **PERFLUOROPOLYETHERS (PFPE's) HEATED TO TEMPERATURES ABOVE 290º C EMIT TOXIC VAPORS.**

- Lock Pump - Any good grade of hydrocarbon-based oil may be used since the lock pump is not involved with any of the process gases.

NOTE: If perfluoropolyether fluid will be used, the pump must first be prepared by the manufacturer.

2.3.8 ENDPOINT DETECTION

This system may employ the use of non-ionizing light sources. Use of controls, adjustment or performance procedures other than those provided by the manufacturer of the light source may result in hazardous radiation exposure.

> ***WARNING!*** **AVOID DIRECT EYE EXPOSURE.**
>
> **TO PREVENT INJURY TO PERSONNEL OR EQUIPMENT DAMAGE, IT IS RECOMMENDED THAT ALL SYSTEM OPERATORS AND MAINTENANCE PERSONNEL BECOME FAMILIAR WITH THE SAFE USE AND MAINTENANCE PRACTICES PROVIDED BY THE MANUFACTURER OF THE LIGHT SOURCE.**

Safety practices and technical infromation regarding the light source may be found in the equipment manual provided with the system.

2.4 INSTALLATION PREPARATION

Personnel should read the safety precautions listed in Section 2.3 prior to performing any installation. These precautions could prevent injury to personnel and/or avoid accidental equipment damage.

2.4.1 SPECIFICATIONS OF INSTALLATION MATERIALS

The user must supply the following materials:

l. ISO/KF clamps (size and quantity as required).

2. Electrical cable, 5-wire, 6 AWG/8 AWG or better if required by local codes (length as required).

3. Overcurrent protection at the facility service panel (please verify on the System Configuration sheets in Section Six):

Standard Domestic:
208/240 VAC, 3 phase, 60 Amp, 5-wire
Standard International:
200 VAC, 3 phase, 60 Amp, 4-wire
380 VAC, 3 phase, 60 Amp, 5-wire
415 VAC, 3 phase, 60 Amp, 5-wire

4. Gas Lines - Figures 2-3 illustrate gas panel input charts for single and dual chamber systems. The correct chart must be completed by the user at the time of system start-up.

CAUTION: It is recommended that a filter with an absolute rating of 0.3 microns be installed in the nitrogen line between the source and the system.

5. Water lines - If the heat exchanger option was not chosen, the user must supply the water line tubing. It is also recommended that the user supply sediment filters, a flowmeter and, if desired, inlet and outlet pressure gauges (see Section 2.7).

   If the heat exchanger option was purchased, it is supplied with 3/8-inch ID flexible tubing and proper fittings. The Fluid Input Panel (Figure 2-8) is also supplied with fittings designed to connect with the tubing.

6. Heat Exchanger Fluid - Please refer to the System Configuration sheets (Section Six) and the Equipment Manual for specific requirements.

If there are any questions about process requirements, please contact a Unaxis representative.

2.4.2 INSTALLATION TOOLS AND EQUIPMENT

The following tools and equipment are required to install the system:

- Common mechanic's and electrician's hand tools
- Tube bender
- Helium leak detector

2.4.3 UNPACKING

CAUTION: **BEFORE OPENING ANY EQUIPMENT**, be aware that all systems are shipped with potential damage indicators mounted on the sides of crates. If there was excessive shock to the load or if the load was subjected to inordinate tilting, these indicators will reflect potential damage. **DO NOT OPEN CRATE(S) UNLESS A TRUCKING REPRESENTATIVE IS PRESENT** if at all possible.

The following procedure should be used when unpacking the equipment:

1. Be present for the unpacking. Carefully open the shipping crates and remove the contents.
2. Miscellaneous parts are of particular importance when unpacking. Miscellaneous parts are shipped in a separate crate or in a cardboard box packed inside the system crate. Compare the items received with those listed on the packing list. If any items are missing, immediately notify Unaxis, Inc. Failure to do so may result in a charge for replacing the items.
3. Carefully inspect each item for damage. If an item is damaged, notify the carrier and Unaxis, Inc., immediately. The carrier will provide information for filing a claim .

CAUTION: **DO NOT** attempt arm/substrate adjustment or movement. Alignment was set at the factory.

CAUTION: Handle precision equipment with extreme care or damage may occur.

4. Review Section 2.1 and refer to Figure 2-4, Section 2.5.1.2 before proceeding.

2.5 INSTALLATION PROCEDURES

The system can be installed only when all of the preceding requirements have been met.

> ***WARNING!*** **POTENTIAL HAZARDS EXIST IN AN ELECTROMECHANICAL ENVIRONMENT. TO PREVENT INJURY TO PERSONNEL OR EQUIPMENT DAMAGE ENSURE THAT POWER IS OFF AT SERVICE PANEL. FOLLOW COMPANY AND GOVERNMENT SAFETY REGULATIONS. KEEP UNAUTHORIZED PERSONNEL OUT OF THE AREA WHEN WORKING ON EQUIPMENT.**

2.5.1 POSITIONING OF EQUIPMENT

2.5.1.1 CABLES AND PLUMBING

One of the primary considerations when positioning the equipment is the routing of cables and plumbing. Routing will depend on the physical layout of the area and the location of required utilities. Preferred routes are overhead runs or through the floor or ceiling.

A routing survey should be made as soon as the equipment is positioned. The following should be considered:

- Routing should ensure the safety of personnel (i.e., no cables or plumbing projecting out of floors or walls without properly marked safety barriers).
- Some plumbing is restricted to length and the number of 90º bends (a 90º bend is equal to three feet).
- Cables and plumbing must be protected from damage by personnel and material handling equipment.
- Cables and plumbing must be accessible for servicing.
- The finished job should present a neat appearance.

2.5.1.2 MAIN CABINET

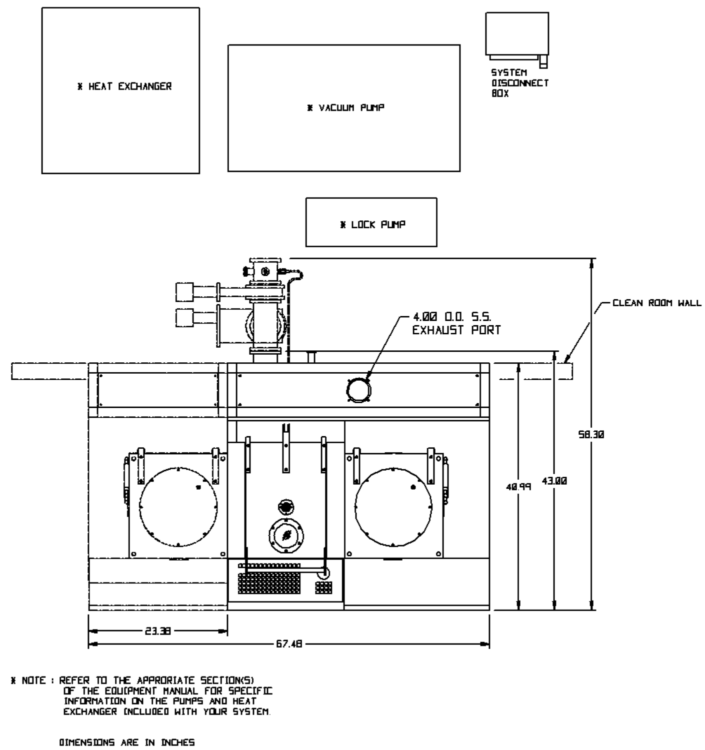


Figure 2-4. Typical Equipment Installation Arrangement

Figure 2-4 illustrates a typical system arrangement.

1. Preparation: The Main Cabinet is typically positioned in a cleanroom with support equipment housed in a local service area. Leveling of the unit is required and should be considered before any wall openings are made. Wall openings should only be large enough to accept the cabling/plumbing. This will reduce the size of the openings to be sealed to maintain cleanroom integrity. Sealing of through-wall plumbing/cabling is done at the customer's discretion.
2. Cleanroom Position: Determine the exact position of the Main Cabinet in the cleanroom. Following the dimensions specified in Figures 2-1 and 2-2, prepare through-wall openings for the pump vacuum lines, the Gas Panel exhaust line, Fluid Input Panel lines, Electrical Interface Panel cables, RF cables, and process gas lines.
3. Leveling: To level the Main Cabinet, position a carpenter's level on the cabinet top, either front-to-back or side-to-side. Adjust the leveling screws (pads) which support the system. Alternate the level between front-to-back and side-to-side until the system is level in both directions. Proper leveling minimizes movement of process samples during pump down cycles.

2.5.1.3 VACUUM PUMPS

Connect the mechanical pump(s) as follows:

l. Drip Pans: The mechanical pump(s) should have a drip pan placed beneath them (not supplied).

2. Leveling: Level the main blower/process pump by adjusting the leveling mounts. If the main pump vacuum line is straight tube (as is typical for a roots blower configuration), the height of the pump must be adjusted so the centerlines of the vacuum port and the Main Cabinet vacuum port are of equal height.

3. Cable Interconnects: The unit power cable (hardwired to the pump) must be routed to the rear of the Electrical Enclosure.

4. Mechanical Pump: Connect the mechanical pump to the vacuum port (or to the turbomolecular pump foreline port, if applicable) with a one meter long flexible vacuum line (shipped with the miscellaneous system components, including all necessary vacuum clamps and size adapters).

5. Lock Pump: Connect the lock pump to the Loadlock vacuum port with flexible vacuum line (shipped with the miscellaneous system components, including all necessary vacuum clamps and size adapters).

2.5.1.4 HEAT EXCHANGER

Connect the heat exchanger as follows:

l. Drip Pan: Place a drip pan (not provided) under the fittings on the side of the unit.

2. Cable Interconnects: Route the power cable hardwired to the rear of the heat exchanger to the rear of the Electrical Enclosure.

3. Fluid Line Connections: Connect the heat exchanger fluid lines. The 3/8" ID flexible tubing connects to the Fluid Input Panel by means of 3/8" tube fitting screw-type connectors and to the heat exchanger with 3/8" brass hose connections (lines and connectors are supplied by Unaxis).

   Customers supplying their own water or heat exchanger must supply their own tubing. Choose heavy wall or reinforced tubing to minimize the possibility of line failure. The distance between the system and the heat exchanger should be minimized whenever possible (see Section 2.7).

2.5.1.5 ENDPOINT DETECTION

The system supports one of three endpoint detection options: an optical filter, a monochromator or a LASER.

1. The optical filter is comprised of a broad-band photo-diode detector and a narrow band (10nm) detector which mounts directly on the Chamber Viewport. A range of filters are available which can be used for specific applications.

2. The monochromator has a 100 mm focal length and is equipped with either a 600 or 1200 groove/mm grating. A PMT detector is used with a range of 200 nm - 900 nm. The spectral band pass is 3 nm (1.5 nm with 1200 groove/mm grating). The head is connected to the Chamber Viewport via a fiber optic cable.

3. The LASER is mounted to the top of the Process Chamber. The LASER incorporates beam-splitting optics; therefore, the chamber top has only one Viewport. The port position is tailored to each customer's individual requirements and, as such, can be in virtually any location on the chamber top. The LASER is the most versatile endpoint technique as it can be used to detect endpoint in a variety of transparent films (oxide, nitride, ITO), semitransparent films (poly-Si), and opaque films (Cr, Ta, Al). It can also be used to determine etch depth and etch rate for some applications. A LASER head with an

integral CCD camera is available which allows simultaneous viewing of a magnified portion of the sample.

The raw analog output of each head is fed into a control box which amplifies the signal according to the individual characteristics of the endpoint system (see Figure 2.5). Each controller can interpret two individual endpoint signals. The controller has an adjustable gain potentiometer for each signal. All endpoint signals are then fed into the computer and manipulated via an internal algorithm in the configuration. The software accepts a signal from the interface and determines endpoint based on a user-selected endpoint algorithm which is accessed during run time.

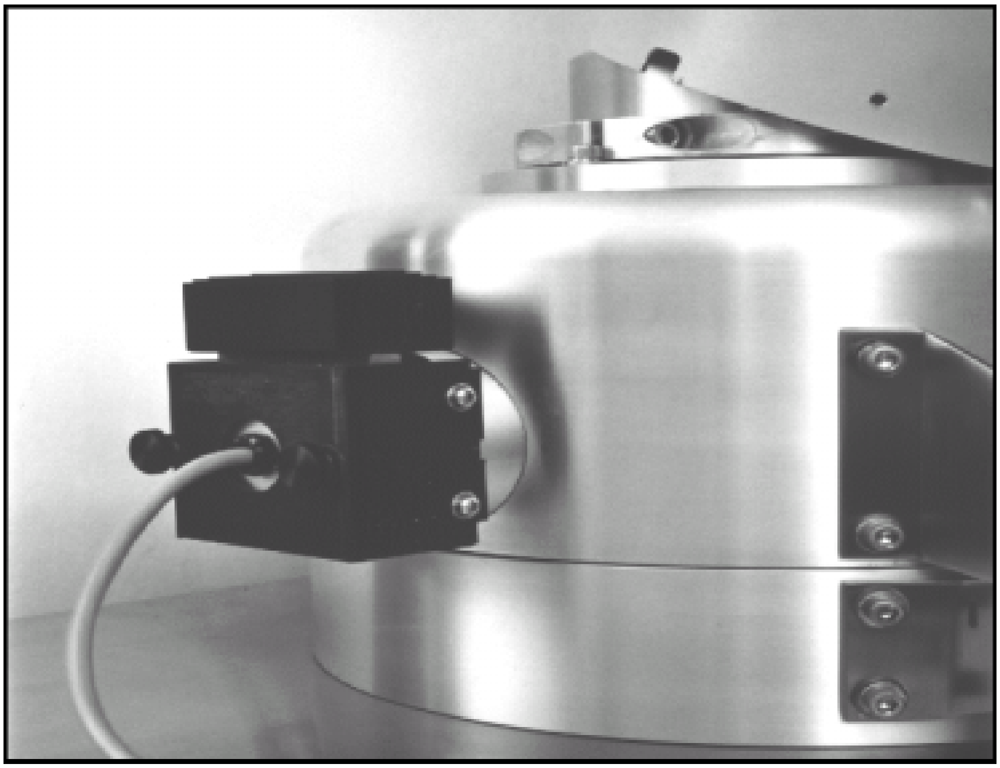


Figure 2-5. Endpoint Detector Head

2.5.2 SYSTEM INTERCONNECTS

System interconnects are performed after the equipment is positioned and the routing survey is complete. Make all power interconnects first, then control cabling and plumbing interconnects.

CAUTION: Do not connect the main power until the system has been checked for correct installation.

2.5.2.1 ELECTRICAL ENCLOSURE CONNECTIONS

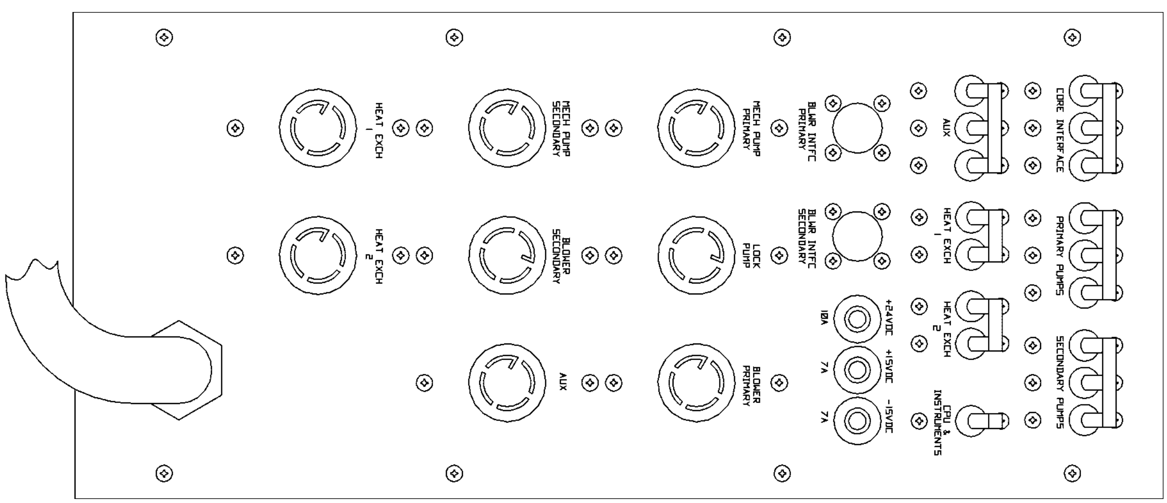


Figure 2-6. Electrical Interface Panel

The Electrical Enclosure is located on the lower right side of the Mainframe. The Electrical Interface Panel (EIP) is located at the rear of the Electrical Enclosure. Review Figure 2-6 before performing any connections described in this section. Ensure that all switches and breakers on the Front Panel (Figure 2-7) are in the OFF position before proceeding.

1. Main Power: The system is shipped with the main power cable hardwired to the System Disconnect Box. Facility power must be hardwired to the System Disconnect Box. It is recommended that a local power disconnect be available and that the disconnect be in the OFF position until the installation has

been thoroughly checked. Consult a licensed electrician for details on allowable facility power connections in your local area.

2. ECR Instrument Cabinet Power: The ECR instrument cabinet power cable is hardwired to the instrument cabinet. At the time of installation it must be hardwired to the System Disconnect Box. System components housed within the instrument cabinet must be connected to components within the Mainframe. All cabling is supplied and marked. Ensure proper connections have been accomplished prior to applying power.
3. Mechanical Pump Power Cable: The mechanical pump power cable is hardwired to the pump package and terminates in a standard plug. Connect this plug to the mating receptacle labeled MECHANICAL PUMP on the EIP.
4. Blower Power Cable: The blower power cable is hardwired to the blower package and terminates in a standard plug. Connect this plug to the mating receptacle labeled BLOWER on the EIP.
5. Turbomolecular Pump Power Cable: The turbomolecular pump power cable is supplied with the Turbo Power Supply/Frequency Converter. It terminates as a standard receptacle that connects to the Frequency Converter. Connect the standard plug on the other end to the appropriate receptacle on the side panel (left side as viewed from front) of the Electrical Enclosure.
6. Lock Pump: The lock pump power cable is hardwired to the pump package and terminates in a standard plug. Connect this plug to the mating receptacle labeled LOCK PUMP on the EIP.
7. Heat Exchanger Power Cable: Make sure that the breaker labeled HEAT EXCHANGER on the front panel of the Electrical Enclosure is in the OFF position. Connect a standard plug (250V, 30 Amp, 3-phase) to the heat exchanger power cable (hardwired to the heat exchanger). Connect the plug to the mating receptacle labeled HEAT EXCHANGER on the EIP.
8. Auxiliary Power Receptacle: The system provides six (6) 125 V, 15 Amp receptacles on the side panel (left side as viewed from front) of the Electrical Enclosure to allow for additional options or future system enhancements. Information on the use of the auxiliary receptacles will be provided as necessary.
9. Dual Chamber System Power: Docking module power is supplied internally by the Main Cabinet via conduit.

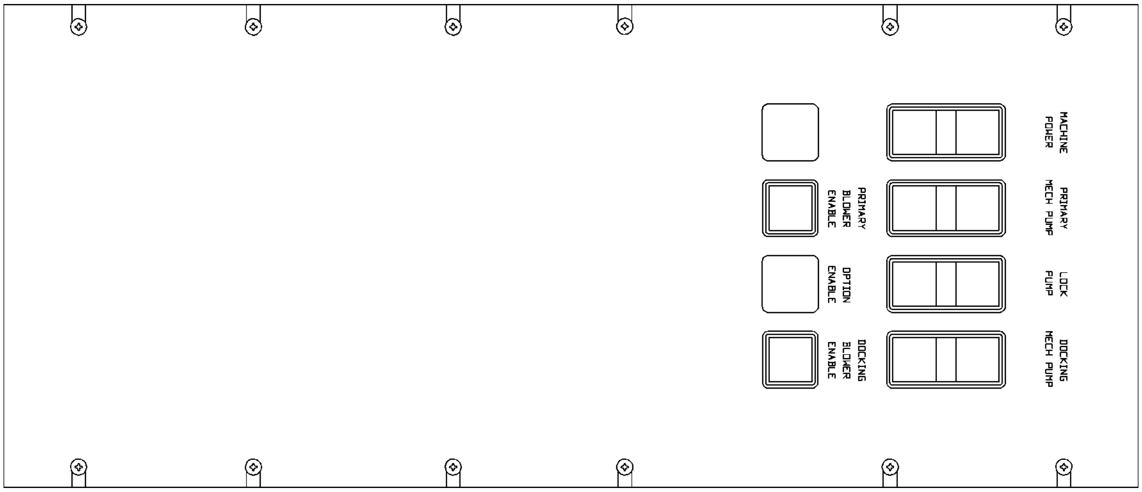


Figure 2-7. Electrical Enclosure Front Panel

2.5.2.2 HEAT EXCHANGER FLUID LINE CONNECTIONS

> ***WARNING!*** **THERMAL TRANSFER MEDIUM (TMM) IS OFTEN HARMFUL AND MAY BE FATAL IF SWALLOWED. PROLONGED EXPOSURE TO TTM VAPOR CAUSES EYE IRRITATION.**

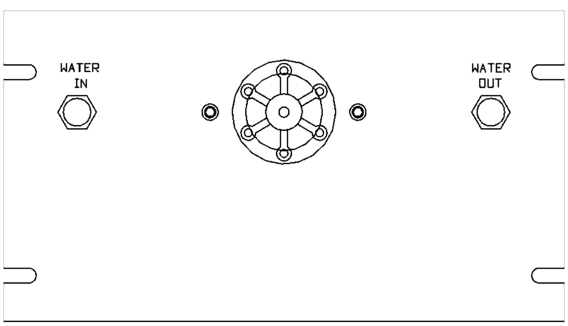


Figure 2-8a. ECR Magnet FIP

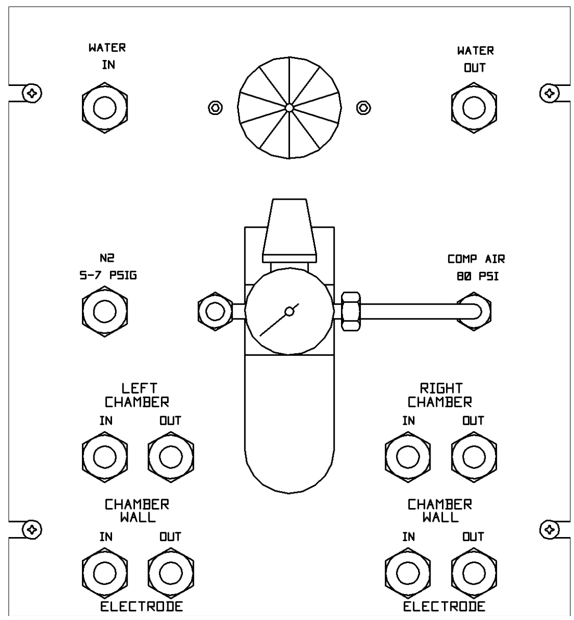


Figure 2-8b. Standard FIP

Figure 2-8. Fluid Input Panel (FIP)

1. Coolant Lines: Connect the two pump connections on the rear of the heat exchanger to the two fluid connections on the back of the Mainframe with 3/8" ID flexible tubing (supplied). Connect the heat exchanger PUMP INLET and PUMP OUTLET to the ELECTRODE OUT and ELECTRODE IN connections on the Fluid Input Panel (Figure 2-8), respectively. Connections labelled WATER IN and WATER OUT use *House Water* (see Table 2-3).
2. Keep the distance between the heat exchanger and the SLR Mainframe to a minimum (maximum length is sixteen (16) feet). Avoid sharp bends in the tubing. Any long lengths of tubing should be prefilled with thermal transfer medium.
3. Keep extra thermal transfer medium on hand. Check the heat exchanger fluid level on a regular basis to ensure that the proper fluid level is maintained while the system is operating.

NOTE: Please see the System Configuration sheets (Section Six) and the Equipment Manual for specific information on the heat exchanger included with this system.

2.5.2.3 STANDARD VACUUM SYSTEM CONNECTIONS

WARNING! **TO AVOID DANGEROUS OR CORROSIVE CONDENSABLE VAPORS FROM ACCUMULATING IN PUMP OIL RESERVOIRS, THE PUMP CASES ARE PURGED WITH AN INERT GAS. THIS PURGE PRESSURE SHOULD BE CAREFULLY REGULATED ACCORDING TO PUMP MANUFACTURER RECOMMENDATIONS.**

1. Mechanical Pump: Connect the following lines to the mechanical pump:
   a. Vacuum line from MAIN VACUUM FLANGE at rear of Main Cabinet to mechanical pump INLET FLANGE.
   b. Exhaust line from mechanical pump(s) EXHAUST FLANGE to facility exhaust outlet(s) or air pollution control device.
   c. OPTIONAL: Provide a source of inert gas per manufacturer specifications (please see the Equipment Manual for specific information).
2. Blower/Process Pump: Connect the following lines to the blower/process pump:
   a. Vacuum line from MAIN VACUUM FLANGE at rear of Main Cabinet to roots blower INLET FLANGE (standard 100 mm bellows and stainless steel tubing is provided).
   b. Provide a source of inert gas per manufacturer specifications (see the Equipment Manual for specific information.
   c. Exhaust line from the mechanical pump EXHAUST FLANGE to facility exhaust outlet(s) or air pollution control device.
3. Lock Pump: Connect the following lines to the lock pump:
   a. Flexible vacuum line from LOAD LOCK VACUUM FLANGE at rear of Main Cabinet to lock pump INLET FLANGE.
   b. Exhaust line from the lock pump EXHAUST FLANGE to an oil mist eliminator, facility exhaust outlet and/or air pollution control device.
4. Pump Oil Filter: If not already connected, connect the oil filter to the main pump as described in the mechanical pump section of the Equipment Manual.

NOTE: Please see the System Configuration sheets (Section Six) and the Equipment Manual for specific information on the pump(s) included with this system.

2.5.2.4 GAS CONNECTIONS

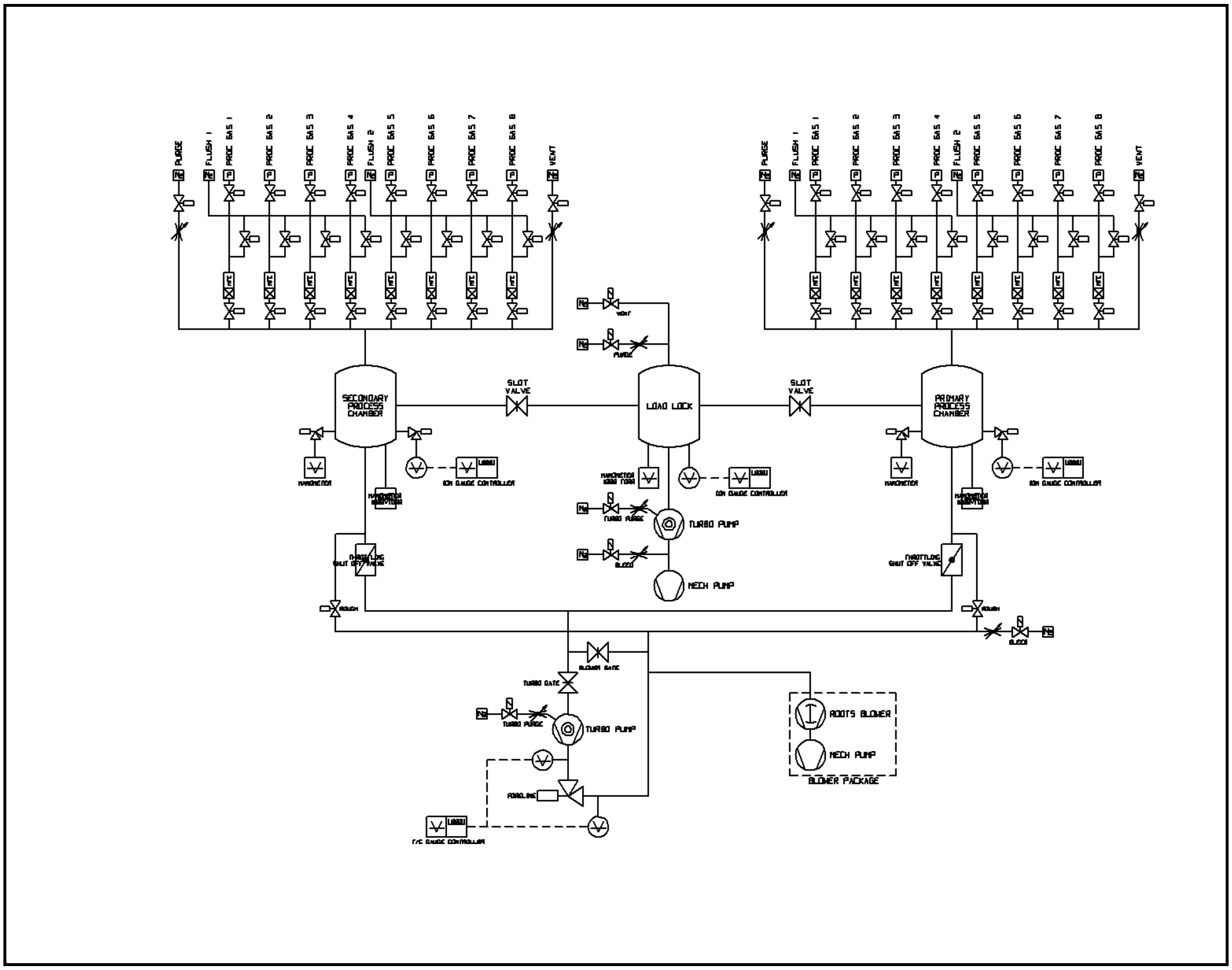


Figure 2-9. Sample Vacuum Schematic (Standard)

1. Refer to the specific Vacuum Schematic in the Service Document (similar to Figure 2-9) and connect an N_2 gas line to the N_2 connector on the Fluid Input Panel (Figure 2-8).
2. All connectors within the Gas Panel are VCR® (or equivalent) fittings.
3. The routing of the gas lines must ensure that they are protected from damage and do not present a hazard to personnel.
4. Determine the most practical routing for your application and make the gas line connections (refer to Section 2.7). The final process gas connections are made within the Gas Panel.
5. Helium leak test all connections to ensure proper sealing.

2.5.2.5 AIR CONNECTIONS

- Connect the house air supply to the COMP AIR 80 PSI connector on the Fluid Input Panel (See Figure 2-8 and Section 2.7)

NOTE: The machine should be supplied with clean, dry, 80-90 psi, regulated compressed air (see Section 2.2).

2.5.2.6 MAIN CABINET EXHAUST CONNECTIONS

WARNING! **IN CASES WHERE TOXIC, NOXIOUS, OR POISONOUS GASES ARE EXHAUSTED, REFER TO THE EPA SPECIFICATIONS FOR HANDLING THESE ATMOSPHERIC POLLUTANTS.**

- Locate the exhaust port on top of the Gas Panel (see Figures 2-1 and 2-2). Connect 4-inch ID exhaust piping to the port.

NOTE: Exhaust is typically piped to an alkaline/H_2O scrubber. Exhaust procedures must comply with local, state and Federal requirements.

2.6 SYSTEM CHECKOUT

2.6.1 GENERAL

After installation, inspect all system units for the following (as applicable):

1. Damage from installation.
2. Foreign objects or remaining packing material.
3. Loose mounting hardware or missing parts.
4. Kinked, stressed or loose gas, water and air lines.
5. Loose power or control cables.
6. All circuit breakers and power-on switches should be turned off.

