8. System Interlocks

Device	Interlock	Required Status
Mechanical Pump	Full Range Gauge #1 Crossover Interlock	NOT MADE
Rough Valve	Vent Valve Output	OFF
	Vent Valve Feedback	CLOSED
	High Vac Valve Output	OFF
	High Vac Valve Feedback	CLOSED
	Door	CLOSED
	Full Range Gauge #1 Crossover Interlock	NOT MADE
Vent Valve	High Vacuum Valve Feedback	CLOSED
	Rough Valve Feedback	CLOSED
	High Vac Valve Output	OFF
	Rough Valve Output	OFF
	Door	CLOSED
High Vacuum Valve	Rough Valve Output	CLOSED
	Rough Valve Feedback	CLOSED
	Vent Valve Output	CLOSED
	Vent Valve Feedback	CLOSED
	Full Range Gauge #1 Crossover Interlock	MADE
	Full Range Gauge #2 Regen Setpoint	MADE
Regen Valve	Rough Valve Output	OFF
	Rough Valve Feedback	CLOSED
Purge Valve	None	
Gas 1 Valve	Gas 2 Active	CLOSED

Device	Interlock	Required Status
Gas 2 Valve	Gas 1 Active	CLOSED
IG 2 Valve	None	
Shutter	None	
Heat Power	Door	CLOSED
	Skin Switch (front panel)	MADE
	Vacuum Bellows (minimum vacuum)	MADE
	Fixture Rotation	ON
Low Voltage Power	Full Range Gauge #1 Crossover Interlock	MADE
	Skin Switch (front panel)	MADE
	Vacuum Bellows (minimum vacuum)	MADE
	Low Voltage Cooling Water	ON
Low Voltage A and B	None	
Ion Source Neutralizer Power	High Vac Valve	CLOSED
	Vacuum Bellows (minimum vacuum)	MADE
	Ion Source Cooling Water	ON
Ion Source Drive Power	Gas 1 or Gas 2	ON
	Full Range Gauge #1 Crossover Interlock	MADE
	High Vac Valve	OPEN
	Vacuum Bellows (minimum vacuum)	MADE
	Ion Source Cooling Water	ON
Electron Beam Gun - High Voltage	High Vac Valve	OPEN
	Full Range Gauge #1 Setpoint #1 Interlock	MADE
	Vacuum Bellows (minimum vacuum)	MADE
	Skin Switch (front panel)	MADE
	E-Gun Cooling Water	ON
	Crucible at Pocket	MADE

Device	Interlock	Required Status
Electron Beam Gun - Emission	High Vac Valve	OPEN
	Full Range Gauge #1 Crossover Interlock	MADE
	Vacuum Bellows (minimum vacuum)	MADE
	Skin Switch (front panel)	MADE
	E-Gun Cooling Water	ON
	E-Gun High Voltage	ON
Flip Mechanism	None	
Fixture Rotation	None	

9. System Alarms

Purpose: The purpose of this section is to outline the manual steps required to correct an alarm condition in an Infinity™ 26 vacuum system

This section will deal only with the alarms that could occur during an automatic process and the manual procedure to recover and continue the process.

Any Alarm that could interrupt an automatic process will be an Audible Alarm. The Alarm Indicators will be visible in red at the top of the Overview Screen and the Audible Alarm will be activated. The Automatic process will be halted until an operator acknowledges the Alarm, corrects the problem, determines the step in the process where the Alarm occurred, and Downloads a new recipe.

The Recovery recipe should contain an AutoPump step, any Auto Deposit steps required to complete the process and an Autovent step. Specific instructions are listed below.

9.1. Alarms

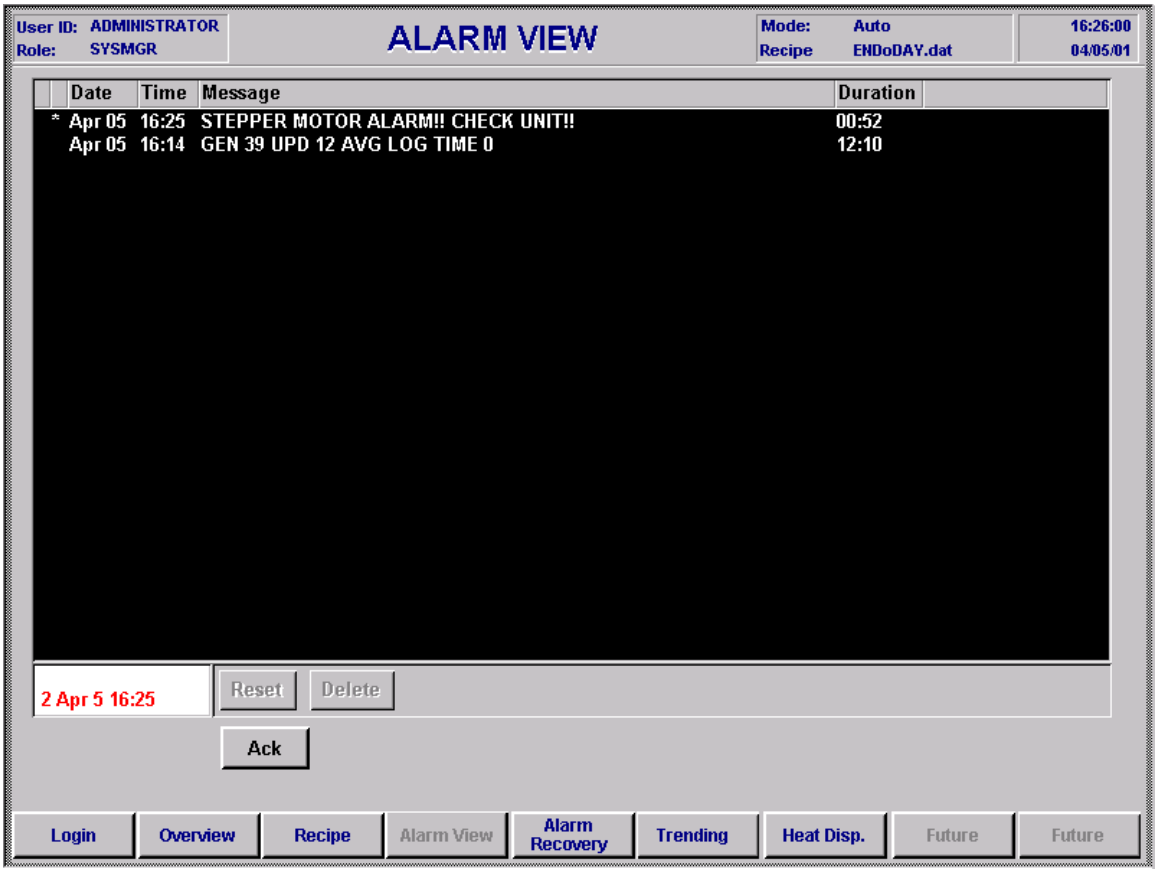
Many Alarms are programmed into the control package. Some will stop an Automatic Recipe. An Audible Alarm and visual indicators appear on the Overview Screen if the Recipe is halted.

A partial list of Alarm conditions is included here for reference. A complete list of Alarms is included later in this section of the manual.

- **AutoPump**
  - Door not closed.
  - Backing pressure too high.
- **Autovent**
  - High vacuum pump pressure too high.
- **AutoHeat**
  - Temperature setpoint not met within preset time limit.
  - Temperature exceeds set point.
- **Ion Preclean**
  - Ion source filament automatic changeover.
  - Minimum pressure setpoint not met.
  - Chamber pressure exceeds maximum setpoint.

- **Deposition**

  - Electron beam gun high voltage is off.
  - Crucible rotation is jammed.
  - Deposition rate crystal failed.
  - Service mode during automatic sequence stops cycle.



9.2. Alarm Screen

1. When an Alarm condition occurs, the Audible alarms will sound and the Alarm indicators will appear on the Overview Screen. Push the Alarm button at the bottom of the Overview Screen to go to the Alarm Screen.

2. There will be an Alarm message listed on the Alarm Screen to alert the operator to what is causing the Alarm.

3. Push the ACK button to stop the Audible Alarm.

4. ***NOTE****: The Alarm condition must be corrected to proceed with an automated process. If the Alarm condition exists and the system is in Auto Mode, the Audible Alarm will reactivate every 60 seconds. This will continue until the Alarm condition is corrected or the system is taken out of Auto Mode.*

5. The operator must determine where the recipe stopped before pushing the Manual or Reset buttons.

6. Check the Sequence Running window on the Overview Screen to determine what step is currently active and compare to the Alarm Recovery Screen,

7. If the Sequence Running is AutoPump, AutoHeat, Ion Preclean:

   - Correct the problem, press the Reset and Start buttons on the Overview Screen and restart the Recipe.

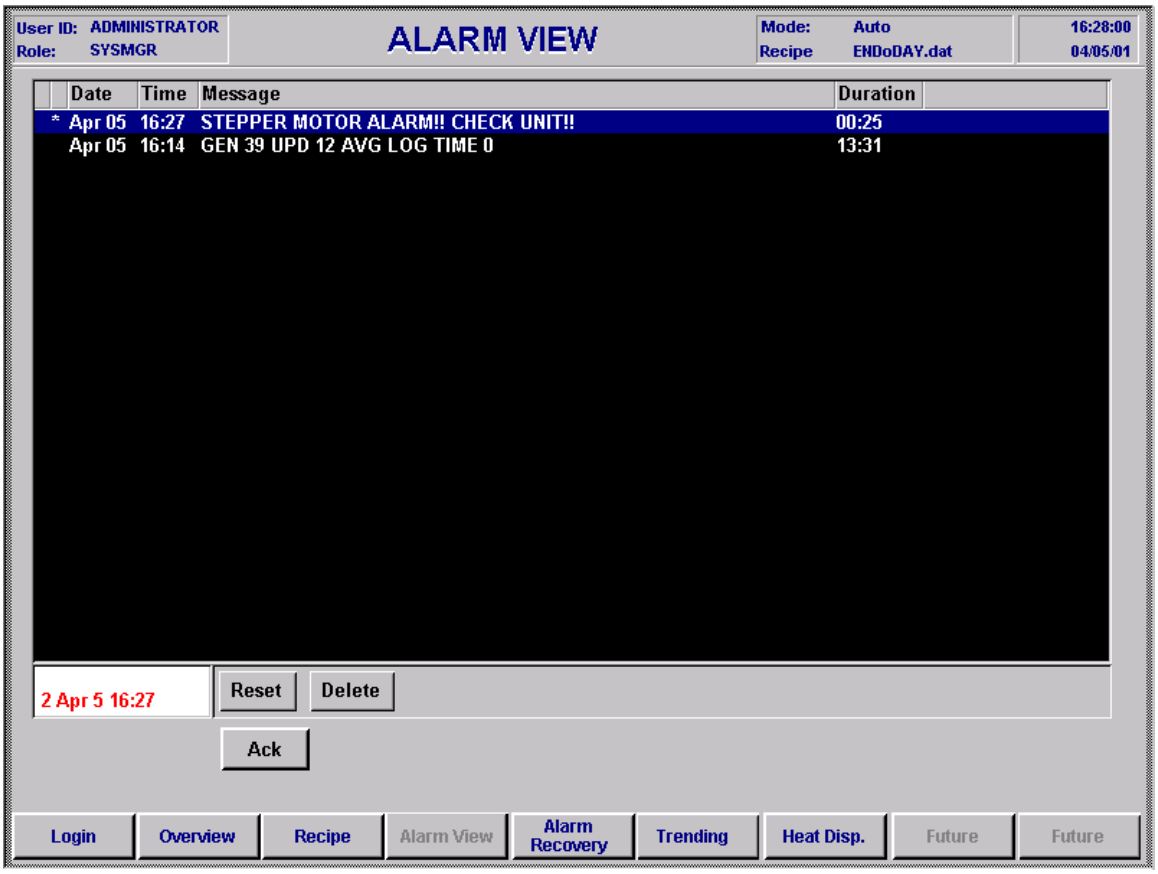
8. If the Sequence Running is Autovent:

   - Go to the Master Recipe Builder Screen, Open the Recipe file, and Open the Recovery file. Verify that Autovent is the only step and download the Recovery recipe and Start it on the Overview Screen.

   - *Or* Go to the Master Recipe Builder Screen, Open the Recipe file, Open the Autovent file. Download the Autovent recipe and Start it on the Overview Screen.

9.If the Sequence Running is an Auto Deposit step:

   - Use Alarm Recovery Program as outlined below.



