AIXTRON



CRIUS II

System Manual

Edition 06/2010

CONFIDENTIAL

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1 Use, data

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1.1 Introduction

1.1.1 Validity of this System Manual

Document identification: System Manual, crius_II_en_00, Edition 06/2010

This System Manual describes the CRIUS II.

You find the project number on the type label of your system.

This System Manual may show or describe components which are not part of the AIXTRON scope of delivery. Such information is intended for better understanding. However, AIXTRON excludes any liability for such components and the corresponding information.

1.1.2 Intended use of the CRIUS II

The CRIUS II is intended for epitaxial deposition of materials on wafers using CVD technology. (CVD = chemical vapor deposition).

To guarantee that the system is run in accordance with the binding stipulations, you must:

- Be qualified for working with the CRIUS II
- Read and observe the information contained in this System Manual
- Adhere to the technical data
- Perform maintenance work punctually

1.1.3 Other uses and applications

Written permission from AIXTRON AG (AIXTRON) is required for uses other than those stipulated above. Any use beyond the applications described above will be regarded as not conforming to provisions. AIXTRON declines all liability for damages which occur when stipulations are disregarded.

1.1.4 Use of this System Manual

This System Manual contains the information required to ensure that the CRIUS II is used correctly. The System Manual is considered to be an integral part of the CRIUS II. It must always be at hand near the CRIUS II.

The System Manual describes all stages of the serviceable life of the CRIUS II: Transport, installation, initial commissioning, operation, maintenance (preventive work), service (corrective work, repair), storage, disposal. Check the table of contents to locate the relevant chapter.



NOTE:

Read Chapter 2 Safety, 🗎 17 prior to any work at the CRIUS II! It contains important information for your own personal safety. This chapter must have been read and understood by all persons who work at the CRIUS II during any stage of its serviceable life.

AIXTRON delivers user documentation along with the product. Documents can be re-ordered:

service@aixtron.com

Contact us if you have queries about the contents of the documentation or if you wish to give us feedback.

1.1.5 Worldwide AIXTRON service centers

For contact addresses of the worldwide AIXTRON service centers, please refer to:

www.aixtron.com

1.2 User qualifications

Access rights

The end user assigns access rights to his personnel according to their level of training, knowledge, experience and responsibility.

The following four access levels are defined for the CRIUS II by default.

- Viewer
- Operator
- Technician
- Supervisor

For more information refer to the AIXACT software manual.

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1.3 Training

This document is intended for technically qualified personnel who have successfully passed appropriate training for their access right on the CRIUS II. This training must have been performed or authorized by AIXTRON. Only appropriately trained personnel can correctly implement the safety regulations contained in this document.

Personnel without this training are considered as unauthorized. Unauthorized personnel are not permitted to work on the CRIUS II. AIXTRON declines all liability for damages which occur when stipulations are disregarded.

AIXTRON offers standard and user-tailored training for AIXTRON products. The training team will be pleased to provide you with further information.

Please send an e-mail to: service@aixtron.com

1.4 System identification

1.4.1 Type label

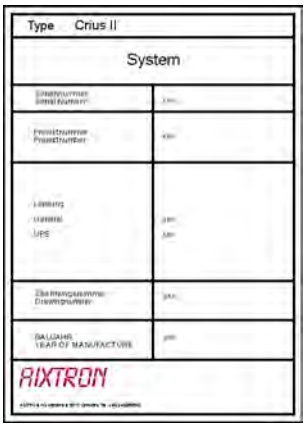
The type labels identify the specific system and includes details of any customer-specific adaptations.

State all details shown on the type label when you contact AIXTRON. Whenever possible, also state the displayed software sequence step when you make diagnosis inquiries in the event of disturbances. This ensures fast and optimum support.

The following type labels are attached to the CRIUS II:

- System type label
  Details of the system
- Heater type label
  Details of the heater

Fig. 1-1, 🗎 10 and Fig. 1-2, 🗎 10 show the type labels.



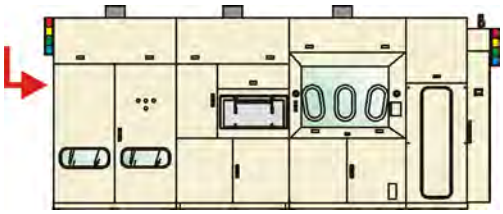
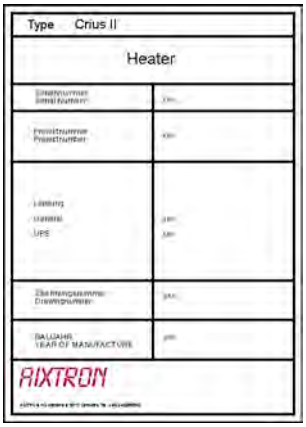


Fig. 1-1 *System type label*



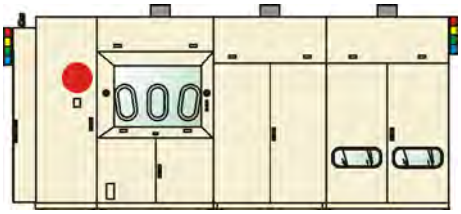


Fig. 1-2 *Heater type label*

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1.5 Dimensions and weight

NOTE:

The technical data stated here may differ from the information in the installation plan. If this is the case, the data contained in the installation plan are binding.

1.5.1 Dimensions

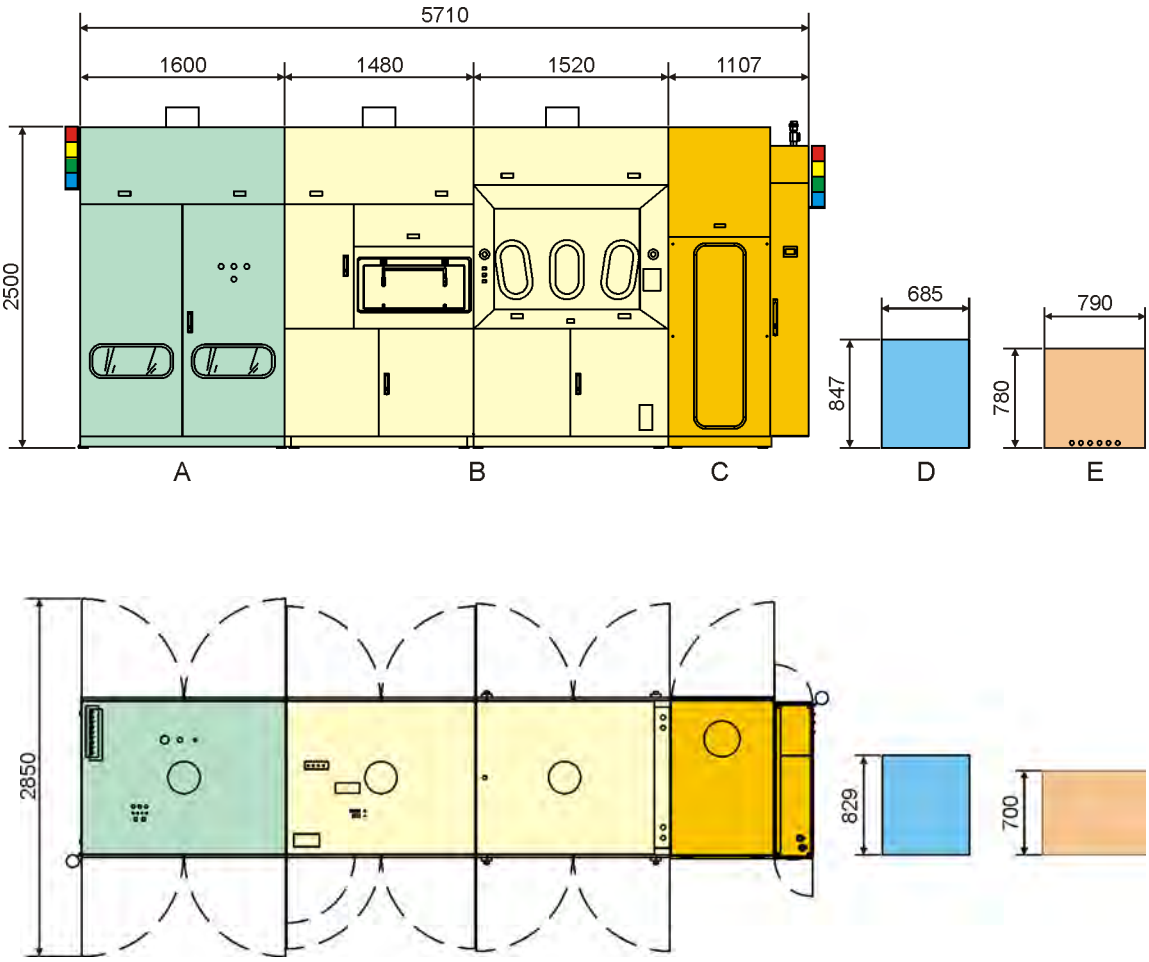


Fig. 1-3 *Dimensions of the CRIUS II [mm]; Side view and top view*

A Gas mixing cabinet
B Reactor cabinet
C Heater power supply unit
D Heat exchanger
E Transformer

1.5.2 Weight

Component	Weight [kg]
Gas mixing cabinet	Approx. 2800 kg
Reactor cabinet	Approx. 3800 kg
Heater power supply unit	Approx. 900 kg
Transformer	Approx. 280 kg
Heat exchanger	Approx. 171 kg

Tab. 1-1 *Weight*

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1.6 Installation data

For installation data refer to the installation plan.

NOTE:

The technical data stated here may differ from the information in the installation plan. If this is the case, the data contained in the installation plan are binding.

1.6.1 Amperes interrupting capacity (AIC)

Amperes interrupting capacity	35 kA

The main switch of the CRIUS II can break a fault current of 35 kA.

1.6.2 Environmental conditions

The CRIUS II is for use within a clean room environment, at an operating temperature of approx. 25 °C and a relative humidity of approx. 60 % (not higher than 80 %).

	Storage	During operation
Temperature	10…50 °C	15…25 °C
Relative humidity	30…80 % (non-condensing)	45…80 % (non-condensing)

Tab. 1-2 *Environmental conditions*

1.6.3 Pneumatic supply

The pneumatic supply is recommended to be a low purity N_2 supply, to prevent any oxygen entering the hydrogen lines in the unlikely event of a valve leaking its pneumatic feed over the valve stem.

NOTE:

Prevent condensation! The temperature of the pneumatic supply must exceed the dew point of the ambient air by at least 2 °C. See Fig. 1-4, 14.

1.6.4 Cooling water

NOTE:

Prevent condensation! The temperature of the cooling water must exceed the dew point of the ambient air by at least 2 °C. See Fig. 1-4, 14.

Dew point diagram

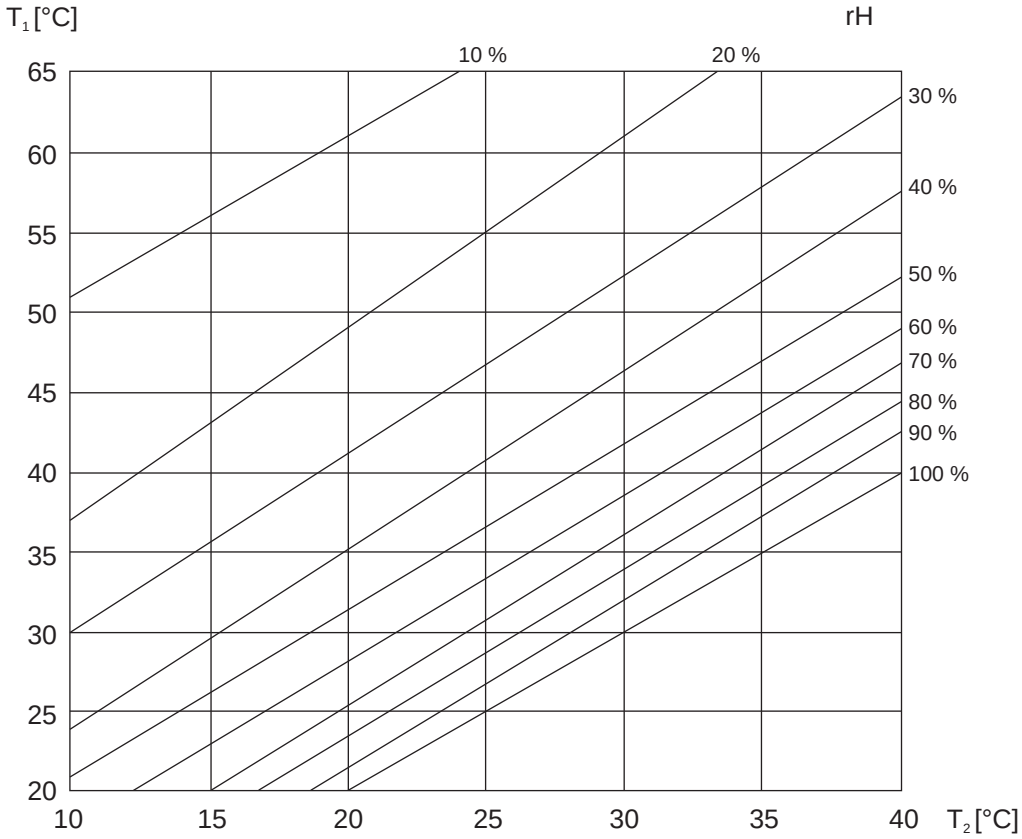


Fig. 1-4 *Dew point diagram*

T_1 Room temperature
T_2 Minimum cooling water temperature
rH Relative humidity

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Cooling water quality

NOTE:

Treat the cooling water with biocide to avoid excessive microbiological concentration.

The following table lists the requirements for cooling water flowing through circuits with and without aluminum components.

	Circuit with Al components	Circuit without Al components
pH	7.5 … 8.0	7.0 … 8.0
German hardness	< 7.5 °dH	< 7.5 °dH
US hardness	< 0.05 ppm	< 0.05 ppm
Total dissolved solids	1…2 ppm	10 ppm
Oil content	< 1 ppm	< 1 ppm
Micro biologicals	< 10^2 cfu *)	< 10^2 cfu *)
Conductivity at 25 °C	2…25 µS/cm	< 110 µS/cm
Resistivity at 25 °C	40…500 kΩcm	
Concentration of inorganic ions		
Chloride	< 0.5 ppm	< 10 ppm
Sulfate	< 20 ppm	< 25 ppm
Nitrate	< 0.1 ppm	
Cyanide	< 12 ppm	
Sodium	< 0.5 ppm	< 0.3 ppm
Calcium	0.6 ppm	0.6 ppm
Magnesium	0.1 ppm	0.1 ppm
Potassium	0.3 ppm	0.3 ppm
Silicate	< 0.1 ppm	< 1.0 ppm
Copper	< 30 ppb	
Aluminum	< 1 ppm	
Ammonia	< 1.7×10^{-3} ppm	
Oxygen	< 20 ppm	
Ozone	< 0.1 ppm	

Tab. 1-3 *Water quality*

**) cfu = colony forming units*

1.7 Conformance statement

Fig. 1-5, 16 shows an example of the EC declarartion of conformity for machines.

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EC Declaration of Conformity for Machines

(according to the Directive for Machines 2006/42/EC, Annex II, sub. A)

Aixtron AG
Kaiserstr.98
D- 52134 Herzogenrath

DIN EN ISO 9001:2000 certified

hereby declares that the design of the system

Type: AIX …
Serial No.: 1001…

corresponds in its delivered type to the following relevant regulations:

- EC-Directive for Machines 2006/42/EC
- EC-EMC (Electro Magnetic Compatibility) Directive 2004/108/EC
- EC-Low Voltage Directive 2006/95/EC

Applied harmonized and national standards as well as technical specifications:

- EN 1037
- EN 13850
- EN 14121-1
- EN 60204-1
- EN 12100-1
- EN 12100-2
- EN 61000 -6-1
- EN 55011

Aachen, 2010-02-26

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Bevollmächtigter für die technischen Unterlagen

This declaration does not contain a gratification for properties. Please follow the safety guidelines of the delivered product documentation. In case of non-agreed modifications of the product without the consent of AIXTRON this declaration loses its validity.

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Fig. 1-5 EC declaration of conformity (example)

2 Safety

2 Safety

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2.1 Introduction

2.1.1 Compulsory reading material!



NOTE:

Read this chapter prior to any work at the CRIUS II! It contains important information for your own personal safety. This chapter must have been read and understood by all persons who work at the CRIUS II during any stage of its serviceable life.

2.1.2 Residual dangers

The CRIUS II is constructed according to the most recent state of the art technology and to the officially approved safety regulations. The equipment has been subjected to a meticulous safety check and a safety acceptance test.

However it is impossible to rule out the possibility of residual dangers during operation. Hazards exist:

- For personal safety of the operator
- For the CRIUS II and other property

For this reason, all work carried out in conjunction with the CRIUS II must be performed by trained personnel only and in accordance with this System Manual. The technical data must be observed on principle.

2.1.3 Responsibilities regarding safety

AIXTRON scope of responsibility
AIXTRON is responsible for the safety of the CRIUS II.

End user scope of responsibility
The end user is responsible for safety in the workspace around the CRIUS II. The end user is also responsible for making sure that all safety regulations pertaining to work at the CRIUS II are adhered to.

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2.2 General safety regulations for the end user

2.2.1 Personnel

All personnel who work at the CRIUS II must have the required technical qualifications and have received appropriate instruction and training. They must be informed about all dangers and risks in conjunction with this system.

Unauthorized persons are not allowed access to the CRIUS II.

2.2.2 System documentation

The system documentation consists of the System Manual, the basic documentation, the electrical documentation and the OEM manuals.

Reading and understanding

The end user must ensure that each person who works at the CRIUS II during any stage of its serviceable life has read and understood the relevant parts of the system documentation.

Basic documentation, electrical documentation

The basic documentation (e.g. installation plan) and the electrical documentation are customer specific and are an integral part of the system documentation.

OEM manuals

OEM manuals (OEM = original equipment manufacturer) will contain safety-relevant information and are an integral part of the system documentation.

Safekeeping

The system documentation is delivered with the CRIUS II and is an integral part of the product. The system documentation must always be at hand near the CRIUS II.

Completeness

Always use a complete and original version of the system documentation! Sections in the documents may contain cross-references to other sections which, in turn, include important information. Incomplete copies of the system documentation cannot convey all the necessary information.

2.2.3 Transport, installation and commissioning

Transport, installation and commissioning of the CRIUS II may only be carried out when technically qualified and authorized AIXTRON personnel supervise the work.

Supply connections

The end user provides the connections to supply the CRIUS II with electric power, gases, compressed air, water, etc. in the required capacity and quality.

Supply lines for these media must be laid at an adequate distance to each other. The lines must be protected against all kinds of mechanical damage or stress. Lines on the floor must be covered properly to prevent the risk of tripping.

Exhaust gases

The end user must take appropriate measures to ensure a safe removal and eco-friendly disposal of the exhaust gases.

Safety labels

Safety labels must be used to notify personnel of residual dangers. The safety labels must be mounted in the CRIUS II production area at all necessary locations.

Acceptance check

Subsequent to initial commissioning, the end user is responsible to perform a system acceptance check according to the local regulations concerning prevention of accidents.

At the end of a successful system acceptance check, the acceptance report will be signed by an authorized representative from AIXTRON and by a specialist delegated by the end user.

2.2.4 Operation

The CRIUS II must only be used as stipulated. See Chapter 1.1.2 Intended use of the CRIUS II, 🗎 6.

All work instructions and procedures which could impair personnel or equipment safety are strictly prohibited. The branch-specific and local regulations concerning prevention of accidents must be followed.

Work place

With appropriate instructions and checks, the end user guarantees for a work environment around the CRIUS II that is orderly and clean. The work place lighting should provide a minimum level 500 lux or should conform with the local regulations.

Escape, rescue and alarm plan

The end user is responsible for creating an escape, rescue and alarm plan for the work place and the CRIUS II surroundings.

Waste

The end user is responsible for the eco-friendly removal and disposal of ecologically harmful waste produced by specific processes.

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2.2.5 Maintenance and service

The end user is obliged to make sure that the CRIUS II is only operated when it is in a perfectly sound technical operating condition. All maintenance and service work must be performed in accordance with the information provided in the system documentation.

Operating state

Bring the CRIUS II to the particular operating state that is required for all maintenance or service work.

Lockout/tagout (LOTO)

Make sure that the relevant system parts are de-energized and that they cannot be switched on again for the duration of the work. This must be done according to the lockout/tagout procedure.

Safety devices

Only remove safety devices once the CRIUS II is completely shut down and disconnected from the mains supply. Make sure that the removed safety devices have been reinstalled and remounted before the unit is switched on again.

Spare parts

Use only original spare parts. Non-original spare parts can cause malfunctions, equipment damage or even fatal injuries.

All orders for parts must contain the order number and a description of the required part. Refer to the provided CD «Spare Parts & Services».

Contamination declaration

Vacuum parts which are returned (for repair or exchange) to AIXTRON must always be accompanied by a contamination declaration that has been filled out completely and signed. For this purpose, copy the corresponding form.

Modifications

Unauthorized modifications and alterations that influence the safety of the CRIUS II are prohibited. Consult AIXTRON prior to making any modifications to the system. The end user must draw up a safety concept and provide the required safety devices if adaptations are made to the CRIUS II.

A written permission by AIXTRON is required for modifications of the software.

Final checks

After maintenance or service work, check to make sure that all safety devices are mounted and functioning faultlessly. In particular, check the safety devices subsequent to all work on the electrical system. This is, for example, relevant for the grounding system and safety circuits.

Revision checks

The end user is responsible to perform the revision checks according to the local regulations concerning prevention of accidents.

At the end of a successful revision check, the acceptance report for revision check is signed by an authorized representative from AIXTRON and by a specialist delegated by the end user.

Obligation to report

The end user must immediately report any changes or observed irregularities which occur at the CRIUS II to AIXTRON.

2.2.6 Disposal

The end user must adhere to the pertinent regulations when disposing of the CRIUS II or components of the system.

Due to the fact that this system utilises toxic gases, the manufacturer does not recommend reuse of any components within the system.

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2.3 Hazard alerts in this System Manual

The hazard alerts are defined for the following three hazard levels:



DANGER!

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or severe injury.



WARNING!

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or severe injury.



CAUTION!

CAUTION indicates a potentially hazardous situation which, if not avoided, may result in moderate or minor injury or in property damage.



NOTE:

A note such as this one indicates particularly important, but not safety-relevant information.

2.4 Danger areas for operating personnel

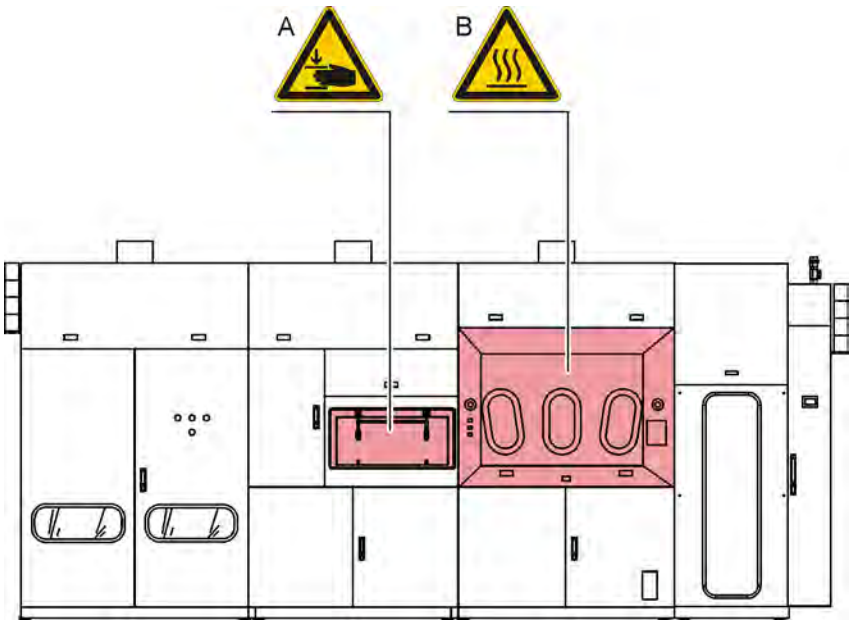


Fig. 2-1 *Danger areas for operating personnel*

A Outer lock chamber door
B Reactor

Item A



WARNING! Pinch points: Outer lock chamber door.

There is the danger of contusions when opening or closing the outer lock chamber door.

Always use the handle when you are opening or closing the door.

Item B



WARNING! Hot reactor parts.

Reactor parts heat up during the process. After the process they may still be hot enough to cause burns.

Allow the parts to cool down to room temperature before working in their vicinity. Wear protective gloves and industrial clothing with long sleeves.

2.5 Danger areas for maintenance and service personnel

2.5.1 Dangers originating from electric power

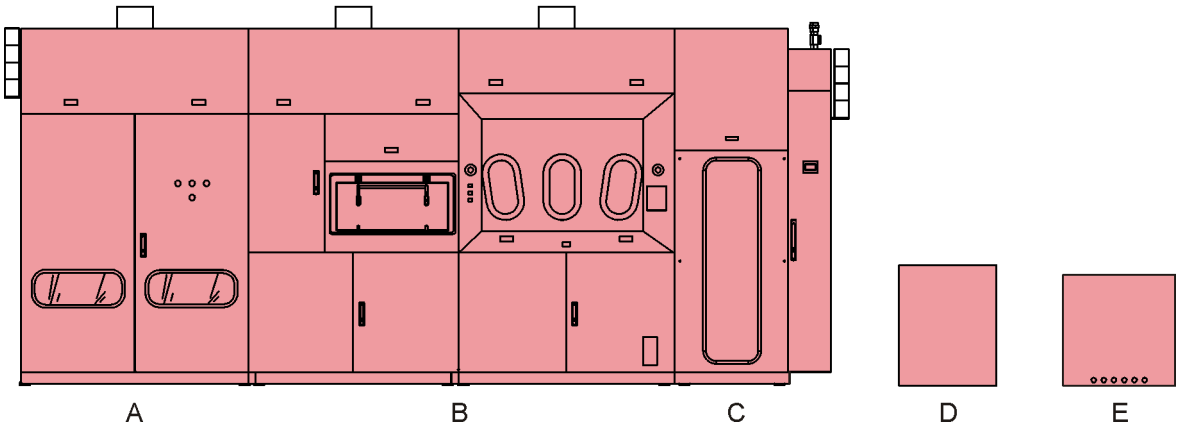


Fig. 2-2 *Danger areas for maintenance and service personnel: Electric power*

A Gas mixing cabinet
B Reactor cabinet
C Heater power supply unit
D Heat exchanger
E Transformer

WARNING! High voltage.

The system contains parts which carry levels of high voltage. Touching these parts will cause an electric shock. The shock may be lethal.

Prior to any work in the danger area:

- **Lock out and tag out the main power supply (system main switch and heater main switch)**
- **Ground the equipment**
- **Check to make sure that no one is in the danger area before you switch the system on again**

WARNING! Mains voltage.



The system contains parts which are connected to the mains supply. Touching these parts will cause an electric shock. The shock may be lethal.

Prior to any work in the danger area:

- **Lock out and tag out the main power supply (system main switch and heater main switch)**
- **Ground the equipment**
- **Check to make sure that no one is in the danger area before you switch the system on again**



NOTE:

Only personnel who have completed electrotechnical professional training are permitted to perform work on the electrical equipment.

2.5.2 Dangers originating from mechanical energy

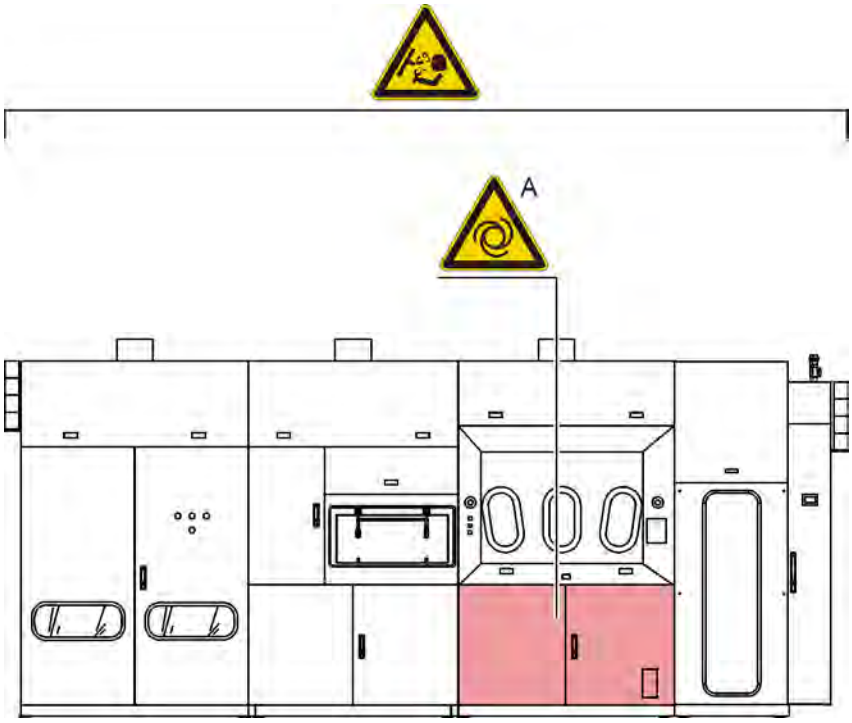


Fig. 2-3 *Danger areas for maintenance and service personnel: Mechanical energy*

A Susceptor motor

Item A



WARNING! Moving component: Susceptor motor.

Automatic movements of this component may cause contusions.

Check to make sure that no one is in the danger area before you energize the motor.

Entire system



WARNING! Pneumatic system.

Opening or damaging pressurized components may lead to serious eye and skin injuries.

Shut off the pneumatic supply and relieve the pressure before you carry out any kind of work to these parts.

2.5.3 Dangers originating from hazardous gases

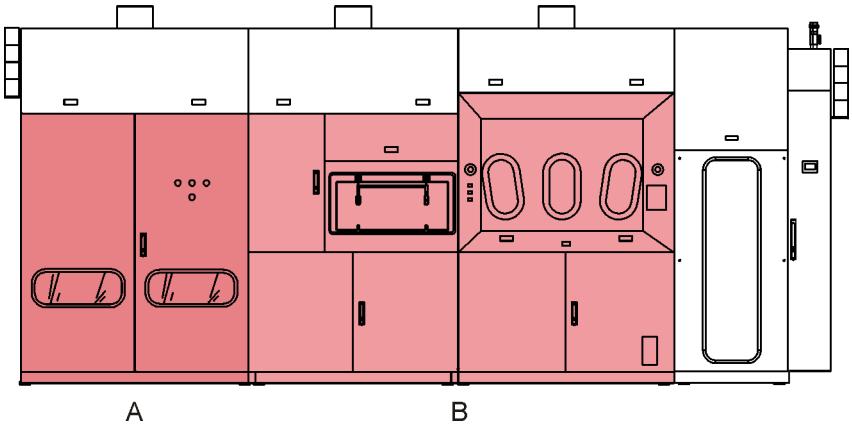


Fig. 2-4 *Danger areas for maintenance and service personnel: Process gases*

A Gas mixing cabinet
B Reactor cabinet

WARNING! Hazardous process gases.

Improper use of hazardous process gases poses numerous dangers which may lead to serious or fatal personnel injuries.



Strictly adhere to the following safety measures:

- **Guide the exhaust lines to a suitable scrubber to prevent hazardous gases or vapor from escaping into the environment**
- **Make sure that the process gas pipes are tight**
- **Make sure that all manual valves are in the correct position before you start the system**
- **Carefully read the safety data sheets for the involved process gases. Adhere to all prescribed protective measures.**

WARNING! Hazardous process gases.



The vacuum system may contain hazardous gases which can be detrimental for your health.



Always wear a gas mask, gloves and industrial clothing with long sleeves when opening parts of the vacuum system. Read the safety data sheets for the gases and follow all instructions.

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NOTE:

The probability of occurrence of an unintended gas leak is very low. But if, the most critical points for unintended gas release are the gas connections of the mass flow controllers and pressure controllers in the gas mixing system.



NOTE:

Mixing of different gas types may cause further risks due to spontaneous chemical reactions. This may cause spontaneous ignition of gas mixtures or an explosion.

The following table gives a brief overview of characteristics and potential dangers of the process gases used in the CRIUS II. For more information refer to the MSDS (Material Safety Data Sheets).

Process gas	Color	Smell	Main dangers for health	Other risks
Ammonia (NH_3)	Colorless	Pungent	Inflammation of respiratory tract, mucous membrane, eyes and skin	
Arsin (AsH_3)	Colorless	Disgusting, garlic taste	Extremely toxic	Very easily flammable
Dinitrogen monoxide (N_2O)	Colorless	Sweet	Difficulty in breathing Narcotic effect	
Ethylene (C_2H_4)	Colorless	Odorless	Difficulty in breathing	Very easily flammable
Helium (He)	Colorless	Odorless	Difficulty in breathing	
Hydrogen chloride (HCl)	Colorless	Pungent	Toxic effect Very corrosive to the respiratory tract, eyes and skin	
Hydrogen (H_2)	Colorless	Odorless	Difficulty in breathing	Explodes if exposed to oxidizers, such as oxygen, air and halogens Easily flammable, burns explosively
Methane (CH_4)	Colorless	Odorless	Difficulty in breathing	Easily flammable, burns explosively
Nitrogen (N_2)	Colorless	Odorless	Difficulty in breathing	

Process gas	Color	Smell	Main dangers for health	Other risks
Phosphine (PH_3 / H_2)	Color-less	Disgust-ing, garlic taste	Toxic effect: Paralysis of breathing tract and of cen-tral nervous system Irritation of the respiratory tract	Very easily flammable, self-ignition when exposed to air Burns explosively
Propane (C_3H_8)	Color-less	Odorless	Difficulty in breathing	Flammable
Sulphur hexaflu-oride (SF_6)	Color-less	Odorless	Difficulty in breathing	
Silane (SiH_4)	Color-less	Disgusting	Irritations of the respiratory tract, eyes and skin	Very easily flammable, self-ignition when exposed to air Burns explosively Explodes if exposed to water
Trimethylbo-rane ($B(CH_3)_3$, TMB / H_2)	Color-less	Disgusting	Toxic effect Irritations of the respiratory tract, eyes and skin	Very easily flammable, self-ignition when exposed to air Burns explosively Explodes if exposed to water, oxidants and halo-gens

Tab. 2-1 Characteristics and dangers of process gases

2.6 Safety circuits

The CRIUS II is equipped with a safety-relevant electric circuit. This circuit is triggered by the following events:

- An EMERGENCY-OFF button is pressed
- A PROCESS-STOP button is pressed

2.6.1 EMERGENCY-OFF button

EMERGENCY-OFF buttons outside the cabinets
Fig. 2-5, 🖹 31 shows a typical EMERGENCY-OFF button. EMERGENCY-OFF buttons are red with a yellow collar.