2.6.2 MAIN POWER CONNECTION

The customer must supply the electrical cable to distribute facility power from the service panel to the System Disconnect Box (cable length as required). The cable gauge must correspond to local code requirements (6 AWG/8 AWG minimum).

> ***WARNING!*** **POTENTIAL HAZARDS EXIST IN AN ELECTROMECHANICAL ENVIRONMENT. TO PREVENT INJURY TO PERSONNEL OR EQUIPMENT DAMAGE, ENSURE THAT POWER IS OFF AT SERVICE PANEL, FOLLOW COMPANY AND OSHA SAFETY REGULATIONS. KEEP UNAUTHORIZED PERSONNEL OUT OF THE AREA WHEN WORKING ON EQUIPMENT.**

2.6.3 PUMP SERVICING

The oil filtration system should contain the required amount of pump oil. The oil should be added before testing the pump system(s).

> ***WARNING!*** **TO PREVENT INJURY TO PERSONNEL OR EQUIPMENT DAMAGE, ENSURE THAT THE CORRECT FLUIDS ARE USED. HANDLE WITH CARE AND USE ONLY AS NEEDED. FRESH FOMBLIN IS NON-TOXIC. HOWEVER, AFTER A PERIOD OF USE IN A VACUUM PUMP IT MAY COLLECT AND HOLD HAZARDOUS EFFLUENTS IN SUSPENSION.**

NOTE: For specific information on the pump(s) included with this system and the oil required, please see the System Configuration sheets (Section Six) and the Equipment Manual.

NOTE: Subsequent tasks require power to the pump(s). Therefore, at this time, enable power to the service panel, and set the (1) Main System Power Disconnect, (2) the disconnect switch, and (3) the circuit breaker labeled VACUUM SYSTEM to ON.

1. Briefly apply power to the pump(s) and check rotation by alternately pressing the MECH PUMP START and OFF buttons and the LOCK PUMP START and OFF buttons. These are located on the Electrical Enclosure front panel (Figure 2-7).
   The motor shaft must turn in the direction of the arrow on the motor housing. If the motor turns incorrectly, reverse any two phases at the disconnect switch in the System Disconnect Box.
2. Apply power to the pump(s) for 20 minutes. This heats the pump oil to operating temperature and reduces fluid viscosity. Be sure N_2 bleed is available and flowing.

WARNING! **POTENTIAL HAZARDS EXIST IN RESETTING THE THERMAL OVERLOAD DUE TO THEIR PROXIMITY TO HIGH VOLTAGE. FOLLOW COMPANY AND OSHA SAFETY REGULATIONS. IT IS NOT UNCOMMON FOR BREAKERS AND/OR THERMAL OVERLOAD TO OCCASIONALLY TRIP WHEN PUMP(S) ARE COLD, AND THUS NEED TO BE RESET.**

NOTE: It is normal to hear the upper and lower blower rotors rotate slowly when it is turned off. This is due to the mechanical vane pumps causing a gas flow through the blower when they are turned on.

3. When the setpoint is reached, the blower will start automatically if the blower enable switch is positioned in the ENABLE mode. The manostat (automatic pressure switch) located on the blower triggers the blower at a preset pressure.

CAUTION: Operating the blower at pressures above the setpoint may cause damage.

4. Allow the pump(s) to run for one hour while constantly monitoring the oil level in the sight glass.
5. Disable power to the pump(s) and oil filtration system. Recheck all fittings.

2.6.4 HEAT EXCHANGER CHECKOUT

The following steps should be taken to check heat exchanger operation:

WARNING! **POTENTIAL HAZARDS EXIST IN AN ELECTROMECHANICAL ENVIRONMENT. TO PREVENT INJURY TO PERSONNEL OR EQUIPMENT DAMAGE, ENSURE THAT THE HEAT EXCHANGER CIRCUIT BREAKER IS OFF.**

NOTE: For specific information on the heat exchanger included with this system, please see the System Configuration sheets (Section Six) and the Equipment Manual.

1. Ensure that all fluid lines are leak tight. Check the bath to make sure it has been properly filled with fluid.
2. Switch ON the heat exchanger circuit breaker.
3. Turn on the heat exchanger using the front panel ON/OFF switch. Let the unit run for approximately five (5) minutes. Check all fluid connections in the cooling loop to ensure that they are leak tight. If pressure and flow gauges are installed, record the gauge values.
4. Turn the heat exchanger off and check the fluid level. Refill the bath to the proper level if necessary. Restart the unit and check for leaks again.

2.6.5 INITIAL START-UP PROCEDURE

NOTE: The initial start-up of the system should be performed by Unaxis, Inc., Field Service Personnel. Contact our Customer Service Department at (727) 577-4999 to schedule start-up.

2.6.6 GAS LINE VACUUM INTEGRITY

To ensure gas line vacuum integrity, every gas line connection must be helium leak tested from the source to the vacuum chamber and vacuum pump(s).

2.6.7 SYSTEM ADJUSTMENTS

System adjustments should only be made after:

1. Determining that an adjustment is needed (i.e., improper operation or a malfunctioning device).
2. Determining which adjustment procedure will correct the malfunction.
3. Having a clear understanding of the normal operation of the function.
4. Having a clear understanding of the purpose and effects of the adjustment(s).

NOTE: If the transfer arm requires adjustment, please contact Unaxis Customer Service Department at (727) 577-4999.

Unaxis Customer Service Department will provide assistance if a system component malfunctions or needs adjusted. Additional system adjustment information can be found in the Service Document and Equipment Manual.

2.6.8 CUSTOMER FACILITY CERTIFICATION RECORD

The Customer Facility Certification (Section 2.6.9) ensures Unaxis, Inc., that all customer facility requirements have been properly met.

An authorized representative of your company is obligated to initial each item on the Customer Facility Certification as it is completed. Please FAX the completed Customer Facility Certification to Unaxis, Inc., using the FAX Cover sheet provided on the following page. Upon receipt, our Customer Service Department will schedule a Field Service Engineer to complete your system start-up.

The following statement should be completed and will serve as your record of notifying us of facility compliance:

____________________________ The completed Customer Facility Certification was FAXed to Unaxis, Inc., on

______________ by ____________ ____
(Date) (Name)

____
(Title)

Facsimile Cover Sheet

To: Customer Service Department

Company: Unaxis USA, Inc.

Phone: 727-577-4999

Fax: 727-576-6648

From: ____

Company: ____

Phone: ____

Fax: ____

Date: ____

Pages including this cover page: ________

Comments:

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2.6.9 CUSTOMER FACILITY CERTIFICATION

SLR SERIES PROCESS SYSTEM
Page 1 of 3

CUSTOMER: ______________________ MODEL: ______________________
ADDRESS: ______________________ CONTROL #: ______________________
______________________ SERIAL #: ______________________

1. **Minimum Installation Clearance:**

INITIAL:	ITEM	*(all dimensions in feet)* FRONT	SIDE	BACK
	Main Cabinet	3	2	3
	ECR Instrument Cabinet	3	2	3
	System Disconnect Box	3	2	0
	Heat Exchanger(s)	2.5	1	2.5
	Vacuum Pump(s)	2.5	1	2.5
	Lock Pump	1	1	2

NOTE: The following facility services should be connected to the system as specified in Section Two of this manual. Please refer to Figures 2-1 and 2-2 for input locations.

INITIAL:

__________ 2. **Compressed Air:**
Clean, dry, 80 - 90 psig. Flow rate less than 1 slpm. Average flow rate 1 scfm. Oil-free to 50 ppm. Max moisture content -60º F dew point, and filtered to max particle size of 3 microns

__________ 3. **Purge Gas:**
Nitrogen, 5-7 psig @ 1 slpm (99.999% purity recommended)

__________ 4. **Vent/Vacuum Bleed Gas:**
Nitrogen, 5-20 psig @ 10 slpm

__________ 5. **Flush Gas:**
Nitrogen, 15-20 psig @ 1 slpm (99.999% purity recommended)

__________ 6. **Process Gases** (8 max per chamber):
5-25 psig, all lines helium leak tested to less than 4.9 x 10^{-9} scc/sec

__________ 7. **Gas Panel Exhaust:**
50 cfm/minute @ 0.5 inch H_2O, connection to 4-inch OD duct

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CUSTOMER FACILITY CERTIFICATION
SLR SERIES PROCESS SYSTEM
Page 2 of 3

INITIAL:

______ 8. **Electrical Input:** (Please verify on the System Configuration sheets in Section Six)

Standard Domestic:
208/240 VAC, 3 phase, 60 Amp, 5-wire
Standard International:
200 VAC, 3 phase, 60 Amp, 4-wire
380 VAC, 3 phase, 60 Amp, 5-wire
415 VAC, 3 phase, 60 Amp, 5 wire

______ 9. **Heat Exchanger Reservoir:**
Filled with proper fluid and to proper level (see the Equipment Manual for specific requirements).

______ 10. **Cooling:**

Standard:
House Water 1 to 1.5 GPM @ 30 to 60 psig differential, supply temperature 20 ºC to 25º C,heat load approximately 1 kW

ICP:
House Water 40 psig @ 15 to 30º C, 1 MegOhm resistivity. RF-20M flow rate 2.5 GPM.

ECR:

House Water 1.25 GPM @ 60 psig differential, supply temperature 4 ºC (40^{O}F), maximum heat load approximately 7 kW.

Helium 20 psig @ 20 sccm, Helium Input connection at Fluid Input Panel.

Heat Exchanger:
(See the Equipment Manual for specific requirements)

______ 11. **Pump Case Purge Gas:**
Typically nitrogen (see the Equipment Manual for specific requirements).

______ 12. **Pump Vacuum Exhaust:**
Piping must be compatible with effluent gases. All joints must be leak tight.

______ 13. All **interconnect cables** have been routed as specified in this Users Manual.

______ 14. All **hoses** have been routed as specified in this Users Manual.

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CUSTOMER FACILITY CERTIFICATION

SLR SERIES PROCESS SYSTEM

Page 3 of 3

This is to confirm that the Unaxis, Inc., semiconductor system ___________________________ , Serial # _______________________________ has been installed and properly connected to our facility as stated above.

____
Name (print)

____
Title (print)

____
Signature

____
Date

Comments:

____

____

____

____

____

____

____

____

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2.6.10 START-UP/SYSTEM ACCEPTANCE RECORD

The start-up will be performed by a qualified Unaxis Field Service Engineer, who will: (1) verify the system electrical and mechanical functions, (2) ensure optimum system operation, and (3) provide operator training during system start-up to include programming, operation and troubleshooting.

The final step in system start-up is the customer's checkout and sign-off. Upon meeting all electrical and mechanical requirements and receiving sufficient training for independent operation, please fill out the Start-Up/System Acceptance (Section 2.6.11) and FAX it to Unaxis at (727) 576-6648.

The following statement should be completed and saved for your records.

The completed Start-Up/System Acceptance was FAXed to Unaxis, Inc., on:

________________ by ____
(Date) (Name)

____
(Title)

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2.6.11 START-UP /SYSTEM ACCEPTANCE

CUSTOMER: ______________________ DATE: ______________________

UNAXIS C/N: ______________________

PO #: ______________________

SYSTEM S/N: ______________________

SYSTEM TYPE: ______________________

This is to confirm that the Unaxis, Inc., semiconductor system referenced above has met all electrical and mechanical requirements for total operation as specified.

System start-up and instruction was satisfactorily performed by a Unaxis, Inc., Field Service Engineer.

CUSTOMER COMMENTS:

AUTHORIZED CUSTOMER REPRESENTATIVE:

____
Signature

____
Print Name and Title

____
Date

AUTHORIZED UNAXIS, INC. REPRESENTATIVE:

____
Signature

____
Print Name and Title

____
Date

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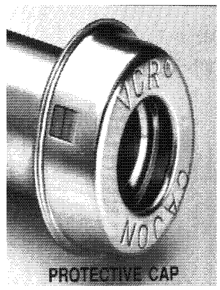
2.7 FITTING INSTALLATION INSTRUCTIONS

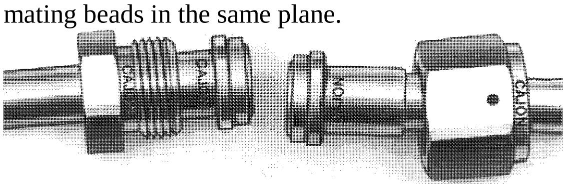
2.7.1 FACE SEAL FITTINGS (VCR®)

Handling
A protective cap is placed on all VCR sealing beads to prevent nicks or scratches. Damage to the sealing beads will affect the fitting performance and cause system leakage. This cap should remain in place during storage and handling.

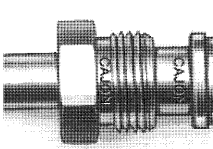


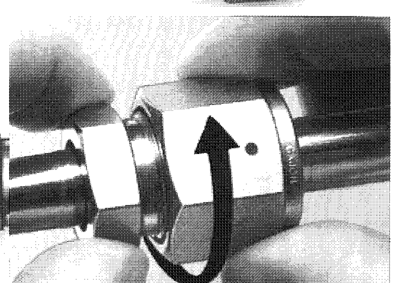
Cleaning
Many chemical processes used for cleaning, electropolishing and passivation will remove the silver plating from the inside of VCR female nuts. Protect this plating. If the plating is damaged or removed, thread galling will occur and prevent a proper seal.

Alignment
A VCR connection cannot compensate for misaligned tubing or components. Keep mating beads in the same plane.

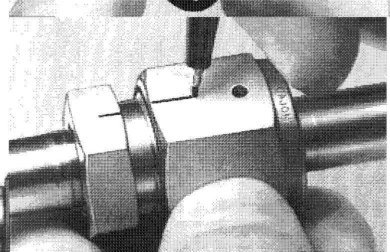


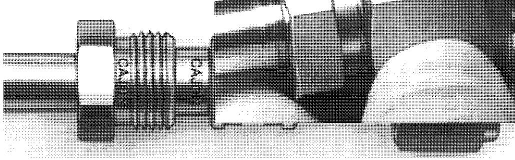
Check for proper alignment before assembly.



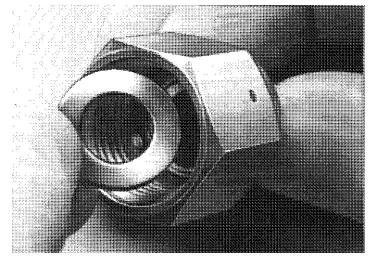


Do not use a VCR connection to close gaps in long runs of tubing.

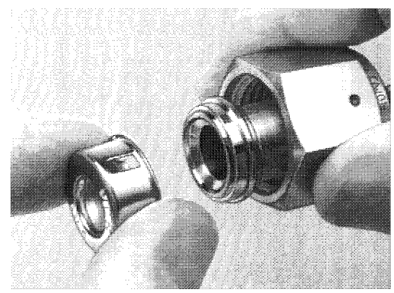




Leave just enough space between the beads to insert the gasket.



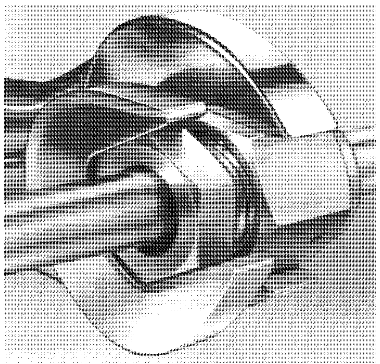
Assembly
Caution: VCR components with fixed threads must remain stationary during installation. Do not allow the sealing beads to rotate against the gasket.
Remove the Original-style Gasket or Gasket Retainer Assembly from its package.
When using an original-style Gasket, place it into the female nut whenever possible. No special positioning is needed, because the gasket is self-aligning.



When using a Gasket Retainer Assembly, press the assembly onto the gland as shown. The retainer assembly will locate the gasket over the bead and hold it in place. Be careful not to scratch or nick the sealing bead. Damage to the bead may cause leakage.

1. To assemble the connection, hold the male nut or body hex stationary. Tighten the female nut finger-tight.
2. Mark both the female and the male nut or body hex.

3. Hold the male nut or body hex stationary with a backup wrench. Tighten the female nut 1/8 turn past finger-tight for 316 stainless steel and nickel gaskets or 1/4 turn past finger-tight for copper and aluminum gaskets.



Caution: Excessive over tightening will damage the sealing beads and possibly cause system leakage.

Disassembly

Removing VCR components in an assembled system requires no axial clearance. To disassemble a VCR connection, hold the male nut or body hex stationary with a backup wrench and loosen the female nut. After removing the components, be sure to protect the sealing beads with the protective caps or Gasket Retainer Assemblies.

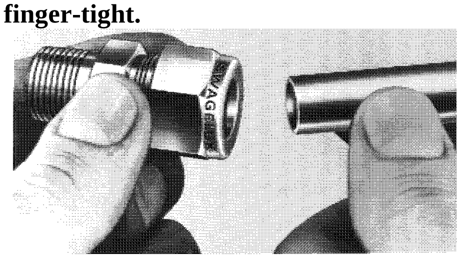
Re-Tightening

To maintain system reliability, install a new Original-style Gasket or Gasket Retainer Assembly on each remake. Simply follow the assembly instructions listed above.

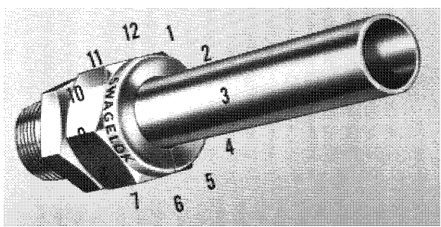
Installation Instructions courtesy of Swagelok Co.

2.7.2 TUBE FITTINGS

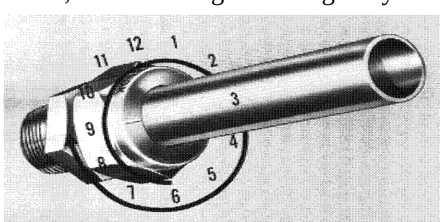
1. Simply insert the tube into the SWAGELOK® Tube Fitting. **Make sure that the tubing rests firmly on the shoulder of the fitting and that the nut is finger-tight.**



2. Before tightening the SWAGELOK nut, scribe the nut at the o'clock position.



3. Now, while holding the fitting body steady



with a backup wrench, tighten the nut 1-1/4 turns*. Watch the scribe mark, make one complete revolution and continue to the 9 o'clock position.
By scribing the nut at the 6 o'clock position as it appears to you, there will be no doubt as to the starting position. When tightening 1-1/4 turns* to the 9 o'clock position you can easily see that the fitting has been properly installed.

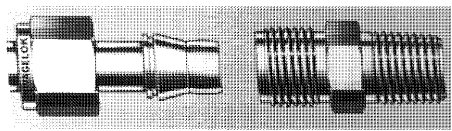
Use Gap Inspection Gage (1-1/4 turns from finger-tight) assures sufficient pull-up.

* For 1/16", 1/8" and 3/16" size tube fittings, only 3/4 turn from finger-tight is necessary.

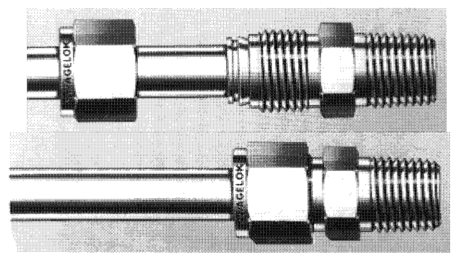
Re-Tightening Instructions
Connection can be disconnected and re-tightened many times. The same reliable, leak-proof seal can be obtained every time the connection is remade.
Fitting shown in disconnected position.

Tubing with pre-swaged ferrules inserted into the fitting until front ferrule seats in fitting.

Tighten nut by hand. Rotate nut to the original position with a wrench. (An increase in resistance will be encountered at the original position). Then tighten slightly with the wrench. The original position will generally be about 1/4 turn for 1/4" to 1/2" tubing. (Smaller tubes sizes will take less tightening to reach the



original position, while larger tube sizes will require more tightening. The wall thickness will also have an effect on tightening).



Installation Instructions courtesy of Swagelok Co.

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SECTION THREE: OPERATION

3.1 SYSTEM CONTROL

The system contains many electronic, electromechanical and pneumatic devices. Proper operation of these devices is dependent upon three sequential control-setting phases of operation. These are:

1. System Initialization
2. Process Programming
3. Process Operation

3.1.1 HARDWARE AND PERIPHERALS

The system control hardware and peripherals include:

- Processor
- CRT
- Keyboard/Pointing Device
- Computer I/O

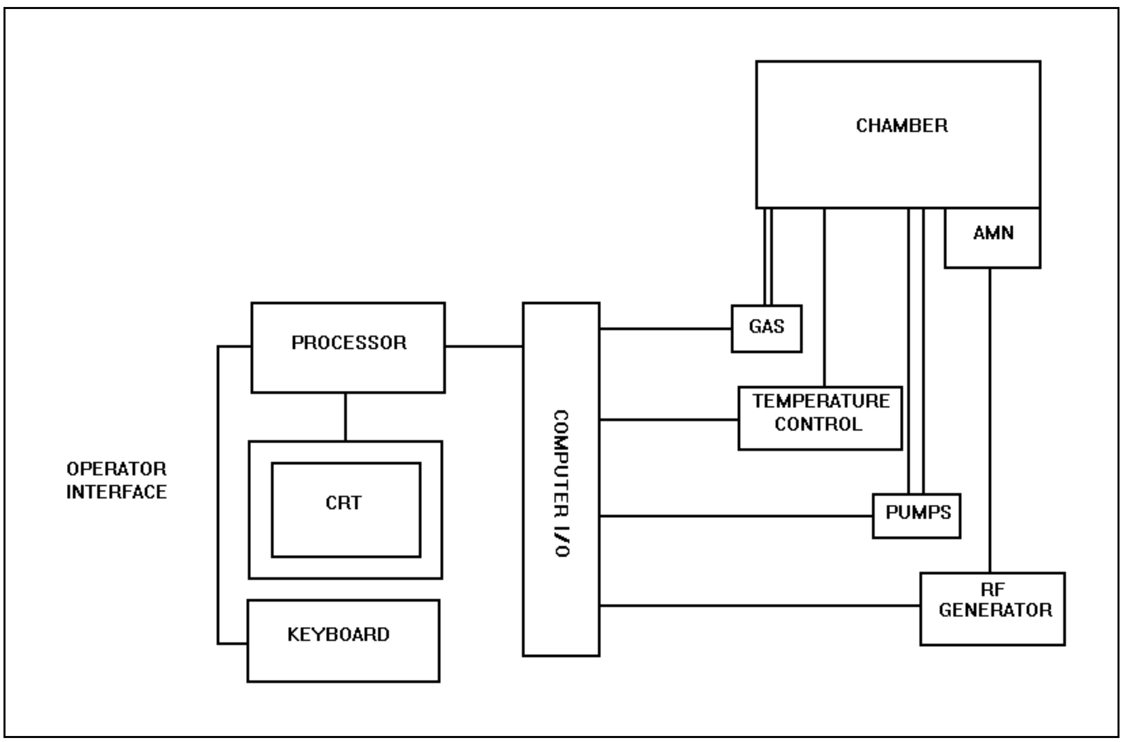


Figure 3-1. System Control

3.1.1.1 PROCESSOR

- Maintains the system configuration.

- Controls the front panel video monitor.
- Controls floppy and hard disk drives.
- Enables operator interface through the keyboard and pointing device.
- Controls all analog setpoints for temperature, gas, RF and pressure.
- Interfaces to the system printer.
- Performs all process timing and endpoint calculations.
- Performs self test, error reporting and compliance control.
- Controls the throttle and pump gate valve position.
- Detects atmosphere and base pressures.
- Controls the vent and N_2 bleed.

3.1.1.2 CRT

The CRT screen provides the operator with system information. Information (*Info*), *Warnings*, and *Alarms* are displayed in the *Master Control Panel* (Figure 3-4) in the lower portion of the CRT. The Windows menu will walk the operator through various functions.

3.1.1.3 KEYBOARD/POINTING DEVICE

The keyboard and pointing device are used for operator inputs to the system. A trackball is used as a pointing device to make menu selections.

3.1.1.4 COMPUTER I/O

The computer I/O is directly connected to the processor bus to enable fast communication with the analog and digital interface boards.

3.1.2 SYSTEM POWER ON

When the system is turned on, power is applied to the computer and the boot-up sequence begins. When the Power On Self Test (POST) is completed, the operating system is loaded into memory. Windows and System Monitor are then started and the system goes through a *Power On* initialization. When this is completed, the operator is presented with the login dialog box:

Figure 3-2. Login Dialog Box

The *Operator* and *Password* default is "3333". This can be changed in the *Service/Configuration* menu of the System Monitor. The logged-in operator has access to all configuration functions enabled at the operator's privilege level.

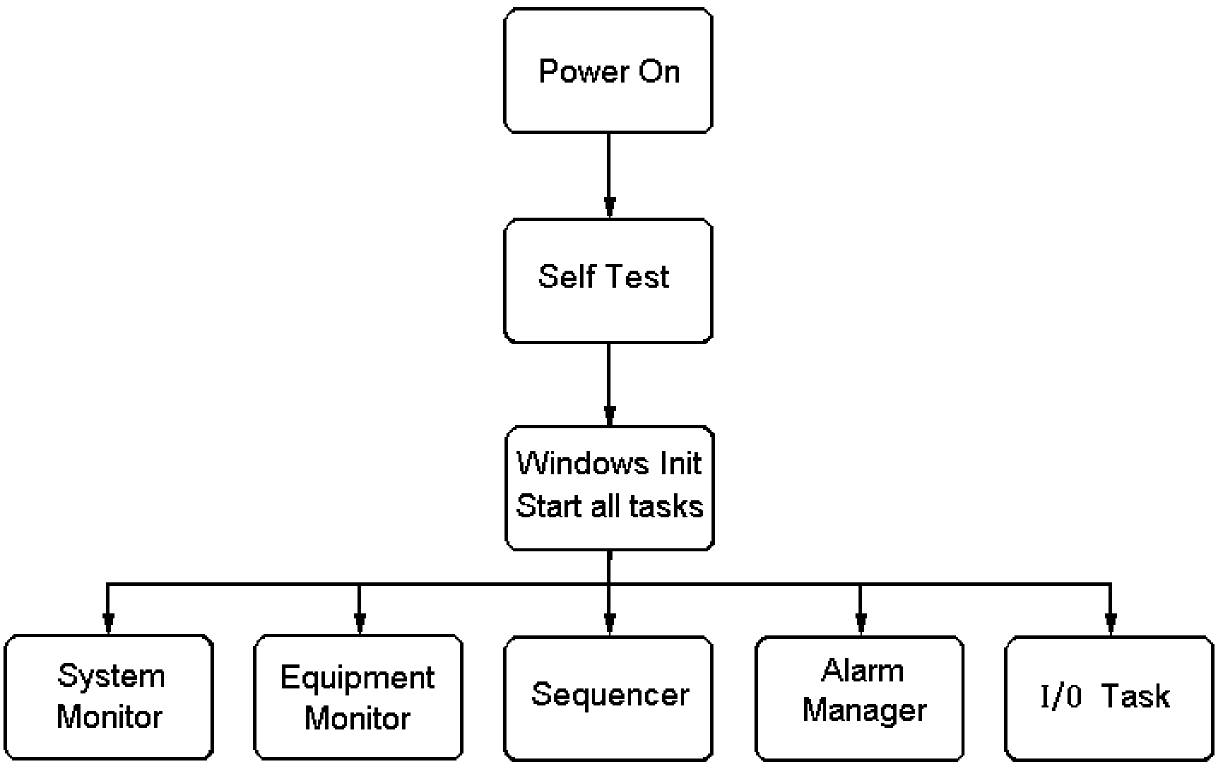


Figure 3-3. Software Task Initialization Flow

3.1.3 SYSTEM MODES

An active system is always in one of four modes: EQUIPMENT-ON, STANDBY, READY or RUN. The mode is indicated in the *Info* field and in the *System Status/Process* areas of the *Master Control Panel* screen:

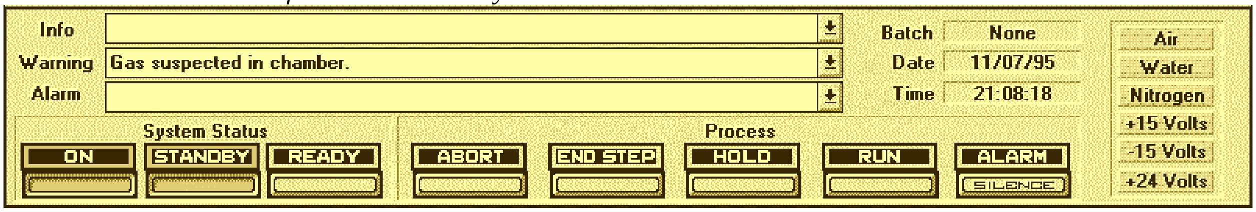


Figure 3-4. Master Control Panel Screen

Control is such that only buttons and menus applicable to the current mode are enabled. A lit button indicates that the system is in the process of achieving the mode requested. A lit button and legend indicates that the system has attained the mode requested.

To the far right of the *Master Control Panel* screen is a group of system function indicators: *Air, Water, Nitrogen, +15 Volts, -15 Volts* and *+24 Volts*. These indicators will have a green background if the corresponding parameter is available and functioning normally and a yellow background if a condition is beyond the normal range.

3.1.3.1 EQUIPMENT-ON

The EQUIPMENT-ON mode is entered immediately after Power On, self-test and configuration reporting. In an EQUIPMENT-ON condition:

- pumps are running.
- all vacuum gate valves are closed to isolate the chamber(s) from the pumps.
- pump nitrogen bleeds are on.
- temperature setpoints are assigned at 25ºC. If temperature setpoints are not in compliance, the indicator will have a yellow background.

The EQUIPMENT-ON mode can only be attained when all necessary system equipment is turned on and there are no system failures. The ON button cannot be used to turn on equipment! The EQUIPMENT-ON mode is indicated in the title block with a message such as “EQUIPMENT ON: IDLE” and the ON button and legend in the *System Status* section of the screen will be lit (see Figure 3-4).

All system functions become accessible after the EQUIPMENT-ON mode is attained. The ON button and legend must be lit before the system can proceed to STANDBY or READY modes. When the ON button and legend are lit, the operator can immediately go into the *Service/Configuration* menu (upon entering a valid security code), the *Process* menu, or load a program from disk. Certain options in the *Utilities* menu will also be accessible.

The ON button is also used to exit STANDBY or READY modes and return to the EQUIPMENT-ON mode.

3.1.3.2 STANDBY

The STANDBY mode serves two purposes. It can be used to: (1) leave the system in a temperature-controlled vacuum state, or (2) perform STANDBY *Service* menu functions. These functions enable the operator to change the status of the system.

The system must be in the EQUIPMENT-ON mode before STANDBY can be activated. To activate the STANDBY mode, click the STANDBY button.

In a STANDBY mode:

- all process pumps are running.
- the heat exchanger or high temperature unit is at the standby temperature that was programmed under *Configuration* in the *Service* menu. This value can be temporarily changed by selecting *Change Standby Temperature* in the *Utilities* menu.

During normal operation, the operator may want to leave the READY mode (see below) to enter a *Service* menu function. By activating STANDBY, the condition of the system will be held at or near the operating parameters of the running process.

To exit a STANDBY mode, click the ON button.