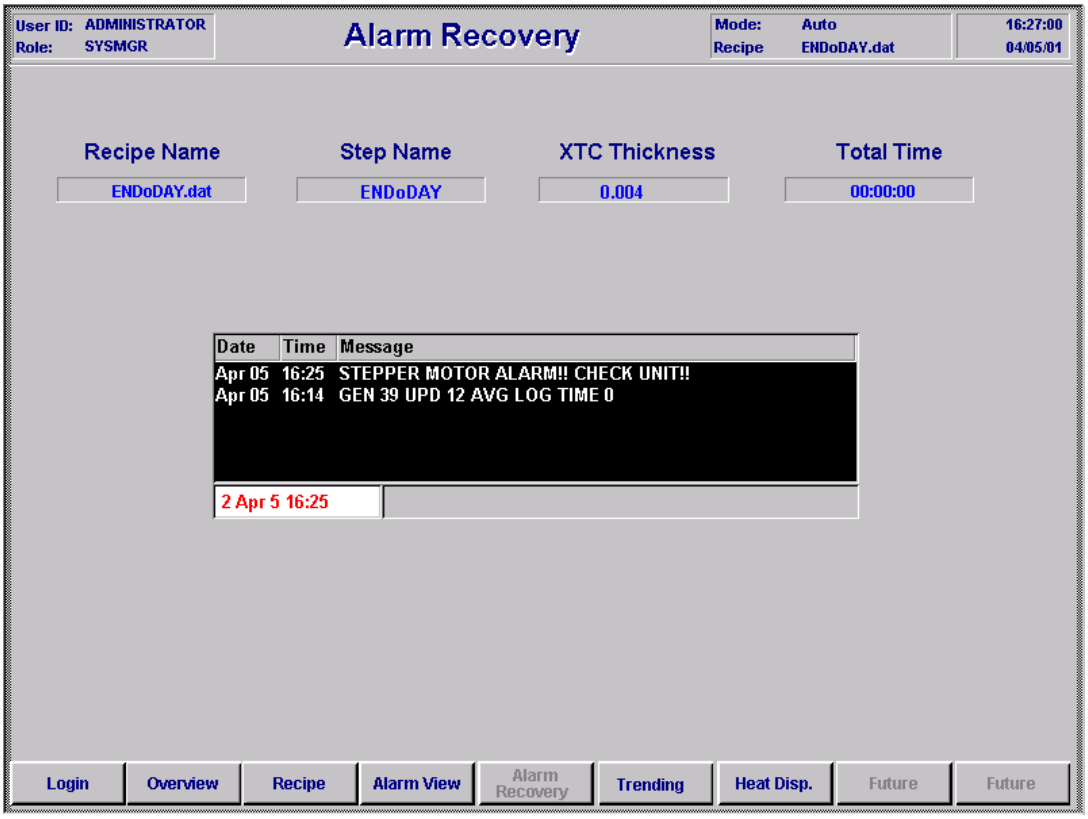
9.3. Clearing the Alarm Screen

1) The ACK button will reset the Audible Alarm.

2) To clear the Alarms displayed on the Alarm Screen, highlight one Alarm by double clicking on it.

3) This will activate two buttons at the bottom: Reset, Delete

4) The Reset and Delete buttons will clear the Alarm from the Alarm Screen.



9.4. Alarm Recovery Screen

Any time an automatic recipe is interrupted, the data required to complete that recipe is captured on the Alarm Recovery Screen. The Alarm Recovery Screen is accessed by pushing the button at the bottom of any other control Screen. The Recipe Name, Step Name, XTC/2 Thickness, Total Time, and the Alarm messages are displayed on this Screen. This information can be used to recover from the interruption.

The Recovery recipe in Recipe Builder is factory programmed to capture the remaining steps in the current automatic recipe. Follow the instructions listed below to complete an automatic recipe that has been interrupted. Administrator security access is required to complete the recovery process.

1. Login as System Administrator

2. Compare the XTC/2 thickness and Step Name on the Alarm Recovery Page with the recipe step thickness in the XTC/2 Configuration. Determine if the current layer is not started, complete or partial.

3. If the layer is *not started or complete*:

   - Go to the Master Recipe Builder Screen and open the Recovery file.
   - Verify the first layer is correct. (Step Name on Alarm Recovery Screen = first layer of Recovery) Insert an Auto Pump step at the top of the recipe.
   - Download the Recovery recipe and Start it on the Overview Screen.

4. If the layer is *partial*:

   - Go to the XTC/2 Configuration Screen and open the file for the incomplete layer.
   - Change the final thickness by subtracting the XTC/2 Thickness from the Alarm Recovery Screen.
   - Go to the Master Recipe Builder Screen and open the Recovery file.
   - Verify the first layer is correct. Insert an Auto Pump step at the top of the recipe.
   - Download the Recovery recipe and Start it on the Overview Screen.

9.5. Alarm Messages

The following list contains all possible alarm messages as they appear on the Alarm Screen and a brief explanation of the alarm message. (%s indicates the name of a point in the system database.)

NOTE: Some alarms are built into the software and are used to control the transfer of information into and out of a database. Others are built into the software to handle network control. These alarms require little or no action on the part of the operator.

Other alarms are programmed into the software to insure safe operation of the vacuum system. These require action by an operator before they are cleared.

Alarm Message	Explanation	Recommended Action
Point %s has exceeded its Raw Limits	The 0-10 volt signal of any instrument has exceeded its limits.	Acknowledge, Delete & Ignore
GEN %s UPD %s AVG LOG TIME %s	Alarm Management internal alarm - for testing	Acknowledge, Delete & Ignore
Logging failure on database table %s	Failure of data logging into the database: internal alarm	Acknowledge, Delete & Ignore
Comm error or dynamic disable, device %s	XTC/2 Deposition Controller is not communicating with system.	Reboot the system.
Failing over to redundant device %s	Device Failover alarm for PLC redundancy.	Acknowledge, Delete & Ignore
Log file almost full	Network alarm.	Acknowledge, Delete & Ignore

Alarm Message	Explanation	Recommended Action
User ID %s disabled, computer %s	User disabled due to bad login.	Acknowledge, Delete & Ignore
User %s Logged ON	Network alarm.	Acknowledge, Delete & Ignore
User %s Logged Out	Network alarm.	Acknowledge, Delete & Ignore
%s of the redundant pair is down	Alarm for PLC redundancy.	Acknowledge, Delete & Ignore
Node %s detect link to %s is %s	Network alarm.	Acknowledge, Delete & Ignore
Ion Source Alarm!! - NEUTRALIZER FILAMENT BROKEN !!	Ion Source neutralizer filament broken.	Replace neutralizer filament.
AUTO PRE-CLEAN ALARM - MIN. VACUUM SETPOINT TIMEOUT!!	Chamber did not pump down to minimum vacuum pressure setpoint in preset amount of time.	Check for possible cause (i.e. leak, outgassing). Correct and proceed.
AUTO PRE-CLEAN ALARM - CHAMBER EXCEEDS MAX. VACUUM	Pressure in chamber exceeds safe limits. Possible gas overflow into chamber or cryopump failure.	Stop gas flow into chamber and check cryopump operation.
AUTO DEPOSIT ALARM - E-BEAM HI-VOLTAGE OFF!!	E-gun high voltage is off during a deposition. Possible arcing.	Turn high voltage ON and proceed. Check e-gun manual.
AUTO DEPOSITION ALARM - CRUCIBLE MALFUNCTION!!	E-gun crucible jammed.	Free the e-gun rotation and proceed.
AUTO HEAT ALARM - TEMPERATURE SETPOINT TIMEOUT!!	Temperature setpoint not reached in preset amount of time.	Check heater operation. Possible blown fuse or failed thermocouple.
AUTO HEAT ALARM – OVERSETPOINT LIMIT!!	Temperature exceeds setpoint.	Check heater operation. Possible failed thermocouple.
AUTO PROCESS ALARM - DOOR NOT CLOSED!!	Automatic cycle will not start: door open.	Close the door and proceed.
AUTO PUMP ALARM - CROSSOVER SETPOINT TIMEOUT!!	Crossover setpoint not reached in preset amount of time.	Check for possible cause (i.e. leak). Check mechanical pump. Correct and proceed.
AUTO PUMP ALARM - PROCESS PRESSURE SETPOINT TIMEOUT!!	Process pressure setpoint not reached in preset amount of time.	Check for possible cause (i.e. leak). Check cryopump. Correct and proceed.

Alarm Message	Explanation	Recommended Action
Rough valve fault	Rough valve not closed or open completely.	Check compressed air supply. Check operation of valve manually.
Vent valve fault	Vent valve not closed or open completely.	Check compressed air supply. Check operation of valve manually.
AUTO VENT ALARM - HI VACUUM PUMP PRESSURE TOO HIGH!!	Pressure in cryopump is too high for safe operation.	Suspect leak in high vacuum valve. Rough out to crossover and cycle high vacuum valve manually a few times. If it still leaks, shut down cryopump and repair leak.
AUTO PROCESS COMPLETE	Automatic process has ended.	No action required.
CHIP CHANGER JAMMED!!!	Rotating crystal sensor is jammed.	Break vacuum, repair sensor. See vendor-operating manual.
XTC/2 CRYSTAL FAIL!!	XTC/2 active crystal has failed.	Change active crystal to back up if equipped. Replace crystal after current process. Break vacuum and replace crystal if backup is not available.
CRYSTAL LIFE ALARM !! – CHANGE CRYSTAL!!	Active crystal sensor has exceeded programmed life setpoint.	Change active crystal to back up if equipped. Replace crystal after current process.
The process %s has lost its database connection to %s	Database connection failed.	Reboot the system.
The process %s has begun to forward data to %s	Database communication error.	Reboot the system.
INTERLOCK ALARM!! NO E-BEAM GUN WATER!!	Insufficient water flow to the e-gun source.	Check water flow at manifold. Adjust flow or eliminate blockage.
ION GAUGE OFF!!	Ion gauge tube has gone OFF probably due to overpressure in chamber.	Turn gauge tube ON and proceed. Identify what caused overpressure condition.
ION SOURCE ALARM!! CHECK ION SOURCE!!	Ion source drive current or voltage is outside of normal operational limits. Ion source is open, shorted or gas flow is incorrect.	Check Ion Source for open or short. Verify gas flow vs. pressure and quality of gas.
INTERLOCK ALARM!! NO ION SOURCE WATER!!	Insufficient water flow to the ion source.	Check water flow at manifold. Adjust flow or eliminate blockage.
ION SOURCE ALARM!! FILAMENT BROKEN!!	Neutralizer filament is broken.	Replace filament.

Alarm Message	Explanation	Recommended Action
INTERLOCK ALARM!! NO LV#1 WATER!!	Insufficient water flow to the low voltage source.	Check water flow at manifold. Adjust flow or eliminate blockage.
MAINT ALARM - SERVICE MODE DURING AUTO PROCESS !!	Service Mode attempted during an automatic process.	Acknowledge and proceed.
MAINT ALARM - ROUGH VALVE OPEN!!	Valves are interlocked for safe operation. Alarm responds to interlocks in Manual Mode.	Close Rough Valve and proceed.
MAINT ALARM - HIVAC VALVE OPEN!!	Valves are interlocked for safe operation. Alarm responds to interlocks in Manual Mode.	Close Hivac Valve and proceed.
MAINT ALARM - VENT VALVE OPEN!!	Valves are interlocked for safe operation. Alarm responds to interlocks in Manual Mode.	Close Vent Valve and proceed.
Process %s Terminated on %s Process name %s	Process terminated unexpectedly.	Reboot the system.
CRYSTAL FAIL!! CHECK XTC/2	Crystal monitor failed.	Replace crystal and proceed.
REGEN ALARM!! 3RD setpoint Failure!!	Cryopump has been purged and pumped three times and has not made minimum vacuum setpoint. Auto Regen program stops after third failure.	Check Cryopump for possible leaks or contamination. Check lowest attainable pressure for mechanical pump
REGEN ALARM!! RATE OF RISE TEST FAIL!!	Cryo-pump will not hold vacuum setpoint for one minute.	Check Cryopump for possible leaks or contamination.
REGEN ALARM!! 20 MIN PURGE CYCLE START!!	Cryo-pump has not made minimum vacuum setpoint. Failed after first or second purge & pump cycle.	This alarm for information purposes only. Auto Regen program will not stop after first or second failure. (See 3rd Failure Alarm above)
INTERLOCK ALARM!! SKINS REMOVED!!	Lower panels removed from the vacuum system.	Replace the panels and proceed.
LOW VOLTAGE ALARM!! BOAT BROKEN	No feedback current when low voltage power is ON.	Replace low voltage source ("boat").
E-BEAM EMISSION OFF	Hardwired interlock open on e-gun power supply when e-beam is ON.	Identify and correct interlock on e-beam power supply.