Fig. 2-5 *EMERGENCY-OFF buttons (outside the cabinets)*

EMERGENCY-OFF buttons can be used to shut down the entire system if dangerous situations crop up.

EMERGENCY-OFF buttons intside the cabinets
Additionally, the system is equipped with EMERGENCY-OFF buttons for maintenance work with open cabinet doors. They are located inside the cabinets.



Fig. 2-6 *EMERGENCY-OFF buttons (intside the cabinets)*

Positions outside

Fig. 2-7, 32 shows the EMERGENCY-OFF buttons installed at the outside of the CRIUS II.

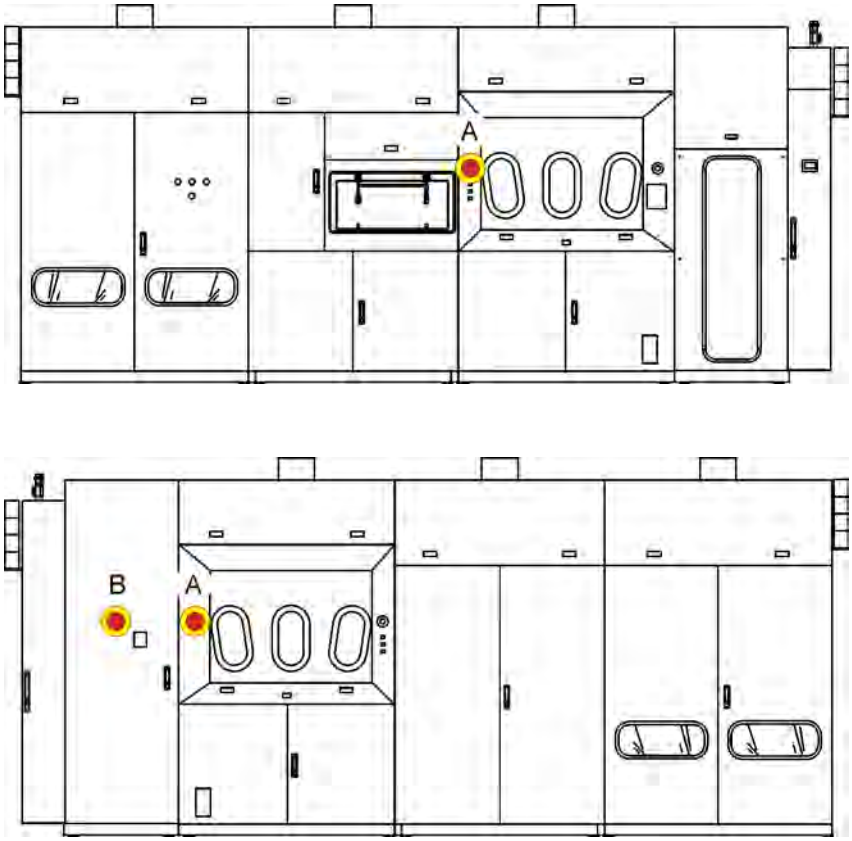


Fig. 2-7

Positions of the EMERGENCY-OFF buttons outside: Front side (top), back side (bottom)

A EMERGENCY-OFF button at the reactor cabinet
B EMERGENCY-OFF button at the heater supply unit

Positions inside

Fig. 2-7, 32 shows the EMERGENCY-OFF buttons installed inside the cabinets.

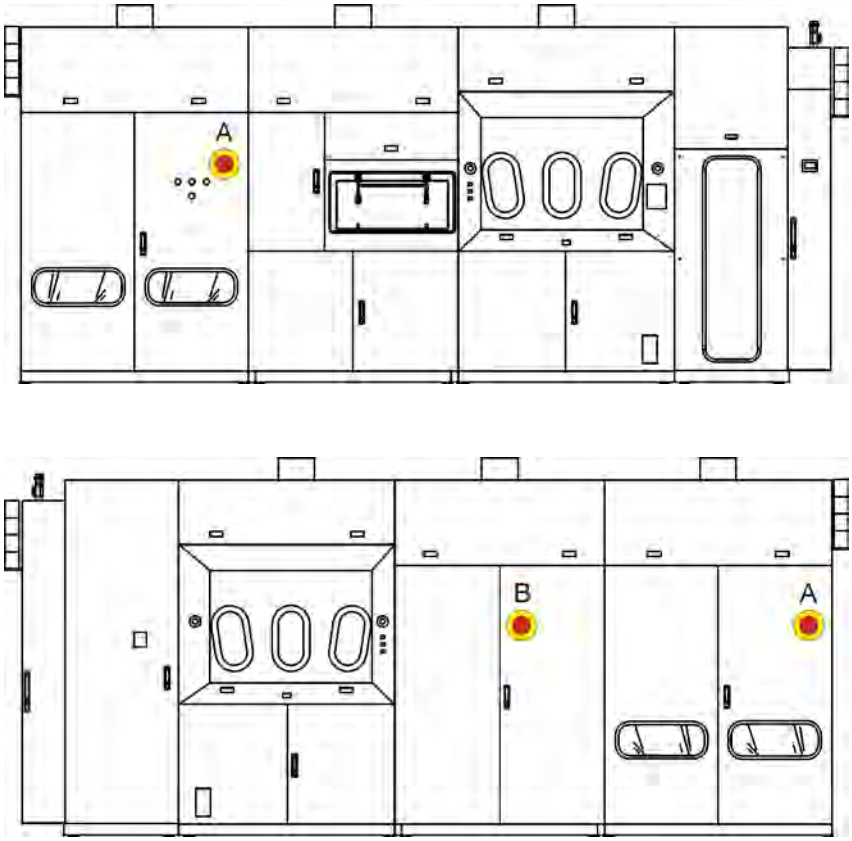


Fig. 2-8

Positions of the EMERGENCY-OFF buttons inside: Front side (top), back side (bottom)

A EMERGENCY-OFF button at the gas mixing cabinet
B EMERGENCY-OFF button at the reactor cabinet

Consequence

Pressing an EMERGENCY-OFF button has the following consequences:

- The power supply of the CRIUS II is switched off



NOTE:

The reactor cooling is guaranteed after an EMERGENCY-OFF shutdown.

Status after an EMERGENCY-OFF

- Electrical power is switched off
- System is purged with nitrogen (reactor and source lines)
- Vacuum system is switched off (bypassed by check valves)
- All hydrogen and process gas valves are closed
- All pumps are switched off
- Reactor is cooled down
- Process heater is switched off

Switching the system on after an EMERGENCY-OFF

Only service personnel are authorized to restart operation after an EMERGENCY-OFF shutdown.

After an EMERGENCY-OFF shutdown the red power [OFF] button is flashing. The flashing frequency indicates the EMO state.

EMO state	Flashing frequency power [OFF] button	Description
EMO active	2 Hz	An EMO button is pressed
EMO error	10 Hz	An EMO button is pressed There was a synchronisation error when pressing the EMO button In this case, check the function of the EMO button by pressing and releasing the button a few times

1 Remove the cause for the EMERGENCY-OFF shutdown

2 In case of an EMO error check the function of the EMERGENCY-OFF button

3 Release the EMERGENCY-OFF button
- The red power [OFF] button is illuminated

4 Press the green power [ON] button
- The red power [OFF] button gets dark
- The green power [ON] button is illuminated

The system is ready for operation.

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2.6.2 PROCESS-STOP button

Fig. 2-9, 🗎 35 shows a typical PROCESS-STOP button. PROCESS-STOP buttons are yellow.



Fig. 2-9 *PROCESS-STOP button*

Positions

Fig. 2-10, 🗎 35 shows the PROCESS-STOP buttons installed at the CRIUS II.

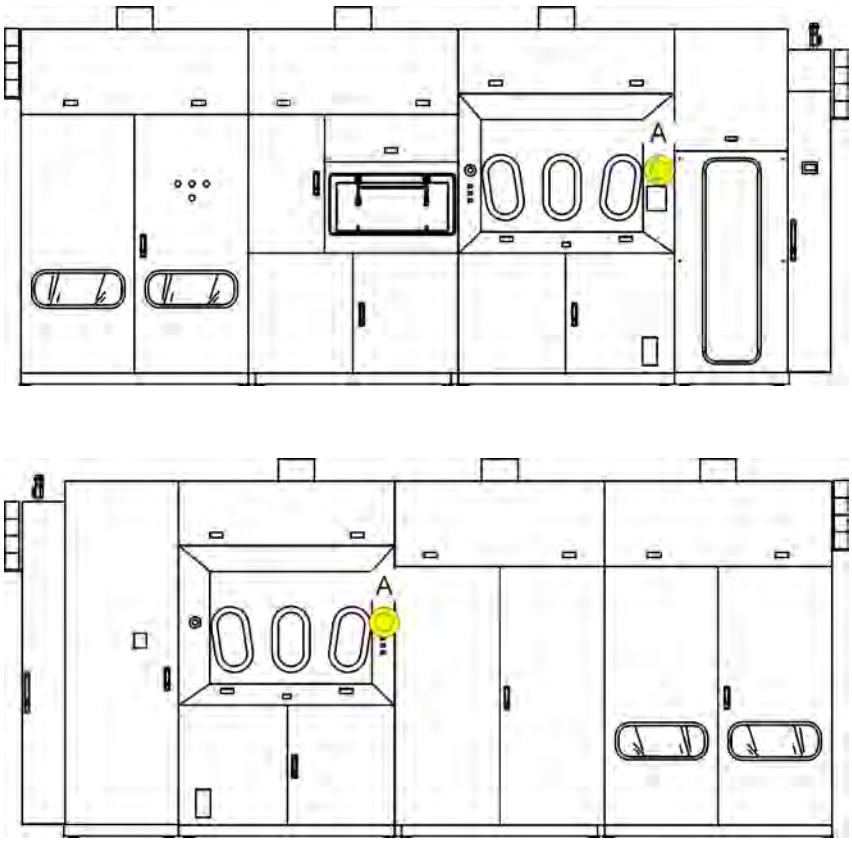


Fig. 2-10 *Positions of the PROCESS-STOP buttons: Front side (top), back side (bottom)*

A PROCESS-STOP button at the reactor cabinet

Consequence

Pressing a PROCESS-STOP button will switch the CRIUS II to the «safe state». The following steps are performed:

- All gas lines are purged with nitrogen
- The throttle valve is closed
- All hydrogen and process gas valves are closed
- Process heater is switched off
- A running recipe is terminated

Switching the system on after an PROCESS-STOP

Only service personnel are authorized to restart operation after an PROCESS-STOP.



NOTE:

A PROCESS STOP causes consequences according to the Cause Effect table.

1 Remove the cause for the PROCESS-STOP

2 Release the PROCESS-STOP button

3 Initiate a reset in AIXACT

The system is ready for operation.

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2.6.3 Door locks

The doors of the CRIUS II are equipped with the following safety components:

- Sensors:
  All cabinet doors are equipped with sensors which detect if the door is closed. A process can only be started if all doors are closed.

- Active door locks:
  Before a process starts, the closed doors will be locked automatically. This prevents unintended opening of a door while a process is running.

Positions

Fig. 2-11, 37 shows the active door locks installed at the CRIUS II.

NOTE:

The lids without an active door lock (reactor cabinet, gas mixing cabinet) are secured actively by the doors located below the lid.

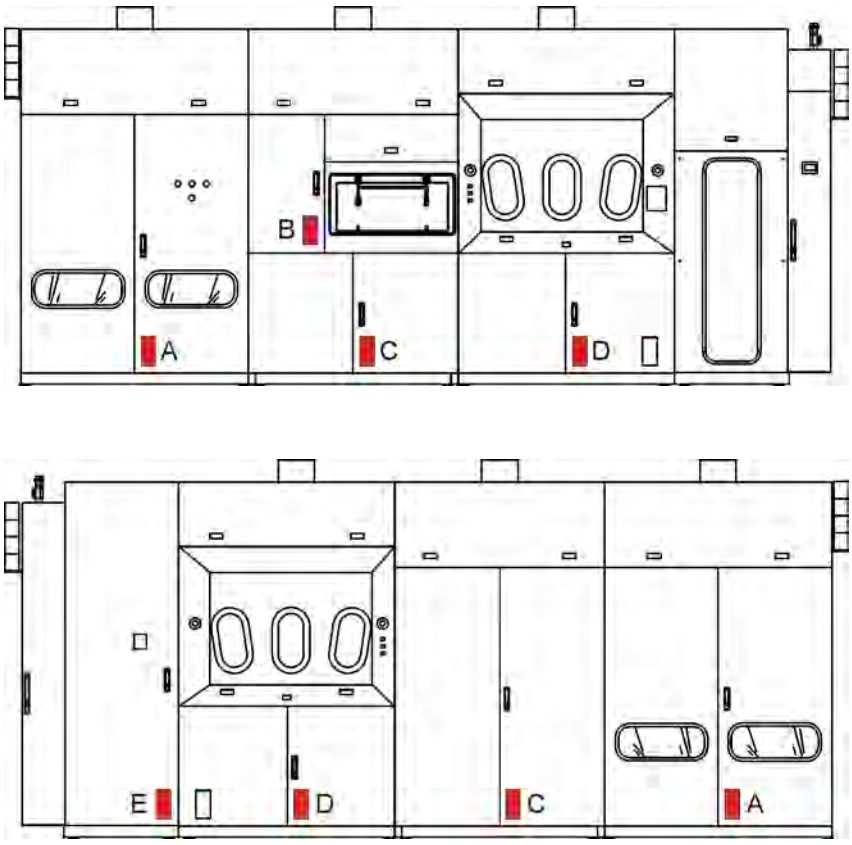


Fig. 2-11

Positions of the active door locks: Front side (top), back side (bottom)

A Gas mixing cabinet
B Reactor cabinet
C Reactor cabinet
D Reactor cabinet
E Heater power supply unit

2.7 Lockout/tagout procedure

Maintenance and service work can be extremely dangerous if the serviced components are not shut down and secured properly. Contact with live parts, the release of stored energy, or the unexpected start-up of the serviced component can cause serious injury to personnel and also damage the equipment.

These hazards can be avoided through the strict use of the lockout/tagout procedure. In short, this means that you have to shut down, de-energize, lock out, and tag out the component before servicing it. In the following, this procedure will be described in detail.

2.7.1 Applying lockout/tagout devices

Before beginning any maintenance or service work, the following steps must be performed in the given order:

Shutting down

1 Prepare the component for shutdown (if necessary). Also make sure that the shutdown of the component will not affect running processes.

2 Shut down the component

Locking out

3 Isolate the component from all energy sources. In small components, this can be done by disconnecting the energy source (e.g. unplugging the line cord). In other cases, this is done by switching relevant energy-isolation devices to the safe or OFF position. Typical examples of energy-isolation devices are:

- Power breakers, switches, fuses (electric power)
- Shut-off valves (process gases, vent gas, pneumatic supply, water)

4 Lock the energy-isolation device in the safe position. For this purpose, apply a padlock which can only be opened with a key. Typical examples are shown below. The lockout devices make sure that the component will not be re-energized by mistake.



Fig. 2-12 *Energy isolation device locked in the safe position (example)*

Tagging out

5 Post a prominent tag onto each lockout device. This tag is a warning to others that the component must not be put back into operation until the lock and the tag have been removed by the authorized person. Tags

must be written in a language that can be understood by all personnel. They must contain the following information:

- A warning text or prohibitive sign
- Name and phone number of the person in charge
- Date and time when the component has been locked out

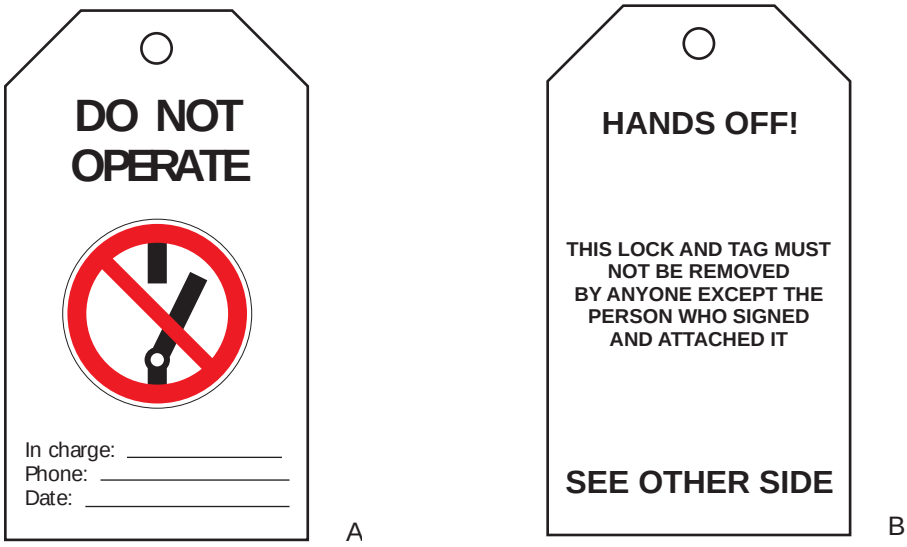


Fig. 2-13 *Front and back of a lockout tag (example)*

A Front *B Back*

Releasing stored energy

6 Release, restrain, or otherwise render safe all potential hazardous stored or residual energy. Typical examples of stored energy are:

6.1 Heat. Heaters and adjacent components may still be hot. Allow the components to cool down.

6.2 Pressurized gas. Pressurized gases may be stored in the related gas lines. Use the pressure relief valve.

6.3 Pressurized liquid. May be stored in water lines and hydraulic systems. Use the pressure relief valve.

6.4 Mechanical energy, stored in springs, flywheels, or similar parts. Relief the energy as required.

Verifying

7 Verify the isolated and de-energized state of the component



NOTE:

If a possibility exists for re-accumulation of hazardous energy, regularly verify during the maintenance or service task that such energy has not reaccumulated to hazardous levels.

2.7.2 What to do if a device cannot be locked

Sometimes an energy-isolating device cannot be locked with a padlock. In this case, you may apply a lockable plastic cover which encloses the energy-isolating device and renders it inoperative. A wide range of these lockout devices is available commercially, such as:

- Circuit breaker lockouts
- Electrical plug lockouts
- Ball valve lockouts
- Gate valve lockouts

Instead of locking a particular switch or valve inside of a cabinet, you may lock and tag the entire cabinet instead. If you have any questions concerning lockout/tagout, refer to the safety department of your company.

2.7.3 Removing lockout/tagout devices



WARNING! Lockouts and tagouts.

Personnel who work on de-energized components may be seriously injured or killed if someone removes lockout/tagout devices and re-energizes the component without their knowledge.

Respect lockout and tagout devices! Locks and tags must not be removed by anyone except the person who attached them.

Proceed as follows to remove lockout/tagout devices:

1 Inspect the component to ensure that it is operationally intact and that nonessential items are removed from the area

2 Make sure that everyone is positioned safely and away from the component

3 Remove the lockout/tagout devices

4 Make sure that all employees who work with the system know that the lockout/tagout devices have been removed and that the component will be energized

5 Energize the component

2.8 Personal protective equipment (PPE)

PPE includes all clothing and other work accessories designed to create a barrier against workplace hazards. It must be worn during potentially hazardous work in order to prevent injuries or illness. Tab. 2-2, 43 shows the PPE that is required for working with the CRIUS II.

Operator and higher

Personal protective equipment	Typical examples
Protective clothing with long sleeves	
Clean room clothing	
Disposable clean room gloves (class 100)	
Chemical-resistant gloves	
Heat-protection gloves	
Work gloves	

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Personal protective equipment	Typical examples
Safety goggles (unbreakable)	
Fine dust mask (P2)	
Cartridge respirator (half facepiece) Filters for inorganic gases and vapors	
Cartridge respirator (full facepiece) Filters for inorganic gases and vapors	
Protective boots	

Maintenance and higher

Personal protective equipment	Typical examples
Lockout/tagout kit containing all the required lockout devices and lockout tags	

Tab. 2-2 *Personal protective equipment (typical examples)*

2.9 Fire risk report

Electrical components
Approved electrical components and subassemblies have been used to limit the risk of fire from the mains powered electrical equipment. In addition electrical equipment that may represent a fire hazard is contained in a metal fire enclosure. Overload devices are fitted to limit the effects of short circuits.

Chemicals
Chemicals that can react exothermically are supplied in separate pipe systems and can only come together intentionally in the reactor.

Oxygen monitoring (nitrogen purging) is used to ensure that chemicals that react with air / O_2 do not pose a risk.

No bulk storage of flammable chemicals is allowed in the tool.

Engineering controls
Engineering controls are considered adequately so that the residual risk from fire and smoke is low. No additional fire detection is required.

2.10 Gas sensing equipment

The end user has to install a proper gas sensing equipment to protect the working area around the CRIUS II.

The gas sensing equipment must meet the following specification:

Gas	Specification	Response time
H_2	T90	< 20 sec
AsH_3	T90	< 40 sec
PH_3	T90	< 40 sec
SiH_4	T90	< 40 sec
NH_3	T90	< 120 sec

Tab. 2-3 *Specification: Gas sensing equipment*

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2.11 Unintended releases

Gases
The probability of occurrence of an unintended gas leak is very low. However, if a gas leak occurs inside the CRIUS II the exhaust system prevents hazardous situations.

Liquids
The entire system is equipped with liquid sensors to detect leaks at the CRIUS II immediately. See also Chapter 6.14.4 Unintended release of liquid, 181.

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2.12 Safety labels on the CRIUS II

The following safety labels are attached to the CRIUS II or its components:

2.12.1 Hazardous materials

Label



Positions

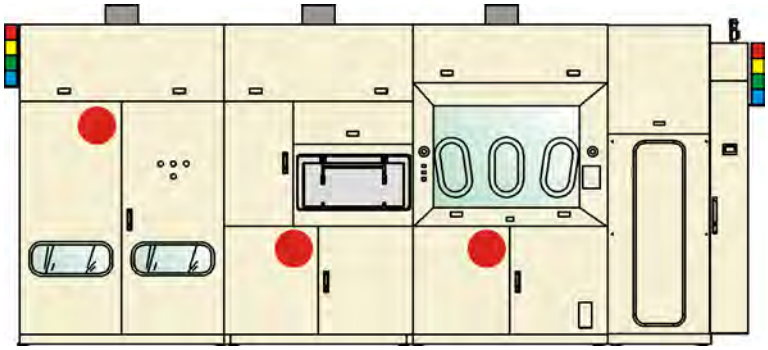


Fig. 2-14 *Label positions (front)*

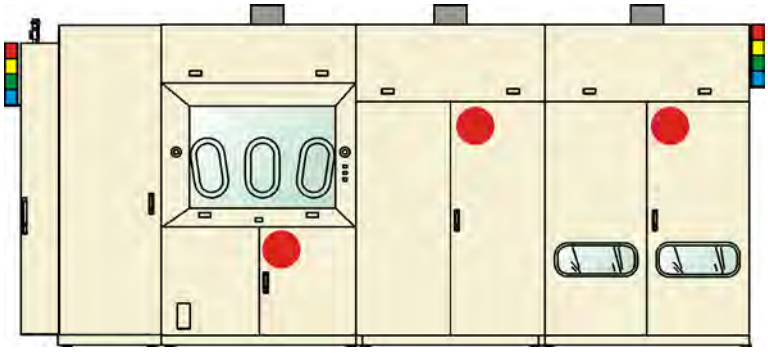
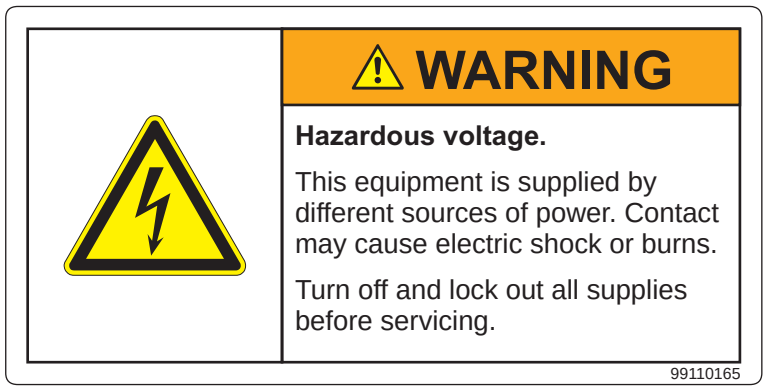


Fig. 2-15 *Label positions (back)*

2.12.2 Hazardous voltage

Label 1



Position

- At the gas mixing cabinet below the main switch

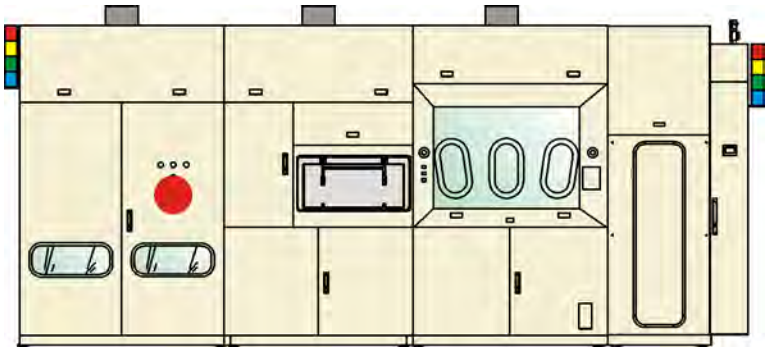


Fig. 2-16 *Label below the main switch*

Label 2



Positions

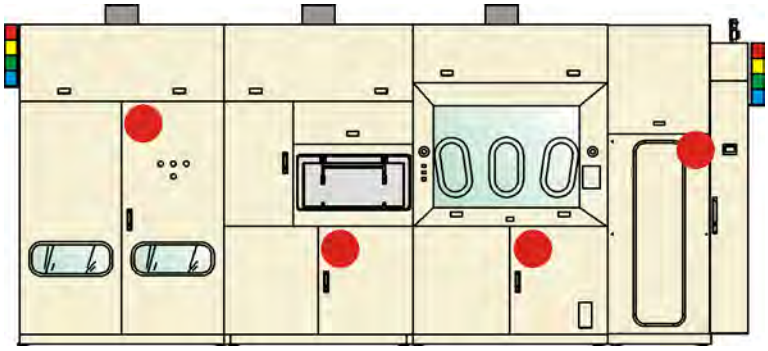


Fig. 2-17 *Label positions (front)*

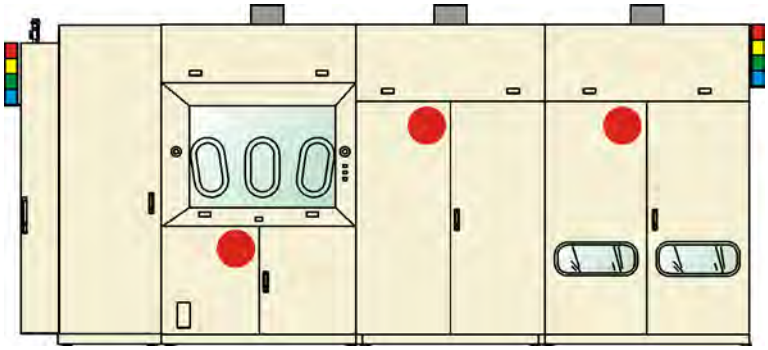


Fig. 2-18 *Label positions (back)*

2.12.3 Hot surface

Label 1



Position

- On the outer lock chamber door

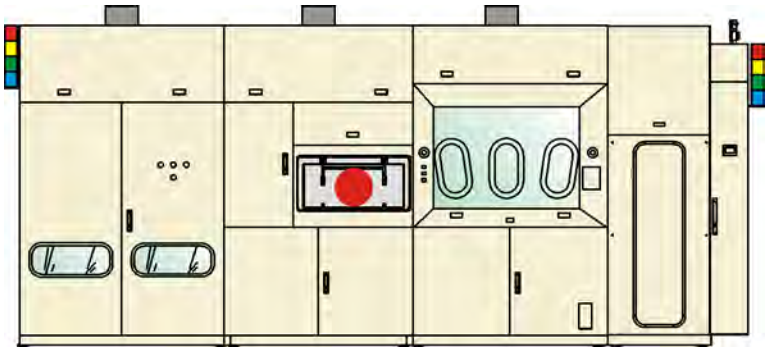
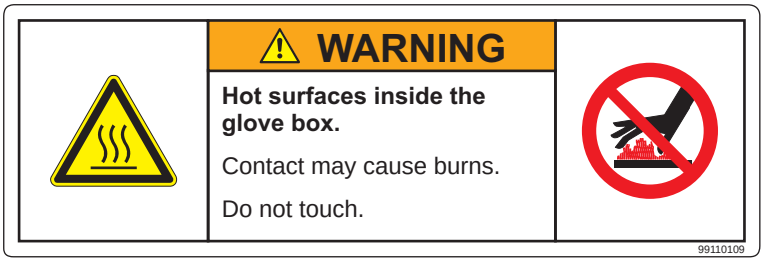


Fig. 2-19 *Label on the outer lock chamber door*

Label 2



Position

- Inside of the glove box on the inner door of the load lock

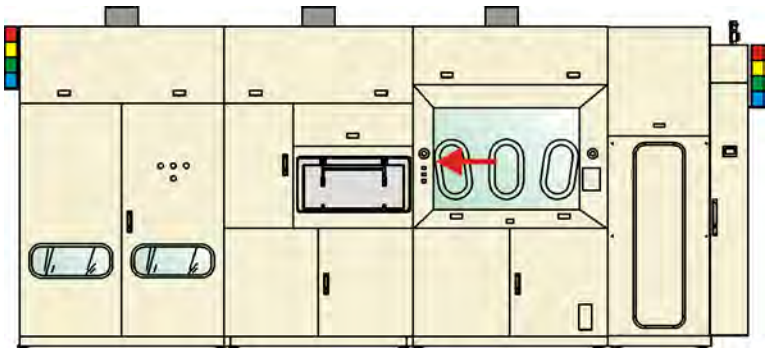


Fig. 2-20 *Label on the inner lock chamber door*

2.12.4 Pinch points

Label 1



Positions

- Inside of the glove box on the inner door of the load lock
- At the motor holder under the glove box

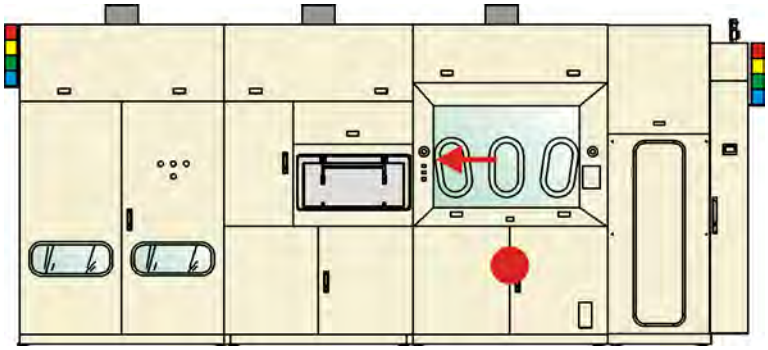


Fig. 2-21 *Label on the inner lock chamber door and on the motor holder (front)*

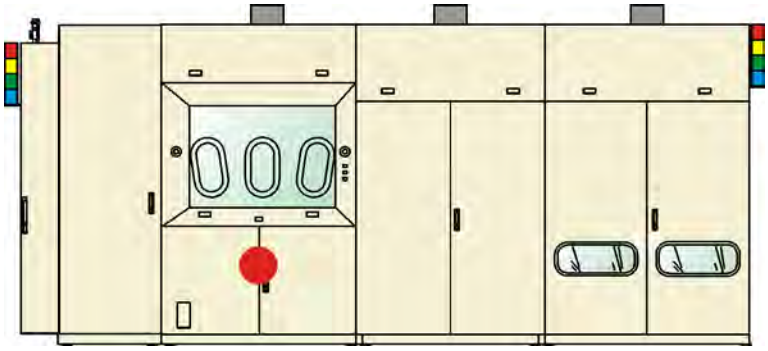
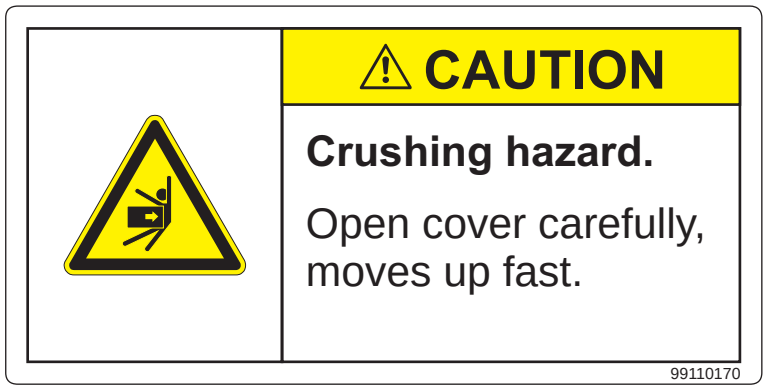


Fig. 2-22 *Label on the motor holder (back)*

Label 2



Positions

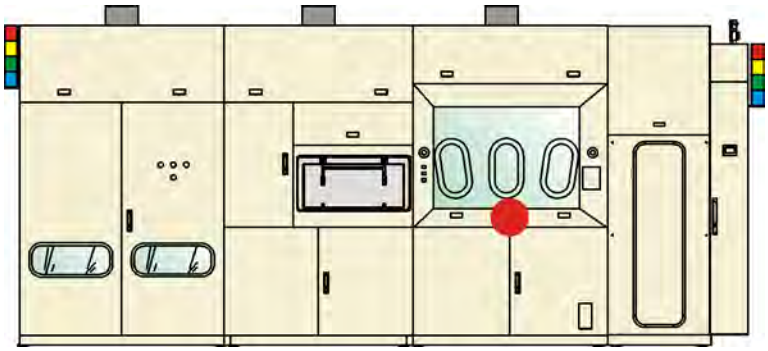


Fig. 2-23 *Label positions (front)*

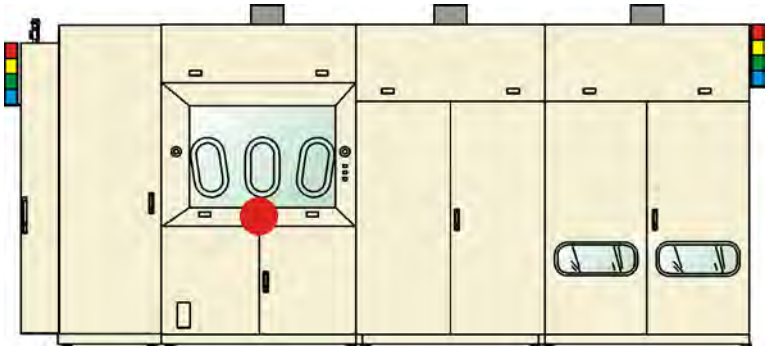
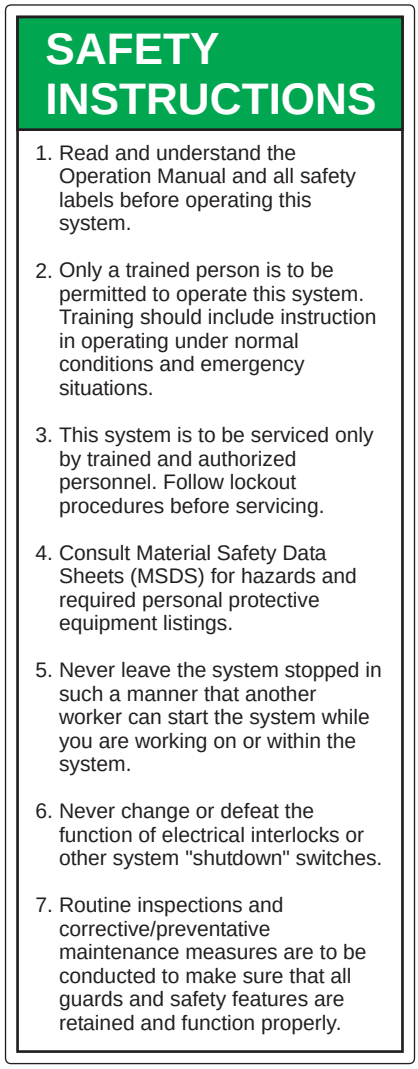


Fig. 2-24 *Label positions (back)*

2.12.5 Safety instructions

Label



Position

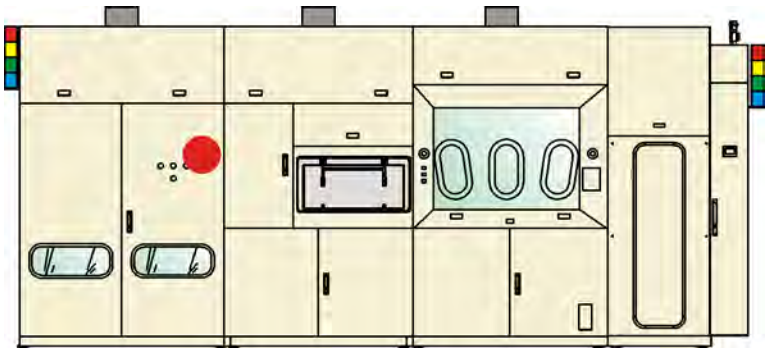


Fig. 2-25 *Label position (front)*

2.13 Appendix

2.13.1 Material Safety Data Sheets (MSDS)

Material safety data sheets contain safety relevant information on materials.