3.1.3.3 READY

The READY button is used to prepare the system for wafer processing or to perform READY *Service* menu functions which change the status of the system. The READY mode indicates that the system is process-ready:

- the system is at the prescribed process temperature.
- all process pumps are running.
- mass flow channels are enabled if they are used in the loaded process program.

For the READY mode to be activated, the system must be in STANDBY mode and have a valid program loaded. To enter the READY mode, click the READY button. To exit the READY mode, click the ON or STANDBY buttons.

If a valid program is loaded, it will be named in the *Batch/Process* field of the *Master Control Panel* screen (Figure 3-4). A program must be resident for two reasons: (1) the program defines process temperatures in the system, and (2) the gases and pumps specified by the program become conditions for the EQUIPMENT-ON mode (which must precede the READY mode).

The *Service* menu is not accessible in the READY mode.

3.1.3.4 STANDBY/READY MENUS

During idle STANDBY and READY modes (as indicated in the *Info* field of the *Master Control Panel*), selecting *Utilities* in the *System Monitor* main menu will display available functions. The operator may use these functions to change the present idle state of the system. The System Monitor will evaluate these states and report any errors to the operator. The processor will return to the normal status and report the success or failure of the function upon completion.

3.1.3.5 RUN

The RUN mode is used to begin the process. The system cannot RUN unless it first achieves a READY mode and passes three self-tests:

1. The Sequence Controller must respond and start or continue pumping.
2. There must be no Sequence Controller errors.
3. There must be no equipment errors.

To activate the RUN mode, click the RUN button.

During the RUN mode, only the *Process* buttons (i.e., ABORT, END STEP, HOLD) and ALARM button are recognized. The system will continue processing unless the operator clicks ABORT, END STEP or HOLD or there is a system failure or compliance error.

3.1.4 PROCESS FUNCTIONS

The process functions (ABORT, END STEP and HOLD) are accessed by clicking the corresponding *Process* buttons on the lower portion of the *Master Control Panel* screen (see Figure 3-4). When activated, these functions will be indicated in the *Info* field of the *Master Control Panel*.

3.1.4.1 HOLD

If there is a system failure or compliance error during processing, the system will go into a system-activated HOLD mode and both the HOLD and ALARM buttons will be lit. The operator should request that the system try again by clicking the lit HOLD button. The system will attempt to continue from the point at which the error occurred.

A system-activated HOLD mode also results when the system reaches a specified point in the process. The system will HOLD that condition until further commands are given.

3.1.4.2 END STEP

END STEP is used to exit a system-activated HOLD mode when no errors or alarms are detected. The END STEP button enables the operator to terminate the current step and proceed to the next step.

3.1.4.3 ABORT

The ABORT button should be used with caution as it will cause all processing to terminate. If ABORT is used to exit RUN, the system will return to a READY mode. The system will return to an EQUIPMENT-ON mode if ABORT was activated under error conditions. The ABORT button will trigger a warning message which gives the operator a chance to cancel ABORT and return to processing:

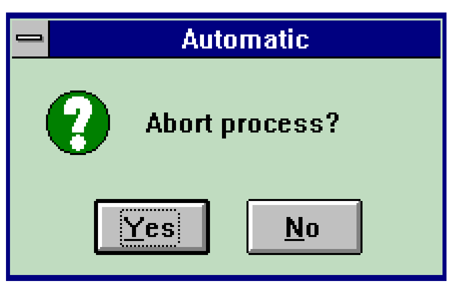


Figure 3-5. ABORT Warning Window

Press <ENTER> or click *Yes* to start the ABORT function. Click *No* to continue the RUN mode uninterrupted.

3.2 Utilities

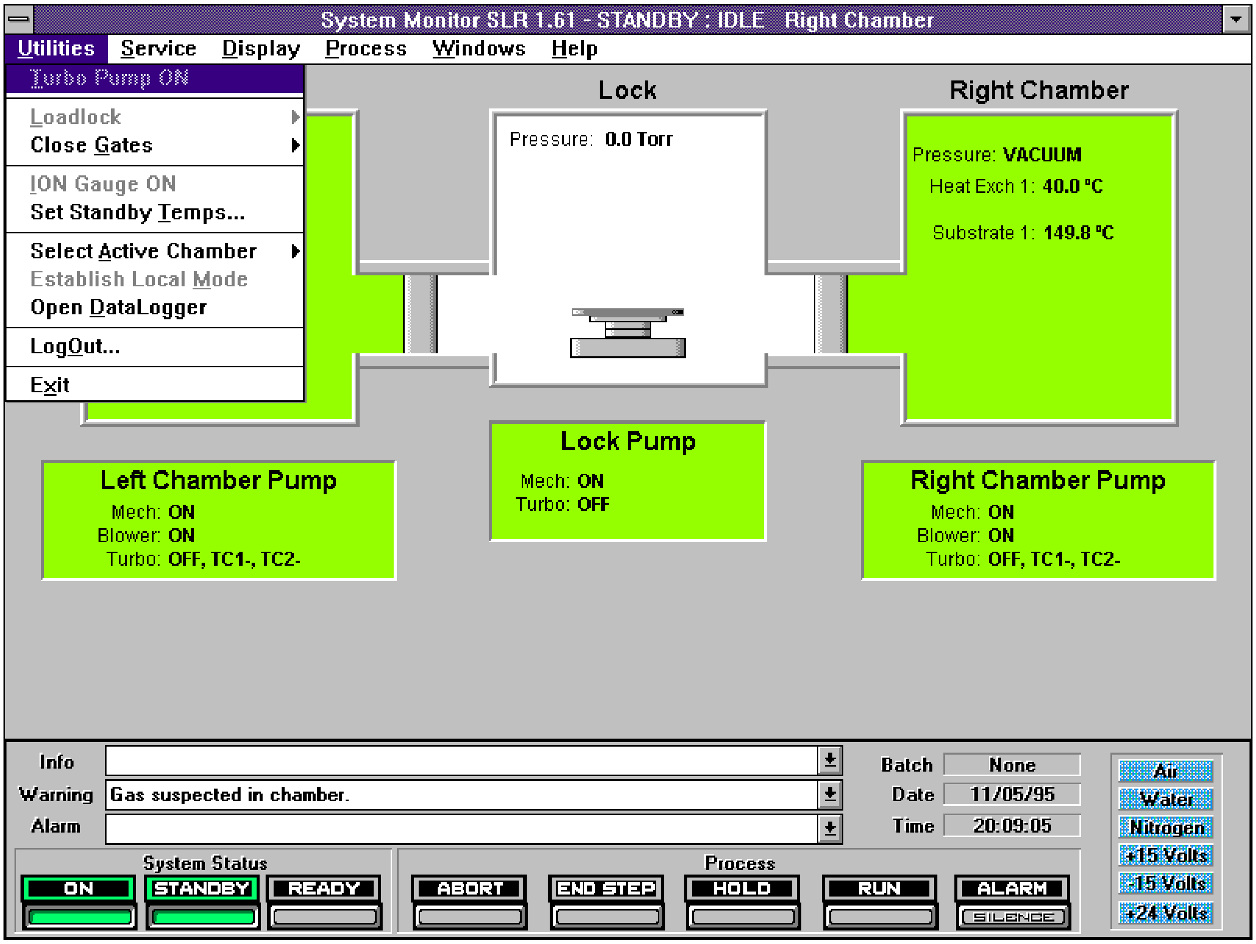


FIGURE 3-6. UTILITIES MENU

3.2.1 *Turbo pump on/turbo pump off*

The operator can select to power up or power down the high vacuum pumps. The success or failure of these actions will be reported in the *Info* field of the *Master Control Panel*.

- *Turbo Pump On* - This powers on the turbomolecular pump.
- *Turbo Pump Off* - This powers down the turbomolecular pump.

This *Utilities* menu option can only be accessed when the system is in an EQUIPMENT-ON mode:

3.2.2 LOADLOCK

The loadlock menu will display a submenu with choices of *Pump* and *Vent*. The system must be in an EQUIPMENT-ON or STANDBY mode to access *Loadlock*.

- *Pump* - This selection opens the lock gate valve and starts pumping the loadlock to base pressure. Pumping continues until the loadlock is below base pressure.
- *Vent* - This selection closes the lock gate valve and starts venting the loadlock. Venting is completed when the atmosphere switch is activated (when the loadlock is at atmospheric pressure).

3.2.3 Close Gates

This selection closes all system valves except the N_2 bleed to the pump(s). The system must be in STANDBY or READY mode to access *Close Gates*.

3.2.4 Ion Gauge ON/off

This selection turns on/off the ion gauge depending upon its current status. This selection can be accessed while the system is in a STANDBY mode and the turbo pump is pumping.

3.2.5 Set Standby Temperatures

This selection enables the operator to temporarily change the standby temperature setpoints. This can only be accessed in a STANDBY mode.

3.2.6 Select Active Chamber

This allows the operator to select which chamber is active on multi-chamber systems. The system must be in an EQUIPMENT-ON or STANDBY mode to access this selection.

3.2.7 Establish Remote/Local Mode

This utility is not currently available.

3.2.8 OPEN DATALOGGER

This selection opens the DataLogger or makes it visible if it is already active. It can be accessed while the system is in an EQUIPMENT-ON, STANDBY or READY mode.

The DataLogger stores periodic 'snapshots' of the state of the system as ASCII files. These log files can then be analyzed for trends or anomaly isolation. The log files are created in a standard, comma-separated variable format which most Windows or DOS-based software packages are capable of reading.

Before using the DataLogger, the operator must set-up a log configuration. Three questions must be answered:

(1) Which items are to be logged?

(2) How often are they to be logged?

(3) Where are they to be logged?

The operator defines these parameters in the DataLogger *Configuration* menu. They will always be displayed in the DataLogger main screen:

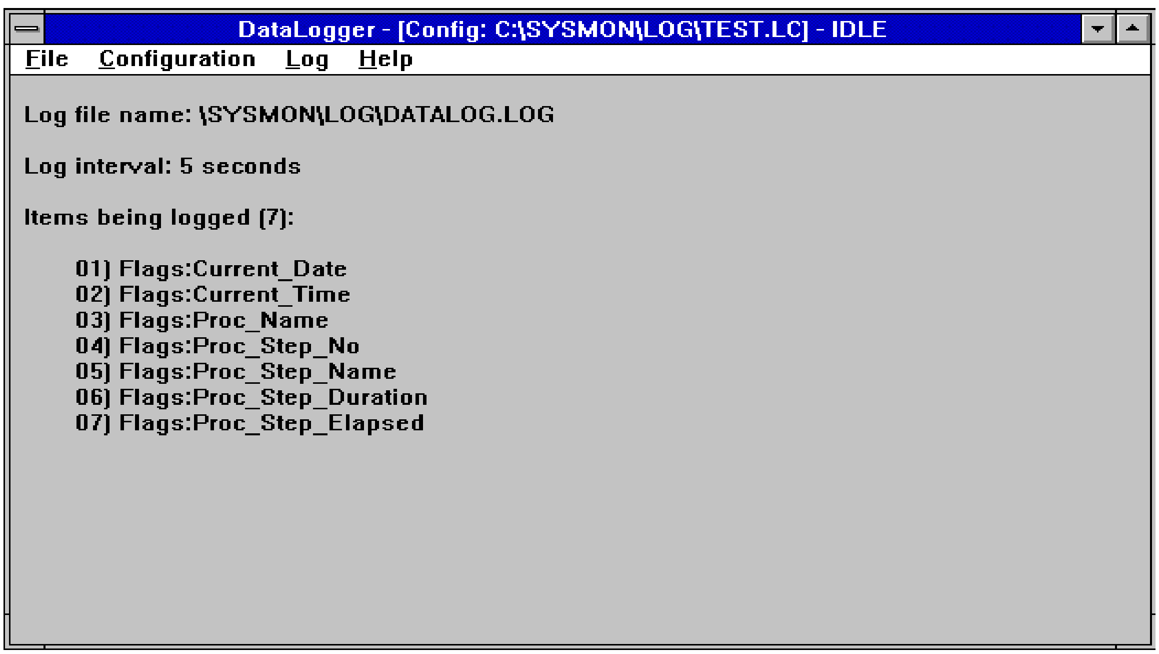


FIGURE 3-7. DATALOGGER MAIN SCREEN

When the operator chooses *Open DataLogger* in the *Utilities* menu, DataLogger will reload the last configuration file that the operator was editing (if applicable). In Figure 3-7, DataLogger automatically loaded the TEST.LC log configuration file as can be seen in the title bar. An unlimited number of different configurations can be created and saved using the *New, Open, Save* and *Save As* commands under the *File* menu.

The title bar of the DataLogger window always displays a filename and the current DataLogger mode.

FIGURE 3-8. DATALOGGER TITLE BAR

There are three possible DataLogger modes: IDLE, WAITING and LOGGING.

- IDLE: Not presently logging to file.
- WAITING: Logging and currently waiting to write the next “snapshot” to file.
- LOGGING: Logging and currently writing to a file.

In an IDLE mode, the title bar shows the name of the loaded log configuration file. In WAITING or LOGGING modes, the title bar shows the name of the log file that is being written to.

3.2.8.1   DataLogger CONFIGURATION

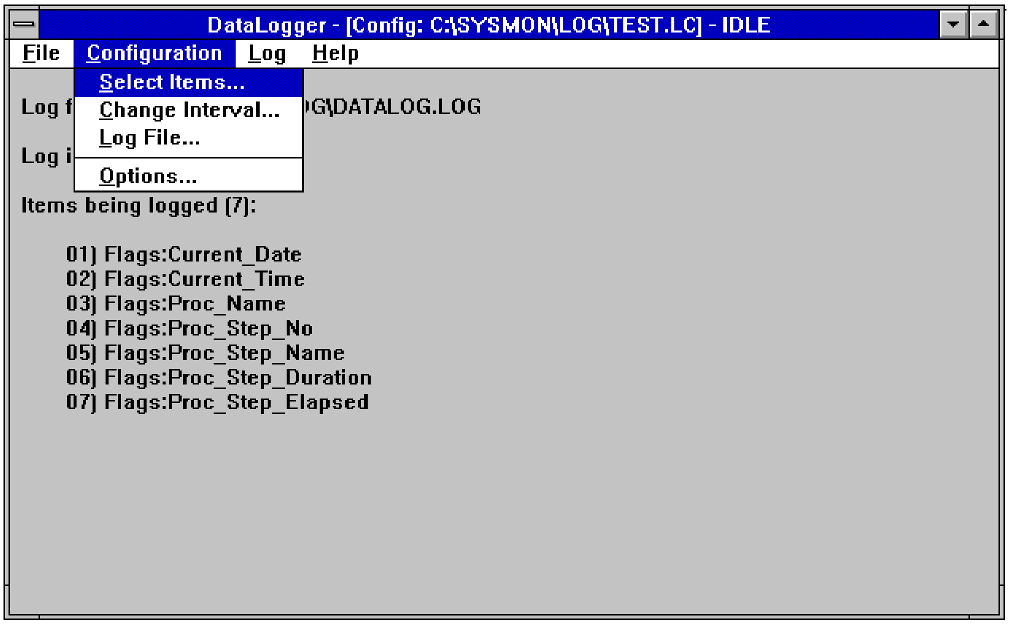


FIGURE 3-9. DATALOGGER CONFIGURATION MENU

- <u>SELECT ITEMS</u>

Clicking on *Select Items* in the DataLogger *Configuration* menu will display the following:

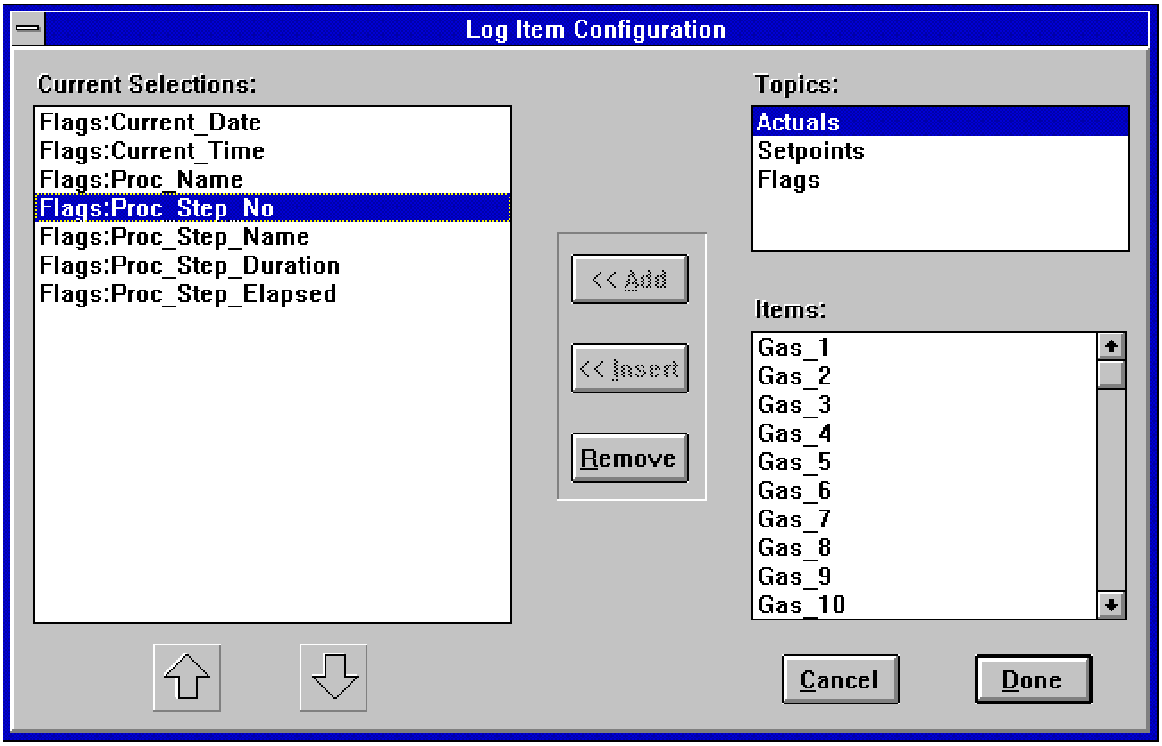


FIGURE 3-10. DATALOGGER CONFIGURATION/SELECT ITEMS SCREEN

Current Selections displays the items that are currently selected to be logged. They are shown in the same order in which they will be written to the log file. To change the order of the files, click on a selection and then click the up or down arrow below the *Current Selections* list. The *Add*, *Insert* and *Remove* buttons are also used to modify the *Current Selections* list.

The *Topics* and *Items* list boxes display all available data items. *Topics* displays categories and *Items* displays data items available for the highlighted *Topic*. *Topics* include:

- <u>*Actuals*</u> - items that are actual measurements such as current temperature and pressure,
- <u>*Setpoints*</u> - the configured setpoints that the system will attempt to achieve, and
- <u>*Flags*</u> - contains all information not included in *Actuals* or *Setpoints*.

- CHANGE INTERVAL

The DataLogger records the system status at an interval ranging from one second to 600 seconds. The default is five (5) seconds and can be changed by selecting *Configuration/Change Interval*. The interval can be changed during a log session, however, the new interval will only become active after the next "snapshot".

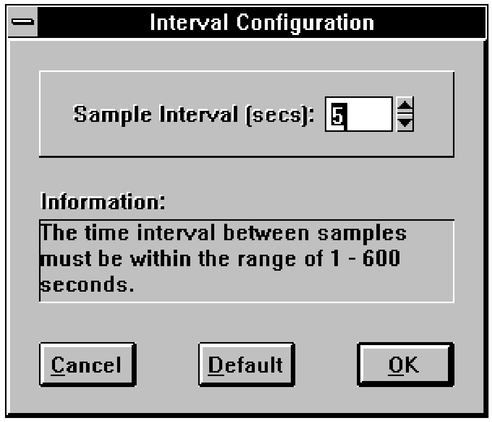


FIGURE 3-11. DATALOGGER CONFIGURATION/CHANGE INTERVAL SCREEN

- LOG FILE

Log File in the DataLogger *Configuration* menu enables the operator to specify the type, name and destination directory of the log file:

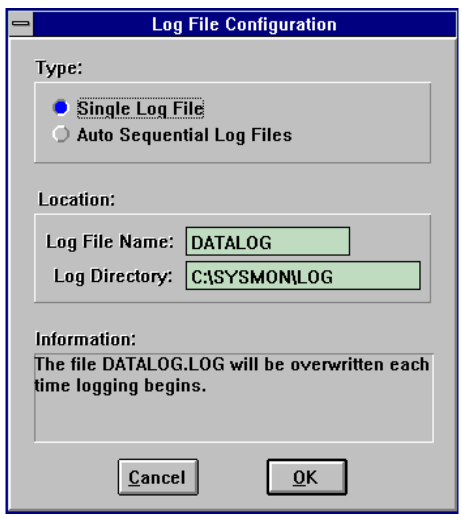


FIGURE 3-12. DATALOGGER CONFIGURATION/LOG FILE SCREEN

There are two types of log files:

- *Single Log File* tells DataLogger to overwrite the same log file each time logging begins. This method is useful if only the most recent machine operation is of interest.
- *Auto Sequential Log Files* tells DataLogger to generate a new log file each time logging begins. *Auto Sequential* log files are named FILENAME.001, FILENAME.002, etc.

- OPTIONS

Options specified in the DataLogger *Configuration* menu are global in nature and will apply to all data logging sessions until they are changed by the operator. Other DataLogger *Configuration* menu items apply only to the specific data log file to which they were assigned. Clicking *Options* in the Data Logger *Configuration* menu will display the following:

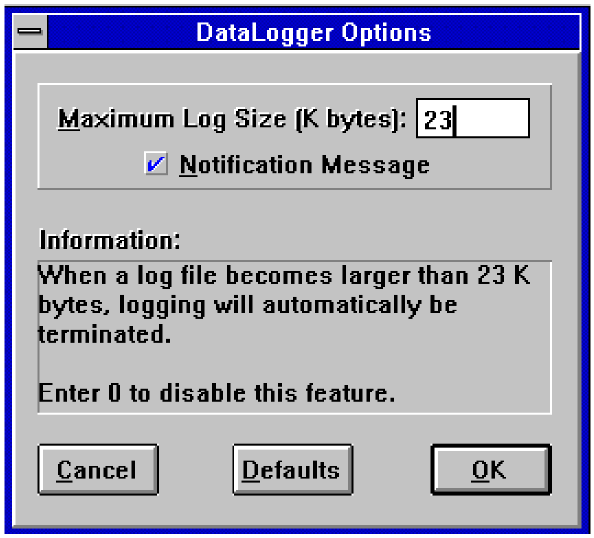


FIGURE 3-13. DATALOGGER CONFIGURATION/OPTIONS SCREEN

Maximum Log Size enables the operator to select a maximum size for the destination log file. As each "snapshot" is taken, the log file grows and could potentially become enormous. *Maximum Log Size* prevents consumption of all available computer disk space by automatically terminating a log session when the log file is larger than a specified size. If the *Notification Message* box is checked, then a message box will appear to tell the operator when maximum log size has been attained.

3.2.8.2 LOG

- START/STOP (MANUAL LOGGING)

When the DataLogger is active, the operator may select *Log/Start* or *Log/Stop* to manually start or stop file logging. These manual logging commands are available even if a logging session was started automatically (see below).

3.2.8.3 AUTOMATIC LOGGING

The System Monitor is able to automatically start and stop the DataLogger during process steps. To enable this, the logging configuration must be entered into the *Initial Data* step of the Process Editor BUILD mode (see Section 3.5.2.2.). To BUILD a process with automatic logging capability, choose *Process/Chamber/New* from the *System Monitor* menu. The following screen will appear:

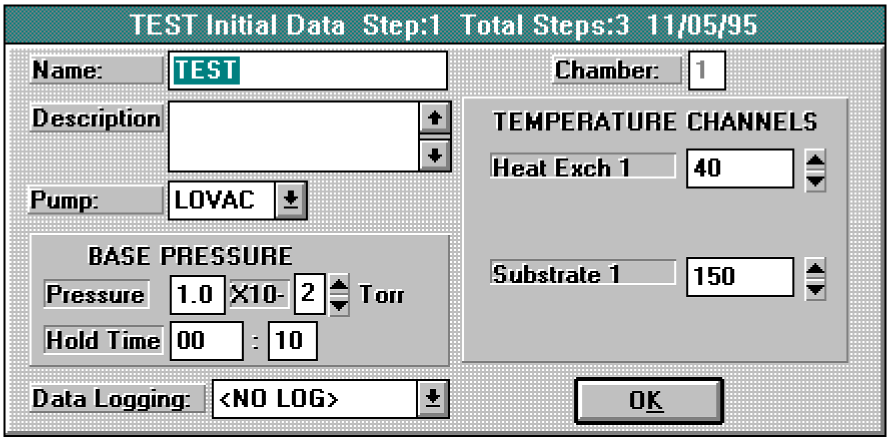


FIGURE 3-14. PROCESS EDITOR INITIAL DATA STEP SCREEN

The *Data Logging* field at the lower left corner of the screen is automatically loaded with all saved log configurations. To enable automatic logging, simply click on the one to use. If <NO LOG> is selected, the DataLogger will not be used during the process unless it is manually invoked.

3.2.9 LOG IN/OUT

Utilities/Log In(Out) controls system access. A logged-in operator has access to all functions as assigned in the *Configuration/Security* menu. *Log Out* is an instantaneous process and, once selected, the login screen will immediately appear to enable the operator to log back into the operating system. This is useful if the operator momentarily steps away and wants to ensure system security.

FIGURE 3-15. UTILITIES LOGIN SCREEN

The *Operator* and *Password* default is “3333” and can be changed in *Configuration/Security*.

3.2.10 EXIT

Choosing *Utilities/Exit* while the system is in any mode other than EQUIPMENT-ON will display a window instructing the operator to enter an *EQUIPMENT-ON: Idle* mode. To enter an *EQUIPMENT-ON: Idle* mode, click the ON button in the *System Status* section of the *Master Control Panel* and then select *Utilities/Exit* to close the System Monitor.

3.3 Service

3.3.1 Maintenance

The system must be in a STANDBY mode to access *Maintenance* utilities:

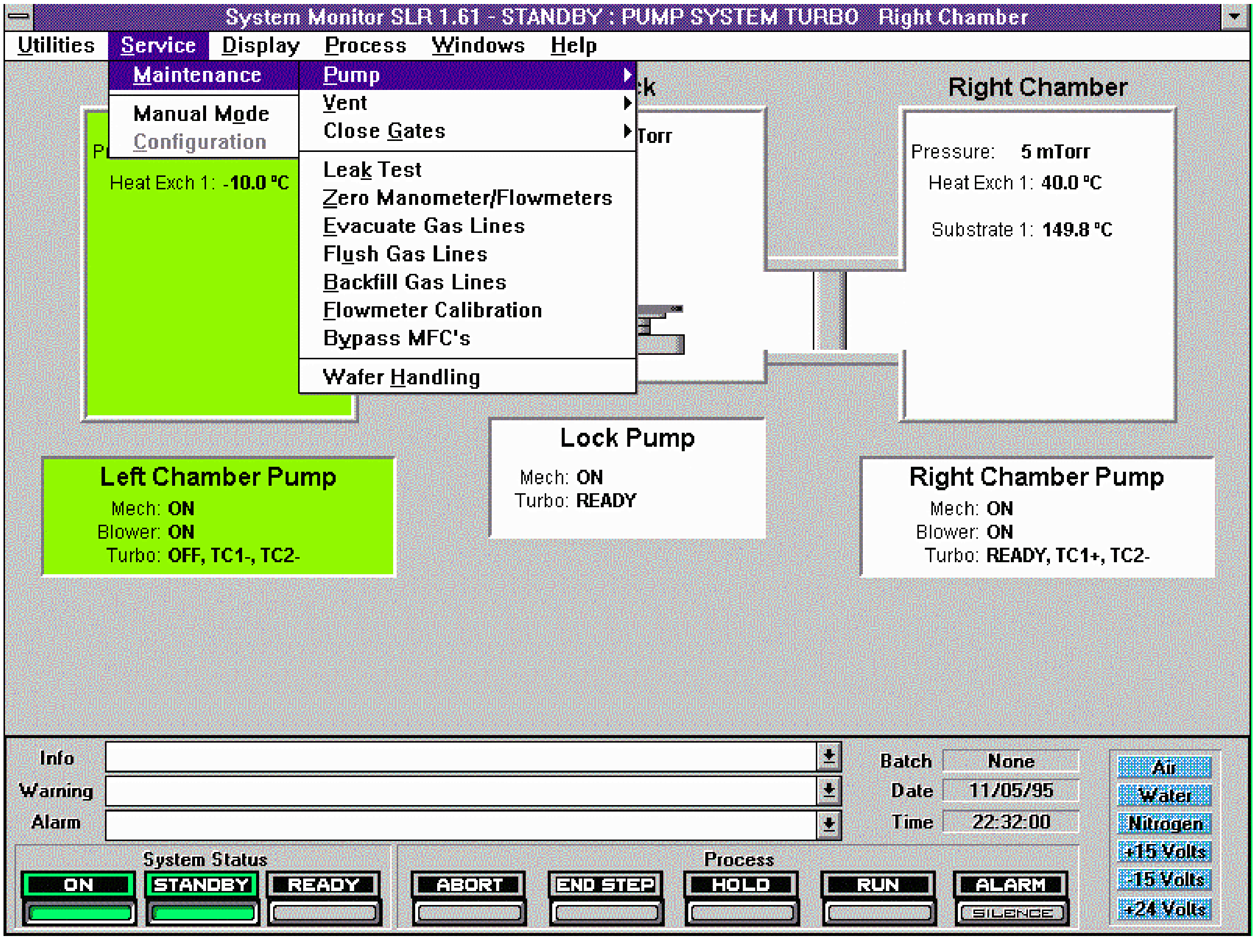


FIGURE 3-16. SERVICE MENU AND MAINTENANCE SUBMENU

3.3.1.1 Pump

Selecting *Service/Maintenance/Pump* will enable the following options (depending upon the configuration of your system):

- *System* - displays a submenu to enable selection of the desired pump for both chamber pump down and loadlock.
- *Low Vac* - starts (or switches to) pumping the chamber and loadlock with the mechanical pump and blower (if applicable).
- *Turbo* - starts (or switches to) pumping the chamber and loadlock with the turbo pump.
- *Chamber* - starts (or switches to) pumping only the chamber.

- *Low Vac* - starts (or switches to) pumping the chamber with the mechanical pump and blower (if applicable).
- *Turbo* - starts (or switches to) pumping the chamber with the turbo pump.
- *Loadlock* - starts pumping the loadlock to base pressure. The loadlock pump down is complete when the lock is below base pressure.

3.3.1.2 Vent

Selecting *Service/Maintenance/Vent* will enable the following options:

- *System* - closes all system gates and vents the chamber and loadlock to atmosphere.
- *Loadlock* - closes the loadlock gate and vents the lock to atmosphere.

3.3.1.3 Close Gates

Selecting *Service/Maintenance/Close Gates* will enable the following options:

- *System* - closes all gates in the entire system, including the loadlock.
- *Chamber* - closes all the gates in the chamber.

