System Manual

PlasmalabSystem100

Modular Cluster System

Works Order No.: **94-219846**

Customer: **California Institute of Technology**

Typical **Plasmalab**System100 (ICP 380)

Issue 1: September 2005

System Manual

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Works Order No.: **94-219846**

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Volume 1: Operation and Maintenance Manual

This manual, Volume 1, is one of a series for the machine as follows:

Volume 1	Operation and Maintenance Manual
Volume 2	System Drawings
Volume 3	OEM Manuals

Notes:

1. Please regard this manual as part of the system.
2. Ensure that any amendment received is incorporated in the text.

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Issue 1: September 2005

OXFORD INSTRUMENTS

CUSTOMER FEEDBACK FORM

The staff at Oxford Instruments Plasma Technology are committed to continuously improving the product & services offered to you. As a valued Customer, please take a few moments to complete part 1 of this questionnaire while our service Engineer is still on your site. Part 2 may be completed upon completion of your warranty term.

Please fax to: UK Customer Service Manager, +44 (0) 1934 837001 Enquiries: Tel: +44 (0) 1934 837000

PART 1 - current installation

Characteristics		Rating (Please tick) Completely satisfied ****	Satisfied ***	Somewhat dissatisfied **	Completely dissatisfied *
Machine System	Overall quality of design				
	Overall quality of manufacture				
Process	Performance to specification				
	Process support				
	Overall quality				
Hardware	System appearance				
	System operation				
	Pump performance				
	Vacuum integrity				
	Gas pod performance				
Software	Overall satisfaction				
	Screen appearance				
	Software flexibility				
	Documentation				
General	Adequacy of service support				
	Adequacy of technical manuals				
	Adequacy of safety labelling				
	Adequacy of packaging				

Name & position : ....
Company : ....
Location : ....
Product : ..Plasmalab System 100.............Works Order No.: 94-219846
Date : ....

PART 2 - Overall satisfaction with Oxford Instruments Plasma Technology Ltd.

Characteristic	Importance rating High	Medium	Low	OPT performance High	Medium	Low
Process capability						
Reliability						
Throughput						
Maintainability						
Value (features for price)						
Vacuum/hardware performance						
Price						
User interface (Control system)						
Flexibility / options						
Company reputation						
Service and process back up						
Other (specify)						

Overall satisfaction rating: Completely satisfied Satisfied Somewhat satisfied Completely dissatisfied

Name & position : ....*(If different from part 1.)*
Date : / /

Goods Return Form

Returns No :

- This form must be completed and a copy sent to Oxford Plasma Technology Service Department by fax or mail before return of any goods to the factory. (Fax No : + 44 (0) 1934 837001)
- If return to the factory is approved a Returns Authorisation Number will be issued. This should be written in the box provided on this form and the completed form returned with the goods as part of the shipping documentation. ***It must be possible to read this form without opening the packaging containing the goods, therefore the form should not be enclosed within the packaging.***
- All sections below must be completed. If any section does not apply, mark that section "not applicable". If the information requested is not known, mark that section "not known".
- ***Any goods returned to the factory without a copy of this form carrying a Returns Authorisation Number will be considered hazardous and may be disposed of at the sender's expense. <u>Mark the returns number on all packages and supporting shipping documentation.</u>***

Equipment description.	**Serial number or identifying marking**	
	Original OPT order No :	**Date of order :**
Reason for return of part/s.	**Description of fault/s.**	
Chemical names of all materials which have come into contact with the goods.	**Precautions which must be taken when handling these materials.**	
Nature of hazard(s) presented by contact with these materials.	**Action to be taken in the event of human contact or spillage of these materials.**	
Details of any decontamination carried out prior to shipping	**Levels of residual substances left in or on the returned goods.**	
Name and address of person to be contacted in case of query.	**Tel No :** **Ext :** **Fax No :**	

Declaration Please strike through the section a) or b) which does not apply and sign the declaration.

a) I hereby confirm that the equipment detailed above has not come into contact with any hazardous substance and has been drained of any lubricant.

b) I hereby confirm that the only hazardous materials to which the equipment detailed above has been exposed are listed above and that the following precautions have been taken.

1. The equipment has been drained of any lubricant
2. All ports have been sealed and the equipment has been securely packed and labelled in accordance with Oxford Instruments Plasma Technology recommendations (available on request)
3. The carrier has been informed of the nature of the consignment.

Signed. . . . . Date. . . . .

Name . . . . Position. . . . .

Contents

Preface

This manual is the **OPERATION and MAINTENANCE MANUAL**. It provides all the information necessary for the operation and routine maintenance of the system. Certain components within the system are supplied by other manufacturers. These components have their separate manuals which are included, and should be referred to for detailed operation, maintenance and repair information.

Where this label is displayed (black text on a yellow background), read the relevant manual before proceeding to operate or maintain the labelled equipment.

Customer Support Facility

Oxford Instruments Plasma Technology has a centralised Customer Support Facility to provide a co-ordinated response to customers queries. All queries are recorded on our Support Database and dealt with as quickly as possible. If we are not able to answer the query immediately, we will contact the customer as soon as possible.

Before contacting our Customer Support Facility, please ensure that you have referred to the appropriate section of your system manual, OEM manuals and electrical drawings.

Please direct all queries through this facility and have the following details available.

System Type, e.g. **Plasmalab**System100 etc.

Works Order No. – This can be found on the front cover of your system manual.

Contact Information – Your name, Company and how we can contact you.

Details of your query – nature of the problem, part numbers of spares required, etc.

You can contact us via any of the following gateways:

Dedicated Customer Support Telephone Line: (44) 1934 837070

This line is manned during office hours (0800 to 1730 Monday to Thursday, 0800 to 1630 Friday UK Local Time). At other times, Voicemail is available on this line.

E-Mail: Support.pt@oxinst.co.uk

Customer Support Fax line: (44) 1934 837071.

1. Health and Safety

A l'attention des clients de langue française

Le document hygiène et securité est disponible en fraçais. Vous devez vous assurer que cette version est présente dans ce manual. Si elle est manquante contactez votre representant Oxford Instruments Plasma Technology.

Für deutschsprachige Kunden

besteht dieses Kapitel "Health and Safety" unter dem Titel "Sicherheit und Unfallverhütung" auch in deutscher Fassung, die in diesem Handbuch enthalten sein sollte. Falls diese fehlt, fordern Sie bitte ein Exemplar bei Oxford Instruments Plasma Technology an.

この安全概要（Health and Safety）に関しましては、日本語版もございますのでマニュアルに含まれてない場合はお問い合わせ下さい。

Contents

1.1 Introduction

This section must be read and understood before the system is approached or operated and before any maintenance work is carried out.

It is a requirement that procedures and practices taught in Oxford Instruments Plasma Technology training courses are followed.

If the equipment is used in a manner not specified by Oxford Instruments Plasma Technology, the protection provided by the equipment may be impaired.

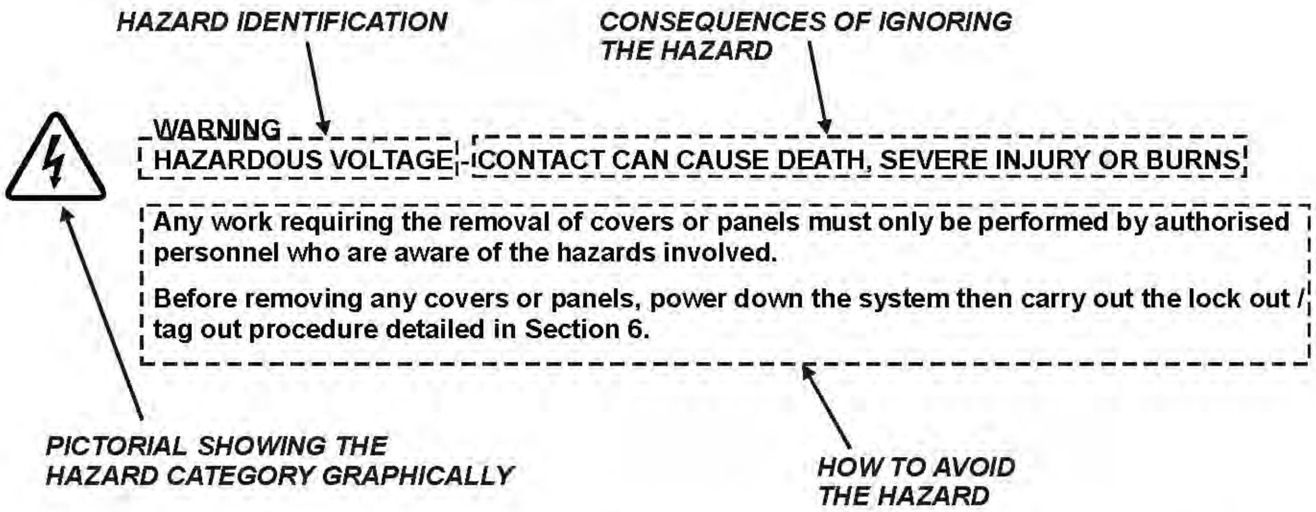
Please read this section carefully, and note that certain aspects of the system can produce more than one hazard (e.g. process gases can be a fire hazard and a toxic hazard).

Some safety features are fitted to guard against more than one hazard. In particular, note that some view ports must guard against UV light emission (sub-section 1.3.3, page 1-6), RF energy emission (sub-section 1.3.2, page 1-5) and must be fitted with implosion guards.

Note that this document is standardised and may contain warnings, which are not relevant to your particular system.

1.1.1 Warnings and Cautions

Throughout this manual **WARNINGS** are inserted in the text to draw the reader's attention to hazards. Failure to comply with a WARNING could result in death or serious injury. A typical warning is shown below:



Throughout this manual **CAUTIONS** are inserted in the text to draw the reader's attention to situations and procedures, which could cause damage to the equipment. A typical **CAUTION** is shown below:

CAUTION

Upper electrodes can become contaminated from finger marks etc.

When working on the upper electrodes, ensure that powder-free cleanroom gloves are worn.

1.2 Hazard Categories

Hazards and associated warnings relevant to Health and Safety which appear in the text of this manual and in this section will fall into the following categories:

a)	**Electrical (sub-section 1.3.1, page 1-4)**	The system carries voltages high enough to cause death or serious injury. Even when the electrical power supply is isolated, electrical energy at dangerous levels is stored by capacitors.
b)	**Electromagnetic Radiation (sub-section 1.3.2, page 1-5)**	Parts of the system produce electromagnetic radiation from audio frequencies to 2.45 GHz. This radiation can have a field strength strong enough to cause death or injury if not properly shielded.
c)	**Light (sub-section 1.3.3, page 1-6)**	Ultra Violet (UV) or Laser light may be emitted in some systems. These can cause permanent damage to the eyes or blindness if not protected by the relevant shields or filters.
d)	**High Temperature (sub-section1.3.4, page 1-7)**	Some components run at a temperature high enough to cause severe burns.
e)	**Low Temperature (sub-section 1.3.5, page 1-7)**	Components and gases at very low temperatures can cause severe 'burns' if allowed to contact the skin.
f)	**Gases (sub-section 1.3.6, page 1-8)**	Some process gases and cleaning fluid vapour may be toxic, corrosive, carcinogenic or flammable. They may also cause asphyxiation through oxygen deprivation. Gases under pressure can, if applied to the body, enter it and cause death or serious injury.
g)	**Materials (sub-section 1.3.7, page1-10)**	Some materials used in the system can become toxic during use. If this happens, then great care must be taken during maintenance to prevent death or serious injury.
h)	**Process Chemicals (sub-section 1.3.8, page 1-12)**	Some etching and deposition compounds are toxic during use, and can leave toxic residues in the system.
i)	**Vacuum (sub-section 1.3.9, page 1-12)**	Chambers or other components under partial vacuum represent stored energy, which can cause injury if released carelessly.
j)	**Compressed Air (sub-section 1.3.10, page 1-13)**	Compressed air can enter the body through the skin and cause serious injury. Pneumatically operated system components can be actuated suddenly, even when the system is not operating, causing serious injury.
k)	**Mechanical (sub-section 1.3.11, page 1-13)**	Injury can be caused by heavy components, sprung components, deposition layers under stress, embrittled wire and machinery in motion.
l)	**General (sub-section 1.3.12, page 1-14)**	Various procedures must be studied and followed. These include procedures specific to the system in question and also local and national Health and Safety standards.

1.3 Specific Hazards

1.3.1 Electrical

> **WARNING**
> **HAZARDOUS VOLTAGE - CONTACT 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 system then carry out the lock out / tag out procedure detailed in Section 6.**

1.3.1.1 Parts of the system carry high voltages, which are capable of causing injury or death. Take great care when carrying out maintenance tasks.

1.3.1.2 Do not operate the system if any of the doors, panels or covers are removed. Parts of the system may still be 'live' even when shut down by a switch, blown fuse or control function. Note that the system POWER OFF button does not isolate the main distribution panel.

1.3.1.3 Ensure that all system units are connected to electrical earth (ground). For details of the required electrical installation, refer to the 'Services Specifications for **Plasmalab** and **Ionfab** systems' document which is included at the rear of this manual's binder.

1.3.1.4 During troubleshooting and calibration, the power supplies may need to be connected with live components exposed. **This work must only be carried out by skilled personnel who are aware of the hazards involved.**

1.3.1.5 Ensure that all safety interlocks are tested before the system is used for the first time and at scheduled intervals thereafter. **These tests must be carried out by suitably qualified personnel.**

1.3.1.6 Inspect the system regularly for damaged components, e.g. cables, connectors or switches. Any components found damaged must be replaced before continuing to operate the system. Refer to the instructions in the maintenance section of this manual for details of any particular tests of the cables that may be required.

1.3.1.7 If any water leaks are detected, immediately switch the system off at the main incoming circuit breaker.

1.3.1.8 No servicing is to be carried out unless all personnel involved fully understand the danger of stored electrical energy. Refer to the lock out / tag out procedure detailed in Section 6.

1.3.2 Electromagnetic Radiation

WARNING
HAZARDOUS RF AND MICROWAVE EMISSIONS - EXPOSURE CAN CAUSE SEVERE INJURY OR BURNS

Before operating the System On button, ensure that all RF and / or microwave shielding is correctly fitted and that all connectors and flanges are in place.

1.3.2.1 Parts of the system produce electromagnetic radiation from audio frequencies to 2.45 GHz. At all frequencies within this range there is a field strength level at which radiation can cause injury. Oxford Instruments Plasma Technology specifies limits for the Electric and Magnetic field strengths within the environment of the system.

The system must be tested to ensure that radiation is within these limits, using suitably calibrated equipment. The tests must be carried out after maintenance involving RF shielding components, and routinely every three months. Refer to the instructions in the maintenance section of this manual.

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

View ports on Plasmalab systems and on certain Ionfab systems are fitted with a metal grid for shielding RF radiation. Replace this item only with the correct part, and ensure that the ports are correctly reassembled.

If a metal grid is not fitted and there is any doubt about whether one should be fitted, you must check with Oxford Instruments Plasma Technology before proceeding. If the view port has been disassembled then tests must be carried out as described in sub-section 1.3.2.1 above.

1.3.2.3 Operating the equipment with any panels removed increases the risk of RF burns. Maintenance procedures, which require this, must only be performed by skilled persons who have access to a suitable field strength meter.

1.3.2.4 Removing panels or modifying the equipment may increase the radio interference emitted by the equipment above permitted levels. This may cause nearby equipment to operate unexpectedly.

1.3.2.5 If portable transmitting equipment, e.g. radio, cellular phone, etc., is used within two metres of the equipment, the equipment could operate unexpectedly. Removing panels or modifying the equipment may increase this risk.

1.3.3 Light

WARNING
LASER RADIATION - EXPOSURE CAN CAUSE SEVERE EYE DAMAGE OR BURNS

Before operating the system, ensure that all covers are fitted correctly.

Ensure that for laser equipment, the manufacturer's instructions have been read and fully understood.

1.3.3.1 Laser equipment when handled incorrectly or in a damaged condition can seriously damage eyesight. Read and follow the manufacturer's instructions carefully. Ensure that all covers supplied by Oxford Instruments Plasma Technology or by the manufacturer are correctly fitted before the equipment is powered up.

WARNING
ULTRA VIOLET RADIATION - EXPOSURE 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.

1.3.3.2 View ports on Plasmalab systems are fitted with a clear plastic UV filter (Perspex -VE-clear-003). Replace this item only with the correct part, and ensure that the ports are correctly reassembled.

If a plastic filter is not fitted, or if there is any doubt about the type of filter that is fitted, you must check with Oxford Instruments Plasma Technology before proceeding.

1.3.3.3 The customer should be aware of the fact that view ports are available in glass or quartz. Most view ports on Oxford Instruments Plasma Technology systems are glass, but quartz is used in certain applications. Quartz view ports allow much more UV light to pass through than glass does, and so present a greater hazard. They will require very careful shielding or filtering in <u>ALL</u> situations on Plasmalab and Ionfab systems.

Be careful if the service history of the system is not fully known. It is possible that a glass view port has been changed for a quartz one.

1.3.3.4 UV light can also escape from other parts of the system, e.g. from ICP plasma sources, and downstream plasma discharge tubes. Discharge tubes of this type are often made of quartz, and so very careful shielding or filtering is needed.

1.3.3.5 UV light can produce ozone from ambient air. Detectable quantities are produced by ICP sources fitted with a quartz tube. Local extraction must be used in this case.

1.3.4 High Temperature

WARNING
HOT SURFACES - CLOSE CONTACT CAN CAUSE SERIOUS INJURY AND BURNS

Allow sufficient time for heated components (e.g. heated lower electrodes) to cool to room temperature before carrying out maintenance.

1.3.4.1 During operation of the system some components can become dangerously hot. Always allow time for these to cool to a safe temperature before handling them.

Components that become hot include electrically heated chambers, chamber liners, lower electrodes, specimen holders and halogen lamps. Items illuminated by halogen lamps can also reach very high temperatures.

Note that items such as neutralizers, ion sources, and ICP sources operate at high temperatures.

1.3.5 Low Temperature

WARNING
COLD OBJECTS - CONTACT CAN CAUSE SERIOUS INJURY TO THE SKIN AND CAN CAUSE THE SKIN TO ADHERE TO THE COLD OBJECT

Allow sufficient time for cold components (e.g. cryogenically cooled lower electrodes) to return to room temperature before carrying out maintenance.

If cold objects must be handled, ensure that suitable protective clothing is worn.

1.3.5.1 Beware of the extreme cold produced in refrigerated or cryogenically cooled systems. Contact with the skin by components at these temperatures can produce 'burns'. Allow the cooling system to reach a safe temperature before attempting any maintenance tasks.

Components that become cold include cryogenically cooled lower electrodes, cryogenic pumps and components that use liquid nitrogen.

1.3.6 Gases

Gases are used in the system for venting and purging (N2), for aiding heat transfer (e.g. helium) and for establishing the process environment (i.e. process gases).

Process gases used in the system are specified dependent on the process for which the system is designed.

The hazards presented by gases fall into one or more of the following categories:

a) Asphyxiant - replaces Oxygen causing respiration difficulties and eventually death. Examples of asphyxiants are: Nitrogen, Helium etc..
b) Flammable - can ignite in the presence of heat or arcing.
c) Toxic
d) Corrosive

The following WARNINGS may be applicable to the gases used in your system; it is your responsibility to be aware of the hazards and take the necessary precautions. Contact your gas supplier for full details.

WARNING
FLAMMABLE GASES - FLAMMABLE MATERIAL CAN IGNITE IN THE PRESENCE OF HEAT OR ARCING, CAUSING SEVERE INJURY.

After a processing run, the process chamber must be subjected to at least one vent cycle before any maintenance work is carried out.

Ensure that the gas lines have been purged before removing or loosening components.

Wear personal protective equipment as necessary.

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.

Ensure that the gas lines have been purged before removing or loosening components.

Wear personal protective equipment as necessary.

WARNING
CORROSIVE GASES - CONTACT CAN CAUSE 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.

Ensure that the gas lines have been purged before removing or loosening components.

Wear personal protective equipment as necessary.

WARNING
PLASMALAB and IONFAB SYSTEMS DO NOT PROVIDE ANY EXCESS PRESSURE REGULATION / PROTECTION FOR PROCESS GASES.

It is the customer's responsibility to ensure that suitable regulation / protection, in accordance with all applicable standards, is installed and correctly maintained external to the system.

1.3.6.1 The effluents of all Plasmalab and Ionfab systems should be considered toxic.

1.3.6.2 Ensure that effluents are extracted into a safe disposal system. The bore of the extraction pipework must be of a greater internal bore than the pump outlet. Exhaust lines carrying hazardous gases must not be used for any other purpose.

1.3.6.3 Rotary and turbomolecular pumps MUST always be nitrogen ballasted, if this feature is provided on the system. For Plasmalab deposition systems, the oil box of the rotary pump should also be purged. If a flow switch and alarm are needed on any of these lines to ensure safe operation, they must be installed and regularly maintained.

1.3.6.4 If toxic, flammable or corrosive gases are to be used, the entire system must be installed in accordance with best practice for the semiconductor production industry.

If no local guidelines are available, the regulations contained in U.S. documents UBC 9.911 (1985) and UFC 51 are recommended reading. Guidance is also contained in 'The Safe Storage, Handling and Use of Liquid Gases in the Micro-Electronics Industry' BCGA/ECIF COP CP18, ISBN 0260 - 4809, available from BCGA or ECIF.

1.3.6.5 If toxic, flammable or corrosive gases are to be used, the entire system must be situated in a purged or extracted environment with suitable gas detectors.

1.3.6.6 Gas pods supplied by OIPT incorporate a 100mm diameter extraction collar. If toxic, flammable or corrosive gases are used, extraction facilities must be connected to this collar. Purge gas extracted from the gas pod should be monitored by a suitable gas detector to give advance warning of any leakage.

1.3.6.7 Ensure that the purge gas extraction system can withstand corrosion or combustion if necessary.

1.3.6.8 Make regular checks on the vacuum integrity of the gas lines to reduce the risk of sudden leaks.

1.3.6.9 Ensure that the system is completely purged BEFORE maintenance is started and suitably leak tested AFTER maintenance is completed.

1.3.6.10 As far as practicable, shut down gas lines when not in use.

1.3.6.11 Pumps must always be operated in accordance with the manufacturers' manuals and with Oxford Instruments Plasma Technology engineers' training courses.

Pumps, when fitted with a nitrogen purging facility, must always be purged during a processing run and for a suitable period after a processing run has finished.

1.3.6.12 Where gas detectors are fitted, their responses should be verified every two weeks (refer to the manufacturer's manuals).

1.3.7 Materials

1.3.7.1 Materials used in the construction of the system are in a safe state when installed. However, fluorine-containing materials may be used as O-rings (e.g. Viton™ materials), as electrical insulation or as electrical isolation block (e.g. Teflon ™ or other tfe or ptfe material) or as lubricating grease or fluid (e.g. Fomblin™, Krytox™ or the NCI™ range from Leybold) If any of these materials are over-heated, hazardous materials are created that can result in the loss of a limb or death.

1.3.7.2 Very great care must be taken to ensure that Perfluoro-elastomer (Viton™) O-rings are not exposed to high temperatures. If overheated, decomposition takes place, producing a highly acidic residue containing hydrofluoric acid (HF).

If there is any evidence that a Viton™ O-ring could 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 protective clothing, remove the O-ring and dispose of it in accordance with local Health and Safety regulations.

(c) Wearing suitable protective clothing, thoroughly clean the contaminated area, disposing of any residue in accordance with local Health and Safety regulations.

(d) Fit a new O-ring.

(e) Investigate the cause of the overheating and review operating procedures and control systems to prevent a recurrence.

1.3.7.3 Teflon™ and other tfe materials. Very great care must be taken to ensure that Teflon™ and other tfe or ptfe materials are not exposed to high temperatures. If overheated, decomposition takes place, producing volatile fluorine containing components.

If there is any evidence that any Teflon™ or other tfe or ptfe material could 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 protective clothing, remove the decomposed material and dispose of it in accordance with local Health and Safety regulations.

(c) Wearing suitable protective clothing, thoroughly clean the contaminated area, disposing of any residue in accordance with local Health and Safety regulations.

(d) Fit a new component.

(e) Investigate the cause of the overheating and review operating procedures and control systems to prevent a recurrence.

Note that swarf and other pieces of material for disposal must be disposed of with great care and must be kept well away from fire, from cigarettes and other smoking materials.

1.3.7.4 PFPE lubricating fluids. Very great care must be taken to ensure that PFPE fluids (e.g. Fomblin™, Krytox™ NCI™ etc) are not exposed to high temperatures. If overheated, decomposition takes place, producing volatile fluorine containing components.

If there is any evidence that any PFPE lubricating fluids could 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 protective clothing, remove the decomposed material and dispose of it in accordance with local Health and Safety regulations.

(c) Wearing suitable protective clothing, thoroughly clean the contaminated area, disposing of any residue in accordance with local Health and Safety regulations.

(d) Replace with fresh grease or fluid.

(e) Investigate the cause of the overheating and review operating procedures and control systems to prevent a recurrence.

Note that all PFPE material, including spillages of fresh fluid must be disposed of with great care and must be kept well away from fire, from cigarettes and other smoking materials.

1.3.8 Process Chemicals

WARNING
SOME MATERIALS USED IN AND RESULTING FROM DEPOSITION AND ETCHING PROCESS CAN BE DANGEROUSLY TOXIC; CONTACT 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.