The end user is responsible for obtaining the material safety data sheets for all used materials: Process gases, coating materials, pump oils, cleaning agents, etc. Material safety data sheets can be obtained as follows:

- Suppliers of chemicals generally include material safety data sheets with the delivered chemicals
- Material safety data sheets are available on the Internet. Example: Enter «msds argon» into a search engine for safety relevant information on argon.

Read the material safety data sheets thoroughly and follow all directions.

2.13.2 Electromagnetic compatibility

The electrical equipment of the CRIUS II was designed and built in accordance with the directives relating to electromagnetic compatibility.

The CRIUS II complies with the requirements of the electromagnetic compatibility standards. With respect to electromagnetic compatibility, the system is intended for use in an industrial environment according to the EN 61000 standards.

Use in other environments, e.g. residential areas, requires additional electromagnetic compatibility measures.

2.13.3 Emission of gases and chemical substances

The exhaust gases of the CRIUS II (vacuum pumps, reactor) must be purified by a suitable scrubber to prevent dangerous gases or vapor from escaping into the environment.

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3 Description

3 Description

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3.1 Process technology

CVD (Chemical Vapour Deposition) is a common method for deposition of thin films.

3.1.1 CVD (Chemical Vapor Deposition)

In a CVD process, volatile compounds are transported into the reactor chamber via the gas phase. Here they are decomposed on a hot substrate by thermal energy.

The following reaction steps take place (see Fig. 3-1, 56):

1 Transport of the reagents in the gas phase to the substrate, e.g. by means of a carrier gas

2 Diffusion of the molecules through the phase interface gas/boundary layer

3 Adsorption on the substrate surface

4 Migration of the molecules to crystallization zones

5 Chemical decomposition

6 Desorption of the by-products and diffusion and convection out from the boundary layer

7 Transport of the by-products out from the reactor

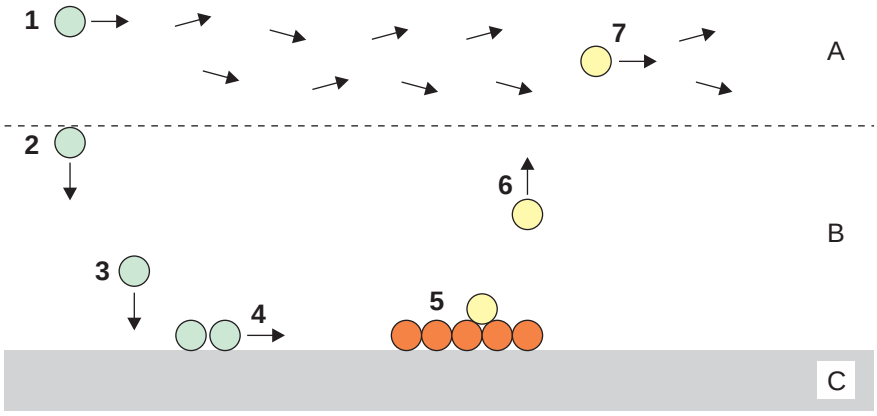


Fig. 3-1 *CVD reaction steps*

A Gas phase
B Boundary layer
C Substrate

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3.1.2 System principle

Fig. 3-2, 57 schematically illustrates the design of a CVD system.

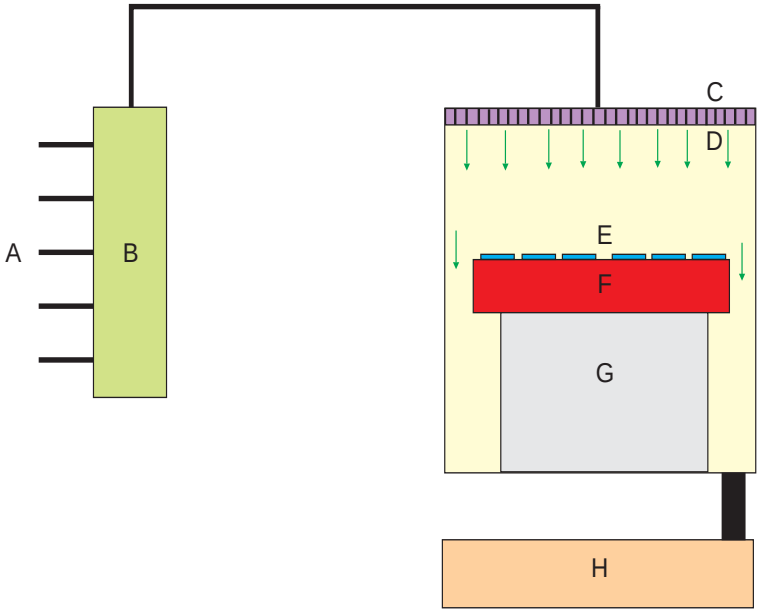


Fig. 3-2 *Schematic design of a CVD system*

A Process gas supply
B Gas mixing system
C Showerhead
D Reactor chamber
E Substrate(s)
F Susceptor
G Heating
H Pump system

During a CVD process, the following steps are performed:

1 The process gases (item A) are mixed in the gas mixing system (item B)

2 The process gases are fed via the showerhead (item C) into the reactor (item D)

3 A coating is deposited on the heated substrates (item E)

Because a CVD process is usually performed at low pressure, the reactor is connected to a pump system (item H).

3.2 System overview

Fig. 3-3, 58 shows the main components of the CRIUS II.

NOTE:

The figure shown below relates to a typical CRIUS II system. Your specific system may differ from this in certain details.

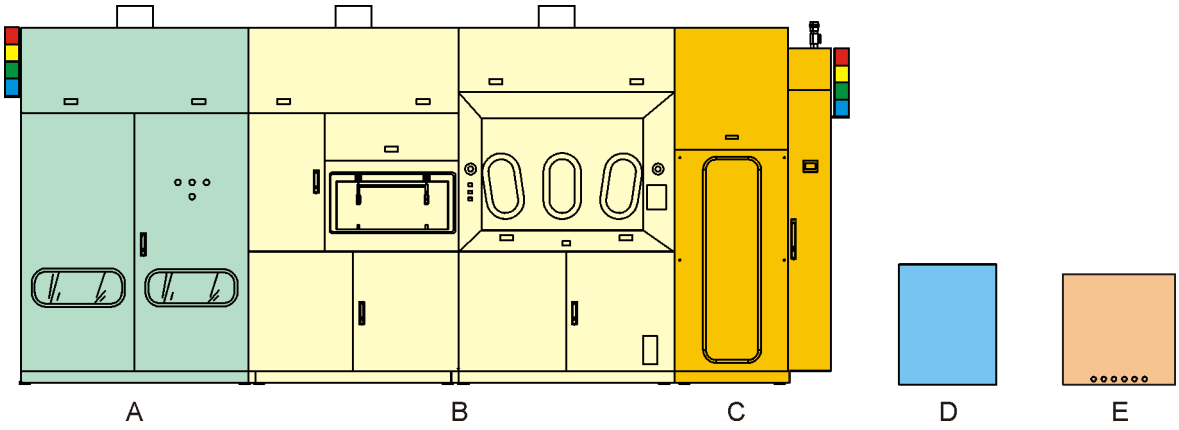


Fig. 3-3 *Design of the CRIUS II (example)*

A Gas mixing cabinet
B Reactor cabinet
C Heater power supply unit
D Heat exchanger
E Transformer

3.3 Glove box

The reactor is installed in the glove box in which pure argon or nitrogen are used. This protects the reactor from contaminations during loading/unloading and when maintenance is performed. Use the integrated gloves to access the operating elements inside of the glove box.

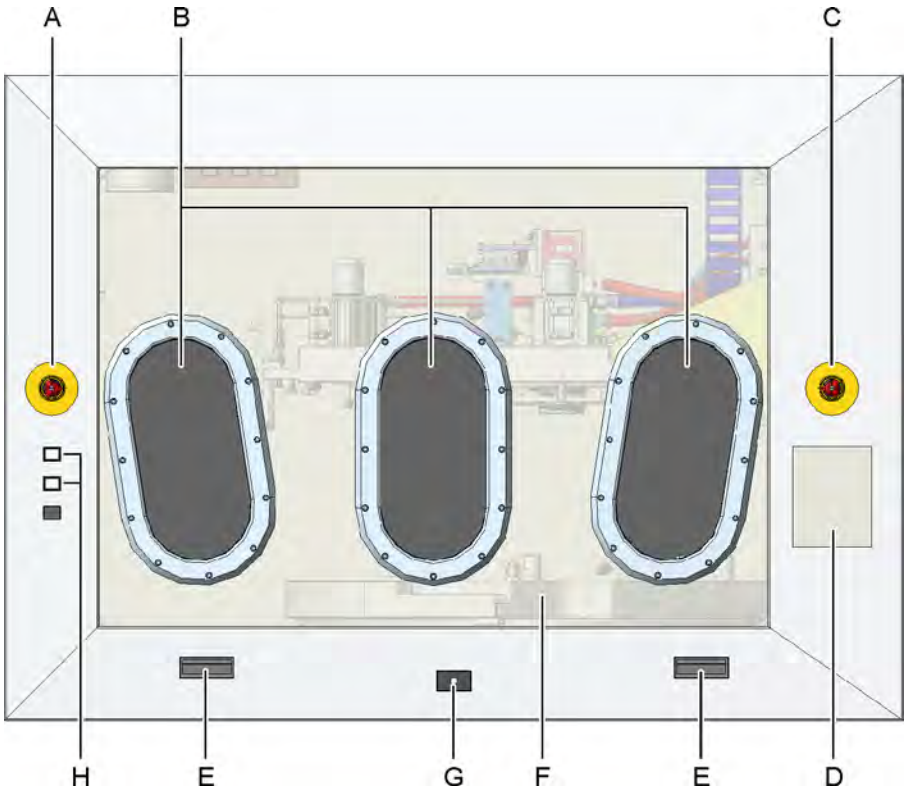


Fig. 3-4 *Glove box*

A EMERGENCY-OFF button
B Glove
C PROCESS-STOP button
D Control panel
E Handle for opening the glove box
F Reactor
G Lock
H [OPEN] and [CLOSE] buttons for reactor

3.4 Load lock

3.4.1 Load lock chamber

Substrates are transported into the glove box via the load lock. The load lock chamber comprises two doors: The outer door is used to load and unload substrates. See Fig. 3-5, 60. The inner door is used to transfer substrates between load lock chamber and glove box. See Fig. 3-5, 60.

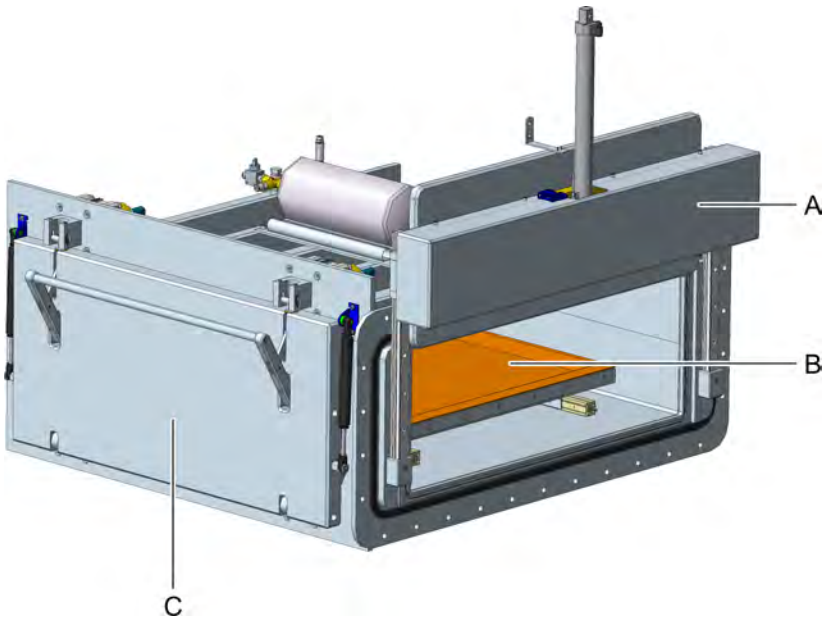


Fig. 3-5 *Load lock*

A Inner lock chamber door
B Drawer
C Outer lock chamber door

3.4.2 Manual susceptor transfer handler (optional)

A manual susceptor transfer handler may be installed inside the load lock chamber instead of the drawer. It is used to transfer the susceptor between the reactor and the load lock chamber.

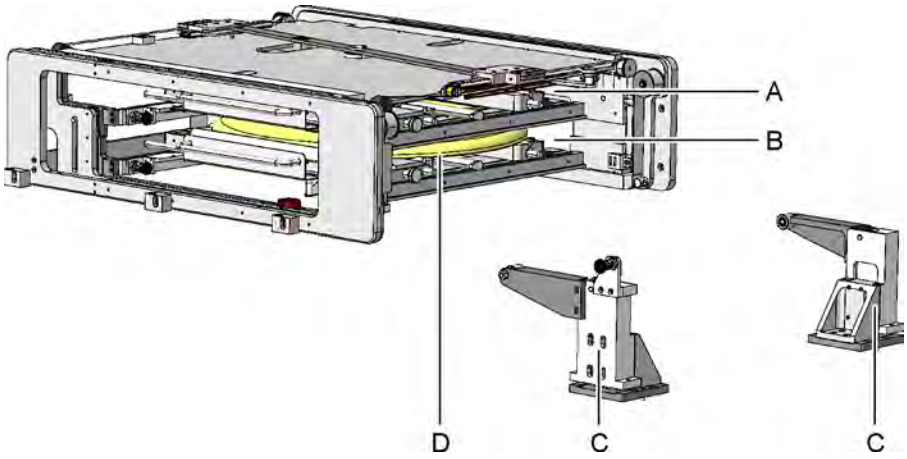


Fig. 3-6 *Manual susceptor transfer handler*

A Upper slot
B Lower slot
C Guide with rolls (installed in the glove box)
D Susceptor

3.5 Reactor

Reagents are fed into the reactor through the water-cooled showerhead which is located directly above the substrates. The system is known as a Close-Coupled Showerhead (CCS) system.

Fig. 3-7, 🗎 62 shows the reactor

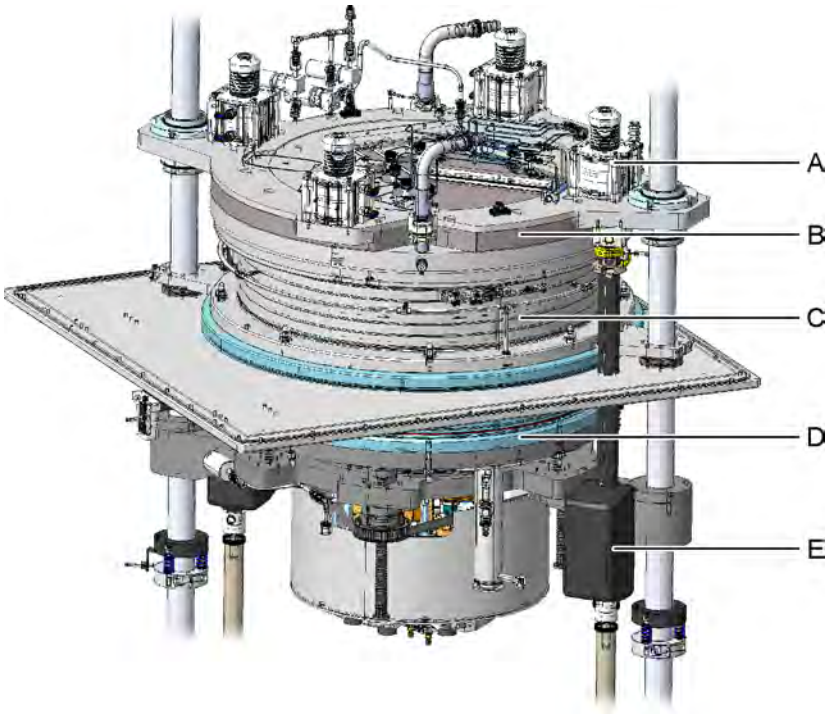


Fig. 3-7 *Reactor*

A Reactor clamp
B Reactor lid
C Reactor chamber
D Reactor bottom
E Electric motor for reactor lid

The reactor consists of the following main components:

- Showerhead, see Chapter 3.5.1, 🗎 63
- Susceptor, see Chapter 3.5.2, 🗎 64
- Tungsten heater, see Chapter 3.5.3, 🗎 65
- Double O-Ring system (DOR), see Chapter 3.5.5, 🗎 68

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3.5.1 Showerhead

Fig. 3-8, 63 shows the showerhead. It has 100 tubes/inch^2 with a tube diameter of 0.6 mm.

The showerhead to susceptor spacing is normally 11 mm on a GaN system, and 16 mm on a GaAs/InP system.

The spacing may be adjusted either by fixed spacer rings, or by the optional servo mechanism (range: 5 mm to 25 mm).

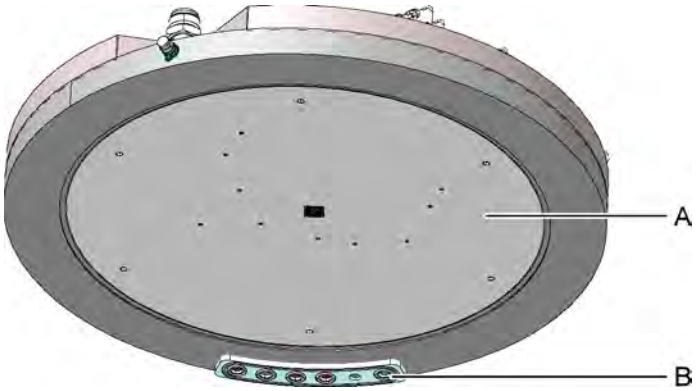


Fig. 3-8 *Reactor lid with showerhead*

A Showerhead
B Gas feedthroughs

The showerhead normally has two plenums, see Fig. 3-9, 63. In rare cases a third plenum can be added to prevent prereactions occurring.

For a normal two plenum showerhead, the configuration is as follows:

- Upper plenum:
  Feeds the group III elements using metal organics
- Lower plenum:
  Feeds the group V elements using hydride gases such as NH_3 or AsH_3

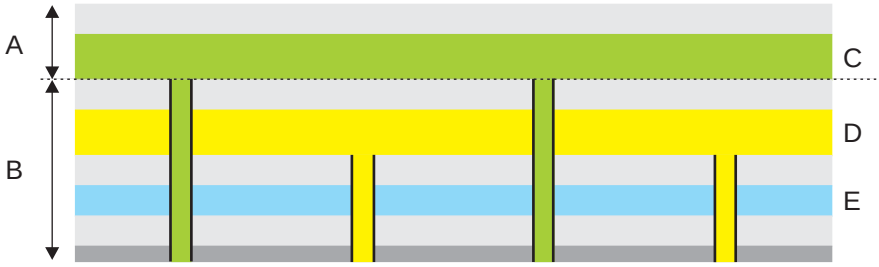


Fig. 3-9 *Showerhead (cross section)*

A Showerhead Cap
B Showerhead Body
C Upper plenum
D Lower plenum
E Water cooling

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3.5.2 Susceptor

The susceptor is a graphite disk, coated with approximately 100 µm of SiC, which holds the process wafers. It is located on top of the susceptor support. The susceptor support rotates in a clockwise direction to ensure homogeneous temperatures during the process.

The susceptor is rotated by a motor drive. A rotation speed of 50 … 200 rpm is normally used (maximum speed: 500 rpm).

Different susceptor variants are available to cater for different numbers, types, and thicknesses of wafers.

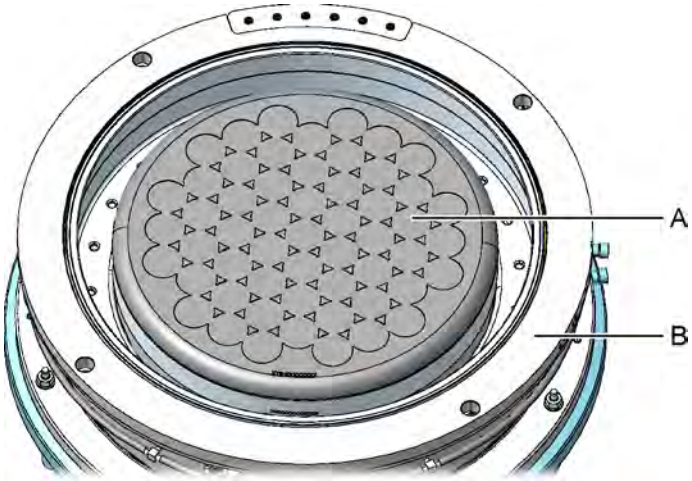


Fig. 3-10 *Reactor*

A Susceptor (example: 55 x 2" wafers)
B Reactor chamber

3.5.3 Tungsten heater

The system is heated by a three zone tungsten heater. See Fig. 3-11, 🗎 65. The heater is located inside of the susceptor support below the susceptor.

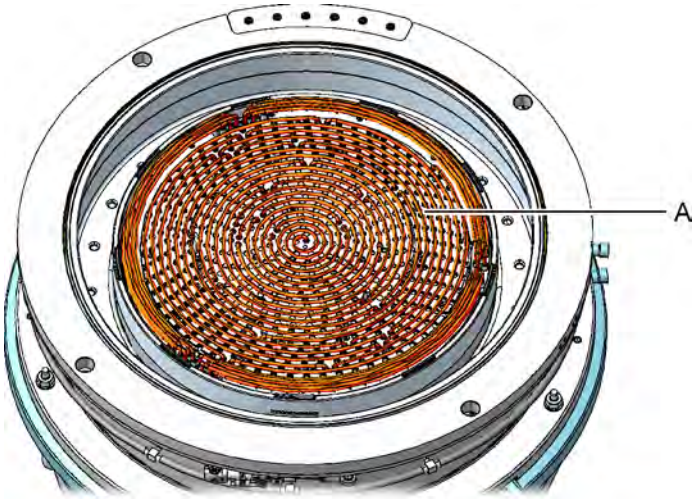


Fig. 3-11 *Tungsten heater*

A Heater coils

Heater coils

The heater consists of three sets of tungsten-rhenium coils which are configured as follows:

- Zone A: Center
- Zone B: Middle
- Zone C: Outside

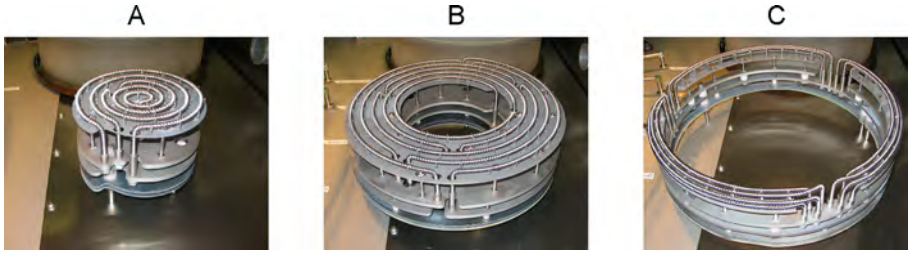


Fig. 3-12 *Heater coils*

A Zone A: Center
B Zone B: Middle
C Zone C: Outside

Each zone may be individually replaced. Power is fed through the ferrofluidic feedthrough.

Coil fixing

The heater is mounted to the quadrant plates by means of clamps. See Fig. 3-13, 66.

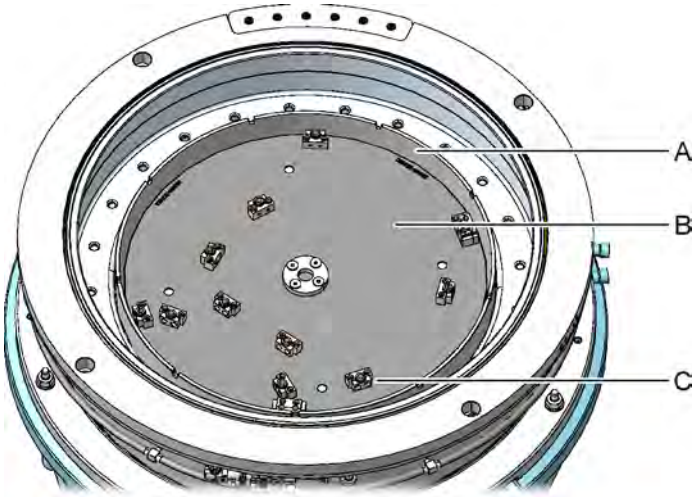


Fig. 3-13 *Coil fixing*

A Susceptor support
B Quadrant plates
C Coil clamp

Heater power supply unit

The heater is fed by 10 power supplies.



Fig. 3-14 *Heater power supply unit*

A Power supply

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3.5.4 Temperature control unit

The temperature control unit consists of the following controllers:

Eurotherm
The Eurotherm temperature controller is used to control the system from ambient temperature up to 1200 °C. It is located at the reactor cabinet. It measures the temperature at the bottom of the susceptor using a thermocouple.

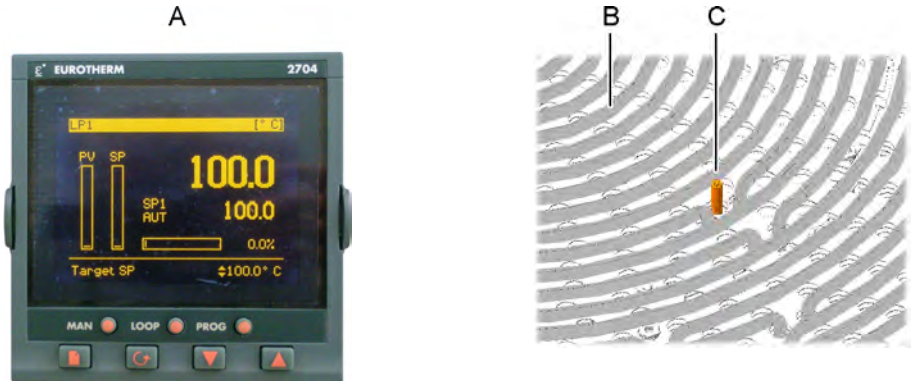


Fig. 3-15 *Temperature measurement at the bottom of the susceptor*

A Eurotherm controller
B Heater coil
C Thermocouple

Mikron pyrometer

A Mikron pyrometer is used to measure the temperature on the top surface of the susceptor (black body radiation). It is located inside the glove box. Using a four channel pyrometer allows all three heater zones to be measured. The zone power ratio may be adjusted to ensure a flat temperature profile across the susceptor.

The black body radiation is measured through the pyrometer probes, mounted on the showerhead.

There are five pyrometer probes on the showerhead to allow full access to all heater zones.



Fig. 3-16 *Temperature measurement on the top surface of the susceptor*

A Mikron controller
B Pyrometer probe

3.5.5 Double O-ring system (DOR)

The DOR system consists of two O-rings: The inner O-ring and the outer O-ring. The intermediate volume is pumped continuously to ensure reliable and controllable sealing.

Fig. 3-17, 68 shows the position of the DOR system.

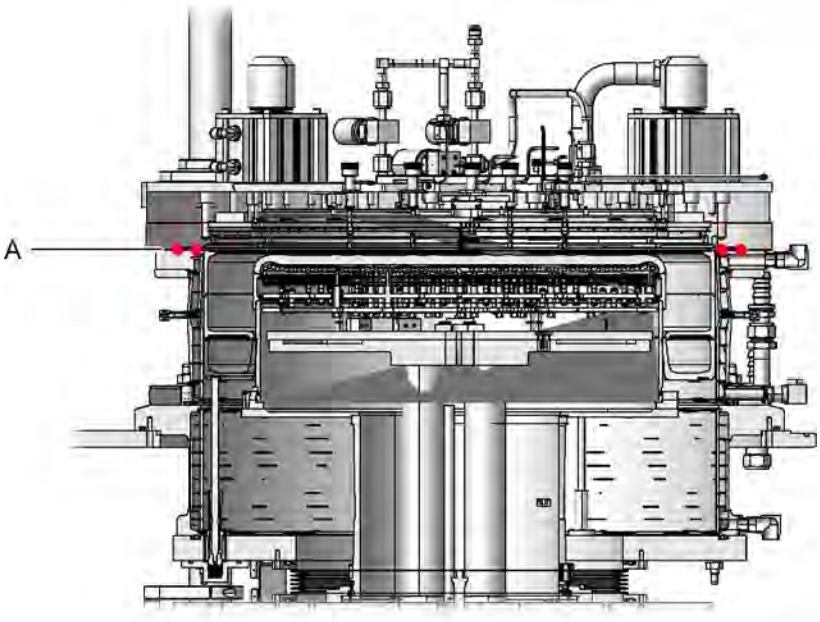


Fig. 3-17 *Position of the DOR system*

A DOR: Sealing between reactor lid and reactor chamber

3.5.6 In-situ layer thickness measurement

During the process, an optical measurement device is used for the temperature and reflection measurement on the wafers. It is mounted on the reactor lid above the sight glass.

The CCS reactor uses one of the following systems:

- AIXTRON Multiwafer Interferometer
- Laytec Epi-TT (optional)

AIXTRON Multiwafer Interferometer

The AIXTRON Multiwafer Interferometer, as a standard product for GaN growth, provides:

- Single wavelength reflectometry at 635 nm. It is used for highly accurate growth rate and surface roughness measurements.

Fig. 3-18, 69 shows both the AIXTRON Multiwafer interferometer & Laytec Epi-TT systems.

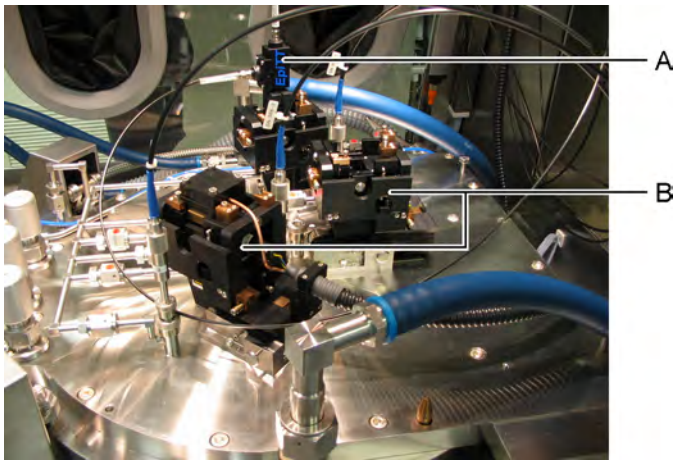


Fig. 3-18 *In-situ layer thickness measurement*

A Laytec Epi-TT head
B AIXTRON Multiwafer Interferometer heads

Laytec Epi-TT

The optional Laytec EpiCurve-TT system provides:

- Single wavelength pyrometry at 950 nm
- Single wavelength reflectometry at 950 nm (used for emissivity correction and complete process fingerprint)
- Single wavelength reflectometry at 600/635/700/850/905/950 nm (wavelength depending on the type of growth process). It is used for highly accurate growth rate and surface roughness measurements.

3.6 Gas system

The gas mixing system comprises the following components:

- Gas pipe system
- Control components
  - Valves
  - Mass flow controllers (MFCs) for controlling the gas flows
  - Pressure controllers (PCs) for controlling the source pressures
- Gas purifier (optional), see Chapter 3.6.7, 🗎 82
- Hydride gas sources, see Chapter 3.6.4, 🗎 74
- Metal organic (MO) sources, see Chapter 3.6.5, 🗎 76

Fig. 3-19, 🗎 70 illustrates the interior of the gas mixing cabinet.