3.3.1.4. Leak Test

Selecting *Service/Maintenance/LeakTest* will display the following screen:

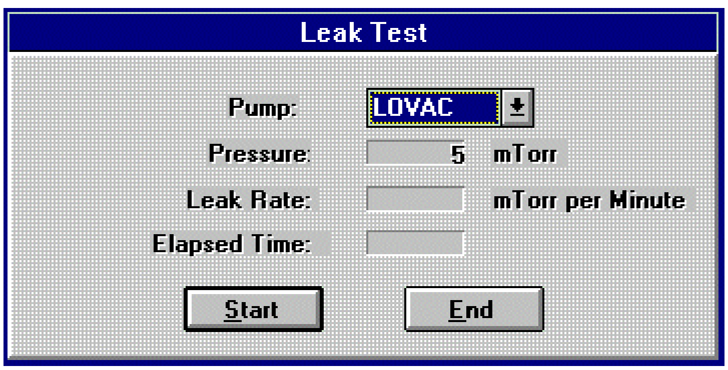


FIGURE 3-17. LEAK TEST SCREEN

A Leak Test will show leak up rates in the chamber(s). The system must be pumping to run a Leak Test. Upon activating *Leak Test*, select *Start* to close the gate valves to leak up the active chamber. The leak rate will be updated every 60 seconds. To stop the Leak Test, select *End* and the system will return to normal operation.

3.3.1.5 Zero Manometer/Flowmeters

Selecting *Service/Maintenance/Zero Manometer/Flowmeter* will display the following screen:

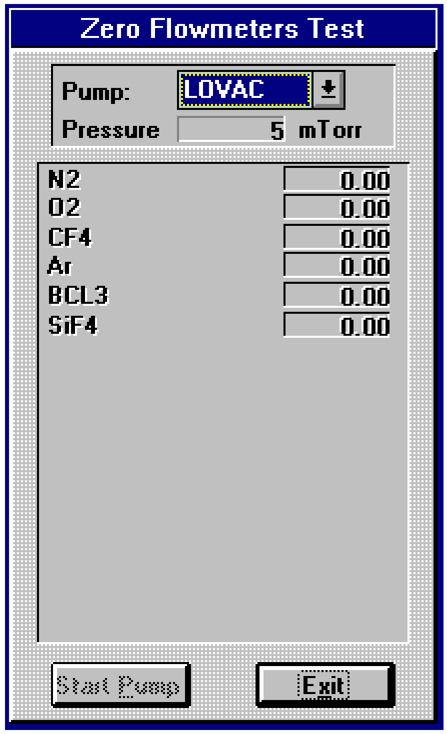


FIGURE 3-18. ZERO MANOMETER/FLOWMETER SCREEN

While gates are closed, click Start Pump to set the zero reference point on the manometers and gas flowmeters.

This calibration should be performed following a satisfactory Leak Test so that the manometer zero reference is accurate. The gas is isolated from the chambers and zero flow setpoints are applied. The gate and throttle valves are open to attain zero pressure.

3.3.1.6 Evacuate Gas Lines

This task removes gas in the mass flow lines back to the source. Selecting *Service/Maintenance/Evacuate Gas Lines* will display the following screen:

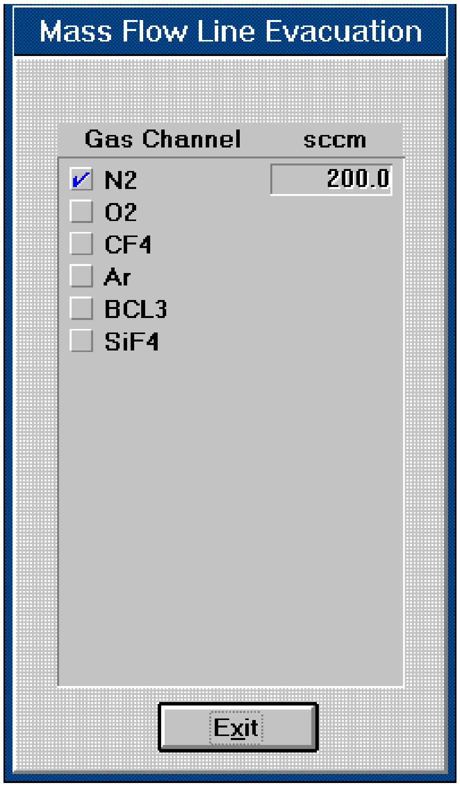


FIGURE 3-19. EVACUATE GAS LINES SCREEN

WARNING! **TO PREVENT INJURY TO PERSONNEL, ENSURE GAS LINE IS TURNED OFF AT THE SOURCE BEFORE EVACUATING.**

Click on the box beside the gas line to be evacuated. Enabled channels are indicated with a check mark. Multiple gas lines may be concurrently opened to speed the evacuation process but forbidden pairs may NOT be selected together. To close a channel, click on the check mark beside that gas name. To exit this function, click on *Exit*.

3.3.1.7 FLUSH GAS LINES

Select *Service/Maintenance/Flush Gas Lines* to (1) remove gas in the mass flow lines back to the source and (2) flush the lines with N_2. The number of *Flush Cycles* is specified in the corresponding field using a drop-down list.

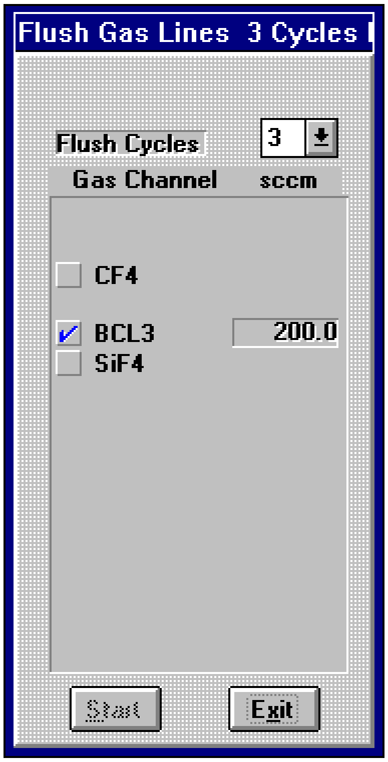


FIGURE 3-20. FLUSH GAS LINES SCREEN

Click on the box next to the gas line(s) to be evacuated and flushed. A check mark will indicate open channels. To close a channel, click on the check mark next to the gas name. Multiple gas lines may be concurrently opened to speed the process but forbidden pairs may NOT be selected together.

3.3.1.8. BACKFILL GAS LINES

Select *Service/Maintenance/Backfill Gas Lines* to (1) evacuate gas in the mass flow lines back to the source, and (2) backfill the lines with process gas.

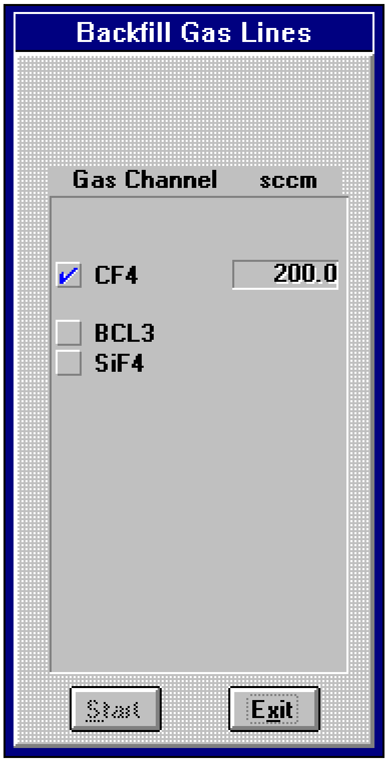


FIGURE 3-21. BACKFILL GAS LINES SCREEN

Select a gas channel to be evacuated and backfilled by clicking on the box beside that channel. A check mark indicates open channels. To close a channel, click on the check mark next to the gas name. Multiple gas lines may be concurrently opened to speed the process but forbidden pairs may NOT be selected together.

3.3.1.9 Flowmeter cALIBRATION

Selecting *Service/Maintenance/Flowmeter Calibration* will display the following screen:

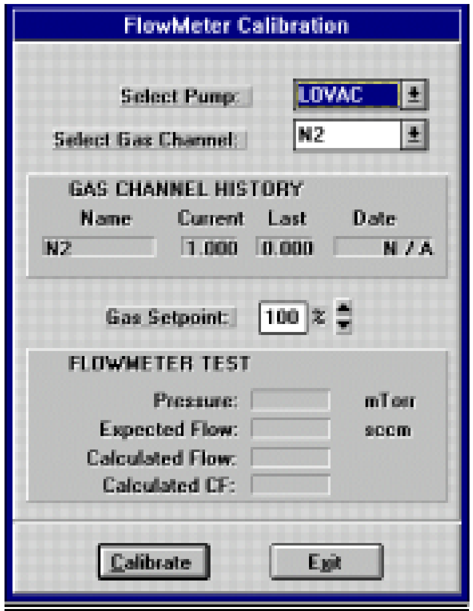


FIGURE 3-22. FLOWMETER CALIBRATION SCREEN

> **NOTE:** *Flowmeter Calibration* uses pressure change to determine gas flow. Therefore, it is imperative that a Leak Test be performed prior to the Flowmeter Test and that the leak rate is satisfactory (low). Ensure that the flowmeter offsets are calibrated to zero. Use the *Zero Manometer/Flowmeter* menu option to adjust the flowmeter offset to a reading greater than zero and then gently adjust it back to zero.

Flowmeter Calibration is used to check the actual flow of gas through a flowmeter. This helps ensure that the gas proportions are equal to those requested in the process recipe. The key parameter in *Flowmeter Calibration* is a volume constant that was programmed into the system configuration file at the factory. Whenever the internal structure of the process chamber is altered, this volume constant must be recalculated. When this constant is known, external calibration is not required for mass flow testing.

Flowmeter Calibration will indicate the need for flowmeter maintenance or replacement. The operator chooses a pump (if applicable) and a gas channel to calibrate, clicks on *Calibrate* and the Flowmeter Test is performed automatically

Flow is calculated using the pressure change in the chamber with the gate valves closed (not the feedback from the flowmeter). This flow is used to calculate the conversion factor. The calculated conversion factor will be displayed in the idle mode of this function. The last calculated and current conversion factors for the same flowmeter are also shown.

The calculated conversion factor is not automatically entered into the system configuration file. The operator must decide to transfer this value to configuration or to perform maintenance on the gas channel. The system configuration file is used in converting the analog signal from the flowmeter for analysis and display.

3.3.1.10 ByPass MFC's

Bypass MFC's is a gas line option which enables the system to evacuate the gas line on both sides of the Mass Flow Controller. When both sides of the mass flow meter have been evacuated of process gas, the mass flow meter can be removed by service personnel without threat of exposure to the process gas.

NOTE: The gas bottle must be isolated (closed off) from the gas line prior to performing this routine.

3.3.1.11 Wafer Handling

The system has a wafer sensor in the loadlock but not in the process chamber(s). When wafer transfers occur, the presence of a wafer in the chamber is stored in memory. Therefore, the system needs to know when the operator removes a wafer from or places it into the process chamber without using the wafer transfer arm. The *Maintenance/Wafer Handling* option enables the operator to modify wafer position information:

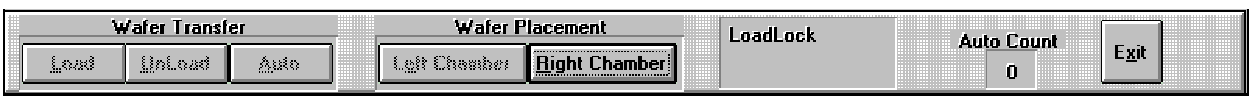


FIGURE 3-23. WAFER HANDLING SCREEN

The operator can also move wafers in and out of the process chamber using the *Load*, *Unload* and *Auto* buttons on the *Wafer Handling* screen:

- *Load* - clicking the *Load* button initiates the wafer transfer from the loadlock into the process chamber.
- *Unload* - clicking the *Unload* button initiates the wafer transfer from the process chamber to the loadlock.
- *Auto* - clicking the *Auto* button initiates the wafer transfer from the loadlock to the process chamber and then from the process chamber to the loadlock. This cycle continues until the ABORT button in the *Master Control Panel* screen is pressed (see Section 3.1.4.3).

If the chamber and the loadlock are at atmosphere, the wafer transfer will take place at atmosphere. If the chamber and loadlock are pumping (i.e., system pump down) then the wafer transfer will take place under vacuum. If the chamber and the loadlock are not in the same condition, the transfer cannot take place.

3.3.2 Manual Mode

This function gives the operator full manual adjustment capability for designing a process or for maintenance and calibration purposes. MANUAL mode may be entered when the system is pumping.

NOTE: The MANUAL mode is constantly monitored for equipment failures. If any are detected, manually-enabled parameters are disabled. Numerical entries are bound by their maximum ranges. Compliance or operational windows are ignored in MANUAL mode so care should be taken when enabling gas and RF at extremely high values.

Selecting *Service/Manual Mode* will display the following screen:

FIGURE 3-24. MANUAL MODE SCREEN

There are two stages to MANUAL mode: (1) setup, and (2) parameter adjustment (ENABLE), which are discussed in Sections 3.3.2.1 and 3.3.2.2.

3.3.2.1 MANUAL Mode Setup

Refer to Figure 3-24.

- *Temperature* -In MANUAL mode, the default temperature setpoints are defined by the *StandBy Setpoint* field in the *Service/Configuration/Temperature* menu. Enter new temperature values if desired. The new setpoint will be output to the temperature controller.
- *Pressure* - Enter the desired pressure setpoint.
- *Helium* - Helium backside cooling is available for ICP systems with *Helium Cooling* selected in the Pressure Parameters dialog box (*Configuration/Process Module/Pressure*). Enter the desired flow setpoint in sccm and the pressure will be indicated dynamically as a read-only value. A yellow Helium annunciator will indicate that Helium cooling is active after the corresponding ON button is pressed.
- *Gas* - Enter the gas setpoints for the channels that are used. Set all unused channels to zero.
- *RF Control* - (1) *Config* (configuration) - Select the desired RF. Select the desired *RF Config Lower* or *Upper* Electrode (if applicable). (2) *Time* - This field can only be set before RF is turned on. After RF is turned on, this field has no effect on RF time out. (3) *Set* - Adjust setpoint as appropriate. (3) Select the desired *RF Mode* (*PWR or DCV).*

3.3.2.2 Manual Mode Enable

Refer to Figure 3-24.

To ENABLE the setpoints (except for temperature), select the ON button beneath the control (*Gas*, *Purge*, *Pressure* or *RF*). The system will prevent the controls from being enabled out of logical sequence. The ALL OFF button turns off all controls. To disable a control, select the OFF button below it.

CAUTION: The use of the purge gas channel for reactive gases is **not** recommended.

NOTE: Click the EXIT or ABORT buttons to disable all controls and exit MANUAL mode.

3.3.3 Configuration

Select *Service/Configuration* to specify configuration parameters. The following login screen will appear:

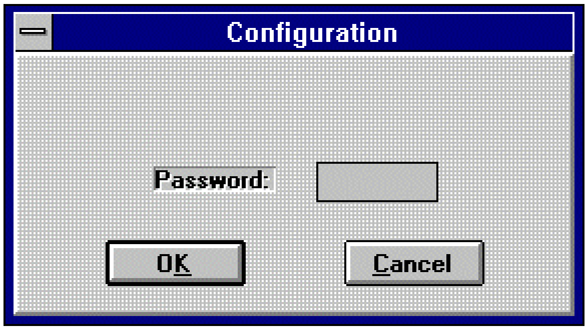


FIGURE 3-25. CONFIGURATION LOGIN SCREEN

Enter the same password that was entered when logging into the system. The following menu will appear:

FIGURE 3-26. CONFIGURATION SCREEN TITLE BAR

Configuration is used to define system equipment and operation parameters. These parameters are then stored on the hard disk and communicated to the system computer.

Reconfiguration is usually unnecessary upon installation as each system is configured at the factory. The ability to reconfigure the system is provided in case equipment or operational changes are made. Each process program is encoded with the system configuration from the hard disk. Therefore, a process generated on one system cannot run on another system unless the systems have identical configurations. Process edit functions can be used to make a process usable after the configuration has changed. The operator must ensure that changed system parameters (e.g., mass flowmeter) are updated in the process programs. Process edit functions are discussed in Section 3.5.2.3.

The *Configuration* function can be entered only when the system is in an EQUIPMENT-ON mode. If the computer detects a configuration error during system Power Up, the *Configuration* function will be automatically entered. Accessing *Configuration* requires the use of two security codes (i.e., *Login* and *Configuration* passwords). This ensures that only appropriate personnel can access this function.

NOTE: Contact Unaxis, Inc., if the security codes are reprogrammed and subsequently lost.

3.3.3.1 Temperature

Temperature entries indicate to the system that the corresponding channels exist. *Max Allowable Setpoint Deviation* entries are the peak compliance windows within which the system will control temperature in all modes. Use the pointing device or <TAB> to move around the screen. Entries will be bound by the *Maximum Range* allowed per channel. When all entries have been made, click *Exit* to return to the *Configuration* menu.

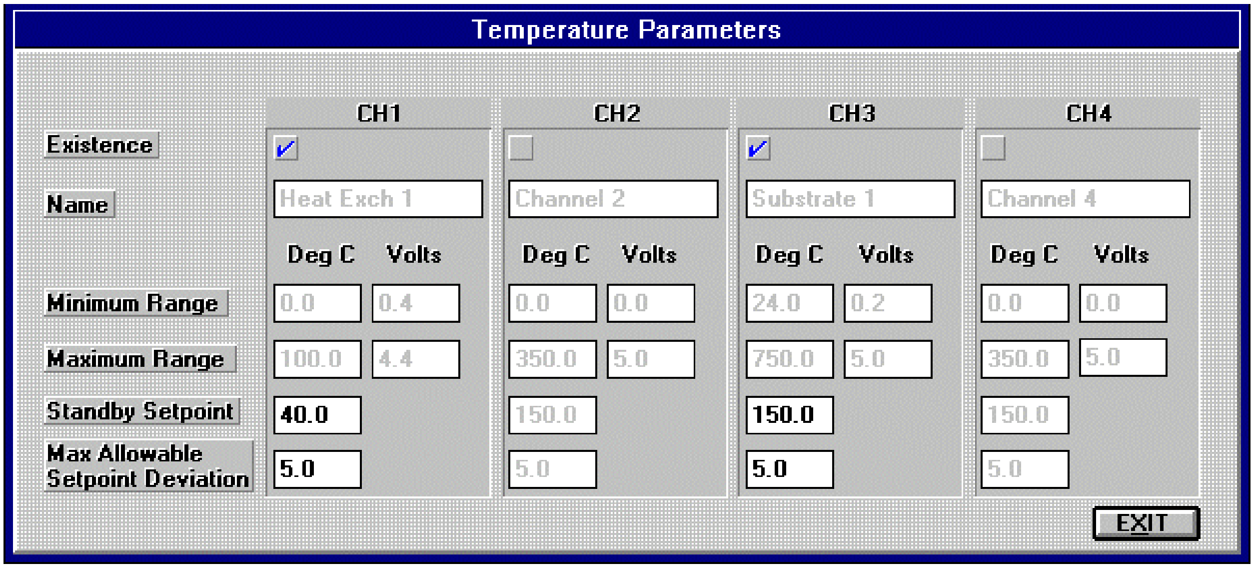


FIGURE 3-27. TEMPERATURE CONFIGURATION SCREEN

3.3.3.2 Gas

Selecting *Service/Configuration/Gas* enables a choice of two submenus: (1*) Gas Channel Parameters*, and (2) *Forbidden Pairs*. Selecting *Gas Channel Parameters* will display the following screen:

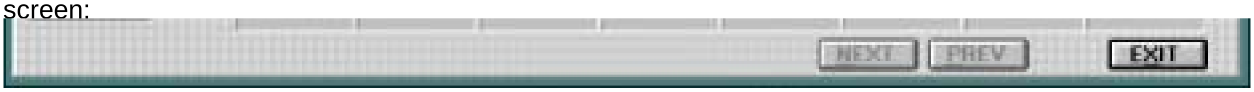


FIGURE 3-28. GAS CHANNEL CONFIGURATION SCREEN

Enter the following data for each gas channel using the pointing device or keyboard:

- <u>*Number Channels*</u> - the maximum number of gas channels that exist.
- <u>*Gas Type*</u> - the type of gas connected to each channel.
- <u>*Max Range*</u> - the channel's maximum flow rate in sccm.
- <u>*Corrected Conversion Factor*</u> - the documented conversion factor for the gas type(s) entered. Check the System Configuration sheets (Section Six) to see if the corresponding flowmeter is

gas specific or calibrated for nitrogen. *The Corrected Conversion Factor* is 1.00 if the corresponding flowmeter is calibrated to the specific gas. The flowmeter value *and Corrected Conversion Factor* data should not be adjusted as long as the corresponding flowmeter exists in the system.

NOTE: The *Corrected Conversion Factor* is used to identify a process gas and limit operator inputs in programming. It changes the range of signal applied to and interpreted from a flowmeter. The operator must consider *Flowmeter Test* results when changing this value in *Configuration*. Most installations will have different tolerance specifications afforded to a "working" flowmeter. If the flowmeter deviation is greater than specified, the flowmeter should be changed.

- *Flush/Bypass Capability* - select only if a channel has this feature.
- *Max Allowable Setpoint Deviation* - creates a compliance window for the controller during gas control.

Click *Exit* to return to the *Configuration* menu.

Selecting *Service/Configuration/Gas/Forbidden Pairs* will display the following screen:

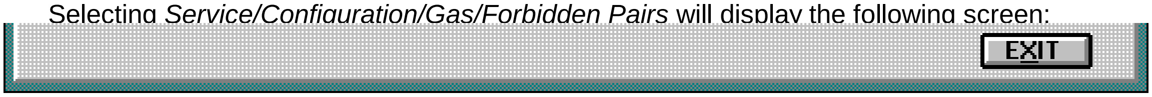


FIGURE 3-29. FORBIDDEN PAIRS CONFIGURATION SCREEN

Gas channel *Forbidden Pairs* are gases that are hazardous when mixed or gases that are never used together in a process. The system prohibits use of declared forbidden pairs during normal process operations and evacuation procedures.

3.3.3.3 RF

First, determine whether high frequency (13.56 MHz), low frequency or microwave generators exist. Then, select the *Max Incident Power* of the RF generators in accordance with the System Configuration sheets (see Section Six). Use the pointing device or keyboard to answer other available RF fields:

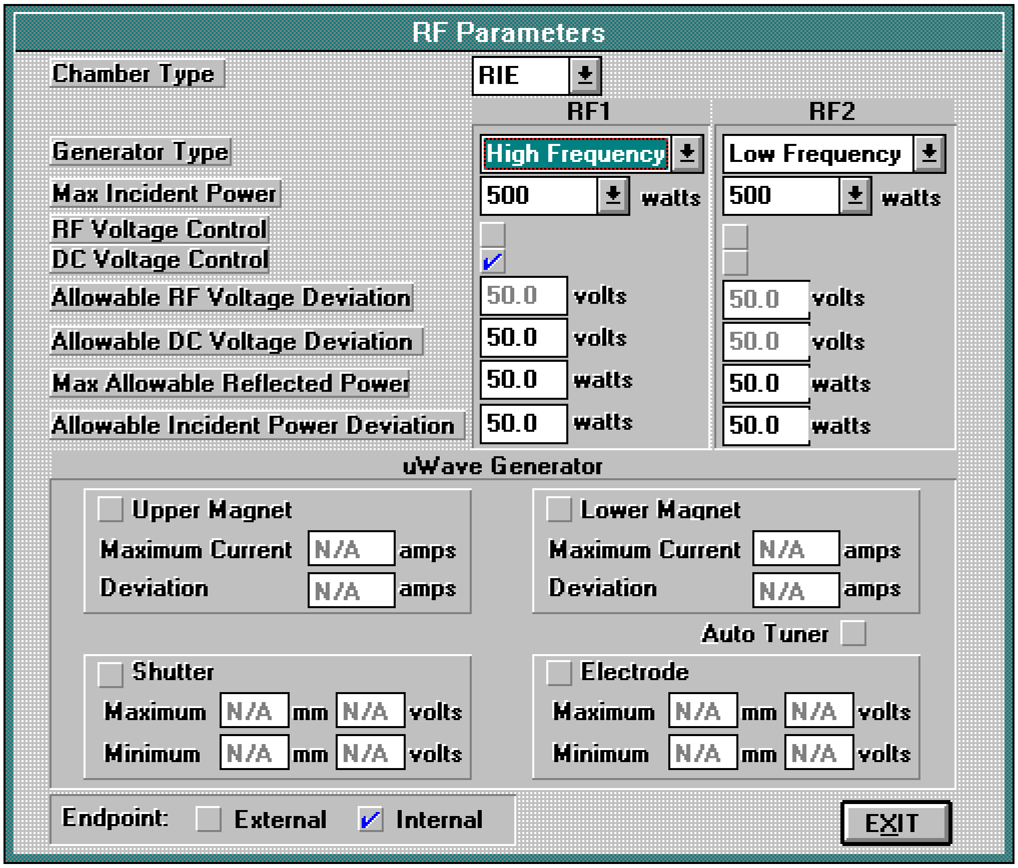


FIGURE 3-30. RF CONFIGURATION SCREEN

NOTE: *Internal* must be checked in the *Endpoint* field to enable endpoint menu selections.

3.3.3.4 Pressure

Enter data by using the pointing device or keyboard. The *Chamber Gas Constant* is used by the *Flowmeter Test* function accessed in the *Service/Maintenance* menu. The *Chamber Gas Constant* is determined at the factory before shipment (see the System Configuration sheets in Section Six). Every time the chamber is modified (thus changing the internal volume), the chamber gas constant should be recalculated. This is done by flowing a known quantity of gas into a closed, preheated chamber and noting the pressure rise.

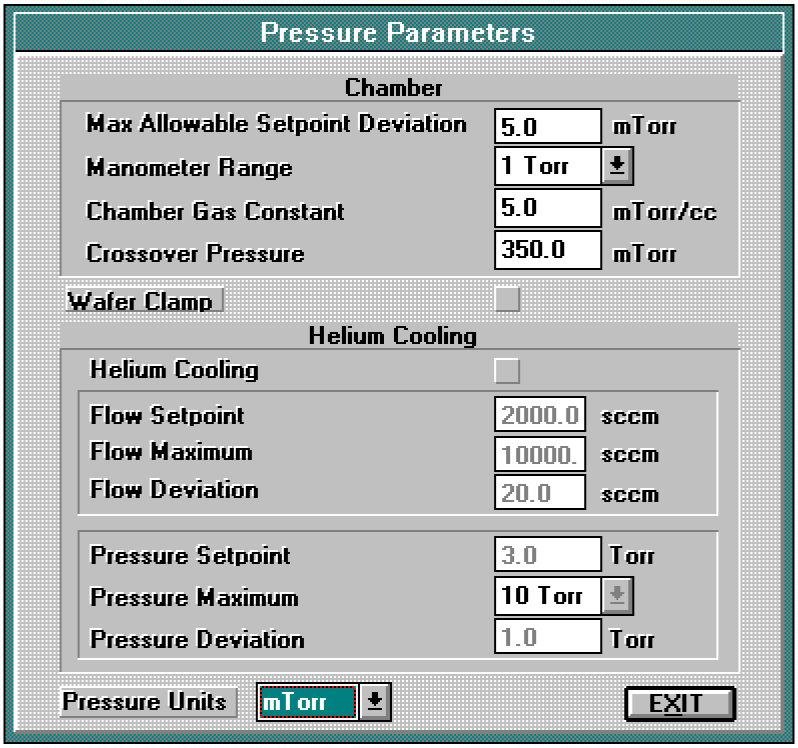


FIGURE 3-31. PRESSURE CONFIGURATION SCREEN

3.3.3.5 Pumps

Enter data in accordance with the System Configuration sheets (Section Six) using the pointing device or keyboard. In a dual chamber system with common pumps, no pump can be selected for an individual chamber.

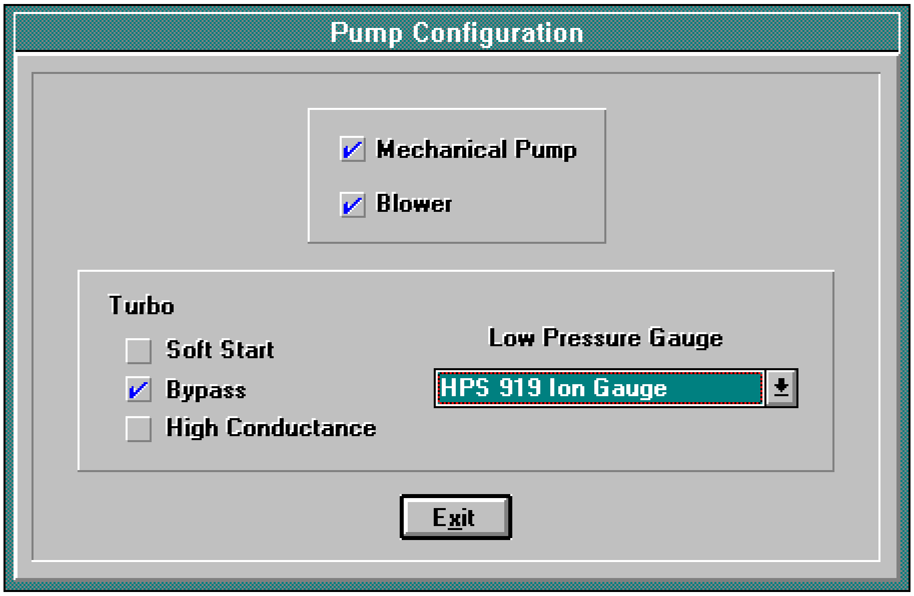


FIGURE 3-32. PUMP CONFIGURATION SCREEN

3.3.3.6 Lock

Enter in accordance with the System Configuration sheets (Section Six) using the pointing device or keyboard.

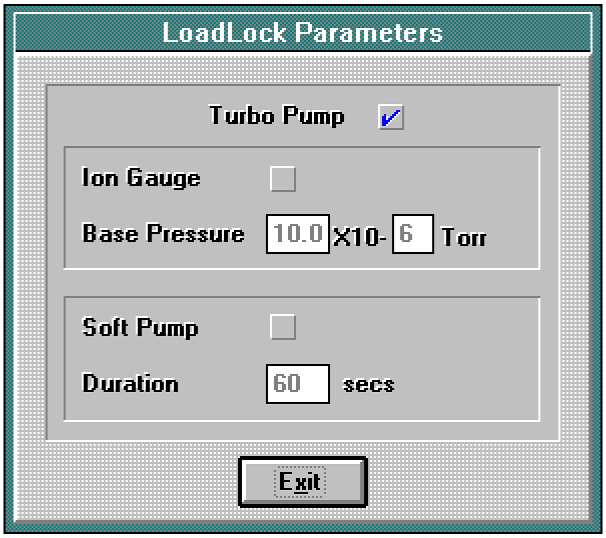


FIGURE 3-33. LOCK CONFIGURATION SCREEN

3.3.3.7 DEPOSITION

Choosing *Service/Configuration/Deposition* will enable deposition submenus:

- *DEPOSITION RATES*

  Deposition rates allow the operator to specify the duration of an automatic process step using thickness in Angstroms. During processing, the conversion from Angstroms to seconds is automatic (see *Configuring Deposition Rates* below). Up to 64 different rates may be stored at one time.