1.3.8.1 Some compounds used in and resulting from deposition and etching processes can be dangerously toxic. These compounds can be deposited as coatings on the inside of the chamber, pipework etc. Therefore, suitable hand and eye protection must be used.

1.3.8.2 Cleaning fluids and the gases given off from them may be toxic. Only use them in a well ventilated area and avoid ingestion.

1.3.8.3 Always use suitable eye and skin protection when handling vacuum pumps and mineral or synthetic oil. Apart from the hazards described in sub-section 1.3.7, used oils and pumps may be contaminated with dangerous chemicals.

1.3.8.4 Study all relevant Material Safety Data Sheets (MSDS), or their equivalents, before carrying out any maintenance work.

1.3.9 Vacuum

1.3.9.1 Do not enter large vacuum chambers.

1.3.9.2 Process chambers and load locks under vacuum represent stored energy. If released accidentally, this can cause injury. These spaces must be vented to atmospheric pressure before the system is powered down in preparation for maintenance.

1.3.9.3 Handle vacuum capacitors carefully; if knocked or dropped they can implode causing serious injury.

1.3.9.4 All view ports that are greater than 100mm diameter must be fitted with a clear plastic implosion eye-guard on the outside. Replace this item only with the correct part, and ensure that the ports are correctly reassembled.

If a plastic implosion eye-guard is not fitted, or if there is any doubt about the type of eye-guard that is fitted, you must check with Oxford Instruments Plasma Technology before proceeding.

1.3.9.5 Take care when opening vented vacuum vessels in case of excess pressure inside.

1.3.10 Compressed air

1.3.10.1 Retained air pressures can be at dangerous levels. Never put your hand or any other obstruction in the path of a slit or gate valve blade unless it has been made safe. Release the pressure as follows:

a) Power down the system by opening the main circuit breaker.

b) Disconnect the pneumatic supply pipes from the system.

c) Operate and padlock the lock-out valves (if fitted) on the gate valves. This will release all air pressure from both sides of the valve actuators. If lock-out valves are not fitted, disconnect the supply pipe at the point where it connects to the valve.

WARNING
AUTOMATICALLY CONTROLLED COMPONENTS CAN MOVE WITHOUT WARNING CAUSING SERIOUS INJURY

Maintenance on automatically controlled equipment must only be carried out by fully trained personnel who are aware of the risks involved.

WARNING
PLASMALAB and IONFAB SYSTEMS DO NOT PROVIDE ANY EXCESS PRESSURE REGULATION / PROTECTION FOR COMPRESSED AIR SUPPLIES.

It is the customer's responsibility to ensure that suitable regulation / protection, in accordance with all applicable standards, is installed and correctly maintained external to the system.

1.3.10.2 Before undertaking any work on the system, you must ensure that all compressed air is released. If lock-out valves are fitted, they must be operated and locked. See the section on powering down the system for more details.

1.3.11 Mechanical

WARNING
LIFTING HEAVY OBJECTS INCORRECTLY CAN CAUSE SEVERE INJURY
When handling heavy system components such as the system unit or vacuum pumps, ensure that the appropriate lifting equipment, operated by fully trained personnel, is used.

When heavy rack-mounted components are handled, ensure that the weight is safely distributed between sufficient personnel.

1.3.11.1 Injury can be caused by attempting to lift heavy components. Always ensure that suitable lifting equipment and assistance, if required, are available when removing or refitting heavy components, e.g. chamber lids, chamber doors or electrodes.

1.3.11.2 Be aware of the weight of racked units, e.g. power supplies. Do not attempt to remove heavy units from their racks unaided.

1.3.11.3 Take care when moving heavy components. Ensure that they remain stable to avoid any risk of toppling. Use any support frames or stabilizers provided when moving, installing or decommissioning equipment.

WARNING
PINCH POINT - LIMBS, FINGERS ETC CAN BECOME TRAPPED RESULTING IN SEVERE INJURY.

Ensure that all personnel are kept clear of pinch points, e.g. chamber doors, hoist mechanisms, variable height electrodes etc, while these components are moving.

1.3.11.4 Close chamber doors carefully; ensure that personnel vacate the vicinity of the door and its operating mechanism before it is closed to avoid trapped fingers etc.

1.3.11.5 Handle sprung components under compression or tension carefully, Take suitable precautions, including eye protection, before maintaining small sprung items.

1.3.11.6 Beware of machinery in motion such as robotic arms, substrate lifting mechanisms and shutters. Remember that machinery can start suddenly. Ensure that all safety guards are correctly fitted before use.

1.3.11.7 Beware of deposition layers under stress. Wear eye protection before cleaning surfaces which are coated with layers of material, as particles can be ejected with considerable force.

1.3.11.8 Handle embrittled wire, e.g. filaments, carefully. They can break and become embedded in the skin.

1.3.12 General

1.3.12.1 Ensure that local and national Health and Safety standards are studied and followed. It is the customer's responsibility to carry out their own risk assessment and to develop a safe system of work.

1.3.12.2 Ensure that all personnel who operate this equipment are trained to use the equipment, and are alerted to the range of hazards present.

1.3.12.3 When working with the equipment, ensure that there are always at least two persons present.

1.3.12.4 If a tool is used to access or alter any part of the equipment, this is classed as a maintenance action. Persons performing maintenance tasks must be skilled and trained to know and avoid the hazards present. Before carrying out any maintenance work, read the relevant manuals supplied by manufacturers of proprietary components.

1.3.12.5 Ensure that the main electrical supply, compressed air, all other gases and the water supply are disconnected before starting maintenance work (Also see sub-section 1.3.9).

1.3.12.6 Consult Oxford Instruments Plasma Technology before making any alterations to the system or changing the process gases.

1.3.12.7 Ensure that all personnel who may be expected to have access to the system during an emergency, such as firemen, paramedics etc. are familiar with the location of the main circuit breakers and valves.

1.3.12.8 Whenever any component is returned to Oxford Instruments Plasma Technology or to any of their agents, it must be accompanied by copies of the Goods Return Form (QCF 60).

1.3.12.9 Never smoke or eat in the 'clean room' or where gases are stored. In addition to the fire risks and particulate contamination presented by smoking, some chemicals when burnt generate carcinogenic or toxic compounds.

1.4 Warning and advisory labels

During manufacture, warning and advisory labels are attached to the system to indicate potential hazards and components, which should not be operated or maintained without first reading the relevant manual. Typical labels and their meanings are as follows:

	Danger of physical injury from RF radiation or from touching components within the labelled equipment.
	Danger of trapping limbs, fingers etc. in the labelled equipment.
	Danger of physical injury from the Strong Magnetic Field generated by the labelled equipment.
	Caution, hot surface IEC 417, No. 5041
	Danger of physical injury, from the labelled equipment.
	Read the relevant manual before proceeding to operate or maintain the labelled equipment.
	Danger of physical injury from RF and UV radiation from the labelled components.
	Danger of physical injury from Laser Beam generated by the labelled components.

WARNING System vent gas: Nitrogen Max inlet pressure : 5 Bar	Warns of gas type and maximum pressure, connected to the system.
WARNING Gas type: Air (compressed) Max inlet pressure : 9 Bar	Warns of gas type and maximum pressure, connected to the system.
WARNING System process gas : Max inlet pressure : 5 Bar	Warns of gas type and maximum pressure, connected to the system.
WARNING Fluid type: Water (cooling) Max inlet pressure : 4.2 Bar	Warns of fluid type and maximum pressure, connected to the system
	Caution, refer to accompanying documents. ISO 3864, No. B.3.1

Continued...

...Continued

	On (Supply) IEC 417, No.5007
	Off (Supply) IEC 417, No.5008
	Earth (ground) IEC 417, No.5017
	Protective earth (ground) IEC 417, No.5019
	Three phase alternating Current IEC 617-2 No. 020206
	Three phase alternating Current with Neutral wire.
	Warns of any voltage between 208V and 240V underneath the cover.
	When used on its own, this label warns of any voltage between 208V and 240V.

The labels below indicate the presence of high voltages within the labelled equipment. There is a danger of electric shock or burns from touching components within the labelled equipment.

2 Services (ICP 380 [variable-height table] & automatic load lock)

2.1 General

The services requirements for the **Plasmalab** System 100 are given in two appendices to this manual:

Appendix S Services Specifications for **Plasmalab** and **Ionfab** Systems. This document gives generic information and mandatory requirements for all services.

Appendix I **Plasmalab**System100 Installation Data Sheets. This document gives the information necessary to prepare the environment for the **Plasmalab**System100. Services information includes electrical power consumption and cooling water flow rates. References are made to the relevant mandatory services requirements, listed in 'Services Specifications for **Plasmalab** and **Ionfab** Systems' (see Appendix S).

Services diagrams of the **Plasmalab**System100 (ICP 380 + automatic load lock) are given in the following drawings:

SP91C24171 System 100 (ICP 380) Services flow diagram

SP91B24018 System 100 Pneumatic circuit

These drawings are located in Volume 2 of this manual. Illustrations of these drawings are also given in sub-section 2.4, page 2-4 for reference. Note that the illustrations may not be up-to-date; for accurate detail, refer to the drawings in Volume 2.

2.2 Services

For details of the services requirements, services panels, etc. refer to Appendix IDS

2.3 Distribution and use of Nitrogen vent and turbo purge gas

Nitrogen (N_2)is supplied to the system via the services panel to allow the process chamber, foreline and automatic load lock to be filled during system venting and to provide a purge gas supply to the turbo pump (if fitted). The N_2 distribution circuit is shown in the services flow diagram; see the following paragraph.

The services flow diagram of the **Plasmalab**System100 (ICP 380) are given in drawing SP91C24171. This drawing is located in Volume 2 of this manual. An Illustration of this drawing is also given at the rear of this Section.

Nitrogen enters the system at the services panel through a ¼" Swagelok bulkhead connector. It is then fed to a regulator and pressure gauge (located behind a panel to prevent unauthorized adjustment) via a stainless steel pipe. The outlet pressure of the regulator can be manually adjusted. To set up the outlet pressure of the regulator, refer to 'Operator Adjustments' in Section 5.

The outlet from the regulator is connected to:

a) A check valve (over-pressure relief valve).

b) The turbo pump purge line (if a turbo pump is fitted).

c) If a Maglev turbo pump is fitted, directly to the turbo pump (for use by the Alcatel turbo controller during system venting).

d) The process chamber vent line.

e) The foreline vent line.

f) The automatic load lock vent line.

Check valve

The check valve is installed to limit the maximum pressure that the regulator can supply. The valve is normally closed and will open at pressures above 5 psi. The outlet of the check valve is fed to the air out connector on the services panel to allow any excess nitrogen to be piped out of the cleanroom if required.

WARNING

IN A NORMALLY VENTED ROOM, THERE IS A LOW RISK OF ASPHYXIA DUE TO VENT GAS DISPLACING AIR.

USERS SHOULD MAKE THEIR OWN RISK ASSESSMENT.

DO NOT REMOVE THE CHECK VALVE OR CAP THE AIR OUT CONNECTOR; THIS WOULD COMPROMISE A SYSTEM SAFETY FEATURE.

Turbo pump purge line

The turbo purge line supplies nitrogen to the turbo pump purge gas inlet via a mass flow meter, restrictor and the turbo purge valve. The mass flow meter's readback is monitored by the PC 2000 software. If the nitrogen flow is too low, this state is detected by the PC 2000 software to display a blue system alert followed after three minutes by a red system alert and subsequent system shut down to prevent damage to the turbo pump. For details of system alerts, see Section 5 (Operating Instructions.).

The turbo purge valve is pneumatically controlled by the system software.

Process chamber vent line

The process chamber vent line supplies nitrogen to the process chamber during the venting sequence via a restrictor and chamber vent valve. The chamber vent valve is pneumatically controlled by the system software.

Foreline vent line

The foreline vent line supplies nitrogen to the foreline during the venting sequence to prevent backstreaming of vapour from the rotary vane pump. Nitrogen is fed from the regulator to the foreline via a restrictor and the foreline vent valve. The foreline vent valve is opened for a period when the primary vacuum pump is turned off.

Automatic load lock vent line

The automatic load lock vent line supplies nitrogen to the automatic load lock during the venting sequence via a restrictor and chamber vent valve. The chamber vent valve is pneumatically controlled by the system software.

2.4 Services diagrams

The services flow and pneumatic circuit are shown in the following diagrams. Note that these are typical schematics; actual components fitted depend on the options supplied.

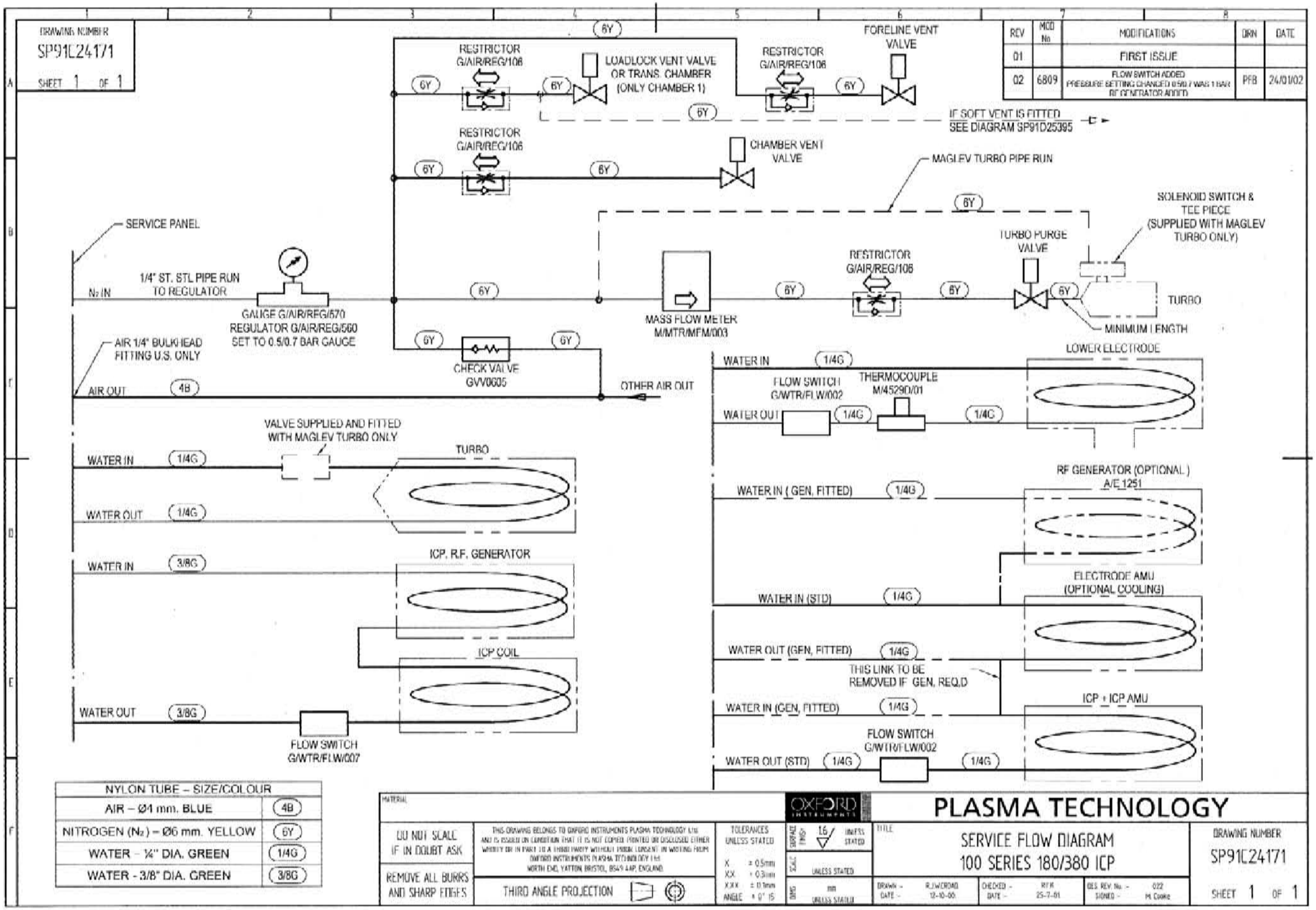


Diagram 2-1: System 100 (ICP 180/380) services flow diagram

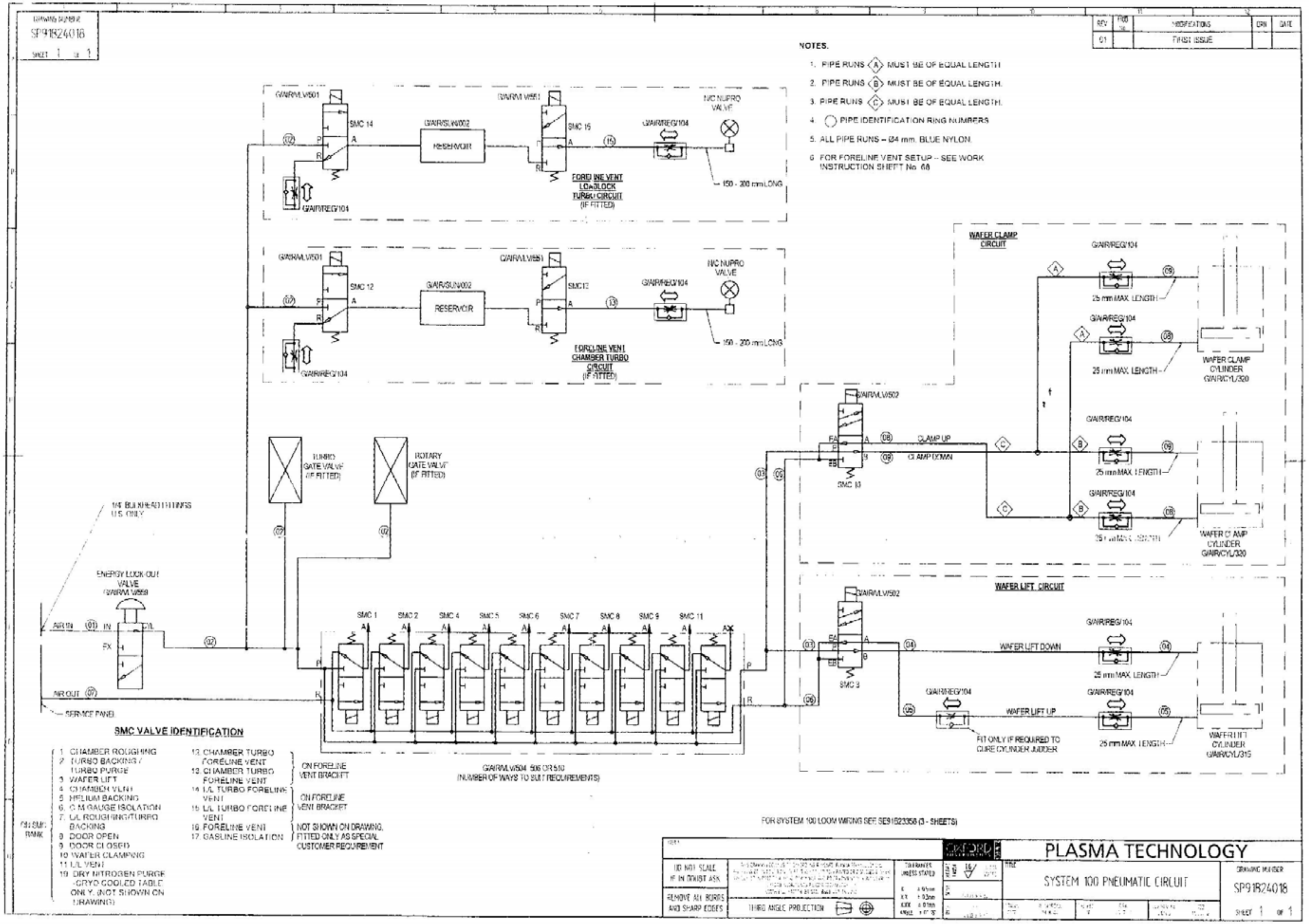


Diagram 2-2: System 100 pneumatic circuit diagram

3. Description

3.1 Introduction

The **Plasmalab**System100 is a modular plasma processing system. It can be configured to carry out Reactive Ion Etching (RIE), Plasma Enhanced Chemical Vapour Deposition (PECVD), Inductively Coupled Plasma (ICP) and Electron Cyclotron Resonance (ECR) processes.

The system can be tailored to suit different rates of throughput using transfer and load lock chambers with manual or automatic loading.

Combinations of processes can be achieved by using a transfer chamber robot to serve up to four process chambers.

3.2 PC 2000 Hardware and software with licence

3.2.1 Hardware

The system is controlled and monitored by a PC compatible computer with a Microsoft Windows Operating System. The computer is fitted with a floppy disk drive and a CD-ROM drive to allow software updates. An Arcnet interface card, for communicating with the Programmable Logic Controllers (PLCs), is fitted in one of the expansion slots. If required, a modem can be fitted to use the 'PC Anywhere' software.

3.2.2 PC 2000 software and single-user licence

The PC 2000 control software runs as a Windows-based application allowing multiple levels of system control: SYSTEMS MANAGER, SYSTEMS ENGINEER, PROCESS DEVELOPER, MAINTENANCE ENGINEER, PROCESS EDITOR and OPERATOR, all of which are accessed by password entry.

The system status is displayed on graphic mimic diagrams with all operational parameters and status displays accessible through pop-up windows selected using the mouse. All the major process parameters are accessible from the recipe and process step set-up pages, including definition of gases on each line and calculation of mass flow settings in sccm's. The software includes data logging to disk of user-selectable run-time process parameters for off-line verification and analysis of process conditions.

Processing recipes can be formulated and stored in the computer and the system can be run in fully automatic mode using the recipes. Alternatively, the system can be run in the manual mode with each phase of the process controlled and initiated separately. All the parameters can be monitored in real time using the PC 2000 software.

3.3 94-100-BW-3FCBL Base wired 3-frame kit

The **Plasmalab**System100 process module base unit houses the process chamber, electronic sub systems, control units, services and power supplies.

The module is mechanically MESC compatible and is constructed using proven Oxford Instruments Plasma Technology hardware designs.

The system is fully interlocked to protect the system hardware from service failure and to protect the operator from electrical shock during maintenance procedures. A lock out valve and associated padlock, mounted on the frame, can be used to prevent operation of all pneumatically operated devices during servicing.

3.3.1 Frame

The frame is constructed from steel with removable access panels. Casters and adjustable feet fitted to the bottom of the frame enable it to be easily manoeuvred, then levelled and locked into position.

3.3.2 Power box assembly

The power box assembly is mounted on the outside of the frame. This distributes mains power to the +24V and ±15V power supply unit, the frame mounted electrical units and the remote auxiliary units. For circuit details of the unit, refer to the relevant drawing in Volume 2 of this manual.

A 24V EMO (Emergency Off) circuit connects all the EMO buttons mounted externally on the machine. If any of these EMO buttons are pressed in, all the power outputs from the power supply boxes are disabled.

NOTE: Freestanding auxiliary units such as water recirculators, Residual Gas Analysers, and the system control PC, are not powered via the base unit power box. These require dedicated electrical service points. These accessories remain live when the system EMO is pressed.

If it is required that all accessories are powered off when the EMO is pressed, the user must supply a power distribution unit with outlets for the accessories, and contact the factory for electrical access to the machine EMO circuit.

3.3.3 System controller

The system is controlled from a remote IBM compatible PC computer terminal using Oxford Instruments Plasma Technology's 'PC 2000' software via a Programmable Logic Controller (PLC) housed in the base unit. See Fig 3.1.

Communications between the PC and PLC are via an Arcnet serial link and between the PLC interface PCB and the Controller Area Network (CAN) modules are via a CAN bus.