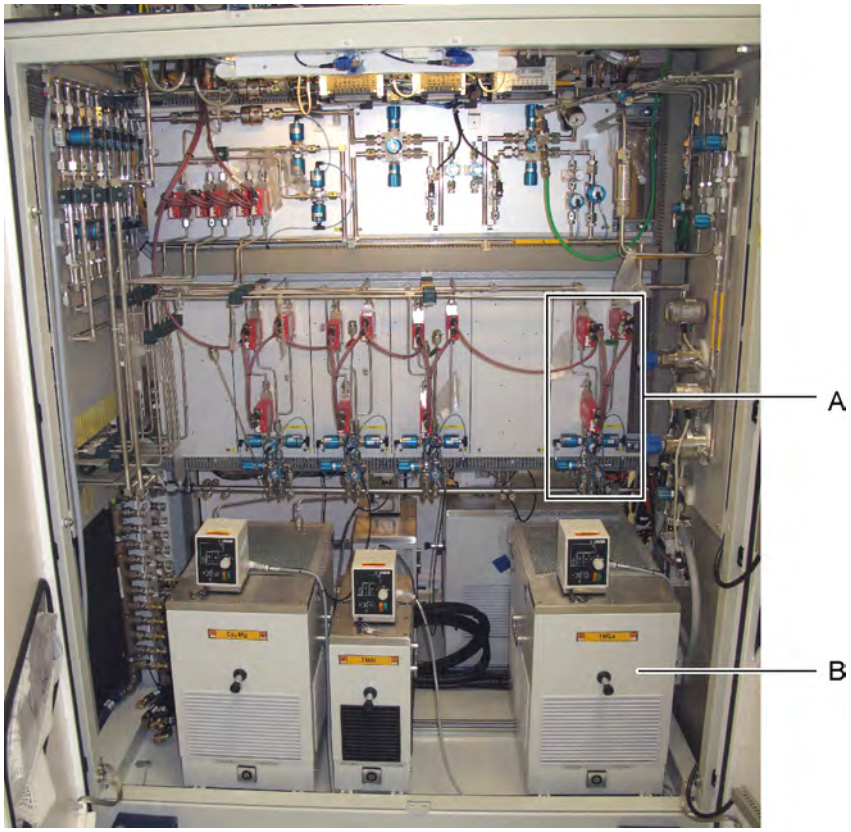


Fig. 3-19 *Gas system*

A Gas dosing unit for MO source
B Heat bath for thermostat, with MO bubbler

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3.6.1 Gas diagram

Fig. 3-20, 71 shows a simplified gas diagram of a CRIUS II.

NOTE:

The figure shown below relates to a typical CRIUS II.

Your specific system may differ from this in certain details. Always refer to the delivered gas diagram.

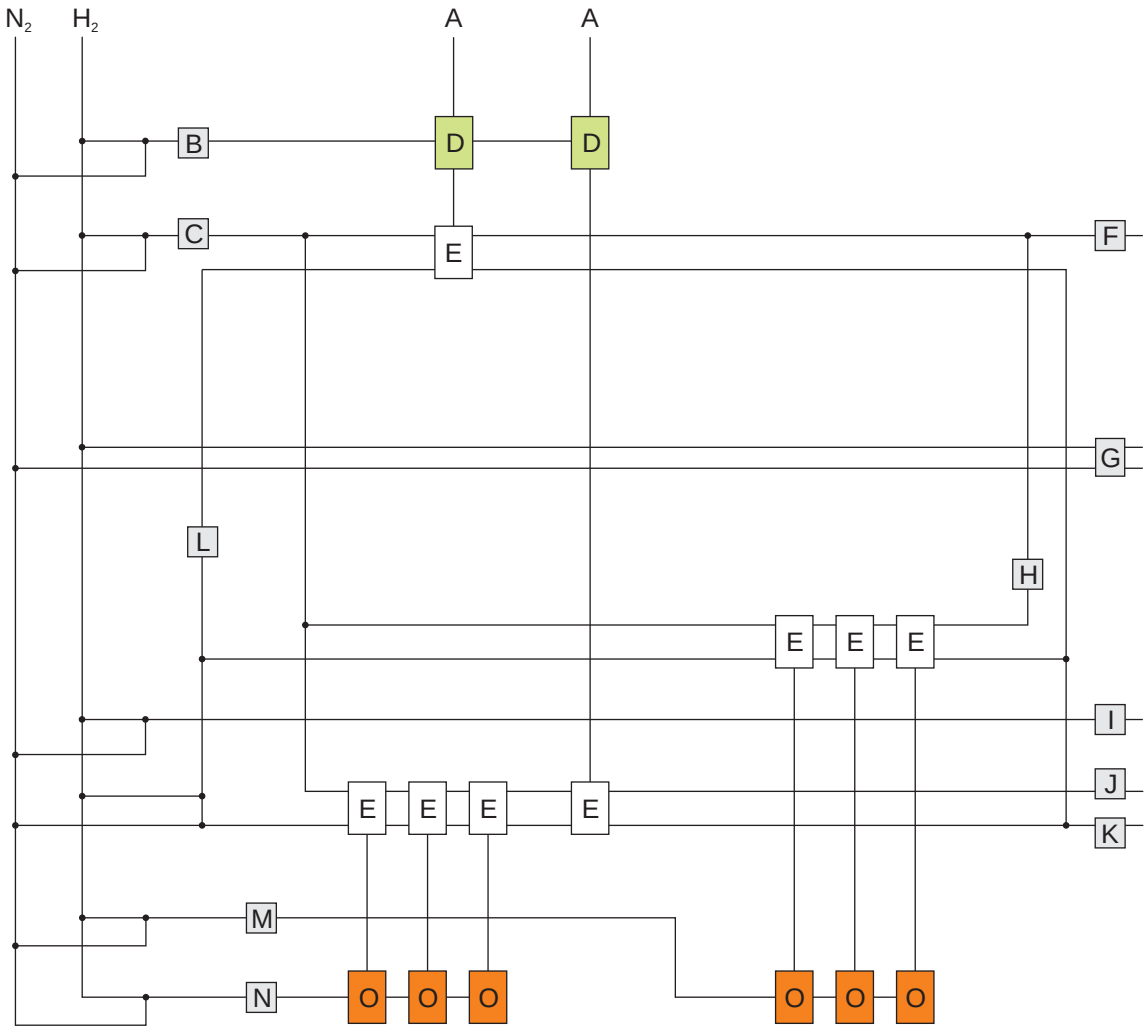


Fig. 3-20 *Gas diagram (example)*

A Hydride gases
B Gas supply for hydride sources
C Gas supply for run lines
D Gas dosing unit for hydride source
E Pneumatic 5/2-way valve
F Hydride run line (lower plenum)
G Purge Panel
H MO2 run line (upper plenum)
I Bypass for MO run line
J MO1 run line (upper plenum)
K Vent line
L Gas supply for vent lines
M Gas supply for MO2 sources
N Gas supply for MO1 sources
O MO bubbler

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3.6.2 Run and vent lines

The CRIUS II is equipped with three run lines. They are used to lead the process gas from the sources to the reactor chamber. Digital flow controllers control the process gas flow:

Run lines

- Hydride run line
  Leads from the hydride sources to the lower plenum of the showerhead.
  See Fig. 3-20, 🗎 71, item F.

- MO1 run line
  Leads from the MO1 sources to the upper plenum of the showerhead.
  See Fig. 3-20, 🗎 71, item J.

- MO2 run line
  Leads from the MO2 sources to the upper plenum of the showerhead.
  See Fig. 3-20, 🗎 71, item H.

Vent lines
For each run line, there is also a vent line. They lead past the reactor chamber into the vacuum system. See Fig. 3-20, 🗎 71, item K.

Switching between run and vent lines
A 5/2-way valve is used to switch between a run and a vent line. The following two states are possible:

Open:	The process gas flows through the run line into the reactor. No process gas flows in the vent line.
Closed:	The process gas flows through the vent line and passes the reactor. Only carrier gas flows in the run line. H_2 is normally used for this.

To avoid pressure compensation reactions during the switching processes between run and vent lines, the pressure in the run/vent lines and in the reactor chamber will be held at the same level.

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3.6.3 Purge gas lines

The following purge lines are provided to eliminate dead volumes within the reactor chamber:

- **Showerhead purge**
  To purge the showerhead during wafer loading and maintenance
- **Viewport/optical purge**
  To purge each of the optical access ports
- **Skirt purge**
  To assist gas flow over the edge of the susceptor to the exhaust
- **Liner purge**
  To purge the annulus between the reactor wall and the liner
- **Heater purge**
  To purge the heater area and prevent the ingress of toxic and/or corrosive materials into the ferrofluidic seal area.

Fig. 3-21, 🗎 73 shows the corresponding gas diagram.

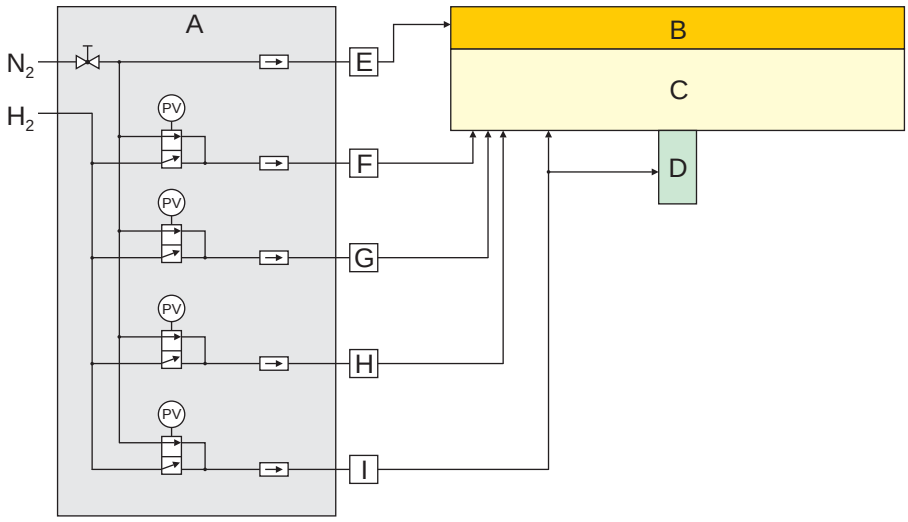


Fig. 3-21 *Purge gas lines*

A Purge Panel
B Showerhead
C Reactor
D Feedthrough
E Showerhead purge
F Optical purge
G Skirt purge
H Liner purge
I Heater purge

3.6.4 Hydride source

Hydride gases (e.g. AsH_3) are used as source material. They are stored in gas bottles and special cabinets outside of the system. Hydride gas is fed into the reactor via a dosing unit.

The following versions of the hydride source are available:

- Standard hydride source
- Doping hydride source

Standard hydride source

Fig. 3-22, 74 shows the gas diagram for the standard hydride source.

The 3/2-way valve (item C) has two operating states:
Open: Hydride source on, carrier gas off
Closed: Hydride source off, carrier gas on

The source MFC (item D) controls the hydride gas flow. The push MFC (item E) adds further carrier gas to dilute the hydride gas.

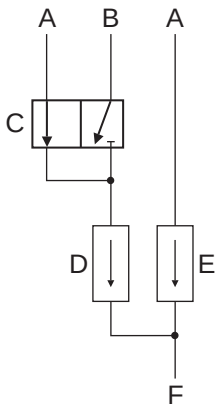


Fig. 3-22 *Standard hydride source*

A H_2 supply
B Hydride gas supply
C 3/2-way valve
D Source MFC
E Push MFC
F To hydride run/vent line

Doping hydride source

The doping hydride source is used if the process requires low gas flows or a large flow range. Fig. 3-23, 75 shows the gas diagram for the doping hydride source.

The source MFC (item D) and the dilute MFC (item E) adjust the gas mixture. The gas mixture is fed via the inject MFC (item F) into the hydride run/vent line.

The pressure controller (item G) controls the pressure operating point for the inject MFC (item F) and leads away excess gas into the hydride vent line (item I).

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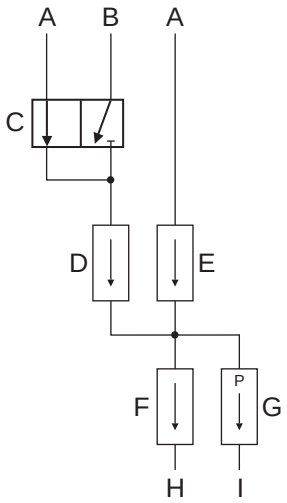


Fig. 3-23 *Doping hydride source*

A H_2 *supply*
B *Hydride gas supply*
C *3/2-way valve*
D *Source MFC*
E *Dilute MFC*
F *Inject MFC*
G *Pressure controller*
H *To hydride run/vent line*
I *To hydride vent line*

Provided that all MFCs are in the control range, you can use the following formula to calculate the process gas flow F_R into the reactor:

$$F_R = F_3 \times \frac{F_1}{F_1 + F_2}$$

F_1 = flow through the source MFC

F_2 = flow through the dilute MFC

F_3 = flow through the inject MFC

3.6.5 MO source

An MO source uses metal organic compounds, either in liquid or solid state. They are provided from containers made of stainless steel (bubbler) which are passed by a carrier gas. The bubblers are mounted in thermostat heat baths. See Fig. 3-24, 76.

Several thermostat heat bath types are available. For more information refer to the related OEM manual.



Fig. 3-24 *Thermostat heat bath (example)*

A Operating unit

Use the following parameters to control the concentration of the metal organic compounds in the carrier gas:

- Temperature of the bubbler
- Carrier gas flow through the bubbler
- Pressure in the bubbler

The following versions of the MO source are available:

- Standard MO source
- Standard MO source with double bubbler
- Doping MO source

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Standard MO source

Fig. 3-25, 77 shows the gas diagram for the standard MO source.

The 4/2-way valve (item G) has two operating states:
Switching position: Carrier gas flows through the MO bubbler
Initial position: Carrier gas passes the MO bubbler

The source MFC (item D) controls the carrier gas flow into the bubbler. The push MFC (item E) adds further carrier gas to dilute the carrier gas from the bubbler.

The pressure controller (item C) controls the pressure in the bubbler.

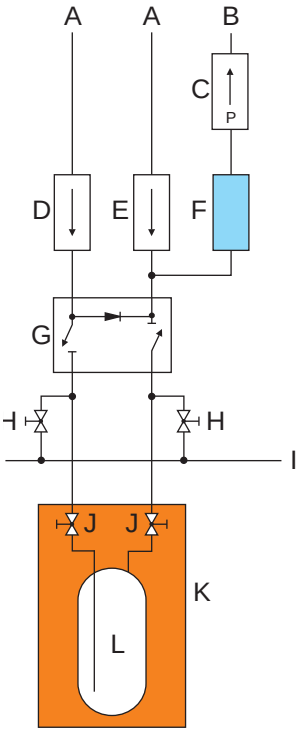


Fig. 3-25 *Standard MO source*

A H_2 *supply*
B To MO run/vent line
C Pressure controller
D Source MFC
E Push MFC
F Measuring device for gas concentrations (optional)
G 4/2-way MO source valve
H Quarter turn manual valve
I MO vacuum (for changing the MO bubbler)
J Manual valve at the bubbler
K Thermostat heat bath
L MO bubbler

Standard MO source with double bubbler

One thermostat heat bath contains two MO bubblers.

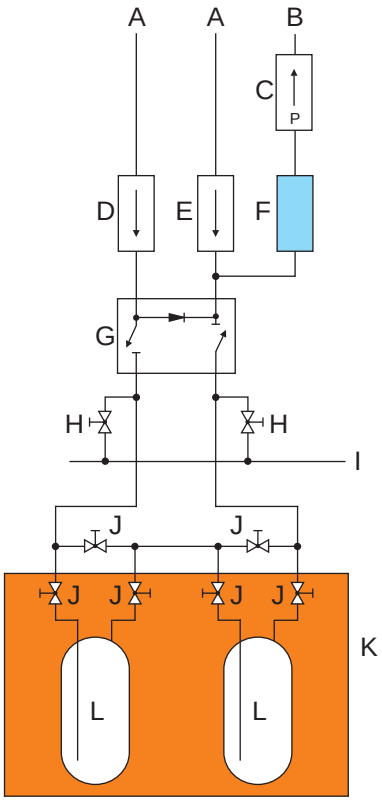


Fig. 3-26 *Standard MO source with double bubbler*

A H_2 *supply*
B *To MO run/vent line*
C *Pressure controller*
D *Source MFC*
E *Push MFC*
F *Measuring device for gas concentrations (optional)*
G *4/2-way MO source valve*
H *Quarter turn manual valve*
I *MO vacuum (for changing the MO bubbler)*
J *Manual valve at the bubbler*
K *Thermostat heat bath*
L *MO bubbler*

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Doping MO source

The doping MO source is used if the process requires low gas flows or a large flow range. Fig. 3-27, 79 shows the gas diagram for the doping MO source.

The source MFC (item D) and the dilute MFC (item E) adjust the MO concentration in the carrier gas. It is fed via the inject MFC (item F) into the MO run/vent line.

The pressure controller (item G) controls the pressure operating point for the inject MFC (item F) and leads away excess gas into the hydride vent line (item C).

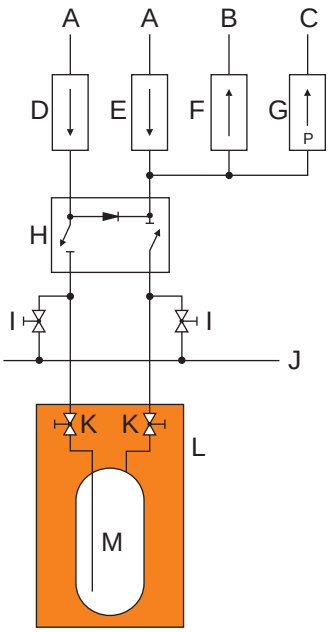


Fig. 3-27 *Doping MO source*

A H_2 supply
B To MO run/vent line
C To MO vent line
D Source MFC
E Dilute MFC
F Inject MFC
G Pressure controller
H 4/2-way MO source valve
I Quarter turn manual valve
J MO vacuum (for changing the MO bubbler)
K Manual valve at the bubbler
L Thermostat heat bath
M MO bubbler

Provided that all MFCs are in the control range, you can use the following formula to calculate the process gas flow F_R into the reactor:

$$F_R = F_3 \times \frac{F_1}{F_1 + F_2}$$

F_1 = flow through the source MFC

F_2 = flow through the dilute MFC

F_3 = flow through the inject MFC

3.6.6 Controlling and measuring components

Valves
As an example, Fig. 3-28, 🗎 80 shows the arrangement of valves installed before a standard MO source.

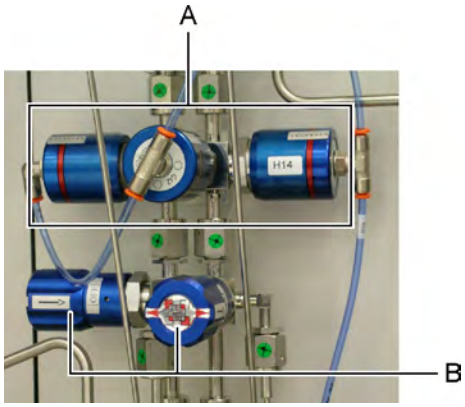


Fig. 3-28 *Valves (example)*

A 4/2-way valve
B Manual valves

NOTE:

An «H» indicates valves that switch hazardous gases.

Pressure and flow controllers
Fig. 3-29, 🗎 80 shows a digital flow controller. The pressure controllers look like the flow controllers.



Fig. 3-29 *Flow controller (MFC)*

Measuring apparatus for gas concentrations (optional)
Fig. 3-30, 81 shows a measuring apparatus for gas concentrations. It is used to measure the mixing ratio of two gases and can optionally be integrated into the gas mixing system.



Fig. 3-30 *Measuring apparatus for gas concentrations*

3.6.7 Gas purifier

Gases purifiers are optionally available in order to obtain ultra-pure gases. Fig. 3-31, 82 and Fig. 3-32, 82 show examples.



Fig. 3-31 *H_2 purifier*



Fig. 3-32 *N2 - N2 purifier (left) and NH_3 purifier (right)*

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3.7 Electrical supply

Front

Fig. 3-33, 🗎 83 and Fig. 3-34, 🗎 83 show the front side of the electrical cabinet.

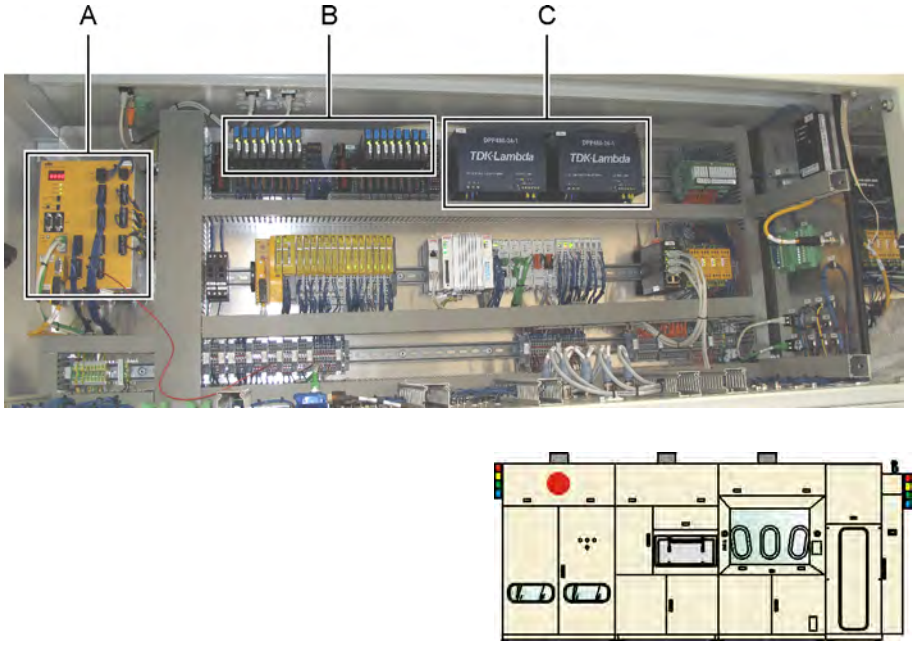


Fig. 3-33 *Electrical cabinet 1 (front side)*

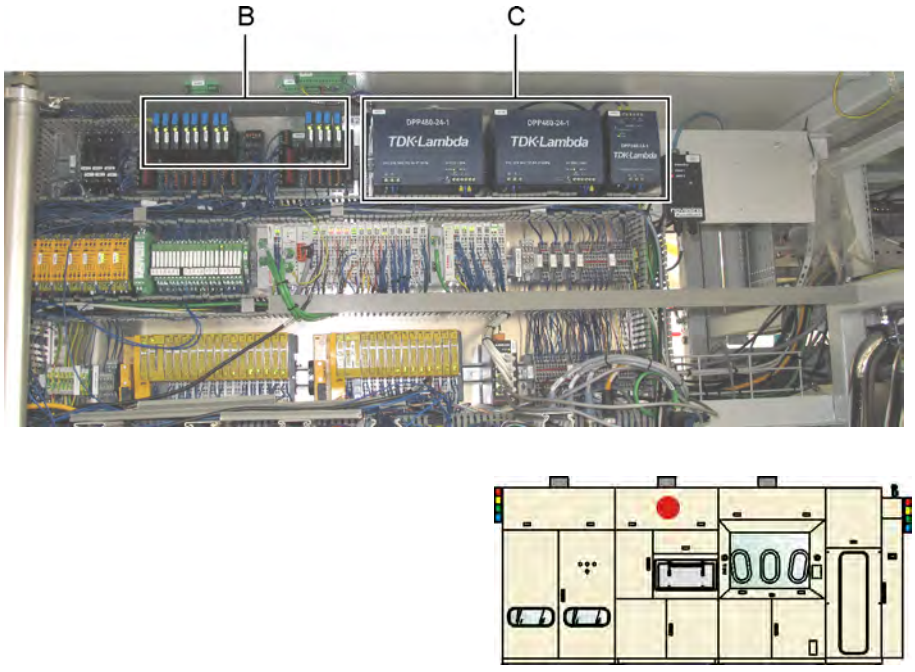


Fig. 3-34 *Electrical cabinet 2 (front side)*

A SCS
B Fuses for low power supply
C Low power supply

Back

Fig. 3-35, 84 shows the rear side of the electrical cabinet.

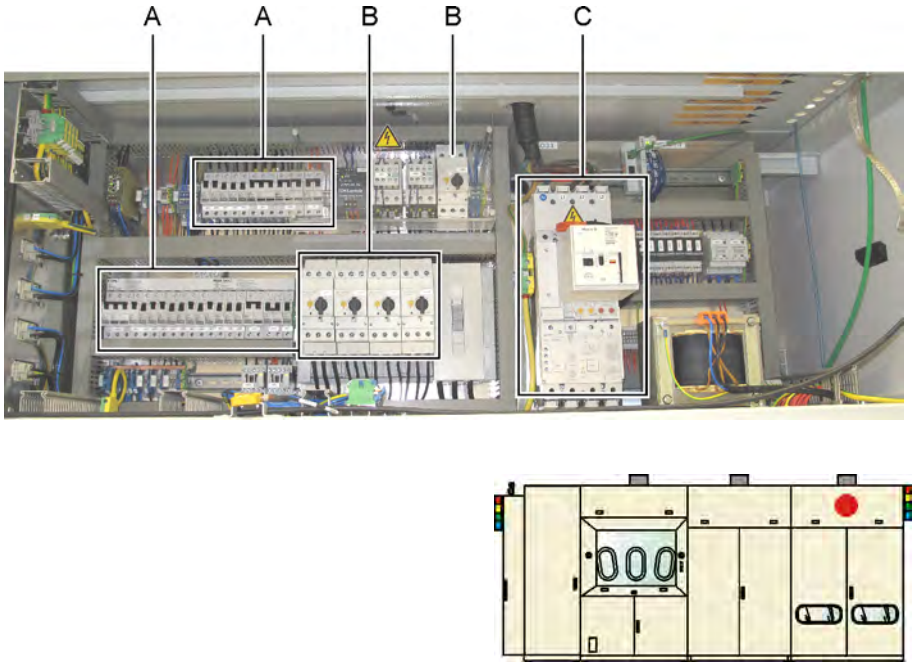


Fig. 3-35 *Electrical cabinet (rear side)*

A Main fuses
B Over-current circuit breakers
C Main switch with RCD

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3.8 Vacuum system

The vacuum system comprises the following components:

- Vacuum pumps
- Manual, pneumatic, solenoid, and electro-pneumatic valves
- Bypass lines with check valves to protect the system
- Exhaust gas filters including a separate water cooling unit

3.8.1 Vacuum pumps

Glove box pump

Fig. 3-36, 🗎 85 shows the glove box pump. It is used for evacuating the glove box.



Fig. 3-36 *Glove box pump*

DOR pump

Fig. 3-37, 🗎 85 shows the DOR pump. It is used for evacuating the intermediate volume between the inner and outer O-ring of the DOR system.



Fig. 3-37 *DOR pump*

Process pump

Fig. 3-38, 86 shows a typical process pump. It is used for evacuating the reactor chamber.



Fig. 3-38 *Process pump (example)*

3.8.2 Vacuum diagrams

The following table lists the symbols which are used to specify the components in vacuum diagrams.

Symbol	Meaning
	Manual valve
	Check valve
	High-vacuum valve
	Pneumatic valve
	Solenoid/pneumatic valve
	Throttle valve
	Filter
	Pressure transducer

Tab. 3-1 *Symbols used in the vacuum diagrams*



NOTE:

The following figures show the vacuum diagrams of a typical CRIUS II.

Your specific system may differ from this in certain details. Always refer to the delivered vacuum diagrams.

Reactor

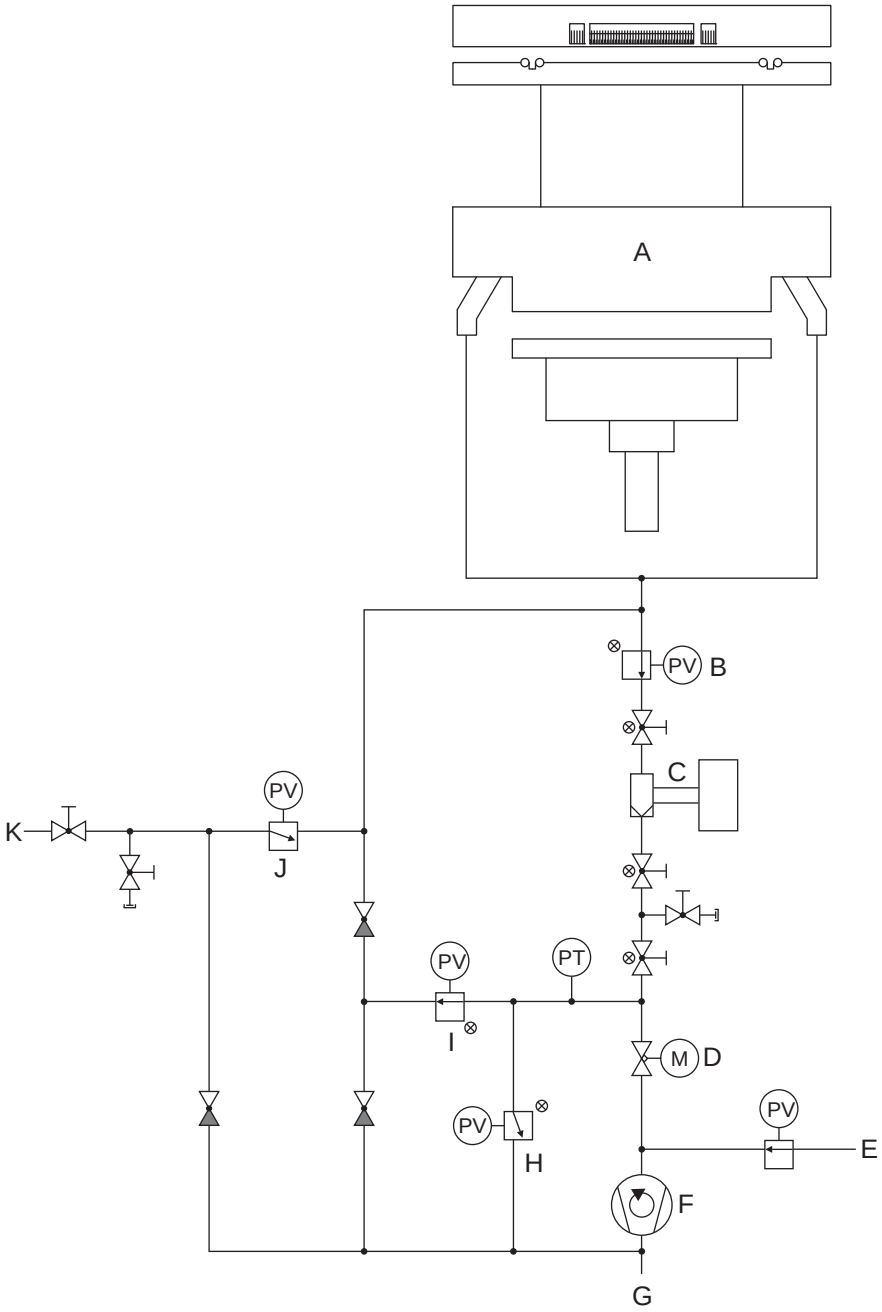


Fig. 3-39 *Vacuum diagram: Reactor*

A Reactor
B Reactor isolation valve
C Exhaust filter device with cooling trap
D Throttle valve for controlling the reactor pressure
E MO vacuum (for changing the MO bubbler)
F Process pump
G Exhaust (to scrubber)
H Pump bypass valve
I Vent bypass valve
J Vent/Vac valve
K Vent gas

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DOR system

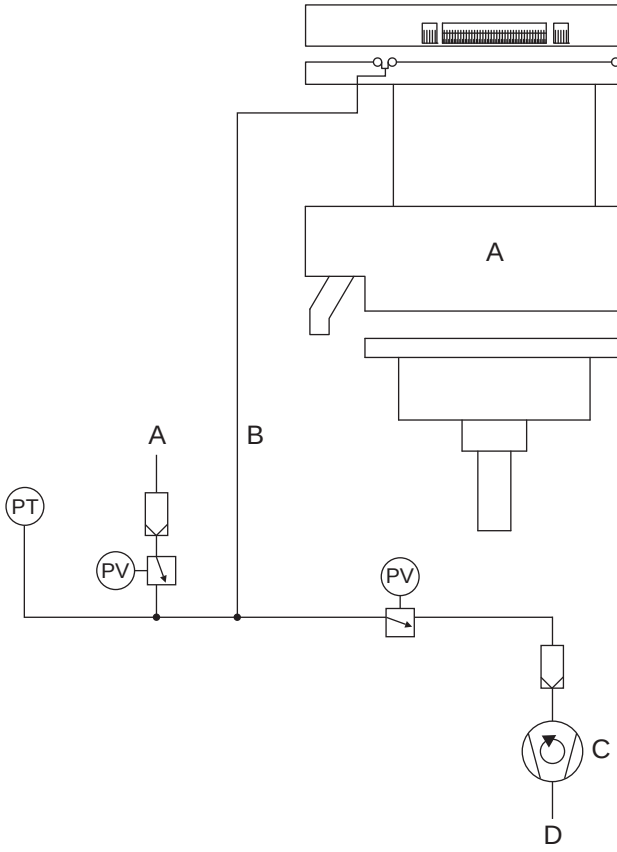


Fig. 3-40 *Vacuum diagram: DOR*

A Line for filling the DOR systems
B Line for evacuating the DOR system
C DOR pump
D Exhaust (to scrubber)

Vacuum cleaner, vacuum tweezers

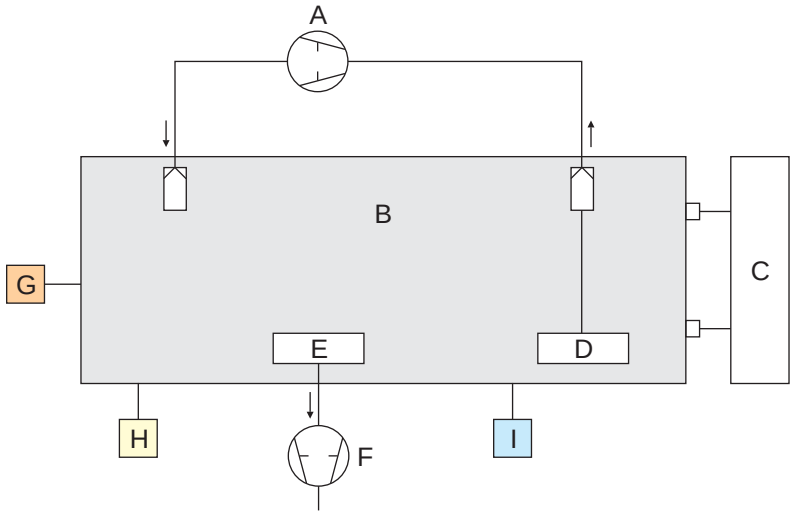


Fig. 3-41 *Vacuum diagram: Vacuum cleaner*

A Pump for vacuum cleaner
B Reactor
C Regeneration
D Vacuum cleaner
E Tweezers
F Pump for vacuum tweezers
G H_2 sensor
H O_2 sensor
I H_2O sensor

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3.8.3 Pressure control unit

The pressure control unit controls the position of the throttle valve and, in turn, the pressure in the reactor. See Fig. 3-42, 90.