- *CONFIGURING DEPOSITION RATES*

Select *Service/Configuration/Deposition* to edit the deposition rate table. The following screen will appear:

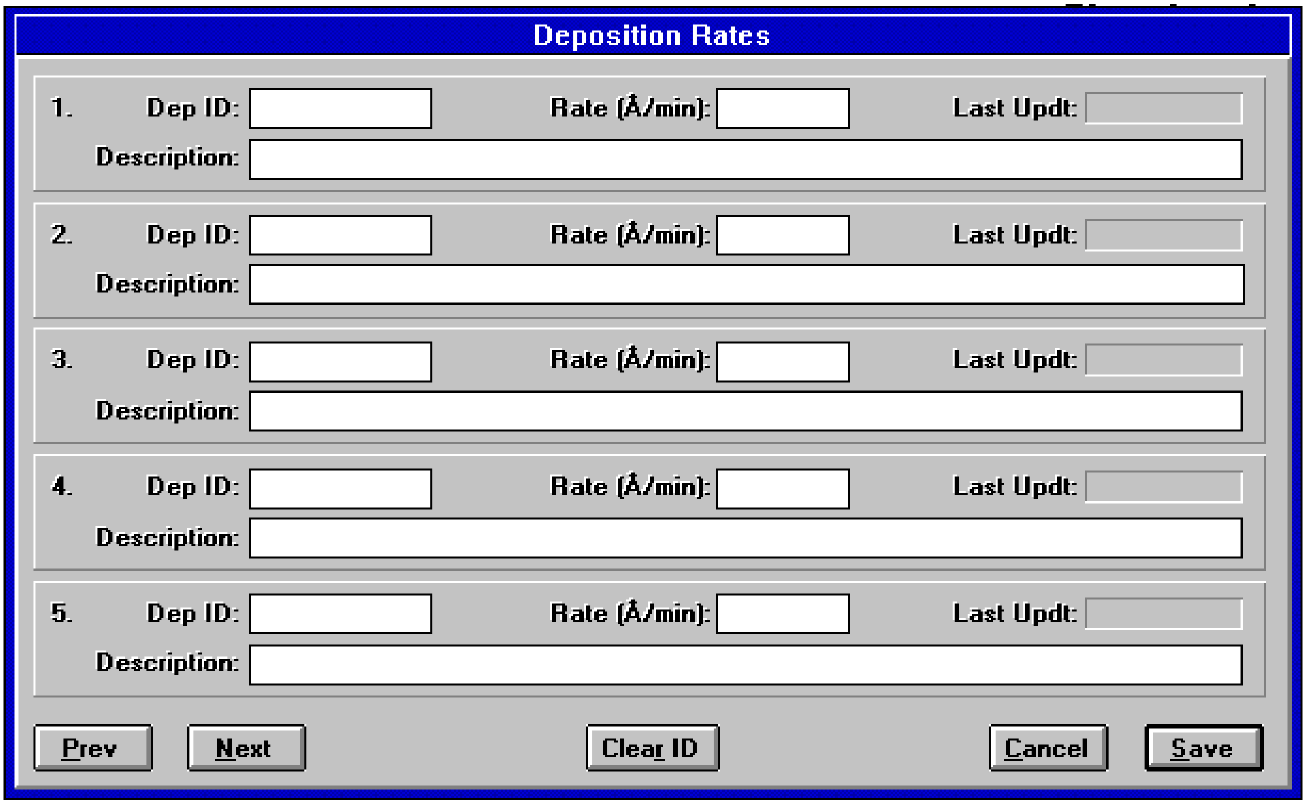


FIGURE 3-34. DEPOSITION RATE CONFIGURATION SCREEN

Each deposition rate record is numbered from one (1) to 64 (the maximum number of rates that can be stored) but only five (5) are shown on the screen at a time. Use the *Prev* and *Next* buttons to page up and down through the table.

Each record is composed of the following fields:

Dep ID: This field contains a unique identifier for the deposition rate. It can not be longer than eight (8) alphanumeric characters.

Rate (Å/min): This is the associated deposition rate in Angstroms per minute.

Last Update: This shows the last date on which this record was modified. It is automatically entered by the system.

Description: This is a description or pertinent information about the deposition rate record.

- *USING DEPOSITION RATES*

Deposition rates are used when editing an automatic process step.

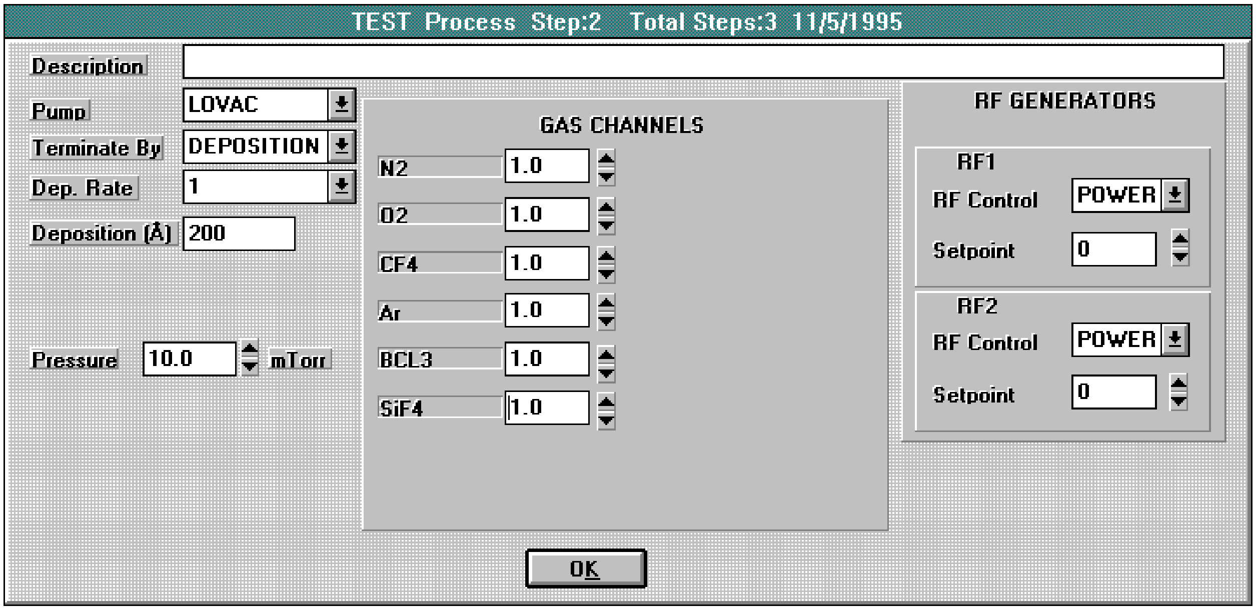


FIGURE 3-35. EDIT PROCESS STEP SCREEN (PROCESS EDITOR)

When *Deposition* is selected from the *Terminate By* field, two other fields become accessible. The first is *Dep. Rate*, a list box that contains all the deposition rate ID's currently configured into the system. The operator must select the one appropriate for the process. The next field is *Deposition (Å)* for entering the desired thickness in Angstroms.

3.3.3.8 Print

This function prints the system configuration. This information is useful if the configuration needs to be restored. Save it for future reference.

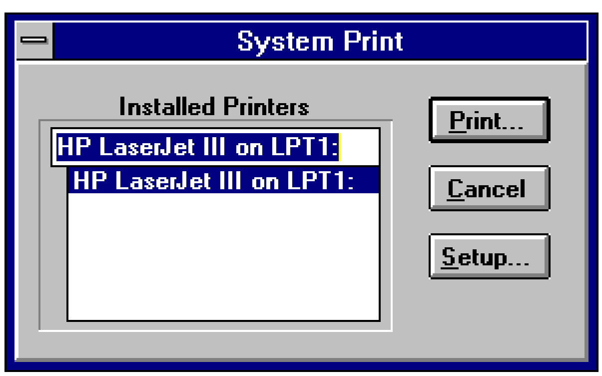


FIGURE 3-36. PRINT CONFIGURATION SCREEN

An example of a configuration printout follows:

System Parameters

CONFIGURATION	CONFIGURATION	CONFIGURATION
Machine Type:	Shuttle Lock	
Chambers:	2	
Digital Boards		
Board 1	Yes	
Board 2	Yes	
Board 3	Yes	
Analog Boards		
Board 1	Yes	
Board 2	Yes	
Board 3	Yes	
Board 4	No	
B1 Supply	Yes	
B2 Supply	Yes	
Gas Panel 1	Yes	
Gas Panel 2	Yes	
Gas System Fail	No	
Nitrogen	Yes	
Air	Yes	
Water	Yes	
Heat Exchanger 1	Yes	
Heat Exchanger 2	No	
Heat Electric 1	Yes	
Heat Electric 2	No	
Blower Gate	Yes	
Foreline Gate	Yes	
Turbo Gate	Yes	
TC Gauge	Yes	
Shared Gas	No	
Purge 1	Yes	
Purge 2	Yes	
Mechanical Pump	Yes	
Blower	No	
Turbo Pump	Yes	
ION Gauge	Yes	
Cold Cathode Gauge	No	

CONFIGURATION	CONFIGURATION Chamber 2	CONFIGURATION Chamber 1
Chamber Type	RIE	RIE
Mechanical Pump	Yes	Yes
Blower	No	No
Turbo	Yes	Yes
Blower Gate	Yes	Yes
Chamber Gate	No	No
Foreline Gate	Yes	Yes
Turbo Gate	Yes	Yes
TC Gauge	Yes	Yes
ION Gauge	Yes	Yes
Cold Cathode Gauge	No	No
Wafer Clamp	No	No
Chamber Constant	05.0	05.0
Max Vent Time	0:00	0:00
Endpoint	Internal	Internal
Gas Channel 1		
Type	No Name	N2
Maximum	200.0	200.0
Corrected Max	200.0	200.0
Minimum	00.0	00.0
Deviation	20.0	20.0
Flush	No	No
CF	01.0	01.0
Last CF	N/A	N/A
CF Date	N/A	N/A
Gas Channel 2		
Type	No Name	O2
Maximum	200.0	200.0
Corrected Max	200.0	200.0
Minimum	00.0	00.0
Deviation	20.0	20.0
Flush	No	No
CF	01.0	01.0
Last CF	N/A	N/A
CF Date	N/A	N/A

CONFIGURATION	CONFIGURATION Chamber 2	CONFIGURATION Chamber 1
Gas Channel 3		
Type		CF4
Maximum		200.0
Corrected Max		200.0
Minimum		00.0
Deviation		20.0
Flush		Yes
CF		01.0
Last CF		N/A
CF Date		N/A
Gas Channel 4		
Type		Ar
Maximum		200.0
Corrected Max		200.0
Minimum		00.0
Deviation		20.0
Flush		No
CF		01.0
Last CF		N/A
CF Date		N/A
Gas Channel 5		
Type		BCL3
Maximum		200.0
Corrected Max		200.0
Minimum		00.0
Deviation		20.0
Flush		Yes
CF		01.0
Last CF		N/A
CF Date		N/A

CONFIGURATION	CONFIGURATION Chamber 2	CONFIGURATION Chamber 1
Gas Channel 6		
Type		SiF4
Maximum		200.0
Corrected Max		200.0
Minimum		00.0
Deviation		20.0
Flush		Yes
CF		01.0
Last CF		N/A
CF Date		N/A
RF 1		
Type	13.56 MHz	13.56 MHz
RF Voltage	No	No
DC Voltage	Yes	Yes
Inc Power Max	500.0	500.0
Inc Power Min	00.0	00.0
Inc Power Dev	50.0	50.0
Ref Power Max	100.0	100.0
Ref Power Min	00.0	00.0
Ref Power Dev	50.0	50.0
RF Volts Max	1000.0	1000.0
RF Volts Min	00.0	00.0
RF Volts Dev	50.0	50.0
DC Volts Max	1000.0	1000.0
DC Volts Min	00.0	00.0
DC Volts Dev	50.0	50.0
Upr Mag Max	185.0	185.0
Upr Mag Min	00.0	00.0
Upr Mag Dev	10.0	10.0
Lwr Mag Max	185.0	185.0
Lwr Mag Min	00.0	00.0
Lwr Mag Dev	10.0	10.0

CONFIGURATION	CONFIGURATION Chamber 2	CONFIGURATION Chamber 1
RF 2		
Type		Low Frequency
RF Voltage		No
DC Voltage		No
Inc Power Max		500.0
Inc Power Min		00.0
Inc Power Dev		50.0
Ref Power Max		100.0
Ref Power Min		00.0
Ref Power Dev		50.0
RF Volts Max		1000.0
RF Volts Min		00.0
RF Volts Dev		50.0
DC Volts Max		1000.0
DC Volts Min		00.0
DC Volts Dev		50.0
Upr Mag Max		185.0
Upr Mag Min		00.0
Upr Mag Dev		10.0
Lwr Mag Max		185.0
Lwr Mag Min		00.0
Lwr Mag Dev		10.0
Temp Channel 1		
Name		Heat Exch 1
Maximum		100.0
Max Voltage		04.4
Minimum		00.0
Min Voltage		00.4
Corrected Max		115.0
Corrected Min		-10.0
Standby Stpt		40.0
Setpoint Dev		05.0

CONFIGURATION	CONFIGURATION Chamber 2	CONFIGURATION Chamber 1
Temp Channel 3		
Name		Substrate 1
Maximum		750.0
Max Voltage		05.0
Minimum		24.0
Min Voltage		00.2
Corrected Max		750.0
Corrected Min		00.0
Standby Stpt		150.0
Setpoint Dev		05.0
Pressure		
Type	1 Torr	1 Torr
Maximum	1000.0	1000.0
Minimum	00.0	00.0
Standby Pres	50.0	50.0
Setpoint Dev	05.0	05.0
Crossover	350.0	350.0
LoadLock		
Pump	Low Vacuum	
ION Gauge	No	
Base Pres	00.0	

3.3.3.9 SECURITY

Selecting *Service/Configuration/Security* displays the following screen:

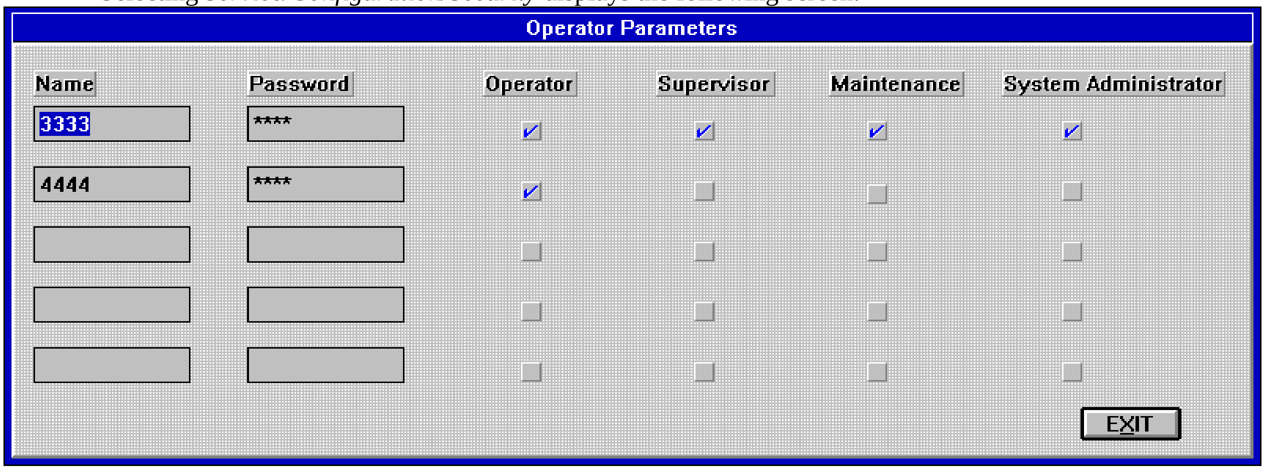


FIGURE 3-37. SECURITY CONFIGURATION SCREEN

The following table shows which access level controls each menu item. The user may Page Up or Page Down to view names below the first five displayed. Access levels include Operator (1), Supervisor (2), Maintenance (3) and System Administrator (4).

Utilities	**Service**	**Display**	**Process**	**Help**
Power Up Pumps,1	Maintenance,3	Sensor Display,1	Load,1,2	All
Pump Chamber,1	Manual Mode,2	SDU,2,3	Build,2	
Close Gates,1	Configuration,2	Alarm History,2	Edit,2	
Vent,1		Disable Automatic Screens,1		
Ion Gauge On,1		Plumbing Diagram,1		
Set Standby Temp.,1				
Select Active Chamber,1				
Logout,1				

3.3.3.10 EXIT

Selecting *Configuration/Exit* will take the system out of the *Configuration* function and return it to an idle EQUIPMENT-ON mode.

3.4 DISPLAY

The *Display* menu allows the operator to access *Sensor Display*,*.SDU*, *Alarm History* and *User Log* screens and perform other screen-related functions.

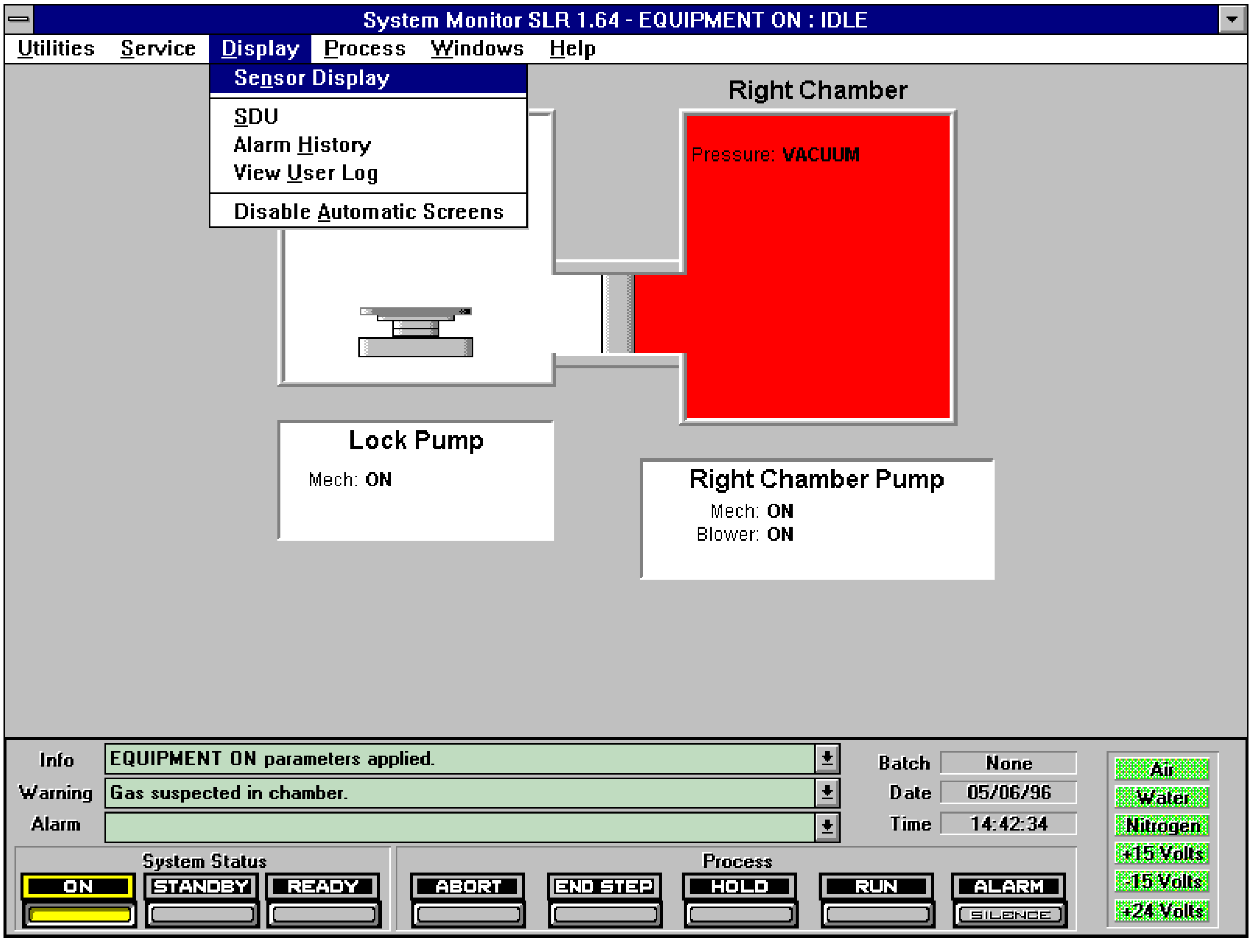


Figure 3-38. Display Menu

3.4.1 Sensor Display

Sensor Display shows the status of all active sensors in the system. It adjusts to show the actual configuration of the system. Selecting *Display/Sensor Display* will present the following screen:

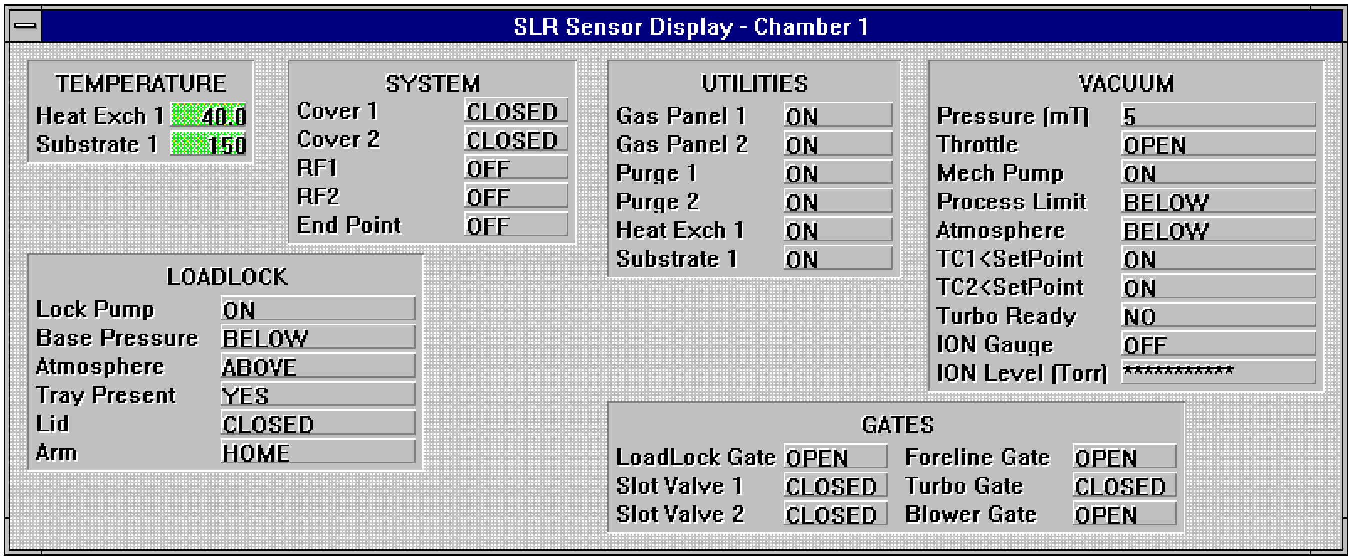


Figure 3-39. Sensor Display Screen

3.4.2 SDU (Signal Distribution Unit)

The SDU allows the operator to view all system digital and analog control signals. The operator can modify control inputs and outputs by selecting *Display/SDU*. The following caution screen will appear:

Figure 3-40. SDU Caution Screen

Below is sample Digital SDU screen. The red action button indicates that the input is on (signal is low true):

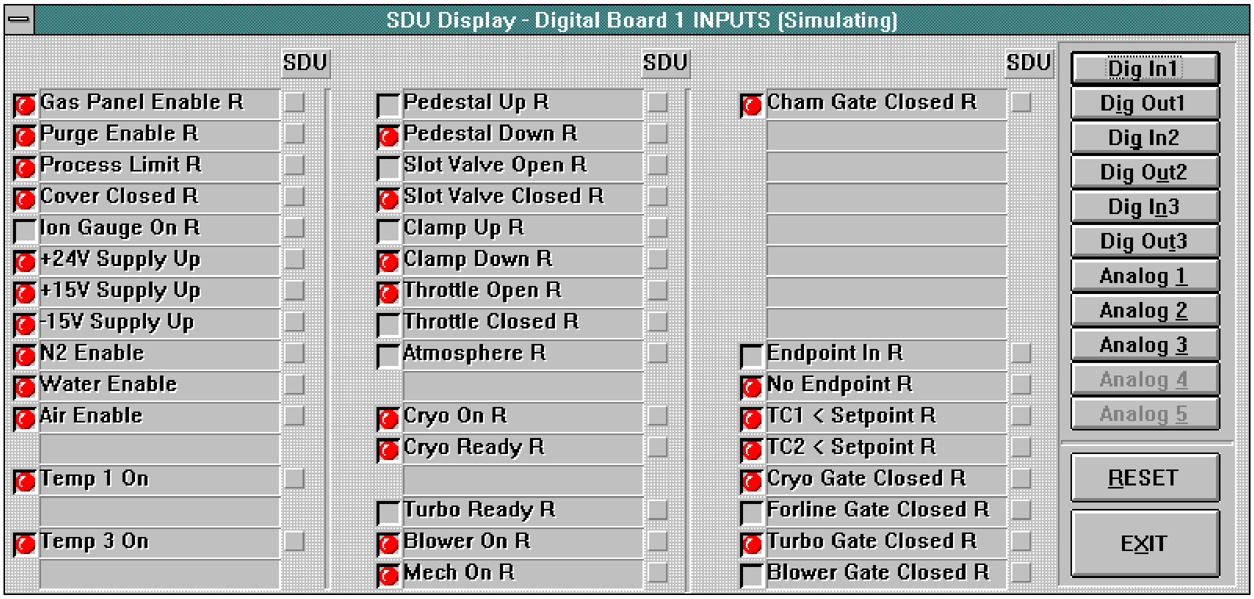


Figure 3-41. Digital SDU Screen

Below is sample Analog SDU screen. The readouts are in volts DC. Only active channels are displayed. An existing input or output can be overridden by clicking on the box located to the right of that channel. Only I/O boards actually installed in the system are displayed:

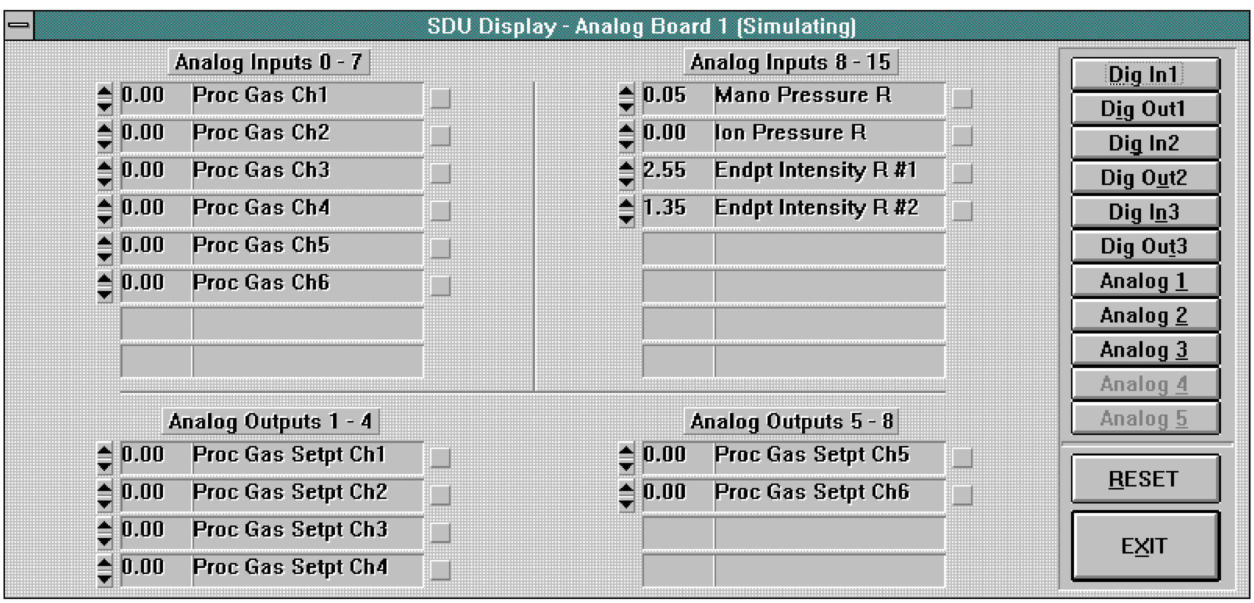


Figure 3-42. Analog SDU Screen

3.4.3 Alarm History

Selecting *Display/Alarm History* will display the following screen:

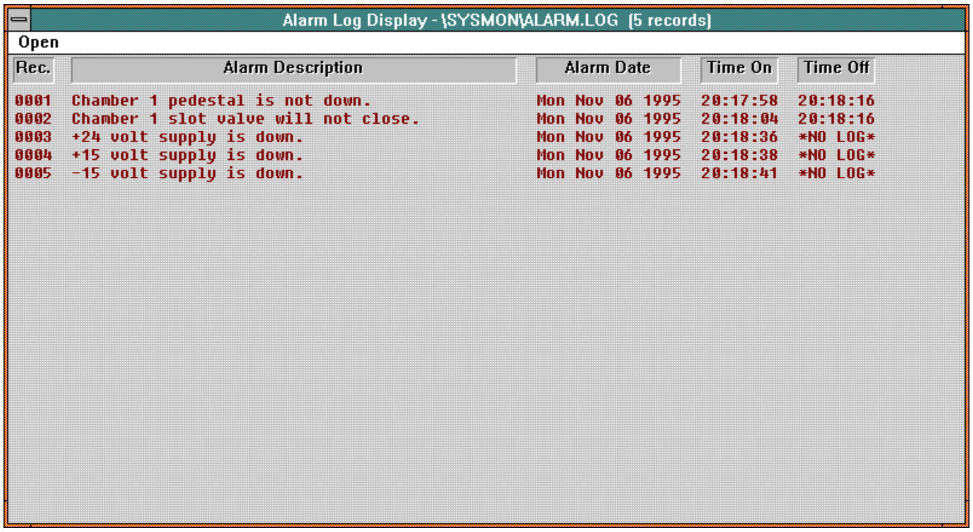


Figure 3-43. Alarm History Screen

This screen shows a history of system alarms. The alarm log holds 1,000 records which include the alarm number, an alarm description, and the time and date of alarm activation and deactivation.

3.4.4 VIEW USER LOG

View User Log allows an Administrator to keep track of system usage via the following listing:

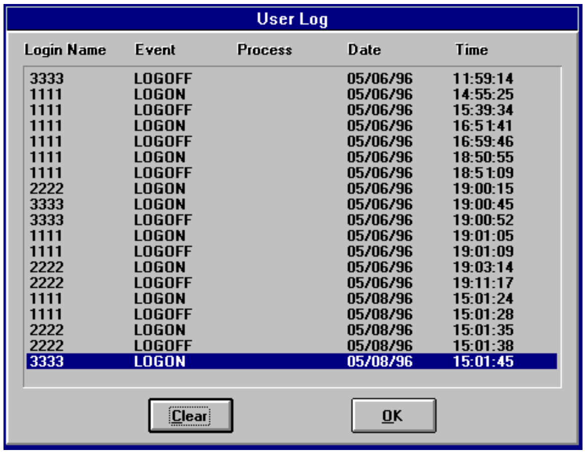


Figure 3-44. User Log Listing

3.4.5 Disable/enable Automatic Screens

Disable Automatic Screens keeps AUTOMATIC mode windows from overlaying the active window. This function is useful when simultaneously running and building a process.