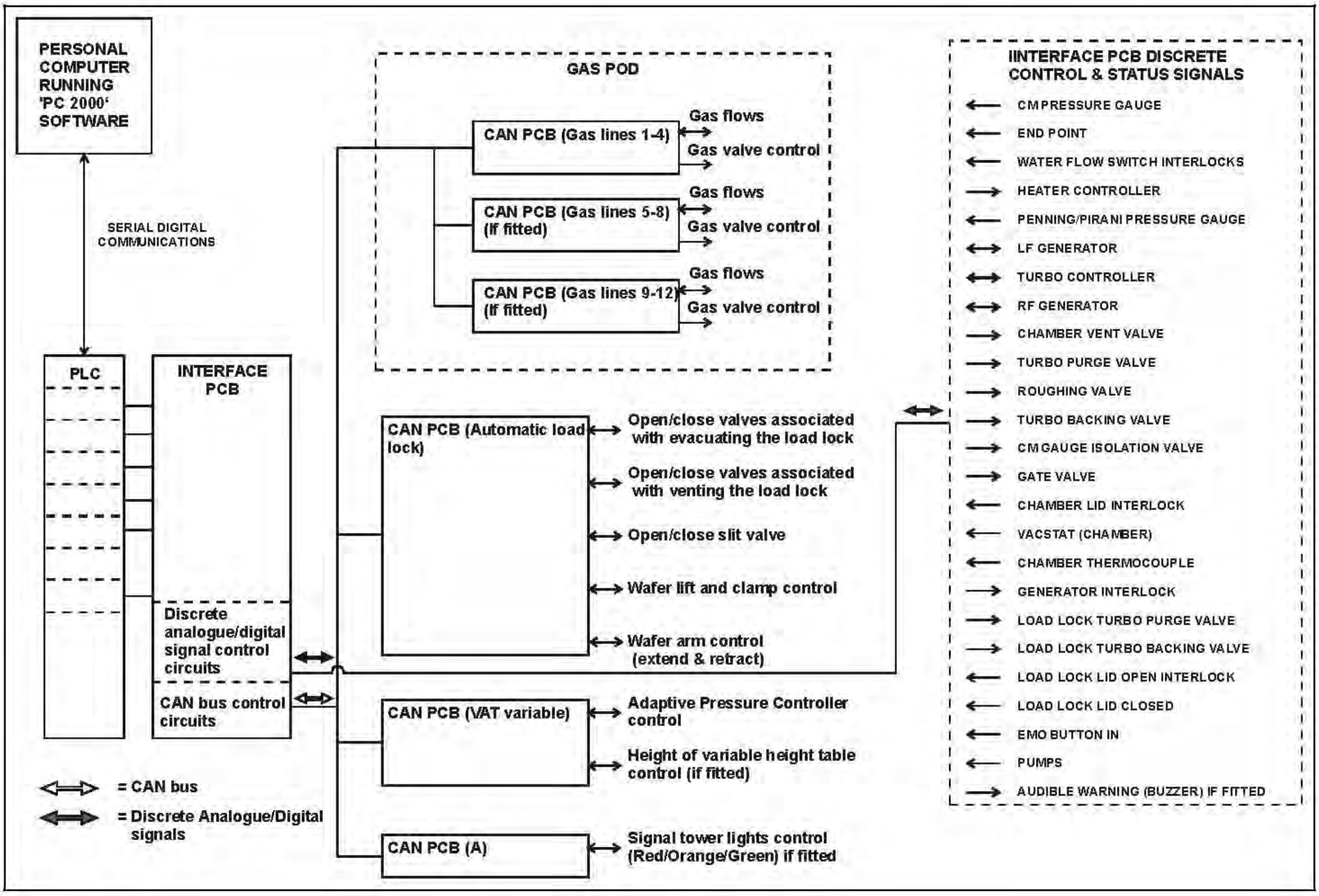


Fig 3.1: Typical control system

The system may be run from the PC terminal in manual mode, that is using direct 'real time' control over the process, or in automatic mode where the system performs the entire process according to previously entered recipes. The extensive Oxford Instruments Plasma Technology process library supports all **Plasmalab**System100 configurations. A full description of the 'PC 2000' control instructions is provided in Section 5.

For details of the control wiring, see the relevant drawings in Volume 2 of this manual.

3.4 PLC interlock chain

3.4.1 General description

The interlocks form a continuous 24Vdc chain, which must be complete before the process gases and RF power supplies are enabled. An output to disable external devices unless the lid/ hoist is closed is also provided; this is typically used to disable a lid-mounted endpoint detector laser.

The interlock chain is monitored by the software, but acts independently. It is also supplemented by machine protection sensors, which operate only via the software.

To enable RF power:

- The 600 mbar vacuum switch ('Vacstat') must be at low pressure
- The process chamber lid must be shut (or its hoist down)
- The primary process pump must be running

- The primary process pressure gauge (normally a capacitance manometer) must be on scale
- The load lock inter-chamber valve (where fitted) must be closed
- Customer-supplied external alarm devices must be in their safe state
- The inert gas purge to the primary process pump must be flowing.

To enable process gases:

- RF power must be enabled
- The gas box lid must be shut
- Specific gases can be set in the gas box hardware to be mutually exclusive, so that they cannot be turned on together.

Machine protections fitted where appropriate:

- A nitrogen pressure switch, to detect adequate purge pressure to turbomolecular pump bearings.

OR:

- A nitrogen flow meter, to detect purge gas flow to pump bearings.

- Water flow switch(es).

RF enable interlock chain details are given in Table 3.1; Refer to drawing SE00A26865 (PC2003 interface schematic).

INTERLOCK	DEVICE	PCB input	PCB1 LED	Link out	Comments
Vacuum Switch	Vacuum Switch	BLK17	11	NONE	Pressure below 600 mBar
Hoist /Lid	a) Air cylinder switch/microswitch or b) Guardmaster Switch N/O Switch	BLK18 BLK19	12 13	NONE	Lid closed or hoist down. Enables end point laser via JP51
Primary pump running	Current monitor in Power Box	JP44	6	15	Interlock disabled if an independent/dry pump fitted
Process pressure gauge on scale	Capacitance Manometer (e.g. Baratron™)	JP16	5	NONE	Analogue input below 11.5V. Switches comparator U5.
Spare interlock 1	External Voltage Free contact or 24V DC input to PCB	JP52	14	Can be bypassed using LK19	Customer-supplied device. Volt free contact JP52 pins 1 and 4. OR 24V DC input JP52 pin 4.
Spare interlock 2 Or Load lock valve	External Voltage Free contact Inter-chamber valve must be shut	JP53	15	20	Customer-supplied device Or Used on 100 and 133 systems
Process pump purge	Gas Flow Switch at Primary Pump	JP55	16	LK21A	Fit LK21B if fitted

Table 3.1: RF enable interlock chain details

If above satisfied, then 24V is at BLK20, 21 & 22 pin 1. This enables the K4 contactor to supply power to the RF Generator.

3.4.2 Gas box interlocks

Refer to drawing: SE81B26657 (PC2003 gas pod loom).

To enable process gases, the RF interlock chain must be complete. The gas box interlock is shown in Fig 3.2.

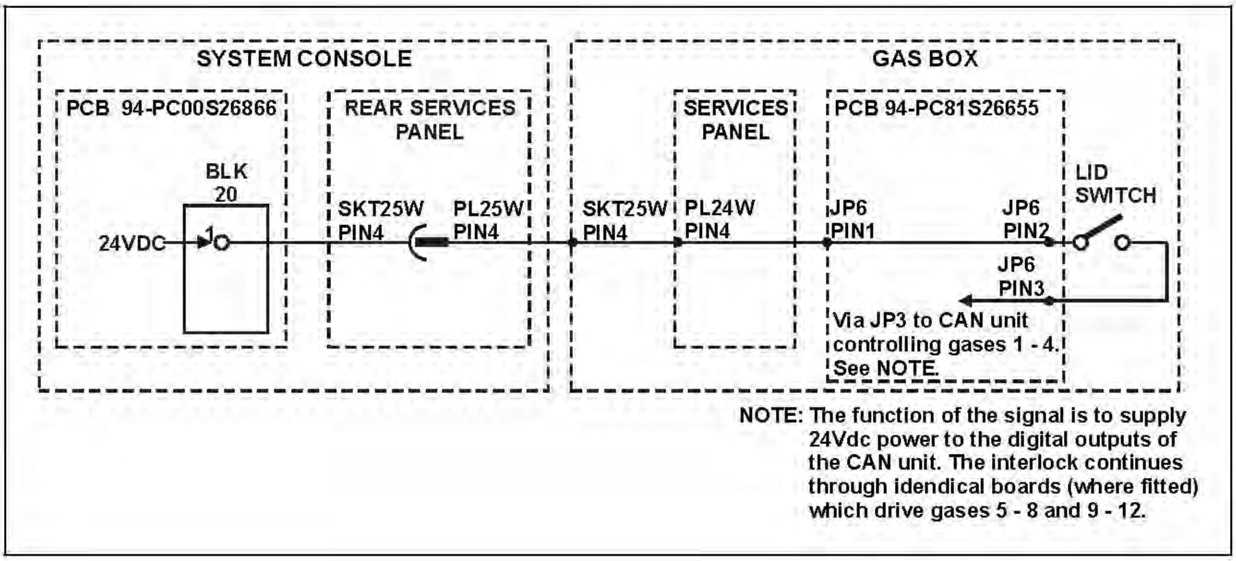


Fig 3.2: Gas box interlock chain

3.4.2.1 Incompatible gases

	1st PCB Gas	2nd PCB Gas	3rd PCB Gas	Type A	Type B	Type X
1st Gas	1	5	9	LK3A + 4	LK3B	LK3A
2nd Gas	2	6	10	LK5A + 6	LK5B	LK5A
3rd Gas	3	7	11	LK7A + 8	LK7B	LK7A
4th Gas	4	8	12	LK9A + 10	LK9B	LK9A

Gases are designated as one of three types:

Gas type A: Typically oxidising gases (e.g. oxygen)
Gas type B: Typically fuel gases (e.g. hydrogen)
Gas type X: Gases normally miscible with most other gas types.

If ANY gas Type A is enabled, then ALL gas Type B lines are disabled.

Table 3.2: Incompatible gases

The gas box has a facility to prevent incompatible gases from being enabled simultaneously, using soldered links.

3.4.2.2 System Link Configuration Table

NAME	FUNCTION	NOTES
LK1	ANALOGUE 0V TO CHASSIS	
LK2	DIGITAL 0V TO ANALOGUE 0V	
LK3	NON – CONTROLLER CRYO ENABLE	
LK4	HEATER SNAP SWITCH BYPASS	
LK5	FIT IF NO OEM CONTROLLER	
LK6 A/B	LK6A = NON PM140 ENDPOINT LK6B = PM140 ENDPOINT	SEE LK7 A/B
LK7 A/B	LK7A = NON PM140 ENDPOINT LK7B = PM140 ENDPOINT	SEE LK 6 A/B
LK8	+24V DC TO RL2 COM1	
LK9	+24V DC TO RL2 COM2	
LK10	+24V DC TO RL6 COM1	
LK11	+24V DC TO RL6 COM2	
LK12	+24V DC TO RL7 COM1	
LK13	+24V DC TO RL7 COM2	
LK14 A/B	LK14A = NON DRY PUMP FITTED LK14B = DRY PUMP FITTED	
LK15	PUMP CURRENT BYPASS	
LK16	+24V DC TO RL8 COM2	
LK17	NON – CONTROLLER HEATER ALARM	
LK18	NON – CONTROLLER HEATER ENABLE	
LK19	SPARE INT/LOCK 1 BYPASS NOT FITTED 100/133	
LK20	SPARE INT/LOCK 2 BYPASS	
LK21 A/B	LK21A = PURGE SWITCH NOT FITTED LK21B = PURGE SWITCH FITTED	

Table 3.3: System link configuration

3.4.2.3 System LED Monitoring Table

NAME	COLOUR	MONITORING
LED1	GREEN	+24V DC
LED2	RED	+15V DC
LED3	YELLOW	-15V DC
LED4	GREEN	+5V DC
LED5	RED	CM COMP OK
LED6	RED	PUMP CURRENT SWITCH
LED7	RED	N2 PRESSURE SWITCH
LED8	RED	WATER ONE
LED9	RED	WATER TWO
LED10	RED	WATER THREE
LED11	RED	VAC STAT
LED12	RED	RL10 (HOIST CONTROL)
LED13	RED	HOIST
LED14	RED	SPARE INTERLOCK 1
LED15	RED	SPARE INTERLOCK 2
LED16	RED	PUMP PURGE SWITCH
LED17	RED	RL15 (MASTER/SLAVE) ACTIVE SLAVE

Table 3.4: System LED monitoring

Note that when the interlock chain is complete, all LEDs are illuminated.

3.4.3 Services

For details of the services required for the base unit, refer to Section 2 of this manual.

3.5 94-100-3-41C ICP 180 chamber kit with gate valve

The ICP chamber kit comprises the following components:

Process chamber.

Pumping port isolation valve and automatic pressure controller suitable for use with a turbomolecular pump.

The ICP process chamber, shown in Fig 3.3, is machined from a single aluminium block with the minimum number of O-rings to provide the highest vacuum integrity.

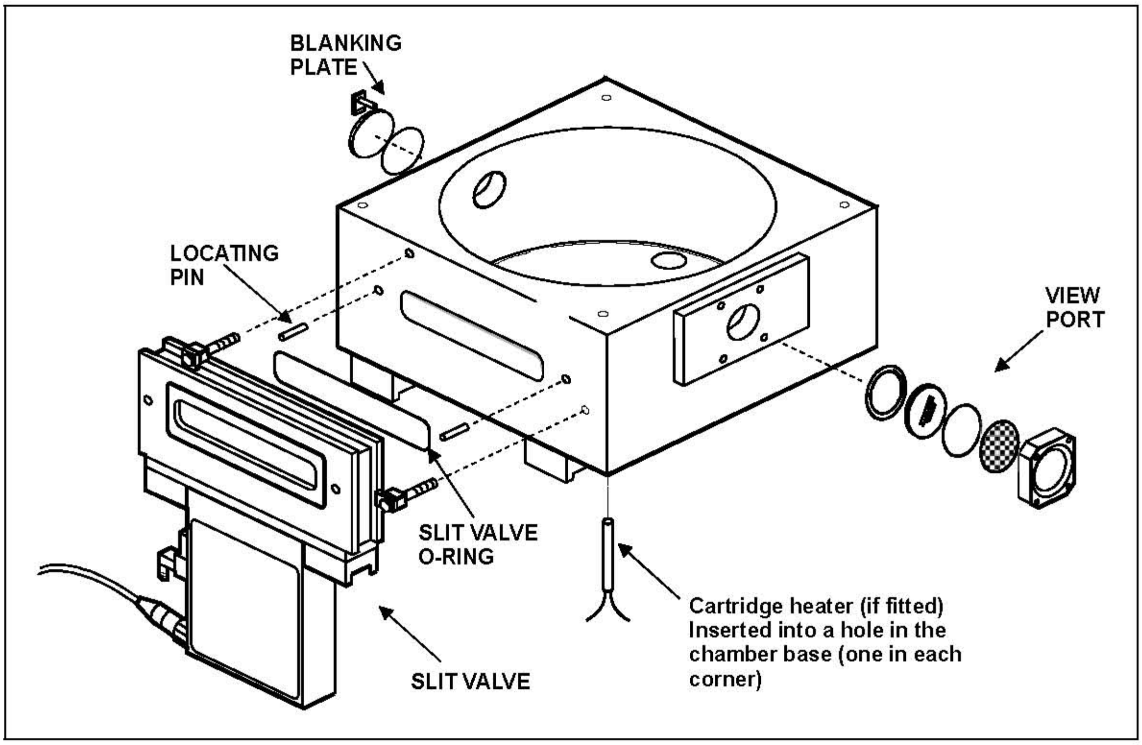


Fig 3.3: 94-100-3-41C process chamber

The chamber is fitted with the following ports:

a) Single view port fitted with an RF shield for viewing the plasma. Note that the view port is mounted on a blanking plate, which can be removed to provide access to the chamber interior.

b) Pumping port.

c) Wafer transfer port to which is attached a pneumatically operated gate valve.

d) Wafer clamp port.

e) Process gas inlet port.

f) Two ports for the connection of vacuum measurement components.

The pneumatically operated gate valve, for connecting to the selected wafer insertion device, is attached to the chamber by six claw bolts and is positioned by two locating pins (dowels). Sealing is provided by a rectangular O-ring.

WARNING

IF THE PROCESS CHAMBER TEMPERATURE IS SET TO A VALUE ABOVE 60°C, CONTACT WITH IT CAN CAUSE BURNS.

BEFORE OPERATING THE CHAMBER ABOVE 60°C, ENSURE THAT EXTERNAL HEAT SHIELDS ARE FITTED.

3.5.1 94-100-3-00/38 Process chamber electrical heating kit

The electrical heating kit comprises four cartridge heaters; inserted into holes at the corners in the base of the process chamber, see Fig 3.3. Heater control is via a unit mounted on the console, where the temperature can be set manually. A temperature in the range 50°C to 60°C is recommended for most processes.

WARNING

IF THE PROCESS CHAMBER TEMPERATURE IS SET TO A VALUE ABOVE 60°C, CONTACT WITH IT CAN CAUSE BURNS.

BEFORE OPERATING THE CHAMBER ABOVE 60°C, ENSURE THAT EXTERNAL HEAT SHIELDS ARE FITTED.

3.5.2 94-100-3-00/13 200mm Pumpdown pipe heater kit

This heating kit is applied to the pump-down pipe to give optimum vacuum performance and to minimise the deposition of loosely adherent material, which might generate particulates.

3.6 100-5-11A Variable-height, cryo/heated, helium-assisted lower electrode

3.6.1 General

The RIE lower electrode is shown in Fig 3.4. The table is fitted with an integral dark space shield from which it is insulated by an isolating ring. The table support tube is mounted on a flange located at the bottom of the pump-down pipe. The lower electrode is heated by an embedded element and cooled by liquid nitrogen flowing through embedded tubing.

In some systems, the table top plate is fixed to the table by a ring of cap-head bolts. If your system has a table of this type, refer to the following text and note.

The bolt heads are concealed behind screw covers, which require a special tool (supplied with the system) for removal. (Tool part number: MD91D21726.)

NOTES: 1) When re-fixing the table top, do not over-tighten the bolts which will cause the table top to bow. Check with a straight edge after tightening: if the table top is not flat, release the bolt tensions until it is.

2) The screw covers (MD91D21723) are aluminium. When removing the covers, it is recommended to use a little iso-propyl alcohol (IPA) to prevent the thread from jamming.

The lower electrode is provided with the following features:

Wafer lift: When a wafer is transferred into the process chamber on the transfer arm, the wafer is lifted from the arm and lowered to the surface of the lower electrode. On completion of processing, the wafer is lifted from the surface of the lower electrode and then lowered onto the transfer arm. See sub-section 3.6.2.

Wafer clamp: Holds the wafer in position on the surface of the lower electrode. The wafer is clamped sufficiently to ensure adequate heat transfer from the surface of the lower electrode to the wafer. See sub-section 3.6.3.

Helium backing: Sets the temperature of the wafer close to that of the temperature-controlled table by heat transfer. See sub-section 3.6.4.

Variable height mechanism: Raises the lower electrode to allow the wafer to be processed at varying distances from the ICP source. See sub-section 3.6.5.

3.6.2 Wafer lift

The wafer is lifted clear of the table (15mm) for transferring into a load lock or transfer chamber by the wafer lift assembly. Compressed air flowing into the air cylinder forces its piston and plunger upwards. The plunger contacts the base of the bellows, which is connected to a push rod. The wafer support, mounted on top of the push rod, rises lifting the wafer clear of the table. The push rod is lowered by the force exerted by the return spring.

3.6.3 Wafer clamp for variable-height lower electrode

The wafer clamp for the variable-height lower electrode comprises three clamp assemblies attached to the outside of the dark-space shield, and a clamping ring.

Each clamp assembly comprises a spring loaded plunger. The plunger is mounted in a bearing attached to the side of the dark-space shield and is free to move vertically depending on the tension of the spring. Its top is attached to the clamping ring and its bottom protrudes below the dark space shield.

When the lower electrode is in a raised position, i.e. during wafer processing, the clamp assemblies' springs extend to bring the clamping ring in contact with the wafer thus holding it in position.

When the lower electrode is in its lowered position, i.e. ready for wafer transfer, the bottom of each clamp assembly plunger contacts the base of the process chamber compressing its spring. This forces the clamping ring to rise 20mm above the wafer to allow the wafer lift to move the wafer to the wafer transfer position.

Wafers can only be transferred when the table is at the load height. Wafers are clamped for all heights greater than 20mm above the load height.

3.6.4 Helium backing

The purpose of helium backing is to set the temperature of the wafer close to that of the temperature-controlled table by heat transfer. Helium is fed from a small hole in the table underneath the wafer (which is clamped to the table) from where it flows radially to the periphery of the wafer. Helium is the preferred gas, because it has a very good heat transfer ability. The use of other gases is possible, preferably inert gases.

The supply of helium is fed by a pressure control device, which receives an analogue setpoint from the machine's control system. The pressure control device adjusts the gas flow through itself to control the pressure at its output side. The pressure is controlled within the range 0 to 20 Torr. A pressure of greater than 20 Torr could damage the wafer.

If the wafer is clamped down successfully, the chamber pressure will show a slight rise of a few milliTorr when the helium is producing a pressure of 10 Torr on the wafer.

If there is a massive pressure rise and the Turbo Controller display shows a high load, then the wafer is insufficiently clamped and in order to achieve the set pressure the controller is using an excessive gas flow.

The helium pressure is released into the process chamber at the end of a process (using a normally-open valve). This prevents the wafer moving when it is unclamped.

Tip: ***Finish a process with a ten-second pumping step without helium. This will reduce wafer mishandling.***

A flow meter in the helium supply also reads the gas flow necessary to maintain the pressure. A typical process uses 5 - 20 sccm to maintain 10 -15 Torr behind the wafer.

Tip: ***Some wafers mate very well with the electrode top surface and use less than 2 sccm to maintain 10 Torr. This can give a control problem, with the helium feeding in pulses. Roughening the aluminium electrode with an abrasive pad can increase the helium flow by a few sccm and allow proper control.***

Do not turn on the helium unless the wafer is clamped.

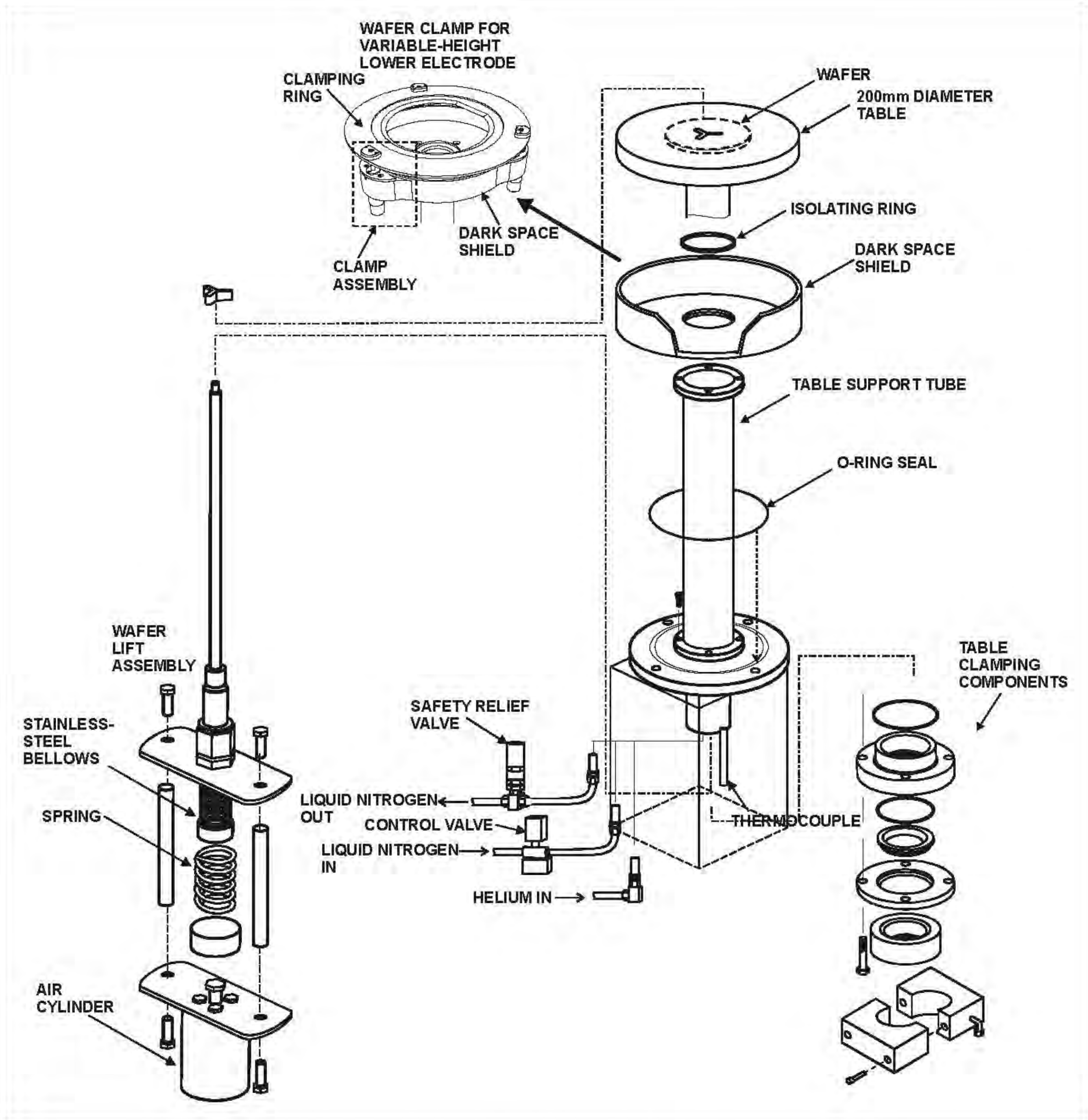


Fig 3.4: 100-5-11A Variable-height, cryo/heated, helium-assisted lower electrode

3.6.5 Variable-height mechanism

The variable-height mechanism, shown in Fig 3.5, allows the lower electrode to be raised from the wafer transfer path level to a maximum height of 150mm above it. This enables the wafer to be processed at varying distances from the ICP source.

The mechanism comprises a support assembly, a linear bearing, a lifting assembly and a linear actuator.

The support assembly, attached to the base of the chamber, carries the linear bearing which is attached to the lifting assembly. The lifting assembly is attached by a collar to the lower electrode and is also attached to the linear actuator arm.

To raise the lower electrode, the system controller sends a demand signal to the linear actuator which moves its arm in the upward direction causing the lifting assembly to move upwards, guided along the linear bearing. Vacuum integrity is provided by the stainless steel bellows attached between the bottom of the pump-down pipe and the lifting assembly.