Fig. 3-42 *Pressure control unit*

Fig. 3-43, 90 shows the pressure gauge that measures the pressure in the reactor.

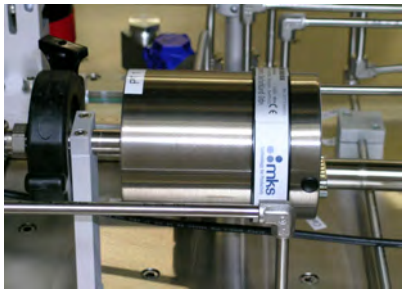


Fig. 3-43 *Pressure gauge*

The pressure gauge forwards the measured pressure to the pressure control unit. This device adjusts the pressure in the reactor according to the setpoint value by adjusting the position of the throttle valve.

3.8.4 Exhaust filter unit

The CRIUS II is equipped with an exhaust filter unit. The two-stage filter system comprises an upstream cooling trap and a downstream particle filter.

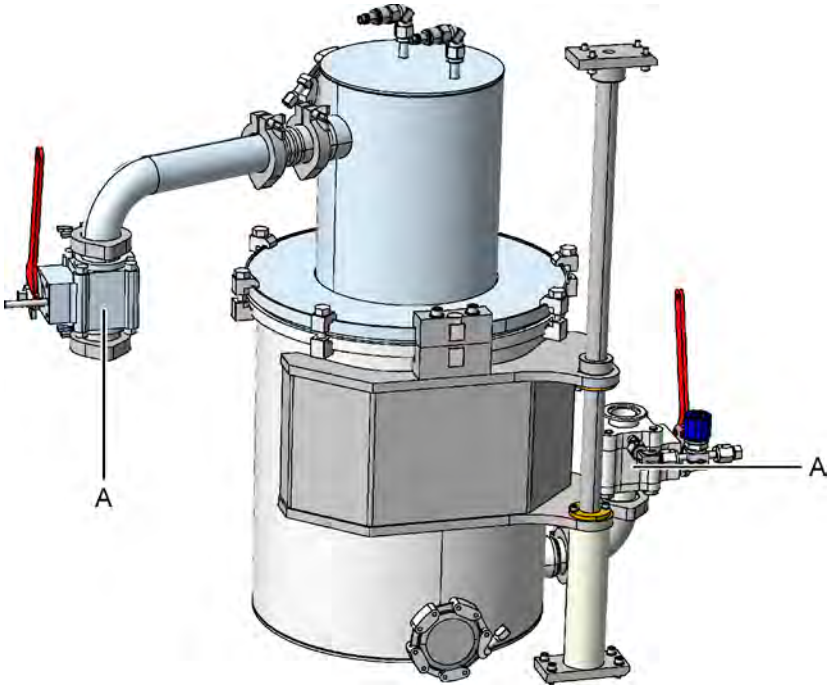


Fig. 3-44 *Exhaust filter unit (standard)*

A Ball valve

The following exhaust filter unit is optionally available.

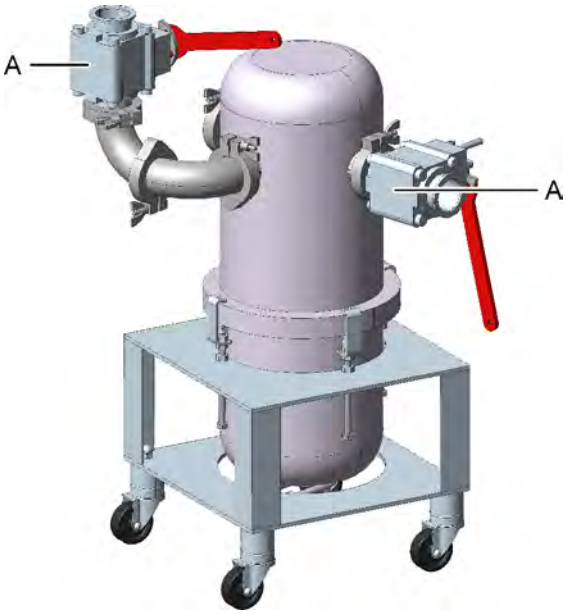


Fig. 3-45 *Exhaust filter unit (standard)*

A Ball valve

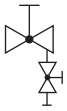
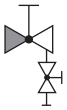
3.9 Media supply

The media supply of the CRIUS II comprises:

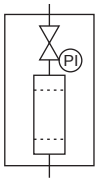
- Water supply, see Chapter 3.9.1, 92
- Pneumatic supply, see Chapter 3.9.2, 96

3.9.1 Water supply

The following table lists the symbols which are used to specify the components in the water diagrams.

Symbol	Meaning
	Manual valve
	Drain valve
	Check valve
	Manual valve with drain
	Manual valve with check valve and drain
	Electromagnetic valve
	Pneumatic valve
	Manometer
	Flow meter with flow limiter
	Filter

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Symbol	Meaning
	Filter with pressure setting and purge system
	Thermometer
	Pump

Tab. 3-2 *Symbols used in the water diagrams*

The cooling water supply consists of three circuits that are shown in the following diagrams. For details refer to the delivered «Cooling System» drawing.

Circuit 1
(without aluminum)

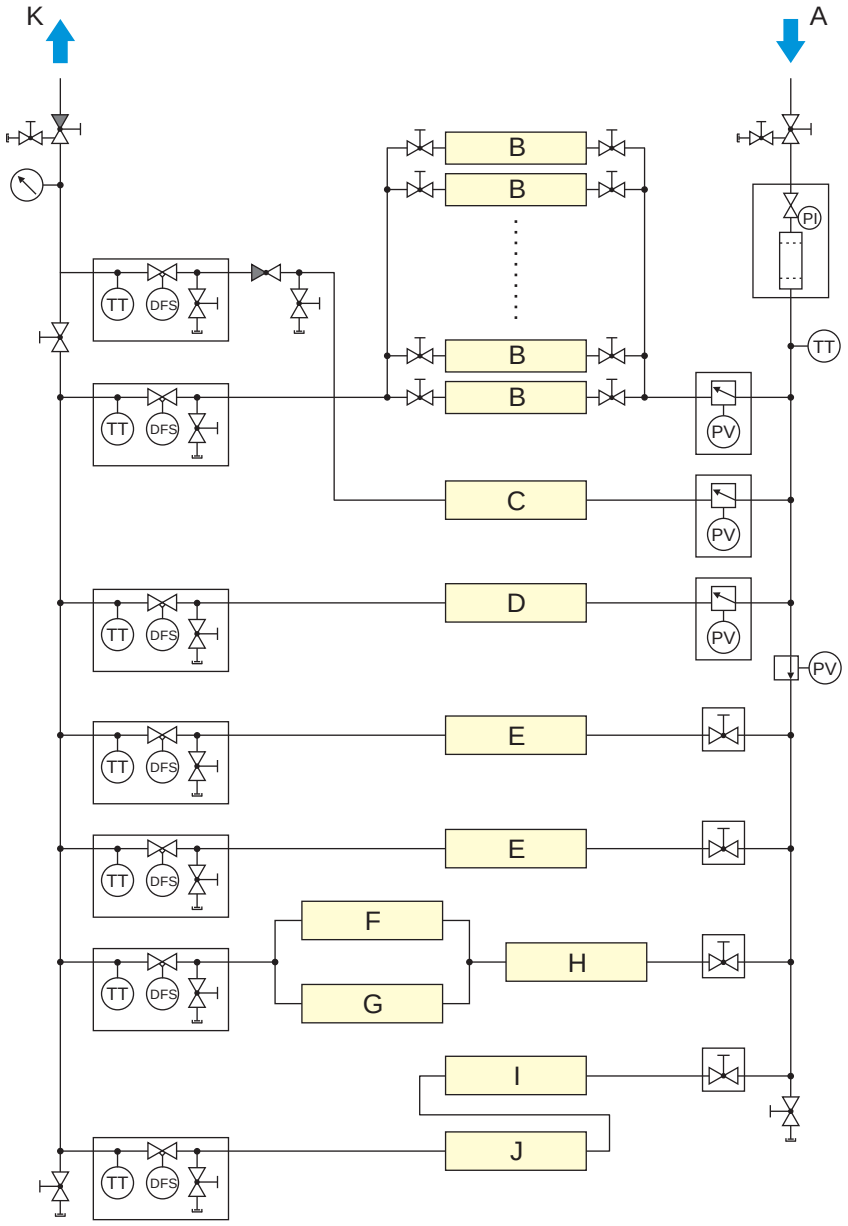


Fig. 3-46 *Water diagram: Circuit 1*

A Inlet
B Thermostat bath 1…x
C Process pump
D Glove box
E Power cables
F Exhaust tube 1
G Exhaust tube 2
H Bus bar
I Reactor base
J Reactor chamber
K Outlet

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Circuit 2
(with aluminum)

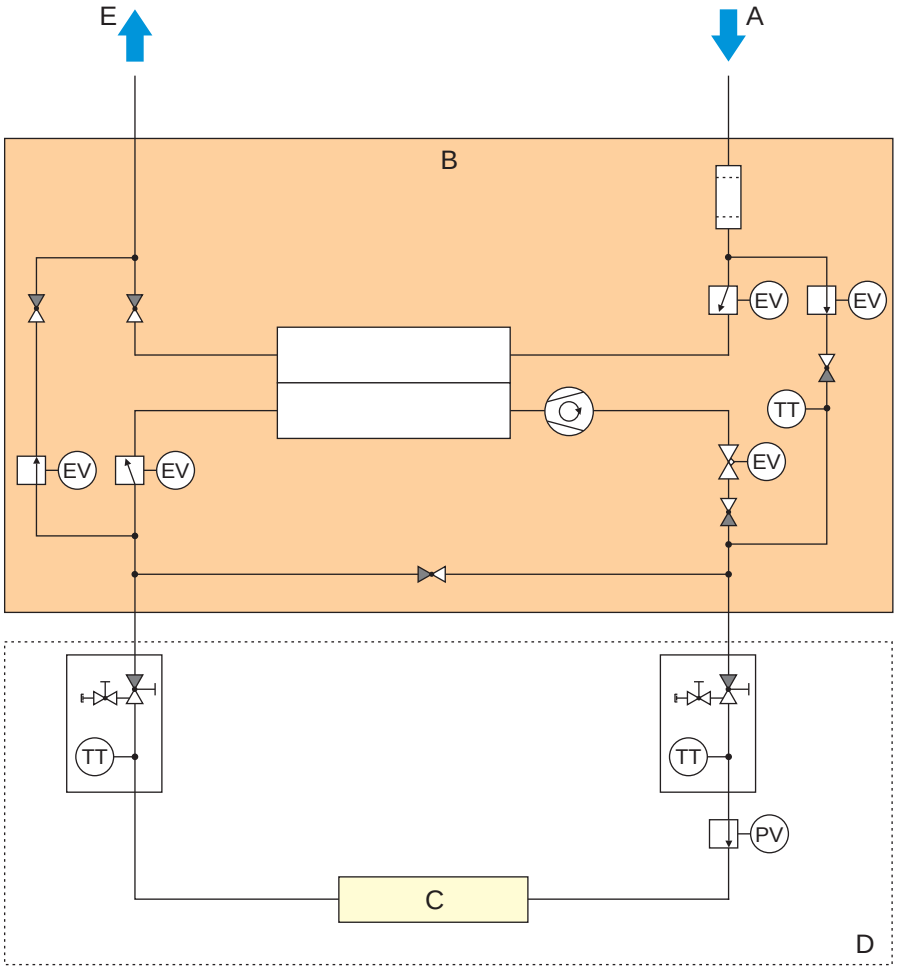


Fig. 3-47 *Water diagram: Circuit 2*

A Inlet
B Heat exchanger
C Showerhead
D Circuit without Al components
E Outlet

Circuit 3
(without aluminum)

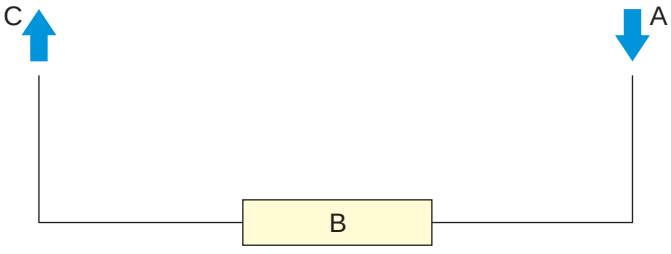


Fig. 3-48 *Water diagram: Circuit 3*

A Inlet
B PSU heat exchanger
C Outlet

3.9.2 Pneumatic supply

A pneumatic maintenance unit supplies the pneumatic components (e.g. valves, clamps) of the CRIUS II with nitrogen via panels:

Panels

- GMS panel
- Reactor Panel 1
- Reactor Panel 2

Component groups

The pneumatic components are divided into the following groups:

- MO Source Supply
- Hydride Source Supply
- H_2 Source Supply
- H_2 Run Supply I
- H_2 Run Supply II
- Run/Vent I
- Run/Vent II
- Independent Valves

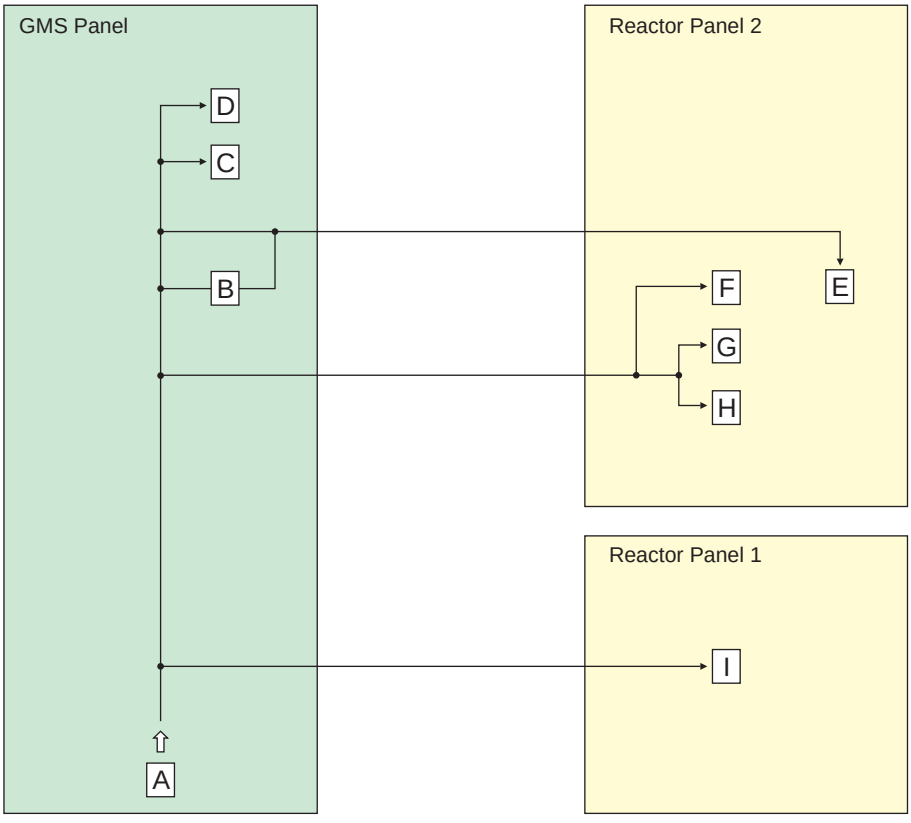


Fig. 3-49 *Pneumatic supply*

A Pneumatic maintenance unit
B H_2 Source Supply + H_2 Run Supply I
C Hydride Source Supply
D MO Source Supply
E H_2 Run Supply II
F Independent Valves (Vac System)
G Run/Vent I
H Run/Vent II
I Independent Valves

For details refer to the delivered pneumatic drawings.

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3.10 Safety Control System (SCS)

The CRIUS II is equipped with a safety control system preventing any unsafe state of the system.

The SCS monitors all signals, valve positions, sensors, and analog limit values. It operates stand-alone and is superior to the control computers. The SCS switches the system to a safe state if a dangerous situation occurs. Alarms and system states are displayed in AIXACT.

The SCS is located in the electrical cabinet.

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4 Installation

4 Installation

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4.1 Introduction

This chapter contains general guidelines for installation of the CRIUS II and provides directions for set-up, connection and function checks.



NOTE:

Only specially trained AIXTRON service technicians are permitted to install and to commission the CRIUS II. Other persons are not allowed to perform these tasks.

Unless otherwise stated in the sales contract, the responsibilities are regulated as follows:

The end user of the CRIUS II is responsible for:

- Unpacking the system
- Factory-internal transport of the system to the intended installation location
- Providing the supply connections (water, power, pneumatic supply etc.) and the exhaust system in accordance with the order and the order confirmation

AIXTRON is responsible for:

- Setting up and starting up the system
- Testing the system (including the acceptance report)

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4.2 Packaging and external transport

Delivery

The system is delivered by means of a lift van with air suspension and a lifting platform. During the transport it is ensured all the time that the transport crates are not tilted or exposed to significant shocks.

Packaging

All packing units that leave the AIXTRON factory are structured as follows:

- The cabinets or product groups stand on wooden pallets which can be transported by means of a lift truck or a forklift truck
- The packing units are protected as follows:
  - Layer 1: Aluminum foil wrap
  - Layer 2: Bubble wrap
  - Layer 3: Aluminum wrap, laminated and vacuum packed, with desiccant
- The individual packing units are placed in wooden transport crates

Packing symbols

Depending on their content, the packing units are labeled with the packing symbols shown below. The symbols must be observed strictly.

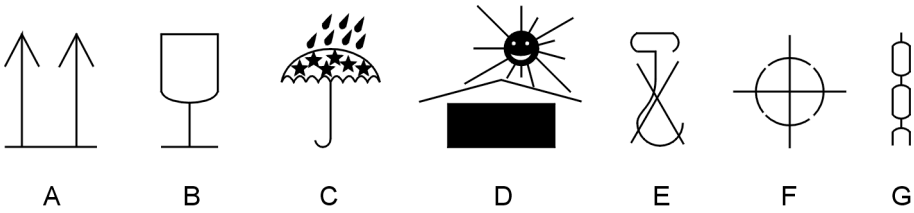


Fig. 4-1 *Packing symbols*

A This side up
B Fragile
C Keep dry
D Keep away from heat sources
E Do not use hooks
F Center of gravity
G Lifting point

Unloading

The forwarding agent unloads the wooden crates by means of the lift platform of the truck. In the following, a suitable fork lift truck is used for transporting the units.

4.3 Unpacking and internal transport

4.3.1 Hazard alerts

WARNING! Heavy components.



Improper handling of heavy components may cause serious contusions, fractures or even lead to death.

Use suitable equipment to lift and transport heavy components. Wear safety boots. Always keep a safe distance to suspended loads. Never stay under a suspended load!

WARNING! Transport devices.



Improper use of transport devices may result in personal injury and material damage.

Only authorized and specially trained personnel are permitted to use transport devices such as ground conveyors or cranes.

CAUTION! Transport damage.



Improper handling of the crates during transport may cause material damage.

During transport, the crates must not be tilted or exposed to significant shocks. Pay attention to the transport symbols.

4.3.2 Unpacking

1 Unpack the packing units from the wooden crates

NOTE:



Do not remove the three layers of protective wrap until the packing units are located in the clean room.

The end user has to remove the packaging and to dispose of it in accordance with the local regulations.

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4.3.3 Internal transport by means of a crane

Because of the non-symmetrical centre of gravity, the cabinets should be lifted and lowered by means of an adjustable H-beam.

AIXTRON recommend using an adjustable H-beam in order to prevent damage.

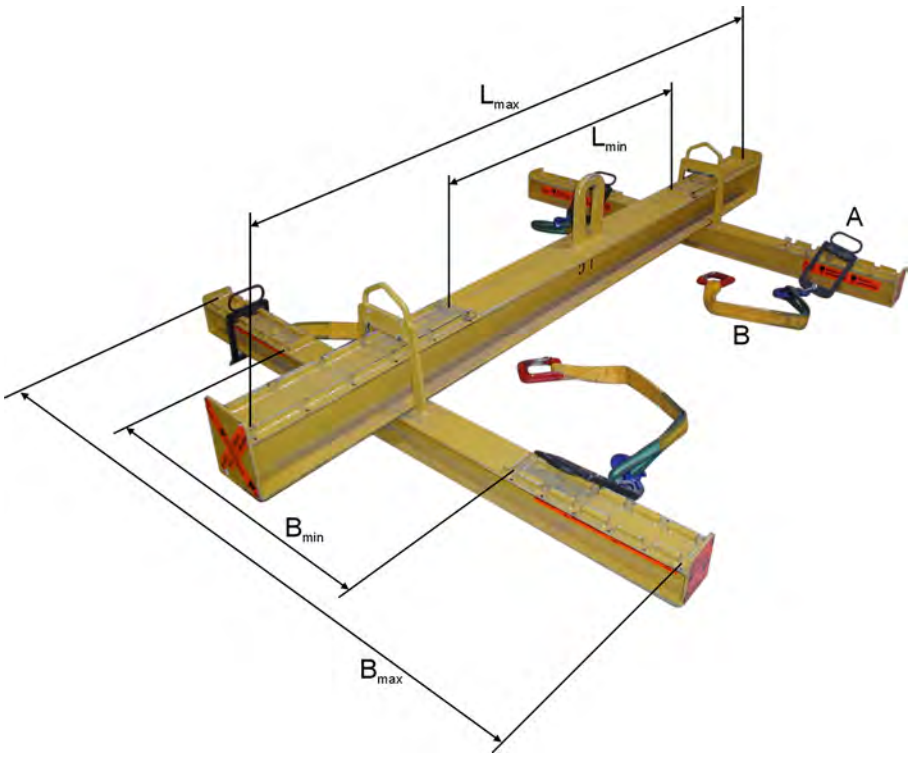


Fig. 4-2 *H-beam*

A Adjustable load hook
B Transport belt

L_{max}:	3000 mm
L_{min}:	1500 mm
B_{max}:	2000 mm
B_{min}:	1000 mm
Dead weight:	350 kg

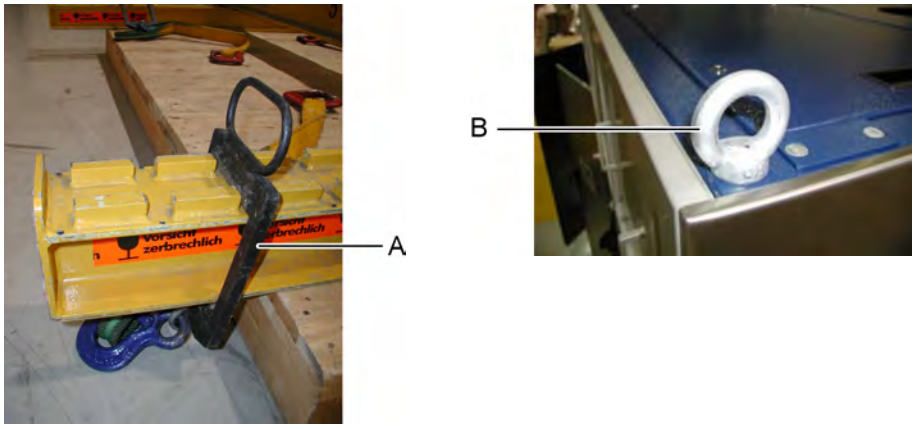


Fig. 4-3 *Transport of the cabinets*

A Adjustable load hooks on the H-beam
B Transport lug on the cabinet frame

Proceed as follows to transport the system by means of a crane:

1 Attach the H-beam to the crane using suitable belts

2 Lift the H-beam with the crane up to the required height

3 Set the load hooks to positions which fit the transport lug positions of the cabinet to be transported

4 Attach the four transport belts of the H-beam to the transport lugs on the cabinet frame

NOTE:

Make sure that the force applied at the transport lugs is perpendicular to the frame. Adjust the positions of the load hooks, if necessary.

5 Carefully lift the cabinet

6 Carefully transport the cabinet to the required position by means of the crane

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4.3.4 Internal transport by means of a lift truck

If a transport by means of a crane is not possible, the cabinets may be transported by means of a lift truck.

Transport conditions

Transport routes
If no additional safety devices are mounted, the cabinets may only be transported on smooth and level surfaces.

Inclines
A separate safety device for protection against tilting is required if the cabinet is transported on inclines.

Load capacity
The surfaces must have a load capacity of at least 3200 kg.

Dimensions
Doors and elevators must have the following clearance dimensions:

Height: 2.70 m

Width: 1.40 m

Depth: 3.30 m

Fig. 4-4, 🗎 105 shows a lift truck.

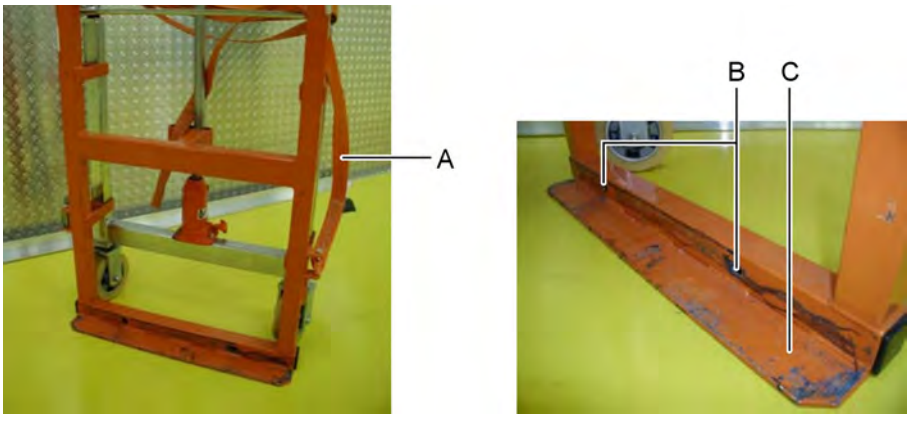


Fig. 4-4 *Lift truck*

A Load strap
B Mounting holes
C Load plate

Transport

Proceed as follows to transport the cabinet by means of a lift truck:

1 Lift the cabinet by means of the crane and the H-beam. See Chapter 4.3.3 Internal transport by means of a crane, 🗎 103.

2 Remove the wooden pallet

3 Put suitable support plates below the cabinet (approx. 1 cm thick). The support plates make sure that it will be possible to insert the load plates of the lift truck below the cabinet frame.

4 Lower the cabinet onto the support plates

5 On both sides of the cabinet, insert the load plates of the lift trucks below the cabinet frame

6 Use the load belts and tighten the load trucks to the cabinet. Position the load straps as low as possible.



NOTE:

It is also possible to mount the lift trucks to the cabinet frame by inserting two screws into the mounting holes at the cabinet frame.

7 Use the lift trucks to lift the cabinet to transport height

8 Remove the support plates

9 Carefully transport the cabinet to the required location

4.4 Site Requirements

Environmental conditions
See Chapter 1.6.2 Environmental conditions, 13.

Vibrations
During the deposition process, the CRIUS II must not be exposed to notable vibrations. For this reason, make sure that no equipment creating heavy vibrations is installed in the vicinity of the CRIUS II. Also make sure that the ground on which the system is installed is capable of absorbing vibrations.

Operating media
The CRIUS II must be supplied with the required operating media. See Chapter 1.6 Installation data, 13.

The supply lines must be laid in keeping with the local safety regulations and with the information in the media diagrams.

Space requirements
The clearance distance for escape routes must be in keeping with the local safety regulations. Safety doors, covers, etc. must be installed in such a way that the CRIUS II remains accessible from all sides for maintenance and service work.

Ventilation system
You find the requirements for the ventilation system in the delivered installation plan.

4.5 Media connection

The end user has to install lockable interfaces for the media supply.

The end user is also responsible to control and interlock the gas supply in his facility (facility-safety concept). If a toxic gas or hydrogen detection alarm occurs, the customer must shut off (close) all toxic and flammable gas feed lines to the system.

4.6 Assembly



NOTE:

Only specially trained AIXTRON service technicians are permitted to install and to commission the CRIUS II. Other persons are not allowed to perform these tasks.

The required steps are not described in this System Manual.

4.7 Checks

4.7.1 Final inspection

The safety- and interlocking functions must be demonstrated when the CRIUS II is handed over to the end user. The CRIUS II must be ready for operation and must have been successfully subjected to previous operational and functional testing.

Both end user and AIXTRON service technician must provide written confirmation (acceptance report) that safety-related, precautionary devices are functioning correctly.

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5 Operation

5 Operation

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5.1 General operating elements

5.1.1 EMERGENCY-OFF and PROCESS-STOP buttons

EMERGENCY-OFF buttons can be used to shut down the entire system if dangerous situations crop up. Pressing a PROCESS-STOP button will switch the CRIUS II to the «safe state». See Chapter 2.6 Safety circuits, 31.

5.1.2 Main switch

The remote control for the main switch of the CRIUS II is located at the gas mixing cabinet. It controls the main switch in the electrical cabinet.

Remote control



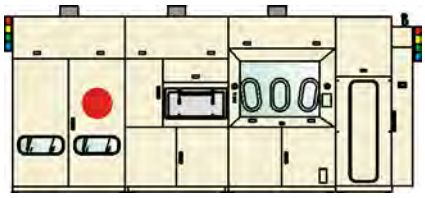


Fig. 5-1 *Remote control for the main switch*

Switch positions

«O» (OFF)
In this position the system is switched off completely.

WARNING! Primary side of main switch.

Parts inside of the supply rack may be connected to the primary side of the main switches. These parts are always live. Touching these parts will cause an electric shock. The shock may be lethal.



Prior to any work in the danger area:
- **Lock out and tag out the power lines leading to the supply rack**
- **Ground the equipment**
- **Check to make sure that no one is in the danger area before you energize the supply rack again**

«I» (ON)
In this position the system can be switched on.

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Lockout/Tagout

For maintenance and service work, you can lock the main switch in the «O» position. Proceed as follows to lock out the main switch:

1 Make sure that the main switch is set to the «O» position

2 Lock the main switch using a padlock



Fig. 5-2 *Locking the main switch (example)*

3 Check to make sure that the switch cannot be moved anymore

For information on the lockout/tagout procedure, refer to Chapter 2.7 Lockout/tagout procedure, 🗎 38.

5.1.3 Power [ON/OFF] buttons

Fig. 5-3, 112 shows the buttons for switching the mains power on and off.

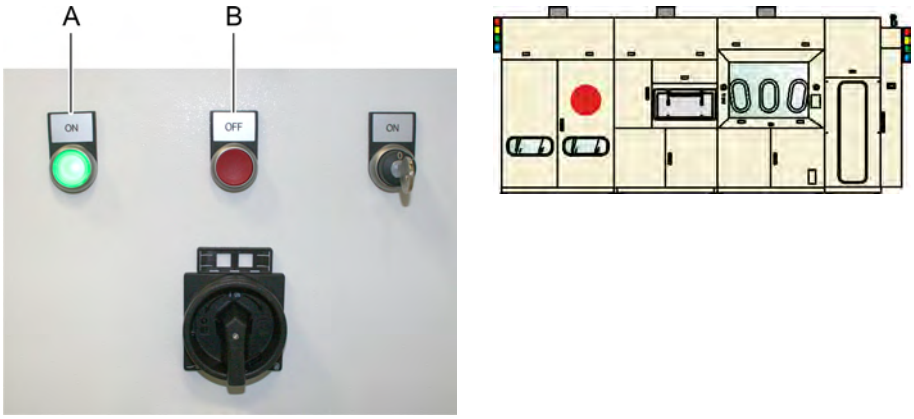


Fig. 5-3 *[ON/OFF] buttons*

A [ON] button
B [OFF] button

5.1.4 Signal lamp

The CRIUS II is equipped with signal lamps. They indicate the state of the CRIUS II.

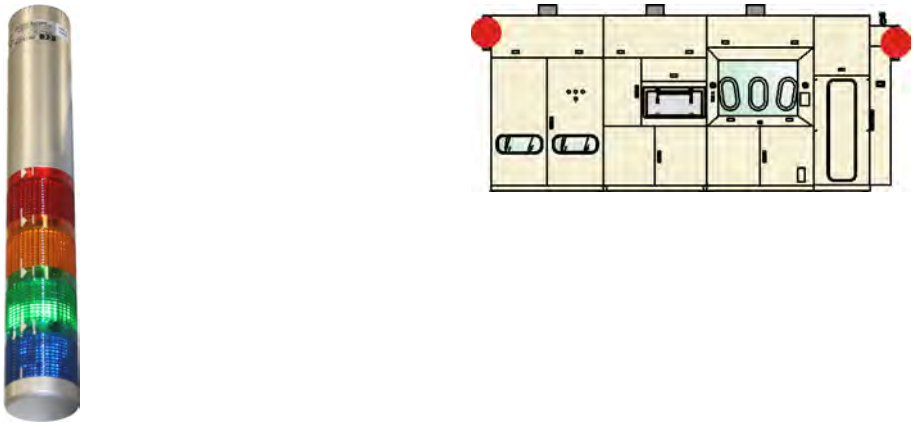


Fig. 5-4 *Signal lamp*

The signal colors are defined as follows:

Color		Meaning
	Red	Error
	Yellow	Not ready for operation
	Green	Ready for operation
	Blue	System is in maintenance mode

Tab. 5-1 *Used signal colors*

5.1.5 Key switch for operating mode

A key switch is used to switch between maintenance mode and operation mode.

Position «0»
System is in operation mode

Position «I»
System is in maintenance mode



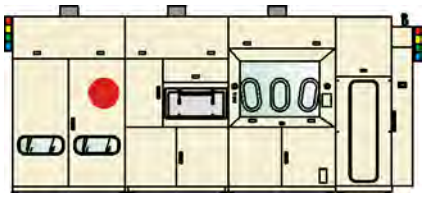


Fig. 5-5 *Key switch for operating mode*

5.2 Operating elements: Glove box

5.2.1 Main switch for components of the glove box

The main switch for the glove box components is located in the reactor cabinet. It switches on the components used for controlling the glove box and the reactor (e.g. pressure control unit, glove box control).