Alarm Message	Explanation	Recommended Action
ION SOURCE FILAMENT CROSSOVER!! REPLACE AND RESET PB	Ion source filament broken or crossover voltage setpoint exceeded. Automatic switchover to second filament.	Acknowledge alarm; replace primary ion source filament when chamber is vented after run; RESET PUSHBUTTON ON ION SOURCE STATUS & CONTROL SCREEN.
ION SOURCE ALARM!! FINAL FILAMENT!!	Second ion source filament broken or crossover voltage setpoint exceeded. Automatic switchover to third filament.	Acknowledge alarm; replace all ion source filaments when chamber is vented after run; RESET PUSHBUTTON ON ION SOURCE STATUS & CONTROL SCREEN.
DIFF PUMP ALARM!! – HI TEMPERATURE!!	Diffusion Pump temperature sensor has exceeded programmed limit.	Check Diffusion Pump cooling water. Check diffusion operating manual.
DIFF PUMP ALARM!! THERMAL PROTECTION CUTOUT	Diffusion Pump temperature sensor has exceeded internal temperature limit.	Check Diffusion Pump cooling water. Check diffusion operating manual.
DIFF PUMP ALARM!! – LOW TEMPERATURE!!	Diffusion Pump temperature sensor has dropped below programmed limit.	Check Diffusion Pump cooling water or electrical circuit. Check diffusion operating manual.
XTC/2 OR OMNISERVER DOWN!! Reboot System CPU	Essential communication software has been shut down. Main PC cannot communicate with subsystems.	Reboot main PC. All required software will reinitialize.
ROTATION ALARM!! ROTATION JAMMED	Not active on this system.	Acknowledge, Delete & Ignore
STEPPER MOTOR ALARM!! CHECK UNIT!!	Fixture rotation motor has faulted.	Automatic process will stop. In Manual, RESET fault on the Rotation Status Screen. Restart run.
NO SIGNAL FROM AMPLIFIER; PROCESS ENDED!!	Not active on this system.	Acknowledge, Delete & Ignore

10. Recipe Builder

Purpose: The purpose of this section is to outline the steps required to create a recipe for depositing multi-layer coatings in an Infinity™ vacuum system.

Master Recipes consist of one or more automated preprogrammed steps. A Master Recipe can contain a maximum of 799 steps. Master Recipes are saved as files for future use. Each step in a recipe consists of a Building Block or Automated Sequence Configuration. Use the Recipe screen for all recipe building functions. Master Recipes can be accessed by system operators and administrators.

Non-Programmable Sequence Configurations are programmed at the factory and cannot be reprogrammed by an operator. Programmable Sequence Configurations can be programmed and saved in files for future use. Programmable Sequence Configurations are not accessible to operators. The System Administrator clearance is required to access Programmable Sequence Configurations. (See System Security)

Auto Regen is non-programmable and is used only for system shutdown, startup, and Cryo-pump regeneration. It should not be combined with other Sequence Configurations. It is programmed to run as a stand alone recipe. A complete description of this program appears later in the AutoRegen Section. (Non-Functional with a Diffusion Pump.)

Flip is factory programmed to flip the substrate holders after the first side of the substrate has been coated. The second side of the substrate can be coated after it has been flipped. No programming is required by an operator for Auto Flip.

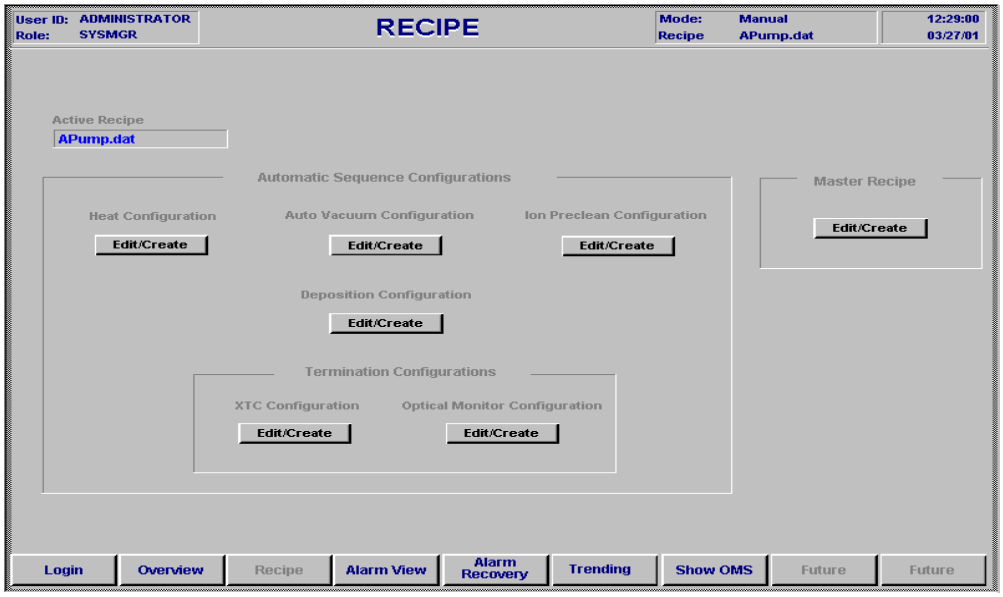
Auto Vent is factory programmed to be the last step in all recipes to vent the system to atmosphere safely. The Vent Delay time is programmed in the Auto Vacuum Configuration and can be changed in the front Overview screen.

Startup is factory programmed to run as a stand alone recipe. A complete description appears later in this section. It is used to start-up the diffusion pump automatically to prepare for system operation.

Shutdown is factory programmed to run as a stand alone recipe. A complete description appears later in this section. It is used to shut down the diffusion pump automatically to prepare for complete system shut down.

The **Recovery** Recipe file is factory programmed to restart a process that has been stopped by an alarm condition or aborted by an operator. The Recovery file will always contain the remaining recipe steps required to complete the current automatic process. The interrupted automatic process can be continued to completion using the Recovery file in conjunction with the information on the Alarm Recovery Screen. See the System Alarms Section for a complete description of this factory programmed recipe file.

All other Automatic Sequence Configurations require initial programming. The System Administrator can program these steps and save them as files for future use as Sequence Configurations in Master Recipes. The Configuration screens are accessed through the Recipe screen by a System Administrator (see System Security). A detailed description of the Automatic Sequence Configurations and programming options follow.



10.1 Automatic Sequence Configurations

- **Non-Programmable**
  - Auto Regen
  - Auto Vent
  - Flip
  - Startup
  - Shutdown
  - Recovery
- **Programmable** *(accessed by System Administrator only)*
  - Auto Heat Configuration
  - Auto Vacuum Configuration
  - Ion Preclean Configuration
  - Glow Configuration (if equipped)
  - Auto Deposition Configuration
  - XTC/2 Configuration

10.2 Non-programmable Automatic Sequence Configurations

10.2.1 Auto Regen (CryoPumps ONLY)

- Fully programmed, complete process - requires *no other* recipe steps and only one programming input.
- The Purge Time is programmed at the factory.
- DO NOT use as a step in a recipe.

- This building block is saved as a recipe in the recipe file: "regen.dat".
- This process is used to start or shutdown the vacuum system. It is also used to regenerate the cryopump for routine maintenance.
- A complete description of this program is included later in this manual (see Auto Regen Section, if equipped).

10.2.2 Startup (Diffusion Pumps ONLY)

- Fully programmed, complete process - requires *no other* recipe steps and only one programming input.
- DO NOT use as a step in a recipe.
- This building block is saved as a recipe in the recipe file: "STARTUP.dat".
- This process starts the diffusion pump in accordance with the manufacturers' recommendations.
- A complete description of this program is included in the Pumping System Operation section of this manual.

10.2.3 Shutdown (Diffusion Pumps ONLY)

- Fully programmed, complete process - requires *no other* recipe steps and only one programming input.
- DO NOT use as a step in a recipe.
- This building block is saved as a recipe in the recipe file: "SHUTDOWN.dat".
- This process shuts-down the diffusion pump in accordance with the manufacturers' recommendations.
- A complete description of this program is included in the Pumping System Operation section of this manual.

10.2.4 Flip

- Fully programmed, complete process - requires *no other* recipe steps or programming input.
- This Building Block is used to flip the substrate holders between coating sides.

10.2.5 Auto Vent

- Fully programmed, complete process - requires *no other* recipe steps and only one programming input. The only operator input is the Vent Delay time in the Auto Vacuum Configuration Screen.

- The Vent Delay time can be adjusted to allow for cooling of substrates before opening the chamber door. The Vent Delay Timer is programmed in the Automatic Vacuum Configuration but can be changed on the Overview screen. The Vent Delay Timer begins AFTER the meissner trap (if equipped) is defrosted.

- This Building Block is saved as a recipe file: "AUTOVENT.dat". Use this recipe to vent the system to atmosphere after the system was in AUTOPUMP.

- Use the Auto Vent Building Block as the last step in any recipe to vent the system to atmosphere safely.

10.2.6 Recovery

a) Factory programmed to capture the remaining recipe steps when an automatic process is stopped or aborted.

b) Final thickness of first remaining recipe step must be changed if process was stopped in the middle of a layer. Use data on the Alarm Recovery screen to make changes.

c) **NOTE:** Auto Pump step must be inserted as first step of Recovery recipe before downloading the recipe.

d) See System Alarms section of this manual for complete instructions on Alarm Recovery.

10.3 Programmable Automatic Sequence Configurations

Note: Programmable Sequence Configurations are not accessible to System Operators. All Programmable Sequence Configurations are accessed *only* by the System Administrator. (See System Security)

All programmable Recipe steps are saved as Windows files. Programmable and non-programmable recipe steps can be combined to develop recipes that are also saved as Windows files.

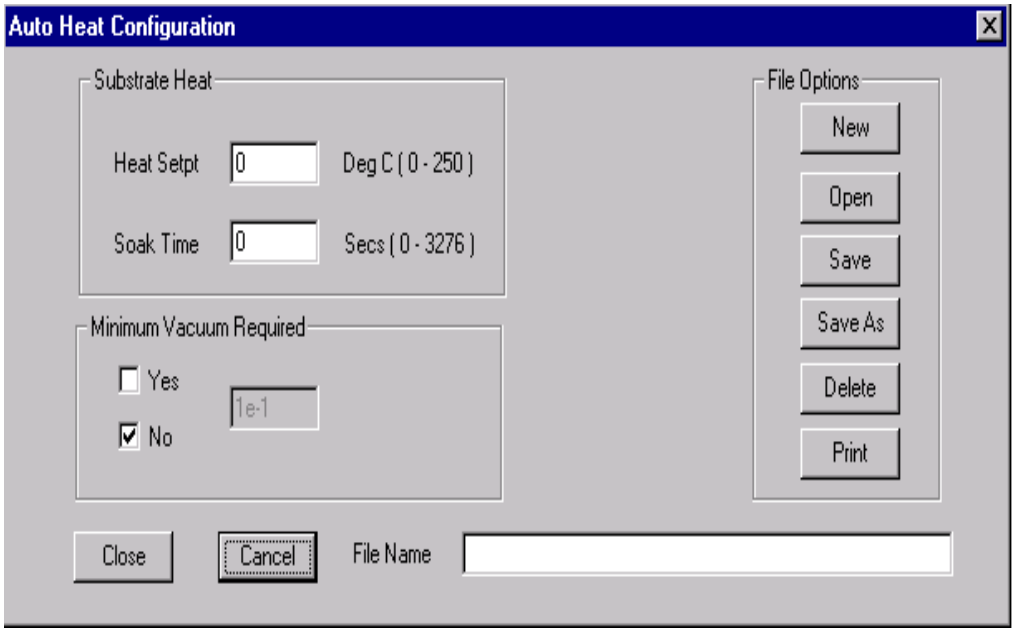
All programmable Automatic Configuration Screens have File Option buttons on the right side. The System Administrator can start a New file, Open an existing file, Save the displayed settings as a new file, Save As a different file, Delete, or Print an existing file. The current file name is displayed at the lower right corner of the configuration screen.

All configuration screens have a Close and Cancel button at the lower left corner. Always Close or Cancel a screen when finished with a screen.

The System Administrator can Open an existing file, make any programming changes, Save As the previous file name, or Save as a new file name.

The Print, Import, and Export buttons convert the displayed file into a .csv file. This file format is compatible with Microsoft Excel spreadsheet software and can be displayed, stored or printed as an Excel file. Every system is supplied with Microsoft Excel. These files can be easily be copied to disk and transferred to other computers.

10.3.1 Auto Heat Configuration



Note: Programmable Sequence Configurations are not accessible to System Operators. All Programmable Sequence Configurations are accessed *only* by the System Administrator. (See System Security)

- The **Auto Heat Configuration** screen is accessed through the Recipe screen.
- This Building Block is used to heat the substrate before deposition.
- Use the Auto Heat Building Block as the second step in a recipe.
- Programming changes are made on the Auto Heat Configuration screen.

