Operator Manual

Oxford Instruments Plasma Technology

PlasmaPro®80

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94-816703

ZJUI

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PREFACE

Welcome to the Instructions for Use for the Oxford Instruments Plasma Technology **Plasma**Pro®80 tool. The **Plasma**Pro®80 is a plasma processing tool for reactive ion etching (RIE), plasma enhanced chemical vapour deposition (PECVD) or plasma etching (PE).

The technical manual set for the **Plasma**Pro®80 comprises the following manuals:

- Operator Manual (this handbook)
- Service Manual
- Facilities Interface Specification
- System Diagrams Manual
- Other Equipment Manufacturer (OEM) manuals

This Instructions for Use Manual provides all the information necessary for the safe and proper installation and operation of the **Plasma**Pro®80.

Certain components within the tool are supplied by other manufacturers. These components have separate other equipment manufacturer (OEM) manuals that are supplied with the tool. Refer to the OEM manuals for detailed operation, maintenance and repair information about the respective components.

Customer support

Oxford Instruments Plasma Technology has global customer support facilities that provide a coordinated response to customer's queries. All queries are recorded on our support database and are dealt with as quickly as possible. If we are not able to answer the query immediately, we will contact you promptly.

Before contacting a customer support facility, please ensure that you have referred to the Facilities Interface Specification, the System Diagrams Manual and the OEM manuals.

Please direct all queries through your nearest support facility (see below) and have the following details available:

Tool type	**Plasma**Pro®80
Works order number	94-816703
Contact information	Your name, the name of your company, and how we can contact you.
Details of your query	The nature of your problem, part numbers of spares required, etc.

To contact us for support or to enquire about training, please email **plasma@oxinst.com**.

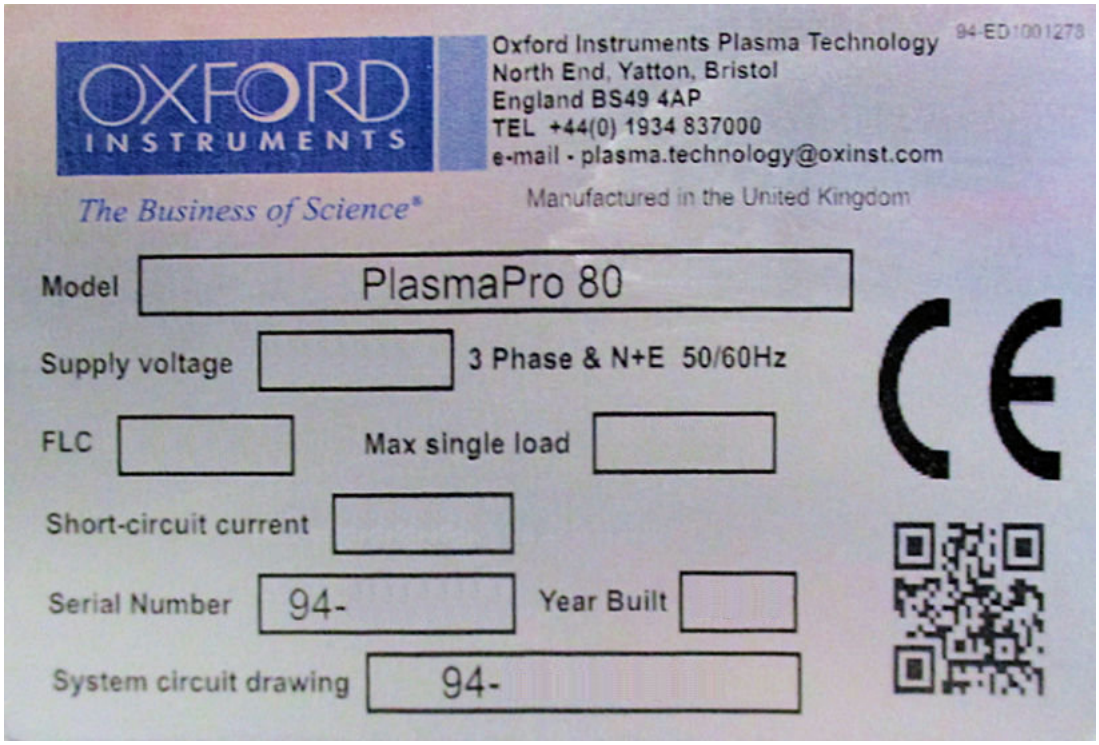
You can also contact us using the details shown below.

Oxford Instruments Plasma Technology

People's Republic of China
Beijing
Tel: +86 10 6518 8160/1/2
Shanghai
Tel: +86 21 6132 9688

Tool identification

This tool, with the works order number **94-816703** for **ZJUI**, is identified by a label attached to the power box of the equipment. A typical label is shown below.



Health and safety information

The **Plasma**Pro®80 contains hazardous areas, materials and substances. Before working with the **Plasma**Pro®80, all personnel must read and become thoroughly familiar with the information given in Chapter 1 and the Emergency shutdown procedure (see Section 4.1). In particular, users must read, understand and strictly observe all:

- Warning notices
- Caution notices
- Safety labels and markings on the equipment

For ease of reference and rapid response in an emergency, this handbook must be safely kept in close proximity to the **Plasma**Pro®80.

Intended users

Intended users of the **Plasma**Pro®80 include the person (or persons) with authority over the equipment, and the following persons who handle and work with the equipment.

- Operators - persons trained in the use of the**Plasma**Pro®80 for the purposes for which the **Plasma**Pro®80 is intended.
- Service engineers - persons trained in the installation, commissioning, maintenance, repair, testing and decommissioning of the **Plasma**Pro®80, and who operate any part

of the **Plasma**Pro®80 for the purpose of performing checks, tests, adjustments and/or repairs to the equipment.

Users of the **Plasma**Pro®80 must have received adequate training on its safe and effective use before attempting to work with the equipment. Please contact Oxford Instruments Plasma Technology for information on training requirements and training courses that are available.

Training requirements vary from country to country. Users must ensure that training is given in accordance with all applicable local laws and regulations.

If any user of the tool has not been directly trained by Oxford Instruments Plasma Technology, ensure that they understand the safety issues associated with the tool, and that they consult relevant personnel for guidance when operating the tool.

Statement of intended use of the tool

The **Plasma**Pro®80 tool has been designed for deposition and etch processes on silicon wafers and other substrates. The tool has been designed to operate within the process parameter limits that are outlined in this manual.

The **Plasma**Pro®80 is intended to be installed, used and operated only for the purpose for which the **Plasma**Pro®80 was designed, and only in accordance with the instructions given in this manual and other accompanying documents. Nothing stated in this manual reduces the responsibilities of users to exercise sound judgement and best practice.

It is the user's responsibility to ensure the tool is operated in a safe manner. Consideration must be made for all aspects of the tool's life-cycle, including, handling, installation, normal operation, maintenance, dismantling, decontamination and disposal. It is the user's responsibility to complete suitable risk assessments, to determine the magnitude of hazards, particularly when using hazardous process gases and chemicals. The use of gas, chemical and fire detection equipment, and gas-pod monitoring equipment, must be considered.

The installation, use and operation of the **Plasma**Pro®80 are subject to laws in the jurisdictions in which the equipment is installed and in use. Users must install, use and operate the equipment only in such ways that do not conflict with said applicable laws and regulations.

Use of the equipment for purposes other than those intended and expressly stated by Oxford Instruments Plasma Technology, as well as incorrect use or operation of the equipment, may relieve Oxford Instruments Plasma Technology or its agent of the responsibility for any resultant non-compliance, damage or injury.

The equipment has been designed to be used in a clean room environment, under stable conditions. The tool’s services must be maintained within the limits defined by the tool services specification. The tool must be operated and maintained using sound vacuum and semiconductor practice.

Statement of non-intended use of the tool

The tool must only be used with all external panels fitted.

The tool must only be used if all services comply with the specifications contained in the **Plasma**Pro®80 Facilities Interface Specification[12].

RF power input to the machine must not exceed the specified power level. RF power must only be provided by a generator which is powered from an electrical source connected to the tool’s interlock chain.

Only process gases that have been recommended by OIPT must be used on the tool.

Mass flow controllers that have been calibrated for the correct process gas must be used.

The tool must only be used as described in the Statement of intended use of the tool section. The tool must not be used with interlocks or other safety features bypassed, removed or over-ridden.

The tool is not intended for use with accessories or additional equipment unless these items have been sanctioned by OIPT. The tool is only intended for use in the configuration that has been discussed and sanctioned by the customer and OIPT.

Hyperlinks

The PDF edition of this manual contains hyperlinks coloured blue, including the superscript reference numbers of document references in the GLOSSARY. The entries in the table of contents are also hyperlinks. Click a link to go directly to the linked item.

Disclaimers

Oxford Instruments Plasma Technology assumes no liability for use of this document if any unauthorised changes to the content or format have been made.

Every care has been taken to ensure that the information in this document is accurate. However, Oxford Instruments Plasma Technology assumes no responsibility or liability for errors, inaccuracies or omissions that may occur herein.

This manual is provided without warranty of any kind, either implied or expressed, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose.

The PTIQ software supplied with this tool is still under development. While every care has been taken to make the information in this document as accurate as possible, some of the illustrations and procedures for the PTIQ software may not accurately match the software supplied with the tool.

Acknowledgements

The following tradenames and trademarks that appear in this manual are the property of Oxford Instruments Plasma Technology:

- PTIQ
- **Plasma**Pro®80

All other tradenames and trademarks that appear in this manual are hereby acknowledged.

Acronyms, abbreviations and special terms

A GLOSSARY of acronyms, abbreviations and special terms is given at the end of this manual.

Certification

Below is a copy of the formal certification document for this **Plasma**Pro®80.

QCF – 185 F

Rev 14

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Declaration of Conformity

Plasma Technology declares that PlasmaPro 80, 100, 1000, PlasmaPro Handlers and Cassettes, Atomfab, Cobra HVX4, Stratum HVX4, Estrelas, Polaris, FlexAL and Ionfab fulfil all the relevant provisions of the following European Directives and standards:

Machinery Directive	2006/42/EC
EMC Directive	2014/30/EU

BS EN ISO 12100:2010 Safety of machinery — General principles for design — Risk assessment and risk reduction (ISO 12100:2010)

BS EN 60204-33:2011 Safety of machinery. Electrical equipment of machines. Requirements for semiconductor fabrication equipment

BS EN ISO 13849-1:2015 Safety of machinery. Safety-related parts of control systems. General principles for design

BS EN 61326-1:2013 Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements

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First issue.

1 HEALTH AND SAFETY

This chapter describes all health and safety considerations relating to the Oxford Instruments Plasma Technology **Plasma**Pro®80 tool. The chapter comprises the following sections:

- About this safety information
- Warning and caution notices
- Lockout and tagout
- Hazard overview
- Detailed hazard information
- Potential routes of unintended release
- Tool safety features
- Tool safety and equipment interlocks
- Personal protective equipment
- Mandatory safety procedures
- Warning and hazard labels
- Solid waste
- Risk assessments
- Tool modifications
- Materials safety data sheets

1.1 About this safety information

The safety information contained in this section must be read and understood before approaching, operating or maintaining the **Plasma**Pro®80 tool. Oxford Instruments Plasma Technology recommends that you keep a printed copy of this chapter in a location that is readily accessible by personnel who operate and maintain the tool.

It is a requirement that the procedures and practices taught in Oxford Instruments Plasma Technology training courses are followed. If any user of the tool has not been directly trained by Oxford Instruments Plasma Technology, make sure that they understand the safety issues associated with the tool, and that they consult relevant personnel for guidance when operating the tool.

The equipment must not be used in a manner outside that specified by Oxford Instruments Plasma Technology. Doing so can impair the hazard protection provided by the equipment.

It is the user's responsibility to make sure the tool is operated in a safe manner. Consideration must be made for all aspects of the tool's life-cycle, including, handling, installation, normal operation, maintenance, dismantling, decontamination and disposal.

It is the user's responsibility to complete risk assessments and to develop and enforce suitable control measures and safe working practices (see Section 1.13). Risk assessments should determine the magnitude of hazards, particularly when using hazardous process gases and chemicals. The use of gas, chemical and fire detection equipment and gas pod monitoring equipment must be considered.

It is the user's responsibility to send Oxford Instruments Plasma Technology the name and contact details of the user's Environment, Health and Safety representative.

It is the user's responsibility to send Oxford Instruments Plasma Technology a list of Oxford Instruments Plasma Technology equipment at each of the user's sites.

Maintenance and fault finding on the system should be carried out, if possible, with the electrical supply and other sources of energy isolated and locked out at the supply. Oxford Instruments does not recommend live working on the tool (Type 4 maintenance). If live working cannot be avoided, it must only be completed by suitably qualified and trained staff.

Read this section carefully. Particularly note that certain aspects of the tool can produce more than one hazard. For example certain process gases can produce a toxic hazard, a fire hazard and a corrosive hazard.

Some of the safety features fitted to the tool provide protection against more than one hazard. For example certain viewports protect against ultra-violet (UV) light emission, radio frequency (RF) energy emission, and incorporate an implosion guard.

This document encompasses all tool options, and may contain warnings that are not appropriate to a particular machine configuration.

1.2 Warning and caution notices

Warning notices are inserted in the text throughout the manual to draw the reader's attention to hazards. Ignoring the notice will probably result in exposure to the hazard, causing serious injury or death. A typical warning notice is shown below.

WARNING

TOXIC GASES
Exposure to toxic gases can cause death or serious injury.
The vent sequence for the process chamber includes a purging step to remove any trace of toxic gas. Always use the proper procedure when venting the process chamber.
Perform a risk assessment before changing the process chamber purging time on the Tolerances page.

Caution notices are inserted in the text throughout the manual to draw the reader's attention to situations or procedures that could cause damage to the equipment or process wafers. Ignoring the notice will probably result in damage to the equipment or process wafers. A typical caution notice is shown below.

Caution

CAUTION
Inadequate flow of nitrogen purge gas can cause damage to the pump. Ensure that the flow rate is set to the value recommended by the pump manufacturer.

1.3 Lockout and tagout

Proper lockout and tagout procedures must always be followed when working on the equipment. In general all tool facility (energy) sources, such as electrical power, compressed air, gases and cooling water, must be isolated and locked off before any maintenance work is carried out. A label must be attached to all lockout devices to

indicate who has fitted the device, when they have fitted the device, and how they can be contacted.

It is recommended that the customer fits the means to safely isolate all energy supplies to and from the **PlasmaPro®80** tool, including cooling fluids, compressed gases and exhaust gas.

Any stored energy must also be released from the tool before starting any maintenance work. Capacitors in the tool are provided with bleed resistors to automatically remove stored electrical charge after a few minutes.

Operating the air dump valve on the services panel at the rear of the machine isolates the tool's pneumatic supply and releases trapped air pressure from the tool's pneumatics (see Figure 1-1). Because the gas pod pneumatic supply is fed from the main tool, operating the air dump valve also disables all the pneumatic valves in the gas pod.

The electrical isolator on the power box and the air dump valve are the only recommended lockout points on the tool (see Figure 1-1). However attention must be paid to auxiliary equipment that may have separate power feeds, such as heater/chiller units and vacuum pumps.

Figure 1-1 Location of the air dump valve

Specific lockout and tagout requirements are detailed in the relevant sections of this manual. However it is the customer's responsibility to perform risk assessments and to design and enforce suitable lockout and tagout protocols for maintenance tasks.

1.3.1 Locking out the tool

1. Shut down the tool.
2. Check that the green **System On** indicator is illuminated.
3. Check that the air pressure gauge on the services panel indicates a positive pressure.
4. Lockout the main electrical isolator on the tool.
5. Check that the green **System On** indicator is NOT illuminated.

6 Lockout the air dump valve.

7 Check that the air pressure gauge on the services panel falls to zero pressure.

1.4 Hazard overview

This section lists specific hazards that may be present on the tool. Refer to the relevant section for a detailed description of each hazard and the precautions that must be taken to avoid harm or injury.

The **Plasma**Pro®80 tool is designed to operate with all panels and covers in place. The panels form part of a barrier to protect the user from hazards that may be present inside the tool. These hazards may be continually present, or may only appear in a fault condition. The panels are also required to meet the tool's electromagnetic compatibility specification. Oxford Instruments Plasma Technology does not recommend operating the tool unless all panels and covers are fixed in place.

1.4.1 Hazard list

The following hazards may be present on a **Plasma**Pro®80 tool:

- Electrical hazards
- Electromagnetic radiation hazards
- Gas hazards
- Mechanical hazards
- Weight and lifting hazards
- Light hazards
- High temperature hazards
- Low temperature hazards
- Material and residue hazards
- Vacuum hazards
- Compressed air hazards
- Magnetic field hazards

1.5 Detailed hazard information

Each of the following sub-sections describes a specific hazard that may be encountered on the tool, and gives the precautions that must be taken to avoid harm or injury. All services (energy sources) must be isolated from the tool, if possible, before maintenance is carried out.

1.5.1 Electrical hazards

WARNING

HAZARDOUS VOLTAGE

Contact with hazardous voltage can cause death, severe injury or burns. Any work requiring the removal of covers or panels must only be performed by authorised personnel who are aware of the hazards involved. Before removing any covers or panels, power down the tool and perform the recommended lock out / tag out procedure.

Parts of the tool carry high voltages that are high enough to cause death or serious injury. Isolating the electrical power to the tool is not always sufficient to provide personal protection, as hazardous electrical energy may be stored in capacitors. Take great care when carrying out maintenance tasks. Maintenance tasks must only be performed by personnel who are trained in lockout and tagout procedures and who fully understand the hazards associated with stored electrical energy.

Do not operate the tool with any of the doors, panels or covers removed. Parts of the tool may still contain hazardous electrical energy even when they are isolated by a switch, blown fuse, or a control function. Note that if the main electrical isolator on the tool is turned off there are still hazardous voltages contained within the power box.

All user maintainable components are readily accessible without exposing the operator to live electrical parts. Access to the power box is only possible if the main circuit breaker is turned off. The power box must only be opened by suitably trained personnel who are aware of the hazards involved. Electrical power to the tool must be locked off before opening the power box.

Ensure that all tool units are connected to a local electrical earth (ground). Refer to the Facilities Interface Specification[12] for details of the required electrical installation.

Proper lockout and tagout procedures must be followed when performing maintenance on the tool. Lockout must only be applied to the recommended electrical lockout point, and must only use an approved lockout device. Refer to Section 1.3 for the recommended lockout procedure. Lockout requirements are detailed in the maintenance procedures described in this manual.

Occasionally it may be necessary to perform maintenance and calibration procedures with electrical components at hazardous voltages exposed. Live electrical working must be avoided if at all possible. If live electrical working is unavoidable, this work must only be carried out by personnel who are suitably trained and are authorised to perform such work. Personnel working in energised areas must follow all relevant regulatory, employer and facility procedures. This includes the use of suitable personal protective equipment. Precautions must be taken to make sure other personnel are not exposed to any hazard, such as the use of safety barriers.

Electrical safety interlocks must be tested before the tool is used for the first time, and at scheduled intervals thereafter. Refer to the **Plasma**Pro®80 Service Manual[13] for recommended test intervals.

These tests must be performed by suitably qualified personnel, and the results must be recorded. Do not operate the equipment if any safety interlocks are faulty. Do not override safety interlocks.

Inspect the tool regularly for signs of damage to electrical components. In particular check that all cables and connectors are in good condition and are properly secured, and that switches operate correctly. If any faults are found during this inspection, the equipment must not be used until the damaged components have been repaired and properly tested. Refer to the **Plasma**Pro®80 Service Manual[13] for a list of electrical tests that must be performed on a regular basis.

Contact with live electrical parts may cause serious injury. Ensure adequate earth bonding is always maintained. When replacing tool panels, refit panel earth wires and ensure the panels are secure and have good contact with the frame. Ensure earth continuity is maintained between the tool's primary earth stud, in the power box, and the building electrical earth. Maintenance must only be performed by a trained and qualified electrician. Modification to the tool's wiring must only be performed after first consulting with OIPT. Ensure wires and crimps are tight, and that there are no loose wires that can come free or get snagged. Always use appropriately rated mains cables and plugs.

If any water leaks are detected, immediately isolate the tool at the local electrical services isolator, if it is safe to do so.

1.5.2 Electromagnetic radiation hazards

WARNING

HAZARDOUS RF EMISSIONS
Exposure to RF emissions can cause severe injury or burns. Before turning on the tool's power, ensure that all RF shielding is correctly fitted, and that all connectors and flanges are in place. RF energy can be induced; contact is not necessary to cause injury.

Parts of the tool produce non-ionising electromagnetic radiation. The field strength level at all frequencies is sufficient to cause injury if proper shielding is not in place. RF energy can be induced - it is not necessary to make contact with live electrical components to cause injury.

Oxford Instruments Plasma Technology specifies acceptable limits for the electrical and magnetic field strengths within the environment of the tool. These limits are based on the lowest permitted emissions under all relevant standards; in particular SEMI S2[1] and Directive 2013/35/EU[6]. The chamber viewport is considered to be a particular risk area, so OIPT specify lower acceptable limits for emissions from the viewport. The equipment incorporates shielding to ensure that these specified field strengths are not exceeded.

Ensure that all flanges and cables are correctly fitted, are secure, and are undamaged.

Viewports on the tool are fitted with a metal grid to provide shielding from RF radiation. Ensure that these viewports are correctly assembled and are undamaged. Only fit the correct OIPT viewport.

If a viewport is not fitted with a metal grid, and there is any doubt whether one should be fitted, contact Oxford Instruments Plasma Technology for advice before operating the tool.

Operating the equipment with panels removed increases the risk of RF burns. Ensure that all RF enclosures, panels and cables are correctly fitted, secure and undamaged. If during maintenance, RF enclosures or panels are removed, ensure they are refitted correctly and all retaining screws are in place and tight. It's important that enclosures, panels, and screws are maintained in a good condition. Do not modify these items in any way. Doing so may compromise the RF shielding on the tool.

1.5.3 Gas hazards

WARNING

FLAMMABLE GASES

Flammable material can ignite in the presence of heat or arcing, causing severe injury.

The vent sequence for the process chamber includes a purging step to remove any trace of toxic gas. Always use the proper procedure when venting the process chamber. Ensure that the gas lines have been purged before removing or loosening components. Wear personal protective equipment as necessary.

WARNING

TOXIC GASES

Exposure to toxic gases can cause death or serious injury.

The vent sequence for the process chamber includes a purging step to remove any trace of toxic gas. Always use the proper procedure when venting the process chamber. Ensure that the gas lines have been purged before removing or loosening components. Wear personal protective equipment as necessary.

WARNING

CORROSIVE GASES

Exposure to corrosive gases can cause severe injury.

The vent sequence for the process chamber includes a purging step to remove any trace of toxic gas. Always use the proper procedure when venting the process chamber. Ensure that the gas lines have been purged before removing or loosening components. Wear personal protective equipment as necessary.

WARNING

EXCESS PRESSURE

PlasmaPro80 tools do not provide any excess pressure regulation or protection for process gases. It is the customer's responsibility to ensure that suitable regulation and protection, in accordance with all applicable standards, is installed external to the tool. It is the customer's responsibility to ensure that this equipment is properly maintained.

Gases are used for venting and purging (e.g. nitrogen), for assisting heat transfer (e.g. helium), and for establishing the process environment (process gases). Some cleaning fluids can also produce vapours. The process gases vary from tool to tool.

Compressed gases can penetrate the skin and enter the blood stream. Avoid direct contact with compressed gases.

Gases may produce one or more of the following hazards:

- Toxic hazard
- Carcinogenic hazard
- Corrosive hazard
- Flammability hazard
- Pyrophoric hazard
- Asphyxiant hazard

Before operating or maintaining a particular tool, ensure that the material safety data sheets (MSDS) of all gases connected to the tool have been read and understood. MSDSs can be obtained from the gas supplier. Treat all effluents from plasma tools as toxic.

Ensure that tool effluents are extracted into a safe disposal system and are treated before release into the atmosphere. The internal diameter of all extraction pipework must exceed the internal diameter of the outlet of the tool's backing pump that is connected to it.

It is advisable to separate exhaust lines for hazardous gases from other exhaust lines. It is the customer's responsibility to make sure that the connection of exhaust lines is safe and conforms to local regulations. It is the customer's responsibility to make sure that incompatible gases can not mix in the exhaust lines, and that exposure of personnel to hazardous gases can not occur.

If toxic, flammable or corrosive gases are to be used, the entire exhaust system must comply with best practice for the semiconductor production industry and with local building codes. Refer to SEMI S2 (Environmental, Health, and Safety Guideline for Semiconductor Manufacturing Equipment [1]) for guidance.

If toxic, flammable or corrosive gases are to be used, the entire tool must be sited in a purged or extracted environment fitted with suitable gas detection equipment.

An external gas pod is designed to be installed remotely from the tool, usually in a grey area (sub-fab or chase). An on-board gas pod is designed to be installed on the tool, in the clean room. It is the customer's responsibility to perform a risk assessment for all consumable process materials used on the tool, and to decide if gas sensors and gas pod extraction monitoring are required.

It is the customer's responsibility to fit appropriate gas detection equipment to protect personnel from accidental gas release. The detection equipment must isolate all toxic gas supplies, and provide a suitable warning, if the detected gas concentration exceeds a threshold value.

Even non-toxic gases can cause a hazard by displacing the oxygen in the atmosphere. It is recommended that the customer installs oxygen detection equipment in a suitable location to warn personnel if the available oxygen concentration falls below a threshold value.

The operation of all gas detection equipment must be formally verified every two weeks. Refer to the appropriate manufacturer's manuals for instructions on testing gas detection equipment.

Gas pods supplied by Oxford Instruments Plasma Technology incorporate a 100 mm diameter extraction collar. If toxic, flammable or corrosive gases are used in the gas pod, this collar must be connected to a suitable extraction facility. Purge gas that is extracted from the gas pod must be monitored by suitable gas detection equipment to provide warning of any leakage of hazardous gas.

The extraction system for the gas pod purge gas must be designed to withstand corrosion or combustion.

The vent sequence for the process chamber includes a purging step to remove any trace of toxic gas. Always use the proper procedure when venting the process chamber. Note that the PTIQ application performs a single purge cycle as standard. Consult OIPT to change the number of purge cycles, if hazardous gases are to be run on the tool. It is the users responsibility to ensure the process chamber is properly purged before opening it.

Gas lines must be regularly leak-checked to ensure their integrity.

Before starting any maintenance activity on the gas delivery system, make sure that:

- all process gas delivery lines are completely purged.
- the tool is shut down.
- electrical, pneumatic and process gas supplies to the tool are locked out.

Leak test any gas lines that have been disturbed after the maintenance has been completed.

As far as is practical, gas lines must be isolated when not in use.

Vacuum pumps must always be operated in accordance with the manufacturer's manuals and with Oxford Instruments Plasma Technology training courses.

Pumps that are fitted with a nitrogen purging facility must always be purged during any activity that might cause process gas to enter the pump. Pumps must also be purged for a suitable period after such an activity has completed.

Each mass flow controller supplied with the tool has been specified for the particular gas that was configured at the time of purchase. Do not use a mass flow controller with a different gas to that specified without consulting Oxford Instruments Plasma Technology.

Each gas line in the gas pod is interlocked according to the nature of the gas it contains. Do not connect a different gas to a gas line without consulting Oxford Instruments Plasma Technologyy for advice.

1.5.3.1 Exhaust emissions

The gas emitted by a plasma etch process is mostly made up of the input gases. However the emitted gas contains a small, but significant, component of etch or plasma by-products (up to ~10% in an RIE tool, possibly more for ICP). The exact amounts of these by-products depend on process type and conditions and can be any combination of etch gas material and etched material.

As many of these by-products are toxic, it is a minimum requirement that these gases are exhausted in an enclosed extraction system to the roof of the building - following health and safety regulations. In addition to this, depending on local regulations, it may be necessary to treat the exhaust gas to prevent releasing these materials to the atmosphere.

Even if there are no gases running through the tool, the tool's exhaust must be extracted correctly to remove small droplets of pump oil which are present in the pump exhaust. These oil droplets are harmful to lung function.

Exhaust gases may contain hydrofluoric acid (HF), which can build up in the vacuum pump oil. It is important to use the correct protective equipment when servicing vacuum pumps or changing pump oil, i.e. suitable gloves, protective clothing, filtered facemask or breathing apparatus.

Perfluorinated polyether (PFPE) oil, rather than mineral oil, must be used in vacuum pumps when using oxygen processes. There is a risk of fire or an explosive reaction between oxygen and mineral oil.

The customer should consider fitting abatement and over-pressure monitoring in the exhaust line. OIPT can supply suitable equipment.

1.5.4 Mechanical hazards

Mechanical hazards can come in many forms. Some examples include moving parts which can crush or cut, sharp edges that can cut, hands becoming trapped in closing valves or pump mechanisms, chamber lids pinching when they close, objects falling or toppling under gravity, potential exposure to fluid under high pressure, and implosion of vacuum components. This list of possible mechanical hazards is not exhaustive.

WARNING

PINCH POINT
This pinch point could cause severe injury. Take care when closing the process chamber lid.

Take care when closing the process chamber lid. Ensure that personnel are clear from the vicinity of the lid and its operating mechanism to avoid trapping fingers, etc.

Take care when handling sprung components that are under tension or compression. Take suitable precautions, including eye protection, before maintaining such components.

WARNING

ITEMS CAN MOVE UNDER AUTOMATIC CONTROL
These items can cause severe injury or death. Ensure that the tool is locked out before working near automatic machinery.

Keep clear of all moveable machinery unless it has been properly locked out. Items such as robotic arms, wafer lifting mechanisms and shutters can move suddenly if their stored energy has not been removed. Ensure that all safety guards are correctly fitted before operating such machinery.

Take care of deposited layers on vacuum surfaces or processed wafers. Such layers may be under stress and can eject particles with considerable force. Wear suitable eye protection before cleaning or disturbing deposited layers.

Take care when handling wire components that may be embrittled, such as filaments. Wire components can break and become embedded in the skin.

Wall mounted equipment (e.g. gas pods) must be supported by bolts and frames that can withstand four times the weight of the item being supported.

1.5.5 Weight and lifting hazards

The tool contains heavy components that could cause injury if not properly secured.

WARNING

HEAVY OBJECT

Incorrectly lifting heavy objects can cause severe injury. Use the appropriate lifting equipment, operated by fully trained personnel, when handling heavy tool components. When handling heavy rack-mounted components, ensure that the weight is safely distributed between sufficient personnel.

Serious injury can be caused by attempting to lift heavy components. Always use assistance or lifting equipment when removing or refitting heavy components. If in doubt whether it is safe to perform a lift, consult the local safety representative before proceeding.

Do not attempt to lift any item unaided if the operation requires excessive reaching, leaning or twisting. Injury can be caused by poor posture as well as by the weight of the object itself.

WARNING

TOPPLING (TIPOVER) HAZARD

If heavy items are not kept vertical, they can topple causing severe injury. When transporting or manoeuvring heavy items, ensure that they remain vertical at all times.

Take care when moving heavy components to ensure they cannot topple or fall. Use the support frames or stabilizers provided when moving, installing or decommissioning equipment.

1.5.6 Light hazards

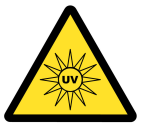
WARNING

LASER RADIATION

Exposure to laser radiation can cause severe eye damage or burns. Ensure that all covers are fitted correctly before operating the tool. Ensure that the manufacturer's instructions for all laser equipment have been read and fully understood. Do not look directly into the beam produced by any class of laser.

Laser equipment can seriously damage eyesight when handled incorrectly or when operated in a damaged condition. Read the manufacturer's instructions carefully and ensure they are followed. Ensure that all equipment covers provided by Oxford

Instruments Plasma Technology are correctly fitted before power is applied to the equipment. Do not look directly into the beam produced by any class of laser.



WARNING

ULTRA VIOLET RADIATION

Exposure to ultra violet radiation can cause severe eye damage or burns. Ensure that all view ports are assembled correctly, and that any replacement filters are of the correct specification.

Viewports on the tool are fitted with clear plastic ultra violet (UV) filters (Perspex® -VE-clear-003). Only fit the correct filter to viewports. Ensure that viewports are correctly assembled.

If a filter is not fitted, or if there is any doubt that the correct filter is fitted, contact Oxford Instruments Plasma Technology for advice before operating the equipment.

Viewports made of either glass or quartz are available. Most of the viewports on Oxford Instruments Plasma Technology tools are made of glass, but quartz viewports are used in certain applications. Quartz viewports pass much more UV light than glass ones, and so present a greater hazard. Quartz viewports require careful shielding or filtering. If there is any doubt whether a viewport is made of quartz or glass, contact Oxford Instruments Plasma Technology for advice before operating the tool.

UV light can also escape from other parts of the tool. Careful filtering and shielding is required to avoid UV exposure.

1.5.7 High temperature hazards

WARNING

HOT SURFACES

Contact with hot surfaces can cause serious injury and burns. Allow sufficient time for heated components to cool to room temperature before carrying out maintenance.

Some components can become heated to a hazardous temperature during operation of the tool. Contact with these items can cause severe burns. Allow these components to cool to a safe temperature before handling them.

Components that become hot during operation include electrically heated chambers, chamber liners, the lower electrode, specimen holders, and recirculating chillers and associated pipework.

1.5.8 Low temperature hazards

WARNING

COLD OBJECTS

Contact with cold objects can cause serious injury to the skin and can cause the skin to adhere to the cold object. Allow sufficient time for cold components to return to room temperature before carrying out maintenance. If cold objects must be handled, ensure that suitable protective clothing is worn.

Components that are cooled in refrigerated or cryogenically cooled systems can cause severe injury if allowed to contact the skin. Allow such components to warm up to a safe temperature before handling.

Components that can reach extremely cold temperatures include cryogenically cooled lower electrodes, all components that use liquid nitrogen, and recirculating chillers and associated pipework.

1.5.9 Material and residue hazards

WARNING

TOXIC MATERIALS

Some materials used in, and resulting from, deposition and etching processes can be dangerously toxic. Exposure to these substances can cause serious injury. Before working on the process chamber, or its associated components, consult a competent authority to ascertain the nature of any coatings. Wear appropriate protective clothing, e.g. hand and eye protection, as necessary.

WARNING

CORROSIVE MATERIALS

Some materials used in, and resulting from, deposition and etching processes can be dangerously corrosive. Contact with these materials can cause serious injury. Before working on the process chamber, or its associated components, consult a competent authority to ascertain the nature of any coatings. Wear appropriate protective clothing, e.g. hand and eye protection, as necessary.

WARNING

FLAMMABLE MATERIALS

Some materials used in, and resulting from, deposition and etching processes can be flammable. Before working on the process chamber, or its associated components, consult a competent authority to ascertain the nature of any coatings. Only use appropriate materials when cleaning flammable coatings. Wear appropriate protective clothing, e.g. hand and eye protection, as necessary.

Some of the compounds used in, or produced by, deposition and etching processes are toxic, corrosive, carcinogenic or flammable. These compounds may be deposited on the vacuum surfaces within the tool and also within the extraction systems and pump exhaust lines. Residues may produce hazardous dust. A risk assessment must be performed and appropriate personal protective equipment must be used when working in these areas.