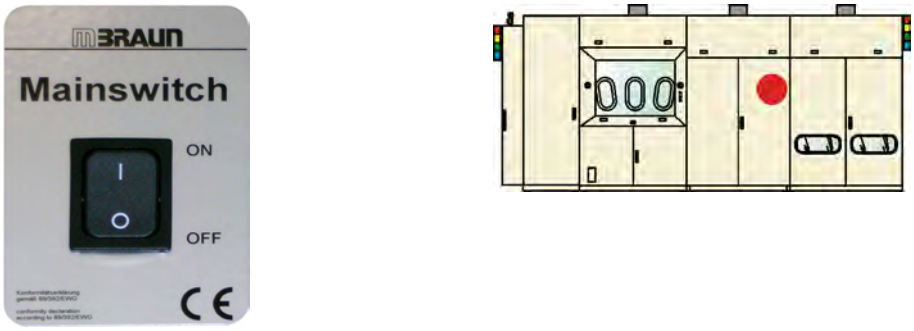


Fig. 5-6 *Main switch for components of the glove box*

5.2.2 Gloves

Three gloves are installed at the front and the back side of the glove box. Use the gloves to perform work inside of the glove box, such as loading substrates into the reactor.

For maintenance work, you can open the glove box at the front side or rear side using the handles.

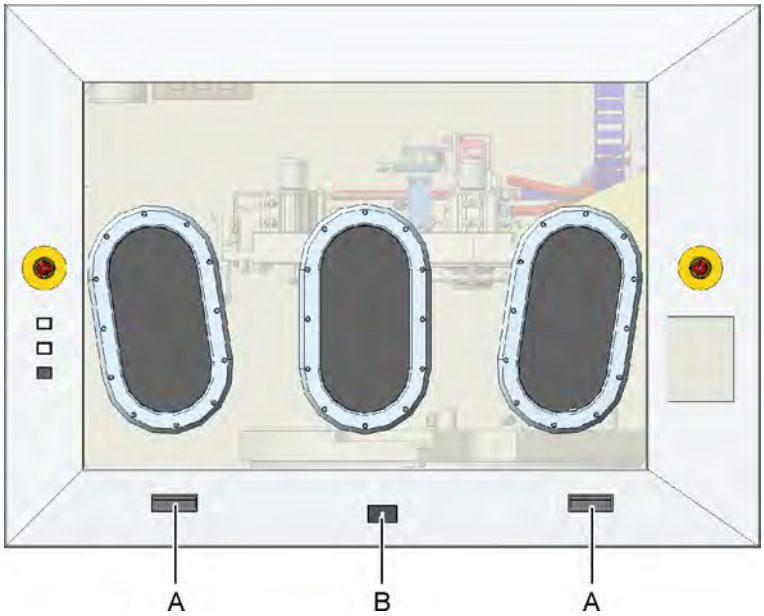


Fig. 5-7 *Gloves*

A Handle
B Lock

5.2.3 Control panel

Fig. 5-8, 116 shows the control panel. The control panel is used to control procedures inside of the glove box, such as opening and closing the load lock doors.

For operation please refer to the corresponding OEM manual.

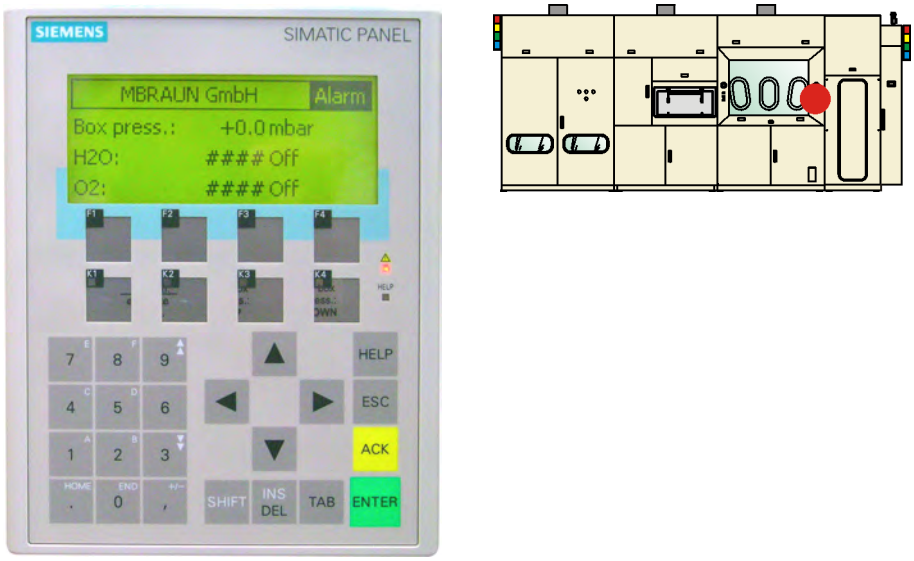


Fig. 5-8 *Control panel for the glove box*

5.2.4 Control box inside of the glove box

A control box is installed inside the glove box at the front and rear side. The control box can be operated via the gloves.

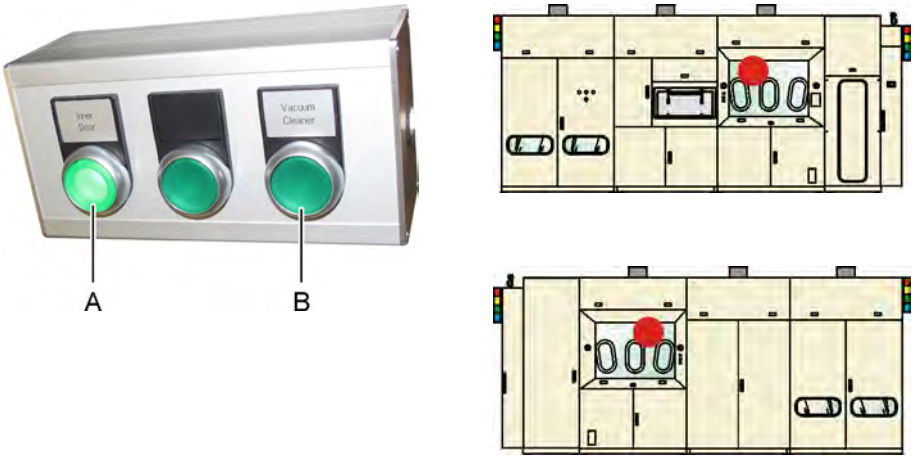


Fig. 5-9 *Control box inside of the glove box*

A [Inner Door] button: Open the inner lock chamber door
B [Vacuum Cleaner] button: Switch the vacuum cleaner on/off

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5.2.5 Pedal switches

The pedal switches are used to initiate the following actions:

- Switch on/off the susceptor rotation
- Evacuate the glove box
- Refill the glove box

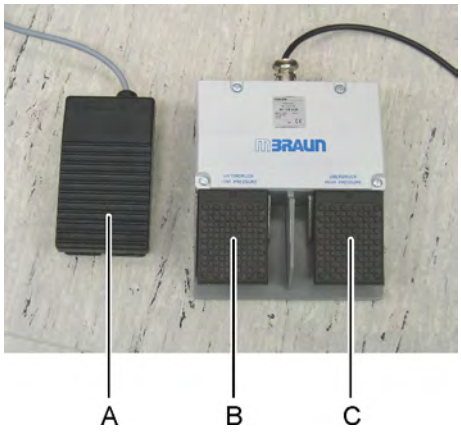


Fig. 5-10 *Pedal switches*

A Rotate the susceptor
B Evacuate
C Refill

5.2.6 Vacuum cleaner

A vacuum cleaner is installed inside of the glove box. See Fig. 5-11, 🗎 117. It is used to remove residues. It can be switched on and off with the control box. See Chapter 5.2.4 Control box inside of the glove box, 🗎 116.

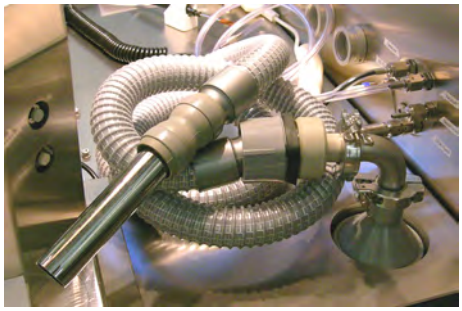


Fig. 5-11 *Vacuum cleaner*

5.2.7 Vacuum wand (optional)

The vacuum wand is installed in the glove box. See Fig. 5-12, 🗎 118. It is operated with a pedal switch. See Chapter 5.2.5 Pedal switches, 🗎 117.

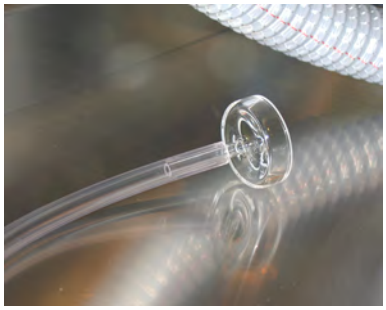


Fig. 5-12 *Vacuum wand*

5.2.8 Vacuum tweezers (optional)

The vacuum tweezers that is installed in the glove box is used to handle the substrates.

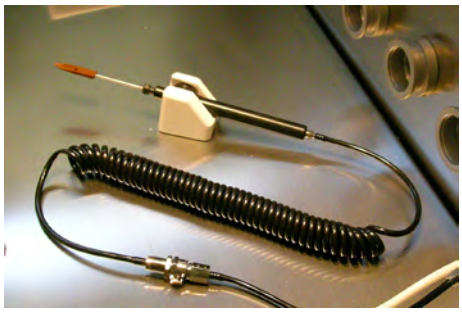


Fig. 5-13 *Vacuum tweezers*

5.2.9 N_2 pistole (optional)

An N_2 pistol is installed inside of the glove box.



Fig. 5-14 *N_2 pistol*

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5.3 Operating elements: Reactor

5.3.1 [OPEN/CLOSE] buttons - reactor lid/chamber

Two buttons are located at the front and the back side of the reactor cabinet. They are used for opening and closing of the reactor lid or the reactor chamber.

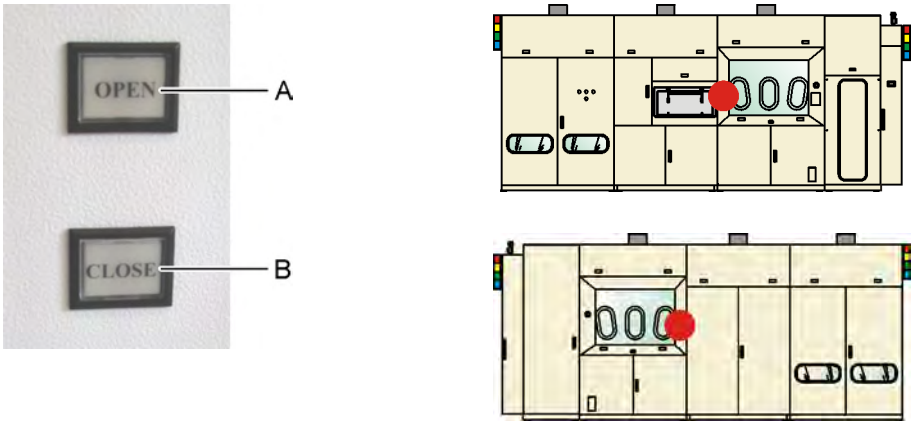


Fig. 5-15 *[OPEN/CLOSE] buttons - reactor lid/chamber*

A [OPEN] button: Open the reactor lid or the reactor chamber
B [CLOSE] button: Close the reactor lid or the reactor chamber

5.3.2 Key switch

Fig. 5-16, 119 shows the key switch.

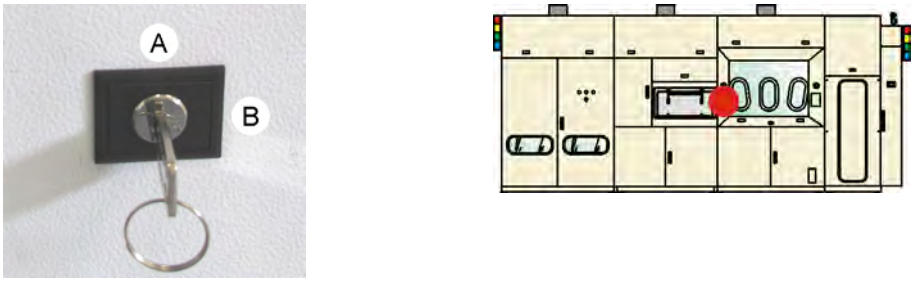


Fig. 5-16 *Key switch*

A Vertical position
B Horizontal position

The key switch has two switching positions:

- Vertical position:
  In this key position, you can raise or lower the reactor lid using the [OPEN] or [CLOSE] buttons.

- Horizontal position:
  When the maintenance mode is selected and the corresponding nuts are removed, you can raise or lower the reactor chamber in this key position using the [OPEN] or [CLOSE] buttons.

5.3.3 [OPEN/CLOSE] buttons - reactor bottom

A box with two buttons are used for moving the reactor bottom. It is loacated inside the reactor cabinet.

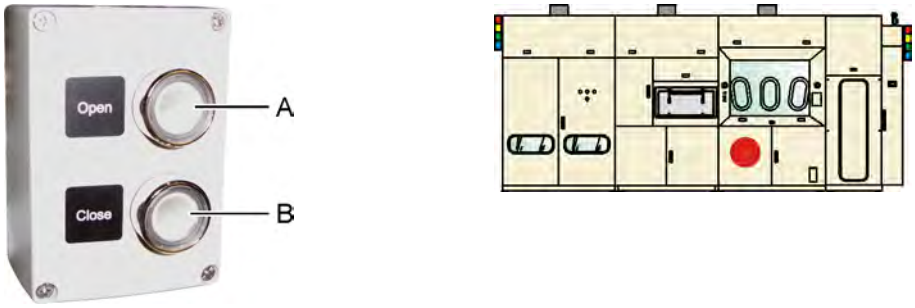


Fig. 5-17 *[OPEN/CLOSE] buttons - reactor bottom*

A [OPEN] button
B [CLOSE] button

5.3.4 [Pins up/down] buttons

A box with two buttons is installed inside the glove box. It allows to raise or lower the pins for susceptor replacement.

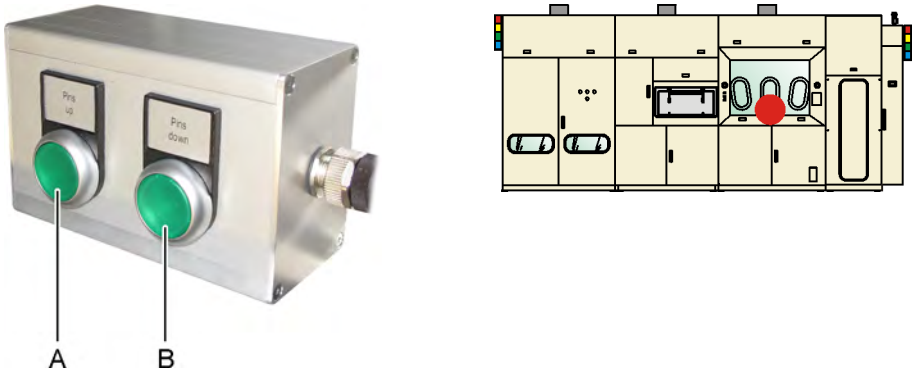


Fig. 5-18 *[Pins up/down] buttons*

A [Pins up] button
B [Pins down] button

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5.3.5 Pressure control unit for throttle valve

The pressure control unit controls the position of the throttle valve and, in turn, the pressure in the reactor. The unit can be operated either directly («Local») or via the software («Remote»).

Fig. 5-19, 121 shows the front side of the pressure control unit with operating and display elements.

For operation please refer to the corresponding OEM manual.

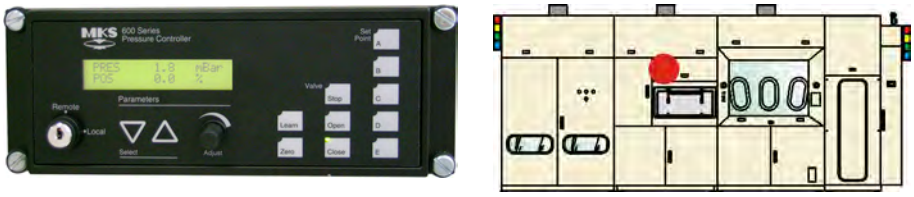


Fig. 5-19 *Pressure control unit*

5.3.6 Temperature control unit

The temperature control unit is located at the reactor cabinet. It consists of the following controllers:

Eurotherm

The Eurotherm temperature controller controls the reactor temperature.

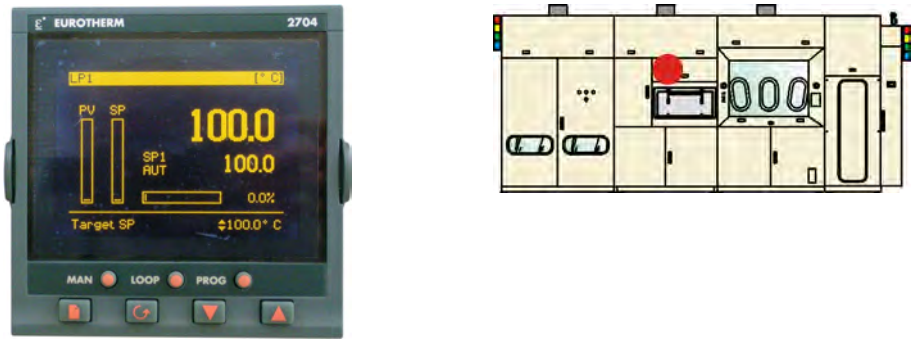


Fig. 5-20 *Eurotherm controller*

5.4 Operating elements: Heating

5.4.1 Main switch

Fig. 5-21, 122 shows the main switch of the heater supply unit.

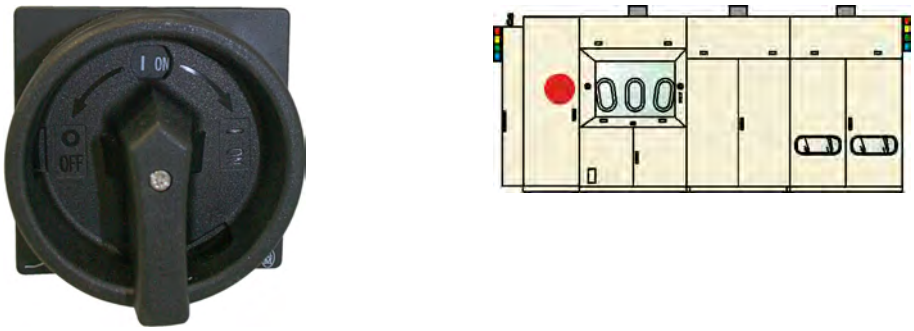


Fig. 5-21 *Main switch*

Switch positions

«O» (OFF)
In this position the system is switched off completely.

WARNING! Primary side of main switch.

Parts inside of the supply rack may be connected to the primary side of the main switches. These parts are always live. Touching these parts will cause an electric shock. The shock may be lethal.

Prior to any work in the danger area:
- **Lock out and tag out the power lines leading to the supply rack**
- **Ground the equipment**
- **Check to make sure that no one is in the danger area before you energize the supply rack again**

«I» (ON)
In this position the system can be switched on.

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5.5 Operating elements: Gas system

5.5.1 Control unit for the thermostat heat bath

Fig. 5-22, 123 shows a control unit for the thermostat heat bath.

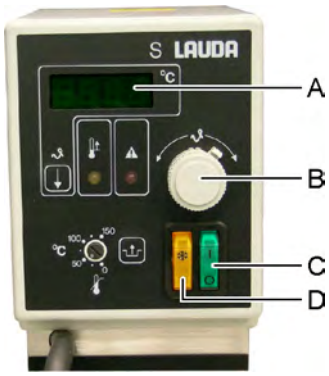


Fig. 5-22 *Control unit for the thermostat heat bath*

A Temperature display
B Temperature control
C On/off switch
D Cooling switch

5.6 Operator terminal

The CRIUS II can be operated via the server operator terminal or the client operator terminal.

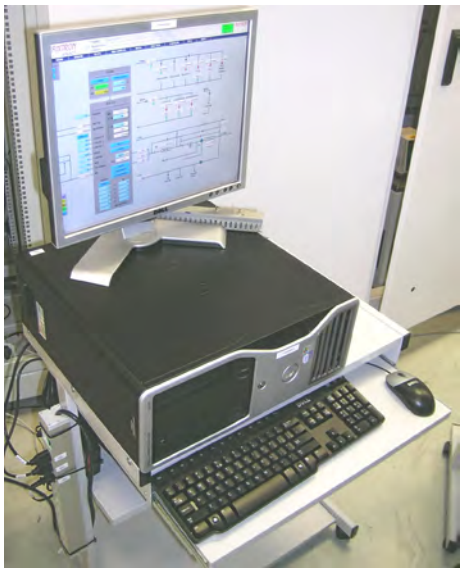


Fig. 5-23 *Operator terminal*

5.7 Switching the CRIUS II on and off

5.7.1 Switching on

Proceed as follows to switch the CRIUS II on:

1 Close all cabinet doors of the CRIUS II

2 Switch the main switch to the ON position

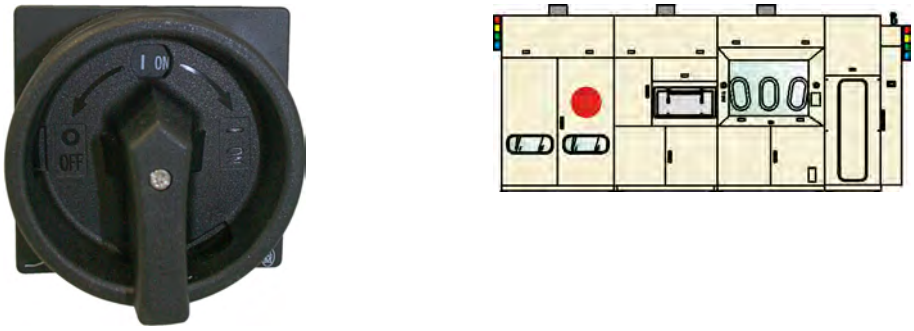


Fig. 5-24 *Switch on the main switch*

The red [OFF] button is illuminated

3 Press the green [ON] button
- The red [OFF] button gets dark
- The green [ON] button is illuminated

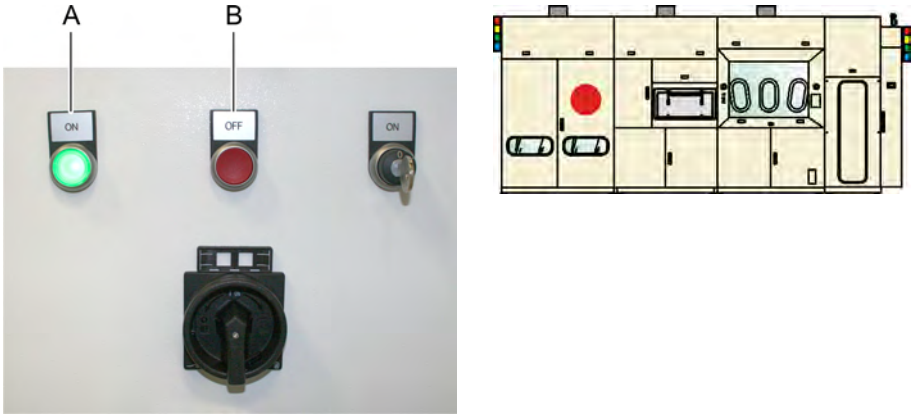


Fig. 5-25 *[ON/OFF] buttons*

A [ON] button
B [OFF] button

4 The server is started automatically. It is located in the electrical cabinet. See Fig. 5-26, 126. You also can switch on the server by means of the Start button.

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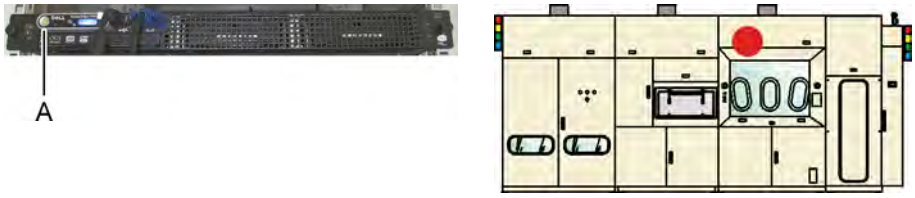


Fig. 5-26 *Server*

A Start button

5 Enter your user name and password at the operator terminal to log in

6 Start AIXACT

5.7.2 Switching off

Proceed as follows to switch the CRIUS II off:

1 Quit AIXACT

2 Shut down the operating system

3 Press the red [OFF] button
- The green [ON] button gets dark
- The red [OFF] button is illuminated

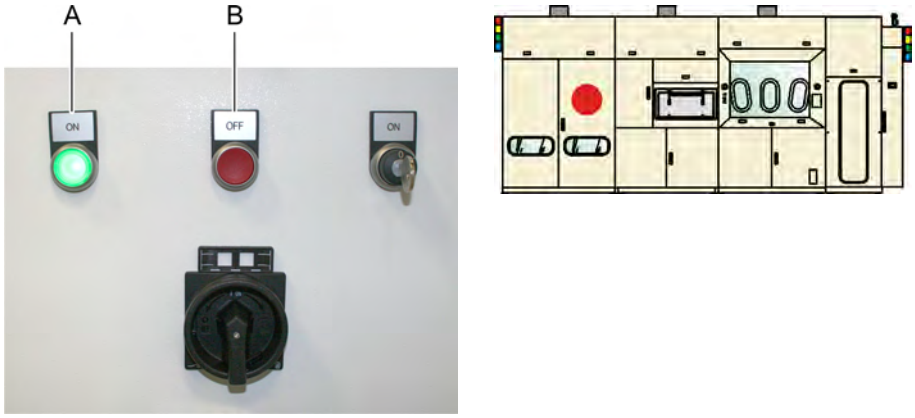


Fig. 5-27 *[ON/OFF] buttons*

A [ON] button
B [OFF] button

4 Switch the main switch to the «OFF» position

5 Secure the system against unintended switching on. Follow the lock-out/tagout procedure. See Chapter 2.7 Lockout/tagout procedure, 38.
- Lock the main switches in the safe position using a padlock
- Post a prominent tag onto each lockout device

5.8 Preparing for a process

5.8.1 Actions inside of the glove box

The actions inside of the glove box are performed by means of the installed gloves. See Fig. 5-28, 127.

NOTE:

For reasons of hygiene, you should put on clean room gloves before slipping into the gloves installed in the glove box.

We also recommend you to wear clean room glove on top of the installed gloves. This prevents contamination of the samples.



Fig. 5-28 *Using the gloves*

NOTE:

Do not use the gloves while opening or closing the reactor lid. The light barriers installed inside of the glove box would interrupt the opening or closing procedure when you reach into the active area of a light barrier.

5.8.2 Loading substrates

Proceed as follows to load substrates:

NOTE:

Detailed information on the control panel for the glove box can be found in the OEM manual by MBRAUN.

Loading substrates into the load lock

1 Release the outer lock chamber door by means of the control panel

2 Pull down the handle at the outer lock chamber door and open the door

3 Pull out the drawer



Fig. 5-29 *Outer lock chamber door*

A Drawer
B Handle

4 Put the substrates into the drawer

5 Push the drawer back into the lock chamber
- A sensor lights up as soon as the drawer is fully back in the lock chamber. Otherwise the outer lock chamber door cannot be closed.

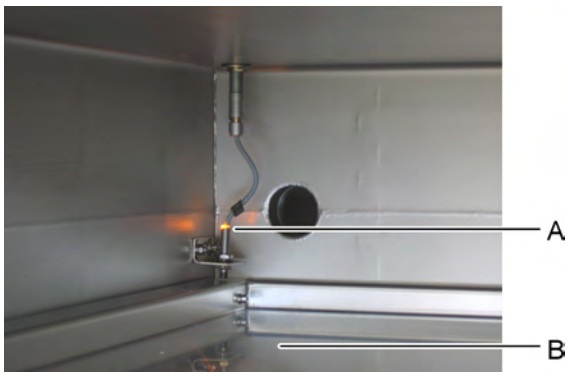


Fig. 5-30 *Sensor for the drawer*

A Sensor
B Drawer

6 Close the outer lock chamber door

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7 Start the automatic pump/refill cycle of the lock chamber by means of the control panel. This procedure makes sure that contamination cannot enter the glove box via the lock chamber.

Loading substrates into the reactor

8 Open the inner lock chamber door by means of the control panel

NOTE:

The inner lock chamber door can also be opened by pressing the [Inner Door] button at the control box inside of the glove box. See Chapter 5.2.4, 116.

9 Press the [OPEN] button to open the reactor lid
- The reactor lid is only cleared for opening if the [OPEN] button is illuminated by green light

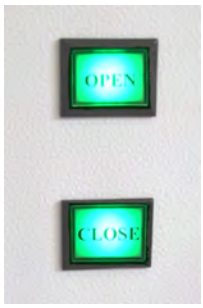


Fig. 5-31 *[OPEN] and [CLOSE] buttons*

10 Pull the drawer from the lock chamber into the glove box

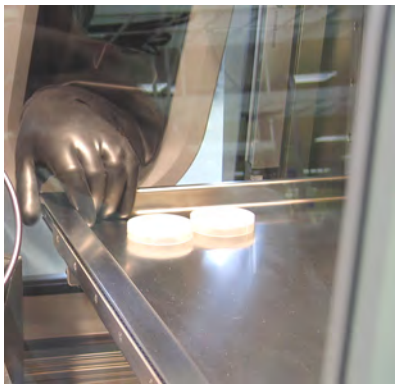


Fig. 5-32 *Pulling the drawer out of the lock chamber*

11 Remove the substrates from the transport containers

12 Use the vacuum tweezers to put the substrates onto the susceptor

13 Push the drawer back into the lock chamber

14 Press the [CLOSE] button to close the reactor lid. See Fig. 5-31, 129.
- The reactor lid is only cleared for closing if the [CLOSE] button is illuminated by green light

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6 Maintenance

6 Maintenance

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6.1 Introduction

6.1.1 Personnel qualifications

This chapter is for users who have been allocated the «Technician» authorization level or higher. See Chapter 1.2 User qualifications, 8.

6.1.2 Visual inspections

The CRIUS II concept keeps the amount of required maintenance work to a minimum. Most of the components do not require any kind of maintenance work if you observe the stipulations for normal operating conditions. It is sufficient to make regular visual inspections.

In addition, you should always listen for unusual noise and pay immediate attention to any malfunctioning.

6.1.3 Maintenance contract

AIXTRON recommends to have the entire system overhauled by AIXTRON service technicians on a regular basis. Various important wear-sensitive system parts such as vacuum seals, sealing rings, ball bearings, etc. will then be replaced by new parts. Please contact your local AIXTRON representative for information about a customer-specific maintenance contract.

6.1.4 Logbook

AIXTRON recommends that a record of all performed maintenance work be kept in a logbook. This is particularly important if various different personnel are responsible for maintenance work on one system. A logbook allows the end user to keep a constant check on the type and date of performed maintenance work.

6.1.5 OEM manuals

Instructions for maintenance work which make reference to any OEM manuals must be carried out in strict accordance with the stipulations in the relevant manuals.

6.1.6 Spare parts

Use only original spare parts for maintenance and service work. You find a spare parts list on the delivered catalog CD «Spare Parts & Services».

For information on spare parts, please send an e-mail to:

service@aixtron.com

6.1.7 RMA (Return Material Authorization)

For returning defective parts to AIXTRON please use the so-called RMA procedure. Contact your local AIXTRON subsidiary. You will get a password to perform the RMA procedure online.

6.1.8 Safety

Before you perform any maintenance work at the CRIUS II, you must have read and fully understood Chapter 2 Safety, 🗎 17. Pay attention to all hazard alerts in Chapter 2.4 Danger areas for operating personnel, 🗎 24 and Chapter 2.5 Danger areas for maintenance and service personnel, 🗎 25.

WARNING! Hazardous materials.



The vacuum system may contain hazardous materials which can be detrimental for your health.

Purge the system with nitrogen about 24 hours before opening parts (e.g. gas pipes, reactor, etc.) that had contact with hazardous materials.

CAUTION! Fingerprints.



Fingerprints in the glove box and in the reactor may impair the process.

Prevent the glove box and the reactor from contamination. Put on clean room gloves before you touch any parts in these components.

6.1.9 Maintenance mode

You must switch the CRIUS II to the maintenance mode to carry out certain maintenance work. See Chapter 5.1.5 Key switch for operating mode, 🗎 114.

6.2 Auxiliary devices and used materials

6.2.1 Auxiliary devices

- Standard tool box, see Fig. 6-1, 🗎 135.
- Standard safety equipment
  The end user is responsible for providing a standard state-of-the-art safety equipment as required for any work on contaminated systems
- Clean and lint-free clean room gloves
- Industrial vacuum cleaner



Fig. 6-1 *Standard tool box*

6.2.2 Contaminated parts

Components which contact process gases must be treated as contaminated parts, e.g.:

- Gas pipes
- Vacuum system parts like valves, MFCs, etc.
- Bubblers
- Gas cylinders



WARNING! Contaminated parts.

The CRIUS II contains contaminated parts which may impair your health.

Wear protective gloves and industrial clothing with long sleeves. Read the safety data sheets and follow all instructions.



NOTE:

Parts of the CRIUS II to be decommissioned or replaced may be contaminated.

The RMA (Return Material Authorization) procedure exactly describes the handling of contaminated parts.

6.2.3 Solid waste materials

The following list specifies parts that become solid waste as a result of operation, maintenance and servicing of the CRIUS II. The disposal of these parts must be regulated by the end user according to the local safety regulations.

- Gas inlet filters
- Particle filter
- Glove box filters
- Vacuum cleaner filters
- Vacuum wand filters
- Circulation filters

6.2.4 Operating materials

- Cleaning agents
- Lint-free cloth
- Isopropanol (2-propanol)

WARNING! Unsuitable solvents.



Acetone, methanol and ethanol are unsuitable solvents. These chemicals attack seals made of nitrile and fluorocarbon rubber (e.g. Perbunan and Viton). In addition, methanol is toxic.

Avoid these solvents. Use isopropanol instead.

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6.3 Maintenance schedule

The required maintenance work at CRIUS II system parts must be carried out at regular intervals. In addition, you should always listen for unusual noise and pay immediate attention to any malfunctioning which occurs in the system during the interim period between official system inspection procedures.