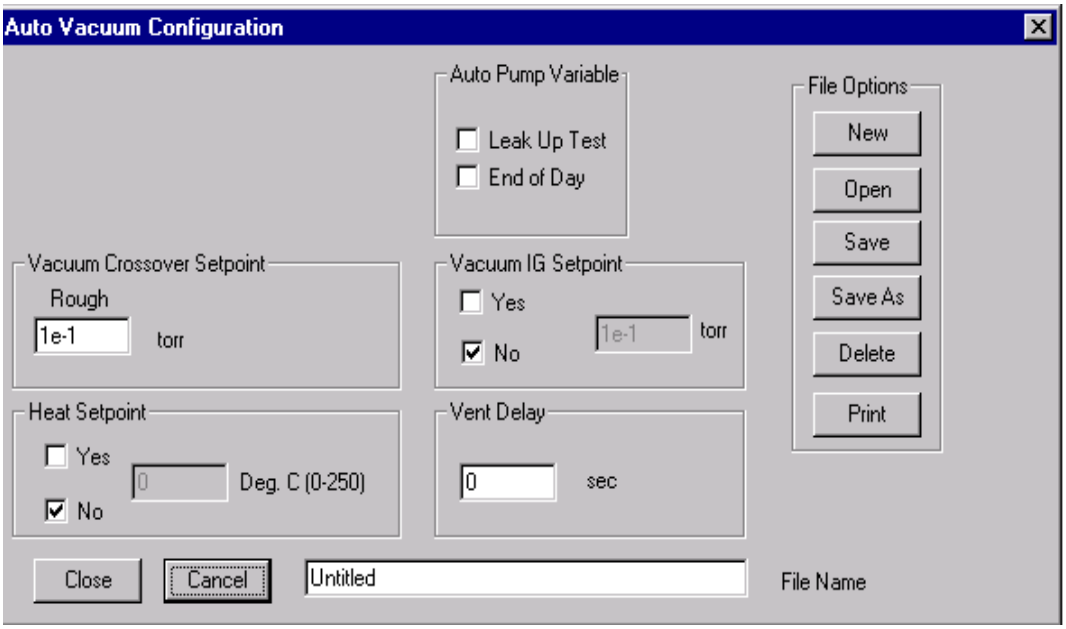
10.3.1.1 Programmable Features:

- Heat Setpoint 0 - 200 ^{0}C
- Soak time 0 - 32767 seconds
- Minimum Vacuum Required (wait for pressure setpoint before process step begins?)
    - Programmable setpoint (mbar) interfaced to PBR-1

Note: Temperature is controlled through the system PLC. Temperature control parameters (PID and Lower Clamp) are programmed on the Heat Status & Control screen. This screen is accessed through the Overview screen with the system in the Manual mode. These parameters are NOT available in the Automatic mode. See the Software Overview section of this manual. Temperature control data can be viewed through the Heat Display screen.

Note: Press CLOSE button to close the configuration screen

10.3.2 Auto Vacuum Configuration

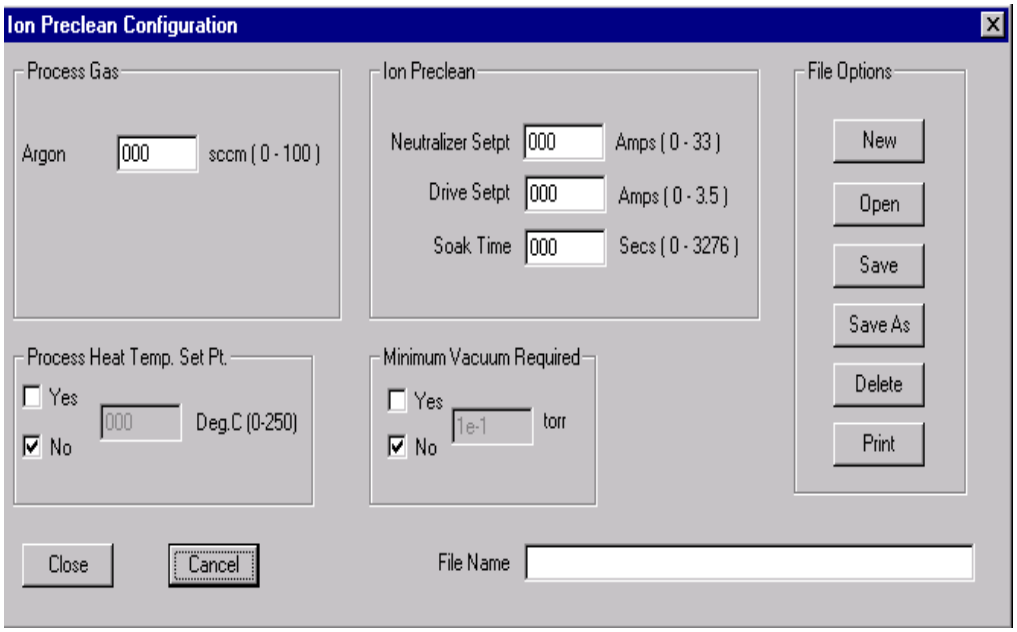


Note: Programmable Sequence Configurations are not accessible to System Operators. All Programmable Sequence Configurations are accessed *only* by the System Administrator. (See System Security)

- This Building Block is used to safely pump the vacuum system down. It is usually used as the first step in a recipe to evacuate the chamber before a process.
- It can be used as a stand alone process to pump the system into high vacuum automatically.
- This recipe step will start the substrate rotation motor; rough out the chamber to a crossover pressure; open the high vacuum valve (if all interlocks are made); and pump down to a vacuum setpoint before moving into the next recipe step. The end of cycle alarm will sound at this time if no other recipe steps follow. The vacuum system will remain in high vacuum until the Reset button is pressed or a new recipe is initiated.
- Use the Auto Vacuum Sequence Configuration as the first step in any recipe to pump the system down into high vacuum before Auto Heat, Ion Preclean, or Auto Deposition.

10.3.2.1 Programmable Features:

- Vacuum Setpoints:
  - Pressure setpoint to crossover from Rough Vacuum into High Vacuum; interfaced to PBR-1
- Heat Setpoint (if selected)
  - Heaters will come on as soon as Bellows switch is made and will heat to programmed setpoint during pump-down: 0 - 1120 ^{0}C
- Auto Pump Variable
  - Leak-Up Test (if selected): Long pump down with programmed heat cycle to run before short leak-up rate can be taken.
  - End of Day (if selected): Programmed to be used at the end of a process in place of an Auto Vent. Close High Vac valve, and leave chamber under rough vacuum. "Park" chamber under vacuum overnight.
- Vacuum IG Setpoint (if selected): Programmable setpoint interfaced to PBR-1; setpoint required **before** moving to next recipe step.
- Vent Delay
  - Programmable delay for the Auto Vent Sequence Configuration. After an automatic sequence, the Vent Valve will not open until after this delay. This delay can be used to allow substrates to cool down before venting the chamber. This number is defaulted to the AutoVent Delay box on the Overview screen.
  - Note: Press CLOSE button to close the configuration screen.



10.3.3 Ion Preclean Configuration

Note: Programmable Sequence Configurations are not accessible to System Operators. All Programmable Sequence Configurations are accessed *only* by the System Administrator. (See System Security)

- The Ion Preclean Configuration screen is accessed through the Recipe screen.
- This Sequence Configuration is used to expose the substrates to an ion source before deposition.
- The Ion Preclean step is used after Auto Pump and before Auto Deposition.

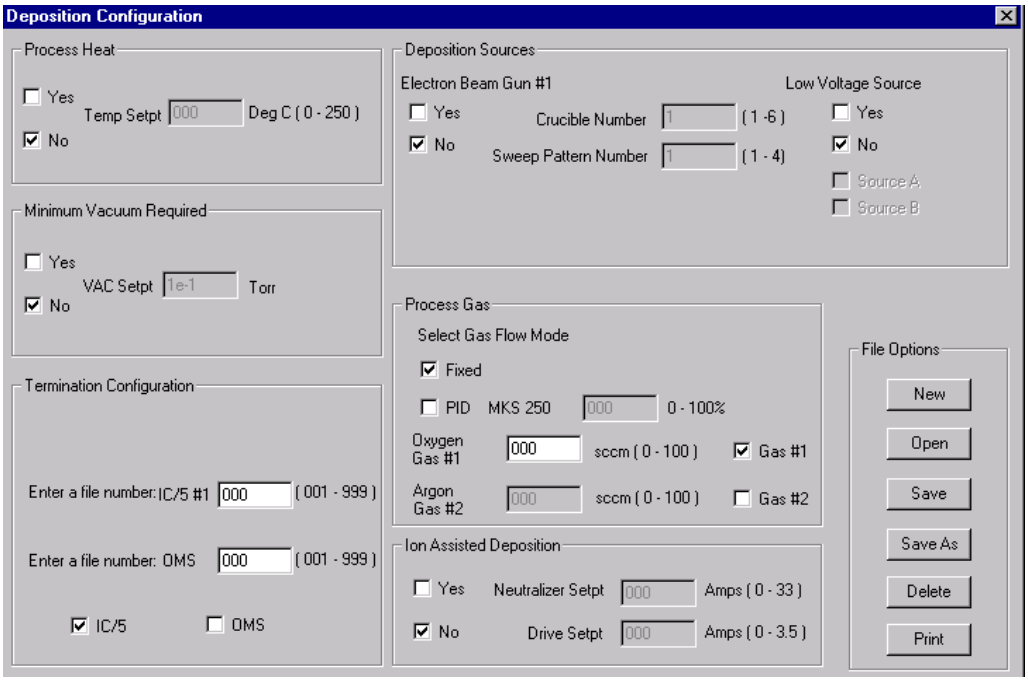
10.3.3.1 Programmable Features:

- Process Gas Flow: 0 - 100 sccm.
- Neutralizer Setpoint: 0 - 33 Amps.
- Drive Setpoint: 0 - 3.5 Amps.
- Soak Time: 0 - 32767 Seconds.
- Process Heat Setpoint: 0 - 1120 ^{0}C.
- Minimum Vacuum Required.

Note: Press CLOSE button to close the configuration screen.

10.3.4 Deposition Configuration

Note: Programmable Sequence Configurations are not accessible to System Operators. All Programmable Sequence Configurations are access only by the System Administrator. (See System Security).



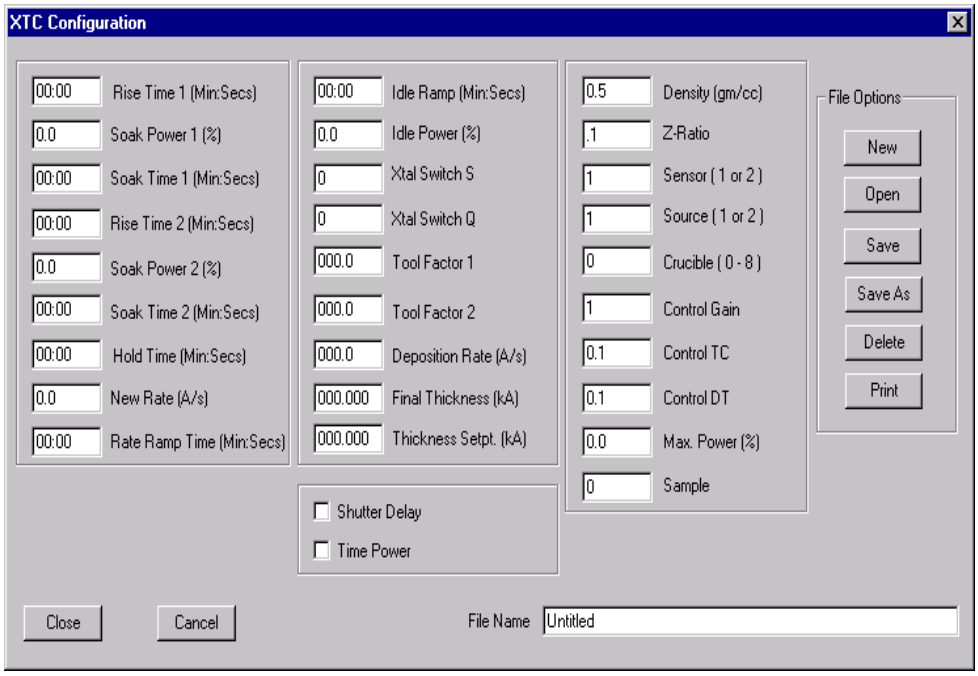
The Deposition Configuration screen is accessed through the Recipe screen.

- The Deposition Configuration contains the deposition parameters controlled by the PLC in the system.
- The XTC/2 Configuration programs the deposition parameters controlled by the XTC/2.
- Termination of a layer is implemented through the XTC/2 controller.
- The vacuum system deposition parameters are *always* programmed into the Deposition Configuration. The evaporation source parameters are *always* programmed into the XTC/2 Configuration.
- A Deposition *and* an XTC/2 Configuration are required for the deposition of a single layer.
- There is a box on the Deposition Configuration Screen to input the associated XTC/2 Configuration number.