Cleaning fluids may be toxic or flammable. They may also produce toxic or flammable gases when they contact contaminated surfaces. Only use such fluids with adequate ventilation. Avoid direct or indirect ingestion of such substances.

Maintenance work inside the vacuum chamber, particularly cleaning operations, can generate dust. This dust may be toxic, corrosive or carcinogenic, depending on the process that is being run. Wear appropriate personal protective equipment to prevent dust contacting the skin, eyes and other parts of the body. Take appropriate precautions to contain any dust that may be generated to prevent it spreading.

Some processes may generate nanoparticles; particles whose sizes range from 1 to 100 nm. The effect of these particles on the health and safety of personnel and the environment is currently unknown. Follow local and national safety procedures to alleviate any risk. If a new process is considered and unfamiliar materials may result, please consult Oxford Instruments Plasma Technology for further health and safety information.

Always use suitable personal protective equipment, including eye and skin protection, when handling vacuum pumps and pump fluids. As well as the hazards described below, pumps and fluids may be contaminated with hazardous chemicals.

Study all relevant materials safety data sheets (MSDS) before carrying out maintenance work.

It is recommended that a dedicated set of tools is used for maintenance on **Plasma**Pro®80 tools. This is to avoid accidentally spreading any toxic material that may be picked up on the tools. If dedicated tools are not used, tools must be thoroughly cleaned after use on **Plasma**Pro®80 tools.

All materials used in the construction of the tool are non-hazardous when they are installed. However overheating of materials that contain fluorine can produce hazardous by-products, which could result in death or serious injury.

The following materials are of particular concern:

- Fluoroelastomer (FKM/FPM e.g. Viton®), which is used in O-rings.
- Perfluoroelastomer (FFKM e.g. Kalrez®), which is used in O-rings for special applications.
- Teflon® or other tetrafluoroethylene (TFE) or polytetrafluoroethylene (PTFE) materials, which are used as electrical insulation.
- Certain lubricating greases or fluid, such as Fomblin®, Krytox®, or the NCI™ range from Leybold
- Silicone oils, such as Thermal H5S

1.5.9.1 Fluoroelastomer safety

Great care must be taken to ensure that fluoroelastomer (FKM/FPM) or perfluoroelastomer (FFKM) O-rings are not exposed to high temperatures. Decomposition occurs at temperatures exceeding 315°C, producing a highly acidic residue containing hydrofluoric acid (HF).

If it appears that a fluoroelastomer (FKM/FPM) or perfluoroelastomer (FFKM) O-ring may have been subjected to temperatures in excess of 300°C, the following actions must be carried out:

a) Consult a competent authority regarding the following items (b) to (e).

b) Wearing suitable personal protective equipment, remove the O-ring and dispose of it in accordance with local health and safety regulations.

c) Wearing suitable personal protective equipment, thoroughly clean the contaminated area, disposing of any residue and contaminated cleaning materials in accordance with local health and safety regulations.

d) Fit a new O-ring.

e) Investigate the cause of the excessive temperature and review operating procedures and control systems to prevent a recurrence of the problem.

1.5.9.2 TFE and PTFE material safety

Great care must be taken to ensure that Teflon® or other TFE or PTFE materials are not exposed to high temperatures. If these materials are over-heated, they decompose, producing volatile by-products containing fluorine.

If it appears that any Teflon® or other TFE or PTFE material may have been subjected to temperatures in excess of 300°C, the following actions must be carried out:

a) Consult a competent authority regarding the following items (b) to (e).

b) Wearing suitable personal protective equipment, remove the decomposed material and dispose of it in accordance with local health and safety regulations.

c) Wearing suitable personal protective equipment, thoroughly clean the contaminated area, disposing of any residue and contaminated cleaning materials in accordance with local health and safety regulations.

d) Fit a new component.

e) Investigate the cause of the excessive temperature and review operating procedures and control systems to prevent a recurrence of the problem.

1.5.9.3 PFPE material safety

Great care must be taken to ensure that PFPE lubricating fluids (e.g. Fomblin®, Krytox®, NCI® etc.) are not exposed to high temperatures. If these materials are over-heated, they decompose, producing volatile by-products containing fluorine.

If it appears that any PFPE lubricating fluids may have been subjected to temperatures in excess of 300°C, the following actions must be carried out:

a) Consult a competent authority regarding the following items (b) to (e).

b) Wearing suitable personal protective equipment, remove the decomposed material and dispose of it in accordance with local health and safety regulations.

c) Wearing suitable personal protective equipment, thoroughly clean the contaminated area, disposing of any residue and contaminated cleaning materials in accordance with local health and safety regulations.

d) Replace the fluid or grease with fresh material.

e) Investigate the cause of the excessive temperature and review operating procedures and control systems to prevent a recurrence of the problem.

NOTE: All PFPE material, including spillages of fresh fluid, must be disposed of with great care. PFPE material must be kept away from fire, cigarettes and other smoking materials.

1.5.9.4 Silicone oil safety

Great care must be taken to ensure that silicone oil is not exposed to temperatures in excess of approximately 250°C. If this material is over-heated, it may decompose, producing hazardous by-products.

Silicone oil is used as the thermal transfer medium in some heater/chiller units. Do not use silicone oil in heater/chiller units that are connected to an electrically heated lower electrode. Use a glycol based fluid in heater/chiller units connected to an electrically heated lower electrode.

Heater/chiller units that use silicone oil as the thermal transfer medium can produce vapours around the chiller bath when operating at elevated temperatures. Consider appropriate extraction for such systems.

1.5.9.5 Galden HT170 coolant safety

Great care must be taken to make sure that Galden HT170 coolant is not exposed to temperatures in excess of approximately 270°C. If this material is over-heated, it may decompose, producing hazardous by-products.

Galden HT170 is used as the thermal transfer medium in some heater/chiller units. Do not use Galden HT170 in heater/chiller units that are connected to an electrically heated lower electrode. Use a glycol based fluid in heater/chiller units connected to an electrically heated lower electrode.

Heater/chiller units that use Galden HT170 as the thermal transfer medium can produce vapours around the chiller bath when operating at elevated temperatures. Consider appropriate extraction for such systems.

1.5.9.6 Rotary pump exhaust vapour safety

Rotary pump exhaust can contain oil vapour, which can be carcinogenic. Ensure that all rotary pump exhaust ports are either connected to a suitable exhaust system, or to an oil mist filter.

1.5.9.7 List of hazardous materials, exposure control and disposal

Table 1-1 lists potentially hazardous materials that may be encountered on the tool. The table details the steps that must be followed to control exposure to the materials, and how to safely dispose of them.

Table 1-1 includes non-hazardous materials that may become hazardous when exposed to the plasma or plasma effluent gases.

Table 1-1 List of hazardous materials

Material		Frequency of Use	Exposure	Hazards	Exposure Control and Disposal
Name	Formula				
Grease used in turbo pumps with ceramic bearings.		Always present if a turbo pump with ceramic bearings is fitted.	Exposure only occurs if a turbo pump is serviced.	The grease presents a low hazard. Refer to the relevant MSDS for guidance and handling information.	
Process gas	Depends on the process.	Present whenever a process is run.	There should be no exposure to process gas during normal operation. There is a risk of exposure to residual gas if the process chamber is opened without proper purging.	There is a significant risk of exposure to toxic or corrosive gas residues if proper purging procedures are not followed. Gas lines must be leak-checked under vacuum prior to use.	See Section 1.6.4.
Compressed gas	Nitrogen	Continuous	Minimal	Compressed gas at pressure in excess of atmospheric. Asphyxiation.	See Section 1.6.3.
Compressed gas	Air	Continuous	Minimal	Compressed gas at pressure in excess of atmospheric.	See Section 1.5.11.
Coolant fluid	Water	Continuous	Exposure only occurs during maintenance tasks that require the coolant circuit to be opened.	Possible hazard from corrosion and bacterial inhibitors in the water.	Refer to the relevant MSDS for information. Wear appropriate PPE.
Coolant fluid	Chiller thermal transfer fluid	If a heater/chiller is fitted, this may be used intermittently or continuously.	Exposure only occurs during maintenance tasks that require the coolant circuit to be opened.	Minimal hazard unless sub-zero temperatures are used.	Refer to the relevant MSDS for information. Wear appropriate PPE.

1.5.10 Vacuum hazards

WARNING

IMPLOSION HAZARD

Vacuum chambers can present an implosion hazard. Before evacuating the tool, ensure that all covers and screens are fitted correctly. Do not remove covers or screens while the chamber is under vacuum.

Components under partial vacuum store mechanical energy, which can cause death or severe injury if released accidentally. Process chambers, loadlocks, and other vacuum chambers must be vented to atmospheric pressure before the tool is shut down for maintenance.

Take care when handling vacuum capacitors. If these items are knocked or dropped, they can implode, causing serious injury.

All view ports with a diameter greater than 100 mm must be fitted with an implosion eye guard. The eye guard is a clear plastic shield that fits on the outside of the view port. Only fit the correct OIPT guard to viewports. Ensure that all view ports are correctly assembled before evacuating the tool.

If a plastic implosion eye-guard is not fitted, or if there is any doubt about the type or condition of an eye-guard that is fitted, contact Oxford Instruments Plasma Technology for advice before proceeding.

Take care when opening vacuum vessels that have been vented, in case they are over-pressurised by the vent gas.

1.5.11 Compressed air hazards

Compressed air is used to power pneumatic items on the machine. Trapped volumes of compressed air store mechanical energy, which can cause death or serious injury if released accidentally. Pneumatically actuated components can move suddenly, even when the tool is not operating, causing serious injury. Compressed air can penetrate the skin and enter the blood stream, causing severe injury. Avoid direct contact with compressed air.

Before working on the tool, the compressed air supply must be locked out and all compressed air pressure must be released. Refer to the **PlasmaPro®80** Service Manual for the detailed shut-down procedure that is required prior to performing maintenance tasks.

WARNING

PNEUMATIC PRESSURE

Pneumatic valves or components can move unexpectedly, causing severe injury. Lockout the compressed air supply, and release the stored pressure, before working near pneumatic items.

Use the following sequence to release the air pressure from pneumatic items, prior to working in their vicinity:

a) Remove electrical power from the tool and lockout the main circuit breaker.

b) Isolate and lockout the pneumatic supply to the tool and disconnect the pneumatic supply pipes to the tool.

c) Operate the air dump valve on the services panel at the rear of the tool. This releases air pressure from both sides of the valve actuators.

1.5.12 Magnetic field hazards

WARNING

MAGNETIC FIELDS

Powerful magnetic fields can interfere with the operation of cardiac pacemakers. Do not approach the equipment if you wear a cardiac pacemaker.

Some parts of the machine may contain powerful electromagnets, depending on the tool's configuration. These electromagnets can produce a powerful magnetic field, which can interfere with the operation of cardiac pacemakers in the vicinity of the tool, causing death or serious injury.

Personnel who wear a cardiac pacemaker must not approach the tool at any time, even when it is powered off.

WARNING

MAGNETIC FIELDS

Powerful magnetic fields can cause metallic items to move unexpectedly. Take care when working in the vicinity of magnetic fields.

Strong magnetic fields can also cause metallic items to move suddenly, possibly causing serious injury. Take care when using magnetic tools or other magnetic items near areas of the machine that contain magnets.

1.6 Potential routes of unintended release

1.6.1 Cooling fluid

All cooling liquid fittings within the **Plasma**Pro®80 tool are stainless steel swage fittings. The cooling circuit for the lower electrode is connected to the tool via inlet and outlet fittings on the service panel. All other cooling circuits are fed from inlet and outlet manifolds within the base frame. Each manifold connects to a single fitting on the service panel.

Individual cooling circuits are connected to the manifolds using swage fittings. Each circuit uses either 1/4”, 3/8” or 1/2” tubing, made of nylon, polyurethane, PFA or PTFE. Wherever possible, the pipes are routed to avoid sensitive electronics that may be damaged by leakage. Drip trays and splash guards are incorporated into the tool to minimise the impact of coolant leaks.

All cooling connections must be checked regularly to ensure that there is no leakage or loosening of the fitting. Coolant pipes must be checked to ensure they are fixed securely, and that they haven’t moved into a position where they might be strained or trapped.

1.6.2 Compressed air

Compressed air fittings must be checked regularly to ensure they are not damaged or loose. Failure of a compressed air connection will cause compressed air to leak into the tool. This leakage may be continuous, or may only occur when the relevant compressed air line is pressurised.

Failure of a compressed air line will cause incorrect functioning of the pneumatic item (e.g. a valve) that the line is connected to. Depending on the exact problem, the failure may cause a recipe to abort or a programmed sequence to fail. The tool is designed to shut down in a safe manner if such a failure occurs.

Unexpected release of compressed air is usually audible, if the user is adjacent to the tool’s frame. If the tool is mounted through a wall, the release may not be audible, but diagnosis is usually possible by interpreting the information displayed on the PTIQ control pages.

Use of the tool must be restricted to personnel who have been trained to understand and interpret the behaviour of the tool.

1.6.3 Purge nitrogen

Nitrogen fittings must be checked regularly to ensure they are not damaged or loose. Failure of a nitrogen connection will cause nitrogen to leak into the tool and the environment. Nitrogen displaces the oxygen from the atmosphere and high concentrations can cause death by asphyxiation.

Failure of a nitrogen component may interrupt the flow of nitrogen to a pump or a vent line. Purge flows are monitored and failure will trigger a tool alert. Failure of a vent line will cause slow venting of a chamber, which also triggers an alert.

The tool must be located in a well ventilated location to prevent dangerous concentrations of nitrogen accumulating in an unintended release occurs. The room should have a volume of at least 30 m^3 and should have at least four changes of air per hour.

Unexpected release of nitrogen is usually audible, if the user is adjacent to the tool frame. If the tool is mounted through a wall, the release may not be audible, but diagnosis is usually possible by interpreting the information displayed on the PTIQ control pages.

Use of the tool must be restricted to personnel who have been trained to understand and interpret the behaviour of the tool.

1.6.4 Process gas

The design, installation and maintenance of process gas lines to the machine are the responsibility of the user. Such gas lines must be constructed of materials and components that are appropriate for the gases that they contain.

Personnel must follow specified pump and purging procedures before and after maintaining the gas system. Process gas connections within the tool use stainless steel VCR face gasket fittings. Maintenance personnel must ensure that any replacement parts (including gaskets) are of the correct type.

Most of the process gas delivery system is contained within a gas pod, which is extracted to remove any accidental release. The extraction system must be compatible with the process gases connected to the gas pod. The extraction flow rate must be sufficient to remove any accidental release of process gas. The customer must fit appropriate gas detection equipment to monitor accidental release of any hazardous gases connected to the tool.

The gas pipes connecting the gas pod to the process chamber are under vacuum when the tool is operating. This vacuum level is monitored by tool's interlocks, which disable the gas pod when the process chamber pressure is above 600 mbar. The vacuum within the pipes guarantees that any leakage produces a net flow of gas into the process chamber.

A leak on the parts of the gas system that are external to the gas pod will produce a high vacuum leakage rate on the process chamber. This may cause a high base pressure within the chamber. Conventional vacuum leak-checking techniques can be used to locate such a leak.

1.6.5 Vacuum

The process chamber and pumping system are all under vacuum when the tool is operating. The tool's interlocks disable the gas pod when the process chamber pressure is above 20 Torr. The vacuum within the process chamber guarantees that any leakage produces a net flow of gas into the process chamber.

A leak on the process chamber will produce a high vacuum leakage rate. This may cause a high base pressure within the chamber. A leak on the pumping system will not affect the process chamber leak rate, but may cause a high base pressure. Conventional vacuum leak-checking techniques can be used to locate such leaks.

1.7 Tool safety features

This section describes the principle safety features incorporated into the tool, and how they impact the operation and maintenance of the machine.

Table 1-2 lists design features that mitigate against specific hazards.

Table 1-2 Safety design features of the tool

Hazard	Design Feature
Fire	Electrical wiring complies with the EN 60204-33 standard.
Explosion	Pressure switch in the process chamber protects against the accumulation of flammable gas.
Chemical leakage	Joints in the positive pressure parts of the gas lines are contained in an extracted enclosure.
	External joint in the gas lines are in sections that contain negative pressure. Any leakage is inwards.

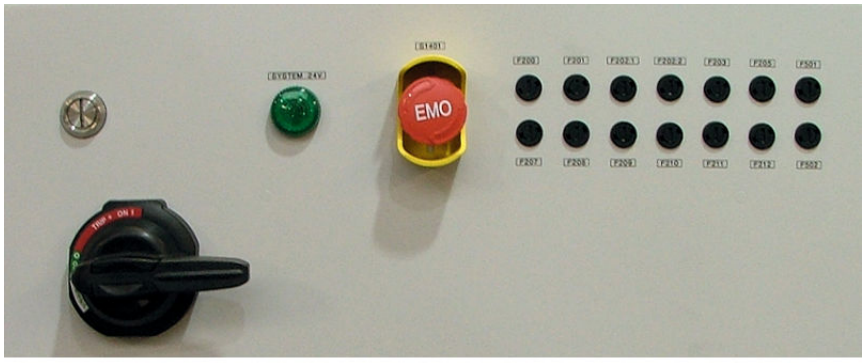
1.7.1 EMO buttons

The tool is provided with **EMO** (emergency off) buttons in the following locations:

- on the tool console
- on the power box

Press a button once to remove hazardous electrical power from the tool. Once operated, the button latches in the OFF position.

EMO button on control console



EMO button on the power box

Figure 1-2 Location of EMO buttons

NOTE: Customers may fit additional **EMO** buttons in other locations, for example near a remote gas pod or pump. The operation and function of additional buttons is identical to that of the main **EMO** buttons.

The **EMO** buttons are intended for use when hazardous electrical power must be immediately removed from the tool to prevent personal injury or an imminent hazard. They must also be operated if the building is being evacuated because of fire, earthquake or other major event.

1.7.1.1 Hazards present after an emergency off event

It must be noted that pressing an **EMO** button does not remove all potential hazards from the tool. In particular the following hazards may still be present:

a) Hazardous voltages in the mains input cable

b) Hazardous voltages on the main circuit breaker and contactor in the power box

c) Hazardous voltages on the 24 VDC power supply in the power box

d) Stored electrical energy in capacitors

e) Toxic gases trapped within the gas pod, gas lines, vacuum pumps and process chamber

f) Pressurised air trapped in pneumatic components

g) Parts of the tool may still be under vacuum.

h) Parts of the tool may still be at high or low temperatures.

Caution

EMERGENCY OFF

Press an **EMO** button only if an immediate hazard is perceived. Repeated use of the **EMO** buttons can degrade parts of the tool, resulting in premature failure.

The **EMO** buttons do not shut the machine down in a controlled way, and so should not be used for shutting the machine down for maintenance or as part of the routine operation cycle.

Once an **EMO** button has been pressed, it can be released by rotating the red button. This must only be done by trained personnel once the emergency situation has been resolved and all potential hazards have been isolated. The normal machine start-up sequence must then be followed to return the tool to service. Care must be taken to evacuate and purge the process chamber in order to remove toxic gases before opening it.

1.7.2 Electrical protection devices

Power box circuit breakers and protection devices are listed in Table 2-1 and Table 2-2.

1.7.3 Mechanical safety devices

The process chamber is fitted with a safety mechanism for the use of service engineers only. It's purpose is to lock the chamber in the open position. Service engineers must ensure that the locking mechanism is engaged whenever the chamber is opened for any length of time, or if maintenance is being performed inside the chamber (see Section 6.1.1).

Tools with a turbo pump on the process chamber are fitted with bracing. This bracing prevents ejection of the pump in the unlikely event of catastrophic failure.

1.7.4 Fixed and moveable guards

The following guards protect the user against access to hazardous parts of the tool.

Table 1-3 Guards on the tool

Guard Device	Guard Type	Hazard	Interlock
Process chamber lid	Moveable	RF energy inside the process chamber	Safety switch disables electrical power to the RF generators.
		Toxic gases inside the process chamber	Safety switch disables the electrical supply to the gas pod.
Gas pod door	Moveable	Toxic gases inside the gas pod	Safety switch disables the gas valves.
RF covers	Fixed	RF energy inside the tool.	Not applicable.

Table 1-3 Guards on the tool

Guard Device	Guard Type	Hazard	Interlock
External covers	Fixed	Electrical and RF energy, toxic gases, compressed air, hot and cold surfaces inside the tool	Not applicable.
Viewport	Fixed	Exposure to RF energy and UV radiation	Not applicable.

1.7.5 Residual risks

Despite the safe design of the tool, some residual risks remain. Table 1-4 explains how to avoid these risks.

Table 1-4 How to avoid residual risks on the tool

Residual Risk	How to Avoid the Risk
Electric shock	All hazardous electrical components are protected by guards and interlocks. Only personnel with suitable skills and training: ▪ must perform maintenance ▪ reset circuit breakers if they switch off Follow the maintenance procedures in this manual.
Exposed hot surfaces	Follow the procedures described in this manual. Procedures instruct the user to wait for hot surfaces to cool where this hazard is a possibility. Hazard labels are attached at appropriate positions on the tool.
Persistent toxic fumes	Perform recommended pump and purge procedures before opening the process chamber. Assess if the likely fumes require the user to wear personal protective equipment.
Pinch point	Keep clear of the mechanism when closing the process chamber lid.
Strong magnetic field	Keep clear of the tool if you wear a pacemaker.
Process dust in the process chamber	Assess the risk before opening the chamber. Wear suitable personal protective equipment.

1.8 Tool safety and equipment interlocks

The tool incorporates many interlocks. In general interlocks fall into one of two classes:

Safety interlock
The primary function of a safety interlock is to protect personnel from exposure to a hazard.

Equipment interlock
The primary function of an equipment interlock is to protect the equipment from damage.

1.8.1 Tool safety interlocks

The following functions are protected by safety interlocks:

- Enabling RF power.
- Enabling process gases.
- Enabling pumping.
- Enabling cooling (if fitted).

The main interlock system is discussed in more detail in Section 1.8.1.1. Additional safety interlocks are discussed in Section 1.8.1.3.

1.8.1.1 Main interlock chain

The main interlock chain consists of a double set of safety relay contacts wired in series and fed from a 24 VDC supply.

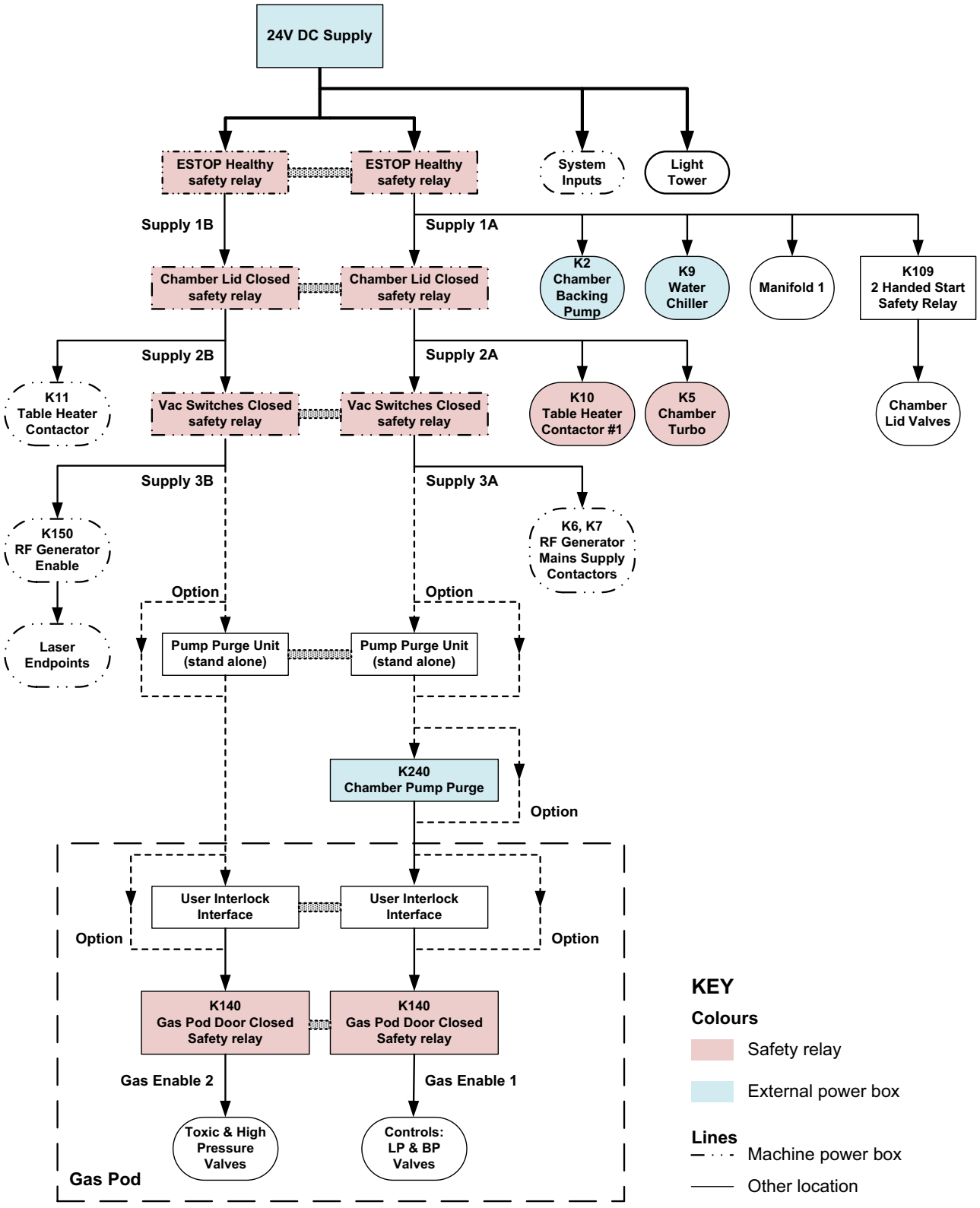


Figure 1-3 Overview schematic of the interlock chain

The interlock chain has several levels of electrical outputs. They are enabled only when previous levels of safety are fulfilled (see Table 1-5).

Table 1-5 PlasmaPro®80 safety relay control hierarchy

Safety Function	Interlock Line	Description	
EMO healthy safety relay K100	Supply 1a	Chamber backing pump Chiller Manifold 1 2-handed control (via K109)	(via K2) (via K9) (via K109)
	Supply 1b		
Chamber lid closed safety relay K102	Supply 2a	Chamber turbo power Table heater contactor 1	(via K5) (K10)
	Supply 2b	Table heater contactor 2	(K11)
Vacuum switch(es) closed safety relay K103	Supply 3a	RF generator 1 AC power control RF generator 2 AC power control	(via K6) (via K7)
	Supply 3b	Interlock - generator(s) enable Interlock - endpoint camera enable	(via K150) (via K150)
Safety controlled lines 3a and 3b continue through interlocks of various equipment in order as:			
Gas pod door closed safety relay K140	Supply 3a	BP and LP valves enable	
	Supply 3b	Toxic and HP valves enable	

The following conditions must be true in order to energise non-toxic control valves in the gas pod:

- The **EMO** button must not be activated.
- The process chamber lid must be closed.
- The chamber vacuum pressure must be less than 20 mbar (vacuum switch on chamber).
- The primary process pump must be running (electrical current monitor in the power box).
- The primary process pressure gauge must not be full scale. (This is normally a capacitance manometer gauge). See NOTE.
- The flow of purge gas to the primary process pump must be sufficient (flow-switch in the purge line). See NOTE.
- The customer external alarms circuit must be made (all alarm devices in their safe state).

NOTE: With the exception of these conditions, toxic lines are energised in a parallel path to the non-toxic lines.

1.8.1.2 Customer external interlock input

An electrical interlock input is provided to allow the customer to connect any external safety alarm devices into the main interlock chain. Examples of devices that might be connected include exhaust scrubber alarms, gas detectors, smoke detectors, fire alarms, water spillage detectors etc.

The input requires a simple electrical contact to complete the interlock chain. Any customer devices must provide dual pole relay contact outputs that fail safe (i.e. the contacts open if a fault condition is detected or if the customer device fails for any reason).

If no external devices are connected, the customer alarm input must be linked out.

1.8.1.3 Additional gas panel interlocks

Gas pod door interlock

The gas pod contains a safety switch that operates when the door is closed. Opening the door causes the contacts to break which, in turn, disables the 24 VDC outputs from the door monitor safety relay. The 24 VDC powers the pilot valves that control the pneumatic valves in the gas pod. Interrupting this power supply forces all normally closed valves in the gas pod to close and all normally open valves in the gas pod to open.

Bypass valve interlock override keyswitch.

The bypass valve in a toxic gas line is interlocked with the low pressure isolation valve in the same gas line, so that both valves cannot be operated together. A keyswitch is provided in the gas pod to override this interlock. This keyswitch must only be operated by trained personnel.

1.8.2 Equipment interlocks

The interlocks listed in this section are designed to protect the equipment from failure, and do not have a primary safety function.

Incompatible gases interlock

The gas panel contains an additional interlock circuit to prevent incompatible gases from mixing. This circuit is located on the gas control card, located at the bottom of the gas pod.

Each gas line has an associated circuit link which can be connected in one of three ways:

- Fuel gas
- Oxidiser gas
- Neither fuel or oxidiser gas

These links are configured in the factory to match the gas configuration specified by the customer. The gas control card uses safety relays to prevent any fuel gas mixing with any oxidiser gas.

For example, if silane (a fuel gas) is already flowing into the chamber, the interlock circuit prevents the operator opening the selection valve for oxygen (an oxidiser gas).

Turbo pump interlock

If the tool has a turbo pump fitted to the process chamber, the following interlock must be made in order to start the pump:

- Nitrogen pressure on the turbo pump bearing purge line must be sufficient to purge the pump bearings (pressure switch on the purge line).

Backing pump interlock

The following interlocks must be made in order to start the pump:

- Nitrogen flow in the pump purge gas line must be sufficient to purge the pump bearings (flow-switch on the purge line).

1.9 Personal protective equipment

It is important to wear the correct personal protective equipment (PPE) when working on the tool. This section lists typical items of PPE for guidance only. It is the customer's responsibility to perform risk assessments and to produce their own list of personal protective equipment.

Table 1-6 Examples of personal protective equipment

PPE Item	Use
Latex or nitrile gloves	Handling any vacuum components. Working near components that may contain toxic or corrosive gas or residues. Using solvents or cleaning materials. Working near process wafers.
Eye protection (e.g. safety goggles or face mask)	Working near components that may contain toxic or corrosive gas or residues. Changing gas bottles. Using solvents or cleaning materials. Performing any tasks that may generate dust or particles. Maintaining any part of the tool that may contain pressurised gas. Maintaining any components that may contain springs. Working near cryogenic components.
Self-contained breathing apparatus	Changing gas bottles that contain toxic or corrosive gas. Maintaining components that may have contained toxic or corrosive gas.
Filtered mask (e.g. 3M® 6899B with an appropriate filter such as ABEK2P3)	Changing gas bottles that contain certain toxic or corrosive gases. Maintaining components that may have contained certain toxic or corrosive gases. General cleaning operations when organic solvents are used.
Dust mask	Cleaning or maintaining vacuum components that may contain toxic or corrosive deposits. Performing any tasks that may generate dust or particles. NOTE: A dust mask does **not** provide protection against toxic or corrosive gas.
Disposable overall	Handling any vacuum components. Working near components that may contain toxic or corrosive gas or residues. Using solvents or cleaning materials. Performing any tasks that may generate dust or particles.

Table 1-6 Examples of personal protective equipment

PPE Item	Use
Thermal protective gloves	Working near cryogenic components. Working components that may be at high temperature. Handling or transporting cryogenic fluids (e.g. liquid nitrogen).
Safety shoes	Moving or lifting heavy items.

1.10 Mandatory safety procedures

It is the customer's responsibility to perform risk assessments and to develop and enforce suitable safety procedures. However, the following sections stipulate minimum precautions that must be taken when performing various tasks.

1.10.1 Response in case of fire

WARNING

TOXIC GASES

Exposure to toxic gases can cause death or serious injury. Parts of the tool can generate toxic fumes if they are subjected to fire (e.g. PTFE components).
It is the customer's responsibility to consider the hazards caused by the process gases and precursors used on the tool. Perform a risk assessment before the tool in installed and implement appropriate procedures in case of fire.

If any part of the tool catches fire, perform the following procedure.

1 Press an **EMO** button.

2 Perform the appropriate local fire response procedure.

3 If appropriate, use a fire extinguisher that is suitable for electrical fires.

1.10.2 Maintenance on the process chamber or vacuum system

1.10.2.1 If toxic, corrosive or flammable gases are present on the tool

WARNING

TOXIC GASES

Exposure to toxic gases can cause death or serious injury. The vent sequence for the process chamber includes a purging step to remove any trace of toxic gas. Always use the proper procedure when venting the process chamber. Ensure that the gas lines have been purged before removing or loosening components. Wear personal protective equipment as necessary.

WARNING

FLAMMABLE GASES

Contact with flammable gases can cause death or serious injury. The vent sequence for the process chamber includes a purging step to remove any trace of toxic gas. Always use the proper procedure when venting the process chamber. Ensure that the gas lines have been purged before removing or loosening components. Wear personal protective equipment as necessary.

If toxic, corrosive or flammable gases are present on the tool, perform the following mandatory procedure before maintaining the process chamber or vacuum system:

1 Allow the chamber to pump down to its base pressure after the gas supply has been turned off.

2 Select the **Vent** button on the process module page to vent the process chamber. This action purges the process chamber before venting it. DO NOT manually open the vent valve to bypass this purging step.

3 Perform the maintenance, using appropriate PPE.

4 Treat all vacuum components as toxic and corrosive.

5 Dispose of any vacuum components or cleaning materials according to local and national regulations.

6 Perform a vacuum leak check on the tool before returning it to service.

1.10.3 Maintenance on gas components and the gas pod

WARNING

TOXIC GASES

Exposure to toxic gases can cause death or serious injury. Trapped volumes of hazardous gas may be present in process gas supply lines, including the gas pod. Ensure that all gas lines and gas components are purged and isolated before disconnecting or removing any part of the gas delivery system. Wear personal protective equipment as necessary.

If toxic, flammable or corrosive gases are present on the tool, trapped volumes of hazardous gas may be present in process gas supply lines, including the gas pod. Care must be taken to follow the appropriate pump, purge and bypass procedures before performing any action that may release this trapped gas. If equipment failure prevents the operation of normal evacuation and purge procedures, consult the local safety representative before proceeding. A risk assessment must be performed to decide the safest method for resolving the issue before any action is attempted.

Perform the following mandatory procedure before disconnecting or removing any part of the gas delivery system:

1 Shut all gas delivery valves at source (e.g. the point-of-use valves or gas bottle valves).

2 Evacuate each gas line in turn, including gas lines that are not directly affected by the maintenance. Use the proper procedure for evacuating gas lines, including correct operation of the bypass valves.

3 Purge and evacuate the gas line that is to be worked on. Use the proper procedure for purging the gas line.

4 Perform the maintenance, using appropriate PPE.

5 Treat all components that may have come into contact with toxic or corrosive gas as toxic and corrosive.

6 Purge, evacuate and leak check all gas components that have been disturbed or replaced before turning on the gas supply.