3.5 PROCESS

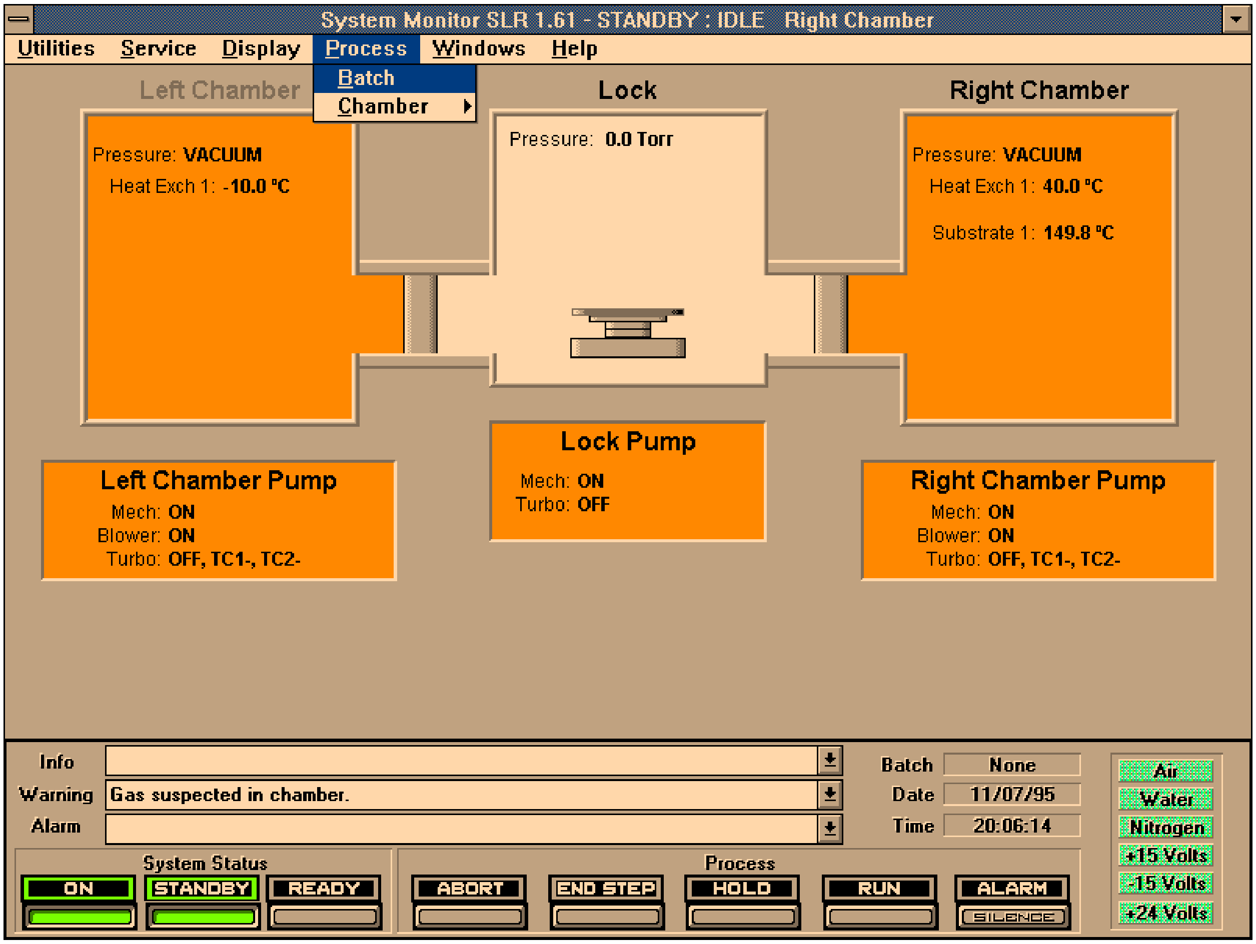


FIGURE 3-45. PROCESS MENU

3.5.1 BATCH (BATCH EDITOR)

3.5.1.1 OVERVIEW

The purpose of the Batch Editor is to combine wafer handing and automatic processing into a single automatic task. This is accomplished by making a list of predefined functions that move the wafer tray and activate automatic processes. These lists are called "batches" and carry the MS-DOS filename extension ".BCH" when saved to disk. Batch process files are stored in the same subdirectory as automatic process files (C:\SYSMON\PROCESS*.BCH). Only one batch process file can be opened at once. The Batch Editor has three operational modes: (1) BUILD, (2) EDIT, and (3) DELETE as are indicated in the Mode field of the Batch Editor screen (Figure 3-45).

3.5.1.2 Operation

To access the Batch Editor, select *Process/Batch* from the *System Monitor* menu. The following screen will appear:

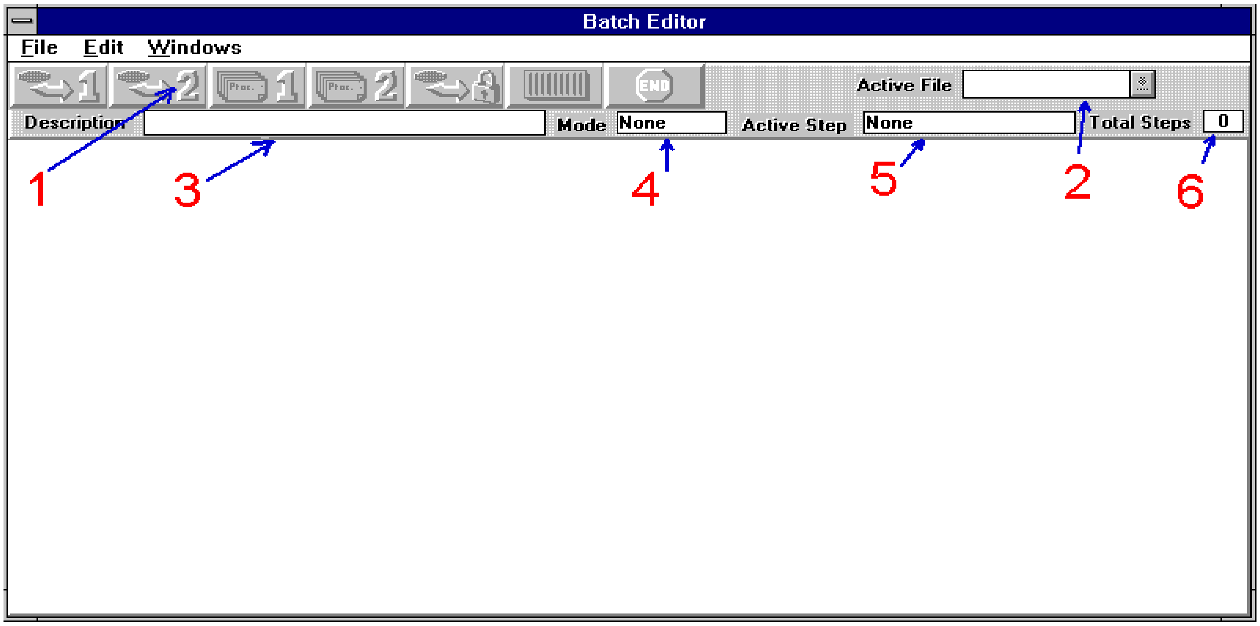
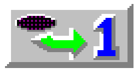


FIGURE 3-46. BATCH EDITOR SCREEN

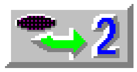
Labeled items are discussed below:

1. <u>Step Button Toolbar</u>

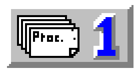
This enables the operator to add batch steps to the active batch process file. Each button represents a particular action as follows:



Move Wafer to Chamber 1

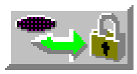


Move Wafer to Chamber 2



Process in Chamber 1

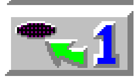
Process in Chamber 2



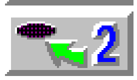
Move Wafer to Loadlock

Vent Loadlock

End



Move Wafer Out of Chamber 1



Move Wafer Out of Chamber 2

2. <u>Active File</u> **-** lists the open batch process file.
3. <u>Description</u> - allows a 64-character description to be saved with the active batch process file.
4. <u>Mode</u> - indicates the mode of the active batch process file.
5. <u>Active Step</u> - shows the current step of the active batch process file.
6. <u>Total Steps</u> - shows the total number of steps in the active batch process file.

The Batch Editor provides the following menu options:

3.5.1.3 FILE

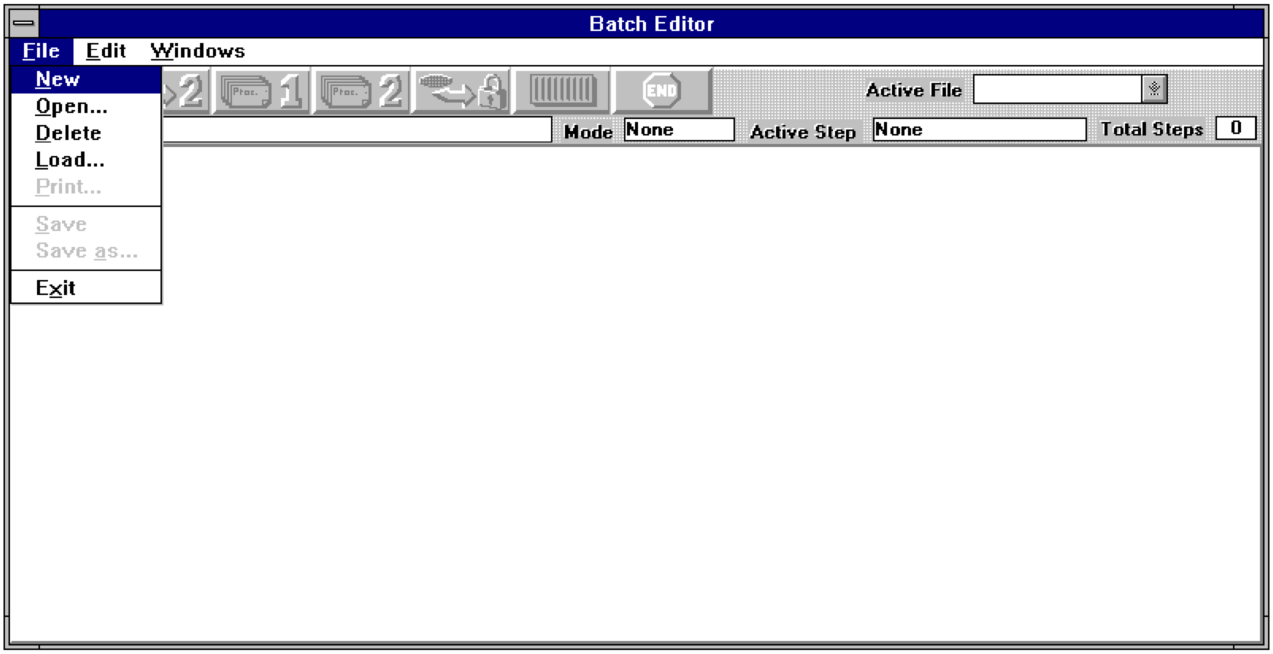


FIGURE 3-47. BATCH EDITOR MAIN MENU; FILE SUBMENU

- *NEW* (BUILD mode)- Select *File/New* to create a new batch process. **Every new batch process must start with a *Pump System* step and end with a *Vent Loadlock* or *End* step.**
  Batch Process Descriptions - A batch process *Description* can be added or modified using the *Description* field of the Batch Editor screen (Figure 3-46). Entered text is attached to the currently active batch process and will be saved and displayed in conjunction with that batch process.
- *OPEN* (EDIT mode)- Select *File/Open* to modify an existing batch process (also see Section 3.5.1.4). A window will appear that requests a batch process filename. This can be keyed into the *File Name* field or selected from the drop-down list of existing batch processes. Upon selecting a batch process, a window will open that displays the steps of that process. The drive and/or subdirectory field in this window should only be specified if exporting/importing batch process files to/from floppy disks.
  Process Editor Access - The *Process Editor* can be accessed from the *Batch Editor* through the active batch process if the active batch process has at least one process step. To activate the *Process Editor,* point to the *Process* step to be viewed or edited and double click on it. The *Process Editor* should be activated with that process loaded and ready for modification or viewing. If the *Process Editor* is already active, you must close it before following this procedure.
- *DELETE* (DELETE mode)- Select *File/Delete* to remove outdated batch process files from the disk. This menu sequence displays a window requesting a batch process filename. The name can be keyed into the *File Name* field or selected from the drop-down list of existing batch process files. Upon selecting a batch process filename, the Batch Editor will delete the selected batch process file from the disk.
  Mode mixing between open batch process files is allowed and can be referenced for the active file in the *Mode* field of the Batch Editor screen (Figure 3-46).

- *LOAD* - In order to load a batch process, the system must be in STANDBY mode with the Batch Editor running. Select *File/Load* in the *Batch Editor* main menu. The name can be keyed into the *File Name* field or selected from the drop-down list of existing batch process files. The target drive and/or subdirectory can also be selected during this operation but should only be used to export/import batch process files to/from floppy disks. The selected batch process will be loaded into system memory to await automatic execution in the READY mode. When a batch file is successfully loaded, the filename will appear on the *Master Control Panel* (Figure 3-4).
- *PRINT* - To print a batch process, select *Print* from the *Batch Editor* main menu. The following screen will appear:

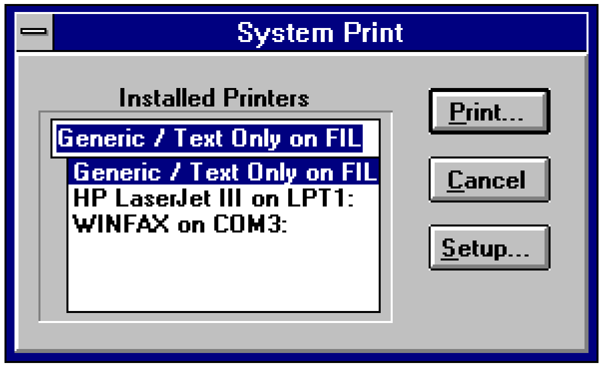


FIGURE 3-48. BATCH EDITOR PRINT SCREEN

Select the printer type and press the  button.

- *SAVE* - When all desired steps have been added to the active batch process, it can be saved to disk for later use. To do this, select *File/Save* in the *Batch Editor* main menu. If the active batch process is new and not yet named, you will be presented with a window requesting a MS-DOS filename. The new filename can be keyed into the *File Name* field of the *Save* window. There will be an asterisk (*) in the title bar of each batch process file that has been modified but not saved. The target drive and/or subdirectory can also be selected during this operation.
  Correct sequencing of the batch process steps, inserted process file checksums and values are ensured by the *Save* and *Save As* menu selections. If step sequence errors result at this point, the Batch Editor will return to the previous interactive mode to allow correction.
- *SAVE AS* (Renaming A Batch Process) - To rename an existing batch process, select *File/Save As* from the *Batch Editor* main menu. Enter the new filename in the *File Name* field of the *Save As* window and click *OK*.
- *EXIT* - To exit the Batch Editor, select *File/Exit* from the *Batch Editor* main menu. The Batch Editor will ask for disposition of each modified, unsaved file.

3.5.1.4 EDIT (Adding and Removing Batch Process Steps)

Batch process steps can be placed into the active batch file by clicking once on the desired step button in the *Step* toolbar (Figure 3-46) or by selecting *EDIT* in the *Batch Editor* main menu and then selecting the appropriate submenu (i.e., *Chamber 1*, *Chamber 2*, *Loadlock*, *End* or *Remove Step*)

The position of the step is determined by the *Active Step* field of the *Batch Editor* screen. If no step is active, all selected process steps will be placed at the end of the batch process list. Notice that the status of the step buttons and the equivalent menu selections change from active to inactive as the focused step in the active batch changes. This is done to ensure proper step sequencing for the batch process when it is executed during a RUN mode.

Batch process steps can be removed by dragging the step out of the active batch process list: place the mouse pointer on the desired step, click and hold down the left mouse button; begin moving the mouse with the left button depressed (the pointer should change into a pair of scissors with a rope through them to indicate step removal); move the scissors pointer off the active batch step list to a place on the main *Batch Editor* window where the scissors pointer is still visible; release the left button on the mouse. The highlighted step in the batch process list will disappear and the mouse pointer will turn back into an arrow.

3.5.1.5 WINDOWS

- *Arrange* - This menu selection is not currently applicable to SLR systems.
- *Close All* - Closes the open batch file.

3.5.2 CHAMBER (Process Editor)

Select *Process/Chamber* to activate the Process Editor. The following screen will appear:

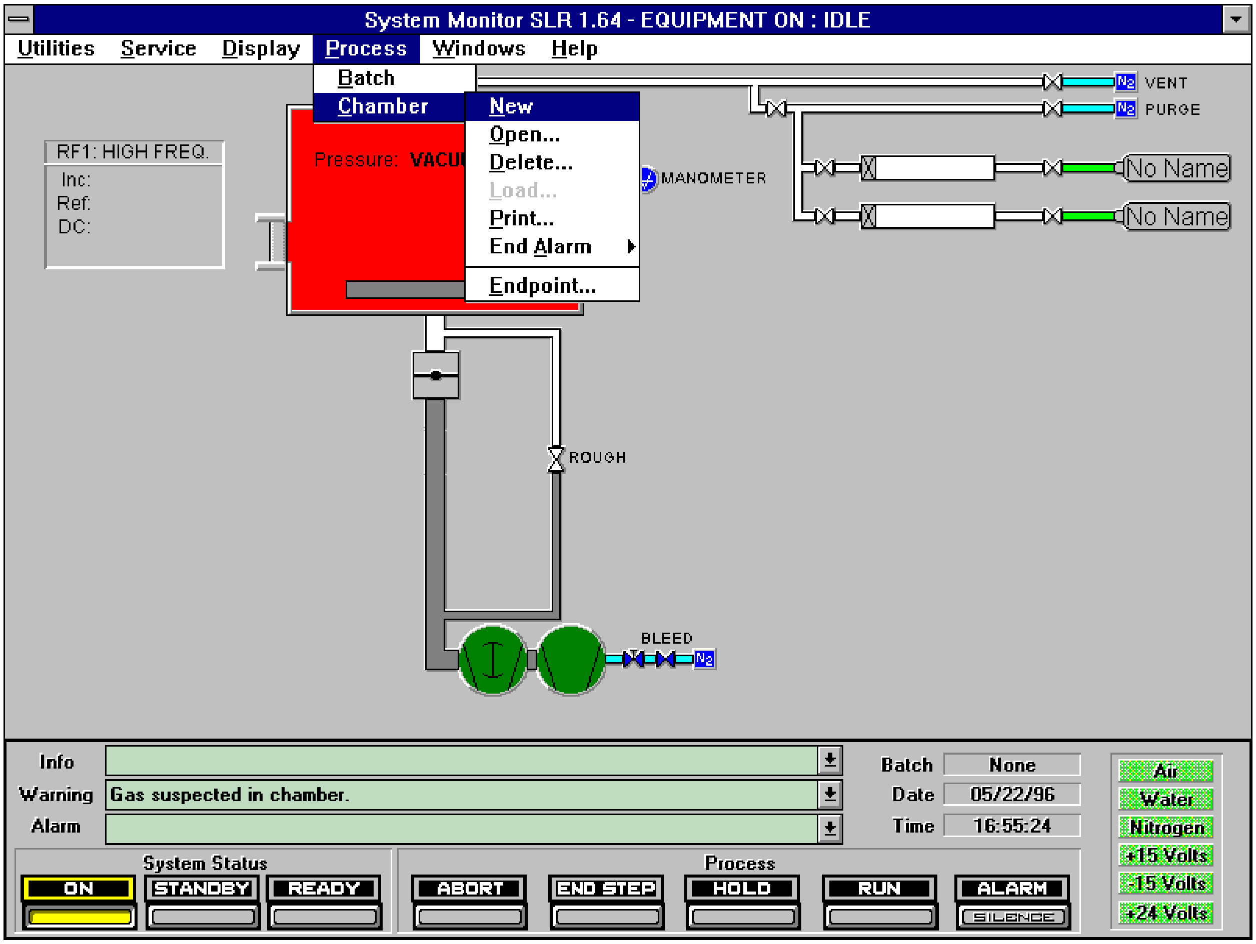


FIGURE 3-49. PROCESS EDITOR SUBMENU

3.5.2.1 OVERVIEW

Etch or deposition processes are created with the Process Editor. Only one process can reside in memory at a time but many processes can be stored on the hard disk and loaded into memory when needed. Processes stored on the hard disk are automatically encoded with the configuration of the system on which they were created. This prohibits the use of a process on a system with a different configuration. The process programmer should consider the following guidelines when building a process:

1. Architecture and accuracy of process parameters are the responsibility of the programmer.
2. Process programming capability is dependent upon system hardware as specified in the *Configuration* menu. The build sequence will automatically adjust to the system configuration.
3. Gases are named by channel numbers. The operator should document which gas types belong to which channel number and the process programmer must be aware of these assignments. Gas names assigned in the *Configuration* menu appear when building a process.
4. Process parameter maximum ranges and resolutions are not displayed during a build sequence. The system will inform the operator if an entered parameter is out of range or is of improper resolution.

The system automatically compensates flowmeter maximum rates in relation to the gas conversion factor (or coefficient) used for that channel as specified in the *Configuration* menu.

5. Additional process steps are required to vary a process parameter during a process (e.g., power).
6. Endpoint detection and RF generator selection cannot be repeated or switched until a step without RF is programmed.
7. Process history and experience should be considered when setting the *Maximum Time* parameter of endpoint detection. Overetch can be programmed in the same process step as endpoint detection.

3.5.2.2 New (Build mode)

Click *Process/Chamber/New* to create a new process. The following screen will appear:

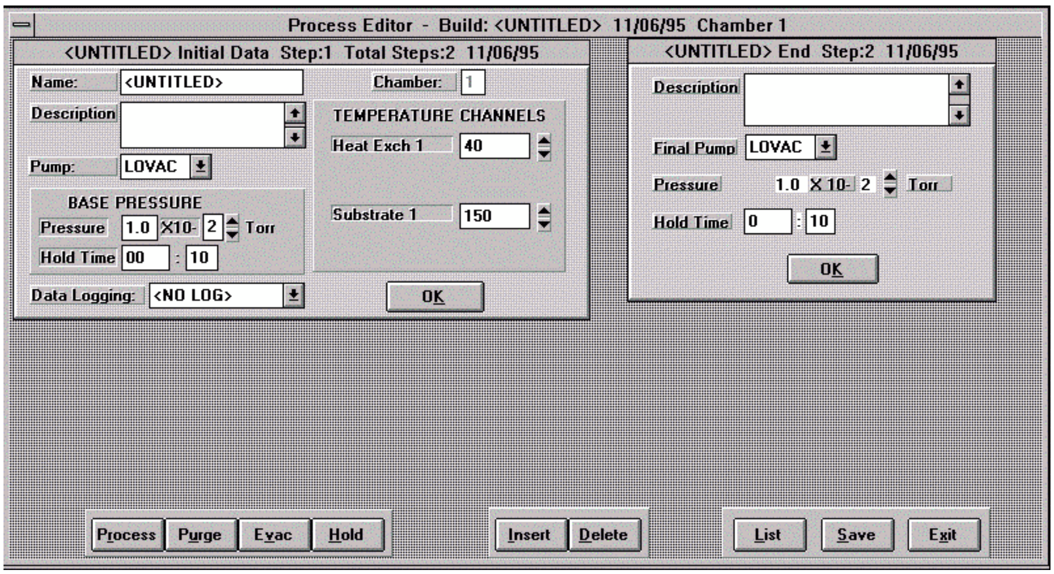


FIGURE 3-50. PROCESS EDITOR BUILD SCREEN

The process is built by using the keyboard and pointing device to enter appropriate data. Process data and architecture are the responsibility of the programmer.

Flexible program architecture is provided through a variable block concept which uses a sequential series of blocks (steps) as determined by the programmer to define a total process. The programming blocks include:

1. Initial Data
2. 

Process
3. 

Purge
4. 

Evacuate Chamber
5. 

Hold
6. End

The *Initial Data* and *End* steps must appear at the beginning and end of every process, respectively, and are displayed automatically. They can be edited but never inserted or deleted. The other program steps may be placed in any order.

Starting with *Initial Data*, build a process by filling in the step fields. The fields and field names may vary from those illustrated herein depending on the configuration of your system.

- *Initial Data* - The *Initial Data* step establishes the chamber conditions (including pump configuration, base pressure and temperatures) that must be attained before processing sequences can be initiated:

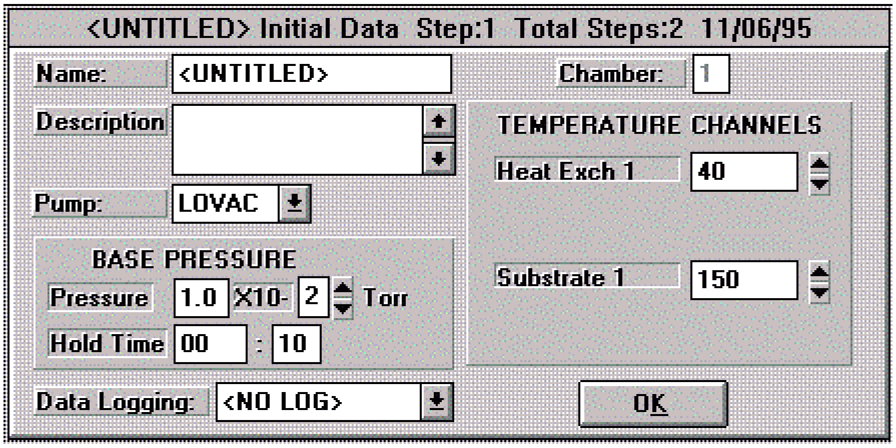


FIGURE 3-51. INITIAL DATA STEP SCREEN

Field	Prompt Type	Remarks
Chamber	Data Entry	Applicable only if more than one chamber
Name	Data Entry	Limited to eight (8) alphanumeric characters
Description	Data Entry	Describes process to be loaded.
Base Pressure	Data Entry	X.Y x 10^{-Z}
Hold Time (mm:ss)	Data Entry	Enter zero (“0”) for no hold time
Pump	List Box	Enter the desired pump type (only if more than one pump)
Temperature Channels	Data Entry	Only if a temperature channel exists in configuration.
Data Logging	List Box	Select log configuration file or <NO LOG> if data logging is not required.

Process

The *Process* step defines gas flow, chamber pressure, RF mode and setpoints for the desired deposition or etch sequence. The pumping configuration (if more than one pump) and the method of controlling the process duration (if an endpoint option is available) may also be selected. A *Process* step may be operated without RF (e.g., a thirty-second, intermediate non-RF step is useful in ensuring stable gas flow and chamber pressure prior to initiating a plasma).

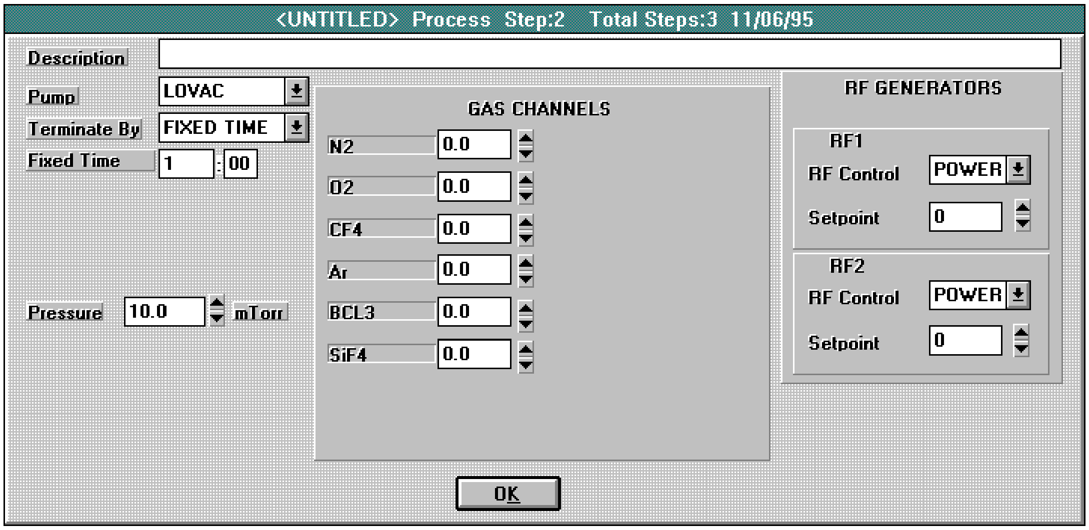


FIGURE 3-52. PROCESS STEP SCREEN

Field	Prompt Type	Remarks
Description	Data Entry	Describes this step
Pump	List Box	Enter the desired pump type (only if more than one pump)
Terminate By	List Box	Controls termination method
- Fixed Time (mm:ss)	Data Entry	Time to terminate (not subject to change)
- Var. Time	Data Entry	Time to terminate (variable; time confirmation requested whenever process step is accessed during RUN).
- Endpoint	List Box	If terminated by Endpoint
- Maximum Time	Data Entry	An upper limit as to how long the process step should continue (whether endpoint is or is not reached)
- Overetch By	List Box	Method of determining end of step
- None	Data Entry	Disables Overetch
- Time	Data Entry	Time of Overetch
- %	Data Entry	Percentage of Overetch
- Method	List Box	Saved endpoint method files (internal endpoint detection)
- Deposition	List Box	If terminated by Deposition
- Dep Rate	List Box	Lists saved deposition rates (see Section 3.3.3.7)
- Deposition Å	Data Entry	By thickness in Å
Pressure	Data Entry	In mTorr
Gas Channels	Data Entry	Make appropriate selection(s)
RFX Control	List Box	X = RF1 or RF2
RFX Setpoint	Data Entry	Desired RF control value

Purge

The *Purge* step causes the chamber to be back-filled with the gas plumbed to the purge inlet. The data entered in the *Purge* screen controls the pumping configuration, chamber pressure, RF (if required) and the duration of the *Purge* step.

Purge flow is controlled by a needle valve located in the gas cabinet. Use of the *Purge* step should, therefore, be limited to cases where accurate control of gas flow is not necessary. Such cases may include chamber cleaning operations, post-etch resist strips and substrate treatments and passivations, either before or after processing.

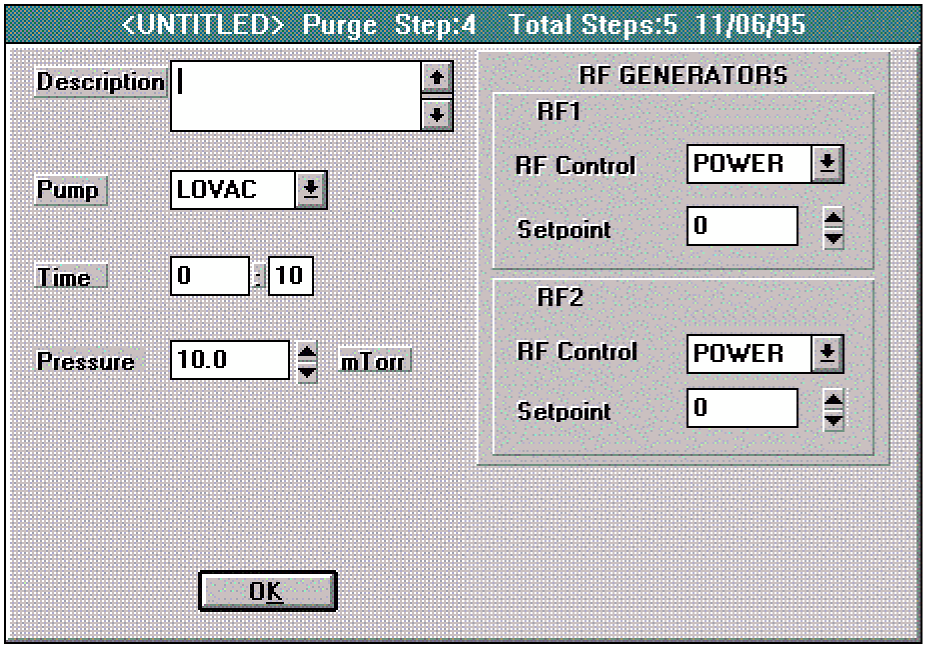


FIGURE 3-53. PURGE STEP SCREEN

Field	Prompt Type	Remarks
Description	Data Entry	Describes this step
Pump	List Box	Enter the desired pump type (only if more than one pump)
Purge Time	Data Entry	In minutes and seconds
Pressure	Date Entry	In mTorr
RFX Control	List Box	X = RF1 or RF2
RFX Setpoint	Data Entry	Desired RF control value

The *Evac* (evacuation) step pumps the chamber to base pressure. The base pressure, pumping configuration and duration of the step are user programmable.