10.3.4.1 Programmable Features:

- Process Heat & Temp Setpoint (if selected): 0 – 200.
- Minimum Vacuum Required (wait for pressure setpoint before process step begins?): Programmable setpoint interfaced to PBR-1.
- Deposition Sources.
  - Electron Beam Gun (duplicate controls for two e-beam sources)
    - Electron Beam Gun Selection.
    - Sweep Pattern: 1 – 4.
- Process Gas Flow.
  - Fixed Flow (or PID if equipped).
  - Ion Source (and Chamber Gas if equipped).
  - 0 - 100 sccm.
- Ion Assisted Deposition.
  - Neutralizer Setpoint: 0 - 33 Amps
  - Drive Setpoint: 0 - 3.5 Amps

Note: Press CLOSE button to close the configuration screen.



10.3.5 XTC/2 Configuration

Note: Programmable Building Blocks are not accessible to System Operators. All Programmable Building Blocks are accessed *only* by the System Administrator. (See System Security)

- The XTC/2 Configuration screen is accessed through the Recipe screen.
- This configuration contains all of the information required by the XTC/2 Deposition Controller for a single layer.
- The XTC/2 Deposition Controller is the device that controls the power applied to the source, the rate at which the evaporate are deposited on the substrate, the final thickness of the layer deposited. It also contains data required to maintain accuracy and safety.
- Rise Time 1 is the time taken to raise the power to Soak Power 1.
- Soak Time 1 is the time spent at Soak Power 1.
- Rise Time 2 is the time taken to raise the power to Soak Power 2.
- Soak Time 2 is the time spent at Soak Power 2.
    - Note: Soak Power 2 can be higher, lower, or equal to Soak Power 1
- Hold Time, New Rate, Rate Ramp Time, Idle Ramp, Idle Power, Xtal Switch S, Xtal Switch Q are defined in the XTC/2 manual. They should be set to 0 for AR Coating applications.

- Tooling Factor 1 & Tooling Factor 2 are defined in the XTC/2 manual. The tooling factor varies for each material. They will be set upon installation and should need no further adjustment.

- Deposition Rate should be set for each layer upon installation and need no further adjustment.

- Final Thickness must be set for each layer. It is the thickness at which the layer stops. The combination of layer thickness is referred to as the thin film formula or design.

- Thickness Setpoint is defined in the XTC/2 manual. It should be set to zero for AR Coating Applications.

- Density & Z-Ratio are specific to the material being deposited. There is published data for most materials in the XTC/2 Manual.

- Sensor should always be set to 1.

- Source should be set to 1 for the Electron Beam Gun and 2 for the Low Voltage Source.

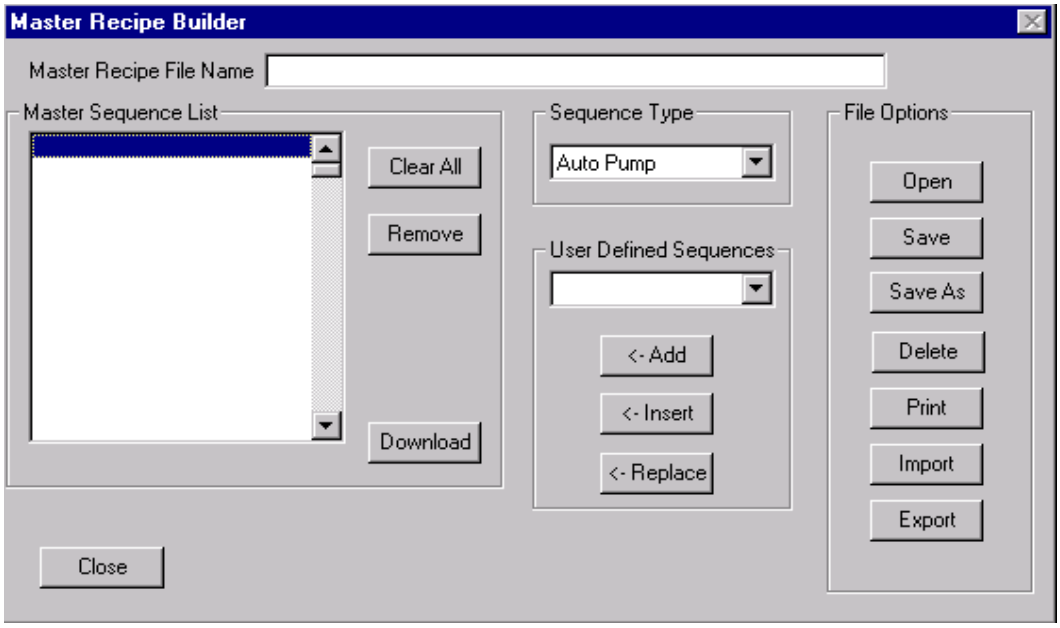
- Control Gain, Control TC, Control DT should be set for each material upon installation and need no further adjustment. These terms are defined in the XTC/2 manual.

- Max Power should be set for each layer. It is the maximum power applied to the source during the disposition of a layer. It is a safety feature.

- Sample should be set for each material upon installation and need no further adjustment.

- Shutter Delay & Time Power is defined in the XTC/2 manual. They should not be selected for AR Coating Applications.

10.4 Master Recipe Builder



Note: Master Recipe Builder is accessible to System Operators and Administrators. (See System Security)

- The **Master Recipe** screen is accessed through the **Recipe** screen.
- New recipes are created using the Master Recipe Builder Screen. Recipes that have been saved as files are accessed through the Master Recipe Builder Screen.
- The File Option buttons on the right side of the screen allow an operator to Open or Delete existing files; Save new files or Save As new recipes as old file names.
- When a recipe file is Open, the steps in that recipe will be displayed in the Master Sequence List window.
- The Download button is used to download the recipe displayed in the Master Sequence List into the PLC.
- The Print button converts the displayed file into a .csv file. This file format is compatible with Microsoft Excel spreadsheet software and can be displayed, stored or printed as an Excel file. Every system is supplied with Microsoft Excel. These files can be easily be copied to disk and transferred to other computers.

- The Import and Export buttons convert the displayed file into a format that is compatible with MS Excel. This file can be displayed, stored or printed with Microsoft Excel spreadsheet software. Every system is supplied with Microsoft Excel. These files can be easily be copied to disk and transferred to other computers.

- The Clear All, Remove, Add, Insert and Replace buttons are used to modify the steps in the Master Sequence List.

- Use the mouse to move the blue highlighted area up and down in the Master Sequence List Window.

- Use the Sequence Type window to select the required Sequence Configuration or recipe step.

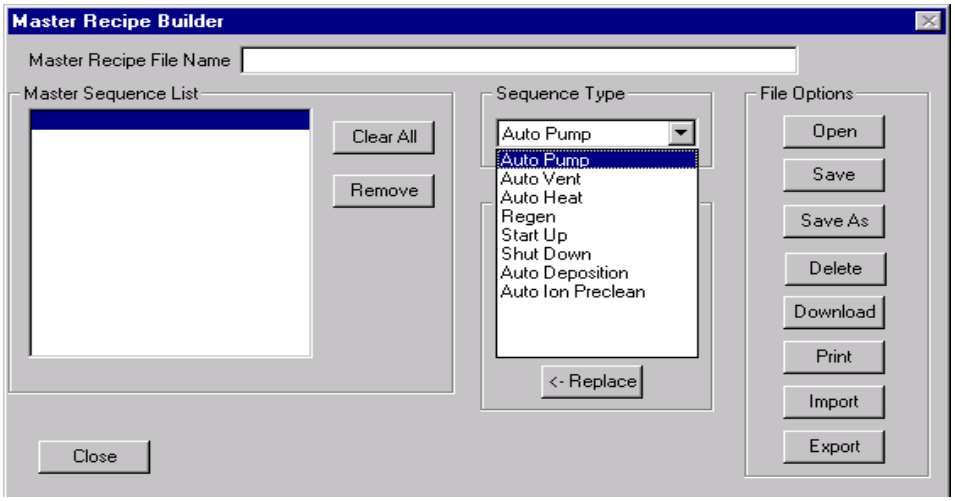
- Use the User Defined Sequence window to select the saved files under each Sequence Configuration type.

10.4.1 Examples:

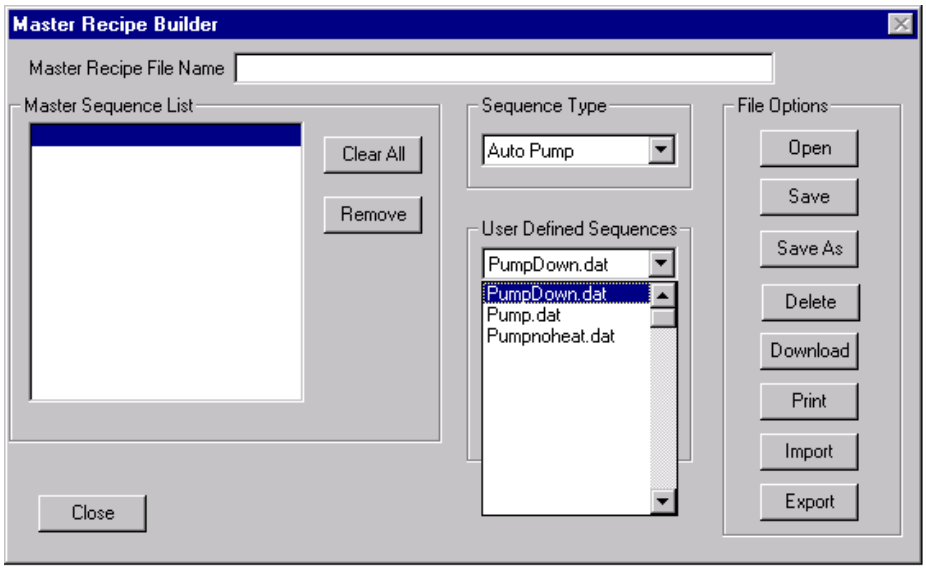
- Sequence Type: Auto Deposition
- User Defined Sequence:
  - LYR1.dat
  - LYR2.dat
- Sequence Type: Auto Heat
- User Defined Sequence:
  - heatest.dat
  - heatest1.dat

10.4.2 To create a new Recipe:

- Open the Master Recipe Builder screen from the Recipe screen.
- Press the Clear All button to clear the Master sequence List.
- Use the mouse to direct the blue highlighted area to the top of the Master Sequence List.
- Push the arrow button under Sequence Type to display the Sequence Configurations.



- Use the mouse to highlight the selected Sequence Configuration (i.e. AutoPump).



- Push the arrow button under User Defined Sequence to display the saved files under the Sequence Configuration folder (i.e. Pumpdown)
- Press the Add button to add this step to the Master Sequence List.
- Use the mouse to direct the blue highlighted area to the next step of the Master Sequence List.
- Push the arrow button under Sequence Type to display the Sequence Configurations.
- Use the mouse to highlight the selected Sequence Configuration (i.e. AutoHeat).

- Push the arrow button under User Defined Sequences to display the saved files (i.e. heatest).
- Use the mouse to highlight the selected saved file.
- Press the Add button to add this step to the Master Sequence List.
- Use the mouse to direct the blue highlighted area to the next step of the Master Sequence List.
- Repeat this until all required steps are listed on the Master Sequence List.
- The Remove button will remove the highlighted step. The Replace button will replace the highlighted step with the highlighted User Defined Sequence.
- When a Recipe is complete, it must be saved as a Recipe File. If you want to save the new recipe under an old file name press the Save As button to select the old file name.
- To use the new Recipe, press the Download button to download it into the PLC. It will then become the active recipe on the Overview Screen.

Note: Press CLOSE button to close the configuration screen

10.4.3 To Use an Existing Recipe File:

- Open the Master Recipe Builder screen from the Recipe screen.
- Press the Open button.
- Select the recipe file and double click the left mouse button.
- The selected recipe will be displayed in the Master Sequence List.
- Use the Remove, Add, or Replace buttons to change the steps in the recipe if necessary.
- Press the Save or Save As button to save the new recipe if you have made changes.
- To use the existing Recipe file, press the Download button to download it into the PLC. It will then become the active recipe on the Overview Screen.

Note: Press CLOSE button to close the configuration screen.

11. Automatic Optical Monitor

Purpose: The purpose of this section is to outline the operation of the Optical Monitor in an Infinity™ 26 vacuum system.

This system is not supplied with an Optical Monitor.

12 System Security

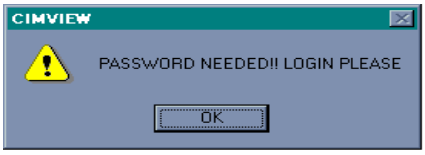
Purpose: The purpose of this section is to describe the control system security in an Infinity™ 26 vacuum system.

GE Cimplicity® HMI software functions as the interface between the person operating the equipment and the machine. One component of this control system is a Login Panel. The Login Panel controls access to the overall system. The person operating the vacuum system can login to the software on either of two levels: System Operator or System Administrator.

The System **Administrator** has access to the entire control system - nothing is blocked.