1.11 Warning and hazard labels

Warning and hazard labels are placed at appropriate locations on the tool to warn personnel about potential hazards. The following categories of label are used:

- DANGER
  Exposure to the hazard **would** result in serious injury or death.
- WARNING
  Exposure to the hazard **could** result in serious injury or death.
- CAUTION
  Exposure to the hazard could result in minor injury or damage to the equipment.

1.11.1 List of hazard warning labels

Table 1-6 shows all the labels that may be encountered.

Table 1-7 Equipment hazard warning labels

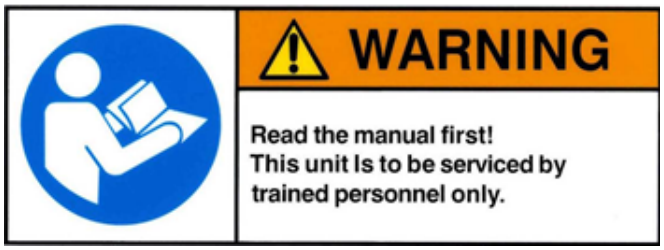
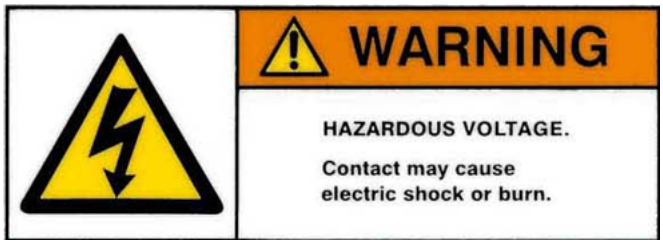
Label	Description
	Read the manual before servicing this item.
	The assembly that this label is attached to contains hazardous voltages. Ensure that the electrical power to the tool is locked out before removing the assembly covers or attempting to service the assembly.

Table 1-7 Equipment hazard warning labels

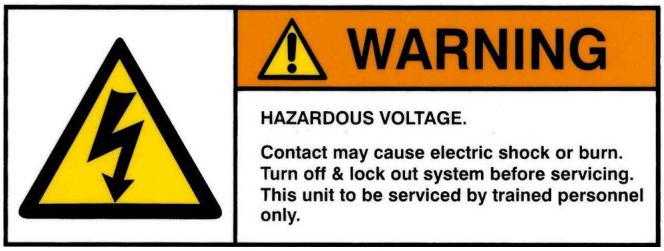
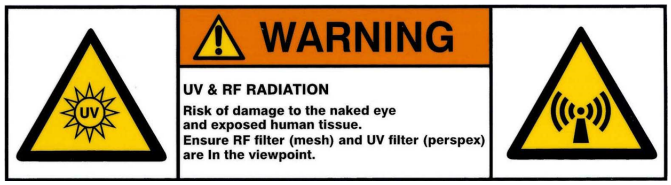
Label	Description
	The assembly that this label is attached to contains hazardous voltages. Ensure that the electrical power to the tool is locked out before removing the assembly covers or attempting to service the assembly.
	The assembly that this label is attached to contains hazardous RF energy. Ensure that the electrical power to the tool is locked out before removing the assembly covers or attempting to service the assembly.
	The assembly that this label is attached to contains hazardous RF energy. Ensure that the electrical power to the tool is locked out before removing the assembly covers or attempting to service the assembly.
	There is a pinch point adjacent to this area. Ensure that operating personnel are aware of the hazard. Keep fingers and hands clear of the mechanism unless the electrical and pneumatic supplies to the machine are locked out.
	The equipment generates UV and RF radiation. Ensure that the viewport has a RF filter and a UV filter fitted. Do not operate the equipment without the filters in place.

Table 1-7 Equipment hazard warning labels

Label	Description
	The assembly that this label is attached to contains fluid under pressure. Read the manual before servicing this item.
	The assembly that this label is attached to contains hazardous DC voltages. Ensure that the electrical power to the tool is locked out before removing the assembly covers or attempting to service the assembly.
	The assembly that this label is attached to generates strong magnetic fields, Keep all personnel who wear a pacemaker away from the machine. Read the manual before servicing this item.

Table 1-7 Equipment hazard warning labels

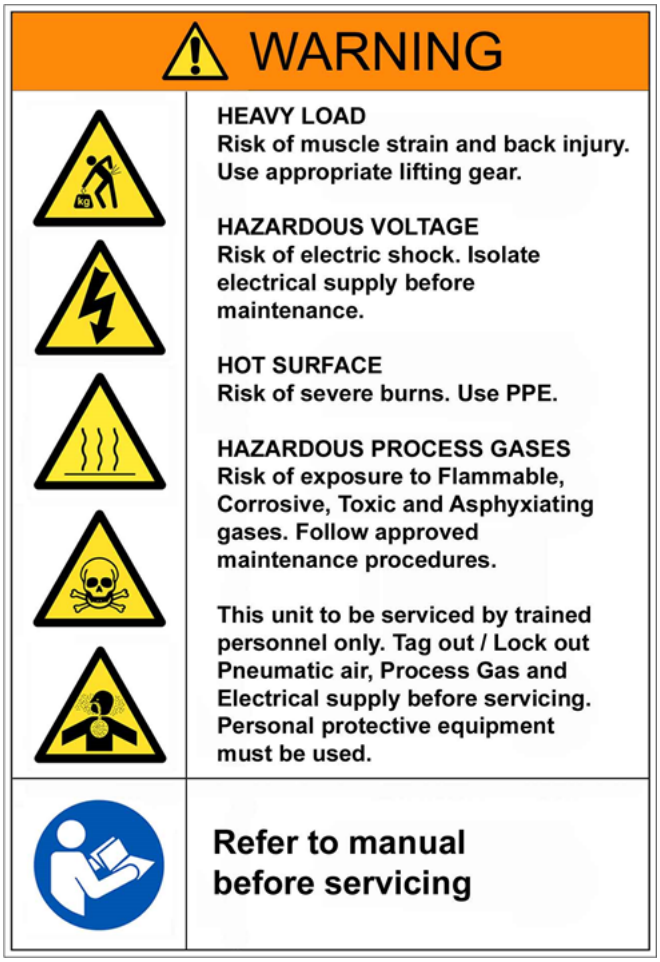
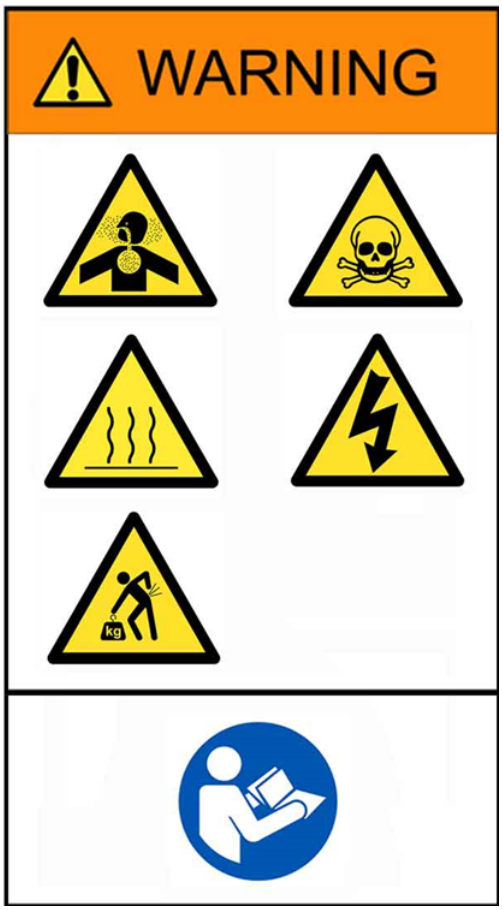
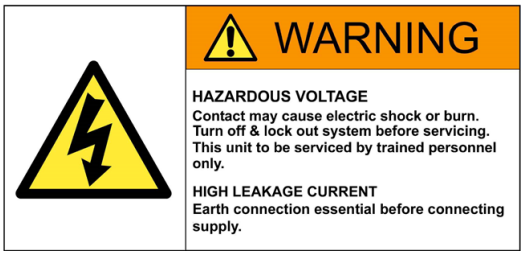
Label	Description
	The assembly that this label is attached to contains multiple hazards. Read the manual before servicing this item. Ensure that the electrical power, the pneumatic supply, and all process gas supplies to the tool are locked out before removing the assembly covers or attempting to service the assembly. Use appropriate lifting gear when moving this assembly. Wear appropriate PPE to avoid contact with hot surfaces.

Table 1-7 Equipment hazard warning labels

Label	Description
	The assembly that this label is attached to contains multiple hazards. Read the manual before servicing this item. Ensure that the electrical power, the pneumatic supply, and all process gas supplies to the tool are locked out before removing the assembly covers or attempting to service the assembly. Use appropriate lifting gear when moving this assembly. Wear appropriate PPE to avoid contact with hot surfaces.
	The assembly that this label is attached to contains hazardous voltages. Ensure that the electrical power to the tool is locked out before removing the assembly covers or attempting to service the assembly. Ensure that a secure earth is connected to the assembly before connecting the electrical power supply.

1.11.2 Location of hazard warning labels

Table 1-8 lists the location of the hazard warning labels on a typical **Plasma**Pro®80 tool.

Table 1-8 Location of the tool's hazard warning labels

Location	Comment
APC controller	High voltage label
Process chamber	UV & RF radiation label
	Pinch point label
Penning gauge	Magnetic field label
Pirani gauge	Read the manual first label
Vacuum switch	Read the manual first label
CM gauge	Read the manual first label
APC valve	Read the manual first label
Gate valve	Read the manual first label
Helium pressure controller	Read the manual first label
RF generator	High voltage label
	Hazardous RF energy label
RF cables	Hazardous RF energy label
RF enclosures	Hazardous RF energy label
AMUs	Hazardous RF energy label
	Read the manual first label
Turbo pump controller	High voltage label
Turbo pump	Read the manual first label
Power box	Read the manual first label
	Hazardous voltage and high leakage current label.
Gas pod exterior and interior	Multiple hazard label
Pneumatic reservoir	Fluid under pressure label
Endpoint detector	Read the manual first label

1.12 Solid waste

Wherever possible, OIPT has used components and materials that comply with the Restriction of Hazardous Substances (RoHS) directive[11] to construct the **Plasma**Pro®80 tool. However some parts can become contaminated with plasma effluent or vacuum oil during use, and can thus become solid waste.

This section lists items that become solid waste as a result of the operation, maintenance and servicing of the equipment, and that are constructed of, or contain, substances whose disposal might be regulated.

- Vacuum pipework downstream of the turbo pump, in a turbo pump system. This includes flexible pipes, solid elbows and tees that may have become contaminated with plasma effluent.
- Vacuum pipework downstream of the automatic pressure controller / gate valve assembly, in a plasma enhanced chemical vapour deposition (PECVD) system. This includes flexible pipes, solid elbows and tees that may have become contaminated with plasma effluent.
- Turbo pump isolation valve, on turbo pump systems
- All vacuum O-rings.
- Chamber viewport glass
- The lithium battery in the programmable logic controller (PLC)

1.13 Risk assessments

OIPT recommends that the customer completes a risk assessment in line with the requirements given by BS EN ISO 12100:

- Safety of machinery.
- General principles for design.
- Risk assessment and risk reduction.

A risk assessment must consider the following points.

- The likelihood of occurrence of the hazard.
- The degree of possible harm caused by the hazard.
- The frequency of exposure to the hazard.
- The number of persons at risk.

1.14 Tool modifications

Modifications are not permitted unless authorised in advance by Oxford Instruments Plasma Technology. Unauthorised modifications will void the tool's warranty.

Please contact Oxford Instruments Plasma Technology before modifying the **PlasmaPro®80** tool, or fitting any accessories.

1.15 Materials safety data sheets

The CD that ships with the tool contains materials safety data sheets (MSDS) for all chemical substances shipped with the tool. The user is responsible for obtaining process related MSDSs and should contact their suppliers to obtain them.

2 TECHNICAL DESCRIPTION

This chapter describes the function and layout of the **Plasma**Pro®80 tool. The chapter comprises the following sections:

- Tool overview
- Base unit
- Gas delivery system
- Pumping module
- Process specific module
- Auto matching unit

2.1 Tool overview

2.1.1 General description

The **Plasma**Pro®80 is a modular plasma processing tool, which can be configured to carry out reactive ion etching (RIE), plasma enhanced chemical vapour deposition (PECVD) or plasma etching (PE). The tool features a small footprint and a convenient open loading design. The **Plasma**Pro®80 can process a wide range of wafer sizes, from small wafer pieces up to 200 mm (8”) diameter wafers.

The wafers to be processed are manually loaded onto the lower electrode within an aluminium vacuum chamber. This chamber is evacuated by a pumping module, which can be supplied in various configurations to suit the required process. A precise flow of one or more process gases is then supplied to the chamber from a gas pod, which is usually located remotely from the main tool.

The tool uses radio frequency (RF) power to create a plasma inside the process chamber. The reactive ionic species generated within the plasma are guided onto the front surface of the wafer. The resulting deposition or etch process can be varied by altering the plasma conditions, the source gas for the plasma, the vacuum pressure, the wafer temperature, and various other parameters.

Figure 2-1 shows the outline of a typical **Plasma**Pro®80 tool.

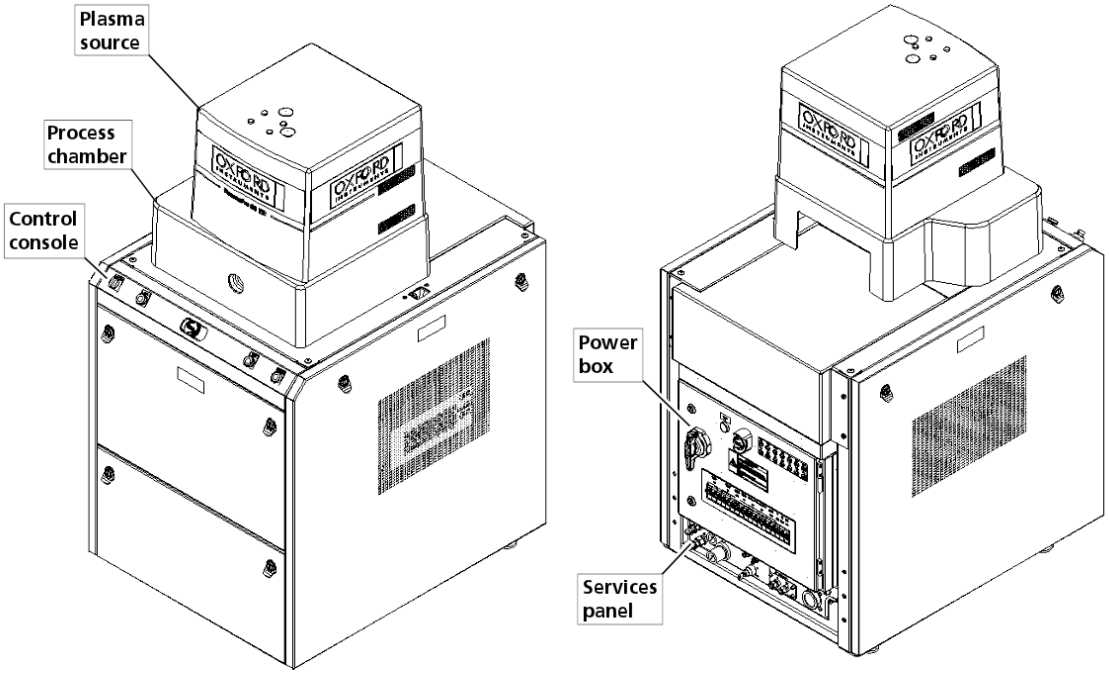


Figure 2-1 General view of a typical PlasmaPro®80 tool

The primary components of the tool are:

- Base unit - the tool's frame, which houses equipment for electrical power distribution, compressed air and nitrogen services, cooling water distribution, and part of the control system.
- Process chamber - a vacuum chamber located on the base unit: it provides the environment in which plasma deposition or etching take place.
- RF generators - mounted in the base unit. RF generators provide the power for generating the plasma or for controlling the energy of ions hitting the wafer.
- Auto matching unit - mounted above the process chamber or in the base unit. Each auto matching unit (AMU) matches the impedance of an RF generator to that of the process chamber. This maximises the power delivered to the plasma.
- Pumping module- which provides vacuum pumping for the tool. The configuration of this module matches the customer's process. Most of the pumping module is located within the base unit, although the backing pumps may be located remotely.
- Process specific module - which contains the process chamber, lower electrode, electrodes, plasma sources, RF generators, vacuum pumps and associated equipment required to drive a particular process.
- Gas delivery system - manages the selection and flows of the various process gases required by the **Plasma**Pro®80 tool. The gas pod is located apart from the main assembly.
- Services panel - the interface between most external services and the tool. Refer to the **Plasma**Pro®80 Facilities Interface Specification[12] for information on the services panel.

- Control system - which runs the PTIQ software and recipes that control the **Plasma**Pro®80 tool.

2.1.2 Principle of operation

The basic principle of operation of a **Plasma**Pro®80 tool is illustrated in Figure 2-2.

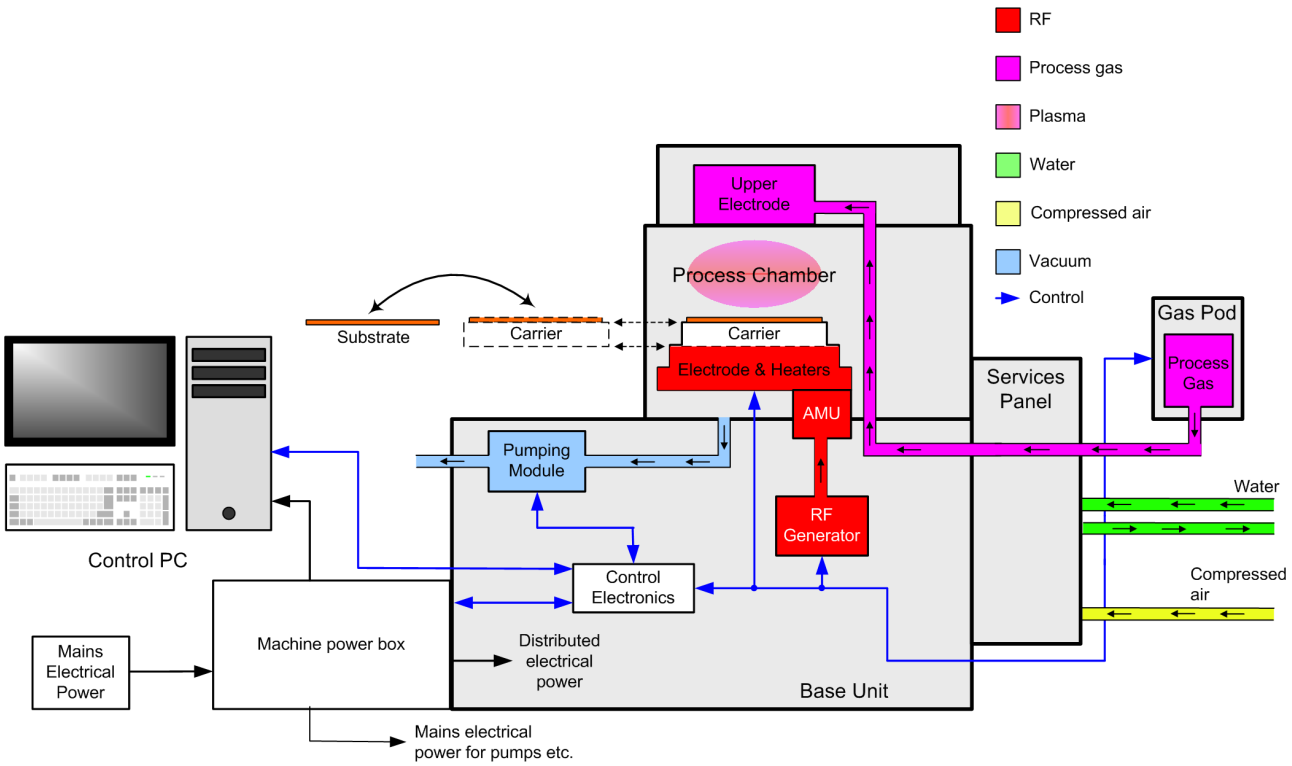


Figure 2-2 Principle of operation of a PlasmaPro®80 tool

There may be one of more RF generators in the tool, either connected to the upper electrode or the lower electrode.

In summary, the principle of operation is:

1. The user selects the required recipe at the PC.
2. The user manually places unprocessed wafers on the lower electrode (also known as the table).
3. The tool evacuates the process chamber.
4. The etching process takes place (see Section 2.1.3).
5. The tool evacuates the process chamber to its base pressure to remove any residual process gas.
6. If required, the tool vents and pumps the process chamber several times to remove any hazardous process residues.
7. The user manually removes processed wafers from the process chamber.

2.1.3 Process configuration

Reactive ion etch (RIE)
The lower electrode is powered from an RF generator while the upper showerhead is grounded. The lower electrode acquires a DC negative self-bias, which attracts reactive ion species to the surface of the wafer.

Plasma etch (PE)
The upper electrode is powered from an RF generator while the lower electrode is grounded. There is only a small self-bias on the wafer.

RIE/PE switching
There is an option to configure the tool so that it can be switched between RIE and PE modes of operation.

2.2 Base unit

2.2.1 Description of the Base unit

The Base unit comprises the tool's frame and various services within it. The main components of the CBU are:

- Frame
- Removable access panels
- Services panel
- Power box (see Section 2.2.2)
- Control system (see Section 2.2.3)
- Pumping module, except for the external backing pumps (see Section 2.4)
- Tool electronics (RF generators, AMUs etc.)

2.2.2 Description of the power box

The **PlasmaPro®80** has an electrical power box, which is located on the rear of the tool.

All electrical power for the tool (including external devices such as pumps) is routed through the power box. The power box:

- distributes mains electrical power via appropriate switching and protection devices.
- generates and distributes low voltage DC supply rails.
- provides emergency electrical isolation, controlled by an emergency off button.
- contains most of the safety relays that control the tool's safety interlocks.

Power box circuit-breakers

The electrical isolator in the power box is a rotary 3-pole circuit-breaker that is physically interlocked with the power box door. This isolator must be switched off before the power box door can be opened.

Figure 2-3 Power box

The other circuit-breakers in the power box are lever-action devices. Each circuit-breaker is set to ON when its lever is raised, and is set to OFF when its lever is lowered.

Table 2-1 Circuit-breakers in the power box

Number	Function	Phases	Rating (A)
Q2	Backing pump	3	6A
Q9	Chiller/heater	3	16A
Q25	Gas pod heaters	1	3A
Q5	Process chamber turbo pump	2	4A
Q6	RF generator 1	2	6A
Q7	RF generator 2	2	
Q10	Table heater (lower electrode heater)	2	16A
Q44	PC	1	6A
Q40	DC PSU	1	6A
Q45	Endpoint detector	1	

Power box circuit protection devices

The power box contains several protection devices.

Table 2-2 Power box protection devices

Device	Rating
F200	10A
F201	4A
F202.1	2A
F202.2	2A
F203	10A
F205	5A
F301	
F207	6.3A
F208	3.15A
F209	2A
F210	2A
F211	1A
F212	2A
F302	
F204	2A
F206	2A
F10:1 and F10:2	8A
F501	200mA
F502	200mA

2.2.3 Control system

A dedicated personal computer (PC) running the OIPT PTIQ application provides a graphical user interface (GUI), process recipe management, data logging and several other functions. Section 3.2 describes the PTIQ application.

2.2.3.1 Control system hardware

The tool's controller PC comprises a base unit, a keyboard, a mouse, a disc writer, and a colour monitor. The PC uses the Microsoft® Windows® operating system and communicates with PLC in the base unit via an Ethernet link.The PLC communicates with additional I/O located in the system frame and in the gas pod.

2.3 Gas delivery system

The interior of the external gas pod can contain toxic or corrosive gases. The front panel must be properly secured during normal operation of the tool. Only suitably trained maintenance personnel must remove the front panel (see **Plasma**Pro®80 Service Manual).

The 8-line gas pod can be configured with an optional expansion box fitted to the top. This box adds an additional 4 gas lines.

The top of the gas pod contains an extraction port that must be connected to a suitable air extraction system. This arrangement maintains a flow of air through the gas pod to remove any leaks of process gas.

The gas pod contains a separate gas line for each process gas. The output of each gas line connects to a common manifold, that connects to the gas feed on the process chamber. Each gas line contains one of more pneumatic valves, which open or close to allow gas to flow. Each gas line also contains a mass flow controller (MFC) that controls the rate of flow of gas through the gas line. In order for gas to flow through a gas line, the relevant pneumatic valves must be open and the MFC must be commanded to deliver a positive flow rate.

Gas lines for hazardous gases also include a bypass valve, that provides a high conductance path past the mass flow controller. This valve can be manually operated (see the Service Manual) or pneumatically operated, depending on the type of gas pod that is fitted. If the valve is pneumatically operated, the tool opens the bypass line when evacuating or purging the gas line. The bypass valve must be closed at all other times.

Process gases are supplied to the gas pod from the customer installation. The safe storage, operation and maintenance of the gas installation are the customer's responsibility and are outside the scope of this manual.

Most installations include point-of-use valves located close to the service panel or gas pod. These valves must be turned ON when the tool is in operation and must be turned OFF when the tool is likely to be idle for an extended period.

Some sections of this manual refer to switching gas supplies ON and OFF. It is the customer's responsibility to design and enforce appropriate procedures for operating and maintaining the gas system. Ensure that these procedures are obeyed at all times when operating or maintaining the tool.

2.4 Pumping module

The pumping module controls and measures the vacuum pressure in the process chamber. The module contains vacuum pumps, valves, vacuum gauges and all the hardware necessary to connect those items together.

Turbo pumps can be damaged by a sudden inrush of gas. When operated automatically, the **Plasma**Pro®80 control system switches the valves in the correct sequence to protect the turbo pump. Take care when performing manual operations on a turbo pump system to avoid damaging the pump.

2.4.1 Vacuum gauges and vacuum switches

The pumping system contains various vacuum gauges and vacuum switches.

All tools contain one or two vacuum switches which form part of the main interlock chain (see Section 1.8.1). The contacts of each switch open if the pressure in the process chamber rises above a preset value.

Figure 2-4 A typical vacuum switch

All tools contain a capacitance manometer (CM) gauge. This is located in the common base unit.

Figure 2-5 Tool CM gauge

Table 2-3 Key to Figure 2-5

Number	Description
1	Vacuum connection
2	Electrical connection

Tools with a turbo pump are fitted with a Penning gauge. This is located in the common base unit.

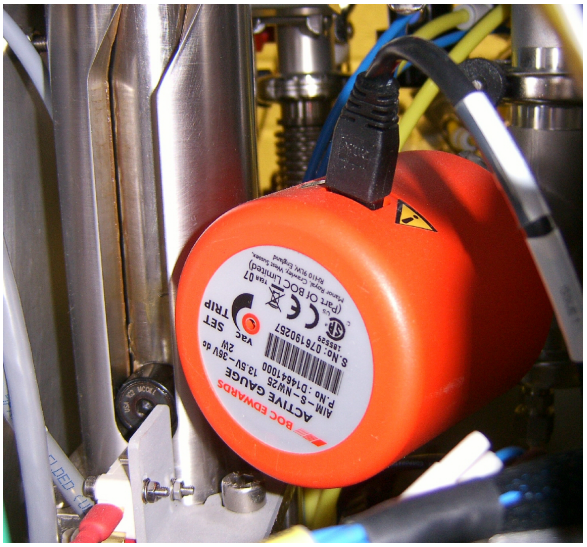


Figure 2-6 Tool Penning gauge

The process chamber vacuum pressure is displayed on the tool's GUI (see Section 3.2.2).

2.4.1.1 Pressure control

During a process run, the process chamber vacuum pressure is controlled by an automatic pressure controller (APC). The APC incorporates a rotating valve, the angle of which corresponds to a different pumping speed. An angle of 0° signifies the valve is fully closed. An angle of 90° signifies the valve is fully open. When controlling the chamber pressure, the valve angle is moved closer to 90° to increase the chamber pressure, and closer to 0° to reduce the pressure. The valve angle can be controlled directly from the GUI, if desired.

2.5 Process specific module

The process specific module determines which processes can be run on the tool.

2.5.1 Process chamber

The chamber module forms the environment for processing the wafers. The user manually loads wafers into the process chamber before processing, and manually unloads them after processing.

2.5.1.1 Lower electrode assembly

The lower electrode:

- supports the wafer in the optimum position for the process.
- keeps the temperature of the wafer stable and uniform.
- heats or cools the wafer.

The tool has the following lower electrode.

Table 2-4 Lower electrode

Lower electrode	Temperature Range
Fluid cooled and heated lower electrode	Depends on heater/chiller

Wafer clamping option

The wafer clamp is a quartz ring that the user attached to the lower electrode using four screws. It is located on top of the wafer, clamping it against the upper surface of the lower electrode. The wafer clamp option is used in conjunction with the helium cooling option to improve thermal coupling between the lower electrode and the wafer. Figure 2-7 shows the wafer clamp.

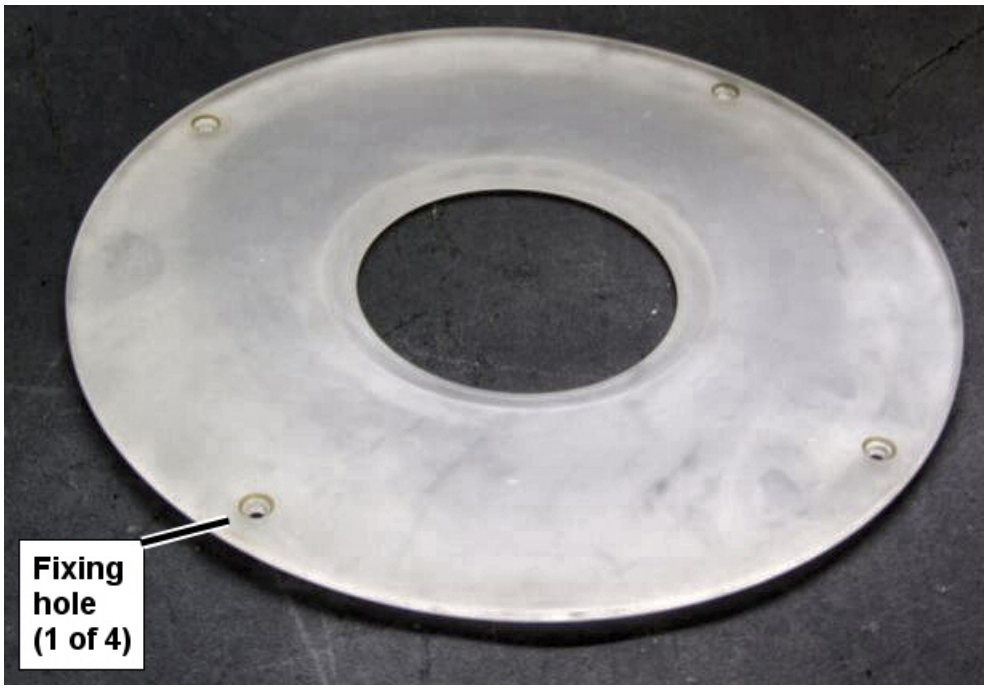


Figure 2-7 Wafer clamping option

Helium backing option

This option allows the space between the wafer and the lower electrode to be pressurised with helium. This improves heat transfer between the wafer and the lower electrode. This option can only be used if a wafer clamp is fitted.

The PTIQ application controls the helium pressure. The application monitors helium flow, as this indicates the quality of the seal between the wafer and the lower electrode.

2.5.1.2 Upper chamber

The upper chamber body is a passive module forming the sides of the process chamber. It supports the process specific module. The user can raise or lower the upper chamber, by operating the lid hoist, to allow access to the lower electrode.

2.5.1.3 RF generators

The tool contains one or more radio frequency generators. These generators are controlled from the tool's GUI and do not require operator intervention during normal tool operation.

2.6 Auto matching unit

A **PlasmaPro®80** tool contains one or two RF generators, each driving a plasma chamber electrode or plasma source. The output impedance of all RF generators is fixed at 50 Ω, whereas the input impedance of a plasma varies according to the conditions in the chamber or plasma source. If uncorrected, this impedance mismatch would cause poor energy transfer between the generator and the plasma. Each RF generator uses an auto matching unit to maximise power transfer from the generator into the plasma.

The **PlasmaPro®80** advanced auto matching unit corrects the impedance mismatch by continually varying its conjugate match. The unit consists of a variable tuned circuit, and a control circuit that keeps the tuned circuit optimised at all times. The ratio of forward power to reflected power for a particular generator defines how well the AMU is matched. For a well matched system this ratio should be greater than 20:1.

Figure 2-8 shows an AMU driving an RIE chamber.

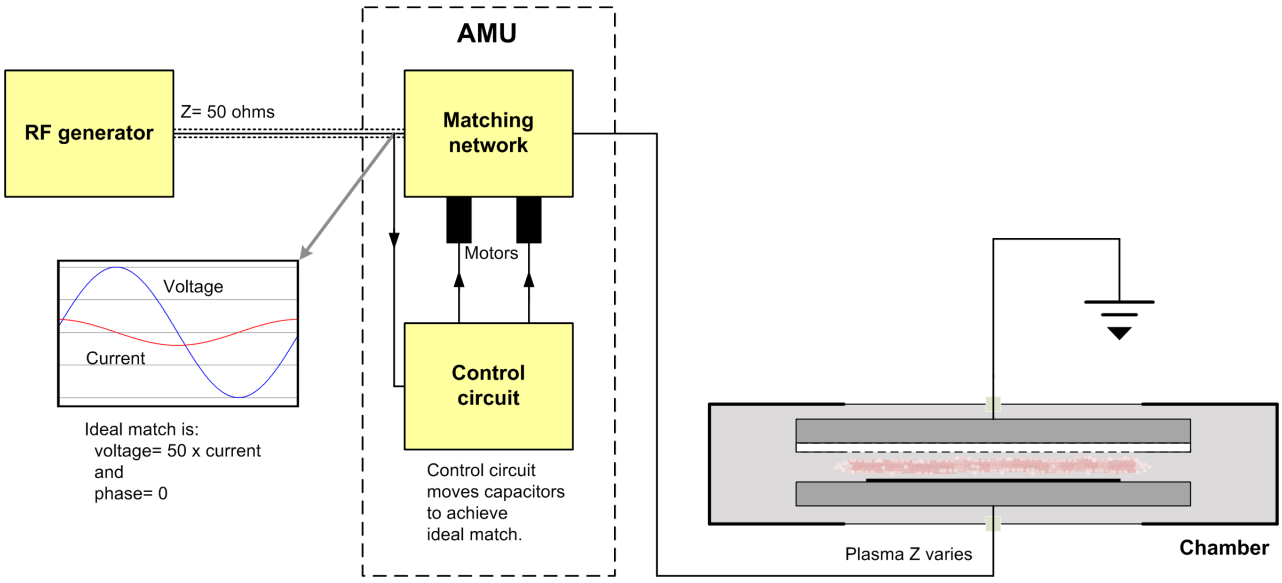


Figure 2-8 AMU operation

Each RF generator fitted to the tool requires a separate AMU. Each AMU is located close to the plasma electrode or plasma source it is driving.