Maintenance logbook

AIXTRON recommends that a record of all maintenance work performed at the CRIUS II be kept in a logbook. This is particularly important if various different personnel are responsible for maintenance work on one system. A logbook allows the end user to keep a reliable check on the type and date of performed maintenance work.

Layout of the maintenance schedules

Column	Explanation
Action	Specifies the specific type of required maintenance work.
Interval	Specifies the recommended maintenance intervals.
Comments	Here you can find brief notes on maintenance work or references to relevant chapters or documents which contain further explanations. Instructions for maintenance work which make reference to any OEM manuals must be carried out in strict accordance with the stipulations in the relevant manuals. See Chapter 2.1.1 Compulsory reading material!, 18.
Date and signature	Here you can keep a record of the performed maintenance work. Make copies of the maintenance schedule for this purpose.

Tab. 6-1 *Layout of the maintenance schedules*

6.3.1 Maintenance schedule: Main power supply

Action	Interval	Comments	Date and signature
Checking the main switch	Monthly	See Chapter 6.7.2, 149	
Checking the fuses	Quaterly	See Chapter 6.7.3, 151	
Checking the over-current circuit breakers	Quaterly	See Chapter 6.7.4, 151	
Checking the EMERGENCY-OFF buttons	Quaterly	See Chapter 6.7.5, 152	

Tab. 6-2 Maintenance schedule: Main power supply

6.3.2 Maintenance schedule: Low power supply

Action	Interval	Comments	Date and signature
Checking the low power supply	Quaterly	See Chapter 6.8.1, 153	
Checking the fuses	Quaterly	See Chapter 6.8.2, 154	

Tab. 6-3 Maintenance schedule: Low power supply

6.3.3 Maintenance schedule: SCS

Action	Interval	Comments	Date and signature
Checking the Cause/Effect diagram	Half-yearly	Please contact your local AIXTRON service center for more information	
Checking the Enable Table	Half-yearly	Please contact your local AIXTRON service center for more information	

Tab. 6-4 Maintenance schedule: SCS

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6.3.4 Maintenance schedule: Glove box

Action	Interval	Comments	Date and signature
Checking the control panel	Daily, during operation	See Chapter 6.9.1, 155	
Replacing the particle filters	Quaterly	See Chapter 6.9.2, 155	
Cleaning the pump filter	Quaterly	See Chapter 6.9.3, 156	
Checking the gloves	Quaterly	See Chapter 6.9.4, 157	
Checking the O-rings of the gloves	Quaterly	See Chapter 6.9.5, 157	
Checking the circulation	Daily, during operation	See OEM manual by MBRAUN	
Checking the regeneration function	Quaterly	See OEM manual by MBRAUN	
Checking the tightness of the glove box	Monthly	See Chapter 6.9.6, 158	

Tab. 6-5 Maintenance schedule: Glove box

6.3.5 Maintenance schedule: Reactor

Action	Interval	Comments	Date and signature
Opening the reactor lid		See Chapter 6.10.2.1, 160	
Opening the reactor chamber		See Chapter 6.10.2.2, 161	
Opening the reactor bottom		Please contact your local AIXTRON service center for more information	
Checking the O-rings of the DOR system, replace if necessary	Daily, during operation	See Chapter 6.10.3, 162	
Replacing the showerhead	Depends on coating	Please contact your local AIXTRON service center for more information	
Checking the susceptor rotation	Daily, during operation	See Chapter 6.10.4, 163	
Replacing the susceptor	Depends on coating	Please contact your local AIXTRON service center for more information	
Replacing reactor parts	Depends on coating	Please contact your local AIXTRON service center for more information	

Tab. 6-6 Maintenance schedule: Reactor

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6.3.6 Maintenance schedule: Heating system

Action	Interval	Comments	Date and signature
Checking the heater coils	With susceptor removal	Please contact your local AIXTRON service center for more information	
Replacing the heater		Please contact your local AIXTRON service center for more information	
Mounting the thermocouple		Please contact your local AIXTRON service center for more information	

Tab. 6-7 Maintenance schedule: Heating system

6.3.7 Maintenance schedule: Vacuum system

Action	Interval	Comments	Date and signature
Checking the process pump	Monthly	See Chapter 6.11.2, 164	
Checking the KF clamps	Monthly	See Chapter 6.11.3, 165	
Checking the throttle valve	Quaterly	See Chapter 6.11.4, 166	
Checking the pneumatic valves	Monthly	See Chapter 6.11.5, 167	
Replacing the exhaust filter	Quaterly	Please contact your local AIXTRON service center for more information	
Performing a leak test of the complete system	Monthly	See Chapter 6.11.6, 168 Perform the leak test according to the SEMI standard	

Tab. 6-8 Maintenance schedule: Vacuum system

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6.3.8 Maintenance schedule: Pneumatic system

Action	Interval	Comments	Date and signature
Checking the pneumatic tubing, if necessary replace defective hoses	Quaterly		
Checking the working pressure	Quaterly	See Chapter 6.12.2, 169	
Checking the pressure switch	Quaterly	See Chapter 6.12.3, 170	
Checking the EPV valves	Yearly	See Chapter 6.12.4, 170	

Tab. 6-9 Maintenance schedule: Pneumatic system

6.3.9 Maintenance schedule: Gas mixing system

Action	Interval	Comments	Date and signature
Replacing a bubbler	Depends on consumption	See Chapter 6.13.1, 171 and Chapter 6.13.2, 173	
Checking the communication	Daily, during operation	See Chapter 6.13.3, 175	
Performing a zero offset of a MFC	Quaterly	See Chapter 6.13.4, 176	
Performing a leak test of the complete system	Quaterly	See Chapter 6.11.6, 168 Perform the leak test according to the SEMI standard	

Tab. 6-10 Maintenance schedule: Gas mixing system

6.3.10 Maintenance schedule: Cooling water system

Action	Interval	Comments	Date and signature
Checking the water pressure	Weekly	See Chapter 6.14.1, 178	
Cleaning the water filter	Quaterly	See Chapter 6.14.2, 179	
Checking the water flows	Before starting a process run	See Chapter 6.14.3, 180	

Tab. 6-11 Maintenance schedule: Cooling water system

6.4 Lockout/tagout (LOTO)

«Lockout/Tagout» is a safe method to switch off machinery and equipment and safeguard personnel from unexpected energization or startup.

- Lockout = Switch off and lock
- Tagout = Label

Refer to Chapter 2.7 Lockout/Tagout-Prozedur, 🗎 37 for general description of the LOTO procedure.

LOTO positions

Fig. 6-2, 🗎 142 shows the LOTO positions of the CRIUS II.

NOTE:

The following figure shows the LOTO positions of a typical CRIUS II.

Your specific system may differ from this in certain details. Always refer to the delivered installation plan.

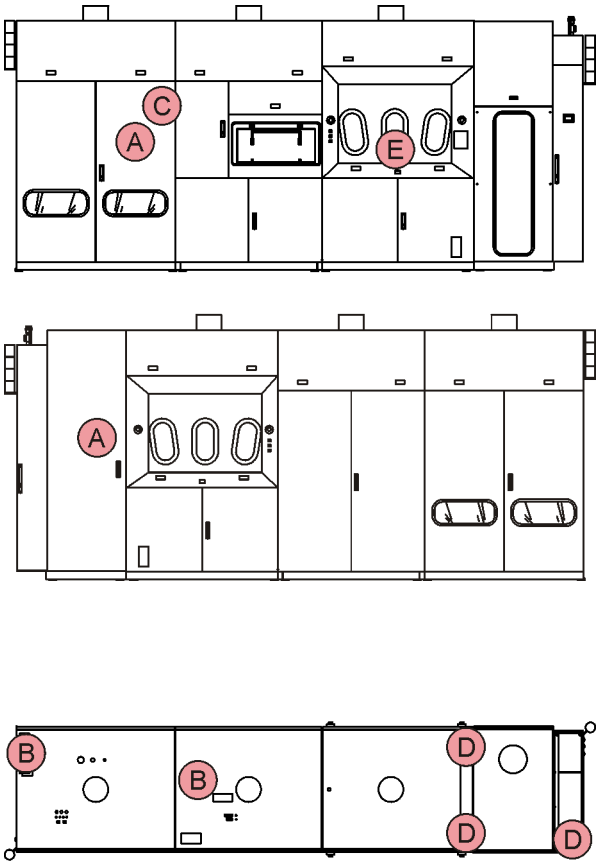


Fig. 6-2 *LOTO positions: Front and back view (top), top view (bottom)*

A Main switch - system and PSU
B Gas interface
C Pneumatic maintenance unit
D Water connections
E Reactor

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LOTO table

Item	Energy type	Component	Action
A	Electric current	Main switch at the system and at the RF generator	Switch off the main switches, lockout and tagout them
B	Gases	Lockable shut-off valves between the gas interface of the CRIUS II and the media supply of the end user	Close lockable shut-off valves, lockout and tagout them
C	Pneumatic	Shut-off valve at the pneumatic maintenance unit	Close lockable shut-off valve, lockout and tagout it
D	Water	Lockable shut-off valves between the water connections of the CRIUS II and the media supply of the end user	Close lockable shut-off valves, lockout and tagout them
E	Heat	Reactor	Allow hot parts to cool down to room temperature

Tab. 6-12 LOTO table

6.5 Information on elastomer seals

There are two basic types of ring-shaped elastomer seals:

- Sealing ring: Elastomer cord whose ends have been glued or vulcanized together
- O-ring: Molded as one piece

6.5.1 Materials

Most elastomer seals are made of the following materials:

Trade name	Abbreviation	Material	Temperature range
Buna-N, Perbunan	NBR	Nitrile rubber	-30…+100 °C
Viton	FKM, FPM	Fluorocarbon rubber	-20…+200 °C
Kalrez	FFKM, FFPM	Perfluorocarbon rubber	-15…+230 °C

Tab. 6-13 *Common elastomer seal materials*

Solvents

WARNING! Unsuitable solvents.



Acetone, methanol and ethanol are unsuitable solvents. These chemicals attack seals made of nitrile and fluorocarbon rubber (e.g. Perbunan and Viton). In addition, methanol is toxic.

Avoid these solvents. Use isopropanol instead.

6.5.2 Checking elastomer seals

1 Remove the seal from the sealing groove

NOTE:



Be careful not to scratch the seal or the groove. Never use hard tools (e.g. screwdriver) to remove a seal.

Visual inspection

2 Inspect the seal. It must be:
- Regular in diameter
- Free from noticeable gluing joints
- Free from any damage, such as cuts or swellings. See Fig. 6-3, 145.

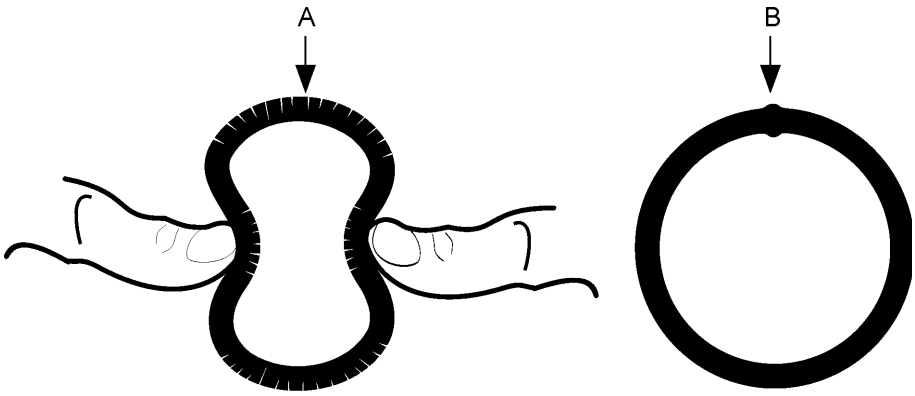


Fig. 6-3 *Inspecting a seal*

A Cuts and porous areas
B Enlargement, swelling

Cleaning

3 Pull the seal through a dry and clean cloth to remove coarse soiling

4 Pull the seal through a cloth moistened with isopropanol

NOTE:

Do not apply vacuum grease to seals used in the vacuum system or process gas system of the CRIUS II!

Inserting

5 Insert the seal

6 Check the excess of the seal in the groove. See Fig. 6-4, 145.
- Seal thickness 5 mm: Excess = 0.8 mm
- Seal thickness 6 mm: Excess = 1.1 mm

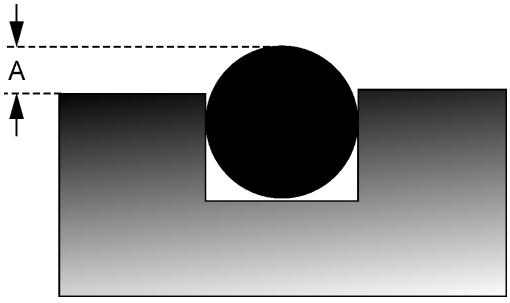


Fig. 6-4 *Excess of a seal in the groove*

A Excess

6.6 Cleaning procedures

6.6.1 Fused quartz glass parts

Solution
AIXTRON recommends using aqua regia:

$HCl : HNO_3$ 3 : 1 or

$HCl : HNO_3$ 5 : 1

This method works well for Arsenides and Phosphides as well as Antimonides.

It might not work well on Nitrides. For thin GaN layers the methode should be applicable.

Etching time
The etching time will depend on amount of deposition. Account few hours.

Rinsing
Rinsing should be performed for 24 hours with running DI water. Rinse the quartz parts thoroughly (8-10 rinsing cycles). The progress can be checked by measuring drain water resistivity.

Drying
Drying should be performed in an oven (preferentially nitrogen-purged) with 100…150 °C for at least 12 hours.

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6.6.2 SiC-coated graphite parts

High-temperature baking
AIXTRON recommends to use high-temperature baking. The baking conditions must be adapted to the SiC coating.

Etching
Etching in aqua regia is also possible except for susceptors. See Chapter 6.6.1 Fused quartz glass parts, 146.

NOTE:

Do not use etching for susceptors!

The SiC coating prevents diffusion of the etching solution in the graphite bulk.

But any fracture or chip in the SiC will cause issues as the etching solution will locally diffuse into the graphite bulk where it would be difficult to rinse away and/or dry off.

6.6.3 Molybdenum parts

Solution
AIXTRON recommends using a solution of 90% KOH and 10% H_2O_2.
KOH is prepared from KOH pellets (30% in weight) in DI water.

However, the etchant also partly attacks the molybdenum and the coating is lifted off rather than dissolved.

Etching time
Account few hours

Rinsing and Drying
See Chapter 6.6.1 Fused quartz glass parts, 146.

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6.6.4 Stainless steel parts

Solutions
AIXTRON recommends a Sodium Hydroxyde solution on systems growing Arsenides.

H_2O : NaOH 10 : 1 or

If grown layers are predominantly Phosphides AIXTRON recommends to use a solution of orthophosphoric acid (30%) and hydrogen peroxide (30%) in DI water.

H_2O : H_3PO_4 : H_2O_2 8 : 1 : 1

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6.7 Main power supply

6.7.1 Hazard alerts

Maintenance and service personnel working on the electrical equipment must pay special attention to the following safety notes.

WARNING! Hazardous voltage.

The system contains parts which carry dangerous levels of voltage. Touching these parts will cause an electric shock. The shock may be lethal.



Prior to any work in the danger area:

- **Lock out and tag out the main power supply**
- **Ground the equipment**
- **Check to make sure that no one is in the danger area before you switch the system on again**



NOTE:

Only personnel who have completed electrotechnical professional training are permitted to perform work on the electrical equipment.



NOTE:

Maintenance and service on the electrical equipment requires no type 4 tasks.

6.7.2 Checking the main switch

Checking the remote control switching function

1 Check the switching function of the main switch remote control.



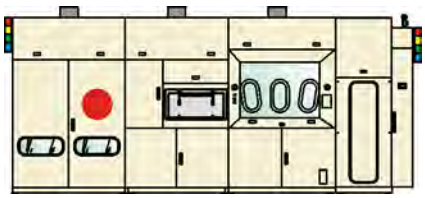


Fig. 6-5 *Remote control for the main switch*

Checking the remote control switching function

Fig. 6-6, 🗎 150 shows the main switch. It is located in the electrical cabinet.

2 Check the switching function of the main switch using a screw driver

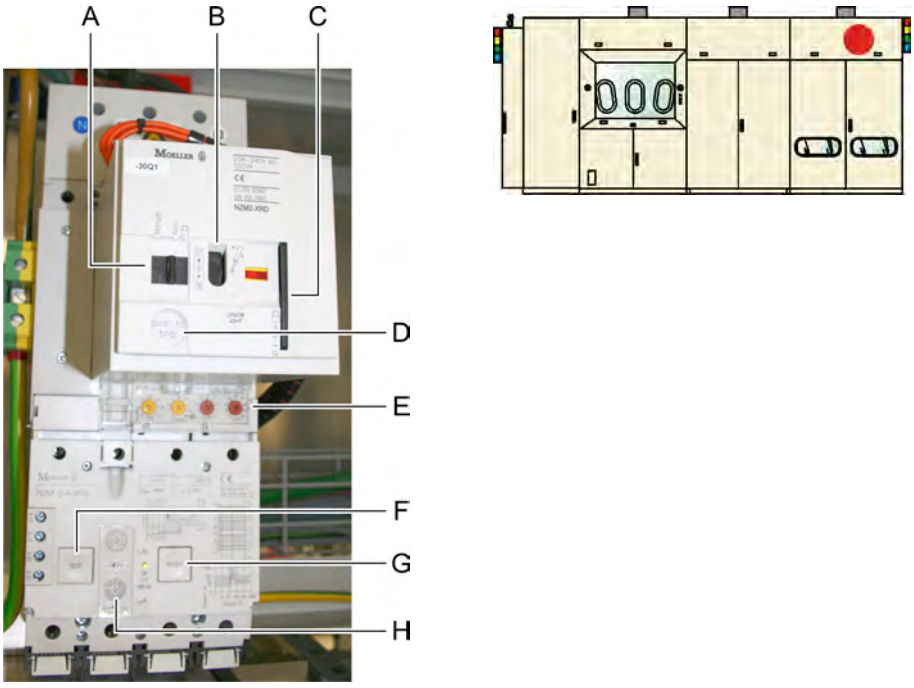


Fig. 6-6 *Main switch*

A «Manual - Auto» switch
B «On - Off» switch
C Plastic bow for locking
D [push to trip] button
E Tripping characteristics
F [TEST] button
G [RESET] button
H Tripping characteristics

Checking the RCD

The main switch also acts as a residual current device (RCD). If current leaking out of the circuit (e.g. current leaking to earth) exceeds the safety limits, the main switch disconnects and jumps to the «trip» position.

The RCD can be tested to see if it is operational. Proceed as follows:

1 Make sure that the system is in a state where it may be switched off safely

2 Open the door of the electrical cabinet at the rear side

3 Press the [TEST] button (item F in Fig. 6-6, 🗎 150)
- This button creates a residual current
- The main switch jumps to the «trip» position

4 Press the [RESET] button (item G in Fig. 6-6, 🗎 150) to reset the residual current device

5 Turn the main switch back to the «I» position

NOTE:

Never change the tripping characteristics of the RCD.

6.7.3 Checking the fuses

The fuses are located in the electrical cabinet.

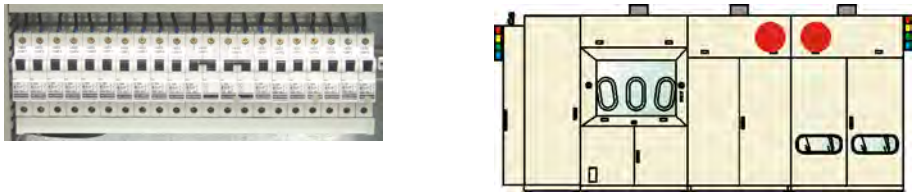


Fig. 6-7 *Fuses*

1 Open the corresponding doors

2 Check the switching function of the fuses by means of a voltmeter

6.7.4 Checking the over-current circuit breakers

The system contains over-current circuit breakers. They are located in the electrical cabinet and in the heater supply unit.

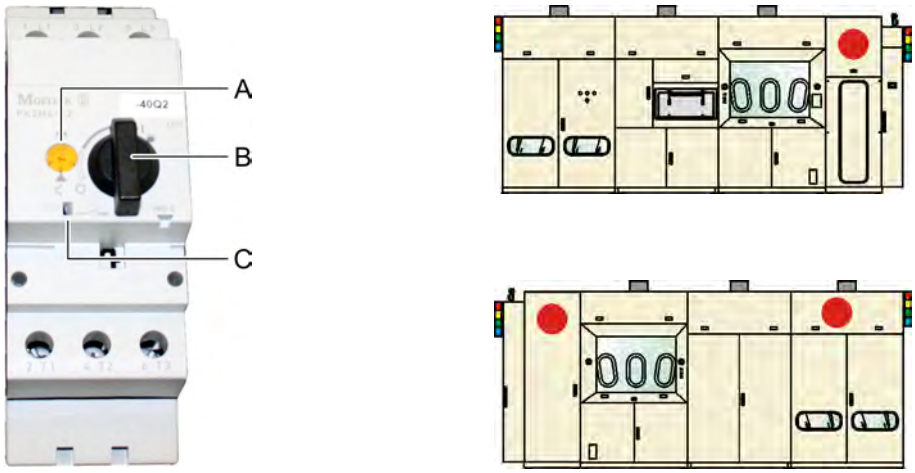


Fig. 6-8 *Over-current circuit breakers*

A Switch
B Over-current value
C «Test» switch

1 Open the corresponding doors

2 Check the correct setting of the over-current value
- The required value is 40 A

3 Activate the «Test» switch using a screw driver
- The circuit breaker must switch off

4 Switch on the circuit breaker after the test procedure

6.7.5 Checking the EMERGENCY-OFF buttons

1 Check the function of the EMERGENCY-OFF buttons

EMERGENCY-OFF buttons outside the cabinets

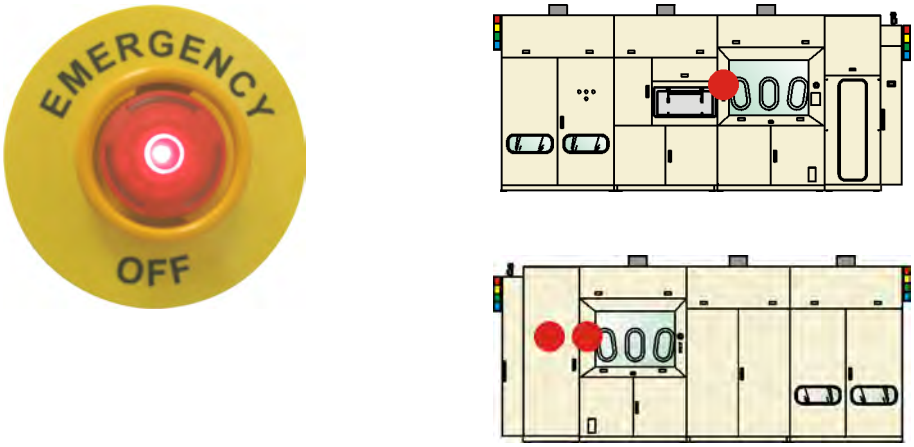


Fig. 6-9 *EMERGENCY-OFF buttons (outside the cabinets)*

EMERGENCY-OFF buttons (inside the cabinets)

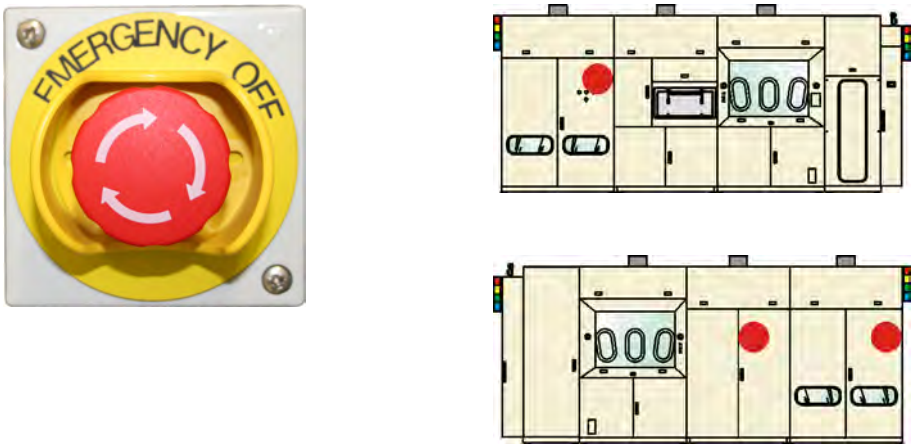


Fig. 6-10 *EMERGENCY-OFF buttons (inside the cabinets)*

6.8 Low power supply

6.8.1 Checking the low power supply

Fig. 6-11, 🗎 153 shows a low power supply.

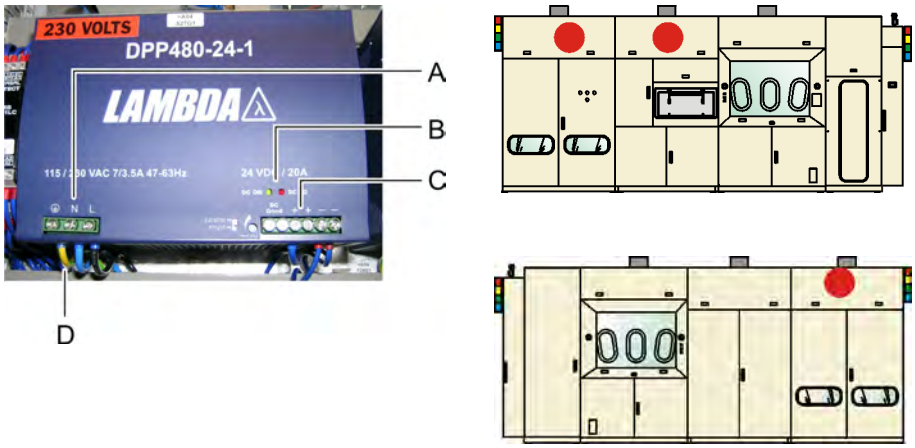


Fig. 6-11 *Low power supply (example)*

A Inlet
B LED display
C Output
D Grounding

1 Open the corresponding doors

2 Check the LED display at the low power supply
- Normally the green LED is illuminated

3 Check the voltage by means of a voltmeter

4 If necessary, set the voltage to 24 V. See OEM manual for the power supply.

5 Check the grounding by means of a ground meter

6.8.2 Checking the fuses

The fuses for the low power supply are located in the electrical cabinet.

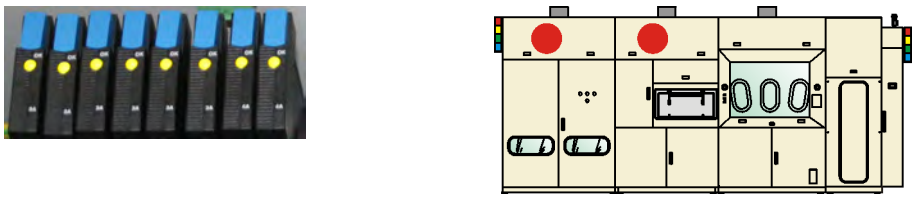


Fig. 6-12 *Fuses*

1 Open the corresponding doors

2 Check the switching function of the fuses by means of a voltmeter

6.9 Glove box

6.9.1 Checking the control panel

1 Check the functions of the control panel (e.g. opening/closing the load lock)
- See MBraun OEM manual



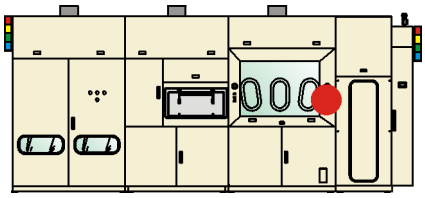


Fig. 6-13 *Control panel*

6.9.2 Replacing the particle filters

1 Replace the particle filters in the glove box
- See MBraun OEM manual



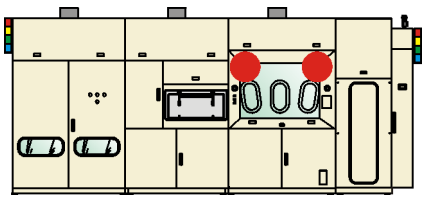


Fig. 6-14 *Replacing the particle filters*

6.9.3 Cleaning the pump filter



WARNING! Hazardous process gases.

The vacuum system may contain hazardous gases which can be detrimental for your health.

Always wear a gas mask, gloves and industrial clothing with long sleeves when opening parts of the vacuum system. Read the safety data sheets for the gases and follow all instructions.

1 Open the corresponding door to access the glove box pump



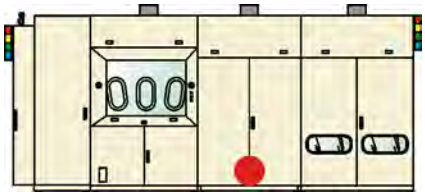


Fig. 6-15 *Glove box pump*

2 Open the KF clamp at the glove box pump

3 Remove the filter

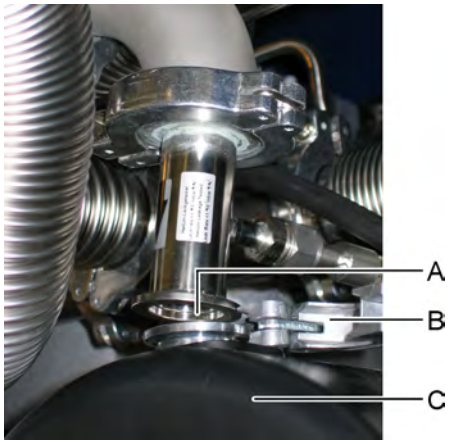


Fig. 6-16 *Removing the pump filter*

A Position of the filter
B KF clamp
C Pump

4 Blow out the filter grid with compressed air and clean it with alcohol

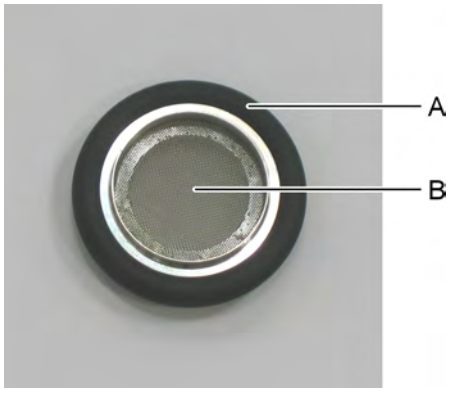


Fig. 6-17 *Filter (vacuum side)*

A O-ring
B Filter grid

5 Install the filter
- Pay attention to the orientation! The filter grid must be located on the vacuum side. See Fig. 6-17, 157.

6.9.4 Checking the gloves

1 Pull the gloves out of the glove box

2 Check the gloves for tears. Especially check critical parts like kinks!

6.9.5 Checking the O-rings of the gloves

1 Screw out the 12 Allen screws at the glove frame

2 Remove the frame

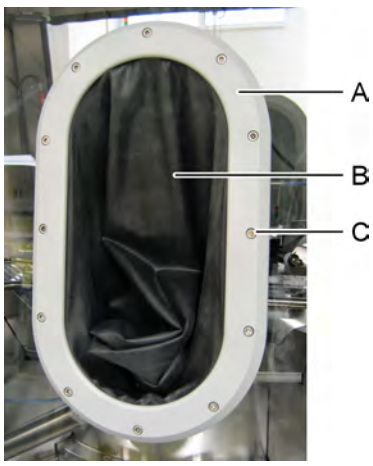




Fig. 6-18 *Glove (right: frame removed)*

A Frame
B Glove
C Allen screw

3 Remove the glove

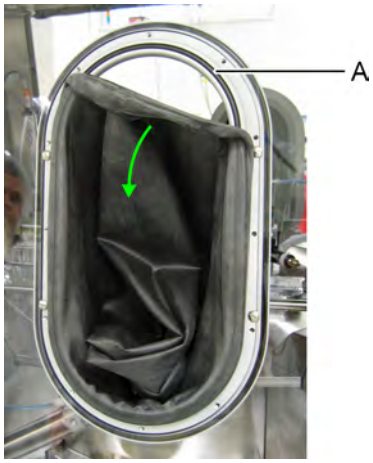


Fig. 6-19 *Removing the glove*

A O-ring

4 Remove the O-ring

5 Check the O-ring for damage and replace if necessary

6 Insert the O-ring again

7 Pull the glove over the O-ring

8 Install the frame

8.1 Attach the frame and screw in the Allen screws. Do not tighten the screws

8.2 Push the glove to the interior of the glove box. Call a second person for assistance.
- This avoids crinkles when screwing on the frame

8.3 Tighten the Allen screws

6.9.6 Checking the tightness of the glove box

NOTE:

Other effects can impair the pressure rise test (e.g. leak in the DOR system or the vacuum tweezers).
- **Refill the DOR system**
- **Check the vacuum tweezers for leaks**

1 Set the pressure to 8 mbar above ambient pressure. Wait until the pressure display has stabilized.

2 Observe the pressure display for at least 10 minutes
- Within this time the pressure must not rise or fall

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6.10 Reactor

6.10.1 Hazard alerts

Maintenance and service personnel working on the reactor must pay special attention to the following safety notes.





WARNING! Hazardous process gases.

The vacuum system may contain hazardous gases which can be detrimental for your health.

Always wear a gas mask, gloves and industrial clothing with long sleeves when opening parts of the vacuum system. Read the safety data sheets for the gases and follow all instructions.



WARNING! Hot reactor parts.

Reactor parts heat up during the process. After the process they may still be hot enough to cause burns.

Allow the parts to cool down to room temperature before working in their vicinity. Wear protective gloves and industrial clothing with long sleeves.

6.10.2 Moving reactor components



NOTE:

Do not use the gloves while moving the reactor lid. The light barriers installed inside of the glove box would interrupt the opening or closing procedure when you reach into the active area of a light barrier.

The following reactor components may be raised and lowered:

- Reactor lid
  See Chapter 6.10.2.1, 160
- Reactor chamber
  See Chapter 6.10.2.2, 161
- Reactor bottom
  Please contact your local AIXTRON service center for more information

6.10.2.1 Opening the reactor lid

The reactor lid is raised for loading the susceptor.