The amount of travel is restricted by limit switches, contained within the linear actuator, which disconnect the arm drive when the end-of-travel is reached in either direction. The top of the linear actuator is attached to the bottom of the process chamber via a trunnion mounting to allow freedom of movement. The linear actuator arm is attached to the lifting assembly via a trunnion bearing to allow freedom of movement.

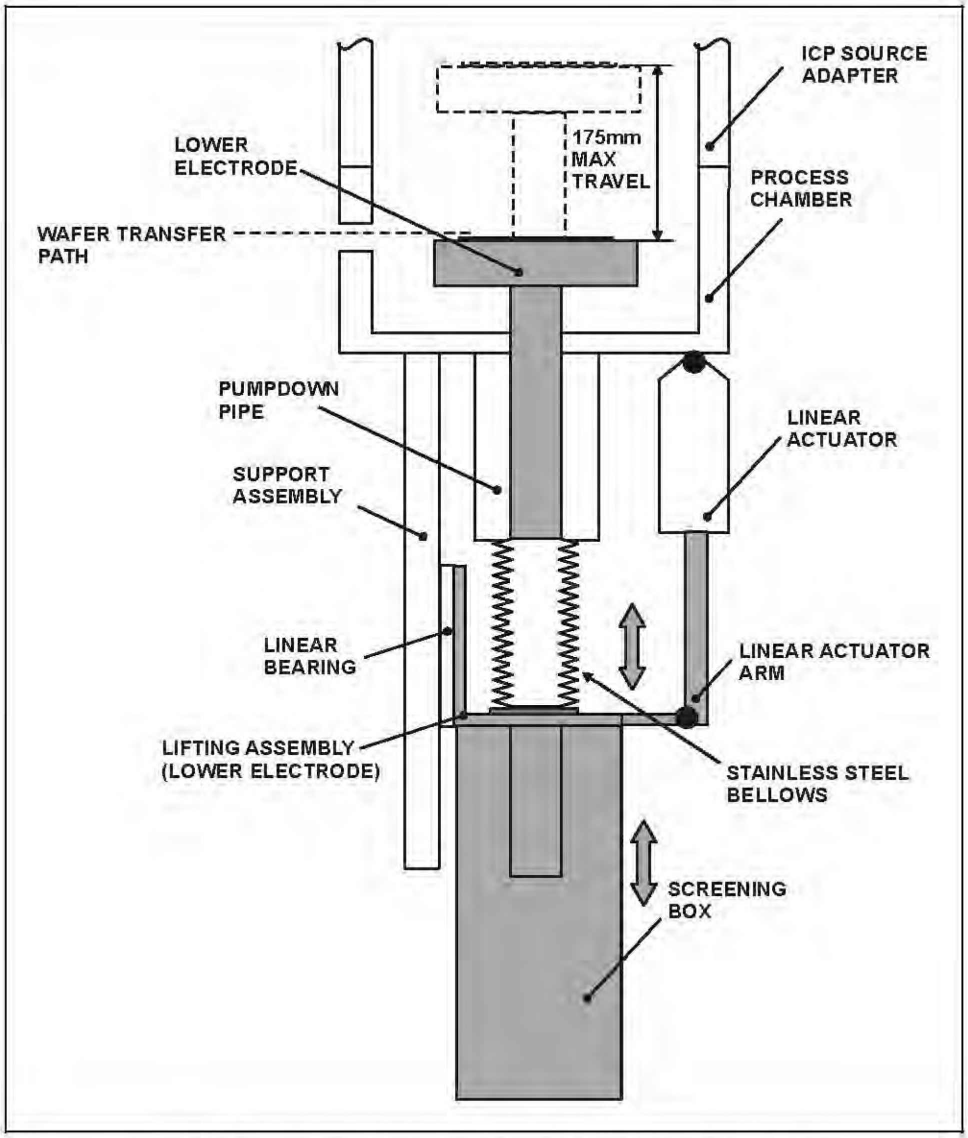


Fig 3.5: Lower electrode variable-height mechanism (simplified)

3.7 94-100-6-300EHA 300W RF generator / OIPT AMU kit

This kit comprises a Dressler 300W RF Generator and an OIPT Automatch Unit.

The RF generator produces a 13.56MHz output, which is fed via the automatch unit to the lower electrode to produce the plasma. The automatch unit adjusts the impedance of its output to match the impedance of the lower electrode to ensure maximum power transfer.

For details of these units, refer to the manufacturer's literature in Volume 3 of this manual.

The automatch unit can be manually adjusted if necessary, see the process chamber page description in Section 5 of this manual.

3.7.1 100-6-70 ICP 380 Inductively Coupled Plasma Source

380mm diameter Inductively Coupled Plasma source giving uniformity suitable for use with wafers up to eight inches in diameter. Complete with 5kW 2 MHz RF generator, interferometer port and automatic matching unit. Alumina discharge chamber provided according to process specification.

For full details of this source, refer to the separate manual supplied with the system (located at the rear of this manual).

3.8 Vacuum system

The vacuum system is shown in Fig 3.6.

The process chamber is pumped by an Alcatel ATH1300MT turbomolecular pump via an Automatic Pressure Controller (APC). The turbomolecular pump is backed via an isolation valve by an Edwards IQDP80 dry pump.

The process chamber process pressure is measured by a temperature compensated 100-mTorr Capacitance Manometer gauge. Note that the CM gauge output does not stabilise until it has been switched on and under vacuum for 15 minutes.

Base pressure is measured by an active Penning gauge, which is disabled at pressures above 10 mTorr.

A Vacuum Switch monitors the chamber pressure. When the pressure falls below 600 mbar, its contacts close to enable the 24V process line and allow the process gases and the RF to operate.

The automatic load lock is pumped by an Edwards scroll pump. A Pirani gauge measures pressure.

The load lock is fitted with a soft pump valve (SMC Series XLD), which is designed to reduce disturbance of particles due to turbulence when evacuating the load lock. Refer to Appendix SP for details of the operation and adjustment of this valves.

For details of the vacuum pumps and gauges, refer to the manufacturer's literature in Volume 3 of this manual.

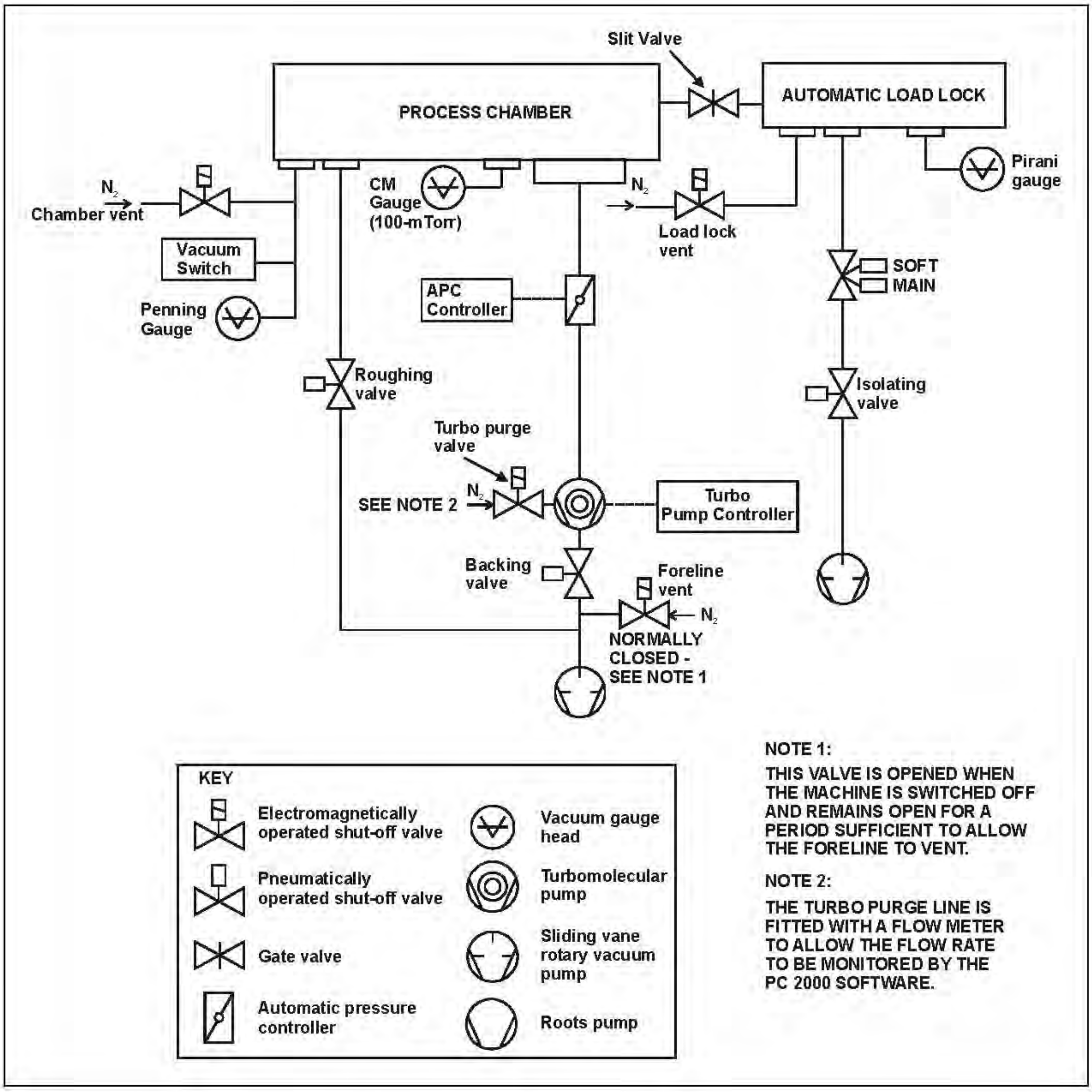


Fig 3.6: Caltech 94-219846 vacuum system

3.9 Gas handling system

WARNING

CONTACT WITH TOXIC GASES CAN CAUSE DEATH OR SERIOUS INJURY.

USERS SHOULD PERFORM THEIR OWN RISK ASSESSMENT OF HAZARDOUS GASES TO BE USED ON THE SYSTEM.

BEFORE VENTING THE PROCESS CHAMBER, ALWAYS ENSURE THAT THE SYSTEM IS ADEQUATELY PURGED AND PUMPED; SEE 'VENTING THE SYSTEM' IN SECTION 5 OF THIS MANUAL.

3.9.1 12-line gas pod

The purpose of the gas pod is to feed a mixture of process gases, at specified flow rates, to the process chamber. Selection of gases and flow rates are determined by the system controller. A 'clean gas' line can be incorporated to feed an etch gas mixture into the process chamber to remove process residues.

The gas pod, shown in Fig 3.7, comprises a steel case with a folded removable cover. In the unlikely event that a leak occurs, an extraction collar at the top of the case enables any leaked gas to be safely removed by a laboratory extraction system. The back panel of the case is fitted with fixing holes for wall or frame mounting.

The case incorporates stations for up to 12 gas lines. The outputs from the gas lines are fed into a common manifold, which is connected to the process chamber gas line. The gas output manifold can be split to provide two out puts; one to the process chamber and the other to another device, e.g. gas ring.

Pneumatically operated shut-off valves in each gas line are driven by associated SMC valves mounted on the associated gas pod CAN PCB. Each SMC valve is powered by compressed air and controlled by signals from the system controller.

All gas pod functions are controlled by interlocks, refer to sub-section 3.4.2 (page 3-8) for details. A gas pod cover interlock microswitch disables all gas pod functions unless the cover is correctly fitted.

Three CAN (Controller Area Network) PCBs are fitted, each controlling four gas lines (1 – 4, 5 – 8, and 9 – 12).

Each Gas Pod CAN PCB receives signals from the system controller, to control the SMC valves, and the Mass Flow Controllers (MFC) fitted in the associated gas lines. For a circuit diagram of the Gas Pod CAN PCB, refer to the electrical drawings in Volume 2 of this manual.

A 'clean gas' line can be fitted in place of gas line 1.

The 'clean gas' line flow rate can be set either manually by a variable valve or by an MFC. Note that the 'clean gas' is usually supplied from a cylinder containing the required gas mixture. An alternative method is to mix separate gases in optional additional gas lines.

WARNING

THE CONNECTION FROM THE GAS POD MANIFOLD TO THE PROCESS CHAMBER SHOULD NOT INCLUDE ANY SHUT OFF VALVE, UNLESS THIS HAS BEEN CLEARED WITH OXFORD INSTRUMENTS PLASMA TECHNOLOGY. A BLOCKAGE HERE COULD CAUSE PROCESS GASES TO MIX AND CROSS CONTAMINATE IN THE HIGH PRESSURE GAS DELIVERY PIPEWORK.

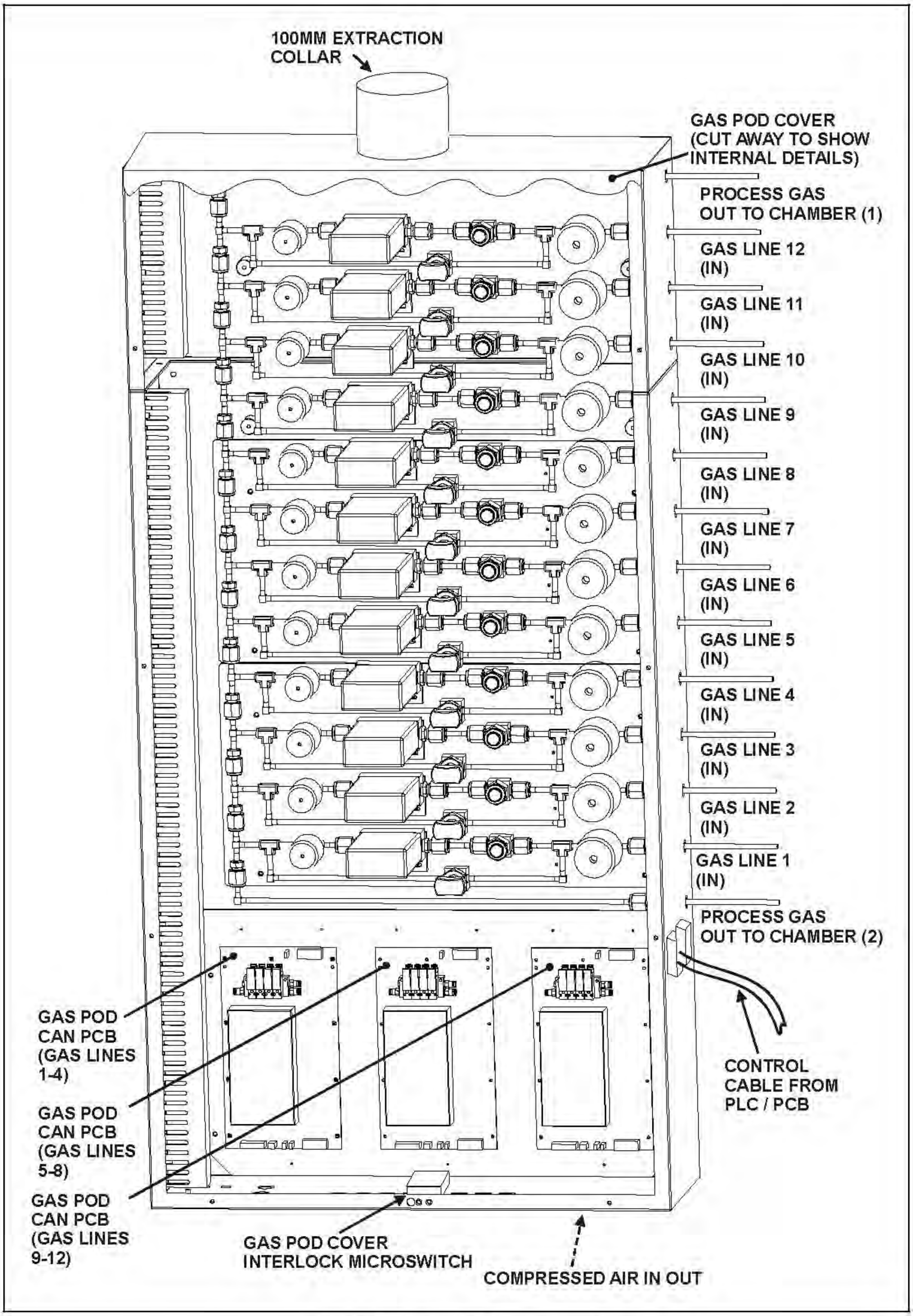


Fig 3.7: Typical 12-line gas pod

3.9.2 94-81-9-11/12 Standard non-toxic gas line

The standard non-toxic gas line is shown in Fig 3.8. All gas fittings are VCR and all stainless steel pipework connections are welded. The 'gas in' tube passes into the side of the case, protected by a grommet. A ferrite core, fitted to the 'gas in' tube, reduces the susceptibility of the gas pod electronics to signals from nearby transmitting devices, e.g. mobile phones, modems, etc..

Gas from the customer's cylinder/regulator/filter flows into the gas in tube to the filter.

The gas flows through the 2-µm filter to the mass flow controller (MFC). The MFC controls the flow of gas as commanded by the system controller. The gas then flows through the pneumatically controlled outlet shut-off valve and into the gas out manifold where it is mixed with the other process gases before flowing into the process chamber.

WARNING

THE CLOSED INLET VALVE REMAINS SHUT FOR DIFFERENTIAL PRESSURE UP TO 5 BAR. A FAILURE UPSTREAM, WHICH PRODUCES LINE PRESSURES ABOVE THIS, WILL NOT BE CONTAINED. IF THIS PRODUCES A HAZARD, THE CUSTOMER IS WARNED TO FIT ADDITIONAL PROTECTION UPSTREAM.

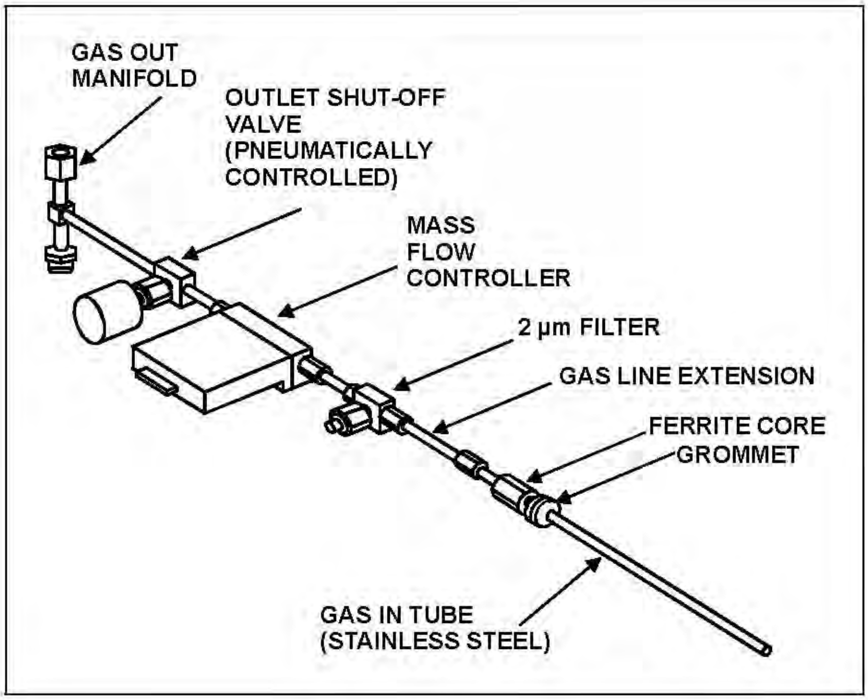


Fig 3.8: 94-81-9-11 Standard non-toxic gas lines

3.9.3 94-81-9-21/12 Standard toxic gas line

The standard toxic gas line is shown in Fig 3.9. All gas fittings are VCR and all stainless steel pipework connections are welded. The gas in tube passes into the side of the gas pod case, protected by a grommet.

Gas from the customer's cylinder/regulator/filter flows into the gas in tube to the filter.

> **WARNING**
>
> **THE CLOSED INLET VALVE REMAINS SHUT FOR DIFFERENTIAL PRESSURE UP TO 210 BAR. A FAILURE UPSTREAM WHICH PRODUCES LINE PRESSURES ABOVE THIS WILL NOT BE CONTAINED. IF THIS PRODUCES A HAZARD, THE CUSTOMER IS WARNED TO FIT ADDITIONAL PROTECTION UPSTREAM.**

With the Inlet Valve and Outlet Valve open and the Bypass Valve closed, the gas flows through the 2-µm filter to the mass flow controller (MFC). The MFC controls the flow of gas as commanded by the system controller. The gas then flows through the outlet valve and into the gas out manifold where it is mixed with the other process gases before flowing into the process chamber.

With the Bypass Valve open, the gas flows through the bypass line directly to the gas out manifold. This facility is provided to enable the toxic gas line to be evacuated by pumping down the process chamber. This is necessary to prevent air entering the gas line and contaminating it during a gas cylinder changeover, and to service the gas line in the event of an MFC or filter blockage.

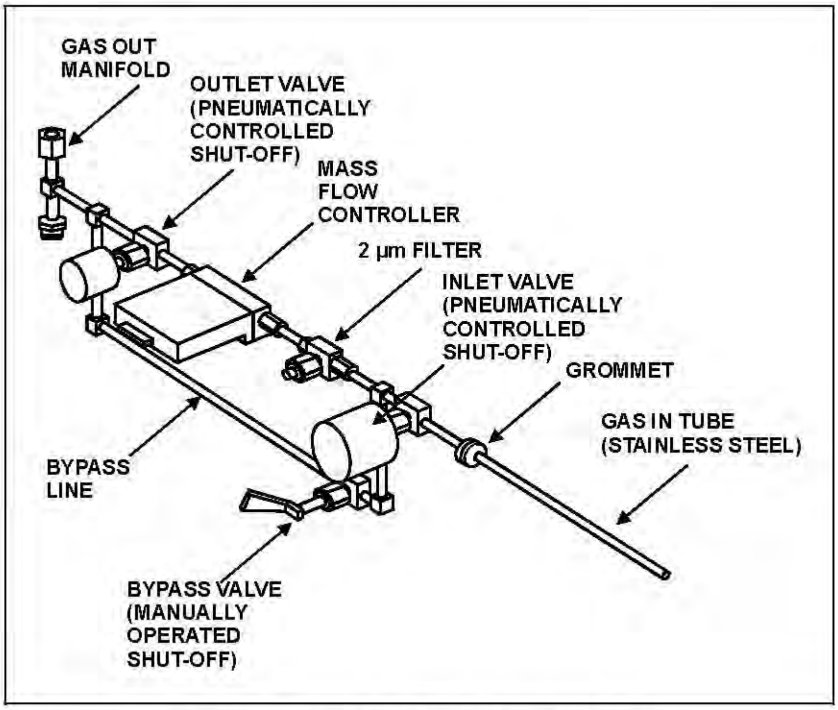


Fig 3.9: 94-81-9-21 Standard toxic gas line

3.9.4 94-81-9-00/1 Split gas manifold

This option allows process gases to be split into two groups, with different entry points into the chamber. One group usually feeds a plasma source (ECR, ICP or microwave) and the second group enters the process chamber directly.

3.9.5 94-81-9-00/4 Gas line interlock kit

The gas line interlock kit is a pneumatically controlled hardware interlock, which prevents the simultaneous flow of process gases, which if combined could produce a hazardous mixture.

3.9.6 94-81-9-42 Heated gas line kit

This is an electrically heated gas line kit for four gas line (1 – 4 or 5 – 8) in the gas pod.

The gas line valves and the mass flow controllers are heated by a heater mat, which is controlled by a temperature controller mounted in the gas pod.