The AMU consists of an impedance matching circuit and a control circuit. The matching circuit consists of two motorised variable capacitors and a fixed value inductor. Fixed value capacitors can also be fitted to offset the impedance range of the circuit. The variable capacitors are either air vaned or vacuum types, depending on the AMU version. The PTIQ application GUI monitors the rotary position of each capacitor, which is linearly related to the capacitance.

The control circuit in the AMU monitors the incoming RF signal from the plasma generator and determines its magnitude and phase. The circuit then uses digital processors to derive drive signals for the capacitor drive motors. The motors rotate the capacitors in accordance with the drive signals to minimise the reflected power seen at the plasma generator. Each motor incorporates a magnetic encoder which measures the relative angular position of the motor.

Normally the operation of the AMU is transparent to the user. However the AMU can be manually controlled from the GUI, if required. The GUI provides four modes of AMU operation:

Auto Hold mode
In *AUTO HOLD* mode the AMU controls itself without user intervention. After the process step, the AMU capacitors stay in their process positions. If the same process is run again, the AMU should tune quickly. This mode can be used if running similar processes repeatedly.

Auto Park mode
In *AUTO PARK* mode the AMU controls itself without user intervention. After the process step, the AMU capacitors move to their park positions. This mode gives stable results and is recommended for most processes. Use this mode if running different processes.

Hold mode
In *HOLD* mode the GUI directly controls the positions of both AMU capacitors. Use this mode to tune extreme processes, or to move the capacitor positions during maintenance.

Park mode
In *PARK* mode the AMU capacitors remain in the preset **Park** positions. The user can alter the Park positions in the GUI.

When the tool is first powered up, or if power is lost during operation, the AMU resets itself and performs a homing routine to calibrate the capacitor encoders. The homing routine drives the variable capacitors to their end-stop positions, typically their minimum values, before returning to the **Park** positions ready for processing.

3 CONTROLS AND INDICATORS

This chapter describes the controls and indicators the operator uses to control the **PlasmaPro®80** tool, as well as the graphical user interface (GUI). The chapter comprises the following sections:

- About the tool's controls
- PTIQ page reference

3.1 About the tool's controls

The user controls the tool from the following locations:

- The power box at the rear of the base unit (see Section 3.1.1.1).
- The console panel on the base unit (see Section 3.1.1.2).

3.1.1 Controls and indicators

3.1.1.1 Power box

Figure 3-1 shows the controls on the power box.

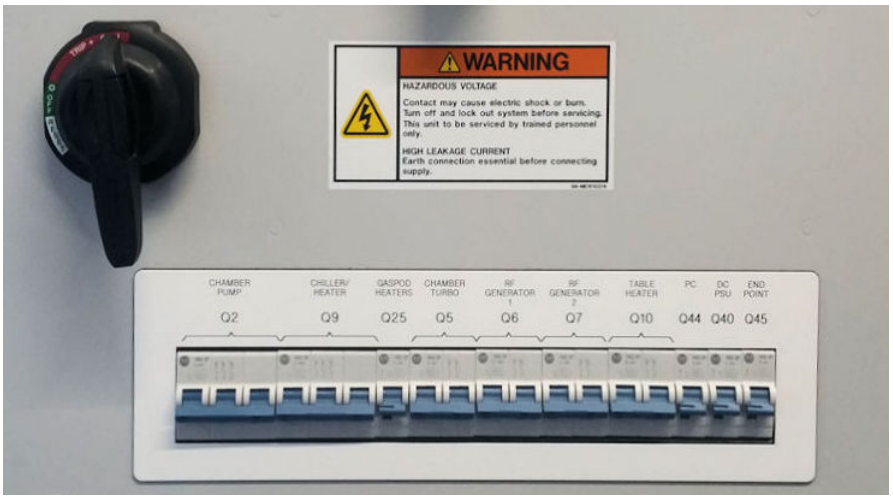


Figure 3-1 Power box controls

The main isolator is used for switching the tool mains power ON and OFF. It does not switch OFF the DC power.

3.1.1.2 Console panel controls and indicators

Figure 3-2 shows the tool's console panel.

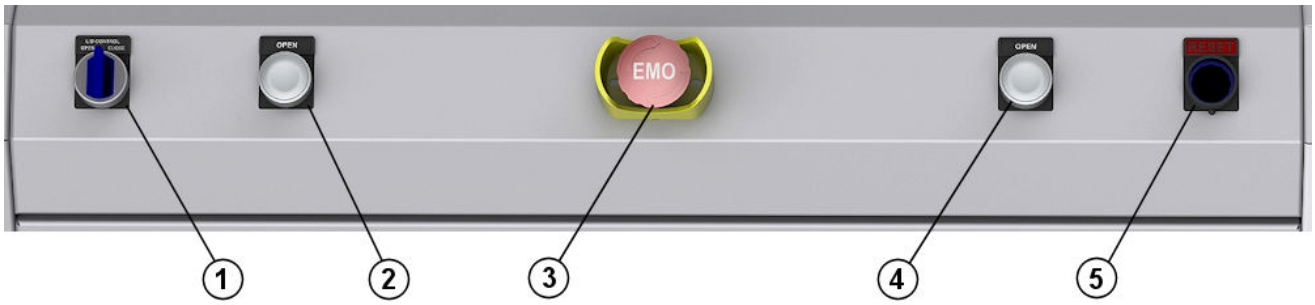


Figure 3-2 Tool console controls and indicators

Table 3-1 Controls and indicators on the tool console

Number	Description
1	Lid Control switch This switch selects the direction that the process chamber lid will move when the two chamber hoist buttons are pressed. **Open** lifts the chamber lid, providing access to the chamber for maintenance. **Close** lowers the chamber lid, sealing the chamber for evacuation.
2 and 4	Hoist Operator buttons To lift or lower the chamber lid, simultaneously press both buttons. The direction of motion of the lid is set by the Lid Control switch.
3	EMO button Press this button to immediately remove electrical power from the tool. The switch latches in place to prevent the power from being restored accidentally.
5	RESET button Press the RESET button after an EMO event, or on powering up the tool. If all conditions are OK, the safety relay will activate and this button will illuminate to indicate the GOOD status.

3.1.1.3 Control PC

The control PC runs the PTIQ application, which is used to control the pumping system, gas pod, RF generators. The PC is also used to edit and run process recipes.

The PC can be mounted on a moveable arm attached to the tool's frame, or on a separate work surface.

3.1.1.4 Manual bypass valve in the gas pod (if a manual valve is fitted)

Each gas line for a hazardous gas has a bypass valve. This valve allows the tool to evacuate the MFC when changing the gas bottle. In some gas pods, the bypass valve is manually operated.

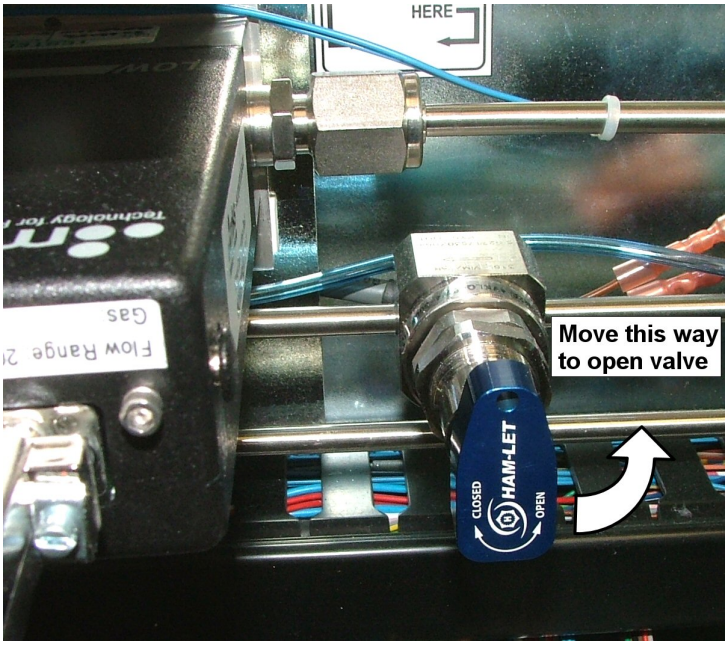


Figure 3-3 A manual bypass valve in the gas pod

Figure 3-3 shows the valve in the closed position.

3.2 PTIQ page reference

This section describes all the pages in the PTIQ application.

3.2.1 PTIQ application page features

The PTIQ application runs on the main tool controller. The application contains several pages, which are described in more detail in Section 3.2.2 and Section 3.2.4. However there are some common features that appear on more than one page.

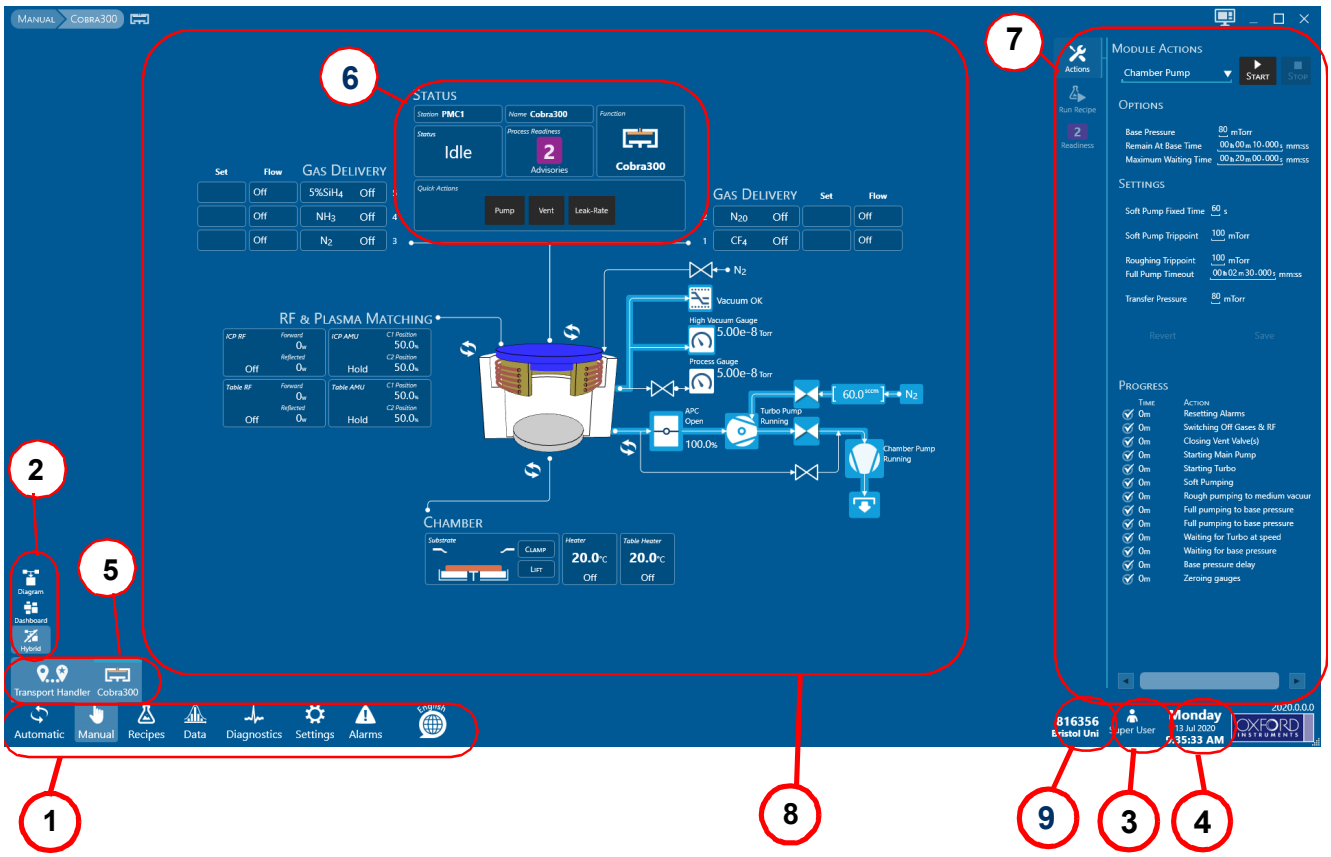


Figure 3-4 Common features on a typical control page (cobra tool shown)

Table 3-2 Key to Figure 3-4

Number	Description		Number	Description
1	Main menu icons Click a menu icon to access its sub-menu. Use this menu to navigate between pages.		6	Status panel Displays the status and actions for the process chamber.
2	View selection icons Click on an icon to select the desired view in the Information panel (not all icons are available on all pages). Hybrid is a combination of diagram and dashboard views.		7	Right command panel Click on any device in the Information panel to display its possible actions in the upper part of the right command panel. In the lower part of the panel you can select module actions, run a process recipe, examine the state of readiness of the module and alter settings for the device selected in the upper part of the panel.

Table 3-2 Key to Figure 3-4

Number	Description		Number	Description
3	User and login level The login privilege of the user. Click on the icon to log out.		8	Information panel Displays all the devices included in the module using the selected view (Diagram, Dashboard or Hybrid).
4	Clock Displays the local time and date.		9	Identity The identity of the tool.
5	Sub-menu icons Click on a sub-menu icon to access the page for that module. The name of the page currently selected is shown at top left of the page.			

3.2.2 Process module page

Use the process module page to view and change the states of the process chamber and associated components. The fields and controls on this page depend on the configuration of the pumps and valves on the tool. You can view this page in Diagram, Dashboard or Hybrid view.

To access this page, click the **Manual** icon followed by the sub-menu icon for the process chamber (in this example, Cobra300).

3.2.2.1 Diagram view

Diagram view is a functional block diagram of the process chamber and associated components. Inactive devices have a simple outline while active devices are shown in light blue panels. If the option is available for a device, click on the device icon while holding down the <Ctrl> key to toggle a device between active and inactive states.

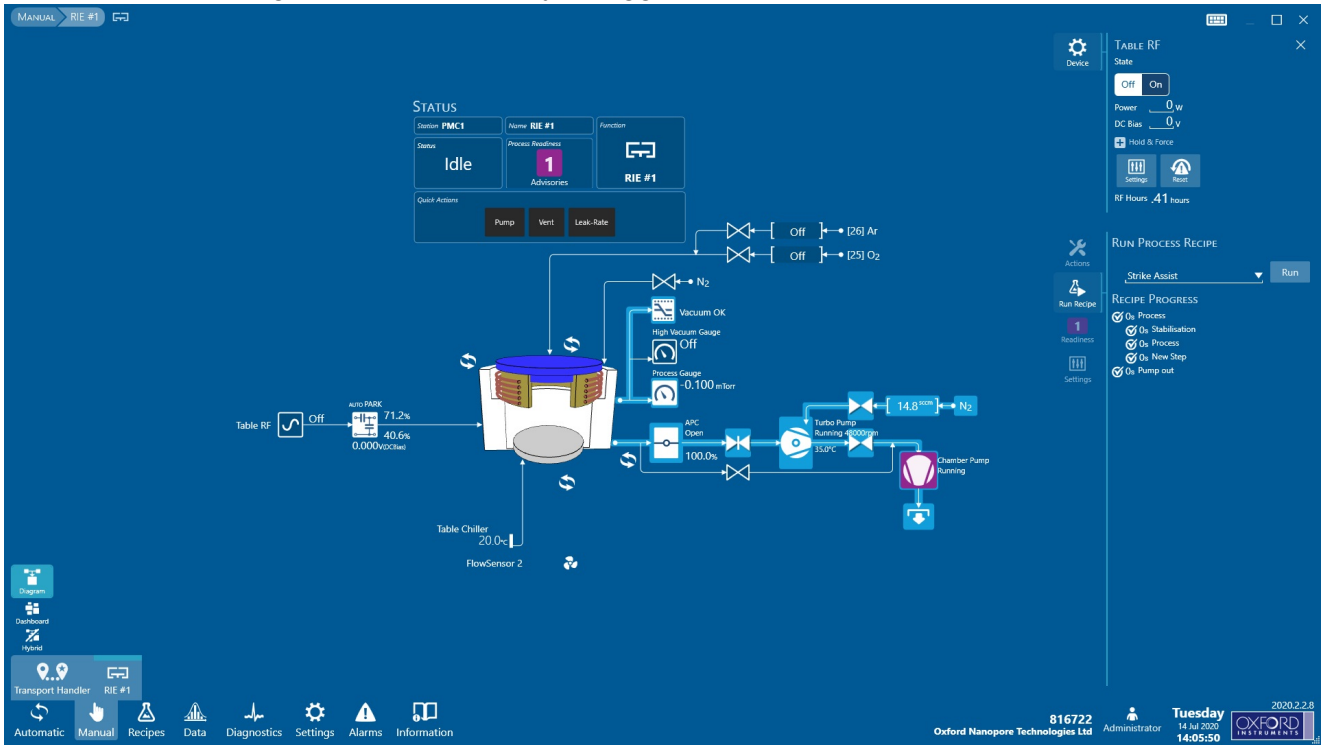
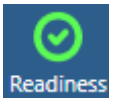
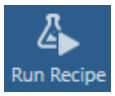


Figure 3-5 Process module page (diagram view)

3.2.2.2 Graphical symbols on the process module page

Table 3-3 describes the graphical symbols and function blocks that are present on the process module page in diagram view. Some of these symbols are also used on the Transport Handler page.

Table 3-3 Diagram view graphical symbols

Graphical Symbol	Description	Graphical Symbol	Description
	A closed gate valve		A closed valve
	An open gate valve		An open valve
	Turbo pump (running)		Rotary backing pump (running)
	Automatic pressure controller valve (shown fully open)		Vacuum switch icon
	RF generator		RF attenuator
	Auto matching unit (AMU)		Gas supply MFC
	Readiness icon Shows a green tick or shows a purple square with the number of readiness advisories		Change View icon Click to change the mode of a group of icons between dashboard and diagram views
	Actions icon		Run Recipe icon
	Safety Hub icon Shows an alarm when there is a fault with the transport module		
	Process chamber lid in the closed position. Lifts up when the process chamber is open.		

3.2.2.3 Details of the diagram view page

Figure 3-6 shows the major components displayed in the process module page.

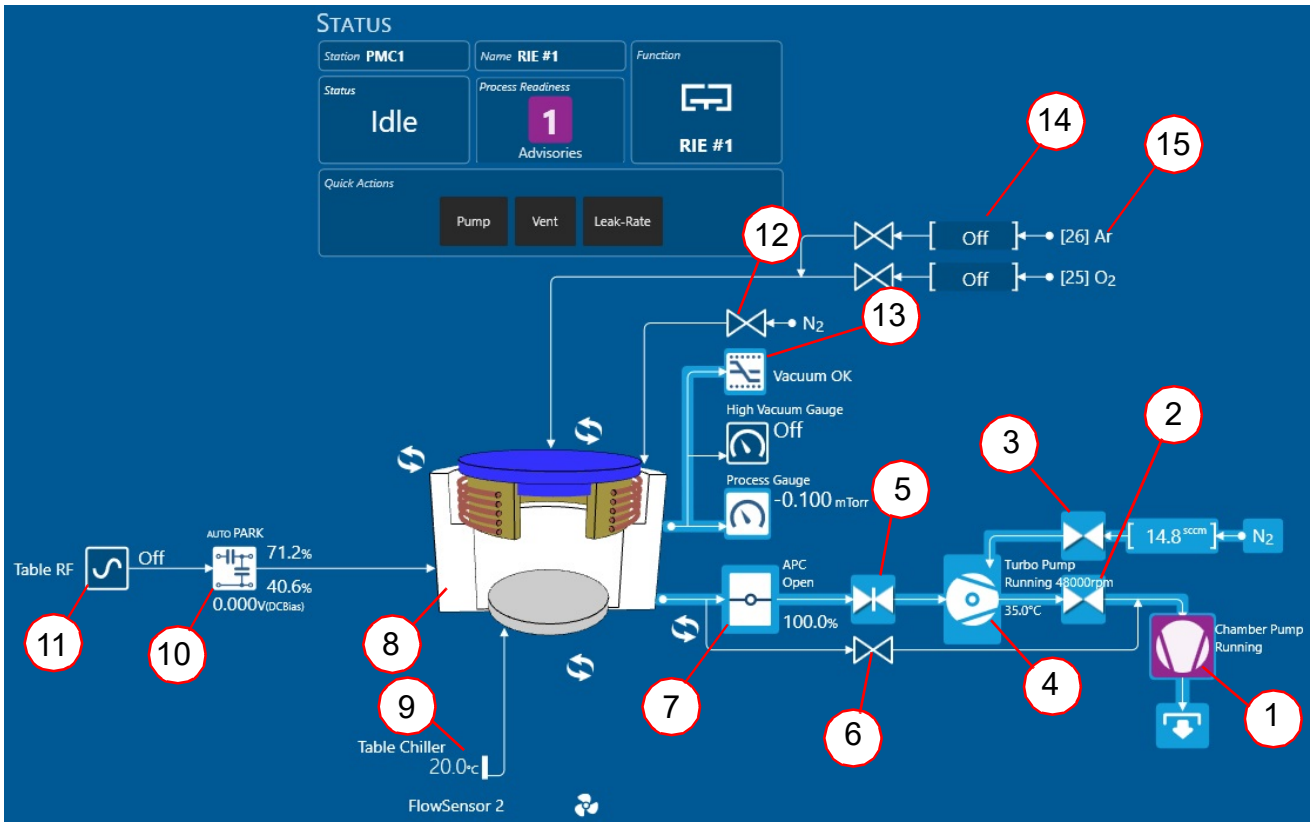


Figure 3-6 Detail of the process module page

Table 3-4 Key to Figure 3-6

Number	Description		Number	Description
1	Chamber backing pump		9	Chiller controls
2	Turbo backing valve		10	Automatic matching unit AMU
3	Turbo purge valve		11	RF generator for lower electrode (table)
4	Turbo pump		12	Chamber vent valve
5	High vacuum valve		13	Vacuum switch
6	Chamber roughing valve		14	Mass flow controllers (MFCs)
7	APC valve		15	Process gases
8	Process chamber			

Click on any item on the page to display its controls and parameters in the device panel in the upper part of the right Command panel.

3.2.2.4 Dashboard view

Dashboard view displays each device as a small device panel. Inactive devices have a simple outline border while active devices are shown in light blue panels. To toggle a device between active and inactive states, click on the small device panel while holding down the <Ctrl> key.

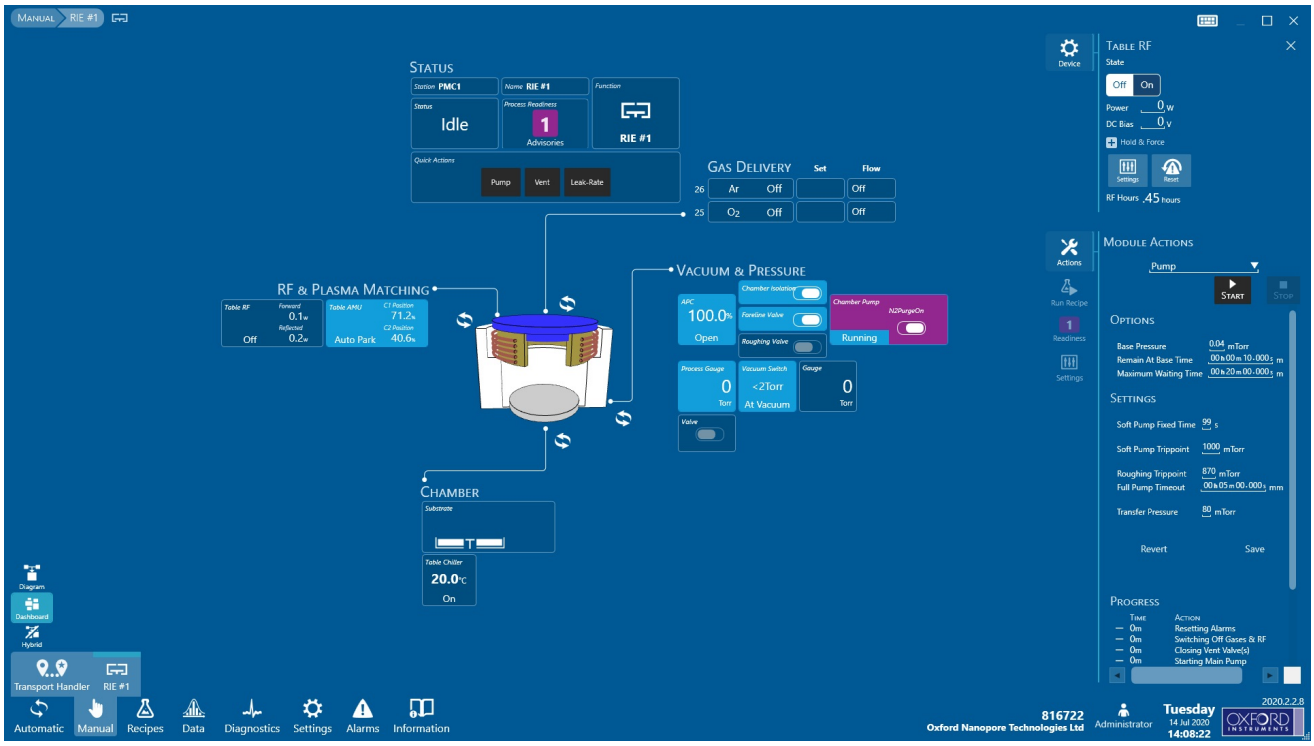


Figure 3-7 Process module page (dashboard view)

Click on any item on the page to display its controls and parameters in the device panel in the upper part of the right Command panel.

3.2.2.5 Status panel

The Status panel is a quick access panel which displays the status of the process chamber. It contains quick action buttons for the common Pump, Vent and Leak check actions.

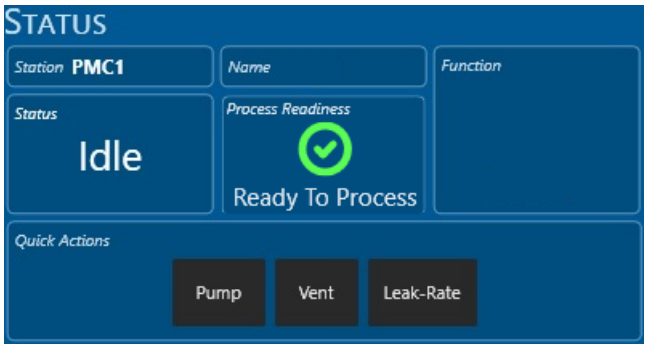
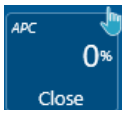
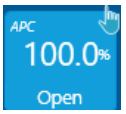
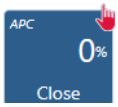
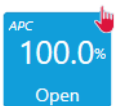
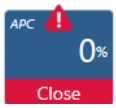


Figure 3-8 Status panel

3.2.2.6 Small device panels

Table 3-5 shows the possible states for the small device panels in the dashboard view.

Table 3-5 Possible states of the small device panels

Icon	State		Icon	State
	Device inactive			Device active
	Device inactive, in Hold state			Device active, in Hold state
	Device inactive, in Force state			Device active, in Force state
	Device inactive with a fault present			There is an advisory message for the device

3.2.2.7 Hybrid view

Hybrid view is available on the process module page and allows the user to display some groups of devices in Diagram view and other groups in Dashboard view. Inactive devices have a simple outline border while active devices are shown in light blue panels.

To toggle a group of devices between Diagram view and Dashboard view, click the Change View icon  associated with the group. If you click the  icon while in Diagram view or Dashboard view, the display automatically changes to Hybrid view.

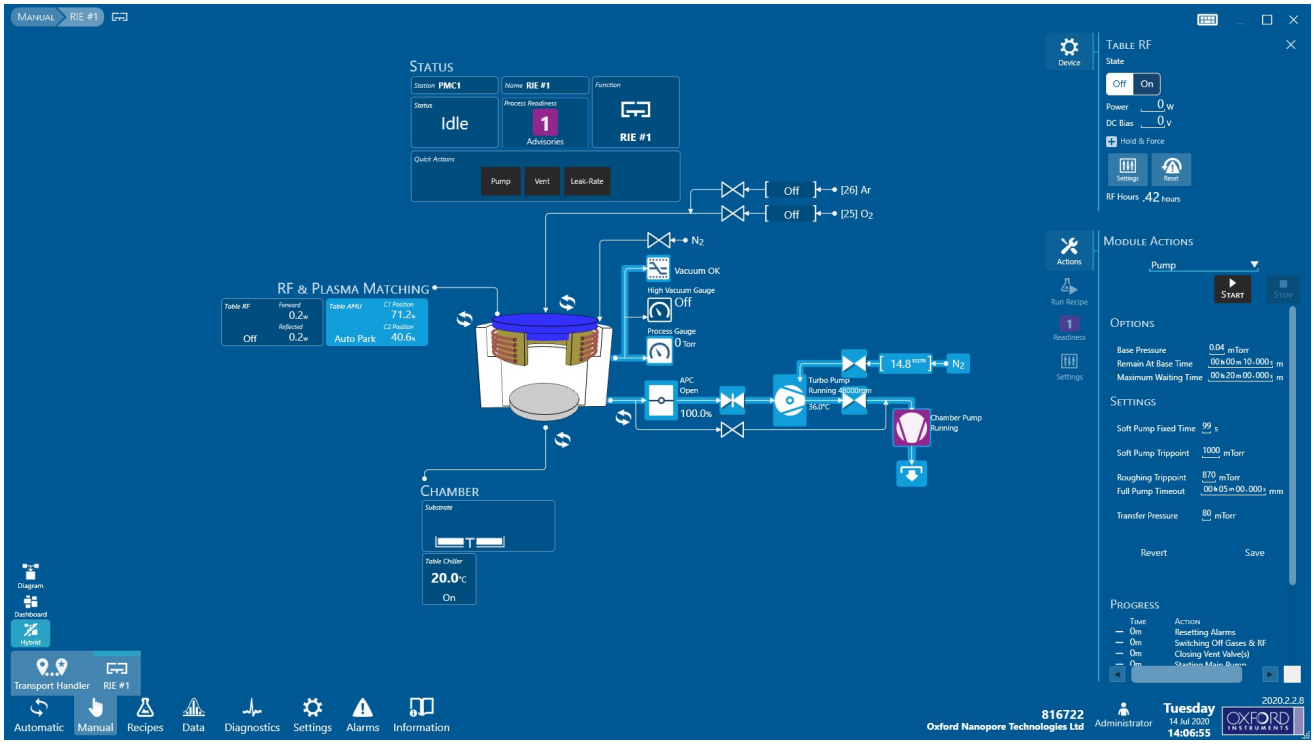


Figure 3-9 Process module page (hybrid view)

Click on any item on the page to display its controls and parameters in the upper part of the right Command panel.

Figure 3-9 above shows the Pumping, Vacuum and RF groups in Diagram view and shows the Gas Delivery and Chamber groups in Dashboard view.

Click the Hybrid icon  to change the view to the last remembered Hybrid selections.

3.2.3 Batch View page

Use the Batch View page to run a recipe.

To access this page, click on **Automatic** in the main menu.

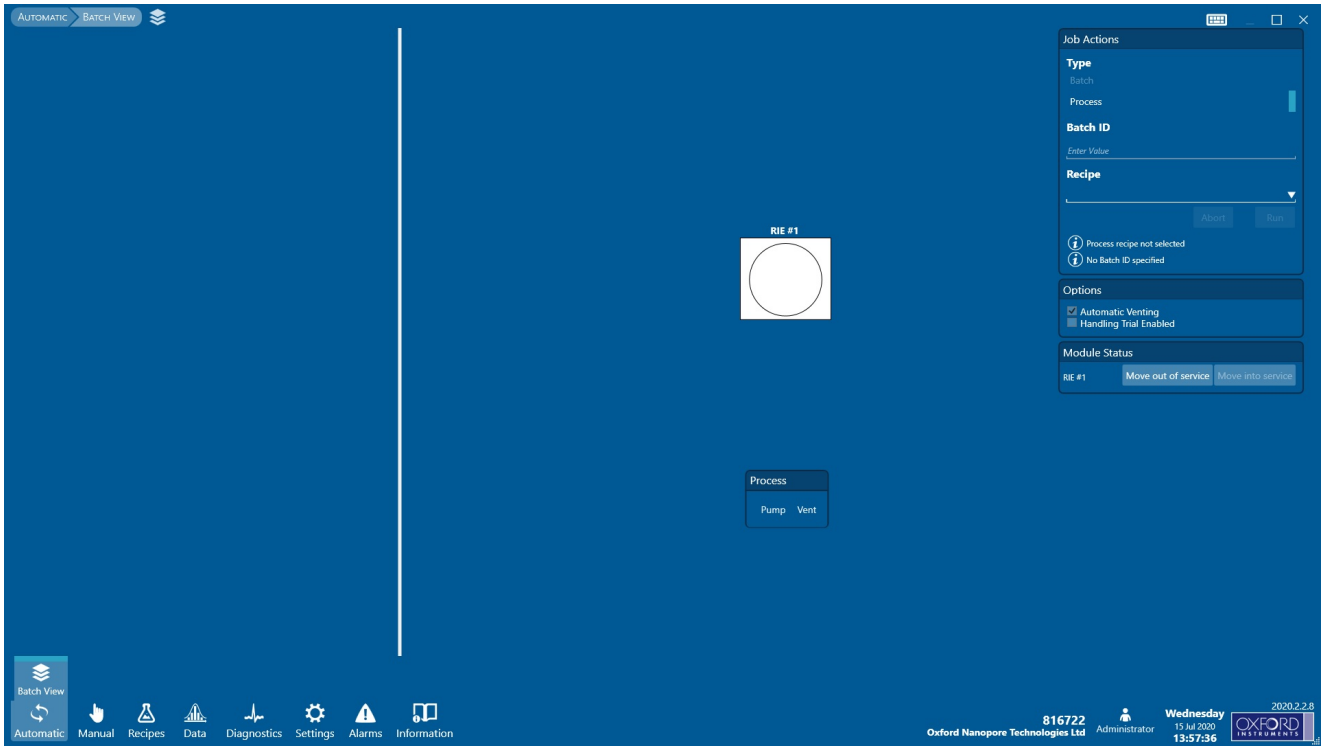


Figure 3-10 Batch view page (RIE tool shown)

3.2.4 Transport Handler page

The fields and controls on this page depend on the configuration of the tool.

Figure 3-11 shows the vacuum components displayed on the Transport Handler page.

To access this page, click the **Manual** icon followed by the sub-menu icon for the **Transport Handler**.