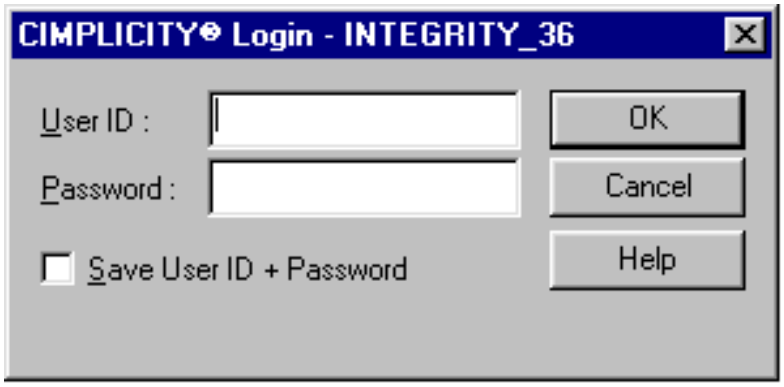
The System **Operator** has limited access to the control system. Service Mode on the Overview Page is blocked because all interlocks are inactive. The PID parameters for the heater are blocked to prevent unauthorized changes. The Recipe Configuration pages (Auto Heat, Ion Preclean, Deposition, and XTC) are blocked to prevent unauthorized process changes. The Purge and Vent Delay Timers on the Overview screen are also blocked in the Operator Mode.

When a System Operator attempts to access a password protected area the following warning will appear. Click the OK button and return to the previous screen. Open the Login Panel and logon as System Administrator to access the controlled area.



The control system defaults to the last known security level upon startup. The security level can be changed at any time through the Login Panel. The current security level is always displayed as "User ID" at the top left corner of the Overview page.

The Login Panel is a file within the Cimplicity folder. It can be access through the Windows "Start" button under the Cimplicity folder or through a shortcut on the Windows desktop.



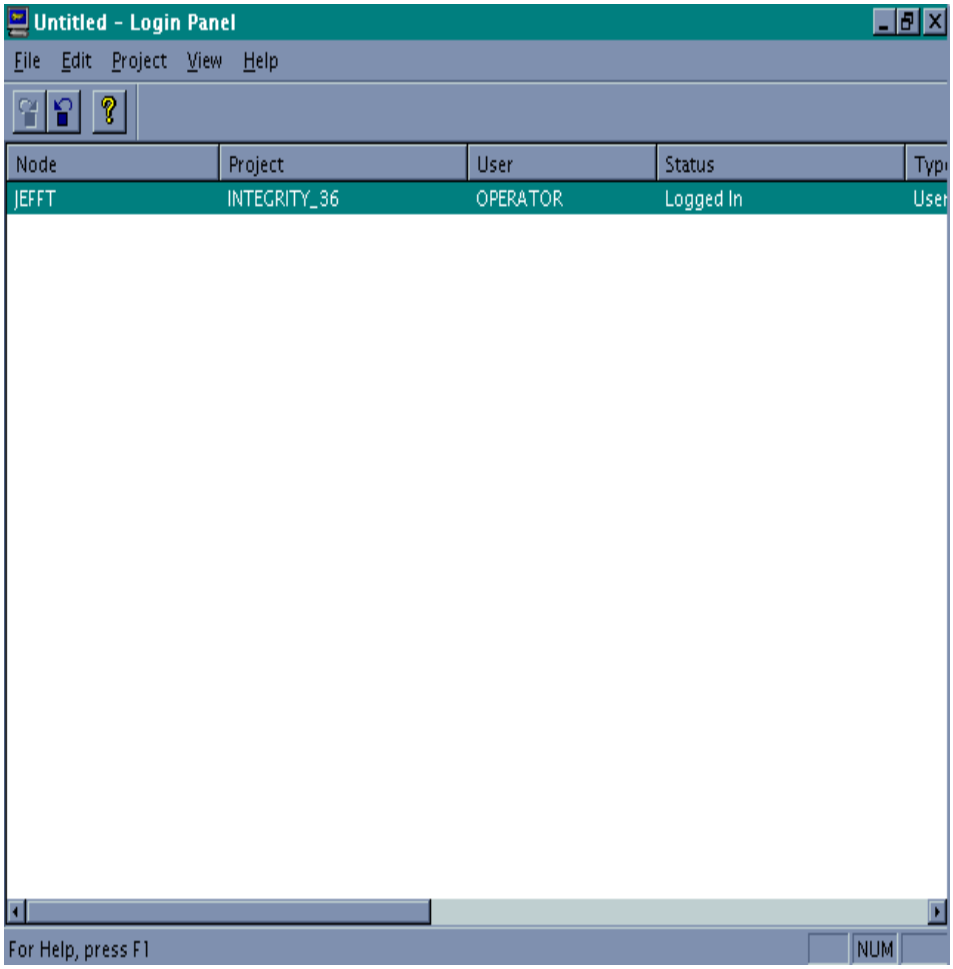
12.1 Log-in at Startup

When the system is started up initially, the software requires an initial Login. The CTR-ALT-DELETE key must be pressed when prompted by an on screen message. The Cimplicity Login screen will appear and a user ID and Password must be entered. This will allow the HMI software to begin.

This is required every time the system is powered down or rebooted. The Login level can be changed at any time. See the Login Panel described below.

12.2 Login Screen

The Login Panel is used to log on and off the system. The Login Panel is accessible Through the Main or LOGIN screen by double clicking on the Login button in the center of the screen.



12.3 Login Panel

When the Login Panel in open click on the small icons at the top left of the window (the square and arrow) to initiate the logon or logoff process. A small window will appear with two entry blocks.

The person operating the system must enter a Username and Password. There are many Usernames: Operator, Manager, and Administrator. Each user name has an acceptable password. These passwords are factory set. Other Usernames can be added at any time with access to any defined input (buttons, data, etc.). Any questions concerning passwords or instructions on changing a password must be directed to Denton Vacuum 1-856-439-9100.

User and status are also displayed on the Login Panel. Close the Login Panel after completing the login process.

13. Remote Access

GE Cimplicity® HMI software functions as the interface between the person operating the equipment and the machine. This software runs in a Windows NT environment. The computer supplied with the vacuum system functions as a server and is delivered with an internal modem.

This allows for remote access to the operating system. Remote access to the system is implemented through a commercially available program – PC Anywhere. This program is installed on the computer at the factory and configured and tested to allow a Denton representative to access the operating system remotely.

Remote access is possible only at the highest security level (see the Security section of this manual). The PC Anywhere program must be open and running on the desktop before remote access is possible. A direct phone line is also required.

NOTE: *Remote access cannot be implemented without the customers' full knowledge and cooperation.*

Contact Denton Vacuum (856-439-9100) for detailed instructions on the implementation of remote access.

14. System Maintenance

Note: *All fuse ratings are contained in the schematic drawings included with this manual.*

14.1. Chamber Cleaning

1. Change shields when coating begins to flake off the metal.
2. Partial shield changes can be made when required.
3. All shields must be cleaned using a bead blaster to remove built-up coating. Care must be taken to prevent contact with oils or grease.
4. After cleaning in a bead blaster, the shields must be wiped down with isopropyl alcohol or acetone before being reinstalled.
5. Any exposed chamber areas must be scrubbed with Scotchbrite and wiped with isopropyl alcohol or acetone.

14.2. Mechanical Pump

1. Check oil level daily. **Do this when pump is <u>not</u> operating.**
2. Check the color of the oil monthly. Compare it with a sample of new oil. **If the oil is brown, black or smell "burnt", it has deteriorated.** Drain the pump and change the oil.
3. See the Troubleshooting section of the subsystem-operating manual.

14.3. Cryogenic Pump

1. Check the temperature gauge daily. A reading above 20K indicates the pump requires regeneration.
2. Check and record the operating pressures monthly.
3. Replace the seals and inspect the valve stems at 10,000 hours of operation.
4. Replace the absorber unit at 30,000 hours of operation.
5. See the Troubleshooting section of the subsystem-operating manual for specific instructions.
6. Fuse Rating: 3 - 20 Amp Slo-Blo

14.4. High Vacuum Valve

1. Check main o-ring seal annually. This requires disassembly of the valve. Replace o-ring seal if it is scored or brittle.

2. See the Troubleshooting section of the subsystem-operating manual.

14.5. Rotary Feedthroughs

1. Fixture Drive, Shutter Drive, Electron Beam pocket select drive should be disassembled and inspected every 6 - 12 months.

2. Replace all damaged, brittle, or worn seals. Clean and lubricate all seals before reassembly.

3. Fuse Rating: FUS2 - 5A, 250 VAC.

14.6. Heater Assembly

1. Disassemble heater assembly every 6 - 12 months. Beadblast all metal components.

2. Heater tubes can be cleaned if overcoated. Use Pol brand metal polish (or equal) and rinse with alcohol before reassembly.

14.7. Vacuum Gauge Tubes

1. Degas G1 and G2 for 10 minutes periodically.

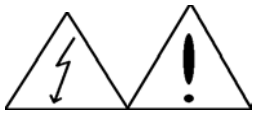
2. Replace gauge tubes when filaments fail. **Do Not remove gauge tube when under vacuum.** Vent chamber or cryo-pump before changing gauge tube.

3. Loosen flange clamp around gauge tube and remove failed tube. Remove electrical connector.

4. Install new gauge tube and tighten flange clamp. Reconnect electrical connector.

5. Degas tube according to the guidelines in the subsystem-operating manual.

14.8. Electron Beam Gun Source



SAFETY WARNING

HIGH (POTENTIALLY LETHAL) VOLTAGES ARE PRESENT WITHIN AN EVAPROATION SYSTEM. GREAT CARE MUST BE EXERCISED WHEN PERFORMING MAINTENANCE.

HUMAN CONTACT WITH THE VOLTAGES CAN BE FATAL.

SHORT ALL HIGH VOLTAGE FEEDTHROUGH CONNECTIONS WITH A GROUNDING HOOK.

DANGER - HIGH VOLTAGE

1. **The Electron Beam Gun operates at lethal voltage levels! Always touch the grounding rod to the high voltage feedthroughs before servicing the Electron Beam Gun. Read the Electron Beam Gun Operating Manual completely before servicing the unit.**

2. The electron beam gun emitter assembly requires rebuilding and cleaning on a routine basis. The emitter assembly should be rebuilt if there is a short in the assembly or if maximum power settings are exceeded during a deposition. Emitter disassembly, cleaning, and reassembly instructions are in the subsystem-operating manual. Read the manual completely before proceeding with any electron beam maintenance.

3. Disassembly of the Electron Beam Gun Source is outlined in the subsystem-operating manual. **The cooling water supply and drain lines must be OFF before disassembly of the source.**

4. Inspect all internal seals every 6 - 12 months. Replace all damaged, brittle, or worn seals. Use caution when handling all sealing surfaces.

5. **The cooling water supply and drain lines must be ON before operation of the source.**

14.9. Ion Source

CAUTION!

HIGH VOLTAGES CAN BE PRESENT IN AND AROUND THE CC-104 POWER SUPPLIES AND CHAMBER FEEDTHROUGHS.

DANGER - HIGH VOLTAGE

1. **Read the ion source operating manual before proceeding with any maintenance.**

2. Neutralizer filament life is dependant on processing parameters and system use. No recommendation can be made. Inspect visually for thinning or breaks before each run.

3. Neutralizer filaments are made from 0.020" diameter tungsten wire. Begin with a 71/2" length of wire. Bend the ends to connect to the posts on the ion source. Coil the center of the wire to reduce the length to fit between the two posts on the ion source. *Be sure to keep the wire clean and oil free!*

4. Remove the grid and visually inspect the interior of the ion source at every complete chamber cleaning.

5. If there is considerable build up in the source, disassemble and clean the ion source according to the subsystem operating manual.

14.10. Overall System Maintenance

1.  Refer to instrument manuals.

15. Troubleshooting

15.1. Safety Warnings

Warning!

DUE TO THE NATURE OF THE SUBSYSTEMS, THERE ARE MANY TYPES OF VOLTAGES ON A VACUUM SYSTEM. **LETHAL HIGH VOLTAGES ARE PRESENT!**

READ THE OPERATING MANUALS SUPPLIED WITH THE SYSTEM BEFORE ATTEMTING ANY TYPE OF TROUBLESHOOTING ON THE VACUUM SYSTEM. REFER TO THE PROPER SECTIONS OF THE OPERATING MANUALS TO VERIFY THAT THE SYSTEM IS BEING OPERATED IN THE PROPER MANNER.

INTERLOCKS ARE BUILT IN TO THE CONTROL SYSTEM. RATHER THAN ASSUMING A SYSTEM FAILURE, VERIFY THE PROBLEM IS NOT AN INTERLOCK INTENDED TO PREVENT UNSAFE OPERATION.

NOTE ON JEWELRY

WHEN WORKING AROUND A VACUUM SYSTEM, THERE IS ONE GOOD PRACTICE:

DO NOT WEAR JEWELRY!