3.10 94-100-10-05CBL Single wafer automatic load lock

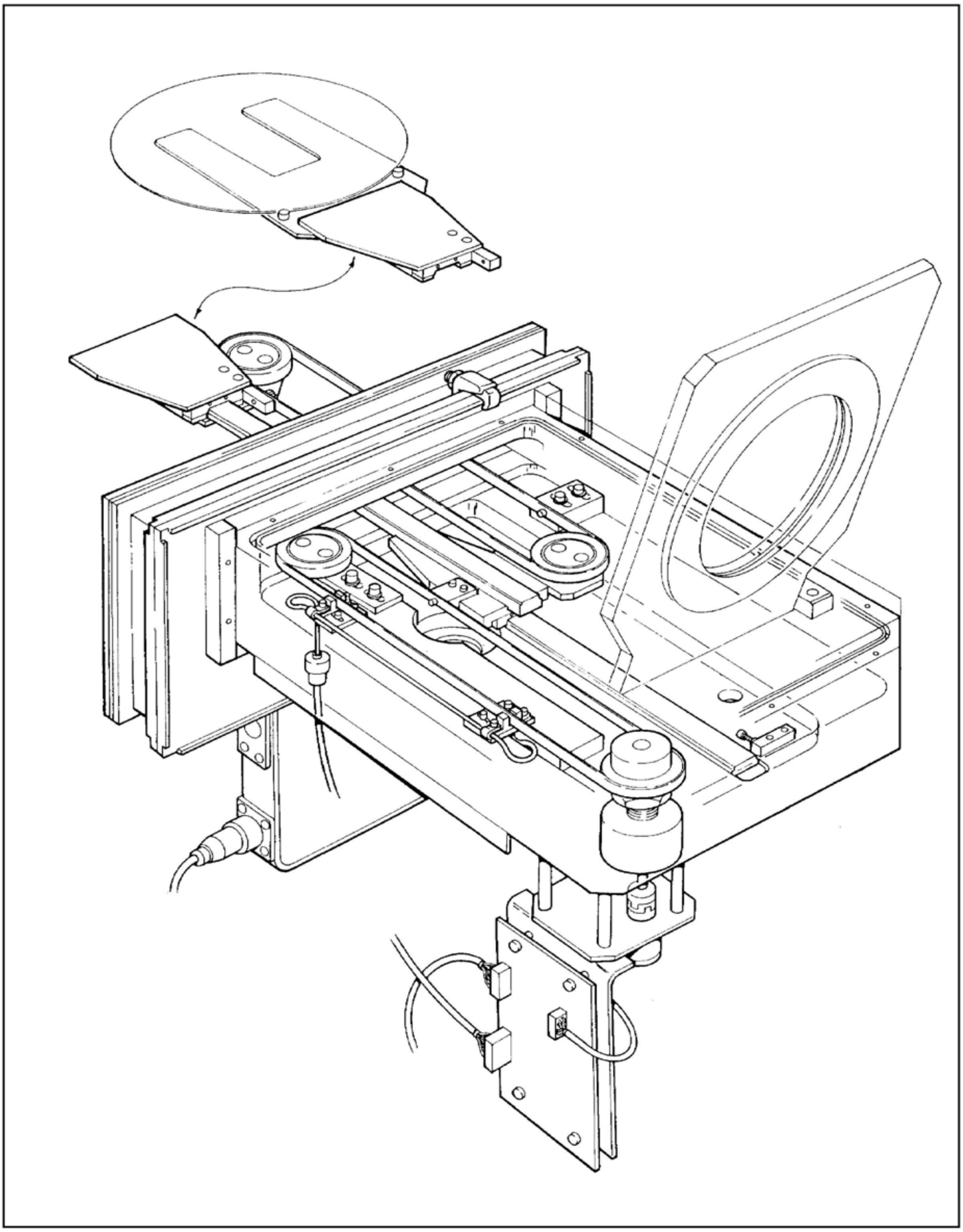


Fig 3.10: Single wafer automatic load lock

The automatic load lock, shown in Fig 3.10, enables wafer loading and unloading to be automatically achieved under vacuum. These operations are controlled by computer, requiring minimum operator involvement. The Oxford Instruments Plasma Technology design results in a very compact load lock (395 mm long with 400 mm of wafer support travel). The load lock is capable of handling MESC[1] standard wafers up to 200 mm diameter.

3.10.1 Wafer transfer mechanism operating principle

The operating principle of the automatic load lock wafer transfer mechanism is shown in Fig 3.11. This simplified illustration shows the three major components of the mechanism: the fixed track, the carriage and the wafer support.

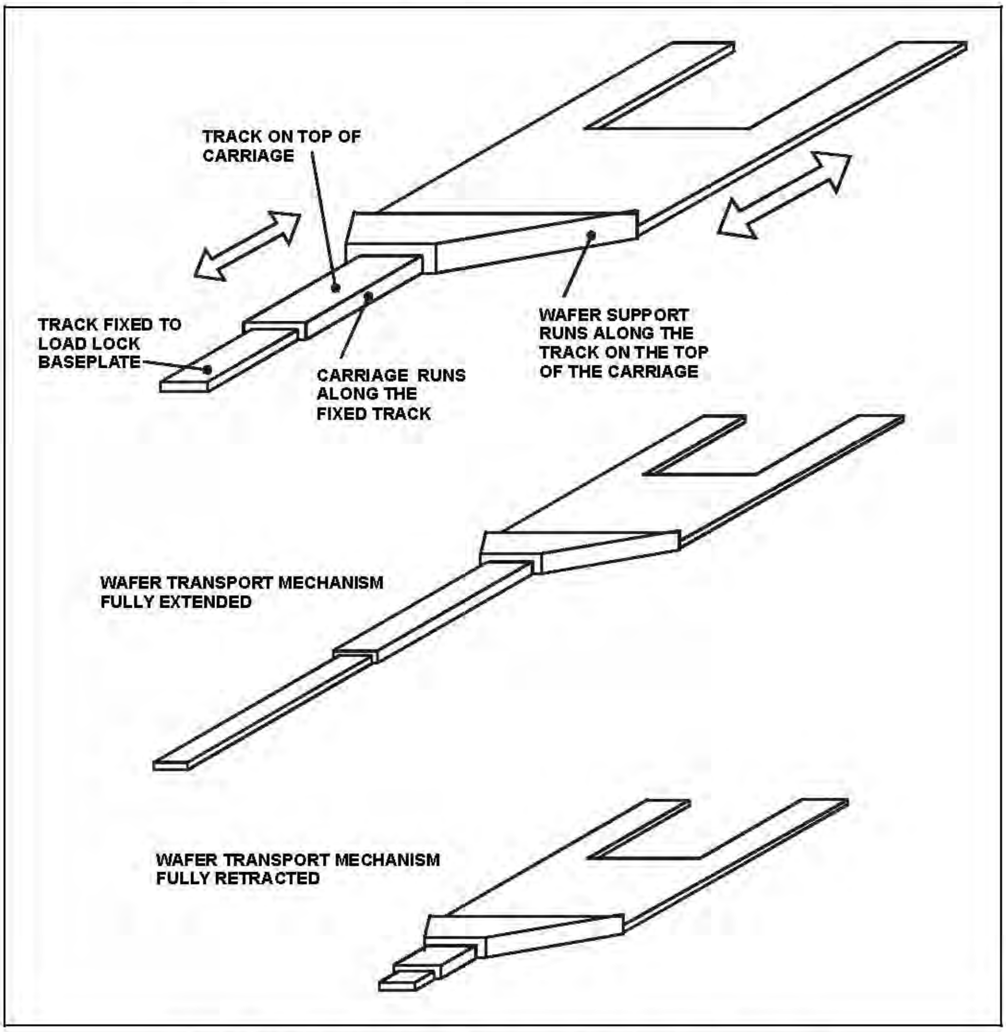


Fig 3.11: Simplified wafer transport mechanism operation

The fixed track is mounted on the load lock's baseplate and provides the bearing surface on which the carriage runs. The carriage also has a top bearing surface on which the wafer support runs.

When the mechanism is driven, the carriage runs along the fixed track and the wafer support runs along the carriage's track simultaneously. This enables the wafer support to travel from its fully retracted position (entirely contained in the load lock) to its fully extended position (wafer load/unload position in the processing chamber).

[1] Modular Equipment Standards Committee

3.10.2 Functional Description

The load lock, shown in Fig 3.12, is fabricated from aluminium and incorporates a hinged lid containing a view port. The chamber is pumped by a rotary pump or a turbomolecular pump with the pressure being detected by an appropriate vacuum gauge mounted on the chamber base plate. A pneumatically operated gate valve enables the load lock chamber to be isolated from the processing chamber.

The wafer is transported from the load lock into the processing chamber on a wafer support, which runs on a carriage, which in turn runs on a track.

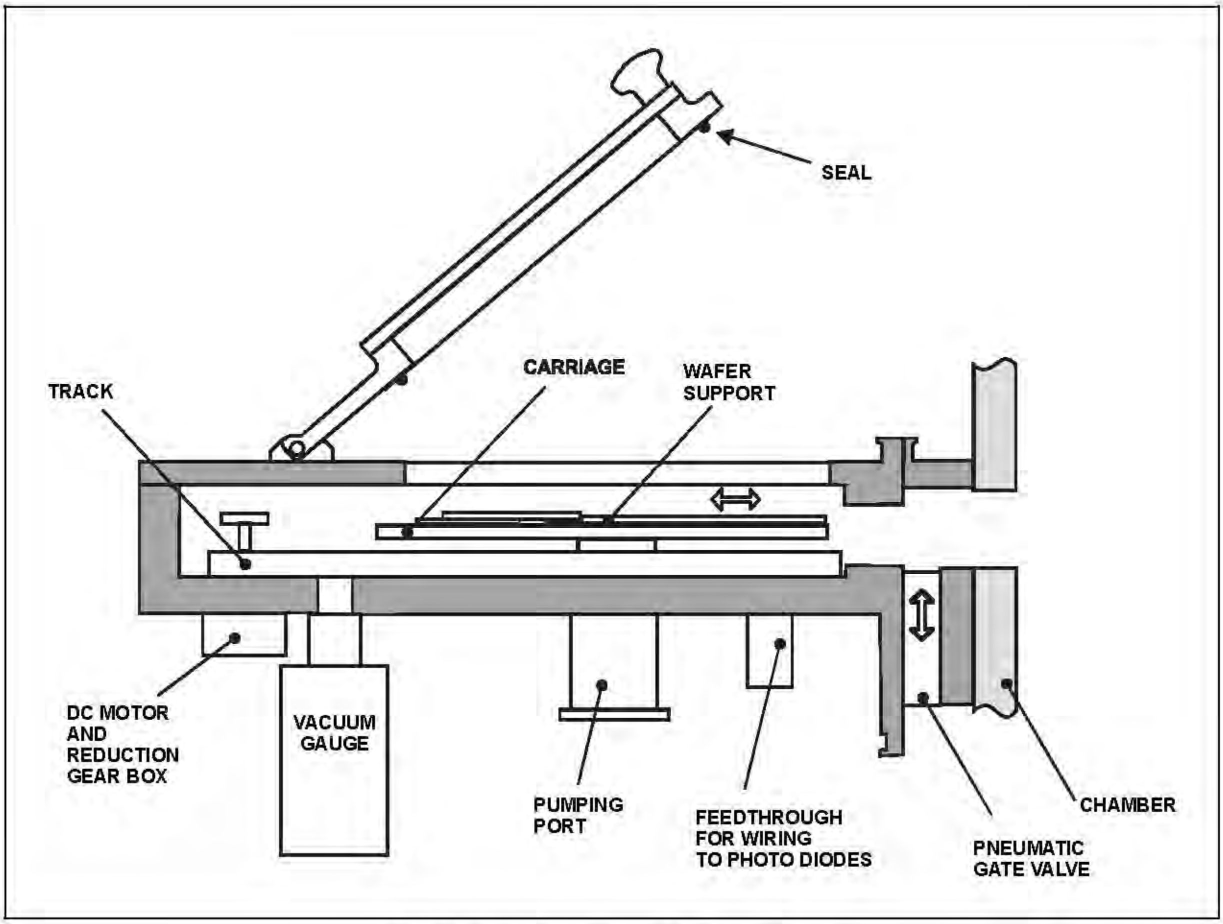


Fig 3.12: Automatic load lock, side view

The wafer transport mechanism, shown in Fig 3.13, comprises the following main components:

a) A Direct Current (DC) motor and associated reduction gearbox located outside the load lock with the drive shaft entering the load lock through a vacuum seal.

b) Two steel belts each carried by two pulley wheels.

c) A track fixed to the load lock baseplate.

d) A carriage, which runs linearly along the track. The carriage is attached to Steel Belt 1.

e) A wafer support mounted on the carriage. The wafer support runs linearly along the carriage and is attached to Steel Belt 2.

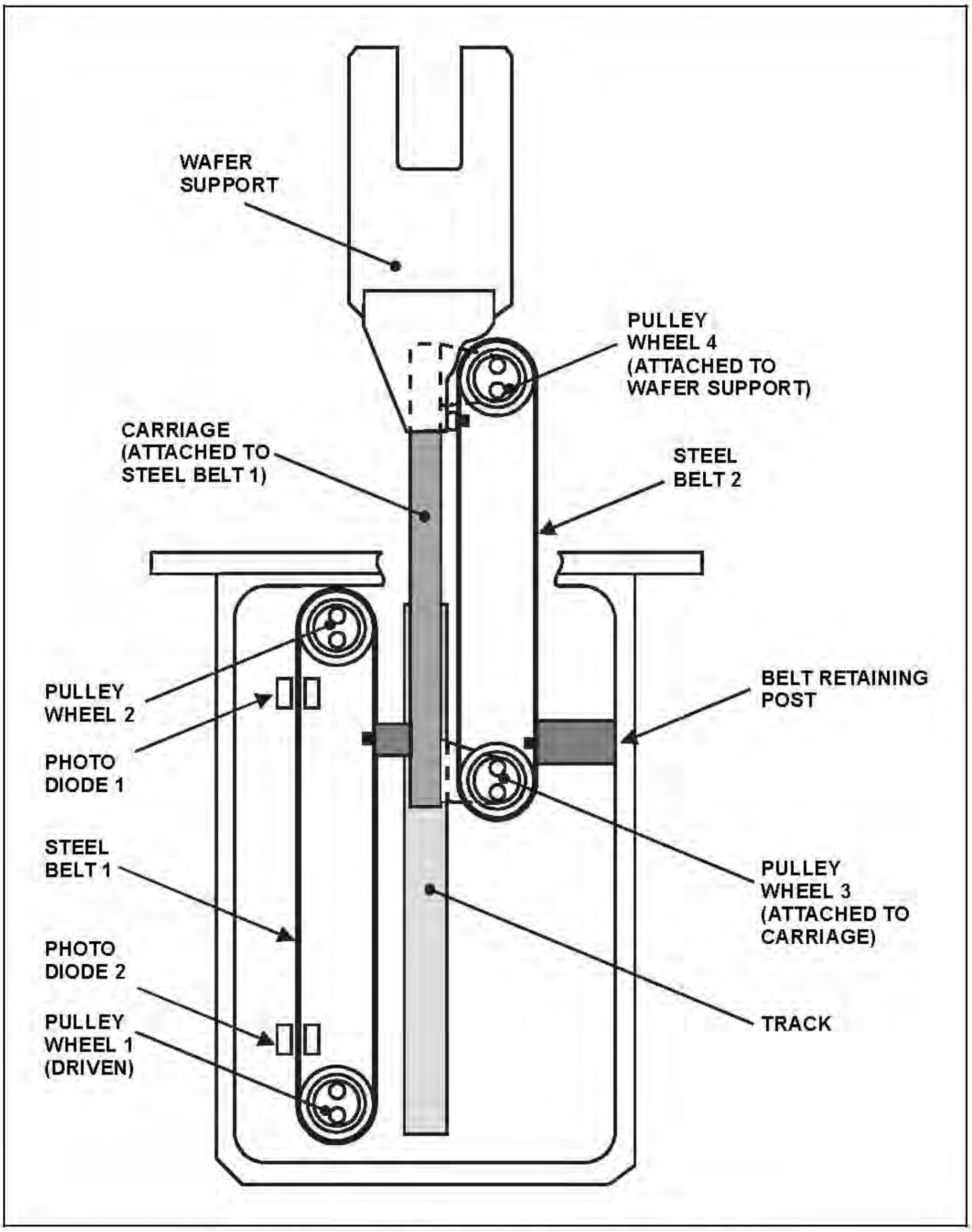


Fig 3.13: Automatic load lock wafer transport mechanism

Before operation, the Wafer Support is fully retracted into the load lock. To load a wafer into the process chamber the following sequence of events occurs:

1) The operator opens the load lock door, places the wafer onto the Wafer Support, and then closes the load lock door.

2) The load lock chamber is pumped down to base pressure.

3) The pneumatically operated gate valve is opened.

4) The DC Motor drives Steel Belt 1 via Pulley Wheel 1. Note that Pulley Wheels 1 and 2 are mounted on the load lock baseplate. As Steel Belt 1 is driven, it moves the Carriage, which is attached to it.

5) As the carriage travels, it causes Steel Belt 2 to travel around Pulley Wheels 3 and 4. Note that Pulley Wheels 3 and 4 are attached to the carriage and Steel Belt 2 is prevented from moving with respect to the load lock chassis by the retaining post.

As Steel Belt 2 travels with respect to the Carriage, it causes the Wafer Support attached to it to travel along the Carriage.

6) As the Wafer Support reaches the end of its travel, a hole in Steel Belt 1 is detected by Photo Diode 2 to stop the DC Motor.

7) The wafer is lifted from the wafer support by a wafer lift within the processing chamber, the wafer support is withdrawn from the chamber, and the wafer is lowered onto the processing table by the wafer lift.

8) As the Wafer Support reaches its fully retracted position within the load lock, the hole in Steel Belt 1 is detected by Photo Diode 1 to stop the DC motor.

9) The gate valve is closed and the load lock can be vented if required.

The above sequence of events is repeated to remove the wafer from the processing chamber.

3.10.3 Wafer support (end effector)

The automatic load lock end effector (wafer support) can accommodate wafer diameters of 3" to 8". See Section 6 (Maintenance) for the end effector wafer size adjustment procedure.

3.11 94-100-12-21/1 Neslab RTE7 heater/chiller

A recirculating 120V 60Hz or 230V 50Hz heater/chiller unit, used for electrode temperature control from +5°C to +80°C. For details of this unit, refer to the manufacturer's literature in Volume 3 of this manual.

NOTES:

4. Installation and commissioning

4.1 Introduction

The installation and cabling of this system is the responsibility of the customer (unless this has been specifically altered in the sales contract). On completion of the system installation, Oxford Instruments Plasma Technology (OIPT) will commission the system.

4.2 Installing the system

The following instructions are a general guide for installing a typical **Plasmalab**System100 system, supplied with a remote gas pod and rotary vane pump. Customers should be aware of any special requirements for their specific system, e.g. rotary pump purging, hazardous processes, endpoint detectors etc..

For details of the services required, refer to the Installation Data Sheets and the Services Specifications documents included in this manual as Appendices.

IMPORTANT: BEFORE INSTALLING THE SYSTEM, ENSURE THAT ALL PERSONNEL WHO WILL BE INVOLVED HAVE READ AND UNDERSTOOD SECTION 1 'HEALTH AND SAFETY' OF THIS MANUAL.

4.2.1 Unpacking

Unpack system components and check for damage and missing items against the packing list. If any items are damaged or missing, report immediately to the carrier and OIPT.

4.2.2 Positioning the system components

WARNING

LIFTING HEAVY OBJECTS INCORRECTLY CAN CAUSE SEVERE INJURY

When handling heavy system components such as the system unit or vacuum pumps, ensure that the appropriate lifting equipment, operated by fully trained personnel, is used.

When heavy rack-mounted components are handled, ensure that the weight is safely distributed between sufficient personnel.

WARNING

TOPPLING (TIPOVER) HAZARD - SOME SYSTEM COMPONENTS, E.G. ROBOTIC HANDLERS AND AUTOMATIC LOAD LOCKS / TRANSFER CHAMBERS (ESPECIALLY IF FITTED WITH CASSETTE LOAD LOCKS) CAN TOPPLE CAUSING SEVERE INJURY.

When transporting or manoeuvring the system frames, robotic handlers etc., ensure that they remain vertical at all times and use the appropriate lifting / handling equipment.

Ensure that any support frames, supplied with the system, are correctly fitted whenever the system is transported / manoeuvred or dismantled for service / maintenance.

It is entirely the user's responsibility to ensure that all components are supported safely before and during any transporting, manoeuvring or maintenance operations. Support frames provided by Oxford Instruments Plasma Technology are not necessarily adequate for any such operations. The absence of a support frame must not be taken as an indication that no further precautions need to be made before such operations are undertaken.

1) Transport the system frames to the clean room, then position them in the required location. Level the system frames (ensuring that the wafer transfer path is aligned from frame to frame) using the adjustable feet, then lock the feet.

   OIPT recommends that at least 600mm service access space is allowed between any obstacle (e.g. walls, partitions, etc.) and serviceable items, e.g. the power distribution unit.

2) Transport the system PC to the clean room and position it in the required location.

3) Transport the gas pod to the grey area and mount it in the required position.

4) Transport the rotary vane pump to the grey area and mount it in the required position in accordance with the pump manufacturer's instructions. Refer to the manufacturer's literature in Volume 3 of this manual.

4.2.3 Connecting the services

IMPORTANT NOTES	**(A)**	**BEFORE CONNECTING ANY OF THE SERVICES, ENSURE THAT THEY ARE TURNED OFF. E.G. COMPRESSED AIR AND GAS SUPPLY VALVES SET TO THEIR OFF POSITIONS AND ELECTRICAL SUPPLIES SWITCHED OFF AND LOCKED OUT.**
	(B)	**DO NOT RESTRICT ACCESS TO THE EMERGENCY OFF SWITCH (EMO CONTROL) BY LOCATING CABLES AND OTHER OBSTACLES IN FRONT OF THE SYSTEM.**
	(C)	**DO NOT LOCATE CABLES WHERE PERSONNEL ARE LIABLE TO WALK. OIPT RECOMMENDS THAT CABLES ARE LOCATED IN CABLE TRUNKING / TRENCHES.**

1) Connect the extraction collars on the process chamber(s) (e.g. ICP process chambers) and the gas pod to the appropriate extraction systems.

2) Connect the rotary vane pump exhaust line.

3) Connect the Nitrogen purge lines to the system services panel(s) and the rotary vane pump.

4) Connect the compressed air supply to the system services panel(s) and to the gas pod.

5) Connect the gas supplies to the gas pod (all gas supply valves closed).

6) Connect the gas outlet line, control cable and earth cable (see Fig 4.1) from the gas pod to the system console.

7) Connect the cooling circuits to the system console.

8) At the system PC, connect the monitor, keyboard and mouse, then connect the control cable(s) from the PC to the system console.

9) Connect the electrical supply from the safety isolation box to the system console. If it is necessary to connect the 3-phase electrical supply cable to the power box, refer to sub-section 4.2.3.1.

10) Connect the electrical supply to the PC.

11) Ensure that all covers and panels are fitted and attach notices to the system indicating that the system is not ready for service.

    Installation is now complete and the system is ready for commissioning by OIPT. Note that customers who have arranged to commission the system themselves can ignore the remainder of this Section.

12) Complete and sign the 'System Readiness' form QCF 89 (shipped with the system), then fax it to OIPT who will arrange for the system to be commissioned.

4.2.3.1 Connecting the 3-phase supply cable to the power box

If it is necessary to connect the 3-phase supply cable to the power box, use the following steps.

1) Ensure that the supply cable is not connected to the safety isolation box.

2) Remove the power box cover.

3) Inside the power box, remove the clear plastic safety cover from the power box (secured to the right-hand side of the power box by four screws).

4) Connect the 3-phase supply cable wires as shown in Fig 4.1.

5) Re-fit the clear plastic safety cover and then the power box cover.

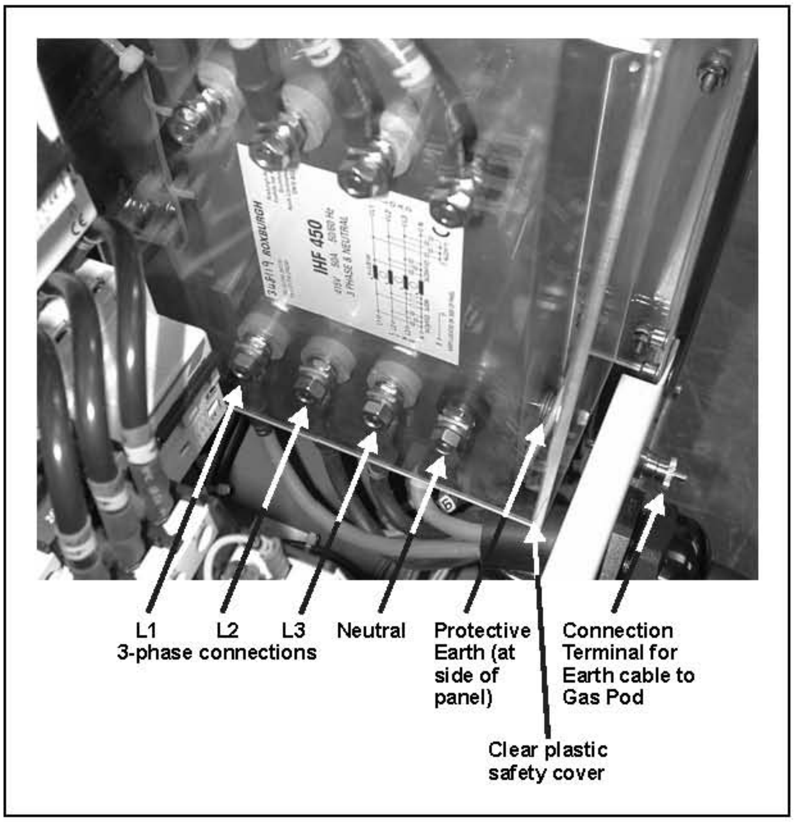


Fig 4.1: 3-phase supply cable connections at the power box

4.3 Commissioning the system

Commissioning of the system will be carried out by OIPT in accordance with their standard procedures and any additional requirements stated in the sales contract. Generally, this will include the following items:

1) Checking that the installation has been carried out satisfactorily.

2) Powering up the system.

3) Checking the operation of the system, including the Emergency Off facility and all interlocks.

4) Ensuring that the system can perform the processes specified in the sales contract.

5) Providing training on the system.

4.4 System adjustments

This sub-section gives details of adjustments which may be necessary depending on system configuration. In addition to these adjustments, refer to the Operator Adjustments sub-section in Section 5 (Operating Instructions) of this manual.

4.4.1 Heater/Chillers

If your Plasmalab system has a remote Betta-Tech heater/chiller, e.g. CU500, with a Eurotherm Controller, please note the following.

The Eurotherm controller has a default temperature setpoint. For the system to operate correctly, this setpoint must be set to a temperature suitable for the system and coolant used. For example, if the coolant is water, do not set the setpoint to 0° C or below.

Check the setpoint before using the system and if necessary change it in accordance with the instructions given in the Eurotherm Controller's manual.