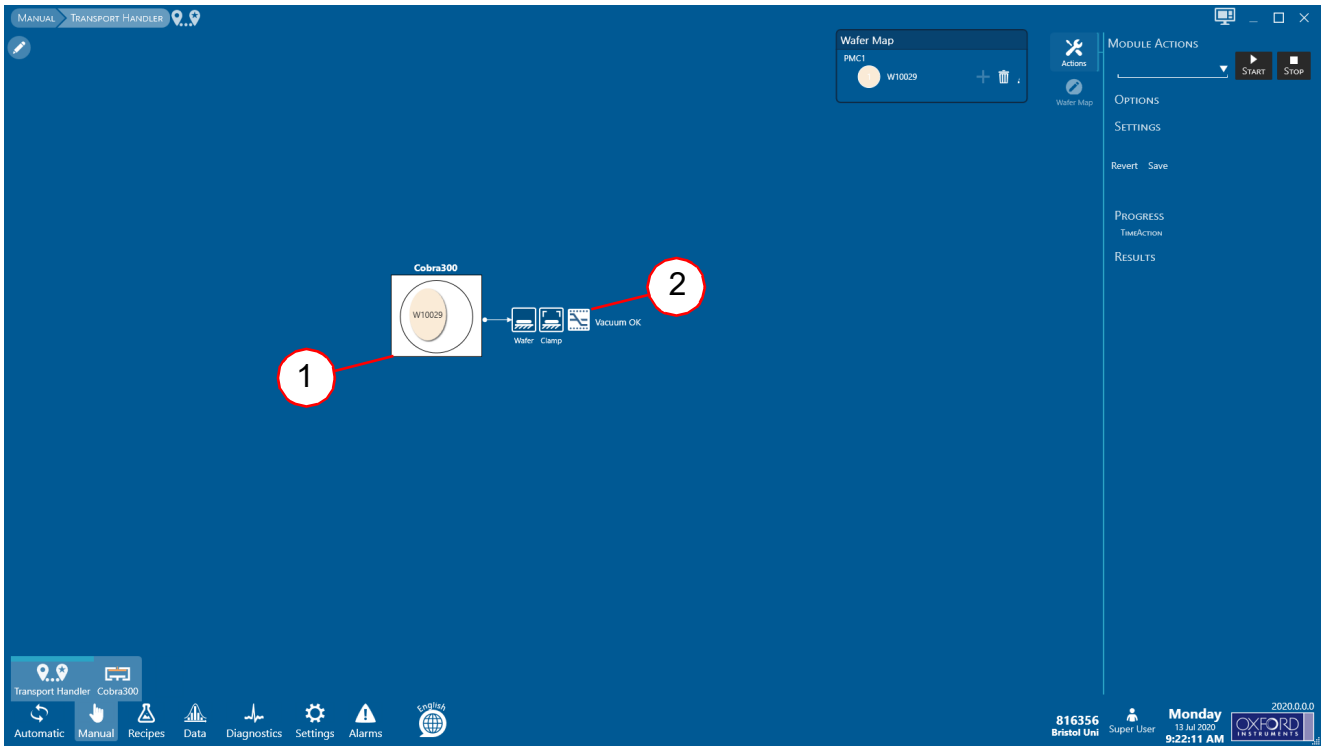


Figure 3-11 Transport Handler page (Cobra tool shown)

Table 3-6 Key to Figure 3-11

Number	Description		Number	Description
1	Process chamber		2	Vacuum switch

The upper panel on the right of the page changes when you click on an icon or component on the page.

Click the **Wafer Map** icon 

to display the **Wafer Map** panel. This shows the status and position of the wafer.

Click the **Actions** icon 

to display the **Module Actions** panel. This shows the actions available for the active device panel at the top right of the page.

3.2.5 Alarms & Warnings page

Click the main menu Alarms icon on any page to access the Alarms & Warnings page.

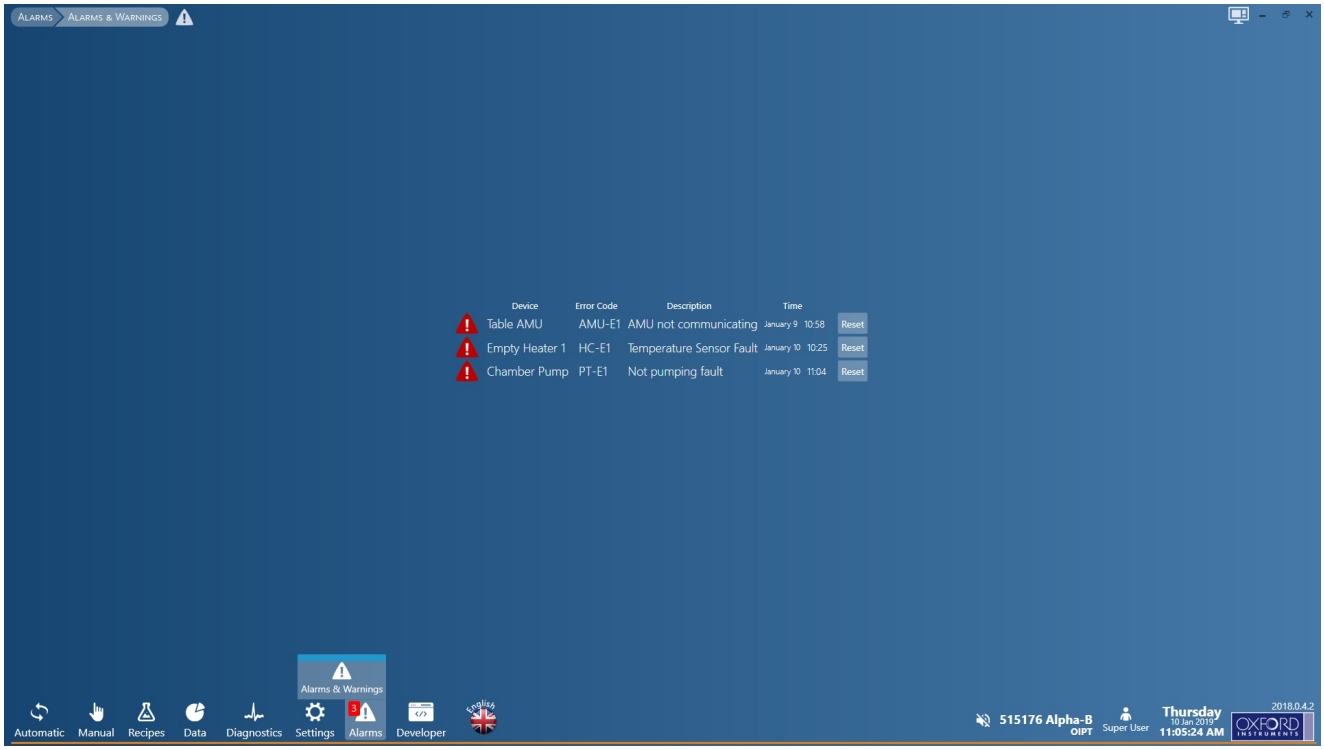


Figure 3-12 Typical alarm page

A red warning triangle signifies an alarm, an amber triangle signifies a warning.
Click **Reset** to reset an alarm.
Refer to Section 4.4 for information on responding to system alarms.

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4 OPERATING INSTRUCTIONS FOR OPERATORS

This chapter describes how to operate the Oxford Instruments Plasma Technology **Plasma**Pro®80 tool. All procedures described here must only be performed by operators with the appropriate skills and training.

The chapter comprises the following sections:

- Shutting down the tool in an emergency
- Starting up the tool
- Performing basic operations
- System alarms and warnings
- Leak testing the process chamber
- Pumping, venting and opening the process chamber

4.1 Shutting down the tool in an emergency

In an emergency, press the red **EMO** button on the console panel (see Figure 1-2). Once operated, the button latches in the off position to ensure that hazardous electrical power is removed from the tool.

The **EMO** button is intended for use when electrical power must be immediately removed from the tool in order to prevent personal injury or an immediate hazard. The button must also be operated if the building is being evacuated because of fire, earthquake, flood or other major event.

Caution

EMERGENCY OFF

Only press the **EMO** button if an immediate hazard is perceived. Repeated use of the **EMO** button can degrade tool hardware, resulting in premature failure.

Note that pressing the **EMO** button does not remove all potential hazards from the tool. Refer to Section 1.7.1 for a list of hazards that may still be present after pressing the **EMO** button.

When the emergency situation has been rectified and it is safe to operate the tool, perform the start-up sequence described in Section 5.1.1 to recover from the shut-down.

4.2 Starting up the tool

This section describes how to start up the tool when it is fully powered down. It is assumed that the tool is switched off at the facility safety isolation box.

1 Check the maintenance log, to ensure that the tool is in a fit state to be operated.

2 Check the history of the tool's gas bottles and gas lines. Particularly check if any gas lines have been recently opened or if any gas lines may contain air.

3 Check that all the tool's covers are correctly fitted and the doors are closed.

4 Check there is no visible damage to the tool.

5 Turn on the cooling water isolation valves.

6 Switch on the heater/chiller unit, if fitted.

7 Check that the cooling water pressures and flows are within specification.

8 Ensure that the tool's compressed air supply is turned on, and that the pressure is within specification.

9 If it can be confirmed that all gas lines do not contain air, turn on all manually operated gas isolation valves, including any cylinder valves. If one or more gas lines may contain air, leave the valves closed and display a clear note of why this has been done.

10 Switch on all the panel mounted units.

11 Rotate all **EMO** buttons to check that they are out (see Figure 3-2).

12 Apply power to the tool by switching on the facility safety isolation box.

13 Switch on the remote PC controller. Check that the controller boots up correctly.

14 Double click the desktop icon 

to launch PTIQ.

15 Log on to PTIQ (see Section 4.3.1).

16 Wait for the PLC to boot up then load the process module page (see Section 3.2.2).

17 Click the **Pump** button in the Status panel (see Figure 4-1).

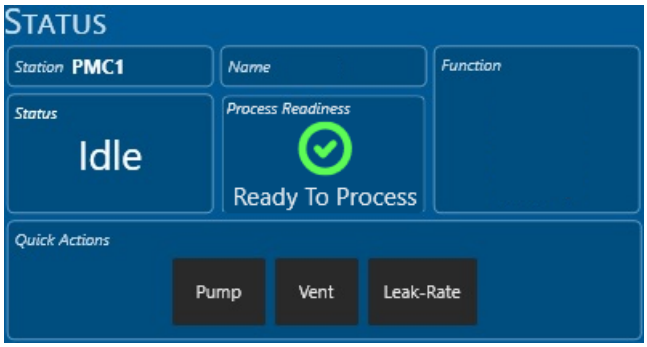

Figure 4-1 Status panel

18 The pump sequence starts and the Status panel displays the progress of the operation, see Figure 4-2.

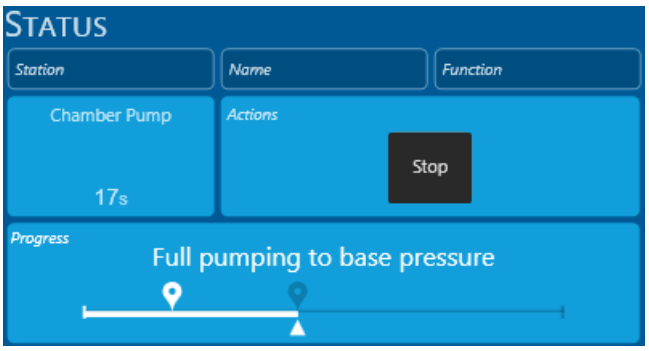

Figure 4-2 Progress panel

19 Check that the chamber pump and turbo pump start, the foreline valve opens and the APC opens. This is shown by the chamber pump, APC and pumping line changing colour to light blue, see Figure 4-3.

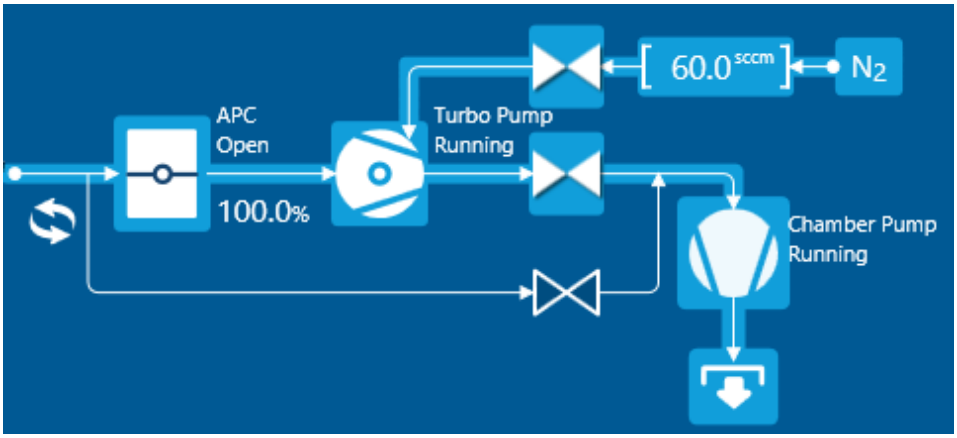

Figure 4-3 Chamber pump running

20 Wait until the chamber pumps down to its base pressure. The Status panel returns to normal and a **Task finished successfully** panel displays for a short time at the bottom right of the page, see Figure 4-4.

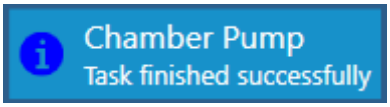

Figure 4-4 Chamber pump finished

21 Click the **Leak-Rate** button in the Status panel (see Section 4.5.1) to carry out a leak test. If no large leak is detected (a large leak is greater than 1 mT/min after two minutes pumping) then the chamber is ready for use. If a large leak is detected then vent the chamber (see Section 4.6.1) and investigate the reason for the leak.

22 The tool is now powered up. If any gas lines are shut off because they may contain air, purge and evacuate those gas lines before turning on the process gas supply (see Section 5.4)

4.3 Performing basic operations

This section describes basic machine operations that apply to all users.

4.3.1 Logging on and off

The PTIQ application allows several different levels of login to match the job functions of different personnel who might use the tool. Section 5.9.1 describes how a person with *Administrator* privilege can create and manage new login accounts.

The login procedure is the same for all login levels.

When the PTIQ application is first started, the Login page opens (Figure 4-5). You can also access this page at any time by selecting the user icon from the bottom right of the page (see Figure 3-6).

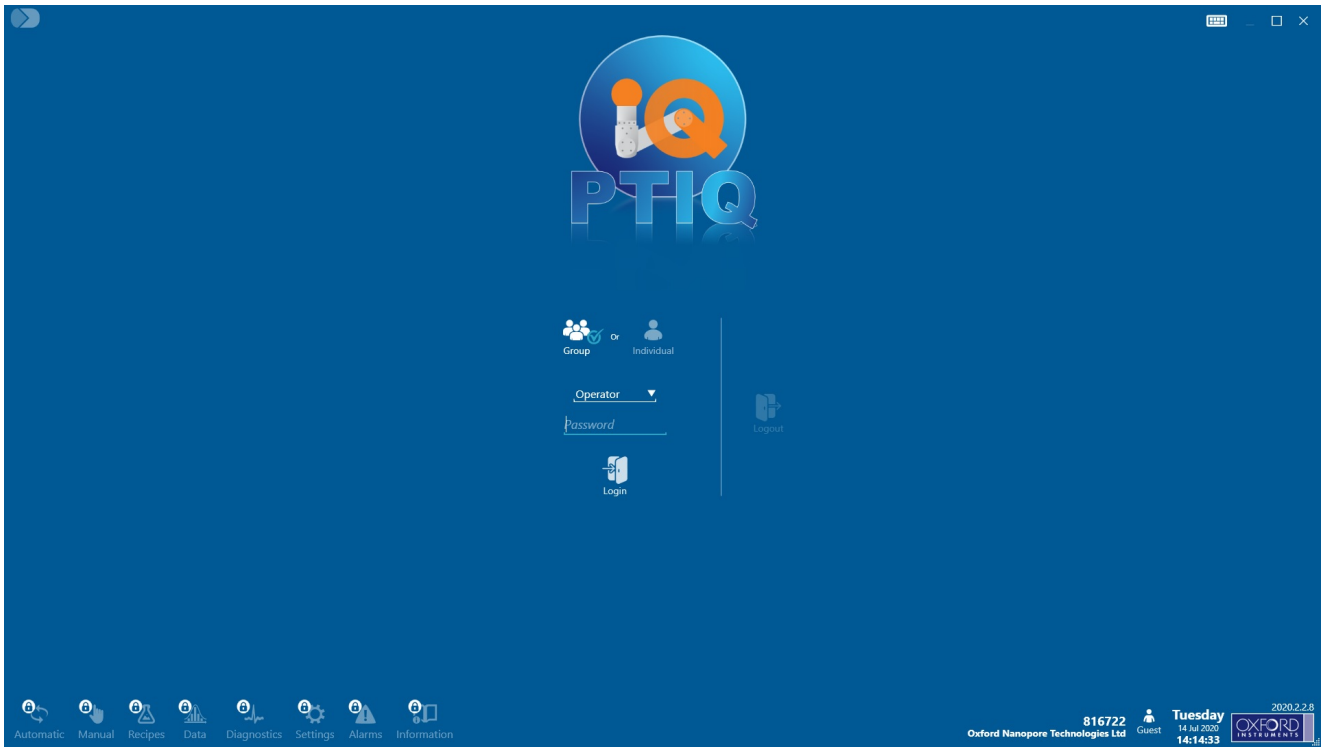

Figure 4-5 PTIQ login page

To log on to the controller:

1 Click either the **Group** or **Individual** icon.

2 If you selected **Individual** then enter your account user name in the **Username** field.

3 If you selected **Group** then select your group from the drop-down list (see Figure 4-6).

NOTE: The list in Figure 4-6 shows the default groups enabled as standard in the software. A user with *Administrator* privilege can create and manage new groups, delete existing groups and change the privilege levels of a group. See Section 5.9.1.

Figure 4-6 Group logon dropdown

4 Type your account password into the **Password** field. The password is case-sensitive: for example, **Password** and **pAsswOrd** are different passwords.

5 Click **Login**.

6 If the information entered is correct, the display changes to the appropriate view for the login level (usually the Batch View). The log-in status is displayed in the bottom right of the page, next to the date (see Figure 3-4).

7 If the login information is not verified correctly, click **Try Again** in the incorrect password pop-up and re-enter your login and password.

8 To change to a different login level or user, click on your login name at the bottom of the page. This returns you to the login page, see Figure 4-5.

9 To log off from PTIQ, click on your login name at the bottom of the page.

4.3.2 Opening and closing the process chamber

You can raise the process chamber lid to allow access to the interior of the chamber for loading and unloading process wafers. To open the chamber, a pneumatically operated hoist lifts the lid and rotates it 90°. To close the chamber the same hoist reverses this motion.

4.3.2.1 Opening the process chamber

WARNING

TOXIC GASES
Contact can cause death or serious injury.
The vent sequence for the process chamber includes a purging step to remove any trace of toxic gas. Always use the proper procedure when venting the process chamber.Wear personal protective equipment as necessary.

To open the process chamber:

1 Ensure that the process chamber is fully vented as described in Section 4.6.1.

2 Set the **Lid Control** switch on the console panel to the **Open** position (see Figure 3-2).

Caution

CHAMBER LID MOTION

If compressed air has just been applied to the tool, the hoist may move rapidly when the hoist buttons are turned. This can strain the hoist mechanism. Operate these buttons for short periods until the hoist is fully open.

3 Press both hoist buttons together. The chamber lid raises and rotates. If compressed air has just been applied to the tool, press the buttons briefly and release them, as the hoist may move rapidly when the buttons are operated.

NOTE: The two hoist buttons are located at either end of the panel and must both be pressed simultaneously to activate the hoist. This design requires the use of two hands to operate the hoist, which is a safety feature to prevent accidental operation of the hoist.

WARNING

HOT SURFACES

Close contact with hot surfaces can cause serious injury and burns. Avoid contact with the lower electrode if it is heated.

4 When the chamber lid has completed its travel, release both hoist buttons. It is permissible to halt the hoist travel part way and then to resume travel, or to reverse its direction. If the lower electrode is heated, avoid touching it.

4.3.2.2 Closing the process chamber

To close the process chamber:

1 Set the **Lid Control** switch on the console panel to the **Close** position (see Figure 3-2).

WARNING

PINCH POINT

The pinch point between the chamber lid and the chamber body could cause severe injury. Take care not to trap fingers or other body parts when closing the chamber lid.

2 Check that nothing can impede the motion of the hoist and that all other personnel are clear of the chamber.

Caution

CHAMBER LID MOTION

If compressed air has just been applied to the tool, the hoist may move rapidly when the hoist buttons are turned. This can strain the hoist mechanism. Operate these buttons for short periods until the hoist is fully closed.

3 Press both hoist buttons together. The chamber lid rotates and closes. If compressed air has just been applied to the tool, press the buttons briefly and release them, as the hoist may move rapidly when the buttons are pressed.

NOTE: The two hoist buttons are located at each end of the panel and must be pressed simultaneously to activate the hoist. This design requires the use of two hands to operate the hoist, which is a safety feature to reduce the risk of trapping fingers, or other body parts, in the pinch point formed between the lid and the base of the process chamber. The design also prevents accidental operation of the hoist.

4 When the chamber lid has completed its travel, release both hoist buttons. It is permissible to halt the hoist travel part way and then to resume travel, or to reverse its direction.

4.3.3 Automatic process run

This section describes an automatic process run, which allows a complete process to run automatically once the wafers have been loaded into the chamber.

1 Check that the following conditions are true:

a) The tool is started up, with all vacuum pumps running (see Section 4.2).

b) The process chamber is vented (see Section 4.6.1).

2 Open the chamber lid (see Section 4.3.2.1).

3 Place the process wafer on the platen or lower electrode.

4 Close the process chamber lid (see Section 4.3.2.2).

5 Evacuate the process chamber (see Section 4.6.2).

6 If you want to manually enter the wafer identity proceed as follows:

a) Click on the Wafer Map icon 

on the Transport Handler page to show the Wafer Map Editor panel, see Figure 4-7.

Figure 4-7 Wafer Map panel

b) Click on the  icon to open the wafer name panel, see Figure 4-8.

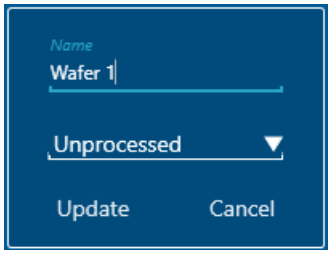

Figure 4-8 Wafer Name panel

c) Enter a name for the wafer. You can select the status of the wafer from the drop-down list, see Figure 4-9, or use the default value (Unprocessed).

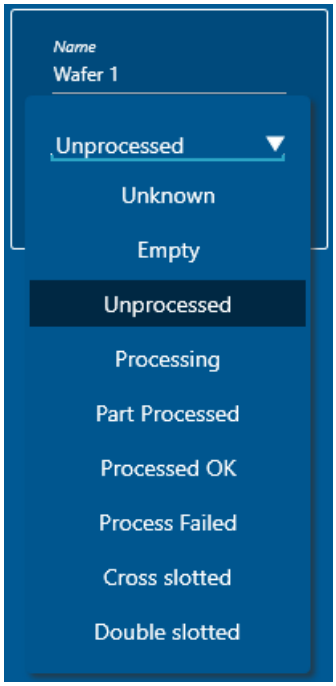

Figure 4-9 Wafer status dropdown list

d) Click on **Update** to save and close the wafer name panel. The wafer name appears in the Wafer Map, see Figure 4-10.

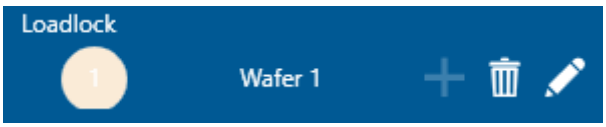

Figure 4-10 Named wafer in the Wafer Map panel

7 Click on **Automatic** in the main menu to open the **Batch View** page. See Figure 4-11.

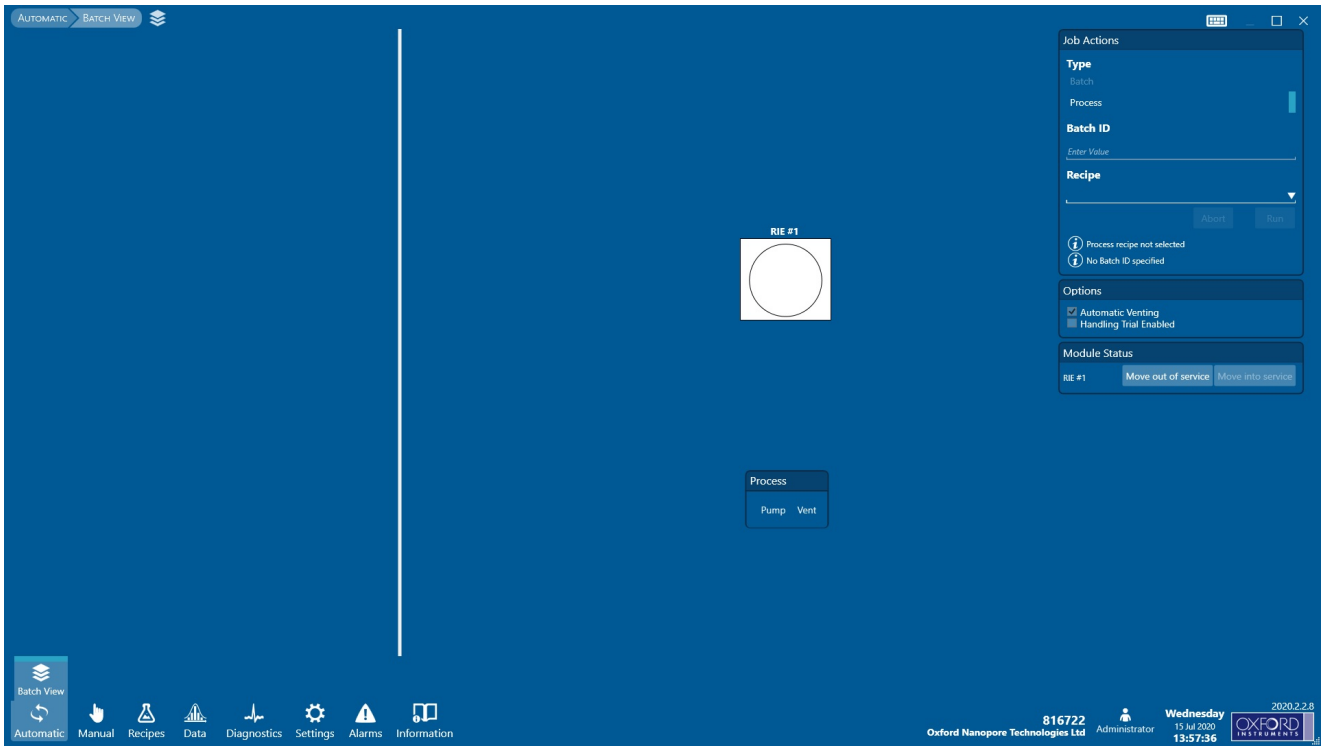

Figure 4-11 Batch View page

8 Enter the wafer ID for the job in the **Batch ID** field.

9 Select the required recipe from the **Recipe** drop-down list.

10 Select any options to be used in the **Options** panel.

11 In the Module Status panel, move the process module into service.

Figure 4-12 Module Status panel

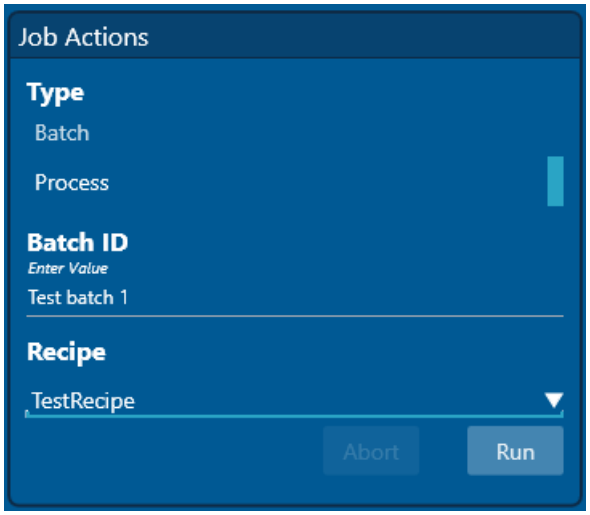

Figure 4-13 Job Actions panel

12 Click **Run** in the Job Actions panel. This starts the following automatic sequence:

a) The tool displays the Run Process Recipe panel to allow monitoring of the progress of the run.

b) The tool evacuates the process chamber.

c) The process starts.

13 To stop the process at any stage, click **Abort** in the Job Actions panel. This causes the process to abort and resets the step timer to zero. The tool also displays the message **Process Complete**. You can then run the same process or a different process, if required. There is also a **Stop** button in the Status panel on the process module page.

14 Wait until the tool has processed the wafer. A **Task finished successfully** panel displays for a short time at the bottom right of the page, see Figure 4-14.

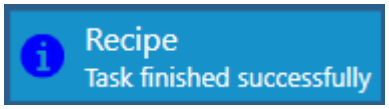

Figure 4-14 Recipe finished

15 Vent the process chamber (see Section 4.6.1).

16 Open the process chamber and remove the wafer (see Section 4.6.1).

17 Repeat the steps in this section to process further wafers.

18 When you have processed all wafers, evacuate the process chamber.

4.4 System alarms and warnings

This section applies to all users.

The tool displays a system alarm when the PTIQ application detects an event that requires the attention of the user. The tool automatically categorizes each alarm, depending on its severity and the level of response required by the user. Details of the alarm categories are shown in Table 4-1.

Table 4-1 System alarm categories

Alarm Category	Description	Example	Action
Amber triangle	A warning. Operator intervention is required. This indicates that a service parameter is out of tolerance but the process is continuing or the operator must perform some function as part of the normal operating sequence of the machine.	End of process reached.	Resolve the issue as soon as possible. If necessary pause the process after the present wafer has completed.
Red triangle	A process abort. This indicates that a fault is so severe that the process cannot be run or must be aborted.	High reflected RF power.	Resolve the issue immediately.

A warning or alarm can be indicated by a pop-up (see Figure 4-15) or by a coloured triangle on the page.

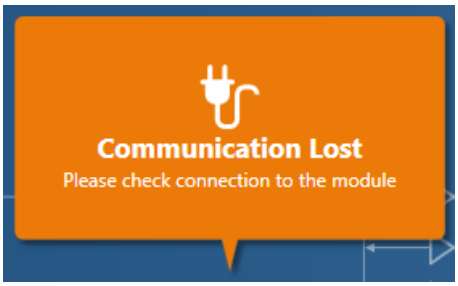

Figure 4-15 Typical alarm

4.4.1 Responding to an alarm

Click the main menu Alarms icon on any page to access the Alarms & Warnings page (see Figure 4-16). This lists all the current alarms and warnings.

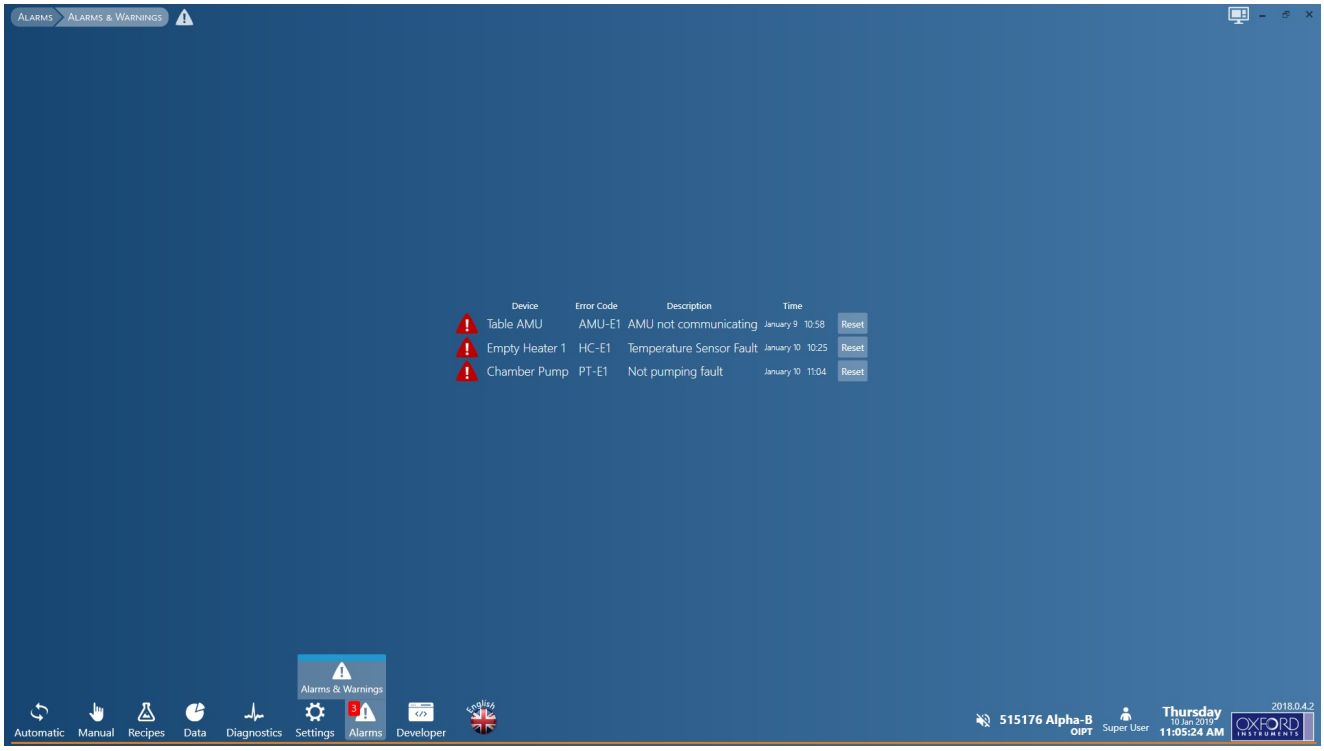

Figure 4-16 Typical alarm page

Click **Reset** to reset an alarm.

A user logged in at any access level can reset an alarm but unless the underlying cause of the alarm is resolved it will reappear.

The alarm message contains a description of the event that caused it. If the cause is a service fault (e.g. wafer flow, gas pressure, etc.), resolve the issue as soon as possible. Depending on the severity of the fault, it may be possible to continue the process with the fault present. Do not start a new process until the fault has been completely resolved.

A red alarm usually indicates that a process parameter has been out of tolerance for too long. This causes the process to pause automatically. Refer to Section 5.7 for instructions on how to recover the process wafer.

4.5 Leak testing the process chamber

This section only applies to users with the appropriate privileges.

To vacuum leak-test the chamber, the user evacuates the chamber, seals it, and then monitors the rate of pressure rise using the chamber vacuum gauge.

It is useful to perform a leak-test as part of the regular maintenance schedule. Investigate any variations in the leak-back characteristics before continuing processing.

The leak-test can detect that a leak is present in the chamber, but it cannot identify its location. You must use conventional leak-detection techniques to identify the location of any leak that is detected.

4.5.1 Performing a Leak Up Rate Check

1 Select the process module page (see Figure 3-7). To access the process view page click the **Manual** icon followed by the sub-menu icon for the process chamber.

2 To leak test the chamber using the previously used settings, click the **Leak-Rate** button in the Status panel (see Figure 4-17).

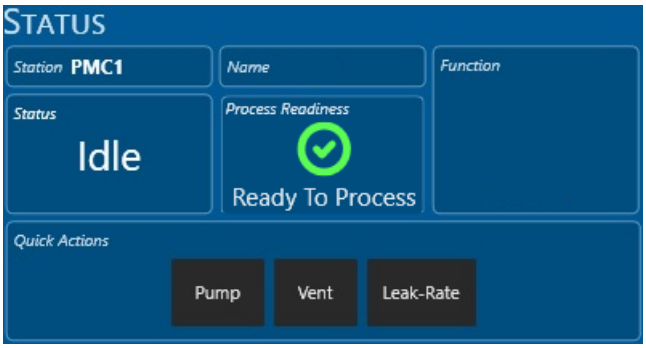

Figure 4-17 Status panel

To check or change the leak check settings, click the Actions icon and proceed as follows:

a) In the Module Actions panel (see Figure 4-18) select the **Leak Up Rate Check** option.

b) Set the **Options**. Suggested values are a maximum **Pre-pump time** of 10 minutes and a maximum **Test time** of 10 minutes.

c) Click **Start**.