AN ARC MAY BE DRAWN FROM A HIGH VOLTAGE SOURCE!

15.2 Required Tools

Tool	Use
Multimeter (Analog or Digital)	A. To read AC or DC Voltages B. To read low AC or DC Current C. To read resistance (Ohms)
Hand-held Current Meter (Amp Probe)	Clamps around an AC line read current.
Screwdrivers (Flat & Phillips)	For disassembly and assembly.
Wrenches (Box Type)	For disassembly and assembly: 3/8″ to 1″
Allen Wrenches	For disassembly and assembly: 1/16″ to 3/8″

15.3 Vacuum System Control Rack

Problem: *No activation of subsystems when main switch is toggled.*

Cause: No +24V DC power from DC power supply.

Solution:

1) Check to see if there is 208V AC, 3-phase power at main breaker of vacuum system.

2) Turn ON main breaker.

3) Turn ON aux. breaker.

4) Press green "START" button.

5) Check the fuse F2 for the 24-volt DC supply located in the NEMA enclosure. Replace if blown.

6) Check the fuse F1 for the AC power to the DC power supply located in the NEMA enclosure. Replace if blown.

7) Pull out 24-volt fuse from panel. Then with voltmeter, check output terminals of the +24 volts at power supply. These terminals can be found on the 24-volt supply P.C. board.

8) Check AC input on transformer of DC power supply to see if 120V AC is present

9) If there is 120V AC input power, but no 24V DC output, replace the power supply.

10) If there is no AC power at this point, call Denton Vacuum (609-439-9100).

Problem: S*ubsystems activated, but no control of pumps, valves and subsystems.*

Cause: 24V Relays.

Solutions:

1) Be sure all relevant interlocks are satisfied *before* proceeding.

2) Pumps, valves and subsystems are controlled through the PLC by relays. Each relay is numbered. Identify the correct relay according to the schematic and check correct position (OPEN/CLOSED) of the relay. Visually verify the proper operation of the relay against the schematic.

3) If the relay fails to operate, remove it and use an Ohmmeter to read the resistance of the coil. Verify that the coil is not shorted.

4) Verify that the contacts are not fused and preventing movement.

5) If there is a problem with a relay, replace it.

6) Use a voltmeter to determine if a signal is going to the relay.

7) If the relay is not receiving a signal to open or close, contact Denton Vacuum (856-439-9100)

15.4 Valves and Shutters

The source shutter and all vacuum valves on the vacuum system are pneumatically controlled. The valve opening procedure is as follows:

There is a 24V DC signal from an output relay that feeds into a DC solenoid (electromagnetic) coil. The electromagnetic field created by the coil pulls up a "plunger valve" mounted to the airflow manifold. When this "plunger" is pulled up it permits air pressure (80 - 100 psi) to pass through the manifold into an air-operated cylinder. The air pressure going into the air cylinder becomes greater on one side than the other. The side of the cylinder with the greater air pressure will move a "diaphragm" the opposite way. Depending on which way the diaphragm is travelling the valve is opened or closed.

Problem: *When the assigned output is activated, the valve or shutter associated with it does not respond. The on-screen indicator changes state.*

Causes:

A. No air pressure to the air manifold.

B. No power at the valve or shutter solenoid.

C. Valve or shutter solenoid defective.

Quick Test: Before going on to the solutions for the above causes, there is a quick way to verify that a solenoid valve has +24V DC and the solenoid is active:

Place a common metal screwdriver on top of the solenoid with the valve output ON. If the screwdriver is slightly magnetized to the top of the solenoid, the coil is good and there is most likely a mechanical problem such as no air or a stuck plunger. **Remember this is only a quick test. It is not 100% foolproof**.

Solutions (Cause A):

1) Verify that there is 80 - 100 psi of air pressure to the vacuum system. Inspect airlines and filter for water.

2) Prove that there is air to the valve in question.

- Each valve has two airlines attached to it: one for air in and one for return. These airlines are attached by special fittings that make it easy to detach or reattach an airline. These fittings are called "LEGRIS" fittings.
- While holding one of the air lines firmly in your hand, push in the red collar on the Legris fitting, pull out air line while pushing the red collar of the Legris fitting inward.
- **NOTE: There might be 80 - 100 psi of air pressure in the line. Make sure that you have a firm grip on it so it does not "whip out of your hand.**
- While holding airline, activate and deactivate power to the solenoid.
- Air should flow out of the Legris fitting mounted in the air manifold when power is at one state (ON/OFF), and air should stop flowing when the power to the solenoid is in the other state (ON/OFF).
- Repeat steps 2 through 5 for the second airline to see if it operates the same way.

- If both Legris fittings operate with alternating air ON/OFF, the problem is internal to the valve assembly.
- Disassemble valve in question and inspect for foreign matter or broken seals.

3) If the airflow from the Legris fitting did not change from one port to the other or when switched ON/OFF, then follow Solutions (Cause #2) below.

Solutions (Cause B):

1) Locate the solenoid valve attached to the air manifold.

2) Open the black plastic enclosure that holds the wires connecting to the solenoid.

3) When the wires have been located, expose the connectors that join the signal wires to the solenoid.

4) Place a voltmeter across the wires at the crimp connectors.

5) Disconnect the solenoid from the output leads and try to read +24V DC power at the ends of the two wires.

6) If there is NO power at the solenoid when the output is high, use the system schematic and a voltmeter, trace the signal lines and inspect for breaks.

7) If there IS power on the signal lines when disconnected from the solenoid and the solenoid is not operating, see Solutions (Cause C)

Solutions (Cause C):

1) Disconnect solenoid from signal leads.

2) Use an Ohmmeter to read the resistance of the solenoid.

3) A reading of approximately 65 - 85 Ohms (+/- 10%) indicates a good solenoid.

4) A reading of 00.0 Ohms indicates a shorted solenoid.

5) Replace the solenoid, then try the valve.

6) A reading of infinity indicates the solenoid is burnt out (open coil).

7) Replace the solenoid, then try the valve.

15.5 Rotation

Problem: *When rotation is powered ON it does not rotate, or it stops rotating in the middle of a run.*

Causes:

A. Fuse blown.

B. Power to and/or from the motor controller is not active.

C. Rotation is mechanically jammed.

Solutions (Cause A):

1) Locate B&B Nova Motor Controller in the control rack. Read the subsystem-operating manual to become familiar with the Nova Controller.

2) Shut power to the Motor Controller OFF before proceeding.

3) At the rear of the Motor Controller under the P.C. board locate the fuse holder and 8 Amp fuse.

4) Remove the fuse and check it with an ohmmeter. If blown, replace.

5) Examine the traces on the P.C. board around the fuse holder. If they are burnt, replace the Nova controller.

Solutions (Cause B):

1) Use a voltmeter to measure the 120 VAC power going into the Nova controller on the terminals "L-1" and "L-2".

2) If NO power is present, use the use the system schematic and a voltmeter, trace the signal lines and inspect for breaks.

3) If there IS power coming in to the controller, then the DC output power from the controller must be checked for both the field and armature.

4) Disconnect the four motor wires from the terminals marked "A1, A2, F1, &F2".

5) Set the voltmeter to DC Volts and read the output power on terminals "F1 & F2" (field). There should be a constant voltage of 135 VDC no matter where the control pot is set.

6) Set the voltmeter to DC Volts and read the output power on terminals "A1 & A2" (armature). Take readings while adjusting the control pot from zero to full scale. The output should vary from zero to 100% output as the control pot is varied. Full power should be 120 VDC to 135 VDC.

7) If either or both DC outputs are disabled for the field or armature, replace the motor controller.

Solutions (Cause C):

1) Inspect main bearings in the planetary drive for damage.

2) Disconnect the motor from the rotation so that the substrate drive can turn freely.

3) Push the planetary with your hand. It should rotate freely for 3 to 5 revolutions after one firm push. Rotation motion should be smooth.

4) If the rack does not rotate, or it is very hard to move, disassemble the planetary and replace the bearings.

5) Reassemble the system and try again.

15.6 Mechanical Pump

Problem: *Rough out times are increasing; Auto regen program fails to complete; mechanical pump pressure is high. Mechanical pump is not able to hold ultimate pressure.*

Cause: Low oil level. Mechanical pump seals bad.

Solution:

1) Place system in Manual Mode.

2) Close all valves and turn ON Mechanical pump.

3) Observe pressure on the Denton DV-23 thermocouple controller. This controller is used as a redundant pressure sensor. It is used to evaluate mechanical pump performance.

4) The pressure should quickly go to less than 1 militorr (off the bottom of the scale).

5) This is the baseline or ultimate pressure of the mechanical pump. The lowest pressure that the mechanical pump can attain isolated from the rest of the vacuum system.

6) If the ultimate pressure is above this reading, check the oil level in the mechanical pump. Refer to the operating manual. Add to or change the oil as required.

7) The mechanical pump may require ballasting if the mechanical pump oil has been contaminated. Refer to the operating manual for specific instructions.

8) If the oil level is correct and the oil is not contaminated, but the ultimate pressure is still above 1 militorr contact Denton Vacuum (856-439-9100).

15.7 Substrate Heat

DANGER HIGH VOLTAGE!

Problem: *Heat lamps do not turn on. No heat control.*

Cause:

A. Fuse blown.

B. Contactor #1 is not closing.

C. SCR #1 LED's not glowing in proportion to output.

D. Lamp is burnt out.

E. Thermocouple defective or not connected.

NOTE: *Verify that temperature setpoint is higher than current temperature before proceeding.*

Solutions (Cause A):

1) The wiring diagram schematics contain the heater circuit diagram.

2) Locate heater fuse in the control rack.

3) Shut power to the heaters OFF before proceeding.

4) Remove the fuse and check it with an ohmmeter. If blown, replace.

Solutions (Cause B):

1) The wiring diagram schematics contain the heater circuit diagram.

2) Toggle the heater power pushbutton on the Overview page. Check Rack 0, Slot 5, Pin 3 of the PLC. Verify that the "2" LED on the PLC toggles with the pushbutton.

3) If LED does not toggle, use an ohmmeter to verify the heater interlock string on the wiring diagram.

4) If LED toggles, replace contactor.

Solutions (Cause C):

The silicon control rectifier (SCR) controller is a solid-state device designed to control a large AC power level with a small DC control signal.

The input of the SCR is 208V AC; protected by a fuse to limit the current that will be seen by the SCR controller. As the DC signal to the gate of the SCR increases so does the output of the SCR controller. The SCR controller is about 95% efficient. This means for a given input, the output voltage will achieve 95% of the actual input voltage. AN SCR has a preset gain and span set on it. If these parameters are readjusted, it will limit the control range of the SCR either at the low end or the high end.

Besides being able to control the SCR with an external 0 - 10 Volt DC source, it can be controlled by an internal signal from it's own source of power. This can be done by removing the 0 - 10 Volt DC signal from the "W" and "CCW" terminals, then attaching a 1K ohm potentiometer to the "CW", "W", and "CCW" terminals of the SCR. An SCR controller has one unusual property. If there is no "LOAD" attached to the output, the SCR will pass full voltage no matter where the DC control voltage is set.

1) The wiring diagram schematics contain the heater circuit diagram.

2) Use a DC Voltmeter on terminals W and CCW on the SCR. Red lead on W and black lead on CCW.

3) If a minus (-) voltage is displayed, reverse the wires on the W and CCW terminals.

4) If there is no voltage at the SCR, check Rack 0, Slot 10 of the PLC for 0-10 Volt DC output.

5) If there is a 0-10 Volt signal at Rack 0, Slot 10 of the PLC, replace the SCR.

Solutions (Cause D):

1) Use Ohmmeter to test continuity in individual heater lamps.

2) Replace heater lamp if it is defective.

Solutions (Cause E):

1) Verify thermocouple connections with Ohmmeter. Reconnect or repair if necessary.

2) Use Ohmmeter to test continuity in thermocouple.

3) Replace thermocouple if it is defective.

15.8 Ion Source

DANGER HIGH VOLTAGE!

Problem: *Drive power supply goes to overload: voltage over 500 volts and no current.*

Cause:

A. Air-cooling is blocked.

B. Anode circuit is open.

C. Anode wire is not connected to the correct feedthrough lead.

Solutions (Cause A):

1) Check air intake on face of power supply.

2) Disconnect and remove drive power supply. Remove cover and blow out the fan area to remove any dust blocking air movement.

Solutions (Cause B):

1) Disconnect power to the drive power supply.

2) Test for continuity through the cable from the drive power supply to the feedthrough to verify that the cable is not broken.

3) Test for continuity through the feedthrough from the outside to the inside.

4) Test for continuity from the feedthrough to the anode.

5) Replace any broken wires or feedthrough if an open circuit is detected.

Solutions (Cause C):

1) Disconnect power to the drive power supply.

2) Open the electrical box below the ion source feedthrough and verify which of the leads is connected to the drive power supply.