4.4.2 Process pump purge

An inert gas, normally nitrogen, is added to the process chamber primary mechanical pump for a variety of reasons:

a) When pumping condensable vapours, it is flowed via the gas ballast port. This helps to prevent condensation during compression, and reduces the amount of liquids such as water vapour or $SiCl_4$ in the pump fluid.

b) When pumping reactive gases, it is bubbled through the pump fluid, to help drive out acidic compounds.

c) When pumping flammable or explosive gases, it is added to dilute the gas below the threshold for explosion.

d) In dry pumps, the purge gas flow is important for managing heat and limiting particle build up.

WARNING
DILUTION IS NOT USED TO MAKE THE EXHUAST SAFE TO BREATH: IT MUST STILL BE DUCTED AWAY AND TREATED APPROPRIATELY.

If your Plasmalab system is supplied with a dry pump, e.g. Alcatel ADP122P or ADS602P, that includes its own purge gas monitor, with an output suitable for inclusion in a hardware interlock chain, it is permissible to use this instead of the OIPT purge kit.

If your Plasmalab system is supplied with an oil filled rotary pump, e.g. Alcatel A2063C2, the purge kit supplied is configured for the process gases specified. Note that information about the Rotameters used is given in Appendix R.

For purge requirements not covered by the standard OIPT purge kits or dry pump purge gas monitor an additional purge supplement is included at the end of this section.

Inert pumping

Tools that are pumping only atmospheric gases need no purge, other than any minimum purge the specific pump requires.

Etch tools - halogen gases

Tools that use gases containing halogens (fluorine, chlorine, and bromine – including compounds which contain these elements, e.g. CHF_3), are supplied with purge into the pump, via a rotameter of full scale at least 4 standard litres per minute (slpm).

Etch tools - flammable gases

Certain processes use the flammable gases hydrogen (H_2) and methane (CH_4), often in combination with chlorine (Cl_2) to etch compound semiconductors. The primary pump for these is purged with sufficient gas to bring the exhaust to one third of the lower flammability limit.

A rotameter is used to set and read the flow. A flow switch monitors the purge. The process gases are turned off by means of a hardware interlock if the flow switch reports low flow below 7.5slpm.

Deposition processes - pyrophoric gases

Tools that use silane to deposit thin films containing silicon shall be purged with sufficient gas to bring the exhaust to one third of the lower explosion limit.

A rotameter is used to set and read the flow. A flow switch monitors the purge. For low rate processes (<25sccm SiH_4) the process gases are turned off by means of a hardware interlock if the flow switch reports low flow below 5.2slpm. For high rate processes (<50sccm Si H_4) the process gases are turned off by means of a hardware interlock if the flow switch reports low flow below 10.5slpm.

NOTES:

5. Operating instructions

WARNING

BEFORE ATTEMPTING TO SWITCH ON (POWER UP OR OPERATE THE SYSTEM), READ AND ENSURE THAT YOU UNDERSTAND SECTION 1 - HEALTH AND SAFETY AT THE BEGINNING OF THIS MANUAL.

5.1 Failure of quartz and alumina components under vacuum

Induction coupled plasma sources contain quartz or alumina tubes or windows under vacuum, which may be subject to attack by the plasma process. If these components fail whilst under vacuum, an implosion can occur. This should not present a safety hazard, provided the equipment is used with all covers and screens in place, but may cause damage to system components.

Failure by implosion becomes more likely as the components age; therefore they should be regarded as consumable items. A programme of regular inspection and renewal of these components is necessary to minimise the risk of implosion.

WARNING

BEFORE POWERING UP THE SOURCE, ENSURE THAT ALL COVERS AND SCREENS ARE FITTED CORRECTLY. DO NOT REMOVE THE COVERS OR SCREENS WHILST THE SOURCE IS UNDER VACUUM.

5.2 System power-up

This sub-section describes the initial power-up (switch on) of the system. It assumes that the system is switched OFF at the wall-mounted safety isolation box.

WARNING

BEFORE POWERING THE SYSTEM UP, CHECK THAT:

A) THE 'ON-SITE' MAINTENANCE LOG SHOWS THAT THE SYSTEM IS IN A FIT STATE FOR CUSTOMER OPERATION.

B) ALL DOORS ARE CLOSED AND ALL COVERS ARE IN PLACE.

C) THERE IS NO VISIBLE DAMAGE TO THE SYSTEM.

CAUTION

Always ensure that any heater/chiller units provided are switched on when the system is powered up.

To power up the system, proceed as follows:

1) Ensure that all manually operated cooling water taps are turned ON.
2) Check that the 'Slit Valve Lockout' control is unlocked and pushed home.
3) Set all Remote/Local switches on the electronics modules to REMOTE.
4) Switch ON all the electronics modules located in the console.
5) Ensure that the compressed air supply is ON.

CAUTION

If the gas lines may contain air, do not open any gas taps. Continue with the start up procedure, and then use the system to evacuate the lines one at a time. When it is certain that the air has been removed and there are no leaks, open the gas taps.

6) If you are certain that the gas lines do not contain air, turn all the manually operated gas taps (on gas cylinders etc.) to ON.
7) Check that the Emergency Stop buttons are OUT.
8) Set the wall-mounted safety isolation box switch to ON (I).
9) Operate SYSTEM ON button (coloured green or with the 'I' legend), located on the console.
10) Switch the remote PC operator terminal ON.

5.2.1 RF Generator centre frequency mode selection

Use the following procedure every time the system is switched on. The centre frequency mode is not stored in the RF Generators memory. If this procedure is not carried out, the automatch unit tuning capacitors may be driven to their end stops.

1) At the HFV8000 RF Generator, press the **Display mode** pushbutton. The message 'Centre/Autotune' is displayed.

2) Press the pushbutton repeatedly until the Load/Regulate LED flashes. The RF Generator is now fixed to the centre frequency.

3) Press the pushbutton to return to the normal display.

5.3 System shut down and restart

The situations, which necessitate system shut down, are given in sub-sections 5.3.1 to 5.3.4.

5.3.1 Emergency shut down

In an emergency, e.g. risk of physical injury, fire, etc., shut the system down by pressing an **Emergency Off** (EMO) button. This will disable all power outputs from the power box (except for low voltage supplies). When any faults have been cleared and the system is safe to operate, restart the system using the procedure given in sub-section 5.3.6.

5.3.2 Routine shut down

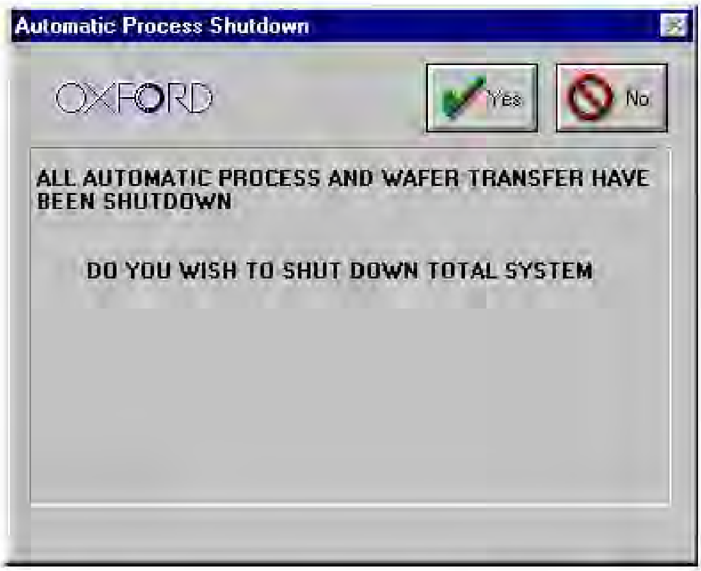
When all processing operations are completed and the system is to be shut down for maintenance and repair, use the shut down procedure given in sub-section 5.3.5. On completion of maintenance and/or repair, restart the system using the System power up procedure, given in sub-section 5.2.

5.3.3 Mains Power failure

A mains power failure will halt all system functions. When power is restored, restart the system using the procedure given in sub-section 5.3.6.

5.3.4 Software abort

To halt processing and wafer transfers, click on the **STOP ALL AUTO PROCESSES** button which is displayed at the top of the page on all screens. Clicking on this button will halt the current process and any further wafer transfers. (Any wafer transfers currently in progress will continue.) Also, a Cluster System Abort dialogue is displayed asking you if you wish to shut down the total system. Clicking on **Yes** will:



a) Switch the RF/microwave/magnet power generators OFF.

b) Switch the pumps OFF.

c) Close the APC and normally-closed vacuum valves.

d) Switch the process gases OFF.

As a result of clicking on **Yes**, the system should be restarted using the procedure given in sub-section 5.3.6.

Clicking on the **No** button in the Cluster System Abort dialogue will limit the abort to the actions already done, i.e. stop all automatic recipes. Further processing operations (automatic or manual) can then be carried out after ensuring that the system controller is aware of the current wafer locations.

5.3.5 System shut-down procedure

CAUTION

If your system is fitted with a turbomolecular pump ensure that you read and understand Appendix B before shutting the system down.

This procedure assumes that the process run is finished and that the system is to be shut down for maintenance or repair.

1) Ensure that the system has been vented, and all pumps are switched off.

2) Exit from the PC 2000 software by clicking on the **System** button, then on the **Exit** option.

3) Exit from Windows.

4) Turn the PC controller OFF.

5) At the Main Console, press the **OFF** button (coloured red or with a '0' legend).

6) Switch off and lock off the wall-mounted safety isolation box.

7) Turn all manual gas taps on the Main Console, gas pod and compressed gas cylinders **OFF**.

8) At the Main Console, set the **SLIT VALVE LOCKOUT** valve to its OFF position (pull the red control knob fully outwards). Fit the adjacent padlock to the slit valve lockout valve's spindle then lock it to prevent any compressed air operated valve movement.

9) Turn off the compressed air supply.

10) Ensure that all heated components have cooled to ambient temperature, then turn off the cooling water.

WARNING

PART OF THE SYSTEM IS ELECTRICALLY ENERGISED IF THE CUSTOMER'S SUPPLY IS TURNED ON. UNLIT INDICATOR LAMPS DO NOT MEAN THAT IT IS SAFE TO WORK ON THE SYSTEM.

5.3.6 System restart following an emergency stop, power failure, or software abort

A power failure, or emergency stop will halt all system functions. A software abort, (by clicking on the **STOP ALL AUTO PROCESSES** button, then clicking on **Yes** in the Cluster System Abort dialogue), also halts the machine quickly.

When power is restored, and it is safe to turn on or restart the system, use the following procedure:

1) Turn off the machine at the system power off switch.

2) Turn on the machine at the system power on switch. (If a robot arm is fitted, it should move slowly to its home position.)

3) Turn off the machine at the system power off switch again (see following Note A).

4) Turn on the machine at the system power on switch. (If cassette load lock(s) are fitted, their elevators will move to find the end positions.)

5) A user with access to the Service Mode can then use the facilities to add wafers to the mimic page so that the system controller knows where any wafers are.

NOTES: A) The double on and off routine (in Steps 3 and 4) is essential only for a system with a Hine robot arm and vacuum cassettes. If the arm has stopped inside the cassette and both are initialised together, then both the arm and the cassette contents will be damaged. Therefore the Hine arm will go to its home position when power is applied, but the cassettes will initialise ONLY if the Hine arm is already at home position when power is applied.

B) System and data log files may have been corrupted. Refer to sub-section 5.9 (page 5-56) for details.

5.3.7 System response to loss of services

This sub-section briefly describes the system's response to the loss of services.

Electrical

Process and pumps stop. Air operated gas and vacuum valves shut. Where the chamber APC function and main chamber vacuum valve are combined in one unit, it is automatically closed on loss of electrical power. Load lock wafer transfer valve(s) retain their current state, or finish their current transition. A Hine arm robot will finish its current movement. Other wafer transfer devices stop moving immediately. Information on the current process and wafer position is lost.

Loss of one of three phases: rotary vacuum pump stops. If the phase powering the process controller remains live then the process aborts, all valves shut but the system controller retains information on the current state of the machine. If the process controller phase is lost, then current information is lost.

Compressed air

All air operated gas inlet and vacuum valves shut. (Exceptions: air-operated valves with electrical solenoids unaffected; normally open gas interlock valves open). Gas flows stop and the chamber is not pumped. Process power(s) are turned off as soon as a flow or pressure exceeds a tolerance band - normally within 5 seconds. Load lock wafer transfer valve(s) go to an undefined state. Rotational movement of the air operated 4-way load lock stops.

Cooling water

Certain components are protected by a water flow switch. If the flow is low, a warning message is displayed on the PC, and the associated device is turned off.

Leybold dry pumps have their own internal over-temperature switches. Loss of flow for these pumps will eventually cause a temperature trip causing a process abort (process chamber pump) and the relevant pump to be switched off. Devices such as turbo pumps have their own internal protection against overheating and are not protected by external flow switches.

Turbomolecular pump nitrogen purge

A flow meter monitors the nitrogen purge flow rate downstream of the purge flow regulator. Low pressure (< 50 sccm) will cause the process to be aborted, all gas and vacuum valves to shut and PC 2000 will display the alert shown below.

Process gases

Loss of process gas is detected when a mass flow controller goes out of tolerance during process. The active process devices (normally plasma power) are paused, and gas flows remain active. The process will resume automatically if gas is restored.

Vacuum pumps

An auxiliary circuit on the pump contactor detects pump failure due to overload or short circuit, and the process gases are immediately halted.

If a rotary vane or dry vacuum pump stops pumping for other reasons during a process, e.g. if it fails or its power is disconnected, and the vacuum interlock switch's contacts remain closed, process gas will continue to flow into the process chamber. Gas flow will stop when the chamber pressure exceeds the vacuum switch trip level of 600 mbar absolute. The front-end software will show the interlock status as 'fault'.

WARNING

DISCONNECTING THE POWER TO AUXILIARY EQUIPMENT, ESPECIALLY VACUUM PUMPS, WHILE RUNNING A PROCESS CAN CAUSE A HAZARD IN THE PROCESS CHAMBER.

ENSURE THAT THE SYSTEM IS SHUT DOWN USING THE PROCEDURE GIVEN IN SUB-SECTION 5.3.5 BEFORE DISCONNECTING ANY POWER CABLES FROM THE POWER BOX, OR SWITCHING OFF ANY ELECTRICAL SUPPLIES TO AUXILIARY EQUIPMENT.

WARNING

IF THE EQUIPMENT HALTS DURING PROCESS BECAUSE THE VACUUM SWITCH HAS OPENED, THERE MAY BE A SERIOUS GAS HAZARD IN THE CHAMBER AND PUMPING LINES.

ASSESS THE RISKS BEFORE TRYING TO PUMP OR VENT THE CHAMBER.

PERSONAL PROTECTIVE EQUIPMENT MAY BE NECESSARY.

5.4 Operator control

The PC 2000 facilities are accessed from the menu bar at the top of the screen as shown in Fig 5.1.

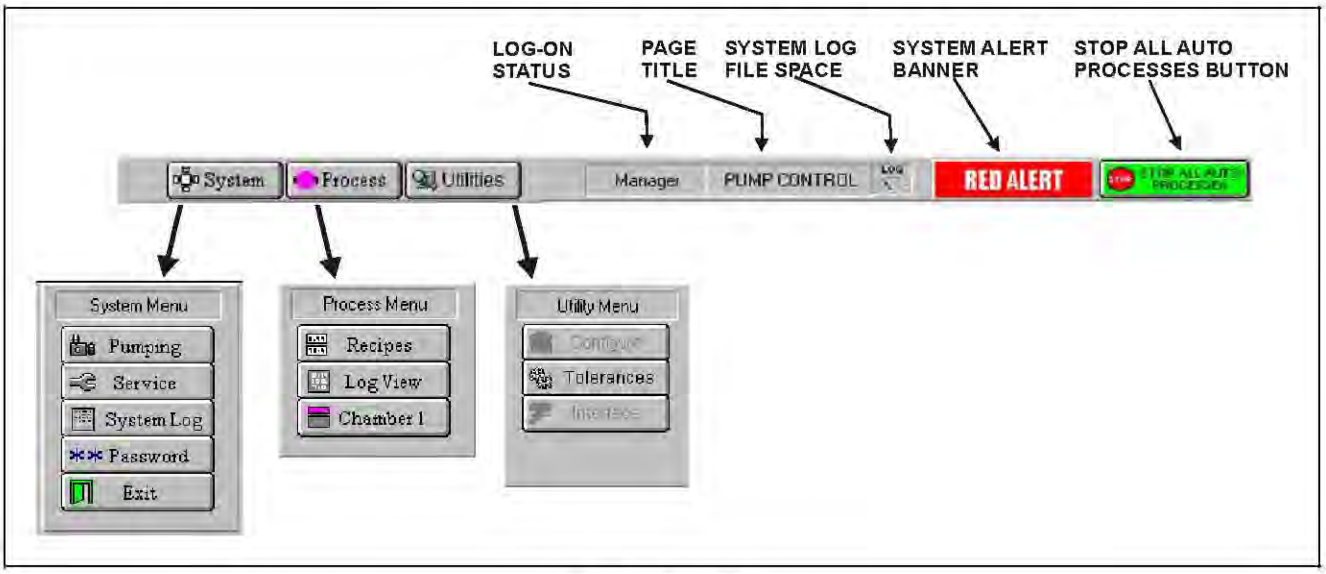


Fig 5.1: Menu bar

This system incorporates an ICP 180 processing station, and an automatic single-wafer load lock chamber. Refer to sub-section 5.8, page 5-32 for diagrams and brief descriptions of the screens/pages.

5.4.1 Turning screen savers and power saver options off

CAUTION

When running the PC 2000 software, using a Screen Saver or allowing the PC to enter any of the Power Saver modes can cause the PC to lose communications with the PLC.

Before starting the PC 2000 software, ensure that Screen Savers and all Power Saver options are turned off. A procedure to do this is given in the following text.

Use the following procedure to turn the screen savers and power saver options off. Note that this procedure is applicable to Microsoft Windows XP™; for other versions of Windows, refer to the on-line help.

1) Right-click anywhere in a clear area on the Windows desktop and then, on the displayed menu, select the **Properties** option. The Display Properties dialogue box is displayed.

2) Select the **Screen Saver** tab.

3) In the Screen Saver drop-down list, select the **(None)** option.

4) Click on the **OK** button.

5) On the taskbar, select the **Start** button, then the **Settings** option, then select **Control Panel**. The control panel is displayed.

6) Select **Power Options**. The Power Options Properties dialogue is displayed.

7) Ensure that all power scheme options are set to '**Never**'. If necessary, use the drop-down lists to select the '**Never**' option.

8) Click on the **OK** button.

9) Close the control panel.

5.4.2 Logging on

To log on to the PC 2000 software, proceed as follows:

1) Select the PC 2000 icon . The PC 2000 splash screen is loaded, and then the Access Control dialogue is displayed:

2) Enter your name and password in the appropriate data fields (note that data entry in the Password field is case sensitive), and then select the **Verify** button. If you make a mistake in entering your name and password, select the **Verify** button and then re-enter the data. After verification of the entered data, your log-on status is displayed in the **Current User** and **Access level** fields.

3) Select the **OK** button. The PC 2000 software continues to load, and then the Pump Control page is displayed.

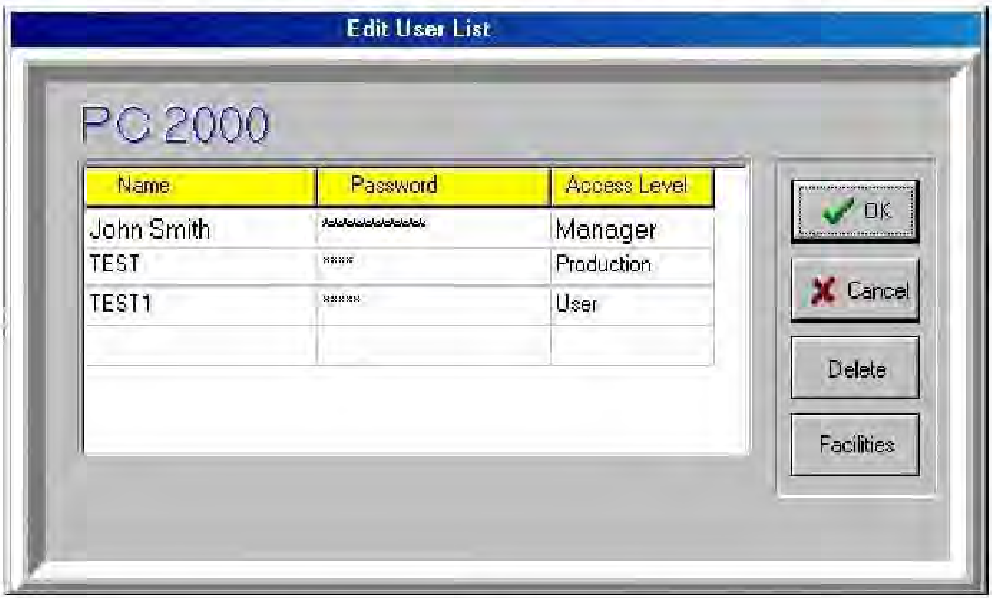
5.4.2.1 Editing users details

Users details, i.e. names, passwords and facility access options can be edited by a person logged on as a Manager. To do this, use the following steps:

1) Log on as a Manager (see sub-section 5.4.2).

2) Select the **System** Menu, and then the **Password** option. The Access Control dialogue box is displayed.

3) Select the **Edit Users** button. The Edit User List is displayed.



4) To add a new user, click on the Name and Password cells then enter the required details (remember that text entered into the Password cell is case sensitive). Clicking on the Access Level cell will display a scrollable drop-down list with the following options:

Option	**Result**
Quit	Exit from the drop-down list.
View_Only	All Facilities automatically disabled.
User	A set of Facilities can be selected, see Step 5.
Production	See sub-section 5.4.7 (page 5-18).
Maintenance	A special set of Facilities is automatically enabled. Note that this access level has its own recipes and steps for maintenance and does not allow access to process recipes and steps, or allow the system log to be viewed.
Manager	All Facilities automatically enabled.

Select one of the access levels for the new user.

Similarly, existing Names, Passwords and Access Levels can be edited. In addition, existing entries can be removed from the list by selecting a name and then selecting the **Delete** button.

5) The Facilities enabled for 'User' (selected in Step 4) can be edited by selecting the Facilities button <u>while the cursor is in the name field for that user</u>. This will display the Edit User Facilities dialogue box.

WARNING

BEFORE ENABLING FACILITIES, CONSIDER CAREFULLY WHICH FACILITIES WILL BE SELECTED FOR THE PERSON USING THE 'LOG ON' NAME. FOR EXAMPLE, ALLOWING AN INEXPERIENCED USER ACCESS TO THE 'TOLERANCES' PAGE WOULD ALLOW THE USER TO CHANGE TOLERANCES WHICH COULD POSSIBLY RESULT IN SYSTEM MALFUNCTION AND EXPOSE THE OPERATOR TO HAZARDOUS SITUATIONS.

6) Click on the appropriate checkboxes to enable the facilities available to the selected name (✔ indicates enabled). Click on the **OK** button to accept the entered data and exit.

Note that the enabled facilities are dependent on the name and not on the access level, e.g. two people logged on as users can have different sets of facilities enabled.

5.4.3 System alerts

System alerts are displayed when PC 2000 detects an event that requires the attention of the user. Each alert is automatically categorised depending on the nature of the event and the response required by the user. The category of the event can range from a warning indicating that a service parameter is out of tolerance to a process abort indicating that a process setpoint has been out of tolerance for so long that the process cannot be completed. A typical system alert is shown in Fig 5.2.

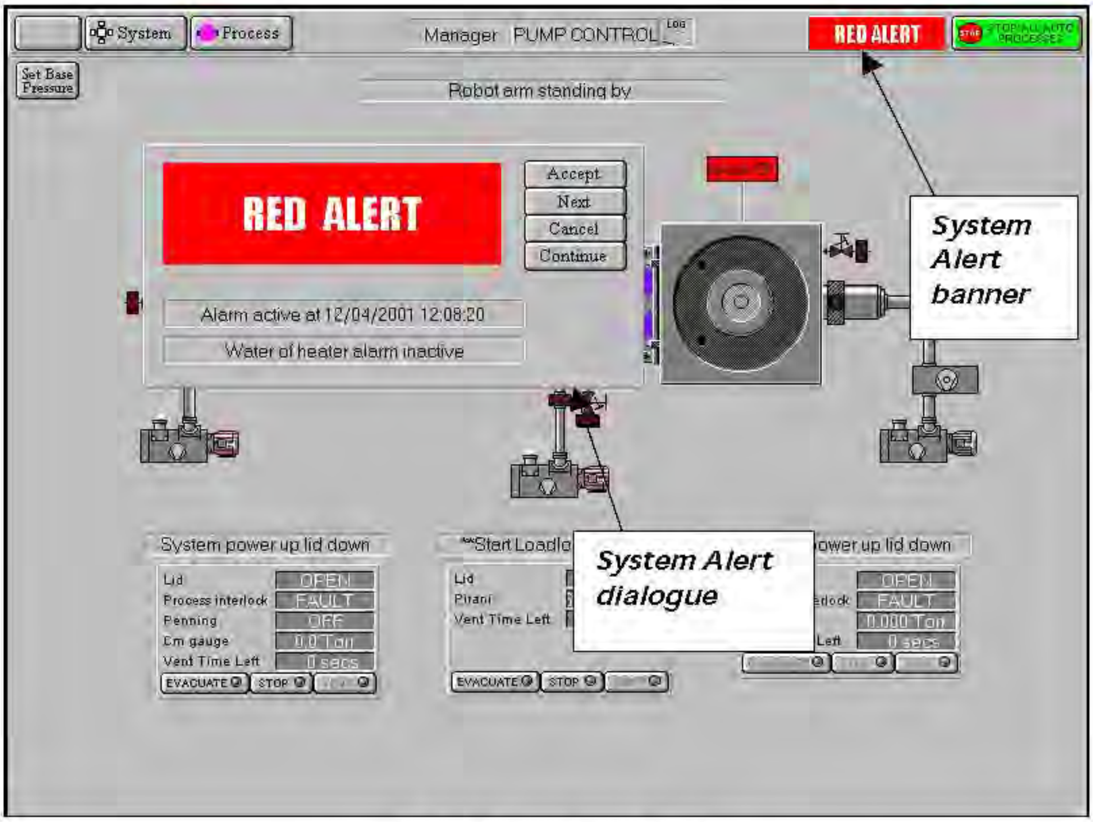


Fig 5.2: Typical system alert

The alert is displayed as a banner in the menu bar at the top of the screen with an associated dialogue in the main screen area. Note that more than one alert can be active at the same time, each requiring action by the user in turn.