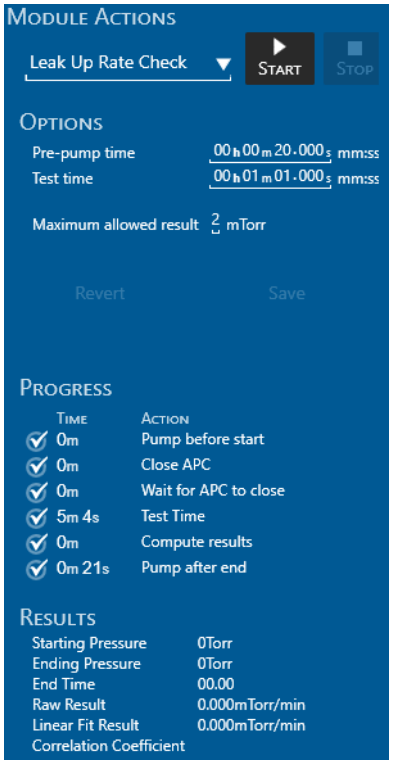

Figure 4-18 Leak up rate check

3 The leak test sequence starts and the Status panel displays the progress of the operation, see Figure 4-19.

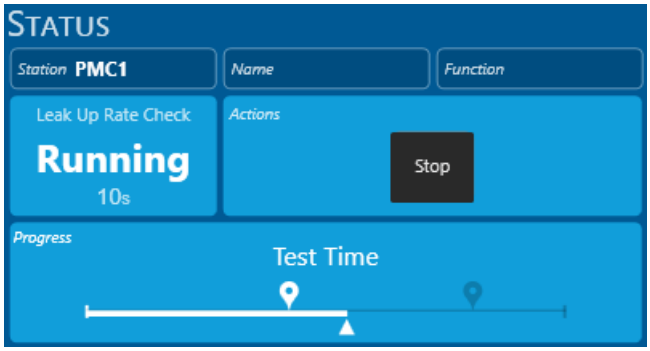

Figure 4-19 Progress panel

4 Observe the progress of the test in the **Progress** fields in the right command panel.

5 Wait until the leak test finishes. The Status panel returns to normal and a **Task finished successfully** panel displays for a short time at the bottom right of the page, see Figure 4-20.

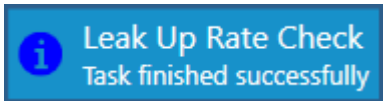

Figure 4-20 Leak test finished

6 When the test finishes note the **Results**. The measured leak rate must be less than 1 mTorr/minute.

NOTE: A high leak rate might be caused by outgassing. It is recommended that you repeat a failed leak test with a longer pre-pump time to confirm that there is a real fault on the tool. Alternatively you can run a pump-purge recipe.

4.6 Pumping, venting and opening the process chamber

This section describes how to evacuate, vent, open and close the chamber. The information only applies to users with *MANAGER*, *SUPERVISOR*, *MAINTENANCE* or *USER* privilege.

4.6.1 Venting and opening the process chamber

WARNING

TOXIC GASES
Exposure to toxic gases can cause death or serious injury.
The vent sequence includes a purging step to remove any trace of toxic gas.
Always follow the proper procedure when venting the process chamber. Do not change the purging time.

1 Select the process module page (see Figure 3-11) or the Batch View page (see Figure 3-10).

2 Click on **Vent** in the Status panel on the process module page (see Figure 4-21) or the Quick Actions panel on the Batch View page (see Figure 4-22).

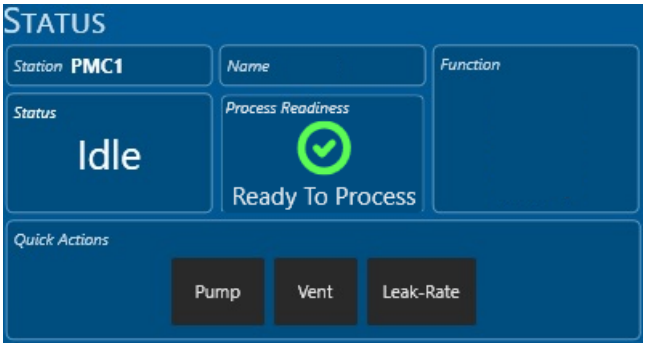

Figure 4-21 Status panel (process module page)

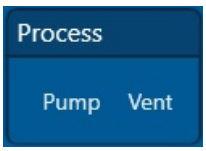

Figure 4-22 Quick Actions panel (Batch View page)

3 The vent sequence starts and automatically purges the process chamber before venting. The tool displays the progress of the operation, see Figure 4-23 or Figure 4-24.

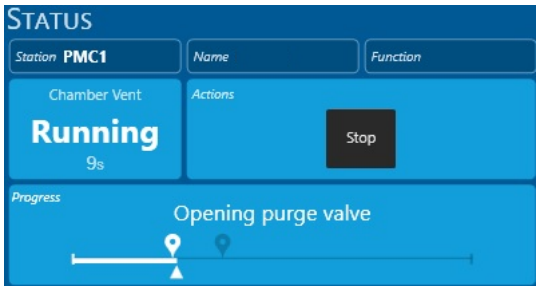

Figure 4-23 Vent progress panel (process module page)

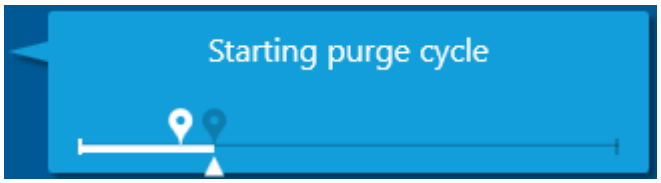

Figure 4-24 Vent progress panel (Batch View page)

4 When venting is complete, the progress panel vanishes and a **Task finished successfully** panel displays for a short time at the bottom right of the page, see Figure 4-25.

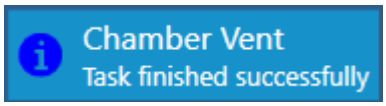

Figure 4-25 Vent finished

5 If required, open the lid of the process chamber and remove the wafer (see Section 4.3.2.1).

4.6.2 Closing and evacuating the process chamber

1 If required, place a wafer in the process chamber.

2 Close the lid of the process chamber (see Section 4.3.2.2).

3 Click on **Pump** in the Status panel on the process module page (see Figure 4-26) or the Quick Actions panel on the Batch View page (see Figure 4-27).

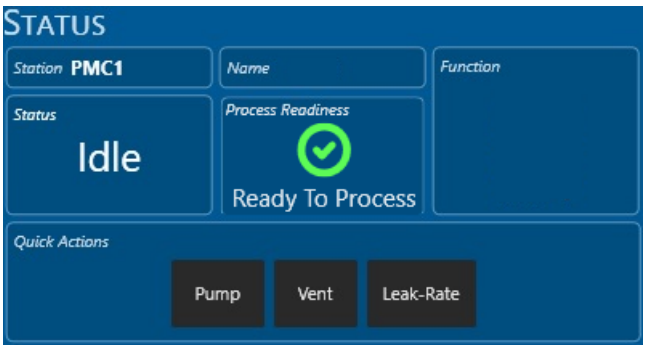

Figure 4-26 Status panel (process module page)

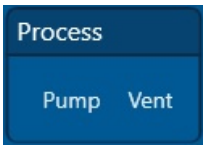

Figure 4-27 Quick Actions panel (Batch View page)

4 The pump sequence starts and automatically pumps the process chamber. The tool displays the progress of the operation, see Figure 4-28 or Figure 4-29.

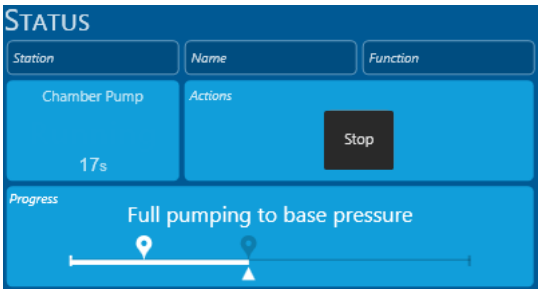

Figure 4-28 Pump progress panel (process module page)

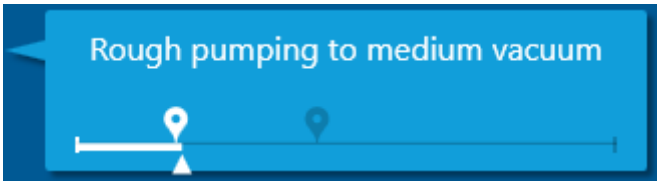

Figure 4-29 Pump progress panel (Batch View page)

5 When pumping is complete, the progress panel vanishes, the *Vacuum OK* status message displays (see Figure 4-30), and a **Task finished successfully** panel displays for a short time at the bottom right of the page, see Figure 4-31.

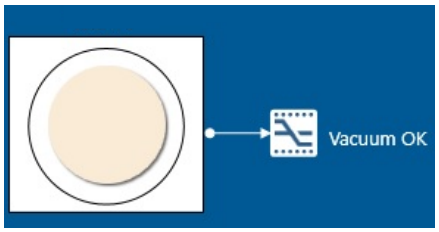

Figure 4-30 Process chamber successfully evacuated

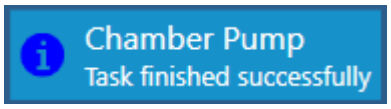

Figure 4-31 Chamber pumping finished

5 OPERATING INSTRUCTIONS FOR MANAGERS

This chapter describes how to operate the **Plasma**Pro®80 tool. The procedures described here must only be performed by maintenance personnel who have been trained by Oxford Instruments Plasma Technology to safely perform these tasks.

The chapter comprises the following sections:

- Shutting down the tool
- Purging the process chamber before venting
- Additional operating procedures
- Evacuating and purging the gas pod
- Creating and editing recipes
- Checking mass flow controller calibration
- Recovering process wafers
- Recovering the tool after a loss of services
- Settings

5.1 Shutting down the tool

After completing this procedure the following conditions will be true:

- All electrical power is removed from the tool.
- The compressed air supply to the tool is turned off.
- The water supply to the tool is turned off.
- All gas valves are turned off.

To shut down the tool for maintenance or repair:

1. Check that all processing has completed and all process wafers have been removed from the tool.
2. Turn off all the manual point-of-use gas valves.
3. Consider the reason for shutting down the tool. If you are performing maintenance of the gas pod, shutting the tool down for a long period, or moving the tool, perform the following steps to evacuate the gas lines.
   a) Decide whether to evacuate the gas lines back to the point-of-use valves, or back to the gas bottle valves. If in doubt, evacuate the gas lines back to the bottles, as you cannot perform further evacuation once the tool is shut down.
   b) Referring to Section 5.4.1, evacuate the gas lines.

4 Vent the process chamber (see Section 4.6.1).

WARNING

TOXIC GASES
Contact can cause death or serious injury.
The vent sequence for the process chamber includes a purging step to remove any trace of toxic gas. Always use the proper procedure when venting the process chamber. Ensure that the gas lines have been purged before removing or loosening components. Wear personal protective equipment as necessary.

5 If toxic or hazardous gases have been used in the previous process, evacuate and vent the process chamber again without opening the lid.

6 Click on **Automatic** in the main menu to open the **Batch View** page (see Figure 3-10).

7 In the Module Status panel, move the process module out of service.

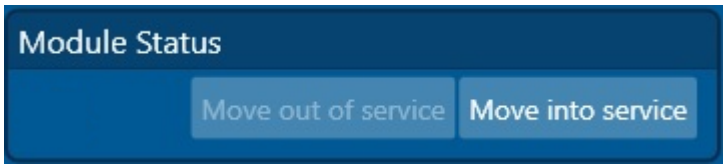

Figure 5-1 Module Status panel

8 Log off from PTIQ by clicking on your login name at the bottom of the page.

9 Close the PTIQ application.

10 Shut down the Windows operating system by clicking the **Start** icon and then the **Turn Off Computer** icon.

11 Switch off the power switch on the PC controller.

12 Switch off the main tool isolator on the power box (see Figure 3-1).

13 Switch off and lockout the facility safety isolation box.

14 Turn off and lockout the compressed air supply to the machine.

15 Allow time for all heated components to cool to ambient temperature. Then turn off and lockout the cooling water supply to the machine.

WARNING

HAZARDOUS VOLTAGE
Contact can cause severe injury or death. Any work requiring the removal of covers or panels must only be performed by authorised personnel who are aware of the hazards involved. Before removing any covers or panels, power down the tool and lockout the main circuit breaker.

16 Wait at least five minutes before removing any panels or covers. This ensures that any stored electrical energy has decayed to a safe level.

17 Attach a notice to the tool, explaining its status.

5.1.1 Start-up after an unscheduled tool shut-down

Perform the following steps to start up the tool after an emergency off event, power failure, or software abort:

1 Determine the reason for the unscheduled shut-down of the tool.

2 Determine if there are any process wafers in the tool.

3 Determine if there may be process gas in the chamber: for example if the tool was shut down during a process run.

4 Confirm that the reason for the shut-down has been resolved and it is safe to re-start the tool.

5 If an **EMO** button has been pressed, rotate the button to release it.

6 Turn on the main tool isolator on the power box, if it is not turned on already (see Figure 3-1).

7 Check that the **System On** indicator on the tool console is now illuminated.

8 While the tool is powering up, check the PC and restart it if necessary. If the PTIQ software is already open, close and reopen the software (see Section 4.1).

9 Evacuate the process chamber (see Section 4.6.2).

10 Vent the process chamber without opening the lid (see Section 4.6.1).

11 Evacuate and vent the process chamber again. This step must always be performed as a precaution, even if the chamber is expected to be free of hazardous gas residues.

WARNING

TOXIC GASES

Contact can cause death or serious injury. When starting up the tool after an unscheduled shutdown, the process chamber must be subjected to at least two vent cycles before the chamber lid is opened. Wear personal protective equipment as necessary.

12 If a wafer is present in the process chamber, open the process chamber and remove the wafer (see Section 4.3.2.1).

13 Referring to Section 5.7.3, remove the wafer mimic on the PTIQ pages.

14 Close the process chamber (see Section 4.3.2.2).

5.1.2 .Manual process run

Because a manual process run does not use a recipe, the operator should monitor the process parameters during the run.

To perform a manual process run:

1 Check the following conditions are true:

a) The tool is started up, with all vacuum pumps running (see Section 4.2).

b) The process chamber is vented (see Section 4.6.1).

2 Open the chamber lid (see Section 4.3.2.1).

3 Place the process wafer on the lower electrode.

4 Close the process chamber lid (see Section 4.3.2.2).

5 Evacuate the process chamber and enter the wafer identity (see Section 4.6.2).

6 Select the process module page (see Figure 3-6).

7 Click on the each item to be used for the process (e.g. a valve, process gas, RF source, AMU) and enter the parameters (e.g. step time, RF generator power, gas flows, chamber pressure, etc.) in the panel which pops up to the right of the page.

8 Click on the first item to be used and click the appropriate button in the panel (e.g. **Open** to open a valve). Wait for the required time then if necessary close the valve or move onto the next item.

9 Repeat as many steps as required for each item.

NOTE: Some buttons are active only under the correct conditions, e.g. when base pressure has been reached.

10 After starting the RF generator, visually check that the plasma strikes within a few seconds. If the plasma does not strike, find and rectify the cause.

Caution

ABSENCE OF PLASMA

Do not run the tool for any length of time with RF power but no plasma, otherwise permanent damage to the equipment may occur.

11 Monitor the progress of the process run and stop the source RF when completed.

12 When the process has completed, evacuate the chamber to its base pressure. If required, you can run another manual process.

WARNING

TOXIC GASES

Contact can cause death or serious injury. After a processing run, the process chamber must be subjected to at least two vent cycles before any maintenance work is carried out. Wear personal protective equipment as necessary.

13 Once all processing has been completed, vent the process chamber and remove the wafer (see Section 4.6.1).

5.2 Purging the process chamber before venting

WARNING

TOXIC GASES
Exposure to toxic gases can cause death or serious injury.
The vent sequence for the process chamber includes a purging step to remove any trace of toxic gas.
Always use the proper procedure when venting the process chamber.
Perform a risk assessment before changing the process chamber purging time or the number of purge cycles.

When you select the **Vent** button for the process chamber, the system automatically purges the chamber and evacuates it again before venting it. The number of these purge steps is set in the Module Actions panel on the process module page. Note that the tool always performs one purge cycle, even if **Purge Cycles** is set to 0.

To set the duration of each purge step, enter a value in the **Purge on Time** field.

Perform a risk assessment to determine the concentration of toxic gas when the process chamber is vented. If necessary, increase the length of each purge step or the number of purge cycles.

To change the vent and purge settings for the process chamber proceed as follows:

1 Select the process module page.

2 Click on the Actions icon 

then select **Vent** from the drop down menu in the Module Actions panel.

3 Check and alter the settings as required (see Figure 5-2) then click the **Save** button to save your changes.

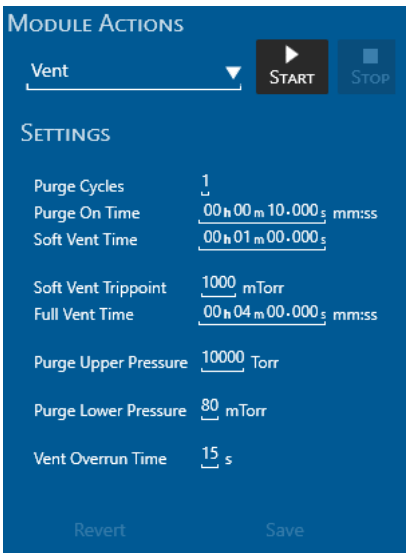

Figure 5-2 Chamber Vent settings

4 Click the **Start** button to start the vent sequence.

5.3 Additional operating procedures

5.3.1 Manually tuning an RF AMU

If a new process is running, the OIPT auto matching unit may not automatically find the best match position. This section describes how to manually tune an AMU to obtain the best match. Once you have achieved a good manual match, you can program the AMU parameters into a recipe.

For information on advanced operation of the AMU, refer to the **PlasmaPro®80** Service Manual.

To manually match an AMU:

1 If possible, load a dummy wafer into the process chamber. The wafer should resemble the actual process wafers as closely as possible as the wafer size and shape affect the plasma matching position.

2 Set up the required process conditions as a manual process run (see Section 5.1.2).

3 Start the process.

4 Click on the icon representing the AMU to be tuned to open the device panel.

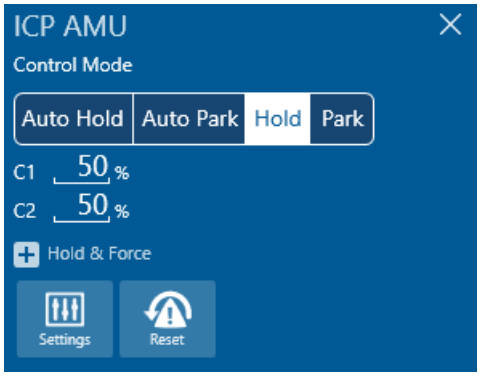

Figure 5-3 Typical AMU device panel (Cobra tool shown)

5 Click **Settings**. The AMU Settings panel opens.

Figure 5-4 AMU Settings panel

6 Click **Motor Control**. The AMU Motor Control panel opens.

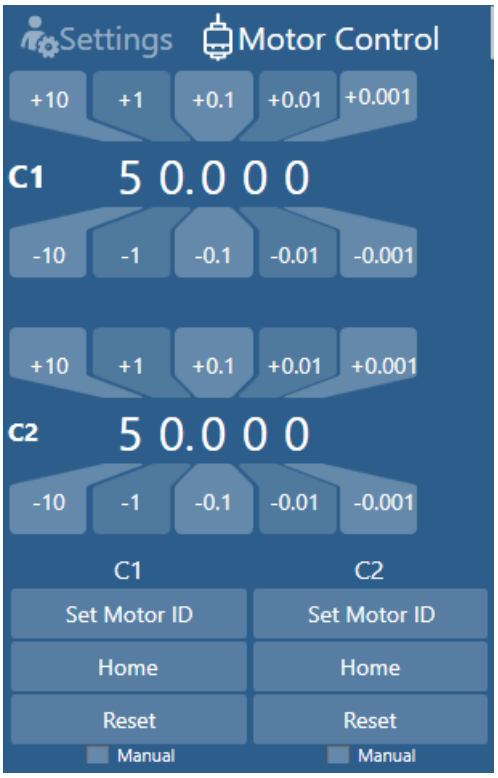

Figure 5-5 AMU Motor Control panel

7 Click the **Show Graph** button, see Figure 5-4.

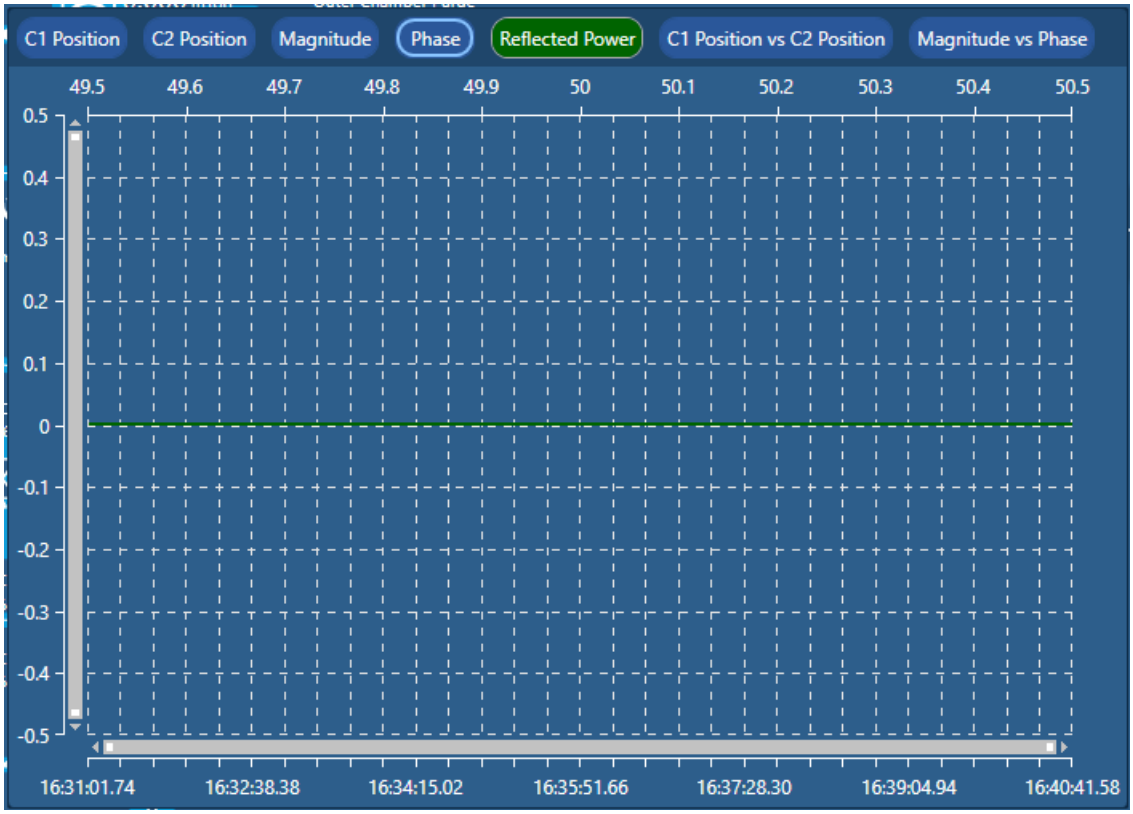

Figure 5-6 AMU graph panel

8 Click on the **Reflected Power** button, see Figure 5-6.

9 Set the position of the magnitude capacitor **C1** to a suitable starting position.

10 Using the **+** and **-** jog buttons on the **Motor Control** panel (Figure 5-5), sweep the position of the phase capacitor **C2**, while monitoring the value displayed in the **Reflected Power** graph. The reflected power should pass through a minimum value as the capacitor is moved.

11 Set the phase capacitor **C2** to the position that produced minimum reflected power in the previous step.

12 Sweep the position of the magnitude capacitor **C1**, while monitoring the value displayed in the **Reflected Power** graph. The reflected power should pass through a minimum value as the capacitor is moved.

13 Set the magnitude capacitor **C1** to the position that produced minimum reflected power in the previous step.

14 Repeat steps 10 to 13 until the reflected power is minimised.

15 Note the position of the **C1** and **C2** capacitors.

5.3.2 Configuring the strike assist facility

Use the strike assist facility to ensure that the plasma strikes consistently when the process pressure is less than approximately 50 mT.

1 Include the strike assist in the first process step in the recipe, see Section 5.5.2.

2 In the Stabilisation sub-step, set the APC to the pressure setting to be used while the plasma is striking, see example in Figure 5-7.

	Alarm Level	Stabilisation 15s 5s	Plasma #1 4m 30s	Plasma #2 1m 20s
N2	± 0.1 sccm	50.0 sccm	No Change	No Change
APC	± 5 mTorr	Pressure 20.0 mTorr	Strike Assist Strike Pressure 20.0 mTorr Pressure 5.000 mTorr Strike Time 5.00 s Min DCBias 10.00 v	No Change
ICP RF	± 5 w	1000 w	No Change	800 w
ICP AMU	± 5 %	Auto Park C1 20.0 % C2 30.0 %	No Change	No Change
Table RF	± 5 w	50.0 w	No Change	40.0 w
Table AMU	± 5 %	Auto Park C1 40.0 % C2 55.0 %	No Change	No Change

Figure 5-7 Strike Assist parameters

3 In the first Plasma sub-step, set the **Strike Pressure** field to the same value as the previous sub-step, set the **Pressure** to the pressure required for processing (usually the base pressure for the chamber) and set the **Strike Time**. Once the strike time has elapsed and the plasma has struck, the pressure ramps down to the Pressure value.

4 Enter a positive voltage in the **Min DC Bias** field. This voltage represents the minimum expected DC bias value when a plasma is running. The software uses this value to detect if the plasma has struck.

If a reliable DC bias measurement is not expected, enter 0 in this field. The software then uses the RF reflected power to detect the plasma.

5.4 Evacuating and purging the gas pod

5.4.1 Evacuating a gas line in the gas pod

This section describes how to evacuate a gas line in the gas pod. This might be done at the end of a shift, or before maintaining the gas pod.

NOTE: This is an operation which is likely to be performed frequently so the user is advised to create a recipe to perform the steps below, see Section 5.5.

1 Select the process module page.

2 Evacuate the process chamber (see Section 4.6.2).

3 Turn off all the gas valves (see Figure 3-6).

4 Click on the MFC for the gas line to be evacuated (see item 2 in Figure 5-9). This opens the panel for the MFC (see Figure 5-8).

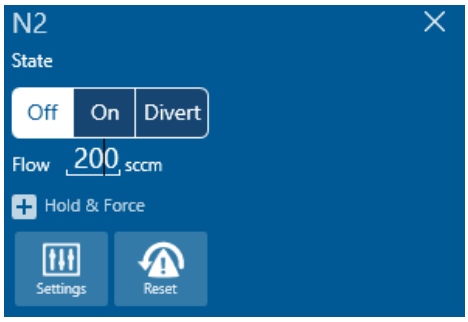

Figure 5-8 Typical MFC panel

5 Set the Flow rate to 0 sccm and click **On**.

6 Open the individual gas valve for the line to be evacuated (item 1 in Figure 5-9). Check that all other valves are closed.

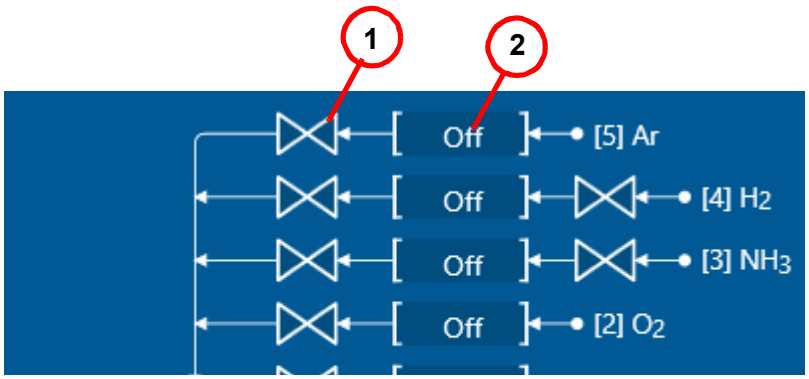

Figure 5-9 Gas valves

NOTE: It is possible to evacuate several gas lines at the same time, if the gases are chemically compatible. The interlocks in the gas pod prevent incompatible gases from being selected together.

7 Close the APC and the Foreline valve. Open the chamber Roughing Valve (item 1 in Figure 5-10) and start the Chamber Pump.

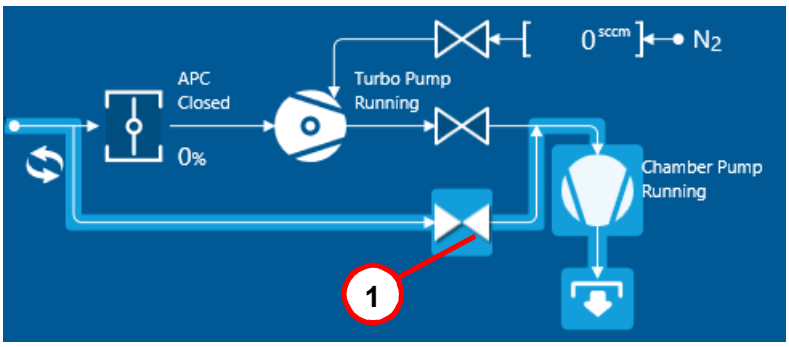

Figure 5-10 Chamber pump running

8 Wait for approximately 30 minutes, until the measured flow of the selected gas falls to zero. This indicates that the gas line has been evacuated.

9 Continue the process for a further five minutes.

10 Click **Off** in the gas panel for the MFC then close the individual gas valve.

11 Repeat this procedure for any other gas lines that are to be evacuated.

12 Once the lines have been evacuated, perform a leak test of the chamber plus evacuated lines (see Section 4.5.1). If the result is ≤0.2 mTorr/min above the leak-up rate for the chamber, then the gas lines have been successfully purged. If not then the pump the chamber and the gas line to base pressure (see Section 4.6.2) before repeating the leak test.

13 Stop the chamber pump and close the chamber roughing valve..

5.5 Creating and editing recipes

A recipe consists of one or more process steps that are automatically executed in sequence.

Use the Recipes page to assemble and store all the set points and instructions which make up a recipe for an automatic or production run (see Figure 5-11). Only users with the appropriate privilege can create recipes.

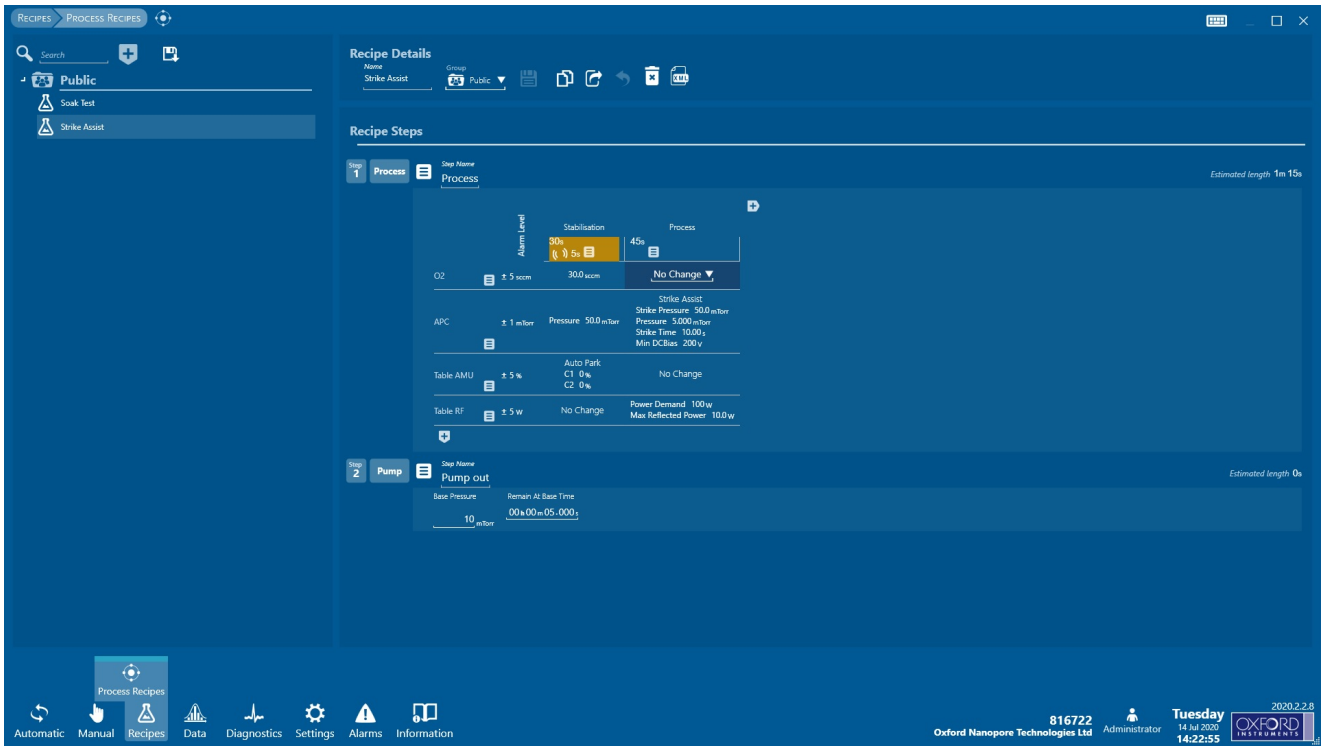

Figure 5-11 Typical Recipes page

A recipe consists of a sequence of individual process steps, each of which runs for a programmed time. A complete recipe should perform the following operations:

- Pump down the process chamber to a specified base pressure.
- Run one or more process steps. You can configure each process step to continue for a specified time, or until a specified condition is reached (e.g. an end-point detection).
- Pump and purge the process chamber as required to dilute process gas residues to a safe level.

Create a recipe by adding and defining new recipe steps or copying steps from an existing recipe. Refer to Section 5.5.2 for information on creating a new recipe.

NOTE: Personnel creating recipes must make sure they understand the operation of key components of the tool to ensure that recipes proceed as expected.

5.5.1 Managing recipes

Recipes are divided into two types:

- Public recipes, which are available to all users.
- Private recipes, these are restricted so that they are only available to the user who created them, or only available to users belonging to the group currently logged in.

5.5.2 Creating a new recipe

To create a new recipe proceed as follows:

1 Open the Recipes page from the main menu.

2 Click on the symbol, then select **Add Process Recipe** in the dropdown menu. A new recipe is created, see Figure 5-12.