A chamber evacuation may be useful in multi-step processes where gases from the previous step are incompatible with the next gases to be introduced into the chamber or where gas residuals can cause shifts in the process performance.

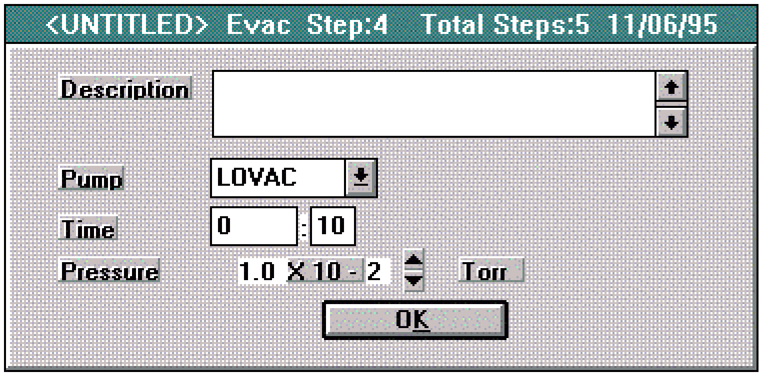


FIGURE 3-54. EVACUATION STEP SCREEN

Field	Prompt Type	Remarks
Description	Data Entry	Describes this process step.
Pump	List Box	Enter the desired pump type (only if more than one pump)
Time	Data Entry	In minutes and seconds
Pressure	Date Entry	In mTorr

This step establishes a HOLD mode on the process sequence. The system remains in a pumped condition with no gas flow or RF and uses the preceding pumping configuration until the HOLD mode is released by the operator.

FIGURE 3-55. HOLD STEP SCREEN

Field	Prompt Type	Remarks
Description	Data Entry	Describes this process step.

- *End*

  The *End* step defines the condition in which the system will complete the automatic run sequence. The final pump down configuration, chamber base pressure and time the chamber remains at base pressure are user programmable.

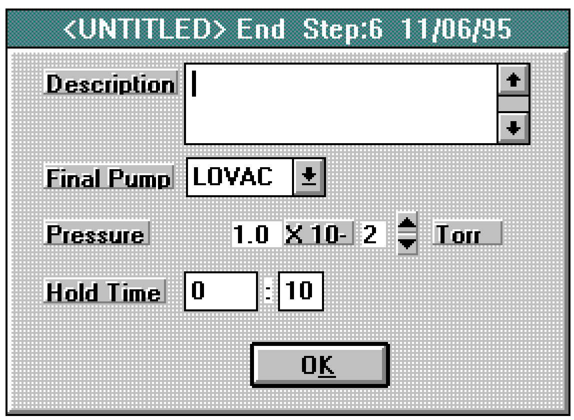


FIGURE 3-56. END STEP SCREEN

Field	Prompt Type	Remarks
Description	Data Entry	Describes this process step.
Final Pump	List Box	Enter the desired pump type (only if more than one pum
Pressure	Data Entry	In mTorr
Hold Time	Data Entry	In minutes and seconds

3.5.2.3 Open

Select *Process/Chamber/Open* from the *System Monitor* menu to open or edit an existing process program. Double-click the filename of the process program to be edited. Process editing functions include:

- Editing or revising a process step
- 

 Inserting a process step

- **Delete** Deleting a process step

Select the **List** button. A screen similar to the following will appear:

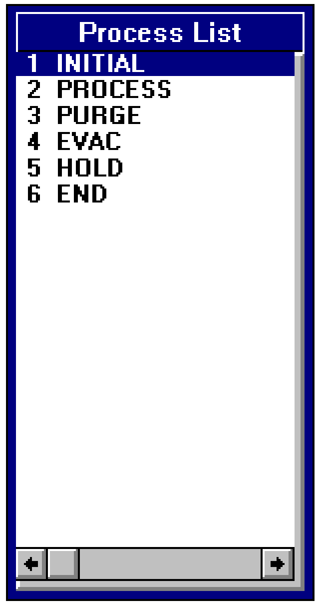


FIGURE 3-57. SAMPLE PROCESS LIST SCREEN

To edit a step, point the cursor at it and double-click; the process step should open. Make any necessary changes and click *OK*.

To *Insert* a step, click once on the step preceding the step to be added, click the **Insert** button, verify placement of the inserted step, and then click on the appropriate process button (Process, Purge, Evac or Hold).

To *Delete* a step, highlight it by clicking it once and then click the **Delete** button.

3.5.2.4 Delete

Select *Process/Chamber/Delete* to delete a process program. The following screen will appear:

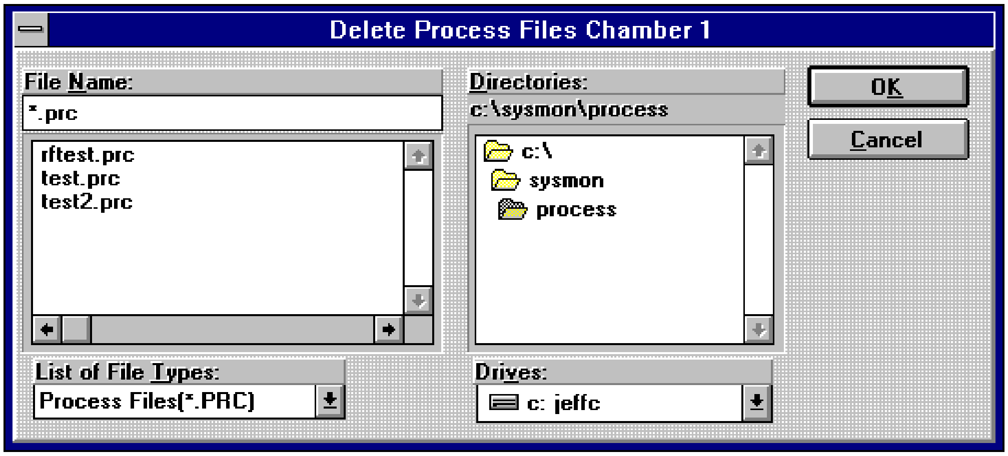


FIGURE 3-58. DELETE PROCESS SCREEN

Double-click on the name of the process to be deleted. If it is not displayed, use the scroll controls on the right side of the *File Name* field until the desired filename is visible. After the process is selected for deletion, the following warning will appear:

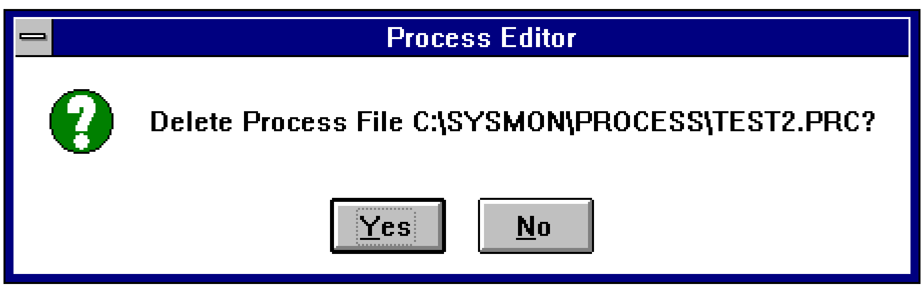


FIGURE 3-59. DELETE PROCESS WARNING SCREEN

Select *Yes* to delete the process or *No* to cancel the command. There is no way to restore a deleted process file unless a backup was made prior to deletion.

3.5.2.5 Load

Select *Process/Chamber/Load* to run a process. The system must be in a STANDBY mode. The following screen will appear:

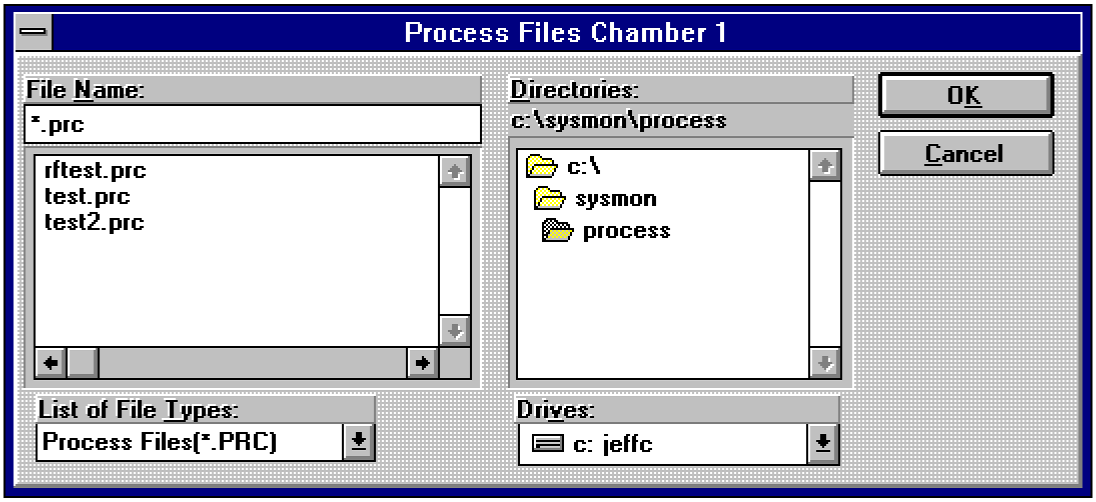


FIGURE 3-60. LOAD PROCESS SCREEN

Click on the name of the process to be loaded. If it is not displayed, use the scroll controls on the right side of the *File Name* field until the desired filename is visible. Load the process by double-clicking it or by clicking it once and then clicking *OK*.

Once the process is loaded, the name will appear in the *Batch/Process* field of the *Master Control Panel* (Figure 3-4). If no process is loaded, "NONE" will appear in this field.

<u>*3.5.2.6 PRINT*</u>

Select *Process/Chamber/Print* to print a process file. The following screen will appear:

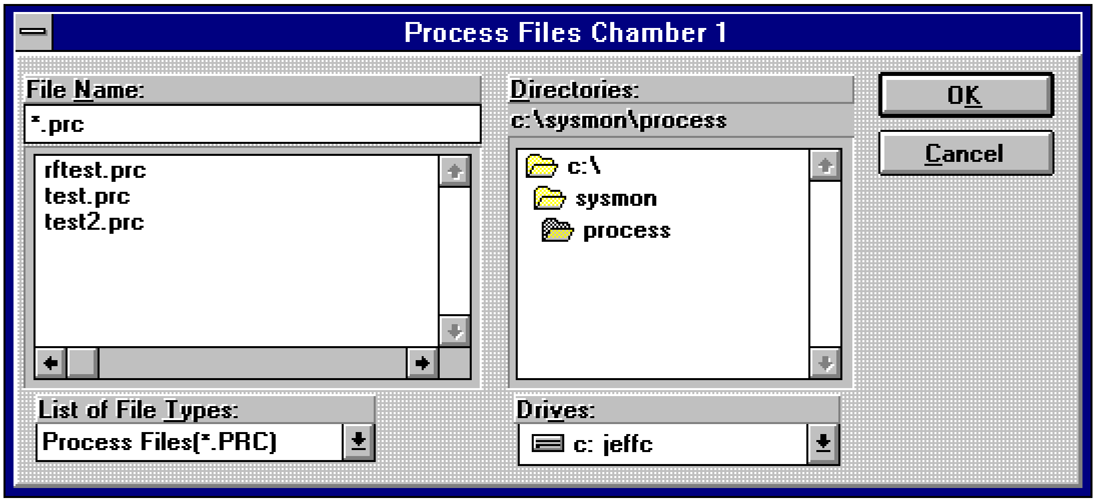


FIGURE 3-61. PRINT PROCESS SCREEN

Click on the name of the process to be printed. If the filename is not displayed, use the scroll controls on the right side of the *File Name* field until the filename is visible. Select the file for printing by double-clicking the filename or click it once and then click *OK*. The following screen will appear:

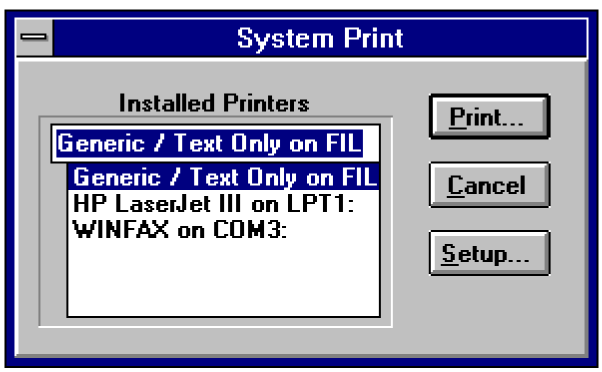
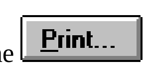


FIGURE 3-62. PRINTER SELECTION SCREEN

Select the appropriate printer from the list and click the 

button.

3.5.2.7 END ALARM

Selecting *Process/Chamber/End Alarm* yields three choices:

- *Ten Seconds* to end the alarm automatically after a 10 second period.
- *Continuous* to keep it on continuously until the alarm condition is acknowledged using the ALARM button in the Master Control Panel.
- *Off* to turn the alarm off (generally used during testing only, not normal operation).

3.5.2.8 ENDPOINT

Endpoint detection is enabled by selecting *Service/Configuration/RF* in the *System Monitor* menu and then choosing *Internal* in the *Endpoint* field (Figure 3-30). *Endpoint* must then be selected in the *Terminate By* field of the *Process* step (Figure 3-35). An endpoint method (see below) and a *Max Time* must also be specified in case automatic endpoint is not detected. Overetch can be set on a time or percentage basis, or omitted.

- OVERVIEW
  The endpoint system used in the SLR etch systems relies on monitoring a signal generated by a plasma emission monitor or a laser interferometer. The signal from the laser will vary with time in a sinusoidal manner when etching transparent films such as SiO_2 and Si_3N_4, but will show a step function (due to changes in reflectivity) when opaque materials are etched. The magnitude of the signal generated by the emission monitor is a function of the material being etched and the wavelength selected. When the appropriate wavelength selection is made, the signal intensity will either increase or decrease at the endpoint of the etch. The software allows the choice of various algorithms to detect endpoint based on these changing signals and has the ability to incorporate automatic endpoint detection into etch recipes.
- BUILDING ENDPOINT METHOD
  Depending on the type of endpoint detector used and the specific etch application, different endpoint detection algorithms can be used to build an endpoint method. Select *Process/Chamber/Endpoint* to edit endpoint method (see Figure 3-62). Once the parameters have been selected, the method is named and saved and subsequently used whenever a process requesting this method is run. Details of the endpoint algorithms are listed below with descriptions of the attributes that must be set to build an endpoint method.

- <u>CONFIGURING ENDPOINT DETECTION AND OVERETCH</u>
  The operation of endpoint detection and process step termination is determined by assigning values to a process step in the Process Editor (Figure 3-35). With endpoint detection present in the configuration, there are potentially three (3) fields that may be addressed with external endpoint detection and four (4) fields with internal endpoint detection:
  - *Terminate By*
  - *Overetch By*
  - *Overetch Time/Percent*
  - *Endpoint Method* (internal only)

  The first field is *Terminate By*. There are four (4) possible values that can be assigned here: *Fixed Time*, *Var. Time*, *Endpoint*, and *Deposition (see Section 3.3.3.7)*. Choosing *Fixed Time* or *Var. Time* will disallow the operation of endpoint detection and process termination will be determined by the amount of time entered.
  Select *Endpoint* to activate endpoint detection in the process step. This will cause other fields to appear: *Maximum Time*, *OverEtch By* and *Method*.
  - <u>*Maximum Time*</u> indicates the upper time limit of the process step, whether endpoint is or is not reached.
  - <u>*OverEtch By*</u> determines the amount of time chamber activity should continue after endpoint has been reached. There are three (3) possible values for the *OverEtch By* field:
    - *None* - disables overetch
    - *Time* - cause chamber activity to continue for a specified amount of time*
    - *Percent* - causes chamber activity to continue for a percentage of the time required to acquire endpoint*

    * Choosing *Time* or *Percent* will cause another field to appear for entering the value of overetch*Time* or *Percent*.
  - <u>*Method*</u> is only accessible with internal endpoint. This field lists all endpoint method files currently on disk in the \SYSMON\ENDPT subdirectory. The operational characteristics of the chosen method file will directly determine when and how internal endpoint is determined for the corresponding process step.

  Once the all other desired values for the process have been entered and the process is saved to disk, these values will be used during the automatic run sequence to determine if endpoint is used and whether to overetch by constant time, percent of the endpoint time or not to overetch at all. When internal endpoint detection is active for a process step, a graphing window will also appear with the process step window to illustrate the chamber activity as it relates to endpoint detection.

- <u>CREATING, MODIFYING AND REMOVING ENDPOINT METHODS</u>
  To create or modify an endpoint method, choose *Process/Chamber/Endpoint* from *the System Monitor* menu. The following window will appear:

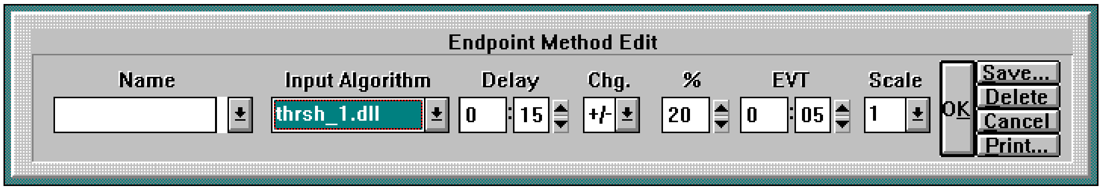


FIGURE 3-63. ENDPOINT METHOD EDIT SCREEN

There are five (5) control buttons on the *Endpoint Method Edit* screen:

OK - saves the displayed endpoint method and exits *Endpoint Method Edit*

Save... - saves the displayed endpoint method

Delete - deletes the displayed endpoint method

Cancel - exits *Endpoint Method Edit* without saving displayed endpoint method

Print... - prints endpoint method

Endpoint methods are composed of seven (7) parameters:

- *Name*
- *Input Algorithm*
- *Delay Time*
- *Change*
- *Percent*
- *EVT*
- *Graph*

To create a new method, enter a filename in the *Name* field to identify the new endpoint method. All other fields will contain default values. Make appropriate changes and click Save....
To modify an existing method , use the pointing device to click once on the arrow beside the *Name* field. Select the filename of the endpoint method to be edited from the resulting drop-down list. Once selected, all fields should reflect values associated with the chosen method. Tab between fields to change the values.
The values listed in the *Graph* field relate to the scale at which signals are amplified on the screen to visually depict chamber activity as it relates to endpoint detection. *Graph* values have nothing to do with the actual operation of endpoint detection.

3.5.2.9 Algorithms

1. <u>THRESHOLD</u> (THRSH_X.DLL)
   This is the most simple technique used to determine endpoint and is appropriate in those applications where a step function is expected. This can be either from the laser head or the optical emission monitor. The values which must be selected are:

Delay Time	(mm:ss)
Direction	(+,-,±)

Threshold	(%)
EVT	(mm:ss)
Graph	(1-100)

Delay Time: During this period of time after the start of the endpoint step, the endpoint search is inactive. This allows time for stabilization of the plasma and emission intensity and should not be set shorter than the compliance time window (15 seconds).

Direction (Change): The setting of this parameter determines whether endpoint is triggered by a rising signal (+), a falling signal (-) or either a rising or falling signal (±). A knowledge of the process or the surface reflectivity is necessary to determine the correct setting of this parameter.

Threshold (%): At the end of the delay time, the endpoint signal is normalized and its value at that time is used to search for endpoint. If the magnitude of the signal subsequently varies from this normalized value by more than the number set in *Threshold* and in the desired direction(s), then endpoint is triggered. The actual value used for *Threshold* will be process sensitive or (when using a laser) surface sensitive and must be determined empirically. The value for *Threshold* is set as a percentage and hence the change is not sensitive to the absolute signal magnitude. This will compensate for long term changes in surface intensity not necessarily process related (loss of signal due to window fogging, changes in laser positioning, etc.).

EVT (Endpoint Verification Time): This time is set to provide immunity to false endpoint triggering caused by noise fluctuations in the endpoint signal. Endpoint is called only after the conditions for endpoint (*Threshold* and *Direction*) have been met consecutively for this period of time. Typical values for this time will be in the range of five to 50 seconds. Values too small may result in false endpoint triggering and values too large will result in late endpoint detection.

Graph: This is used to scale the signal intensity for the purpose of the screen display. Normally this should be set to one (1) but, for very weak signals, it can be increased by a factor up to 100.

Screen Display: When the endpoint routine is selected, a window will appear in the RUN screen displaying the output of the detector. The signal is displayed on a scale of 0-100 as a green line and is updated every one second. The horizontal axis represents a ten minute time period and, for times beyond this, the screen will scroll at one minute intervals.

A vertical red line is displayed at the end of the delay period and a dotted yellow line is drawn to indicate the threshold level calculated from the value of *Threshold* selected in the endpoint procedure. When the signal level drops below this value (if "-" was selected) or rises above this value (if "+" was selected), then the *EVT* timer is started and endpoint is called if the signal meets these requirements for the time selected for *EVT* in the endpoint procedure. At this point, endpoint time is indicated in the window title bar and the program proceeds to the next step.

2. DIFFERENTIAL (DIFF_X.DLL)

This is a useful technique to determine endpoint when a step function is expected but when drift in the signal intensity with time prevents the use of a simple threshold algorithm. It is also the most appropriate choice when etching transparent materials and using the laser as an interferometer to determine endpoint. Instead of the raw data, the differential (change in data with time) is used. The values which must be selected are:

Delay Time	(mm:ss)
Direction	(+,-,±)
Threshold	(T)
EVT	(mm:ss)
Graph	(1-100)

Delay Time: During the period of time after the start of the endpoint step, the endpoint search is inactive. This allows time for stabilization of the plasma and emission intensity and should not be set shorter than the compliance time window (15 seconds).

Direction (Change): The setting of this parameter determines whether endpoint is triggered by either a rising value of the differential (+) or a falling value of the differential (-). If (±) is selected, then endpoint is triggered when the signal value falls within the range set by threshold. A knowledge of the process or the surface characteristics of the substrate is necessary to determine the correct setting of this parameter.

Threshold (%): At the end of the delay time, the value of the differential signal is used to search for endpoint. The maximum value of the differential that can be displayed is a range of ±0.1000 (i.e., a relative change in signal of 0.1 or 10% per update period). The maximum value that can be entered in *Threshold* (1000) corresponds to this. For instance, a *Threshold* value of 100 corresponds to a differential threshold setting of 0.010 and the smallest value that can be entered (1) corresponds to a differential threshold setting of 0.0001.

When the signal level exceeds this threshold in the appropriate direction (if "+" or "-" was selected) then endpoint is triggered. If "±" was selected, then endpoint is triggered when the signal falls within the range set in *Threshold*. The actual signal used to search for endpoint is the normalized differential signal (differential signal divided by signal intensity) so that the procedure is insensitive to changes in the absolute signal magnitude. This compensates for any non-process related changes, such as loss of signal due to window fogging or laser beam misalignment.

EVT (Endpoint Verification Time): This time is set to provide immunity to false endpoint triggering caused by noise fluctuations in the endpoint signal. Endpoint is called only after the conditions for endpoint (*Threshold* and *Direction*) have been met for this period of time. Typical values for this time will be in the range of five to 50 seconds, with smaller values used with rapidly changing signals and larger values with more slowly changing signals. Values too small may result in false endpoint triggering and values too large will result in late endpoint detection.

Smoothing is applied to the differential signal to minimize effects due to noise. Since these tend to be worse with slowly changing signals (when *EVT* should be set high), the degree of smoothing is tied directly to the value of *EVT*.

Graph: This is used to scale the differential signal intensity for the purpose of the screen display. For rapidly changing signals a value of one (1) can be used, in which case the display range is ± 0.1 for the differential. For more slowly changing signals, this value can be increased up to 100 which corresponds to a display range of ± 0.001 for the differential.

Screen Display: When the endpoint routine is selected, a window will appear in the RUN screen displaying the output of the detector at one second intervals. The raw signal is displayed on a scale of 0-100 (a green line) and the differential signal is displayed as a bipolar signal (a blue line) with the range determined by the value set in *Graph*. The horizontal axis represents a ten minute time period and, for times beyond this, the screen will scroll at one minute intervals. Values for the differential (AND), the target threshold, EVT and the selected graph range (X) are displayed in the title bar of the screen.

At the end of the delay period a vertical red line is displayed and either a single dotted yellow line is drawn to indicate the threshold level or two dotted yellow lines are drawn to indicate the threshold range. When the differential value (AND) meets the requirements set by *Threshold* and *Direction*, the EVT timer is started and the number in the title bar will commence to count down. If the signal falls out of the selected limits during this time, then the timer will reset. When the timer reaches zero, then endpoint is called, the endpoint time is indicated in the title bar and the program proceeds to the next step.

3.6 WINDOWS

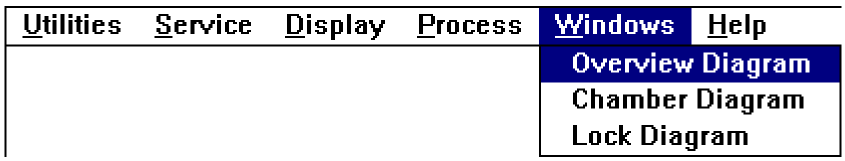


FIGURE 3-64. WINDOWS SUBMENUS

Selecting *Windows* in the *System Monitor* menu displays the following submenus which, when selected, will present the operator with a simple graphic overview of the respective system component(s):

- Overview Diagram
- Chamber Diagram
- Lock Diagram

3.7 HELP

FIGURE 3-65. HELP SUBMENUS

The *Help* menu provides access to a user-friendly on-line User's Manual by selecting *Online Manual*. Selecting *About System Monitor SLR...* yields a screen similar to the following pop-up screen.

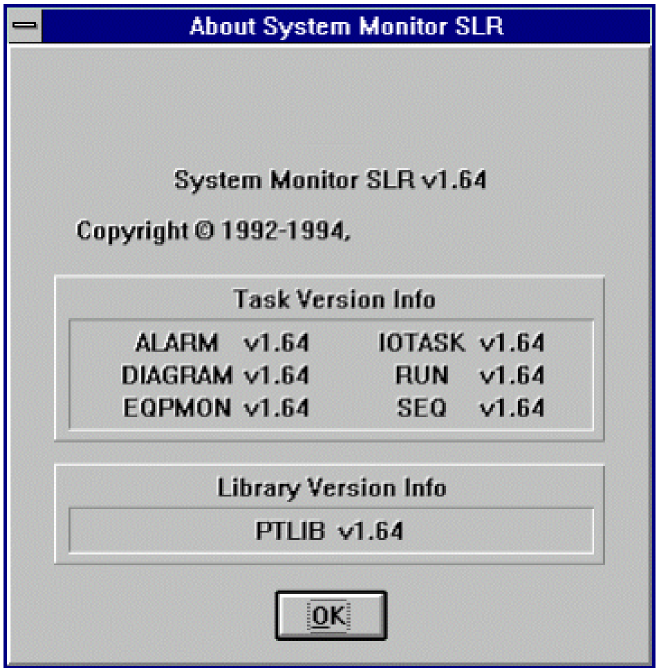


FIGURE 3-66. SAMPLE ABOUT SYSTEM MONITOR SLR POP-UP

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SECTION FOUR: COLD START / SHUT- DOWN

4.1 COLD START PROCEDURE

Use the following procedure to start a SLR system from a cold start, a power failure or an Emergency Power Off (EPO) event. Refer to Figures 2-6 and 2-7.

1. Verify the status of all system utilities - compressed air, nitrogen, cooling water, AC power.
2. Switch wall mounted disconnect switch to ON (up).
3. Ensure that all individual circuit breakers are ON (up).
4. Depress the green MACHINE POWER ON button. It will illuminate to indicate power.
5. OPTIONAL: To test the Emergency Power Off (EPO) circuit, depress the red EPO button on the upper front panel. The machine ON light will go off, indicating power interruption.
6. When machine power is turned on, the core is powered. The core includes the control system, Mainframe power and the heat exchanger (if present). At this time, the operation and leak integrity of the heat exchanger should be verified. Also, the computer, CRT, and all front and rear panel instruments (as well as those in the ECR instrument cabinet, if present) should be turned on. If not, check the position of all individual component ON/OFF switches and correct as necessary.
7. To turn the mechanical pump(s) on, depress the green PRIMARY MECH PUMP and/or DOCKING MECH PUMP ON button(s). The mechanical pump(s) should start. This switch can only be activated after the MACHINE POWER button is activated and power is ON.

NOTE: Cold mechanical pumps will occasionally draw higher-than-normal current during the warm-up period. This can trip the circuit protection. Resetting the circuit protection will be necessary to continue the mechanical pump(s) start-up.

8. To turn the lock pump on, depress the green LOCK PUMP ON button. The lock pump should start. This switch can only be activated after the MACHINE POWER button has been activated and machine power is turned on.
9. After the mechanical pump(s) has been activated, the blower pump (if present) can be activated. The blower can only be activated after the mechanical pump is running.
10. The control system will "boot up" and display a login request. To log in, use the appropriate two passwords and enter the control system. At this time, the EQUIPMENT-ON mode *Utilities* menu can be used to power-up the turbomolecular pump (if present).
11. After a warm-up period to permit the electronics to reach operating temperatures, the machine is ready for routine operation.

NOTE: The capacitance manometer usually requires the longest warm-up time (1 to 2.5 hours).

4.2 SYSTEM SHUT-DOWN PROCEDURE

Use the following procedure to shut-down the SLR system for the weekend or plant closing, etc. If access to the inside of the chamber(s) is required for maintenance or repair after shut-down, the chamber(s) should first be vented to atmosphere. If no access to the chamber(s) is required, it is recommended that the chamber(s) be pumped down and left under vacuum for the shut-down period (refer to Figure 2-7).

> ***CAUTION:*** Prior to disconnecting any delivery lines for process gases or gas control components, those gases should be isolated and the delivery lines evacuated to eliminate any potential exposure to personnel.

1. After the desired vacuum status of the chamber(s) has been established using the PUMP CHAMBER or VENT utilities, the system should be placed in an EQUIPMENT-ON: Idle mode by clicking on the ON button in the lower left hand corner of the *Master Control Panel* (Figure 3-4). This will close all system gate valves and prepare the system for shut-down.
2. If the turbomolecular pump (if applicable) is operating, it should be turned off using the *Utilities* menu.
3. The blower (if present) should be turned off.
4. Turn the mechanical pump(s) off by pressing the red button(s) on the PRIMARY MECH PUMP and/or DOCKING MECH PUMP switch(es).
5. Turn the lock pump off by pressing the red button on the LOCK PUMP switch.
6. Turn system power off by pressing the red button on the MACHINE POWER switch.
7. Turn off the switch on the wall mounted disconnect box.