There are three categories of alert indicated by the colour and text displayed in the banner and dialogue:

Blue Warning e.g. water flow low.

Yellow Hazard – not currently used.

Red Process abort, e.g. high-reflected RF power.

A user logged on at any access level can close the alert dialogue, but only a user logged on as a system manager can clear the alert banner from the menu bar. The dialogue options are:

Accept button: System Managers only. Clear the alert and log it.

Next button: View the next alert.

Cancel button: System Manager only. Clear the alert; do <u>not</u> log it.

Continue button: Close the alert dialogue box – the alert banner remains displayed on the menu bar.

Note that option buttons that are not available (i.e. **Accept** and **Cancel** due to user 'logged on' status and **Next** when there is only one active alert) are greyed out.

The alert message usually contains an adequate description of the detected event. If it is a service fault (water flow, purge gas etc.) then verify that the service is available to the machine as soon as possible. Depending on the nature of the service, the system may allow the machine to continue to operate, so that the current process can be completed. Do not start a new process before checking the service.

The red alerts are often due to a process setpoint being out of tolerance for too long. In these cases, the process is halted by the system. If it is authorised to resume processing with a parameter deviation then:

1) Check the most recent process log to find the process time remaining.

2) Construct a new process with a modified process time and check the 'Ignore tolerance' option. Note that this removes all tolerance checking. The machine should be monitored by an operator for further deviations when operated in this condition.

5.4.4 Pumping down

1) On the Pump Control page, select the **SET BASE PRESSURE** button, then enter the required process chamber base pressure if different from the default.

2) Ensure that the Automatic load lock/transfer chamber's lid is closed. (Automatic load lock/transfer chamber lid open/closed status is shown in the panel adjacent to the mimic).

3) Click on each dry pump/rotary vane pump mimic to start the pump.

4) Select the **Evacuate** button for the process chamber. The relevant valves will operate and the process chamber will be pumped down.

5) Select the Evacuate button for the Automatic load lock. You will be prompted to enter a wafer identity - either enter the identity and click **OK**, or click **Cancel** (to pump down without a wafer in the Automatic load lock). The relevant valves will operate and the Automatic load lock will be pumped down.

   NOTE: Turning off any rotary vane pump will cause all process and pumping actions using that pump to stop.

6) To achieve a low base pressure in the system, pump for at least 12 hours. Where chambers or process heaters are part of the system, raise the temperatures of these near their maximum values for the first six hours of pumping to assist out-gassing, then return the temperature to ambient.

WARNING

PARTS OF THE EQUIPMENT MAY BE TOO HOT TO TOUCH DURING CHAMBER HEATING.

5.4.5 Automatic process run

An automatic process run as described in this sub-section can be carried out by a user logged on as a Manager. See sub-section 5.4.6, page 5-17 for details of a single button automatic process run, which can be carried out by any user.

1) Insert the wafer into the Automatic load lock. (If necessary, vent the Automatic load lock by selecting the **STOP** button then the **VENT** button).

2) Close the Automatic load lock's lid.

3) Select the relevant **EVACUATE** button. A dialogue box will be displayed allowing entry of a Wafer Identity, if any.

4) Check that the system has pumped down to base pressure. (The process chamber message panel should display 'Base Pressure reached'.)

5) Ensure that the Automatic load lock is at the required pressure. (Check the relevant panel on the Pump Control page). Green 'ready for transfer' indicators (◀▶) are displayed on each chamber mimic when it is available for vacuum transfer.

6) Select the Process menu, then the Recipe option. Click on the **Load** button then select the required recipe.

7) Click on the **Run** button. This will start wafer transfers and wafer processing.

NOTES:

a) You can pause the process at any time by selecting the **PAUSE** button. This will cause the Step Time and the plasma power to stop with the current step time indicated. Re-starting the process will cause the process to continue from the time it was paused. If, during the pause period, you change any of the process parameters, e.g. gas demand, pressure etc., you must press the **START** button for the changes made to come into effect, this will cause the step timer to continue from the time it was paused.

b) You can stop the process at any time; the message 'Process Complete' will be displayed, if required, you can then run the same or another process.

WARNING

CONTACT WITH TOXIC GASES CAN CAUSE DEATH OR SERIOUS INJURY.

WHERE ANY PROCESS GAS IS TOXIC, DO NOT TRANSFER A WAFER FROM THE PROCESS CHAMBER TO THE LOAD LOCK UNTIL ALL PROCESS GAS HAS BEEN PUMPED OUT.

ENSURE THAT THE AUTOMATIC VENT SEQUENCE IS ALLOWED TO COMPLETE.

IF THESE PRECAUTIONS ARE NOT CARRIED OUT, THERE COULD BE A HAZARD IN THE LOAD LOCK.

8) When the 'Process Complete' message is displayed, select the Pump Control page and move the wafer from the process chamber to the Automatic load lock using the same method as the transfer in.

9) Open the Automatic load lock's lid and remove the wafer.

10) If required, the system can now be vented, see sub-section 5.4.9 page 5-20.

5.4.6 Single button automatic process run

A single button automatic process run allows a complete process to be run automatically. The run starts by pumping the system down, carrying out the process and then venting the system. The automatic process run can be carried out by a user logged on at any access level, e.g. Manager, User etc..

Before starting an automatic process run, the rotary vane/roots/dry pumps must be started. It is suggested that once the system is powered up, the Manager logs on, starts the pumps, evacuates the process chamber and then re-logs on for the User or Production Operator to carry out the automatic process run(s).

When the pumps have started and the User or Production Operator is logged on, carry out the automatic process run using the following steps.

1) Insert the wafer into the Automatic load lock. (If necessary, vent the Automatic load lock by selecting the **STOP** button then the **VENT** button).

2) Close the Automatic load lock's lid.

3) In PC 2000, select the System menu and then the Recipe option. The Recipe page is displayed.

4) Load the required recipe.

5) Select the **Run** button. You will be prompted enter a wafer identity; enter the wafer identity and select the **OK** button. The following sequence will be automatically carried out:

   i) The automatic load lock will start to evacuate and the Process page is displayed.

   ii) When the automatic load lock reaches base pressure, the wafer will be transferred into the process chamber.

   iii) When the wafer has been transferred into the process chamber, the recipe will start.

   iv) When all of the process steps have completed, the Pump Control page is displayed, the wafer will be transferred into the automatic load lock and then the automatic load lock will vent.

6) When the vent sequence is completed, open the automatic load lock's lid and remove the wafer.

To process another wafer, repeat the above steps from Step 1). If running the same recipe, Step 4 can be skipped otherwise load another recipe.

NOTES:

a) You can pause the process at any time by selecting the **PAUSE** button. This will cause the Step Time and the plasma power to stop with the current step time indicated. Re-starting the process will cause the process to continue from the time it was paused. If, during the pause period, you change any of the process parameters, e.g. gas demand, pressure etc., you must press the **START** button for the changes made to come into effect, this will cause the step timer to continue from the time it was paused.

b) You can stop the process at any time; the message 'Process Complete' will be displayed, if required, you can then run the same or another process.

5.4.7 Production mode

The production mode facility is provided to make operation of the system as simple as possible. In this mode, the user is provided with a 'special' Recipe page, which allows the user to load and run a recipe and then vent the automatic load lock.

To carry out production mode processing, use the following steps:

1) Log on as a Manager.

2) Start the external rotary vane pump/dry pumps for the process chamber and automatic load lock.

3) Evacuate the process chamber. Do not evacuate the automatic load lock at this stage.

4) Select the system menu, and then select the Passwords option.

5) Log on using the appropriate user name and password for the production mode. The Production mode page is displayed. See sub-section 5.8.5, page 5-38.

6) Open the automatic load lock's lid and place the wafer to be processed on the transfer arm. Close the lid.

7) Select the **Load** button, then select the required recipe from the displayed list and select the **OK** button.

8) Enter a batch identity.

9) Select the **Run** button. The automatic load lock will automatically pump down and the recipe will run. Note that this button only becomes active when a recipe has been loaded and a batch identity has been entered, and the associated indicators are coloured green.

10) When the 'Process Complete' message is displayed, select the **System** menu and then the **Pumping** option to vent the automatic load lock. Note that a Vent Time Remaining counter indicates venting progress.

11) When the automatic load lock has finished venting, open its lid and then remove the processed wafer.

12) You can now carry out a further process by repeating steps 6) to 11). If running the same recipe Step 7) can be skipped, otherwise load another recipe.

13) On completion of production mode processing, log on as a Manager.

5.4.8 Manual process run

1) Insert the wafer into the Automatic load lock. (If necessary, vent the Automatic load lock by selecting the **STOP** button then the **VENT** button).

2) Close the Automatic load lock lid.

3) Select the Automatic load lock's **EVACUATE** button. A dialogue box will be displayed allowing entry of a Wafer Name, if any.

4) Check that the system has pumped down to base pressure. (The process chamber message panel should display 'Base Pressure reached').

5) Select the Process menu, then the Chamber 1 option. Set the parameters as required, e.g. Step Time, RF generator power, chiller temperature, chamber pressure, and gas demands.

6) Ensure that the Automatic load lock is at the required pressure. (Check the relevant panels on the Pump Control page). Green 'ready for transfer' indicators (◀▶) are displayed on each chamber mimic when it is available for vacuum transfer.

7) On the Pump Control page, click on the Automatic load lock wafer mimic. The Robot Control page is displayed (see Fig 5.12, page 5-35).

8) Click on the Process Chamber wafer mimic. The wafer is transferred from the Automatic load lock into the Process Chamber.

9) On the Chamber 1 process page, check that the set parameters are correct for your required process.

10) Click the **START** button. (Note that if this button is not active, the chamber has not reached base pressure.) The process will commence.

NOTES:

a) You can pause the process at any time by selecting the **PAUSE** button. This will cause the Step Time and the plasma power to stop with the current step time indicated. Re-starting the process will cause the process to continue from the time it was paused. If, during the pause period, you change any of the process parameters, e.g. gas demand, pressure etc., you must press the **START** button for the changes made to come into effect, this will cause the step timer to continue from the time it was paused.

b) You can stop the process at any time; the message 'Process Complete' will be displayed, if required, you can then run the same or another process.

WARNING

CONTACT WITH TOXIC GASES CAN CAUSE DEATH OR SERIOUS INJURY.

WHERE ANY PROCESS GAS IS TOXIC, DO NOT TRANSFER A WAFER FROM THE PROCESS CHAMBER TO THE LOAD LOCK UNTIL ALL PROCESS GAS HAS BEEN PUMPED OUT.

ENSURE THAT THE AUTOMATIC VENT SEQUENCE IS ALLOWED TO COMPLETE.

IF THESE PRECAUTIONS ARE NOT CARRIED OUT, THERE COULD BE A HAZARD IN THE LOAD LOCK.

11) When the 'Process Complete' message is displayed, select the Pump Control page and move the wafer from the process chamber to the Automatic load lock using the same method as the transfer in.

12) Open the Automatic load lock's lid and remove the wafer.

13) If required, the system can now be vented, see sub-section 5.4.9 page 5-20.

5.4.9 Venting the system

WARNING

CONTACT WITH TOXIC GASES CAN CAUSE DEATH OR SERIOUS INJURY.

BEFORE VENTING THE PROCESS CHAMBER, ALWAYS ENSURE THAT THE SYSTEM IS ADEQUATELY PURGED AND PUMPED.

Do not vent a system which has used toxic gases unless the system has been adequately pumped first.

For example: Gases having Threshold Limit Values (TLVs) of 1ppm or below, e.g. Chlorine, require at least 20 minutes pumping before venting.

After venting, there may still be residual gases in the process chamber. Consider wearing suitable personal protection, e.g. a respirator.

To vent the system, use the following steps.

1) From the System menu, select the Pumping option.

2) On the Pump Control page, select the **STOP** button then the **VENT** button for each chamber. Note that the vent sequence is controlled by a timer to allow time for the turbo pumps to 'spin' down.

3) When all of the 'Vent Time Left' timers have decremented to zero, all of the pumps have been switched off automatically, and the complete system has been vented.

Do not attempt to open the process chamber lid until the vacuum switch has changed status, i.e. to its high-pressure status (In this condition, on the Pump Control page the vacuum status field will display 'FAULT').

5.5 Creating and editing recipes

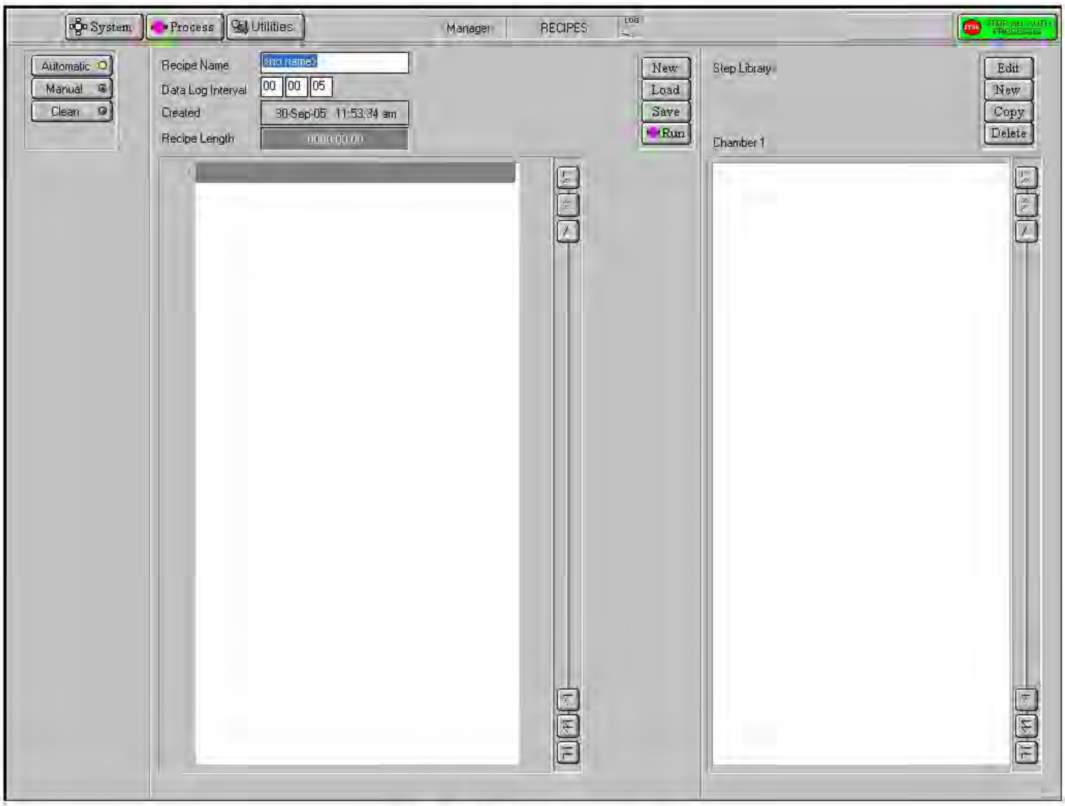


Fig 5.3: Recipe screen

This page is used to assemble and store in memory all the set points and instructions which make up a Recipe for an Automatic Mode run. These recipes consist of a sequence of process Steps. 'Drag and Drop' facilities are provided to copy library steps into a recipe.

NOTE: For a description of the facilities on this page, refer to sub-section 5.8.4, page 5-36.

The **Recipe** option (accessed from the **PROCESS** button) displays the recipe page for the process chamber. This page allows you to create / edit recipes and the recipe steps that they contain.

NOTE: Before creating / editing recipes, make sure that you understand the operation of key components of the system to ensure that recipes proceed as expected.

A recipe is created by adding steps from the **Step Library** to the Recipe Step Name fields. The recipe is then allocated a Data Log Interval and saved.

5.5.1 Working with recipe steps

Recipe steps are stored in the **Step Library** list. The list can contain any number of steps, depending on available hard disk space. When the displayed list is full, it becomes scrollable to allow you to view all of the list contents.

CREATE A NEW RECIPE STEP

To create a new recipe step, use the following procedure:

1) In the Step Library panel, select the **NEW** button. The Step Edit page is displayed.

2) Enter the step parameters as required, then click on **OK**. The step is automatically saved.

To create a recipe step, based on an existing recipe step, use the following procedure:

1) Select a recipe step from the **Step Library** list, i.e. click on it to highlight it.

2) Select the **COPY** button. Enter a new step name.

3) Edit the step parameters as required, then click on **OK**. The new recipe step is automatically saved.

EDIT AN EXISTING RECIPE STEP

To edit an existing recipe, use the following procedure:

1) Select a recipe step from the **Step Library** list, i.e. click on it to highlight it.

2) In the Step Library panel, click on the **Edit** button.

3) Edit the step's process parameters as required, then click on **OK**. The step is automatically saved.

NOTE: Changing an existing recipe step will not alter saved recipes, which use the old version of that step.

DELETE A RECIPE STEP

To delete a recipe step, use the following procedure:

1) Select the recipe step from the **Step Library** list, i.e. click on it to highlight it.

2) Select the **DELETE** button; the selected recipe step is deleted.

5.5.2 Working with recipes

Recipes are 'built' using existing recipe steps, and edited as required.

Within a recipe, steps can be manipulated using the **Step Commands** pop-up menu (accessed by clicking on the Recipe Steps field).

Fig 5.4: Step Commands pop-up menu

The **Step Commands** pop-up menu provides the following options:

Edit Step Enables the selected (highlighted) step to be edited.

Repeat Step Repeats all subsequent steps until a Loop Step is reached. This group of steps can be repeated any number of times. (When you select this option, you are prompted to enter the number of times the group of steps is to be repeated.)

Loop Step Terminates a Repeat Step group.

Insert Step Creates a 'gap' above the selected step to allow another step to be dragged into the list.

Delete Step Deletes the selected step from the list.

Cancel Closes the **Step Commands** pop-up menu.

BUILD A RECIPE

To build a recipe, use the following procedure:

1) In the Recipe panel, select the **NEW** button.

2) Click on a recipe step in the **Step Library** list, hold the left mouse button down then drag the mouse pointer to the **Step Name** field next to the asterisk (*) then release the mouse button. The step name is displayed in the **Step Name** field.

3) Repeat 2) as required to add further steps to the recipe. Note that once you have filled the Step Name field, the recipe step list becomes scrollable, enabling you to add a maximum total of 1000 steps.

4) To remove a step from the list, click on it to highlight it then select the **Delete step** button from the **Step Commands** pop-up menu. Any further steps will move up the list by one place.

5) To add a step before an existing step, click on the existing step then select the **Insert step** button from **Step Commands** pop-up menu. The selected step and all those following it will move down the list by one place. You can then drag another step from the **Step Library** list into the now vacant field.

6) When all steps have been added, enter a time into the **Data Log Interval** field, then enter a name for the recipe in the **Recipe Name** field. Finally, select the **SAVE** button.

EDIT A RECIPE

To edit a recipe, use the following procedure:

1) Select the **LOAD** button, then select the recipe to be edited.

2) In the Step Commands pop-up menu, click on the Edit Step button, then edit the process parameters as required. Note that editing a recipe step will not affect the associated step, i.e. a step having the same filename, in the Library of Available Steps.

3) To remove a step from the list, click on it to highlight it then select the **DELETE STEP** button from the **Step Commands** pop-up menu. Any further steps will move up the list by one place.

4) To add a step before an existing step, click on the existing step then select the **INSERT STEP** button. The selected step and all those following it will move down the list by one place. You can then drag another step from the **Step Library** list into the now vacant field.

5.6 Process Datalog

All processes are automatically data-logged. The interval between logging events is set in the Recipe screen.

The Process Datalog facility allows you to view process data runs and associated comments. The facility comprises three pages:

a) SELECT LOG page – allows you to select the process data to view.

b) RUN LOG page – lists the selected process data, for all runs except Leak detection runs and MFC calibration runs, with respect to time.

c) Leak detection and MFC calibration log page – displays the Leak detection runs and MFC calibration runs in text and graphical formats.

These pages are described in the following text.

5.6.1 Select Log page

The Select Log page is displayed by selecting the **Process** button, then the **Log View** option.

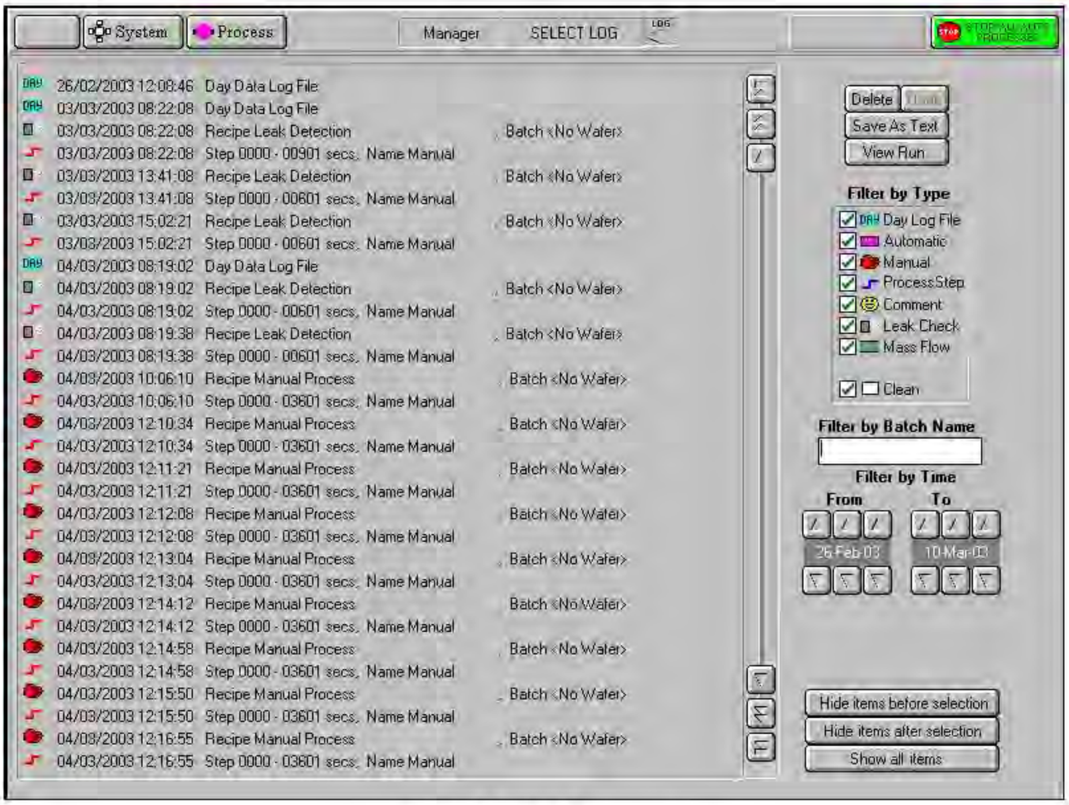


Fig 5.5: Select Log page

The page comprises a list of logged events, which can be filtered by type, batch name and time. When the required events have been selected, they can be viewed on a Log View page.

The facilities provided on the page are as follows:

List of logged events	Displays a list of logged events in a date/time sequence. Each event is identified by an icon, date, time, title, duration, name and comments (if present). An event is selected (highlighted) by clicking on it.
Delete button	Deletes the selected event
Undo button	Undo the last action
Save As Text button	Save the selected event as a text file for use in spreadsheets etc.
View Run button	Opens either the Run Log page (see sub-section 5.6.2, page 5-28) or, if either a Leak detection run ( ) or MFC calibration run ( ) is selected, the Leak Detect and MFC calibration log page (see sub-section 5.6.3, page 5-29) with the selected log data displayed.
Filter by Type list	A list of event types with associated checkboxes. Use this panel to select the events to display in the Event list. A checkbox showing an '**x**' indicates that the associated event type will not be displayed. A checkbox showing a '✓' indicates that the associated event type will be displayed.
Filter by Batch Name field	Enter a batch name to list only logged events associated with that batch.
Filter by time fields and buttons	Use these controls to select events occurring in a time range to be displayed.
Hide items before selection button	Displays all events after and including the highlighted event.
Hide items after selection button	Displays all events before and including the highlighted event.
Show all items button	Displays all previously hidden events.

5.6.1.1 Saving a log file as text for use in Microsoft Excel™

NOTE: OIPT now supplies customers with comprehensive software to view/analyse PC 2000 log files. The software, LogViewer, is provided on the system PC. For full details of LogViewer, refer to its Manual by following the shortcut on the desktop of your system PC.