3) Verify that the wire connecting the feedthrough to the ion source is connected to the proper feedthrough lead.

Problem: *Drive power supply controls the current at the setpoint, but the voltage is less than 10 volts.*

Cause:

A. Anode is shorted to ground.

Solutions (Cause A):

1) Disconnect power to the drive power supply.

2) Disconnect the anode from the feedthrough and check for continuity from the anode to ground (the chamber).

3) There should be no continuity from the anode to ground. If there is, disassemble the ion source and check for possible paths to ground.

4) Be sure to check the insulators on the connection to the anode. This insulator is in two pieces: one large piece outside the ion source and one smaller piece inside the ion source.

5) Check all insulators for build-up of material that might act as a short. Sandblast dirty insulators or replace if cracked.

15.9 Summary

Steps for troubleshooting should follow a logical order.

Vacuum systems are constructed from many different vendor parts and subassemblies: everything from electrical valves to electron beam guns. Each subsystem is supplied with a manual of operation. Familiarize yourself with all the operating manuals supplied with the vacuum system. Refer to these manuals for trouble shooting procedures on the individual equipment in question.

This manual reviews the most common problems experienced with similar vacuum systems. Possible causes are described and solutions are presented in a step-by-step procedure. Most problems can be identified and corrected with a similar approach.

If after a reasonable time the problem cannot be identified, call Denton Vacuum (856-439-9100) to assist with troubleshooting and repair. We can also provide system training to facilitate system maintenance and reduce down time.

16. List of Electrical Schematics

1)	System Power 3 Line Diagram	I260201-23856.DWG
2)	Power Distribution 120VAC Control	I260202-23856.DWG
3)	Power Distribution/24VDC distribution & interlocks	I260203-23856.DWG
4)	Heat Control Wiring & Diagram	I260301-23856.DWG
5)	Heat Cabinet Layout	I260302-23856.DWG
6)	Low Voltage Control & Wiring Diagram	I260401-23856.DWG
7)	Vacuum Gauges Pfeiffer TPR 265	I260501-23856.DWG
8)	Vacuum Gauges Pfeiffer PBR260	I260502-23856.DWG
9)	Ion Source Neutralizer Wiring Diagram	I260601-23856.DWG
10)	Ion Source (Neutralizer Instrument View)	I260602-23856.DWG
11)	Ion Source (Drive Wiring Diagram)	I260603-23856.DWG
12)	Ion Source (Drive Instrument View)	I260604-23856.DWG
13)	Substrate Rotation Wiring Diagram	I260701-23856.DWG
14)	Pumping Power/Mech/Cryo Pump Wiring Diagram	I260801-23856.DWG
15)	Valve Control	I260802-23856.DWG
16)	Valve Sensors	I260803-23856.DWG
17)	Gas Control Wiring Diagram	I260901-23856.DWG
18)	Gas Control Instrument View	I260902-23856.DWG
19)	E-Beam Control Gun P.S. Wiring Diagram	I261001-23856.DWG
20)	Sweep #1 Control Wiring Diagram	I261002-23856.DWG
21)	Crucible Motor & Position Sensors Wiring Diagram	I261003-23856.DWG
22)	E-Beam Control Instrument View	I261004-23856.DWG
23)	Deposition Control/Quartz Monitor Power Diagram	I261101-23856.DWG
24)	Deposition Control Optical Monitor Control Diagram	I261102-23856.DWG
25)	Spare	I261201-23856.DWG

26) Glow Discharge Wiring Diagram	I261301-23856.DWG
27) Glow Discharge Instrument View	I261302-23856.DWG
28) PLC Control Layout & Communications Cable	I261501-23856.DWG
29) PLC Rack Layout & I/O Schematic	I261502-23856.DWG
30) PLC Rack Layout & I/O Schematic	I261503-23856.DWG
31) PLC Rack Layout & I/O Schematic	I261504-23856.DWG
32) PLC Rack Layout & I/O Schematic	I261505-23856.DWG
33) PLC Rack Layout & I/O Schematic	I261506-23856.DWG
34) PLC Rack Layout & I/O Schematic	I261507-23856.DWG
35) PLC Rack Layout & I/O Schematic	I261508-23856.DWG
36) PLC Rack Layout & I/O Schematic	I261509-23856.DWG
37) PLC Rack Layout & I/O Schematic	I261510-23856.DWG
38) General Arrangement (front view)	I261601-23856.DWG
39) General Arrangement (rear view)	I261602-23856.DWG
40) Control Cabinet Arrangement	I261603-23856.DWG
41) Power Panel Arrangement	I261604-23856.DWG

17. List of Mechanical Drawings

1)	General Arrangement & Floor Plan	D-0058-220-002
2)	Baseplate Arrangement	D-0058-220-100
3)	Utility Layout	D-0058-220-101
4)	Bellows Sealed Poppet Valve Assembly	D-0004-007-040
5)	Air Piping Assembly	D-0058-220-015
6)	Water Piping Assembly	D-0058-220-016
7)	Vacuum Piping Assembly	D-0058-213-017
8)	E-Beam Gun Drive Assembly	C-0078-009-027
9)	Shutter Drive Assembly	D-0084-020-061
10)	Fixture Rotation & Flip Assembly	D-0084-073-002
11)	Flip Actuator Assembly	C-0084-067-007
12)	Rotation Drive Assembly	C-0084-066-005
13)	Heater Assembly 3 kW	C-0084-012-168
14)	1/2" Dia. Rotary Motion Assembly	B-0044-011-020
15)	¼" Dia. Rotary Motion Assembly	B-0041-001-008
16)	.38" Dia. Rotary Motion Assembly	B-0041-011-003

18. Spare Parts List

8033-465

SPARE PARTS LIST

E2O Communications

Infinity™ 26
Pumping System

JOB # 23856

	PART NO.	DESCRIPTION	LOCATION	QTY.
	ORG004-0214	O-RING 15.50" ID X .275" C.S.	ISO NW 400 PORTS	2
	ORG004-0156	O-RING 14.0" ID X .275" C.S.	POPPET PLATE	1
	ORG004-0088	O-RING 5.00" ID X .139" C.S.	BELLOWS MOUNT FLANGE	1
	ORG004-0120	O-RING 1.62" ID X .210" C.S.	NW-40 KF PORTS	4
	ORG004-0153	O-RING 12.5" ID X .275" C.S.	ISO NW 320 CRYOPUMP	1
	ORG004-0114	O-RING .75" ID X .210" C.S.	NW-16 KF PORTS	10
	ORG004-0117	O-RING 1.12" ID X .210" C.S.	NW-25 KF PORTS	4
	ORG004-0215	O-RING 2.88" ID X .210" C.S.	ISO NW63 PORTS	2
	BEL001-0001	BELLOWS ASSEMBLY	HIGH VACUUM POPPET VALVE	1
	VAL004-0063	AIR SOLENOID	AIR MANIFOLD	2
	GSK002-0005	COPPER GASKET	4.50" CONFLAT PORT	2
	PMP007-0023	SIEVE ELEMENT	FORELINE FILTER	1

DENTON VACUUM

SPARE PARTS LIST

E2O Communications

Infinity™ 26
Rotation

8033-465

JOB # 23856

	PART NO.	DESCRIPTION	LOCATION	QTY.
	ORG004-0152	O-RING 12.00" ID X .275" C.S.	STATIONARY HOUSING	1
	ORG004-0066	O-RING 2.12" ID X .139" C.S.	½" ROTARY MOTION	1
	BRG003-0048	BALL BEARING	½" ROTARYMOTION	2
	ORG005-0004	U-CUP SEAL	½" ROTARY MOTION	2
	RNG003-0024	RETAINING RING	½" ROTARY MOTION	1
	RNG002-0003	RETANING RING	½" ROTARY MOTION	1
	RNG002-0029	RETANING RING	½" ROTARY MOTION	1
	ORG004-0059	O-RING 1.38" ID X .139" C.S.	FLIP ACTUATOR	1
	ORG005-0002	U-CUP SEAL	FLIP ACTUATOR	1
	BRG011-0008	LINEAR BEARING	FLIP ACTUATOR	2
	BRG001-0012	BEARING	MAIN ROTATION	1
	RNG002-0026	RETAINING RING	FLIP ACTUATOR	1

DENTON VACUUM

SPARE PARTS LIST

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Infinity™ 26
Source Assembly

JOB # 23856

	PART NO.	DESCRIPTION	LOCATION	QTY.
	ROT001-0012	3/8" ROTARY FEEDTHROUGH	E.B. GUN CRUCIBLE DRIVE AND SHUTTER DRIVE	1
	ORG004-0057	O-RING 1.25" ID X .139" C.S.	3/8" ROTARY FEEDTHROUGH	10
	ORG004-0004	O-RING .38" ID X .070" C.S.	3/8" ROTARY FEEDTHROUGH	20
	ORG004-0005	O-RING .44" ID X .070" C.S.	3/8" ROTARY FEEDTHROUGH	10
	ORG004-0055	O-RING 1.12" ID X .139" C.S.	HIGH-VOLTAGE FEEDTHROUGHS	10
	ORG004-0059	O-RING 1.38" ID X .139" C.S.	DUAL WATER FEEDTHROUGH	1
	SRC002-0008	HIGH-VOLTAGE FEEDTHROUGH	1.00" HIGH VOLTAGE FEEDTHROUGH	2
	BRG003-0016	BALL BEARING	3/8" ROTARY FEEDTHROUGH	4
	SST011-0003	BEARING SHAFT	3/8" ROTARY FEEDTHROUGH	2
	SPR001-0048	COMPRESSION SPRING STN. STL. .60" OD X 1.50"	3/8" ROTARY FEEDTHROUGH	4
	RNG002-0025	RETAINING RING	3/8" ROTARY FEEDTHROUGH	10
	CYL001-0006	AIR CYLINDER 1.06" BORE X 2.00" STROKE	SHUTTER DRIVE	1

SPARE PARTS LIST

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E2O Communications

Infinity™ 26
Substrate Heat

JOB # 23856

	PART NO.	DESCRIPTION	LOCATION	QTY.
	LMP001-0023	QUARTZ LAMP	HEATER ASSEMBLY	2
	HDW013-0013	CERAMIC INSULATOR	HEATER ASSEMBLY	12
	SRC002-0121	FEEDTHROUGH	HEATER	1
	CON001-0141	CONNECTOR	HEATER FEEDTHROUGH	2
	SRC002-0016	SCREEN SHIELD	HEATER ASSEMBLY	1

DENTON VACUUM

SPARE PARTS LIST

E2O Communications

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Infinity™ 26
Vacuum Chamber

JOB # 23856

	PART NO.	DESCRIPTION	LOCATION	QTY.
	ORG004-0090	O-RING 5.25" I.D. X .139" C.S.	CHAMBER BOTTOM VIEWPORT	1
	ORG004-0125	O-RING 4.25" I.D. X .210" C.S.	DOOR & PLENUM ELBOW VIEWPORT	4
	ORG004-0170	O-RING 41.00" I.D. X .275" C.S.	DOOR	2
	ORG004-0057	O-RING 1.25" I.D. X .139" C.S.	1" BASEPLATE BLANKS	20
	ORG004-0082	O-RING 4.25" I.D. X .139" CS	MEISSNER PORT	1
	ORG004-0003	O-RING .25" I.D. X .070" CS	¼" ROTARY MOTION	4
	ORG004-0049	O-RING .75" I.D. X .139" CS	¼" ROTARY MOTION	2
	GSK002-0015	COPPER GASKET	2 ¾" CONFLAT PORTS	10
	GLS001-0007	SIGHT GLASS	4" DOOR VIEWPORT	1
	GLS001-0008	SIGHT GLASS	CHAMBER BOTTOM VIEWPORT	1
	LMP001-0062	BULB	CHAMBER LIGHT	2
	PLX001-0001	BULB COVER	CHAMBER LIGHT	1

SPARE PARTS LIST

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E2O Communications

Infinity™ 26
Electrical

JOB # 23856

	PART NO.	DESCRIPTION	LOCATION	QTY.
	FUS001-0061	FUSE ¼ A, 250V, TIME DELAY, CERAMIC BODY	POWER PANEL	1
	FUS001-0070	FUSE ¾ A, 250V, TIME DELAY, CERAMIC BODY	POWER PANEL	1
	FUS001-0049	FUSE 1A, 250V, TIME DELAY, CERAMIC BODY	POWER PANEL	1
	FUS001-0053	FUSE 8A, 250V, TIME DELAY, CERAMIC BODY	POWER PANEL	1
	FUS001-0047	FUSE 10A, 250V, TIME DELAY, CERAMIC BODY	POWER PANEL	6
	FUS001-0081	FUSE 15A, 600VAC, TIME DELAY, J TYPE	POWER PANEL	3
	FUS001-0078	FUSE 30A, 600VAC, TIME DELAY J TYPE	POWER PANEL	2