> ***CAUTION:*** At this time, the system is shut-down. **DO NOT** deactivate any of the system utilities unless necessary. **DO NOT** turn off cooling water on systems with a substrate heater until the heater has cooled to room temperature.

SECTION FIVE: MAINTENANCE

5.1 PRECAUTIONS

WARNING! **POTENTIAL HAZARDS EXIST IN AN ELECTROMECHANICAL ENVIRONMENT. TO PREVENT INJURY TO PERSONNEL OR EQUIPMENT DAMAGE, FOLLOW COMPANY AND GOVERNMENT SAFETY REGULATIONS. KEEP UNAUTHORIZED PERSONNEL OUT OF THE AREA WHILE WORKING ON EQUIPMENT.**

- A competent technician must perform maintenance work.
- Wear appropriate safety clothing when handling contaminated components.
- Allow equipment to cool to a safe temperature before starting maintenance work.
- Do not work unsupervised.
- Check that all required parts are correct and available before starting work.
- If any vacuum or exhaust connections are connected or disconnected, Leak Test the system after maintenance

5.2 MAINTENANCE PREPARATION

Organized maintenance and easy access to information regarding your system will ensure maximum up-time.

A System Configuration sheet is provided in Section Six. This contains information such as system and peripheral model, serial numbers, specific mass flow information, and a footprint of purchased options. You will need to reference this information in the event of warranty repairs.

Record base pressure using a reading from the capacitance manometer. Do not purge flowing process gas or turn on the turbomolecular pump.

Ensure that an adequate supply of the following consumable items is available:

1. Bottled process and inert gases.
2. Distilled water for the heat exchanger (refer to the Equipment Manual for specific information regarding heat exchangers).
3. Vacuum grease for Viton seals.
4. Pump oil (refer to the Equipment Manual for specific information regarding pumps).
5. VCR gaskets.
6. Conflat gaskets (high temperature systems only).

NOTE: Contact the Unaxis Customer Service Department for information about spare parts kits.

5.3 SERVICE CONTRACTS

Unaxis provides Service Contracts that are designed to extend the life of your system and minimize down-time. For more information, contact the Unaxis Customer Service Department at (727) 577-4999.

5.4 MAINTENANCE SCHEDULE

This suggested maintenance schedule is based on moderate daily use:

Maintenance Activity	D	W	M	Q	S	A
CHAMBER AND ELECTRODES						
Chamber - clean (wipe to remove particulates)		X				
Chamber - remove , clean and inspect tooling		X				
O-Rings - inspect, lube if necessary, replace as required			X			
VACUUM SYSTEM						
Mechanical pump oil filter - check pressure, replace as required		X				
Mechanical pump - check oil level	X					
Roots blower - check oil level	X					
Vacuum valves - clean valves and replace O-Rings						X
Check leak up rate (<1u / minute)	X					
LOADLOCK						
O-Rings - inspect, lube if necessary, replace as required			X			
Transfer - verify correct operation, adjust as required				X		
Lock sensor - verify operation, calibrate as required			X			
HEAT EXCHANGER						
Coolant level - check and fill as required	X					
Coolant filter - check, replace as required			X			
Coolant pressure - check, should be <60 psi			X			
RF GENERATOR AND AUTO MATCHING NETWORK						
Forward and reflected power meter - check and calibrate as required			X			
Auto matching network - clean and inspect					X	
RF generator - clean and inspect					X	

(continued)

Maintenance Activity	D	W	M	Q	S	A
GAS CONTROL SYSTEM						
Automatic flow controllers - calibrate		**X**				
Gas panel - clean and inspect					**X**	
Gas panel - perform leak check				**X**		
Perform leak up rate test on each gas line-to-cylinder				**X**		
INSTRUMENTATION						
Capacitance manometer - check and calibrate as required		**X**				
MAIN CABINET						
386/486 Computer - check operation in automatic and manual modes; repair as required				**X**		
Cooling water lines - check for leaks and contamination			**X**			
FACILITIES						
Nitrogen		**X**				
Air		**X**				
Process gas pressure		**X**				
Cooling water pressure		**X**				
Main cabinet exhaust		**X**				
Power				**X**		

Legend
D = Daily
W = Weekly
M = Monthly
Q = Quarterly
S = Semiannually
A = Annually

SECTION SIX: SYSTEM CONFIGURATION

6.1 SYSTEM CONFIGURATION SHEETS

The following System Configuration sheets provide important information regarding your system, such as system and peripheral models, serial numbers, specific mass flow information and a footprint of options purchased, as well as the software configuration. Reference this information whenever you contact the Unaxis, Inc., Customer Service Department.

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APPENDIX A

SOFTWARE TASKS

A.1 System Monitor

The System Monitor controls the system menus, the operator interface and auxiliary task start/stop.

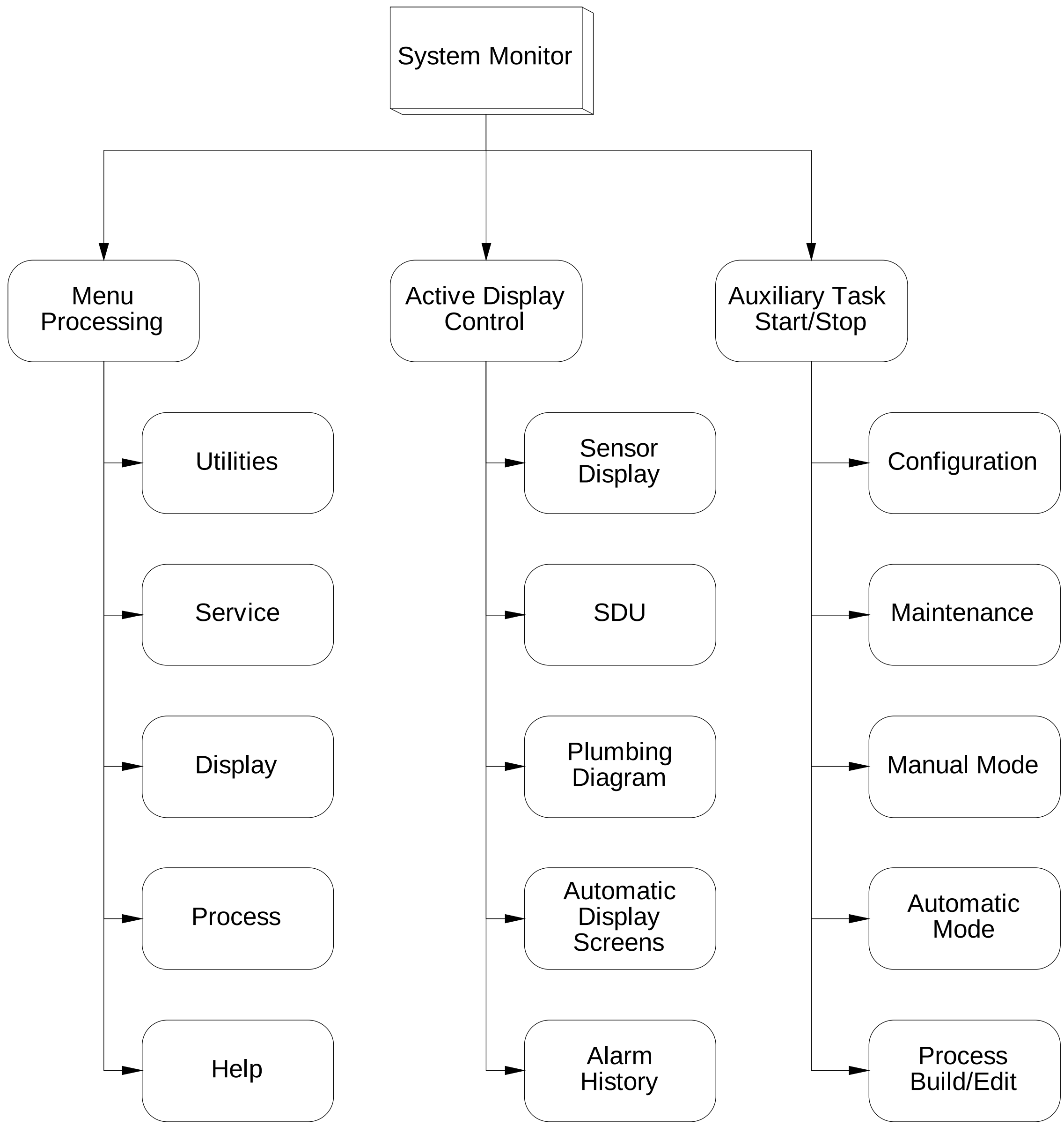

Figure A-1. System Monitor Flow Chart

A.2 Equipment Monitor

The Equipment Monitor runs continuously in the background and makes sure all equipment is in the expected position or condition. The Equipment Monitor will notify the Alarm Manager if an error condition is present.

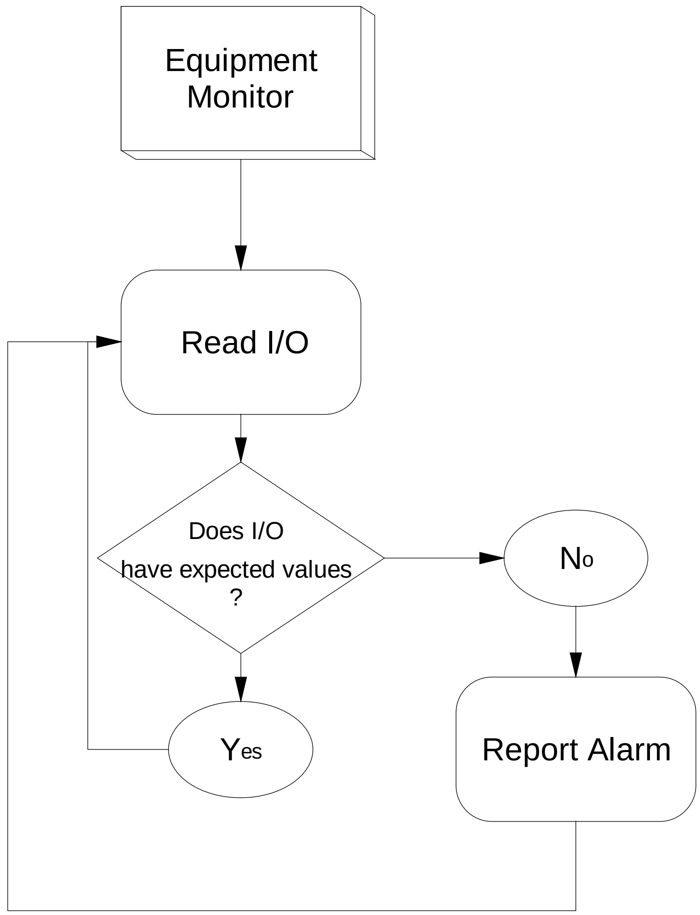

Figure A-2. Equipment Monitor Flow Chart

A.3 Sequencer

The Sequencer controls all standard (canned) operations (i.e., system pump down). The Sequencer also communicates expected conditions to the Equipment Monitor so that errors will be detected by the Alarm Manager. Information will be displayed in the *Info* field of the *Master Control Panel* during sequence operations.

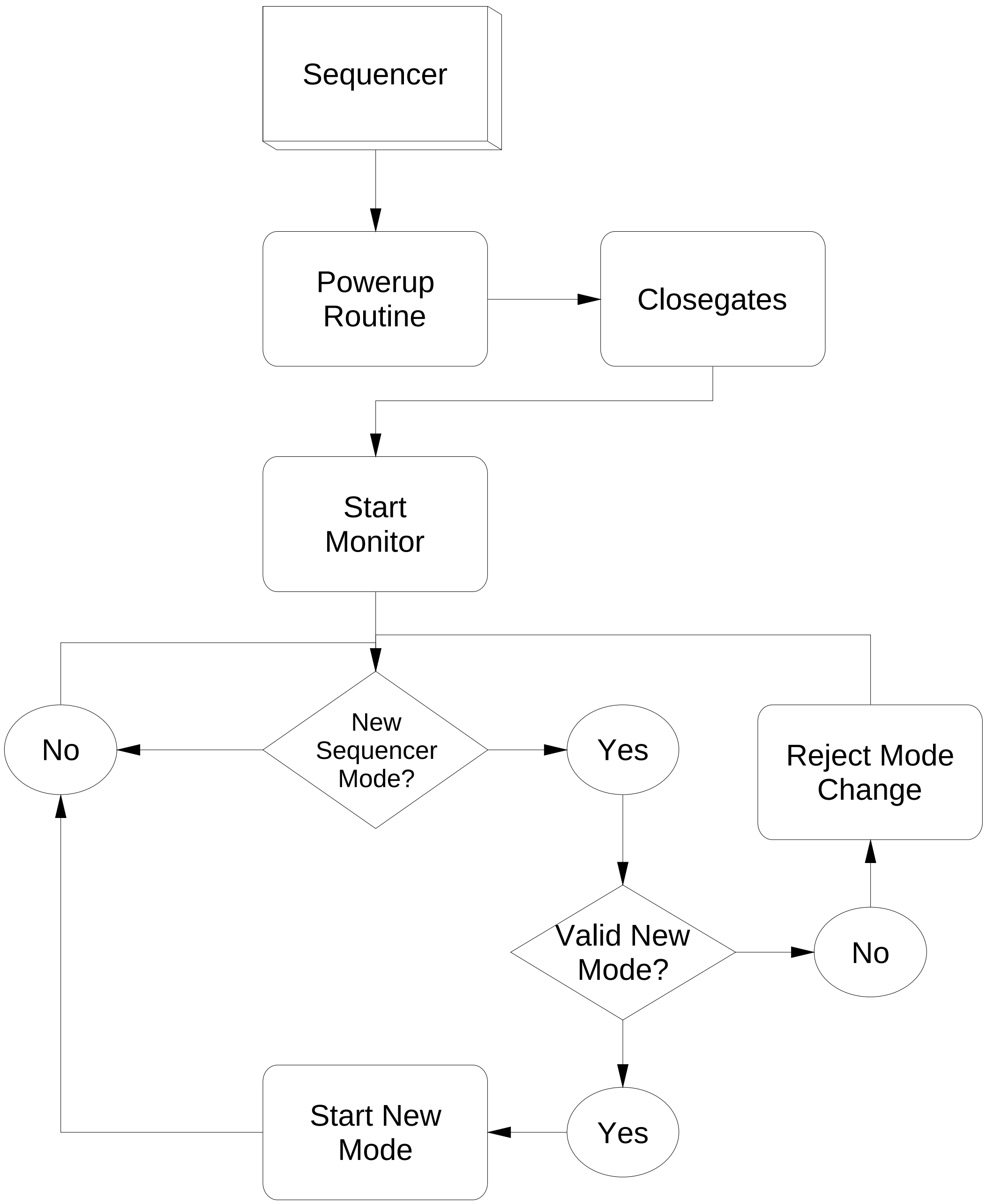

Figure A-3. Sequencer Flow Chart

a.4 Alarm Manager

The Alarm Manager logs alarm messages and communicates alarm information to the System Monitor.

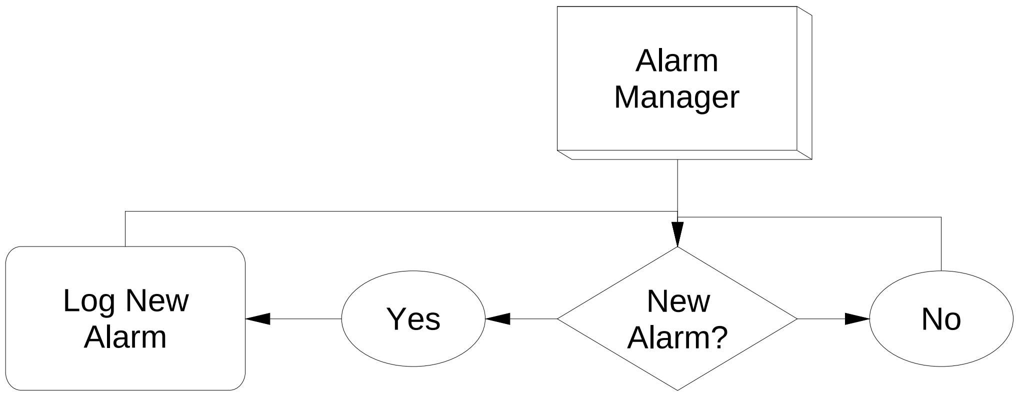

Figure A-4. Alarm Manager Flow Chart

A.5 I/O Task

The I/O Task updates the digital and analog inputs and outputs and sends the updated information to the rest of the system.

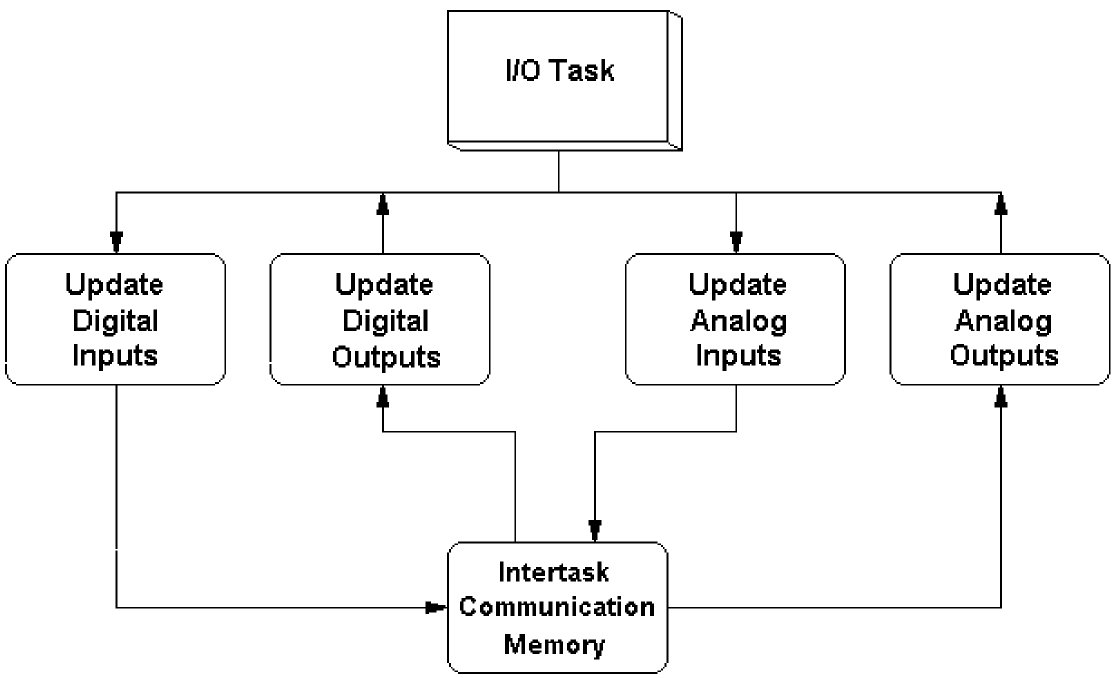

Figure A-5. I/O Task Flow Chart

APPENDIX B

SLR INDUCTIVELY COUPLED PLASMA

B.1 INTRODUCTION.

The Unaxis SLR ICP is an affordable plasma processing platform for processes that require or benefit from high density plasma. The existing base SLR system has been modified to accommodate an Inductively Coupled Plasma (ICP) source. A high conductance pumping system has been included to allow for the relatively low operating pressures of high density plasma systems. Helium backside cooling has been incorporated to allow the temperature of the substrates to be more effectively controlled and the system has been integrated using many of the base features of the Unaxis SLR system.

The major portions of the standard SLR system have been retained and the operation of most of the system features is covered by the standard SLR User's Manual. This supplement will cover the significant differences to allow the ICP user to make effective use of this capable high-density plasma system.

B.2 THEORY OF OPERATION.

In an Inductively Coupled Plasma (ICP) system a high-density plasma discharge is generated by applying RF power into an inductive coil capable of transforming power into a low pressure gas. The coupling mechanism differs from that in a standard diode-type reactive ion etching machine since the power is magnetically applied rather than directly through an electric field. Electrons are heated by an E field (electric field) that exists at right angles to the induced magnetic field. High plasma density can be achieved because power can be transferred into the bulk plasma via the magnetic field resultant from inductive coupling. This differs from capacitive coupling where the applied electric field does not exist within the bulk plasma since it is attenuated by Debye shielding above the pre-sheath. Inductively coupled plasma sources have potential advantages over other high-density sources, such as Electron Cyclotron Resonance (ECR) and Helicons, including simplicity of concept, less stringent requirements on operating pressures, no requirement for *static* magnetic fields and RF power supplied at lower frequencies than microwave systems.

An ICP source is usually configured in either a planar or a cylindrical coil configuration. The Unaxis ICP reactor is based on a cylindrical coil configuration. In this configuration, a dielectric vessel is encircled by an inductive coil into which RF energy is introduced, inducing a strong magnetic field in the center of the chamber. This magnetic field generates a high-density plasma in the chamber (see Figure B-1). This coil configuration is very efficient at coupling RF power into the low pressure gaseous medium.

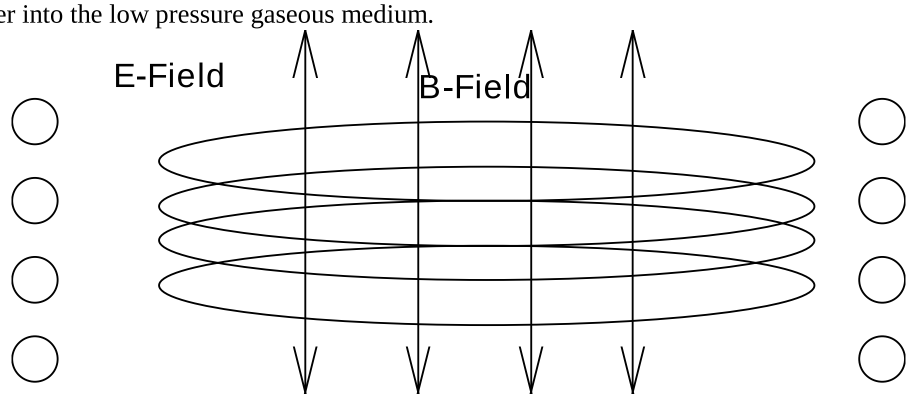

Figure 1

Figure B-1. ICP Electromagnetic Fields

As with most high-density plasma platforms, typical processing pressures are at or below 10 mTorr . At these pressures, plasma quickly diffuses from the generation region to uniformly fill the plasma vessel and drift to the substrate position. Due to the low operating pressure, the excited plasma species are less susceptible to collisional recombination so a high density is maintained at reasonable power levels. Additionally, ions are able to traverse the sheath above the substrate without multiple body collisions. This " collisionless sheath" permits ions to arrive normal to the surface being etched.

The inductive source is mounted on a standard RIE system and consists of a modified chamber top. The modified chamber top contains the inductively coupled plasma source. In addition to the source there is also an RF power supply and impedance matching network. The RF frequency powering the coil is adjustable between 1.7 and 2.1 MHz. This frequency is kept low to reduce the RF impedance of the coil allowing a large current to flow, but above the average ion transit frequencies to avoid direct acceleration of the ions by the RF energy. The lower electrode is powered as in an RIE system, with 13.56 MHz to allow for independent control of the substrate dc bias voltage. The figure below shows a schematic layout of the source design.

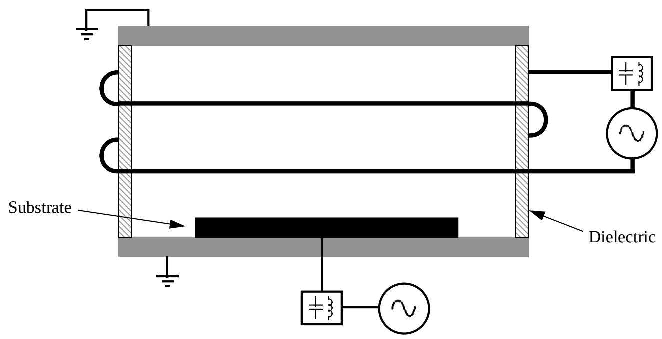

Figure B-2. ICP Source Schematic

High density plasma sources provide some advantages over conventional parallel plate plasma systems. In conventional RIE the plasma density is limited by the method of coupling RF energy into the plasma. This limits the rates at which certain materials can be etched or deposited. This problem becomes particularly acute at reduced pressure where, with the efficiency of an RIE, the plasma density can become prohibitively low. Additionally, in RIE the relationship between power and bias voltage is fixed at any given pressure and gas mixture. This limits bias sensitive applications to low power levels and renders some processing goals unachievable. High density plasma sources allow the bias voltage to be controlled independent of the total input power. By this method the process can be modified for independent control over ion current and bias voltage. This is possible because the primary plasma source does not, by itself generate a power dependent bias voltage on the substrate. (Note: High density sources control the minimum bias voltage for the substrate through the electron temperature and its affect on plasma potential and floating potential.) Bias voltage is controlled through the use of a second RF power supply used exclusively to generate the substrate bias voltage. In this method the ion current density and plasma density are controlled by the power level applied to the high density source and the substrate bias is controlled by the power level applied by the power supply used for substrate bias.

The Unaxis ICP source was designed as an alternative to other existing high density plasma sources and was chosen for its simplicity of construction and user friendly operation. The source consists of a dielectric chamber vessel, an inductive RF coil and a standard RF power supply and automatic impedance matching network. The RF coil was designed to maximize the source current for maximum efficiency in plasma generation versus input power, and to minimize the capacitive coupling component into the plasma.

The vacuum chamber has built-in cooling to ensure temperature control of the source and the system. Active cooling of the substrate is also employed to ensure control of substrate temperature during processing. Many of the physical constraints of the system were determined by the SLR system to which the source was designed to be fitted.

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APPENDIX C

SLR ELECTRON CYCLOTRON RESONANCE

C.1 INTRODUCTION.

The Unaxis SLR ECR is an affordable plasma processing platform for processes that require or benefit from a high density plasma. The existing base SLR system has been modified to accommodate an Electron Cyclotron Resonance (ECR) source. A high conductance pumping system has been included to allow for the relatively low operating pressures of high density plasma systems. Helium backside cooling has been incorporated to allow the temperature of the substrates to be more effectively controlled and the system has been integrated using many of the base features of the Unaxis SLR system.

The major portions of the standard SLR system have been retained and the operation of most of the system features is covered by the standard SLR User's Manual. This supplement will cover the significant differences to allow the ECR user to make effective use of this capable high-density plasma system.

C.2 THEORY OF OPERATION.

In an Electron Cyclotron Resonance (ECR) system a high-density plasma discharge is generated by applying microwave power axially into the center of an electromagnet along the magnetic field lines. The coupling mechanism differs from that in a standard diode-type reactive ion etching machine since the power is coupled into the plasma by means of electron cyclotron resonance. Electrons are heated by absorbing microwave energy at resonance due to the fact that the electron cyclotron frequency of the electrons in an 875 gauss magnetic field equals the microwave frequency of 2.45 GHz. The 875 gauss magnetic field is provided by a large high current solenoidal magnet placed at the window where the microwave energy is introduced into the vacuum chamber. When the electron cyclotron frequency equals 2.45 GHz, resonance occurs allowing electrons to absorb energy and increasing the radius of gyrorotation (see Figure C-1). High plasma density can be achieved because power is transferred into the bulk plasma via this resonant coupling mechanism. This differs from capacitive coupling where the applied electric field does not exist within the bulk plasma since it is attenuated by Debye shielding above the pre-sheath.

An ECR source can contain either a solenoidal magnet or strong permanent magnets to create the 875 gauss region required for resonance with 2.45 GHz. The Unaxis ECR reactor is based on the ASTEX® AX 4400 ECR source which is a solenoidal magnet configuration In this configuration, the microwave window is encircled by a static dc magnetic coil and a microwave source is introduced into the chamber through a quartz window above the chamber along the magnetic field. This generates a high-density plasma in the chamber (see Figure C-2).

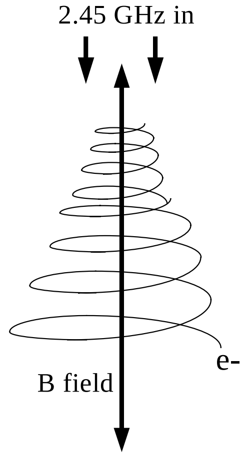

Figure C-1. ECR Coupling Mechanism

As with most high-density plasma platforms, typical processing pressures are at or below 10 mTorr . At these pressures, plasma quickly diffuses from the generation region to uniformly fill the plasma vessel and drift to the substrate position. Due to the low operating pressure, the excited plasma species are less susceptible to collisional recombination so a high density is maintained at reasonable power levels. Additionally, ions are able to traverse the sheath above the substrate without multiple body collisions. This " collisionless sheath" permits ions to arrive normal to the surface being etched.

The modified chamber top contains the Electron Cyclotron Resonance source. In addition to the source there is also an RF power supply and impedance matching network. The microwave frequency is 2.45 GHz. The lower electrode is powered as in an RIE system, with 13.56 MHz to allow for independent control of the substrate dc bias voltage. The figure below shows a schematic layout of the source design.

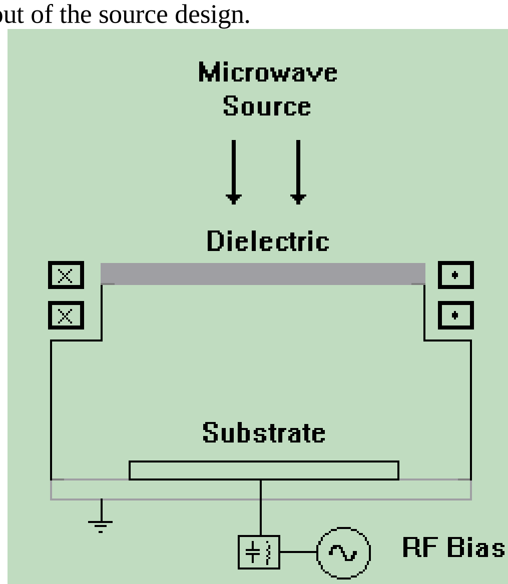

Figure C-2. ECR Source Schematic

High density plasma sources provide some advantages over conventional parallel plate plasma systems. In conventional RIE the plasma density is limited by the method of coupling RF energy into the plasma. This limits the rates at which certain materials can be etched or deposited. This problem becomes particularly acute at reduced pressure where, with the efficiency of an RIE, the plasma density can become prohibitively low. Additionally, in RIE the relationship between power and bias voltage is fixed at any given pressure and gas mixture. This limits bias sensitive applications to low power levels and renders some processing goals unachievable. High density plasma sources allow the bias voltage to be controlled independent of the total input power. By this method the process can be modified for independent control over ion current and bias voltage. This is possible because the primary plasma source does not, by itself generate a power dependent bias voltage on the substrate. (Note: High density sources control the minimum bias voltage for the substrate through the electron temperature and its affect on plasma potential and floating potential.) Bias voltage is controlled through the use of a second RF power supply used exclusively to generate the substrate bias voltage. In this method the ion current density and plasma density are controlled by the power level applied to the high density source and the substrate bias is controlled by the power level applied by the power supply used for substrate bias.

The vacuum chamber has built-in cooling to ensure temperature control of the source and the system. Active cooling of the substrate is also employed to ensure control of substrate temperature during processing. Many of the physical constraints of the system were determined by the SLR system to which the source was designed to be fitted.

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