Any logged process run can be saved at text and then opened in Excel for viewing, analysing, etc. To do this, use the following steps:

1) On the Select Log page, select the required process run (any multiple steps will be automatically highlighted).

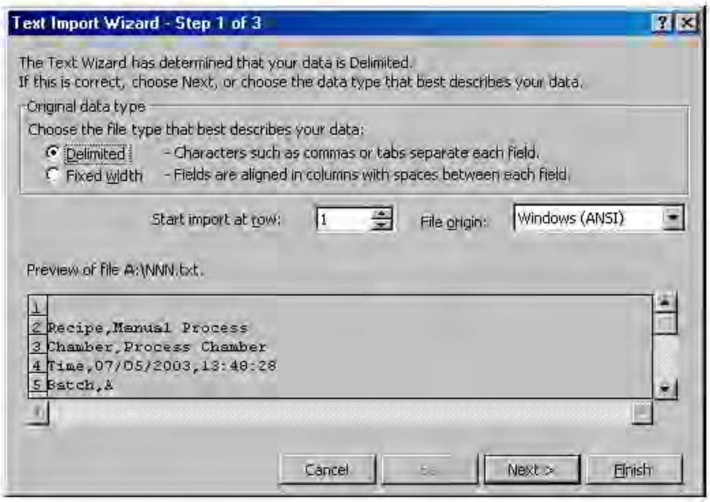
2) Select the **Save As Text** button. The **Save As** dialogue is displayed.

3) Navigate to the target location for the log text file, enter a filename and in the 'Save as type:' field select 'Log Text Files (*.Txt)' from the drop-down list. If saving to a floppy disk, label it and insert into the drive now.

4) Select the **Save** button. The text file is saved in your chosen location.

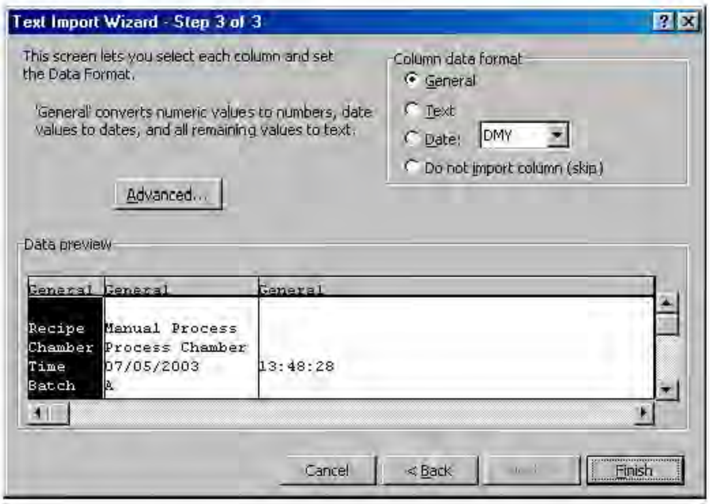
5) Start Excel and then in the File menu, select the Open option. The 'Open' dialogue is displayed.

6) Navigate to the location of the saved text file and in the 'Files of type:' field, select 'All Files (*.*)' from the drop-down list. Select the required text file and then select the **Open** button. The 'Text Import Wizard – Step 1 of 3' dialogue is displayed:



7) In the 'Original data type' panel, select the 'Delimited' option and then select the **Next >** button. The 'Text Import Wizard – Step 2 of 3' dialogue is displayed:

8) In the 'Delimiters' panel, select the 'Comma' checkbox. Select the **Next >** button. The 'Text Import Wizard – Step 3 of 3' dialogue is displayed:



9) In the 'Column data format' panel, ensure that the 'General' option is selected and then select the **Finish** button. The process run log data is now displayed in the Excel worksheet.

10) Adjust the column widths so that all text is visible and then save the spreadsheet.

5.6.2 Run log page

The Run Log page is accessed from the Select Run page by clicking on the **View Run** button with any process run other than a leak detection run ( ) or MFC calibration run ( ) selected.

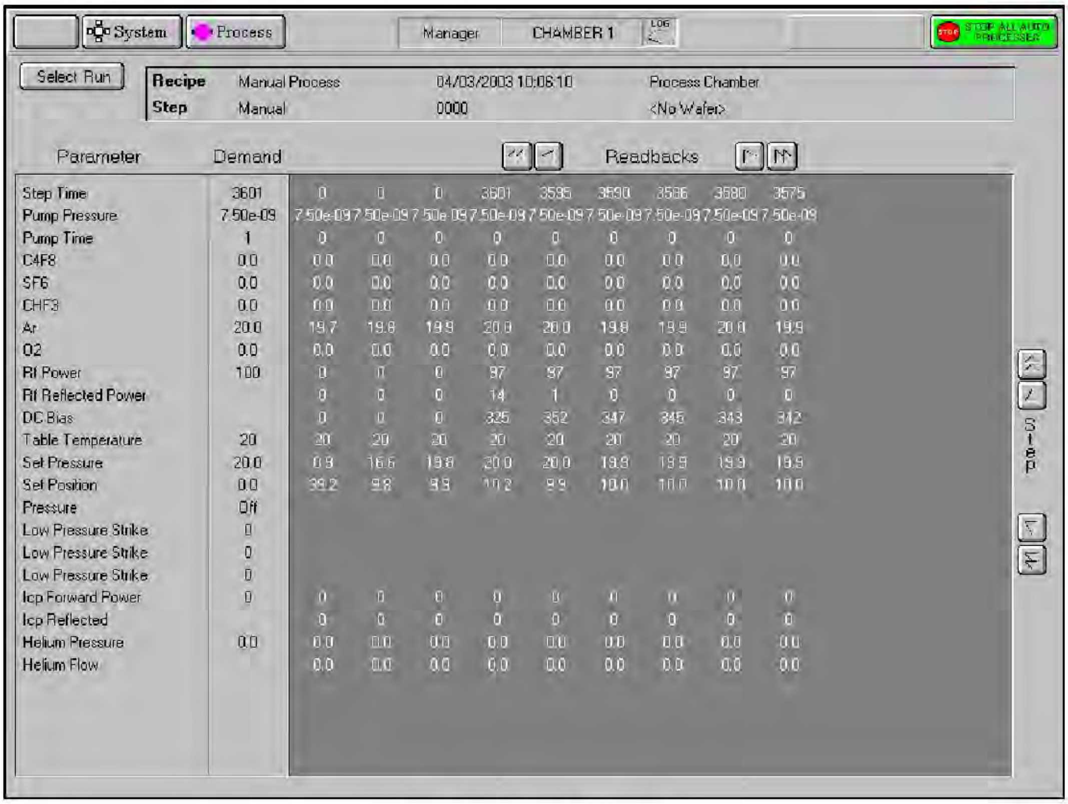


Fig 5.6: Run log page

The page displays the Parameters, Demands and Readbacks for the selected log data.

The facilities provided on the page are as follows:

Select Run button	Displays the Select Log page.
Log information panel	Displays details about the selected log data.
Parameter list	Lists the logged parameter names
Demand list	Displays the demanded parameter value
Readbacks list	Displays the logged parameter values with respect to time at the log intervals specified for the process run. The list can be scrolled horizontally either by single readbacks or by page. The list can also be scrolled vertically to display further steps (for multi-step recipes).

5.6.3 Leak detection and MFC calibration log page

The leak detection and MFC calibration log page is accessed from the Select Run page by selecting either a leak detection run ( ) or MFC calibration run ( ) and then clicking on the **View Run** button.

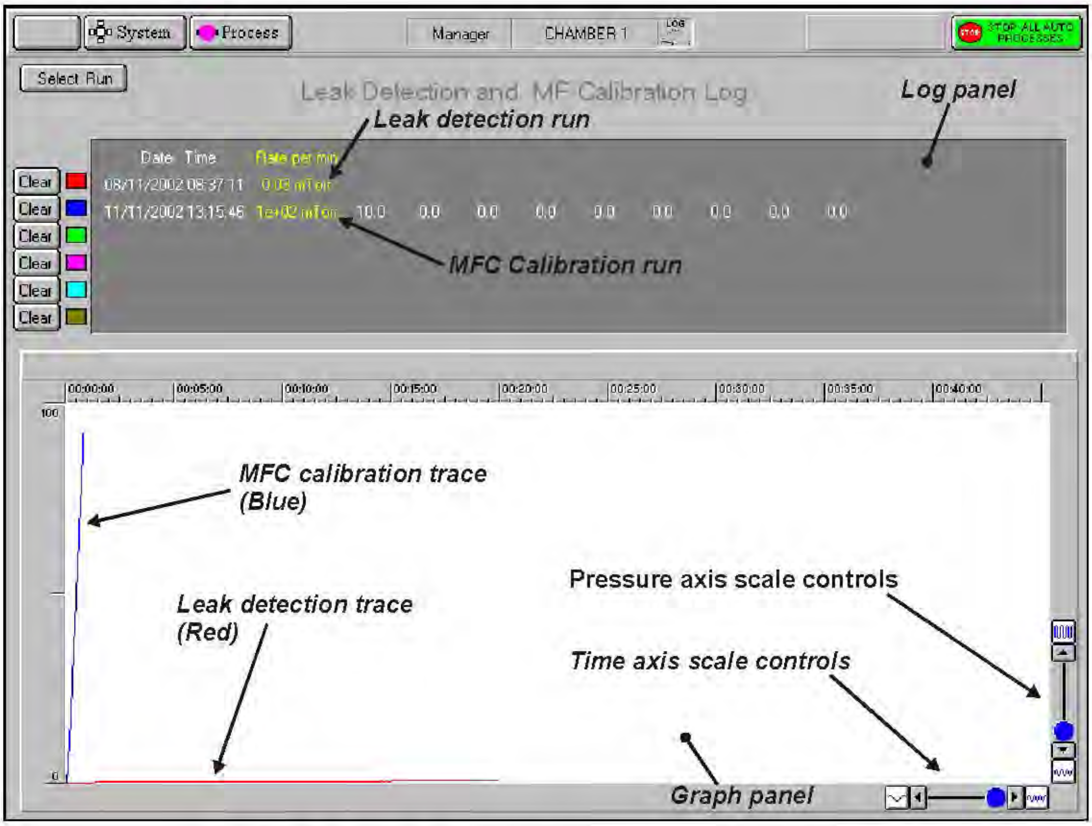


Fig 5.7: Typical leak detection and MFC calibration log page

This page is used to view details of up to six leak check runs and/or MFC calibration runs. Note that Fig 5.7 shows details of a leak test (red trace) and an MFC calibration run (blue trace).

The facilities available on this page are:

Select Run button	Displays the Select Run page.
Clear buttons	Select to remove the associated data from the log panel and graph panel. Note that to re-display the cleared data, you must return to the Select Run page and re-select it.
Log panel	Displays details of each run in text format.
Graph panel	Displays a plot of each run (pressure versus time). Each run is represented by a coloured trace as indicated by the palette displayed adjacent to the run data in the Log panel. The graph can be scaled in each axis by the controls located at the bottom-left corner of the graph.

5.7 Operator adjustments

5.7.1 Adjusting the nitrogen regulator outlet pressure

NOTE: Refer to Section 2 for a description of the Nitrogen vent distribution circuit.

The regulator outlet pressure should not usually require adjustment from its factory setting. However, if adjustment is necessary, proceed as follows.

WARNING

THIS PROCEDURE INVOLVES WORKING ON THE SYSTEM WITH COVERS REMOVED AND WITH THE ELECTRICAL POWER ON. THEREFORE IT MUST ONLY BE CARRIED OUT BY TRAINED AND COMPETENT PERSONNEL WHO ARE AWARE OF THE RISKS INVOLVED.

1) Remove system panels as necessary to gain access to the regulator.

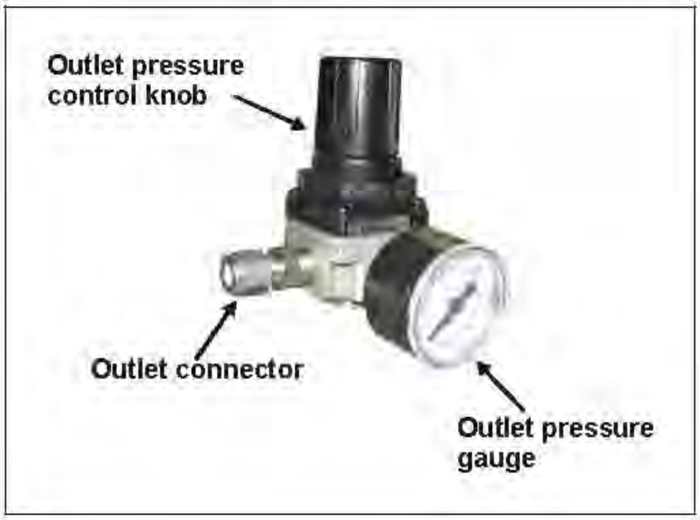


Fig 5.8: N_2 Pressure regulator/gauge

2) Adjust the regulator outlet pressure control knob to set the outlet pressure to the maximum which will not open the check valve; normally 0.5 to 0.7 bar gauge as indicated on the regulator gauge.

   NOTE: Setting the outlet pressure too low will extend system venting times excessively, and may compromise the purge gas flow to the turbo pump if fitted. Setting the outlet pressure too high will open the check valve and waste gas, but will not reduce venting times.

3) Refit all system covers.

4) Carry out a simple process to check that the vent sequence operates correctly.

5.7.2 Rotary/dry pump N_2 purge flow rate adjustment

CAUTION

If the rotary/dry pump's N_2 purge flow rate is inadequate, damage to the pump could occur.

Ensure that the flow rate is set to the value recommended by the pump manufacturer.

The rotary/dry pump's N_2 purge flow rate is set at the factory before system shipment and should not need adjustment. However, the pump purge rate will need to be confirmed on installation and at any time the purge gas supply pressure changes significantly. If adjustment is necessary, refer to Appendix R in this manual.

5.8 PC 2000 screens

5.8.1 Status indicators

These indicators, displayed at the bottom of the pump control page, Chamber 1 process page and Service mode page, give the status of the system and process chamber.

System status indicators

Gas Pod Interlock — Green = OK, Red = Fault. Refer to sub-section 3.4.2 for details.

Water Flow RF — Green when the RF Generator cooling water flow is in tolerance, Red when the flowswitch is tripped (i.e. no cooling water flow).

Water Flow ICP — Green when the ICP cooling water flow is in tolerance, Red when the flowswitch is tripped (i.e. no cooling water flow).

Process chamber status indicators

PSU: — Green when the **+15V**, **-15V** and **+24V** dc supplies are healthy. Red when a supply is faulty.

N2 Vent Gas: — Green when N2 supply is satisfactory. Red when supply pressure is out of tolerance.

5.8.2 Pump control page

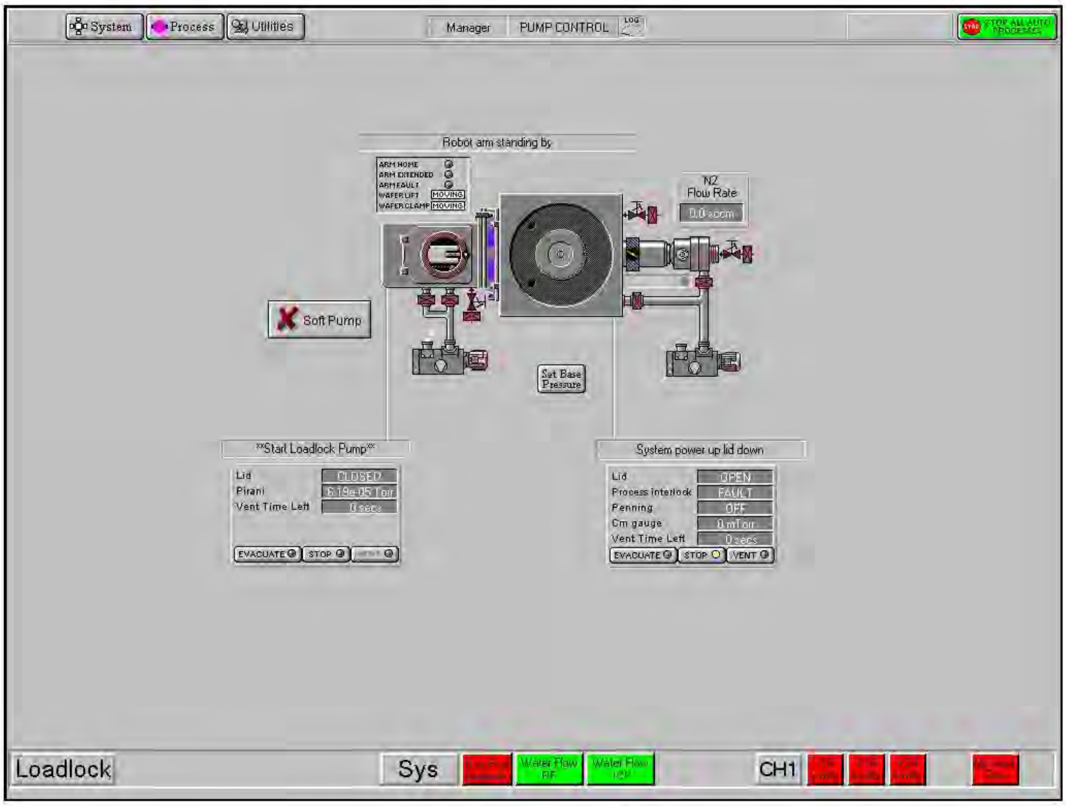


Fig 5.9: Pump control page

The pump control page provides control and monitoring of the vacuum system. The page has the following features:

Vacuum system mimic

The vacuum system mimic is shown in Fig 5.10. Each chamber contains a wafer indicator which when coloured green indicates that a wafer is present in the chamber. Clicking on a green wafer indicator will display the Robot Control page showing the possible wafer destination.

Note that the Automatic Pressure Controller (APC) mimic displays the current status of the valve, i.e. open, closed, mid position or fault (indicated by a red dot).

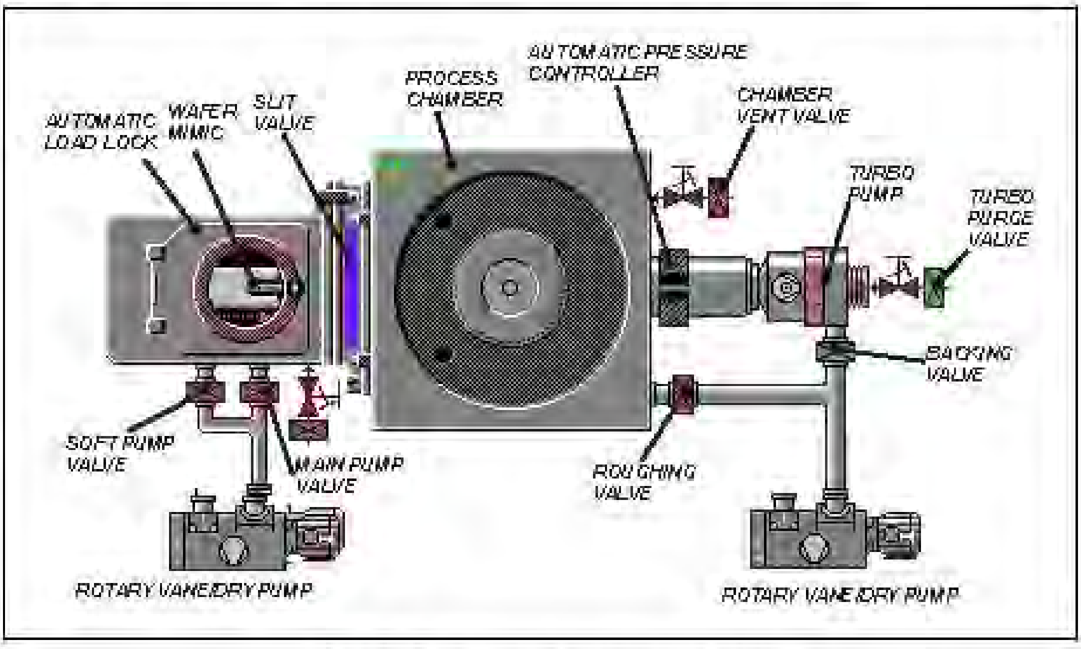


Fig 5.10: Pump control page vacuum mimic

Operator interface

The Pump Control page Buttons, controls, indicators and message panels to allow you to control the vacuum system and wafer transfers are shown in Fig 5.11.

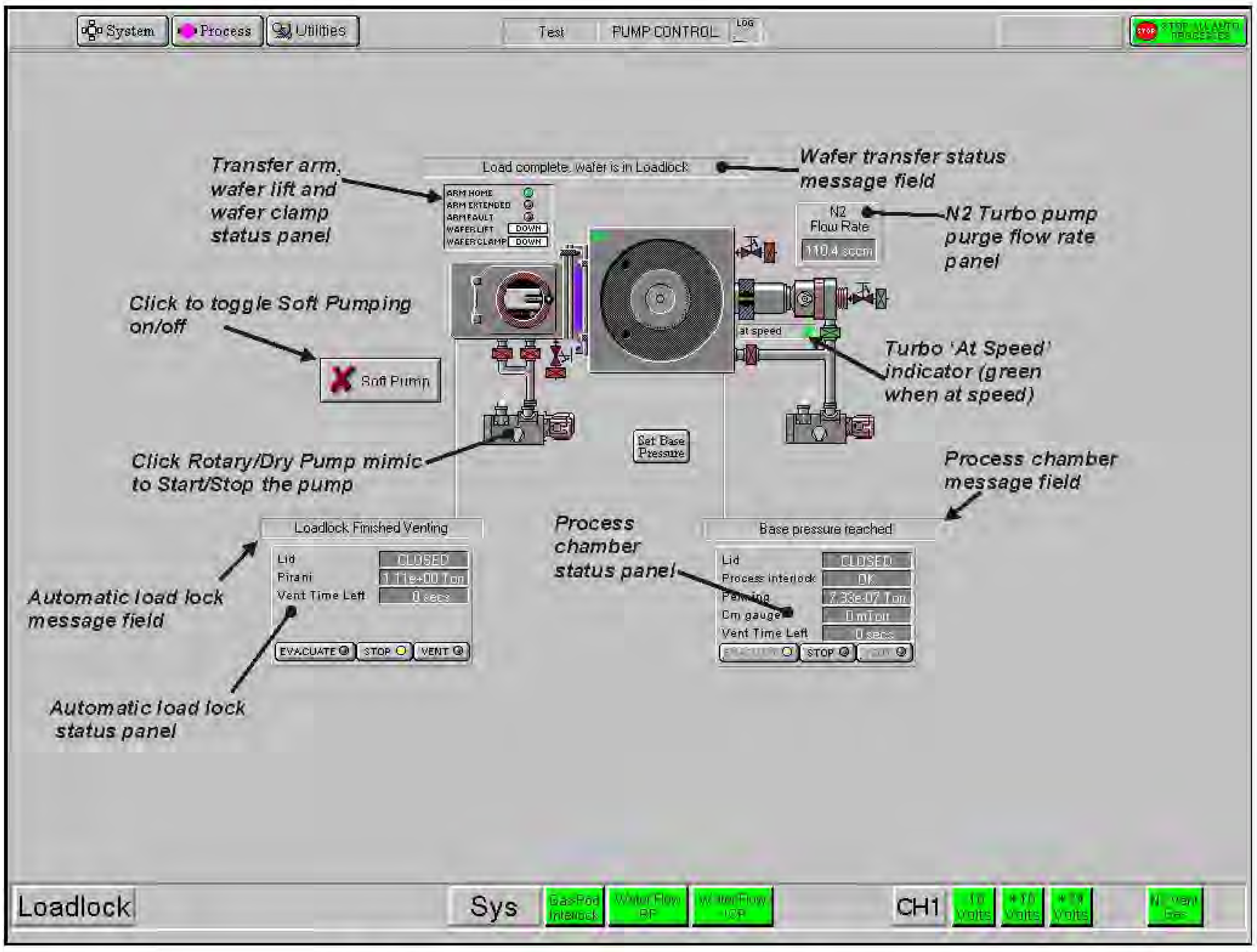


Fig 5.11: Pump control page operator interface

The operator interface facilities are labelled in Fig 5.11.

The following controls are provided:

a) Control and status panels for the process chamber and Automatic load lock. Each Control and status panel has associated EVACUATE, STOP and VENT buttons.

   i) **EVACUATE** buttons: Select to pump-down the associated chamber.

   ii) **STOP** buttons: Select to stop either pumping down or venting the associated chamber. Note that the **STOP** button must be selected before venting to ensure the correct sequencing of the valves.

   iii) **VENT** buttons: Select to vent the associated chamber.

b) Mimics of all valves showing open/closed status (coloured green when open, red when closed).

c) Rotary/dry pump controls. Clicking on a rotary/dry pump mimic will switch the associated pump on or off (a running rotary pump is indicated by animation).

d) Transfer arm, Wafer lift and Wafer clamp status panel. Displays indicators for ARM HOME, ARM EXTENDED and ARM FAULT (illuminated when active). Also displays WAFER LIFT and WAFER CLAMP status (up, down, moving or fault). See the following table.

Message	Meaning
UP	The UP microswitch is detected as active.
DOWN	The DOWN microswitch is detected as active.
MOVING	Both microswitches are detected as inactive.
FAULT	Both microswitches are detected as active.