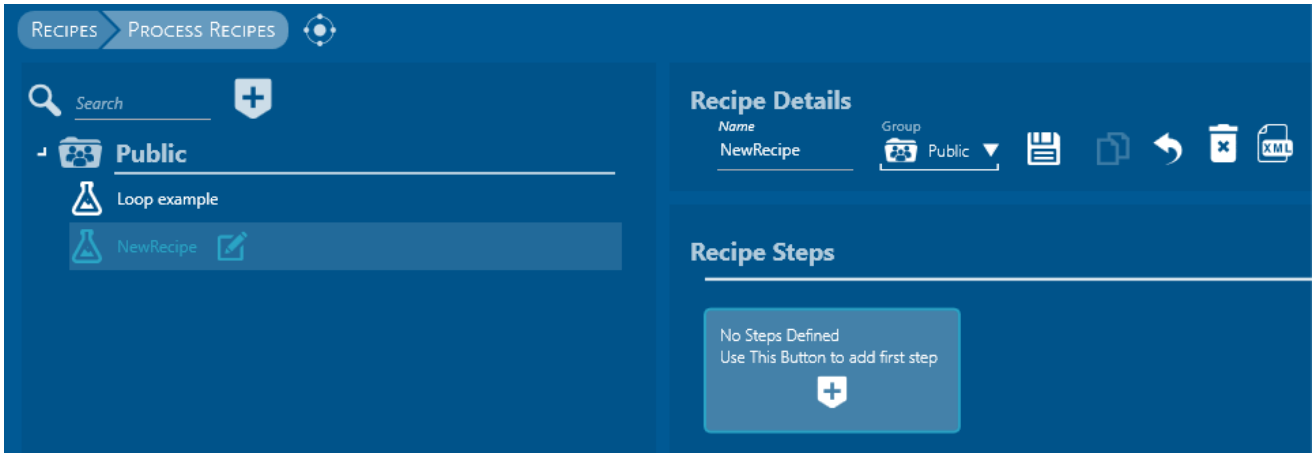

Figure 5-12 New recipe

3 Enter a name for the recipe in the **Name** field, then select the group (Public or Private) in the **Group** field.

4 Click on the Add Step button to add the first step.

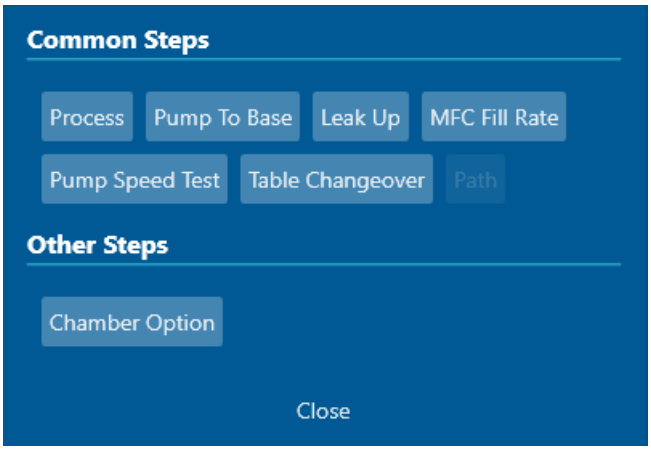

Figure 5-13 Add step menu

5 Select the first step from the menu (see Figure 5-13); the first step in a process is normally **Pump To base**.

6 The first pump step is shown in the recipe. Set the **Base Pressure** and **Remain At Base Time** as required.

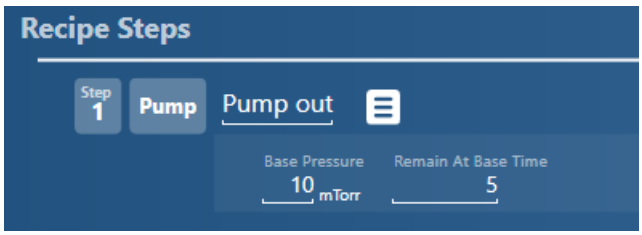

Figure 5-14 Pump step

7 Click on the More Commands icon to access the More Commands menu (see Figure 5-15).

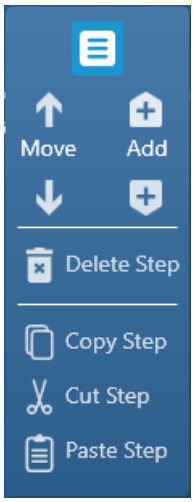

Figure 5-15 More Commands menu

8 With the More Commands menu the user can:

- Move the selected step up or down in the recipe,
- Add a new step before or after the selected step,
- Delete the selected step,
- Copy or cut the selected step,
- Paste a previously cut or copied step below the selected step.

NOTE: You can copy steps from one recipe to another.

9 Click on the More Commands icon to access the More Commands menu (see Figure 5-15) to add another step. This is typically a Process step (see Figure 5-16).

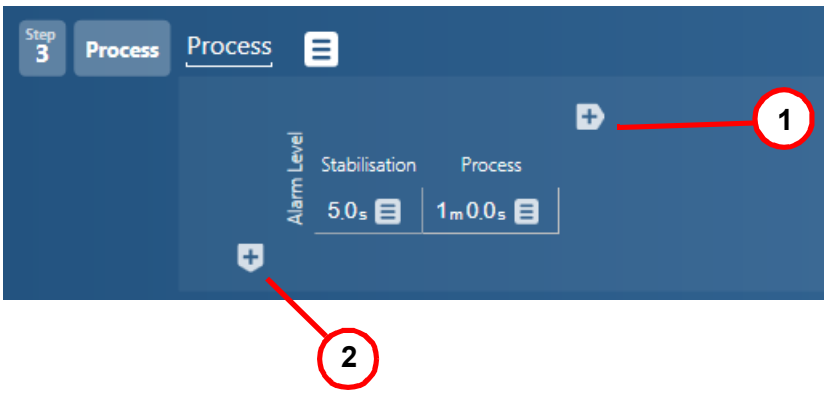

Figure 5-16 Process step

10 A new process step has a Stabilisation column and one Process column, as shown in Figure 5-16. Click on item **1** to add further columns to the process step. This might be needed if, for example, the process is to be started and stopped several times. Click on item **2** to display the Categories and Devices menu, see Figure 5-17.

NOTE: If the process step is to strike a plasma, consider whether to include Strike Assist (see Section 5.3.2).

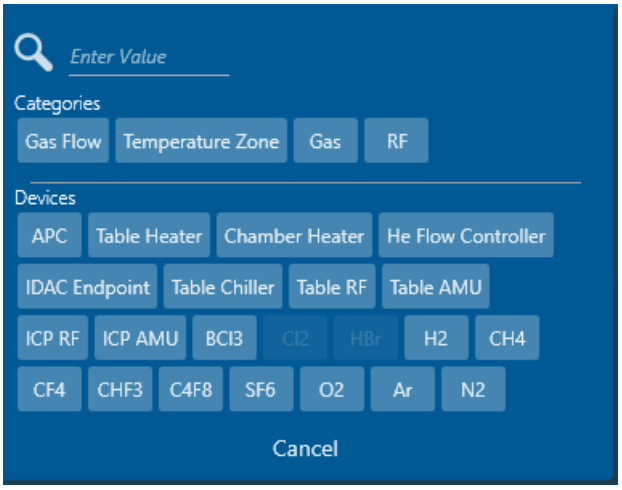

Figure 5-17 Categories & Devices menu

11 Choose a Device from the menu or choose a different category - Gas Flow, Temperature Zone, Gas and RF each have their own menus (see Figure 5-18).

Figure 5-18 Categories menus

12 Several devices can be added to a process step (see the example in Figure 5-19).

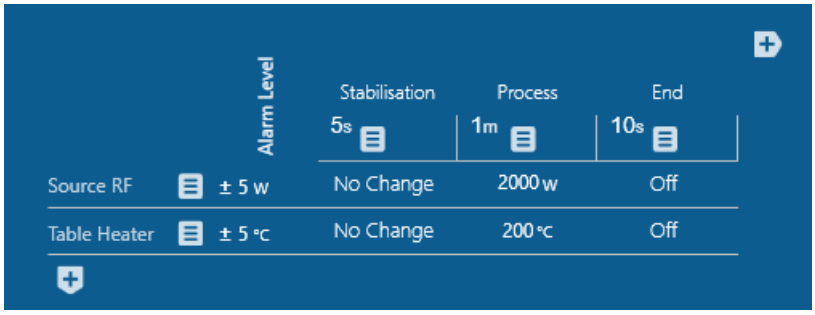

Figure 5-19 Process step example

13 Click on the device menu icon to access the device menu (see Figure 5-20). You can move the device up or down the list, delete it, or add further devices above or below the selected device.

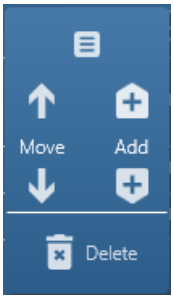

Figure 5-20 Device menu

14 Click on the column menu icon to access the column menu (see Figure 5-21). With the column menu the user can:

- Delete the selected column,
- Add a new column to the right of the selected column,
- Copy or cut the selected column,
- Paste a previously cut or copied column to the right of the selected column.

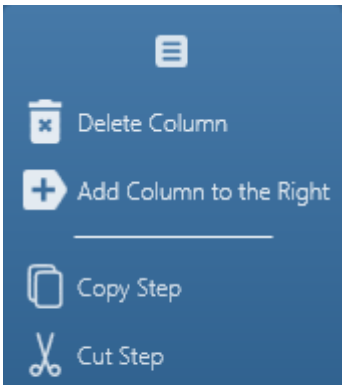

Figure 5-21 Column menu

15 Click on any field in the process step to change the value. Enter a new value and press <return>, or click the arrow to access the drop-down list (see the example in Figure 5-22).

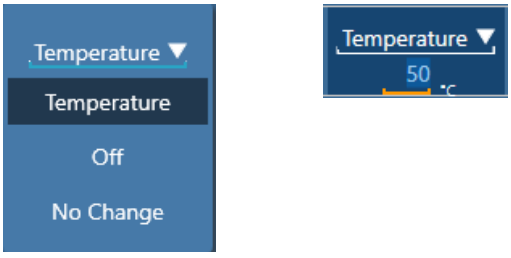

Figure 5-22 Change a field value

16 You can use a loop to repeat one or more of the actions in a process step as many times as required. Hover the cursor over a column name and the loop icon appears. Click on this to access the loop menu, see Figure 5-23.

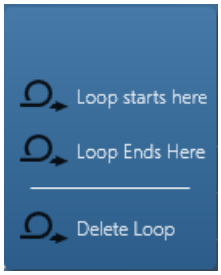

Figure 5-23 Loop menu

17 Click **Loop starts here**. The software inserts a loop from the selected column back to the first column.

18 If you want the loop to end in a different column, access the Loop menu at the required endpoint and click **Loop Ends here**. An example of process step with a loop is shown in Figure 5-24.

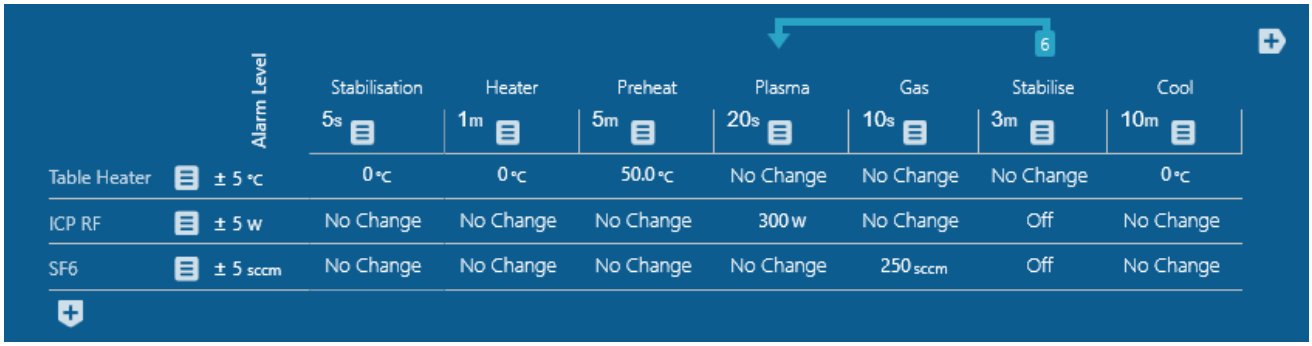

Figure 5-24 Loop example

19 To set the number of times the loop is to repeat, click the light blue square at the start of the loop, enter the required number and press <return>. The total number of times the operation is performed is the loop number plus one. For example if you enter a value of **1**, the tool performs the operation twice.

20 You can move the start or endpoint of the loop. Access the Loop menu at the required column and click **Loop starts here** or **Loop Ends here**.

NOTE: You can only define one loop in a process step. If you require additional loops, define additional process steps.

21 Save the recipe by clicking the disk icon at the top of the page.

NOTE: The disk icon is highlighted if there are unsaved changes in the recipe. If you do not save changes then the tool runs the previous version of the recipe, if requested.

5.5.3 Editing an existing recipe

Either the original author or another member of the same group can run a recipe.

You cannot copy a complete recipe. To create a recipe that is similar to an existing one, create a new recipe (see Section 5.5.2) and copy each step from the existing recipe.

To edit a recipe:

1 Open the Recipes page from the main menu.

2 Click on the recipe to be edited from the list of Public and Private recipes. If there is already a recipe displayed in the Recipe Details panel, the selected recipe replaces it in the display.

NOTE: If a recipe is listed in light blue text, this means that the recipe is undergoing editing and has not yet been saved.

---

3 You can now edit the recipe using the methods described in Section 5.5.2. Click on an icon or a field in the recipe to make changes.

4 To remove a step from the recipe:

a) Click on the More Commands icon for the step. The More Commands menu appears, see Figure 5-15.

b) Click **Delete Step**. All subsequent steps ascend the list by one place to fill the gap that has been created.

5 To add a step before an existing step:

a) Click on the More Commands icon for the step. The More Commands menu appears, see Figure 5-15.

b) Click on the Add Step Above icon .

c) In the Add step menu (see Figure 5-13) select the type of step required. It will be inserted above the current step.

6 To add a step after an existing step:

a) Click on the More Commands icon for the step. The More Commands menu appears, see Figure 5-15.

b) Click on the Add Step Below icon .

c) In the Add step menu (see Figure 5-13) select the type of step required. It will be inserted below the current step.

7 To add a step from another recipe:

a) In the list of Public and Private recipes, click on the recipe where the step is to be sourced.

b) Click on the More Commands icon for the step. The More Commands menu appears, see Figure 5-15.

c) Click **Copy Step**.

d) In the list of Public and Private recipes, click on the recipe where the step is to be added.

e) Click on the More Commands icon for the step above where the step is to be added. The More Commands menu appears, see Figure 5-15.

f) Click on **Paste Step**. The step copied above will be added below the current step.

8 Save the recipe by clicking the disk icon at the top of the page.

NOTE: The disk icon is highlighted if there are unsaved changes in the recipe. If you do not save changes then the tool runs the previous version of the recipe, if requested.

5.6 Checking mass flow controller calibration

You can use the PTIQ application to check the calibration of each of the mass flow controllers on the tool. The procedure pumps the chamber of the process module to its base pressure, isolates the chamber, and then introduces a known flow of a selected gas into the chamber. Because the tool knows the volume of the chamber, it calculates the actual flow of gas from the measured rate of pressure rise in the chamber.

This test is intended as a confidence check of the calibration of mass flow controllers. It is a useful maintenance and diagnostic tool.

Do not use this test to calibrate an MFC for a new gas type.

Certain gases in the tool are incompatible, so it is important that you only check one gas at a time.

5.6.1 Performing a mass flow controller calibration

1 Select the process module page (see Figure 3-7). To access the process view page click the **Manual** icon followed by the sub-menu icon for the process chamber.

2 Click the Actions icon.

3 In the Module Actions panel (see Figure 5-25) select the **MFC Fill Rate Check** option.

4 Set the **Options**. Select the **Gasline required** value corresponding to the MFC to be tested. Suggested values are a **Pre-pump time** of 30 minutes and a **Stabilisation Time** of 10 minutes. **Test time** should be at least 10 minutes, but the actual time for the test depends on the **Gasline flow** rate set.

Caution

CAUTION

Some gas mixtures may produce particles in the chamber or gas lines. Check only ONE gas at a time. Allow at least 15 minutes of pumping before and after any chamber fill using silane or $SiCl_4$.

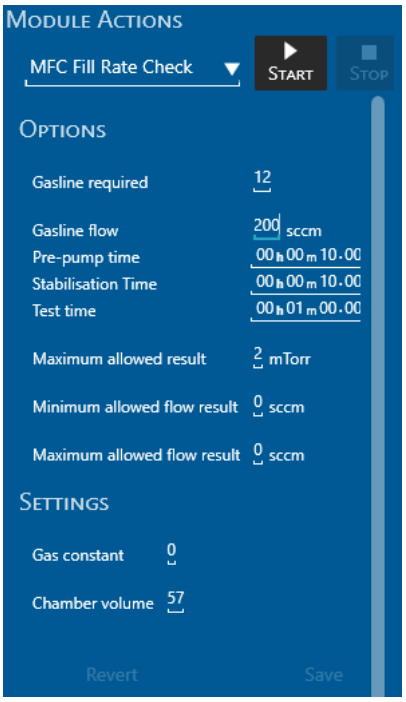

Figure 5-25 MFC fill rate check

5 Click **Start**. The fill rate check sequence starts and the Status panel displays the progress of the operation (see Figure 5-26).

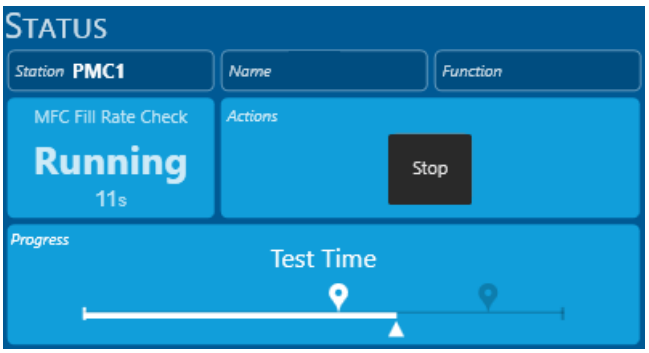

Figure 5-26 Progress panel

6 Observe the progress of the test in the **Progress** fields in the right command panel.

7 Wait until the fill rate check finishes. The Status panel returns to normal and a **Task finished successfully** panel is displayed for a short time at the bottom right of the page (see Figure 5-27).

Figure 5-27 MFC fill rate check finished

8 When the test finishes note the **Results**. The measured flow result must not be significantly different from the Gasline flow set in step 4.

5.7 Recovering process wafers

This section only applies to users with the appropriate privilege.

5.7.1 Recovering broken wafers

If one of more process wafers has broken inside the tool, perform the steps described below:

1 Evacuate the process chamber to its base pressure (see Section 4.6.2).

2 Vent the process chamber (see Section 4.6.1).

3 Open the process chamber (see Section 4.3.2.1).

WARNING

MECHANICAL HAZARD
Broken wafers have sharp edges that could serious injury.
Use tweezers or a similar tool to remove broken pieces of wafer.

4 Using a suitable tool, remove any large pieces of wafer. The edges of broken wafers are sharp and could cause serious injury.

5 Use a vacuum cleaner to remove smaller pieces of broken wafer.

6 Close the process chamber (see Section 4.3.2.2).

7 Evacuate the process chamber (see Section 4.6.2).

8 Make sure that the wafer indication on the Transport Handler page is correct (see Section 5.7.3).

5.7.2 Recovering unbroken process wafers

If a process halts, the wafers will be partially processed. There are several possible actions that can be taken, depending on the severity of the problem that caused the halt:

- Continue processing after resolving the process deviation (see Section 5.7.2.1).
- Continue processing without resolving the process deviation (see Section 5.7.2.2).
- Remove the wafers for assessment or other external action (see Section 5.7.2.3).

These three possible actions are discussed in the following sections.

5.7.2.1 Recovering wafers after resolving a fault

This section assumes that processing has been halted due to a fault or parameter deviation that has been resolved. It is assumed that the wafer in the machine is partially processed but otherwise undamaged. If in doubt whether to use this procedure, consult a process engineer or higher authority before proceeding.

Caution

RISK TO PROCESS WAFERS

Performing an incorrect or inappropriate recovery procedure can permanently damage process wafers. Consult with a process engineer before recovering wafers.

1 Confirm that you have resolved the original issue and that it is acceptable to continue processing the wafer.

2 Visually check that the wafer is correctly positioned in the process chamber.

3 Check that the position of the wafer mimic on the process module page indicates that the wafer is in the process chamber.

Figure 5-28 Wafer in process chamber

4 If the wafer mimic on the process module page is incorrect, perform the steps described in Section 5.7.3 to resolve the situation.

5 Select **Data > Audit Log** from the main menu to open the log file.

6 Scroll through the log file to identify the remaining step time at the moment the RF power switched off.

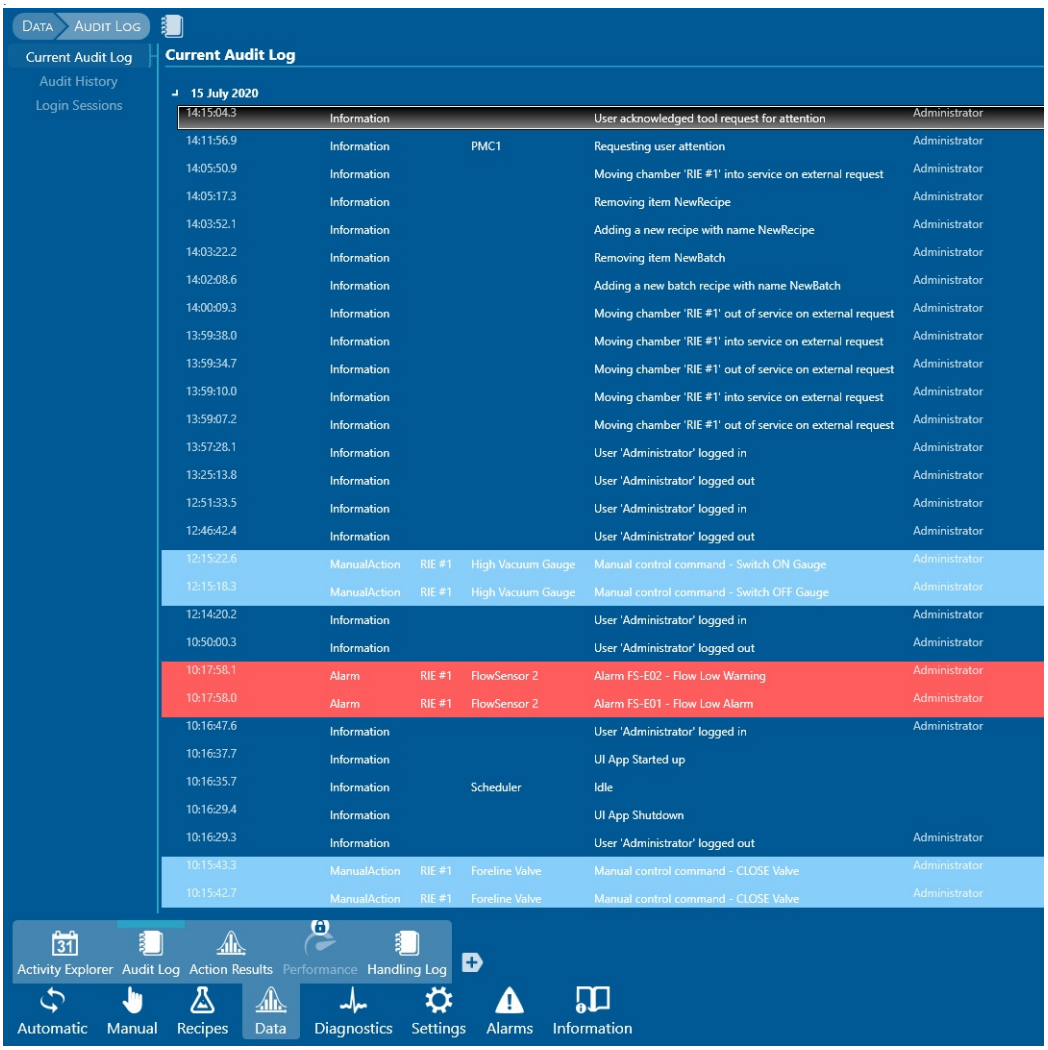

Figure 5-29 Sample log file

7 Create a new recovery process by copying the existing recipe.

8 If the recipe contains multiple process steps, delete any process steps that have already been completed. Do not delete any pumping or purge steps that are still required.

9 Change the time of the partially completed process step in the new recipe to be equal to the remaining process time.

10 Run the recovery process in the normal way.

Example of recovering a process wafer after resolving a fault

For this example, assume you were running the recipe in Table 5-1, and the process aborted at some point.

The steps in the recipe are as follows:

Table 5-1 Example recipe

Step Number	Step Description	Programmed Step Time (Secs)
1	Pumpdown	300
2	Purge	30
3	Pumpdown	30
4	Etch process 1	120
5	Pumpdown	30
6	Etch process 2	360
7	Pumpdown	30
8	Purge	30
9	Pumpdown	30
10	Vent	60

After examining the log file, you find that the recipe aborted after 65 seconds of step 6. Make a copy of the recipe as shown in Table 5-2:

Table 5-2 Example recipe for recovering from an abort

Step Number	Original Step Number	Step Description	Programmed Step Time (secs)
1	1	Pumpdown	300
2	2	Purge	30
3	3	Pumpdown	30
4	6	Etch Process 2	295
5	7	Pumpdown	30
6	8	Purge	30
7	9	Pumpdown	30
8	10	Vent	60

Notice the following points:

- The initial pumpdown and purge steps are retained, to ensure the process chamber is at its base pressure before processing starts.
- Etch step 4 (Etch Process 1) has been deleted as this step had already been run when the tool aborted.
- The time for Etch Process 2 has been reduced by 65 seconds, as this step has already been run for 65 seconds.

5.7.2.2 Recovering wafers without resolving a fault

This section assumes that processing has been halted due to some fault or parameter deviation that has not been resolved. It is assumed that the wafers in the machine are partially processed but otherwise undamaged.

Only perform this procedure if a process engineer or higher authority authorises it. You might use this procedure if you cannot easily resolve the deviation but a process engineer decides the process effects are acceptable.

Caution

Risk to Process Wafers

Performing an incorrect or inappropriate recovery procedure can permanently damage process wafers. Consult with a process engineer before recovering wafers.

1 Visually check that the wafer is correctly positioned in the process chamber.

2 Check that the position of the wafer mimic on the process module page indicates that the wafer is in the process chamber.

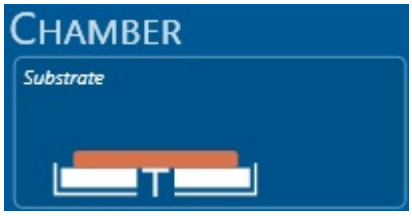

Figure 5-30 Wafer mimic on process module page

3 If the wafer mimic on the process module page is incorrect, perform the following steps to correct the situation:

   a) Vent the process chamber and open the process chamber lid.

   b) Start a new process sequence, and re-enter the wafer ID when prompted to do so.

4 Open the most recent process log.

5 Scroll through the log file to identify the remaining step time at the moment the RF power switched off (see Figure 5-29).

6 Create a new recovery process by copying the existing recipe.

7 If the recipe contains multiple process steps, delete any process steps that have already been completed. Do not delete any pumping or purge steps that are still required.

8 Change the time of the partially completed process step in the new recipe to be equal to the remaining process time.

9 Change the alarm level for the parameter that raised the fault to a larger value.

10 Run the recovery process, while carefully monitoring the tool for process deviations. If any unacceptable deviation occurs, halt processing by clicking **stop**.

5.7.2.3 Recovering wafers without further processing

This section assumes that processing has been halted due to some fault or parameter deviation, and it has been decided not to continue processing the wafers. This might be because maintenance work is required to correct the fault, or you might want to remove the wafers for evaluation or some other processing to recover any damage. For example, you might want to remove an incomplete PECVD layer so you can re-deposit the complete layer.

1 Record details of the most recent process log for reference.

2 Evacuate and purge the process chamber (see Section 4.6.2 and Section 5.2).

3 Vent the process chamber and remove the wafers. If the wafers are part of a batch, make sure that the wafer identities have been recorded so they can be identified in the future.

5.7.3 Ensuring that the software correctly indicates the wafer position

If the electrical power supply to the tool has been interrupted, the PTIQ application may not know if there is a process wafer in the tool. Perform the following corrective actions:

1 Visually check if there is a process wafer in the tool.

2 Open the Transport Handler page (see Figure 3-11).

3 Check if a wafer is shown in the Wafer Map Editor panel (see Figure 5-31).

Figure 5-31 Wafer Map Editor

4 To remove a wafer from the Wafer Map Editor, click the  icon.

5 To add a wafer to the Wafer Map Editor, click the  icon.

5.8 Recovering the tool after a loss of services

Table 5-32 lists the tool's response to a loss of various services.

Figure 5-32 Tool's response to loss of services

Event Caused by Loss of Service	Electrical Power (all phases)	Electrical Power (one phase only)	Compressed Air	Cooling Water	Turbo Pump Nitrogen Purge Flow	Process Gas	Vacuum Pump - Electrical Overload	Vacuum Pump - No Electrical Overload
The process run pauses.						Yes[1]		
The process run stops.	Yes							
The process run aborts.		Yes[2]		Possible [3]	Yes		Yes	Yes
The tool controller shows the interlock status as fault.								Yes
All vacuum pumps stop.	Yes			Possible [4]				
The backing pump stops.		Yes						
Gas flows remain active.						Yes		
All pneumatic vacuum and gas valves close immediately.	Yes	Yes	Yes		Yes		Yes	
All pneumatic vacuum and gas valves close after a delay.								Yes[5]
RF power is turned off immediately.	Yes	Yes				Yes		
RF power is turned off, after a delay.			Yes[6]					
An alarm is raised.				Yes				

1. If the process gas is restored, the process re-starts automatically.
2. If the phase powering the tool controller remains live, then the controller retains the current tool status.
3. The process run aborts if the vacuum pumps stop.
4. If the water flow is lost for an extended time, vacuum pumps may shut down due to their internal temperature alarms.
5. Gas continues to flow into the chamber until the vacuum pressure exceeds 600 mbar. Then all gas flows are shut down.
6. RF power is turned off as soon as the loss of gas flow is detected.

5.8.1 Recovery from a loss of services

1. Correct the cause of the failure. If necessary, contact maintenance staff to troubleshoot and correct any faults found.
2. Restore the failed service to the tool, if it is safe to do so.
3. Check that the service meets the required specification.
4. Recover the process wafer (see Section 5.7).

5.9 Settings

A user with *Administrator* privilege can change settings.

5.9.1 Account setup and management

Only a person with *Administrator* privilege can create and amend user accounts.

To add a new user, or to amend a current user's account:

1 Log on as an *Administrator* (see Section 4.3.1).

2 Select **Settings > Users**  from the main menu.

The Users page opens, see Figure 5-33.

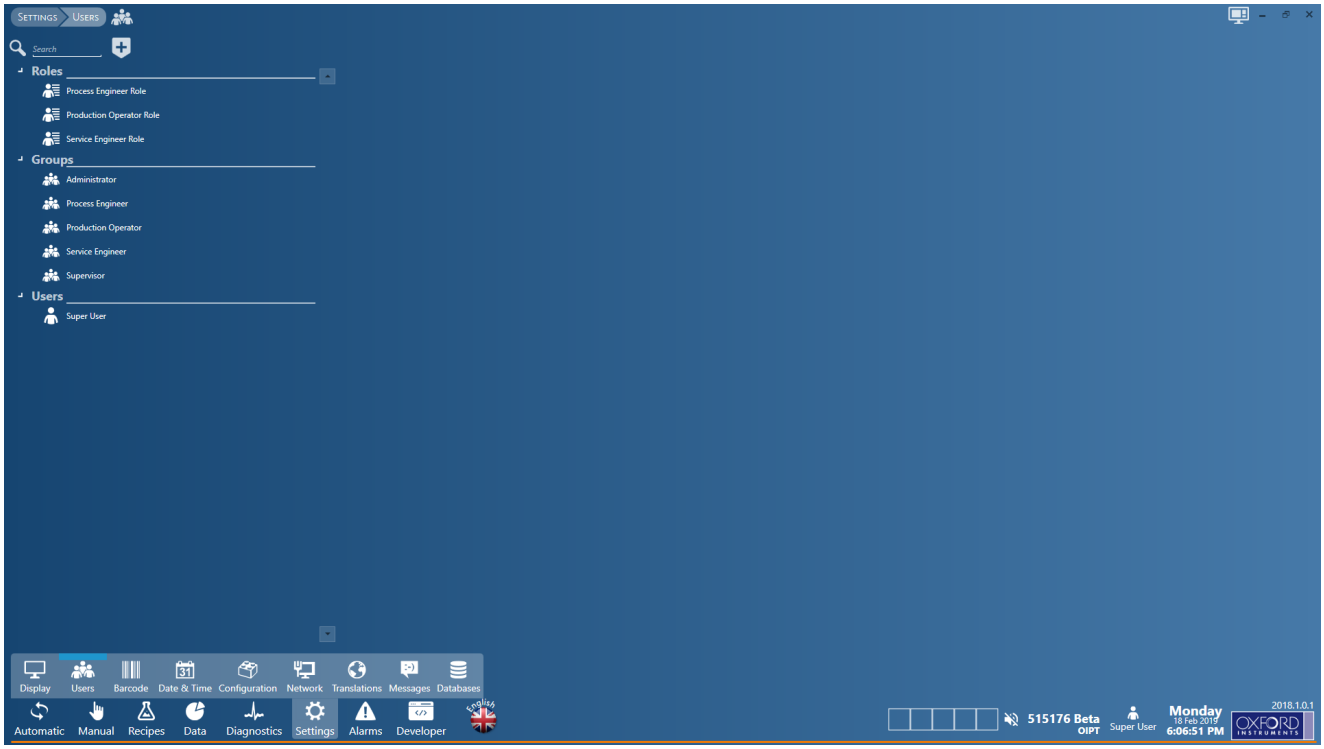

Figure 5-33 Users

Refer to the following sections for instructions on creating, editing and deleting user accounts.

5.9.1.1 Creating a new user account

To add a new user account:

1 Click on the  symbol, then select **Create New User** from the menu.

2 Enter a name for the new user in the **Username** field.

3 Enter the full name for the new user in the **Full Name** field.

4 Click the **Password** field and enter a password for the new user. The password can be of any length and is case-sensitive. Make sure that you record the password for future reference.

5 Select an access level for the new user from the **Role Profile** drop-down list. The following options are displayed:

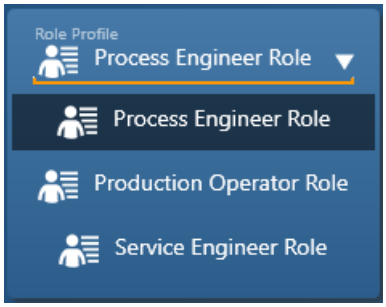

Figure 5-34 Role Profile drop-down

6 Save the new user by clicking the disk icon at the top of the page.

5.9.1.2 Modifying an existing account

To modify the account of an existing user:

1 Click on the name of the user. The user's account is displayed, see Figure 5-35.

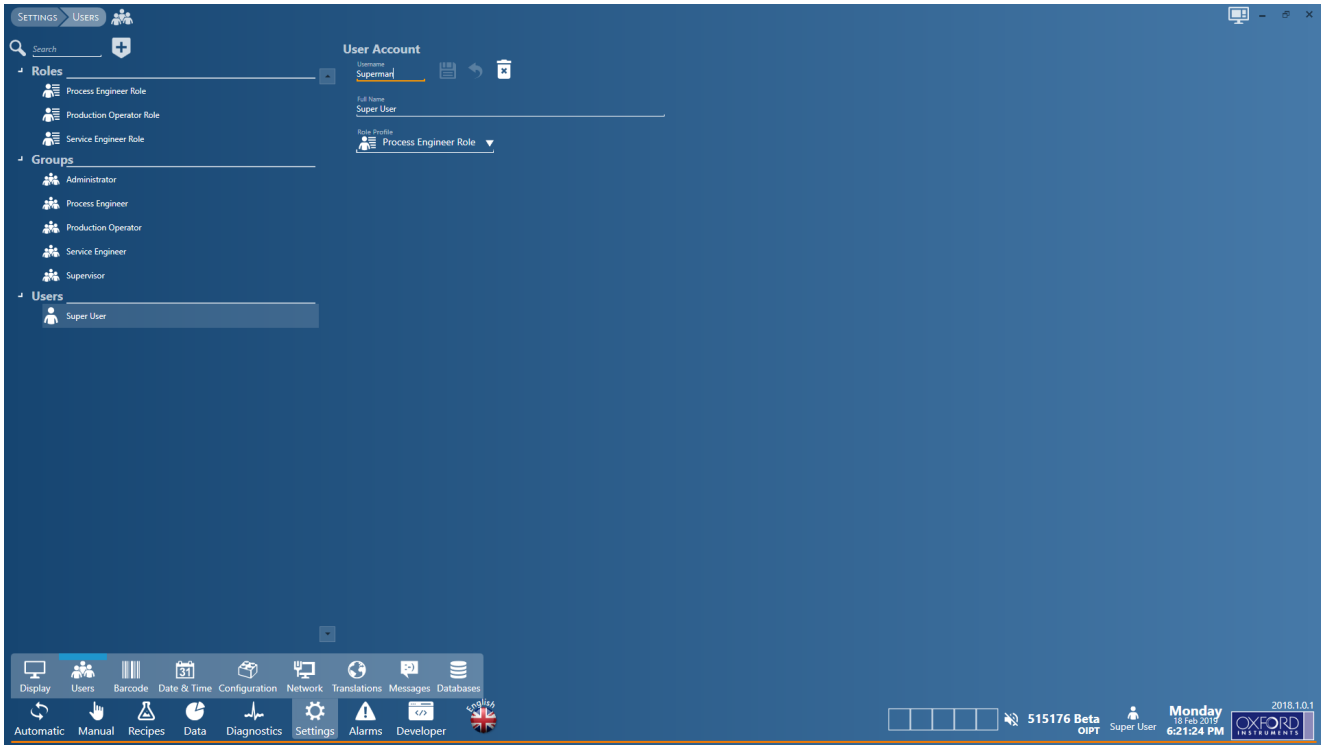

Figure 5-35 User Account

2 To change a user's password, click the **Password** field and enter a new password. Passwords are case-sensitive.

3 To change the access level for a user, click the **Role Profile** field. Then select an access level from the drop-down list.

4 Save the changes by clicking the disk icon at the top of the page.

5.9.1.3 Deleting a user account

To delete the account for a user:

1 Click on the name of the user. The user's account is displayed, see Figure 5-35.

2 Check that the correct account is selected for deletion.

Caution

DELETING ADMINISTRATOR ACCOUNTS

Deleting all the *Administrator* accounts permanently removes all account management capability. Take care not to delete all the *Administrator* accounts.

3 Click the  icon. This immediately deletes the selected user account from the window. There is no confirmation request.

NOTE: If you accidentally delete all the *Administrator* accounts, contact Oxford Instruments Plasma Technology for advice.

5.9.1.4 Modifying an existing role

To modify the profile of an existing role:

1 Click on the name of the role. The Role Profile is displayed, see Figure 5-36.

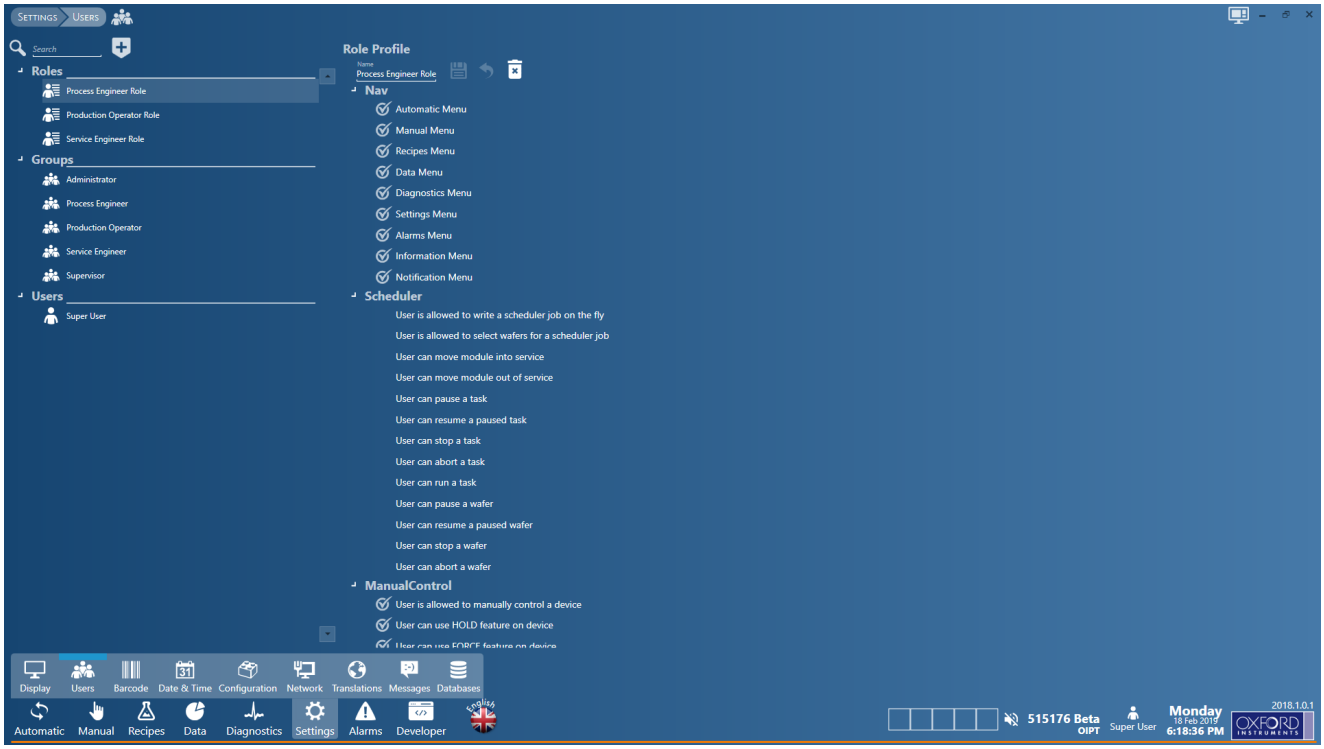

Figure 5-36 Role Profile

2 Click on an item in the profile to grant that particular facility to this role. If there is a tick already next to the facility, click to remove the facility from the role.

NOTE: The enabled facilities are assigned to a particular role, not to a particular user or group. If a facility is added or removed, it affects all users and groups assigned the role.

3 Save the changes by clicking the disk icon  at the top of the page.

5.9.2 Tool configuration

5.9.2.1 Configuring gas lines

You must only configure a gas line if you have changed a process gas or replaced a mass flow controller with one that has a different flow range. Contact OIPT for further information.

6 SCHEDULED MAINTENANCE

This chapter describes the scheduled maintenance tasks that must be performed on the **PlasmaPro®80** tool.

Before starting maintenance on the **PlasmaPro®80** tool, make sure that you read and understand the health and safety information contained in Chapter 1 of this manual.

6.1 Locking out tool services

Proper lockout and tagout procedures must always be followed when working on the equipment (see Section 1.3).

6.1.1 Locking the chamber lid

The chamber lid must be locked in the open position when performing maintenance inside the process chamber. Locking the lid ensures that the lid cannot fall if the compressed air supply to the tool fails.

1. Open the process chamber (see Section 4.3.2.1).
2. Locate the upper lid microswitch under the process chamber.
3. Using a hex wrench (Allen key), remove the microswitch actuator block.

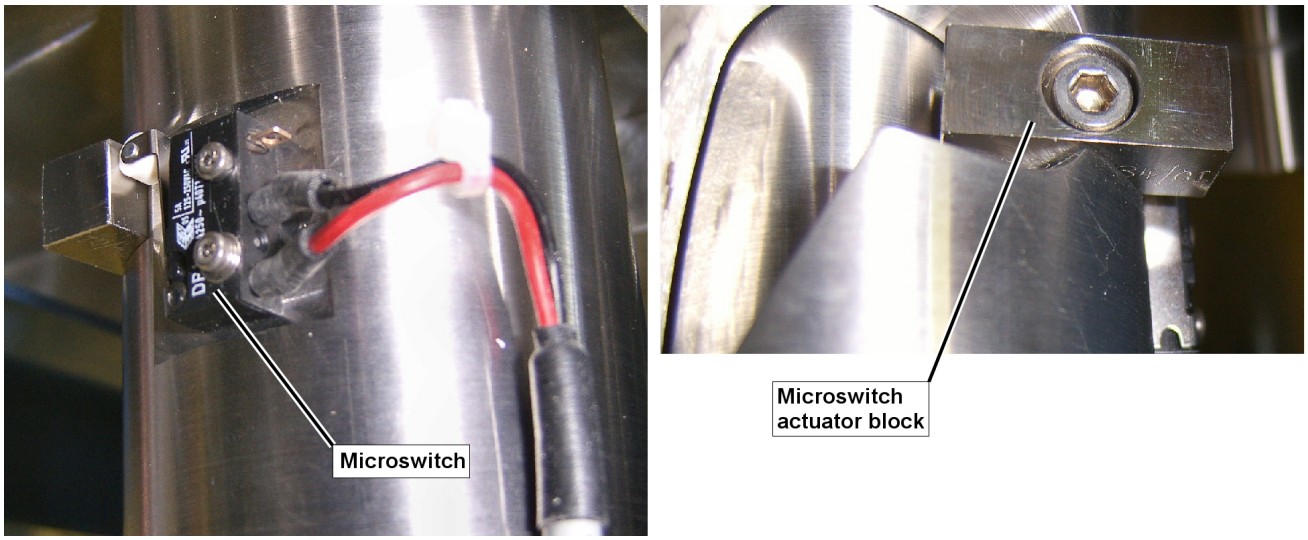

Figure 6-1 Lid upper microswitch

4 Push the process chamber lid back by approximately 30° until it locks in position.

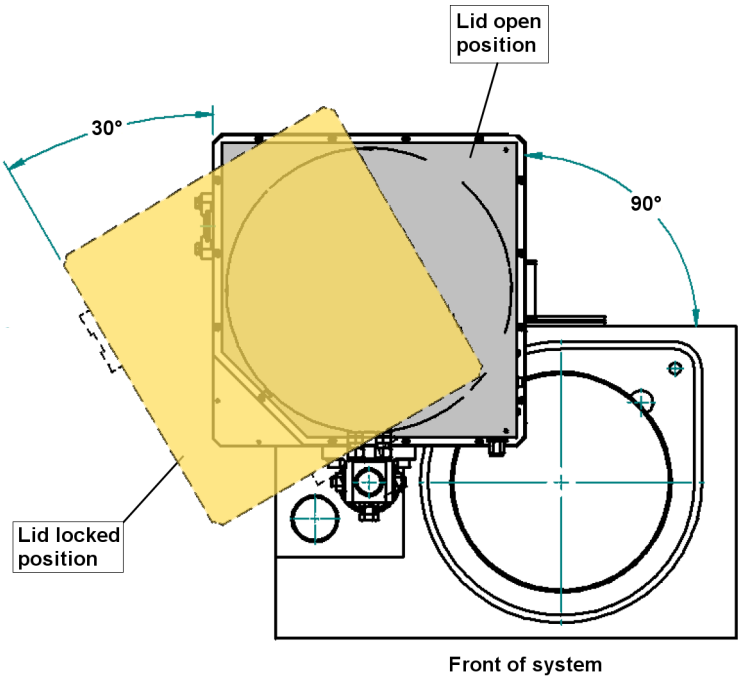

Figure 6-2 Plan view of tool showing lid locking position

6.1.2 Unlocking the process chamber lid

The process chamber lid must be unlocked for normal operation of the tool.

1 Push the process chamber lid forwards by approximately 30° until it reaches its normal open position (see Figure 6-2).

2 Refit the lid microswitch actuator block (see Figure 6-1).

3 Close the process chamber lid (see Section 4.3.2.2).

6.2 Maintenance schedule

The following tables contain a recommended maintenance schedule for the tool. The task frequencies are based on average usage and may require modification to suit a particular customer's process and duty cycle.

Some scheduled maintenance tasks must only be performed by personnel with maintenance expertise and training. Instructions for performing these tasks are beyond the scope of this manual. These tasks must be performed by Oxford Instruments Plasma Technology personnel or by suitably trained maintenance personnel.

Table 6-1 Recommended daily maintenance

Module	Task	Reference
Pumping module	Check the turbo pump temperature.	Section 6.2.1.1
PC	Archive process log files.	Section 6.2.1.2

Table 6-2 Recommended weekly maintenance

Module	Task	Reference
Overall tool	Perform a visual inspection.	Section 6.2.2.1
Vacuum system	Record the pump-down time.	Section 6.2.2.2
Base unit	Check the nitrogen regulator setting.	Section 6.2.2.3
PC	Backup recipes and system log files.	Section 6.2.2.4

Table 6-3 Recommended monthly maintenance

Module	Task	Reference
Vacuum system	Leak check the process chamber.	Section 4.5
	Record vacuum pressure for set gas flows.	Section 6.2.3.1
PC	Backup and delete old log files.	Section 6.2.3.2

6.2.1 Recommended daily operator tasks

6.2.1.1 Check the turbo pump temperature

This section only applies to turbo pump tools.

Tools and equipment

No tools and equipment are required to perform this task.

Procedure

To check the turbo pump temperature:

1 Access the process module page.

2 Check that the value displayed in the information field next to the Turbo Pump (see Figure 6-3). This value must be within the appropriate range listed in Table 6-4.

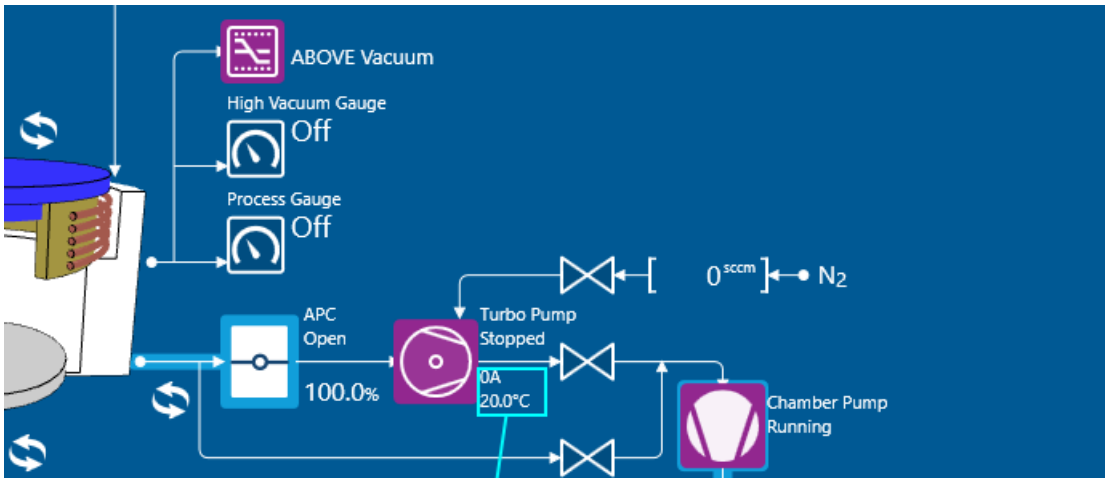

Figure 6-3 Turbo pump temperature

Table 6-4 Acceptable turbo pump temperature ranges

Turbo Pump Type	Minimum Temperature	Maximum Temperature
ATH1600MT	15°C	75°C
ATH2300MT	15°C	75°C
STP451CV	This pump has no cooling. If it overheats it shuts down automatically.	

If another model of turbo pump is fitted, consult the manufacturer's data sheet for temperature values.

3 If the turbo pump temperature is too low, adjust the water flow through the pump accordingly. Most tools have a manual valve for adjusting water flow.

6.2.1.2 Archive process log files

It is recommended that process log files are archived and deleted from the tool's PC every day. Regular archiving of these files minimises usage of the hard disc and helps to maintain the operating speed of the PC.

Tools and equipment

The following item is required to perform this task:

- Backup medium (e.g. a blank CD or a memory stick).

Procedure

To archive the process log files:

1 Open Windows Explorer on the tool's controller.

2 Navigate to the folder **C:\OIPT\DATBASES\StreamedData\<proc>**
The window will display folders containing the logfiles in date order. Copy the logfiles produced since the last backup to the backup location. Logfiles are automatically deleted after 30 days so it is not necessary to delete them from the **C:\OIPT\DATBASES\StreamedData\<proc>** folder.

6.2.2 Recommended weekly tasks

6.2.2.1 Visual inspection of the entire tool

Tools and equipment

No tools or equipment are required to perform this task.

Procedure

To inspect the entire tool.

1 Examine the exterior of the tool for signs of damage or overheating.

2 Inspect all electrical cables for signs of damage or over-heating.

3 Inspect the water connections to the tool for signs of cracking, leaks or erosion of the material.

4 Check that all indicator lamps are functioning correctly.

5 Correct any faults that are found.

6.2.2.2 Record the tool pump-down time

Tools and equipment

The following item is required to perform this task:

- Manually operated timer or watch that can display seconds

Procedure

Perform the following steps to record the tool's pump down time.

1 Ask a manager to allocate a standard base pressure value to be used for all pump down tests.

2 Access the process module page in PTIQ.

3 Click **Vent** in the **Status** panel.

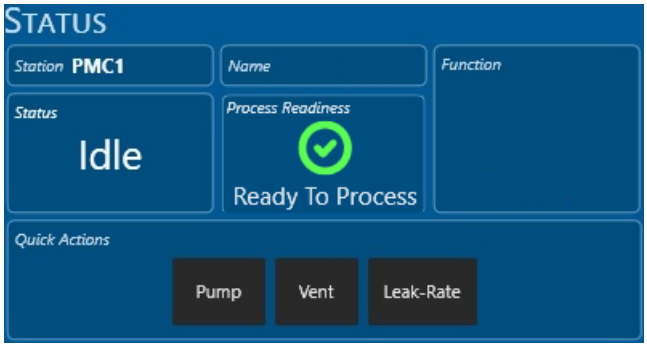

Figure 6-4 Status panel on the process module page

4 The vent sequence starts and the Status panel displays the progress of the operation (see Figure 6-5).

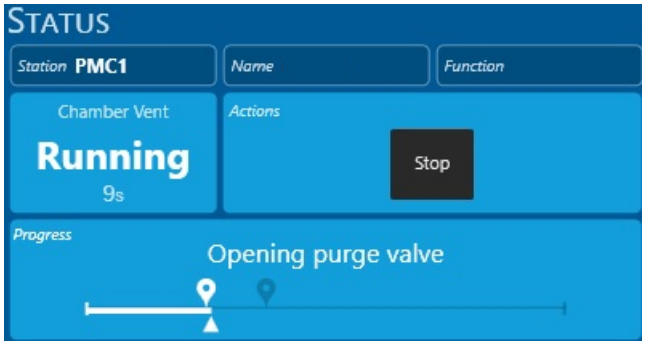

Figure 6-5 Progress panel

5 Wait until the vent and purge sequence finishes. The Status panel returns to normal and a **Task finished successfully** panel displays for a short time at the bottom right of the page (see Figure 6-6).

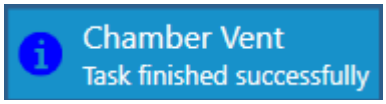

Figure 6-6 Chamber vent finished

6 Click the 

icon.

7 In the Module Actions field in the right command panel (see Figure 6-7) select the **Chamber Pump** option from the drop-down list.

8 Check or change the **Base Pressure** setting in the Options field.

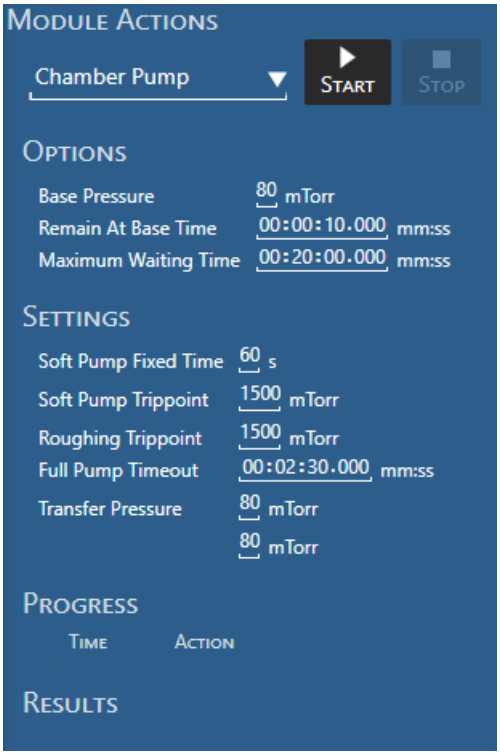

Figure 6-7 Chamber pump

9 Click **Pump** in the Status panel.

10 The pump sequence starts and the Status panel displays the progress of the operation (see Figure 6-8).

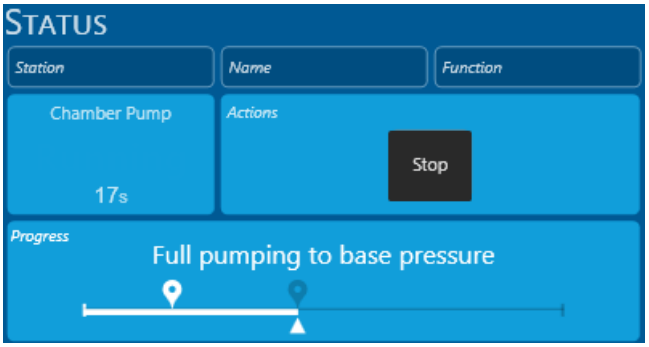

Figure 6-8 Progress panel

11 Wait until base pressure is reached. The Status panel returns to normal and a **Task finished successfully** panel is displayed for a short time at the bottom right of the page (see Figure 6-9).

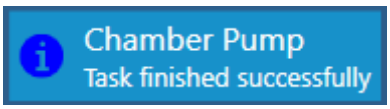

Figure 6-9 Chamber pump finished

12 Note the pumping time in the Progress field in the right command panel. Add the Rough Pumping and Full Pumping values to obtain a total pump-down time.

13 Compare this pump-down time to previously recorded values. If the pump-down time has significantly increased, investigate and correct the cause..

6.2.2.3 Check the nitrogen regulator setting

Tools and equipment

No tools and equipment are required to perform this task.

Procedure

1 Locate the nitrogen pressure gauge and regulator at the rear of the main base unit (see Figure 6-10).

2 Check that the pressure indicated on the nitrogen pressure gauge is 0.1 MPa (g) (1 bar g).

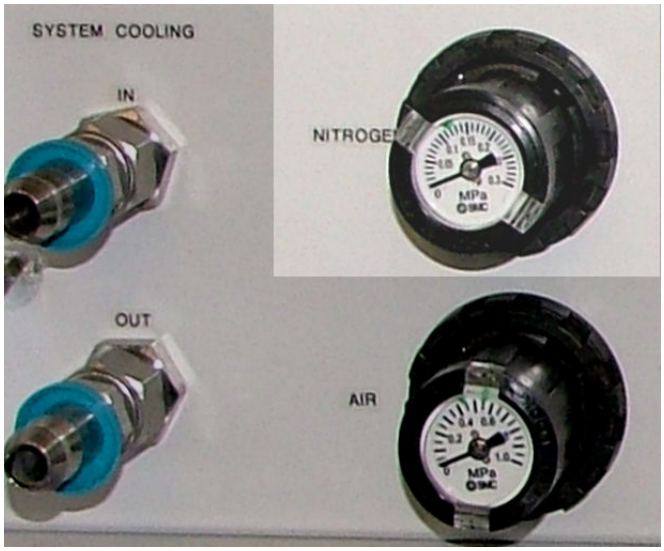

Figure 6-10 Location of the nitrogen regulator and gauge

3 If the nitrogen pressure is incorrect, adjust the nitrogen regulator until the pressure indicated on the gauge is 0.1 MPa (g) (1 bar g).

6.2.2.4 Backup recipe and system log files.

It is important to establish a regular regime for backing up files on the controller PC. The PC incorporates a CD drive which can be used to write copies of the files onto CD. Alternatively backups could be performed onto a network drive or a memory stick.

Tools and equipment

The following item is required to perform this task:

- A suitable backup medium (e.g. a blank CD or a memory stick)

Procedure

1 Open Windows Explorer on the tool's controller.

2 Navigate to the folder **D:\OPTsysIg**. The window should display two folders called **system** and **log**.

3 Copy both these folders to the archive location.

6.2.3 Recommended monthly tasks

6.2.3.1 Check vacuum pressure versus gas flow

The vacuum pressure in the chamber depends on the flow of gas into the chamber and the effective pumping speed of the vacuum system. Recording vacuum pressure for specified gas flows can identify problems with the pumping system.

Tools and equipment

No tools and equipment are required to perform this task.

Procedure

1 Evacuate the process chamber to base pressure and leave the chamber pump running.

2 Check that the APC is fully open (see Figure 6-11).

3 Note the vacuum pressure on the gauge.

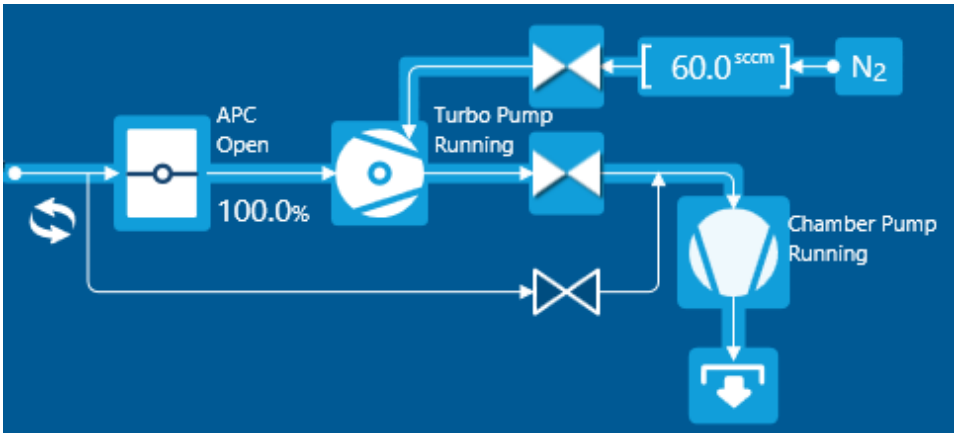

Figure 6-11 APC fully open

4 Click on the MFC to open the device panel for the gas to be used (see Figure 6-12).

5 Set the **Flow** rate then click the **On** button to start the gas flow. The LP valve automatically opens and the a light blue line on the process module page shows the gas flow into the chamber.

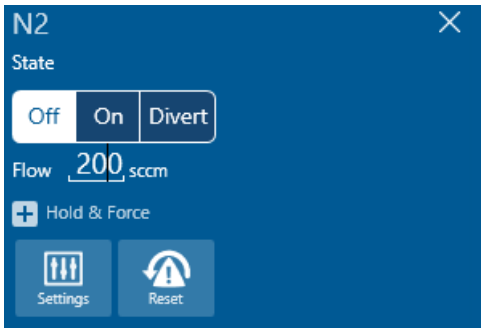

Figure 6-12 N2 device panel

6 Wait until the measured chamber vacuum pressure has stabilised.

7 Record the measured vacuum pressure.

8 Turn off the process gas flow.

9 Wait until the chamber stabilises at base pressure.

10 If the measured vacuum pressure for a particular gas flow has changed, investigate and correct the cause before processing any further wafers.

6.2.3.2 Backup and delete old system log files

It is important to establish a regular regime for backing up files on the controller PC. The PC incorporates a CD drive which can be used to write copies of the files onto CD. Alternatively backups could be performed onto a network drive or a memory stick.

Tools and equipment

The following item is required to perform this task:

- A suitable backup medium (e.g. a blank CD or a memory stick)

Process

1 Open Windows Explorer on the tool's controller.

2 Navigate to the folder where the system executable file resides (e.g. **C:\software\NGP-814961**).

3 Navigate to the folder of the form NGP-XXXXXX, where "XXXXXX" are system dependent characters.

4 Navigate to the folder system\log\. The window should display a list of logfiles of the form system YYYY-MM-DD.logfile.

5 Copy all the logfiles to the archive location and verify that all the files have copied successfully.

6 Delete all the logfiles from the **system\log** folder.

7 TECHNICAL SPECIFICATIONS

This section contains a technical specification of the entire tool. The specification tables contain a column for each possible tool configuration (i.e. RIE, RIE/PE, ICP or PECVD).

7.1 Enclosure specifications

The Oxford Instruments Plasma Technology **Plasma**Pro®80 tool enclosure has an IP rating IP 20.

7.2 Noise specifications

The maximum noise level generated by the tool is less than 80 dBa. Typically the noise level is approximately 72 dBa.

7.3 Vacuum system specifications

Table 7-1 Pumping characteristics

Description	RIE	RIE/PE	Cobra	PECVD	Units
Base pressure after pumping for one hour [1]	TBA	2.0×10^{-6}	TBA	TBA	Torr
Base pressure after pumping overnight	TBA	$<1.0 \times 10^{-6}$	TBA	TBA	Torr
Chamber leak-up rate [2]	TBA	<1	TBA	TBA	Torr/min

1. Base pressure measurements are taken with the turbo pump purge gas turned off.
2. Measured using the tool's CM gauge over 15 minutes, using a PTIQ software utility.

7.4 Standard warranty

The standard warranty guarantee period is 12 months, commencing on the sooner of the date of acceptance of the goods by the purchaser or 90 days from the date of shipment of the goods.

The warranty is subject to terms and conditions. Please refer to OIPT for full details.

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GLOSSARY

This glossary explains the acronyms, abbreviations and special terms used in this Instructions for Use Manual. The entries are presented in alphanumeric order.

The glossary includes a list of references to the documents referred to in this manual.

List of references

[1] SEMI S2 Environmental, Health, and Safety Guideline for Semiconductor Manufacturing Equipment.

[2] BS EN 61010-1:2001 (Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use. General Requirements).

[3] BS EN 61326-1:2006 (Electrical Equipment for Measurement, Control and Laboratory use. EMC Requirements. General Requirements).

[4] BS 6206:1981 (Specification for Impact Performance Requirements for Flat Safety Glass and Safety Plastics for use in Buildings).

[5] ANSI/IEEE C95.1 (IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz).

[6] Directive 2013/35/EU (minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields).

[7] Machinery Directive: 2006/42/EC.

[8] Low Voltage Directive: 2006/95/EC.

[9] Electromagnetic Compatibility (EMC) Directive: 2004/108/EC.

[10] International Electrotechnical Commission standard IEC60950-1: Safety of information technology equipment.

[11] Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2008 (RoHS).

[12] **Plasma**Pro®80 Facilities Interface Specification.

[13] **Plasma**Pro®80 Service Manual.

[14] BS EN 60204-33 Safety of Machinery – Electrical Equipment of Machines. Requirements for Semiconductor Fabrication Equipment.

Acronyms and abbreviations

AMU	Automatic matching unit.
APC	Automatic pressure controller.
BCGA	British Compressed Gases Association.
CAN	Controller area network (a computer network protocol and bus standard).
CBU	Common base unit.
CDA	Clean dry air (compressed air).
CE	Conformance Europe (a conformity mark that certifies a product has met European Union health, safety, and environmental requirements.
CM	Capacitance manometer (a type of vacuum gauge).
COSHH	Control of substances hazardous to health.
CSA	Canadian Standards Association.
CSV	Comma separated variable.
cUL	Underwriter's Laboratory (Canada).
CVD	Chemical vapour deposition.
DIN	Deutsches Institut fur Normung E.V. (the German standards institute).
DSS	Dark space shield.
DXF	Drawing exchange format (a standard Windows format for picture files).
ECR	Electron cyclotron resonance.
EIDE	Enhanced integrated drive electronics.
EMO	Emergency off
EN	EuroNorme.
ESC	Electrostatic clamp.
ETL	An internationally recognised approval mark.
FKM	A fluoro elastomer.
FFKM	A perfluoro elastomer with excellent plasma resistance.
FPM	An alternative term for FKM.
HEPA	High efficiency particle air. This term usually refers to a filter.
HF	Hydrofluoric acid. (The term high frequency is not abbreviated to HF in this manual to avoid confusion).
ICP	Inductively coupled plasma.
IEC	International Electrotechnical Commission.
IP rating	A system produced in IEC publication 529 to rate the degree of protection provided by an enclosure.
ISO	International Organisation for Standardisation.
JTAG	Joint Test Action Group (IEEE 1149).
LED	Light emitting diode.
LF	Low frequency.
LFMU	Low frequency matching unit.
LI	Laser interferometer.
LN_2	Liquid nitrogen.
MELV	Machine extra low voltage.
MEMS	Micro electro-mechanical system.
MFC	Mass flow controller.
NA	Not applicable
N/C	Normally closed.
N/O	Normally open.

OEM	Other equipment manufacturer.
OES	Optical emission spectroscopy.
OIPT	Oxford Instruments Plasma Technology.
PDL PCB	The AMU control board (PDL is a legacy term).
PE	Plasma etch.
PECVD	Plasma enhanced chemical vapour deposition.
PFA	Perfluoroalkoxy polymer.
PFPE	Perfluorinated polyether.
PID	Proportional integral derivative (a type of electronic control loop).
PPE	Personal protective equipment.
PSM	Process specific module.
PTC	Positive temperature coefficient.
PTFE	Polytetrafluoroethylene.
RCCB	Residual current circuit breaker.
RF	Radio frequency.
RIE	Reactive ion etch.
TBA	To be advised.
TFE	Tetrafluoroethylene.
TLV	Threshold limit value.
TM	Thermal management.
UL	Underwriter's Laboratory.
UPS	Uninterruptible power supply.
USI	Ubiquitous serial interface (a serial interface module for use with the U-Bus system).
VCR	A trademark of the Swagelok company. In this manual the term VCR refers to a vacuum connection system using a metal gasket as the seal.
VDE	Verband Der Elektrontechnik.
VHF	Very high frequency.
VSWR	Voltage standing wave ratio.

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