Raising the reactor lid

1 Make sure that the key switch is in the vertical position. See Chapter 5.3.2 Key switch, 119.

2 Press the [OPEN] button
- The reactor lid is only cleared for opening if the [OPEN] button is illuminated by green light

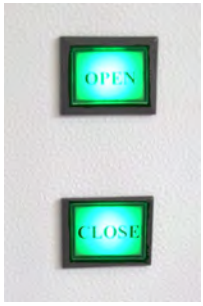


Fig. 6-20 *[OPEN] and [CLOSE] buttons*

Lowering the reactor lid

1 Press the [OPEN] button
- The reactor lid is only cleared for closing if the [CLOSE] button is illuminated by green light

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6.10.2.2 Opening the reactor chamber

The reactor chamber may be raised for special maintenance tasks.

Raising the reactor chamber

Proceed as follows to raise the reactor chamber:

1 Move the key switch to the horizontal position. See Chapter 5.3.2 Key switch, 119.

2 Switch the system to the maintenance mode. See Chapter 5.1.5 Key switch for operating mode, 114.

3 Use the delivered wrench to remove the nuts securing the reactor chamber. See Fig. 6-21, 161.

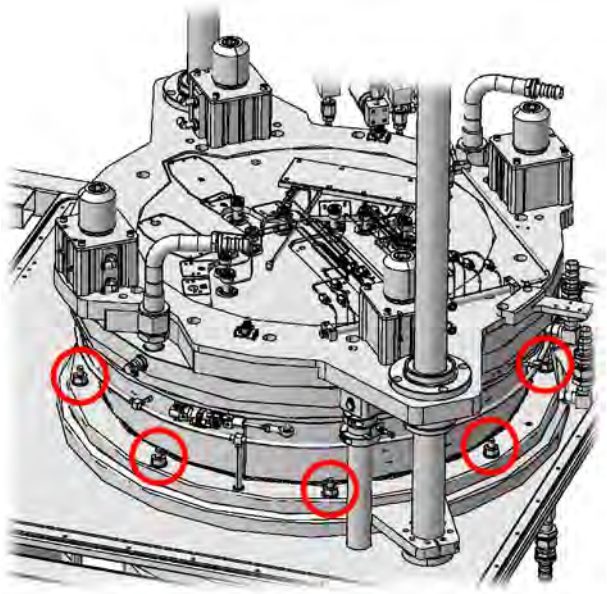


Fig. 6-21 *Removing the reactor chamber nuts*

4 Press the [OPEN] button
- The reactor chamber is only cleared for opening if the [OPEN] button is illuminated by green light

Lowering the reactor chamber

Proceed as follows to lower the reactor chamber:

1 Press the [OPEN] button
- The reactor chamber is only cleared for closing if the [CLOSE] button is illuminated by green light

2 Refit the nuts securing the reactor chamber. See Fig. 6-21, 161. Tighten the nuts crosswise with a torque of 50 Nm (37 lbf-ft), using the supplied ratchet wrench.

3 Move the key switch to the vertical position.

4 Switch the system to the operation mode

6.10.3 Checking the O-rings

Checking the O-rings

1 Raise the reactor lid. See Chapter 6.10.2.1 Opening the reactor lid, 160.

2 Visually check the O-rings for damage

3 Raise the reactor chamber. See Chapter 6.10.2.2 Opening the reactor chamber, 161.

4 Visually check the O-rings for damage

Replacing the O-rings

1 Replace defective O-rings as follows:

1.1 Remove the defective O-ring with plastic tweezers

1.2 Carefully install the new O-ring

2 In case of a large O-ring, proceed as follows:

2.1 Fit the O-ring at the 3 o'clock and 9 o'clock positions

2.2 Then fit the 12 o'clock and 6 o'clock positions

2.3 Smooth the O-ring in the intermediate positions to avoid stretching and distorting the O-ring

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6.10.4 Checking the susceptor rotation

1 Open the reactor lid. See Chapter 6.10.2.1 Opening the reactor lid, 160.

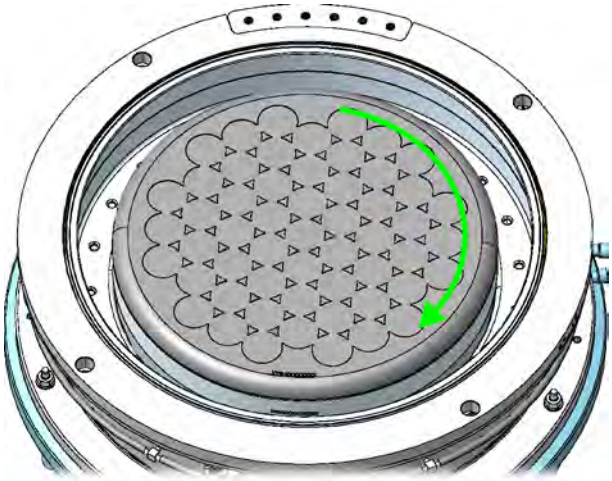


Fig. 6-22 *Susceptor*

2 Make sure that the susceptor rotates smoothly

6.11 Vacuum system

6.11.1 Hazard alerts

Pay special attention to the following safety note before you open parts of the vacuum system:



WARNING! Hazardous process gases.

The vacuum system may contain hazardous gases which can be detrimental for your health.

Always wear a gas mask, gloves and industrial clothing with long sleeves when opening parts of the vacuum system. Read the safety data sheets for the gases and follow all instructions.

6.11.2 Process pump

Several pump types are available. For more information refer to the related OEM manual.

1 Open the reactor cabinet to access the process pump

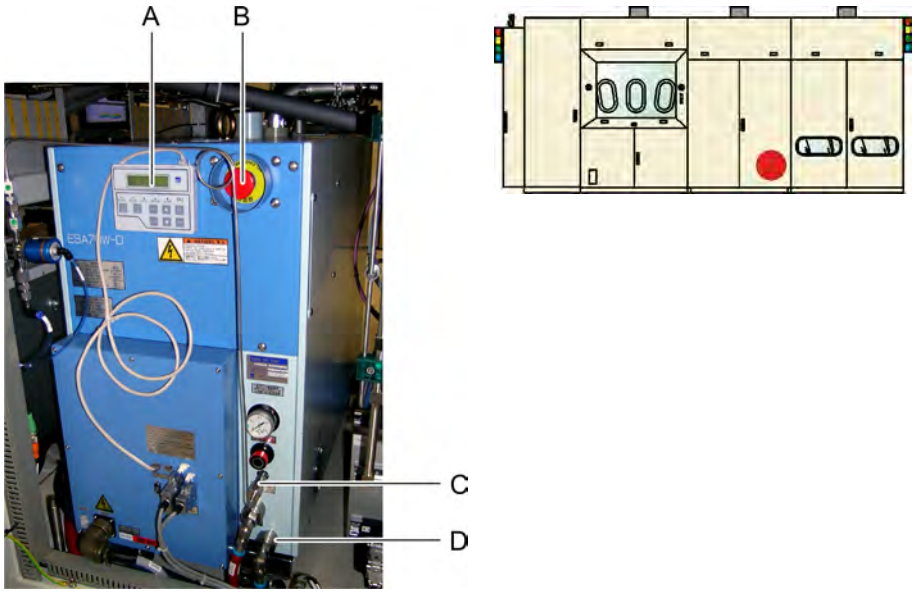


Fig. 6-23 *Process pump (example)*

A Operating unit
B EMERGENCY-STOP button
C Nitrogen supply
D Water supply

Fig. 6-24, 🗎 165 shows the control panel for the pump. For operation please refer to the OEM manual.

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Fig. 6-24 *Control panel (example)*

2 Check the following values:
- Water flow
- Nitrogen flow
- Operating temperature

3 Adjust the values if necessary

NOTE:

Wait at least 4 hours after switching the process pump on. Then the pump has reached the operating temperature and is ready for operation.

6.11.3 Checking the KF clamps

1 Open the corresponding doors to access the vacuum system

2 Check all KF clamps for correct mounting

3 If necessary, tighten the KF clamps



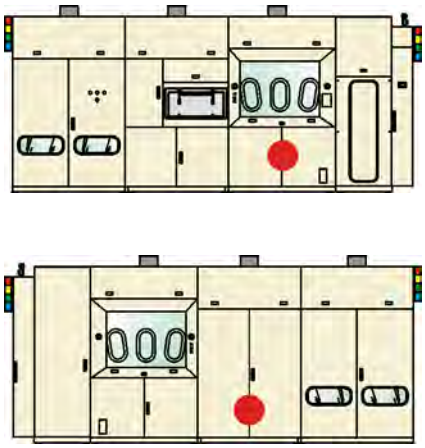


Fig. 6-25 *KF clamps*

6.11.4 Checking the throttle valve



WARNING! Hazardous process gases.

The vacuum system may contain hazardous gases which can be detrimental for your health.

Always wear a gas mask, gloves and industrial clothing with long sleeves when opening parts of the vacuum system. Read the safety data sheets for the gases and follow all instructions.

1 Open the reactor cabinet to access the vacuum system

2 Open the KF clamps and remove the throttle valve



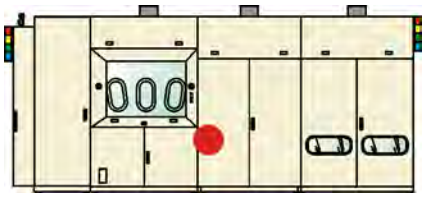


Fig. 6-26 *Throttle valve*

Fig. 6-27, 🗎 166 shows the removed throttle valve.





Fig. 6-27 *Throttle valve (removed)*

Pump side *Vacuum side*

3 Loosen both fastening screws of the seal plate. See Fig. 6-28, 🗎 167.

4 Remove the seal plate

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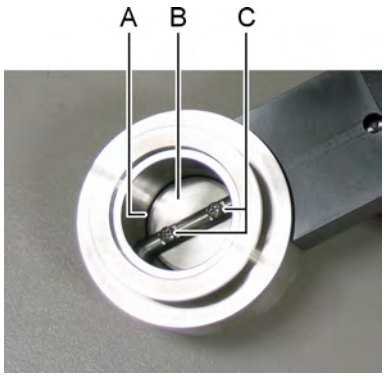


Fig. 6-28 *Removing the seal plate*

A O-ring
B Seal plate
C Fixing screws

5 Check the O-ring for damage and replace if necessary

6 Install the seal plate

7 Install the throttle valve to the vacuum system
- Pay attention to the correct orientation

6.11.5 Checking the pneumatic valves

1 Open the reactor cabinet to access the vacuum system

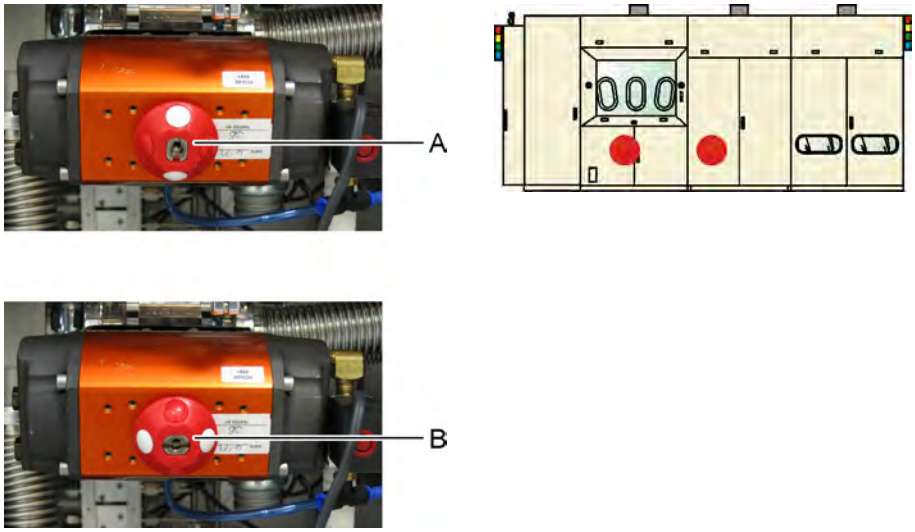


Fig. 6-29 *Pneumatic valve*

A Closed state
B Open state

2 Switch the valve using the AIXACT software and check the switching operation at the valve

6.11.6 Searching for leaks

A leak test is required every time after the vacuum system has been opened. The leak test is required for the following reasons:

- Air leaking into the system may impair the process and thus the product quality
- Hydrogen is used as a process gas. Air leaking into the system may lead to the formation of an explosive gas mixture.

Proceed as follows to search for leaks:

1 Connect the inlet of the He leak detector to the vacuum system

2 Connect the outlet of the He leak detector to a suitable exhaust system



WARNING! Hazardous gases.

The vacuum system may contain harmful or flammable gases. These chemicals end up in the waste gas of the He leak detector. Inhalation of toxic or caustic gases may impair your health and even lead to death.

Connect the outlet of the He leak detector to the exhaust system. Do not release these gases into the open air.

3 Perform a leak search as described in the OEM manual for the He leak tester and according to the requirements of the SEMI standard

6.12 Pneumatic system

6.12.1 Pneumatic maintenance unit

Fig. 6-30, 169 shows the pneumatic maintenance unit. It supplies the pneumatic components of the CRIUS II via EPV valves.

For more information refer to the related OEM manual.

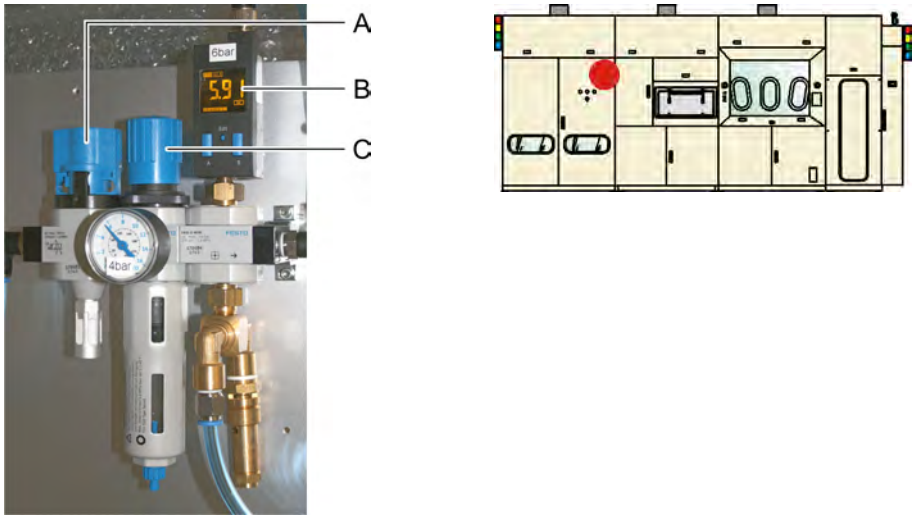


Fig. 6-30 *Pneumatic unit for the glove box*

A shut-off valve
B Pressure switch
C Filter regulator

6.12.2 Checking the working pressure

1 Check the working pressure at the manometer. See Fig. 6-31, 169.
- The pressure must be set to 6 bar

2 If necessary, set the pressure to 6 bar by means of the filter regulator

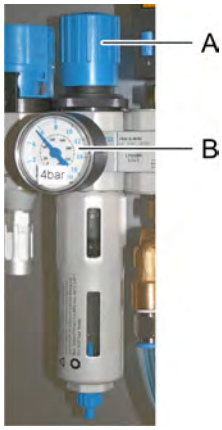


Fig. 6-31 *Checking the working pressure*

A Filter regulator
B Manometer

6.12.3 Checking the pressure sensor

The pressure sensor causes an alarm if the working pressure decreases below the set limit.

1 Check the pressure limit value at the pressure sensor
- The pressure limit must be set to 4 bar

2 If necessary, adjust the pressure limit.
See OEM manual.

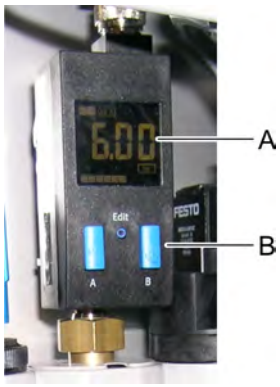


Fig. 6-32 *Pressure sensor*

A Pressure display
B Operating elements

6.12.4 Checking the EPV valves

1 Activate the EPV valve to be checked in AIXACT
- The valves are labeled!

2 Check the activated EPV valve at the corresponding valve cluster
- The LED at the activated valve must emit light

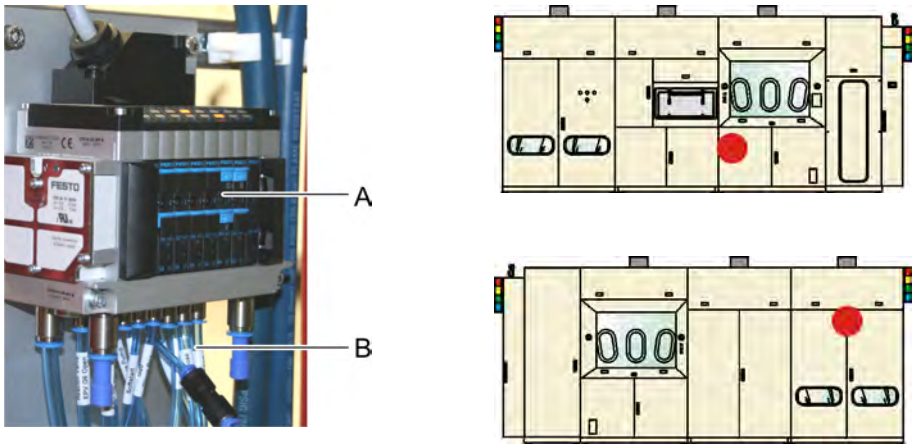


Fig. 6-33 *Valve cluster*

A EPV valves
B Pneumatic hoses

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6.13 Gas system

6.13.1 Removing an MO bubbler



WARNING! MO materials.

MO materials can be harmful to your health.

Wear protective gloves, gas mask and eye protectors when working with MO materials.

For identifying the components please refer to the delivered «Gas Mixing System» drawing.

1 Ensure that the bubbler is at atmospheric pressure (approx. 1000 mbar)

2 Close the 4/2-way MO source valve in AIXACT (item G in Fig. 6-34, 171)

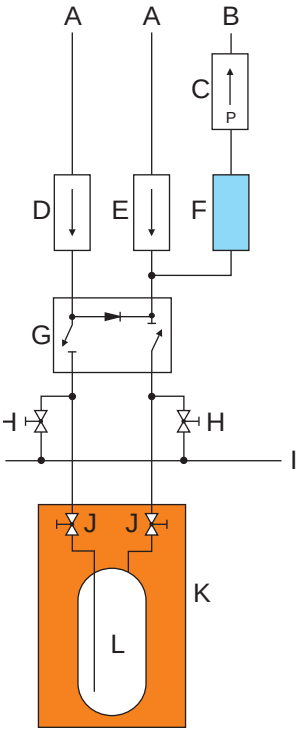


Fig. 6-34 *Standard MO source*

A H_2 supply
B To MO run/vent line
C Pressure controller
D Source MFC
E Push MFC
F Measuring device for gas concentrations (optional)
G 4/2-way MO source valve
H Quarter turn manual valve
I MO vacuum (for changing the MO bubbler)
J Manual valve at the bubbler
K Thermostat heat bath
L MO bubbler

3 Close the manual valves at the bubbler (item J in Fig. 6-34, 171) to isolate the bubbler from the system

4 Switch the system to H_2

5 Set the pressure controller of the bubbler (item C in Fig. 6-34, 🗎 171) to 2000 mbar and the MFCs of the bubbler to their maximum value

6 Set the inject MFC on the dopant sources to its minimum value

7 Switch off CONTROL in AIXACT
- The throttle valve is closed

8 Switch to maintenance mode

9 Open the MO vac valve in AIXACT for at least 10 minutes

10 Open both quarter turn manual valves (item H in Fig. 6-34, 🗎 171) on the source manifold to the MO vac line for one minute
- This will pump the source lines external to the bubbler

11 Close the MO vac valve and open the 4/2-way MO source valve. Wait until the source line is filled again to 2000 mbar.

12 Close the 4/2-way MO source valve and open the MO vac valve again for one minute

13 Repeat the pump/purge cycle (steps 11, 12) at least eight times using H_2

14 Switch the system to N_2

15 Repeat the pump/purge cycle at least two times with N_2

16 Close both quarter turn manual valves

17 Leave the 4/2-way MO source valve open

18 Change the container under these conditions by breaking the bubbler line VCR connection
- The pressure controller isolates the system from the outside while N_2 purges the connection lines. This prevents the source lines from being contaminated by external air.

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6.13.2 Installing an MO bubbler

NOTE:

It is helpful to weigh the bubbler before it is installed in the system. The consumption can then be verified by reweighing the bubbler and calculating the difference.

NOTE:

The pressure in a new bubbler is typically atmospheric pressure at room temperature. If this bubbler is cooled or heated for operation, the pressure in the bubbler will change by the difference of the vapor pressure of the material. If the pressure in the bubbler has to be increased, please ensure that the majority of the purging gas is introduced through the inlet.

For identifying the components please refer to the delivered «Gas Mixing System» drawing.

1 Insert the new bubbler in the thermostat bath

2 Close the 4/2-way MO source valve in AIXACT (item G in Fig. 6-35, 173)

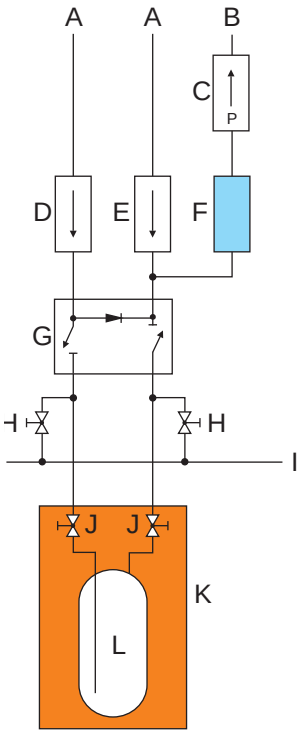


Fig. 6-35 *Standard MO source*

A H_2 *supply*
B *To MO run/vent line*
C *Pressure controller*
D *Source MFC*
E *Push MFC*
F *Measuring device for gas concentrations (optional)*
G *4/2-way MO source valve*
H *Quarter turn manual valve*
I *MO vacuum (for changing the MO bubbler)*
J *Manual valve at the bubbler*
K *Thermostat heat bath*
L *MO bubbler*

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3 Ensure that the manual valves (item J in Fig. 6-35, 🗎 173) supplied with the bubbler are closed

4 Switch the system to N_2

5 Set the bubbler pressure controller to 2000 mbar and the source MFCs to their maximum values

6 Switch off CONTROL in AIXACT
- The throttle valve is closed

7 Switch to maintenance mode

8 Open the 4/2-way MO source valve in AIXACT

9 Leave the MO source (4/2-way valve) lines open

10 Remove the plugs (where applicable) and connect the new bubbler under these conditions.
- The pressure controller isolates the system from the outside while N_2 purges the connection lines. This prevents the source lines from being contaminated by external air.

11 Ensure that the bubbler inlet and outlet are not swapped
- They should be labeled

12 Connect a He leak tester to the MO leak test port on the MO vac line and evacuate the pipe from the leak test port to the leak tester

13 Open the MO leak test port manual valve

14 Close the 4/2-way MO source valve in AIXACT

15 Open both quarter turn valves (item H in Fig. 6-35, 🗎 173) on the source manifold to the MO vac line

16 Evacuate the MO vac line by opening the MO vac valve for one minute (then close again)

17 Perform an He leak test to the newly connected bubbler

18 Close both quarter turn valves (item H in Fig. 6-35, 🗎 173) on the source manifold to the MO vac line

19 Close the MO leak test port manual valve

20 Disconnect the leak tester and place the blind caps on the MO leak test port

21 Open the MO vac valve in AIXACT

22 Open both quarter turn valves (item H in Fig. 6-35, 🗎 173) on the source manifold to the MO vac line for one minute
- This will pump the lines to the source

23 Close both quarter turn valves on the source manifold to the MO vac line and open the 4/2-way MO source valve. Wait until the source line is filled again to 2000 mbar.

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24 Repeat the pump/purge cycle at least five times using N_2

25 Switch the system to H_2

26 Repeat the pump/purge cycle at least five times using H_2

27 Close the MO vac valve

28 Open both quarter turn valves (item H in Fig. 6-35, 🗎 173) on the source manifold to the MO vac line to allow equalization between bubbler inlet and outlet

29 Open the 4/2-way MO source valve in AIXACT

30 Reset the pressure controller from 2000 mbar to 1000 mbar and let the pressure equalize

31 Close both quarter turn valves (item H in Fig. 6-35, 🗎 173) on the source manifold to the MO vac line

32 Close the 4/2-way MO source valve in AIXACT

33 Set all MFCs to normal operating state (default)

34 Return to operation mode

35 For opening the bubbler (manual valves) please refer to the OEM of the bubbler or contact your local AIXTRON service center

The source connection lines are now filled with pure hydrogen at atmospheric pressure. The source is operational once the temperature in the bath has stabilized.

6.13.3 Checking the communication

1 Enter a flow set value for a mass flow controller in AIXACT

2 Observe the actual flow value displayed in AIXACT
- The actual value must automatically reach the set value

3 Check the pressure controllers in the same way

6.13.4 Performing a zero offset of a MFC

At regular intervals, a zero offset of the MFCs should be performed to adjust minimum flow deviations.

Prerequisites

- To guarantee the optimum operating temperature, the system must be switched on at least 4 hours before performing a zero offset of an MFC.

Preparing the system

1 In AIXACT, set the setpoint of the corresponding MFC to zero

2 Make sure that the entire system is on atmosphere pressure

3 Close the inlet valves for the process gas supply

4 Wait approx. 3 minutes to guarantee an absolute zero flow

5 In AIXACT, make sure that the deviation of the MFC is less than 1% of the maximum configurable flow value. Otherwise the MFC must be replaced.

In AIXTRON systems the following MFC types are used:

- Bronkhorst High Tech, see Fig. 6-36, 🗎 176
- Horiba Stec, see Fig. 6-37, 🗎 177

Zero offset for Bronkhorst MFC

1 Press the push button on the back side of the MFC and keep it pressed
- After a short time, the red LED will be illuminated
- Then the green LED will be illuminated

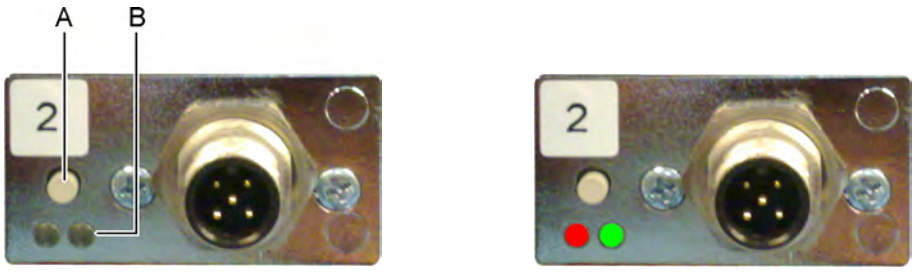


Fig. 6-36 *Zero offset for Bronkhorst MFC*

A Push button
B LEDs

2 Now release the push button

The zeroing procedure starts and the LEDs will be flashing until the zeroing procedure is finished.

Zero offset for Horiba MFC

1 Press the «ZERO» button on the back side of the MFC using a proper tool (e.g. small screw driver)

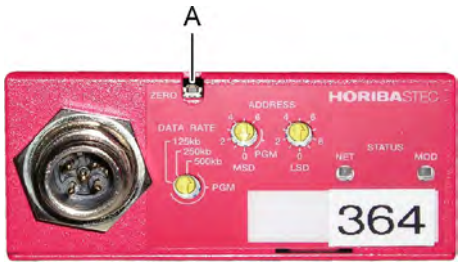


Fig. 6-37 *Zero offset for Horiba MFC*

A «ZERO» button

The zeroing procedure will be performed automatically.

6.14 Cooling water system

6.14.1 Checking the water pressure

1 Open the reactor cabinet to access the cooling water system. For identifying the components please refer to the delivered cooling water diagram.

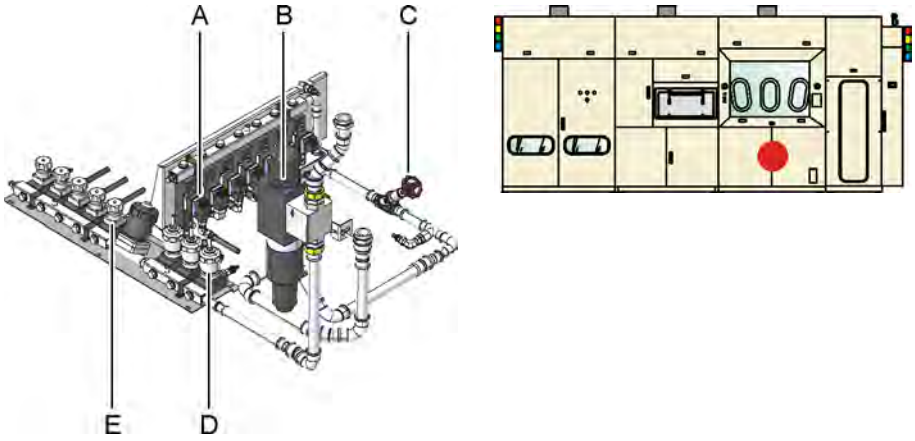


Fig. 6-38 *Cooling water system*

A Flow meter with flow limiter
B shut-off valve
C Water filter
D Pneumatic valve
E Manual valve

Checking the inlet pressure

2 Check the pressure display at the filter units
- You find the required pressure values in the delivered installation plan

3 If necessary, adjust the pressure by means of the handwheel
- If the required pressure cannot be reached this indicates a contaminated filter. See Chapter 6.14.2 Cleaning the water filter, 179.

Checking the outlet pressure

4 Check the pressure display at both outlets
- You find the required pressure values in the delivered installation plan

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6.14.2 Cleaning the water filter

WARNING! Harmful substances.

The cooling water circuit contains substances (e.g. biocide) which can be harmful to your health.

Wear protective gloves and goggles. Dispose cooling water as hazardous waste according to the local regulations.

Fig. 6-39, 179 shows the water filter.

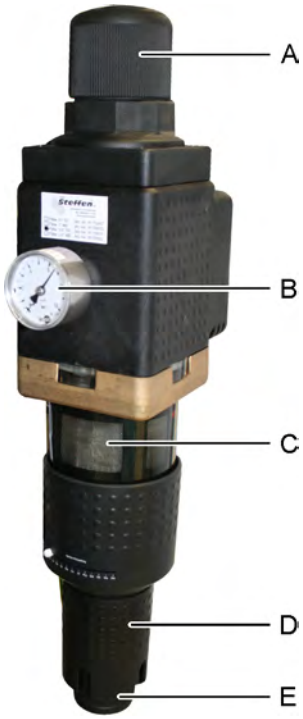


Fig. 6-39 *Water filter*

A Handwheel for pressure adjustment
B Pressure display
C Filter
D Rotary basket
E Drain (with hose)

It is not necessary to remove the filter from the pipe line to clean it. Instead, the filter is cleaned via a manual back washing procedure.

Proceed as follows to clean the water filter:

1 Put a container under the drain (item E) of the filter. You may also connect a hose to the drain as shown in the figure above.

2 Turn the rotary basket (item D) counterclockwise until it is fully open. This will open the ball valve and rinse the filter.

3 Rinse the filter for 20…25 s

4 To end the cleaning process, turn the rotary knob back to its original position

5 Check to make sure that no water leaks out of the drain anymore

Removing the filter

6 If the back washing procedure does not clean the filter properly, dismount the filter

7 Thoroughly clean the filter with a brush and water or replace it if necessary

6.14.3 Checking the water flows

The flow values can be checked at the Data Sampler.

1 Open the reactor cabinet to access the Data Sampler

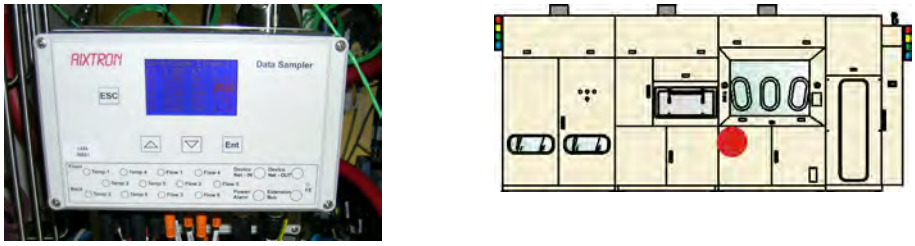


Fig. 6-40 *Data Sampler*

Checking the Data Sampler configuration

2 Check the configuration of the Data Sampler
- All required channels must be activated

Checking the flows

3 Read the flow values in AIXACT or at the Data Sampler

4 Compare the actual flow values with the set values

NOTE:

For assignment of the flows refer to the provided water schematic.

5 If necessary, correct the flow by means of the corresponding manual valve
- The valves are labeled



Fig. 6-41 *Adjusting the flow*

A Manual valve

Checking the flow limits

6 Check the upper and lower limit flow settings in the Data Sampler
- If a flow value is out of range an alarm occurs

7 If necessary, correct the limit values in the Data Sampler

6.14.4 Unintended release of liquid

The entire system is equipped with liquid sensors which are connected to the SCS.



Fig. 6-42 *Liquid sensor*

If a sensor detects liquid (e.g. cooling agent from a thermostat heat bath), the SCS automatically triggers the required safety measures.

1 Remove the liquid with a vacuum cleaner which is suitable for liquids and eliminate the leak

7 Storage, disposal

7 Storage, disposal

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7.1 Storage

7.1.1 Deactivating the system

1 Switch the system off. See Chapter 5.7.2 Switching off, 126.

2 Blow out all water circuits. For this purpose, use compressed air at a pressure of p < 1.5 bar (22 psi). This protects the water circuit from corrosion. In addition, this measure protects the water circuit from damage caused by freezing when the temperature drops below 0 °C.

3 Blow out the pneumatic circuit with compressed air. This removes any condensation water.

4 Switch off the mains and disconnect the system from the mains supply

5 Disconnect all media supply lines

6 Cover the system with plastic sheeting to protect it from dust

7.1.2 Storage conditions

The CRIUS II may only be stored in its original packing units. The storage environment must fulfill the following conditions:

Temperature	10…50 °C
Relative humidity	30…80 % (non-condensing)

Tab. 7-1 *Storage conditions*

7.2 Disposal

7.2.1 Personnel qualifications

Knowledge of mechanical procedures and waste material is a prerequisite for correct system dismantling and the separation of system waste products.

When material which is defined as dangerous by the 91/689/EEC guidelines is to be disposed of, the end user requires additional knowledge in the following fields:

- Risks and dangers
- Disposal regulations
- Regulations for accident prevention
- First aid measures

7.2.2 Safety regulations

Read the safety chapter of this document before you dispose of the system. Adhere to all the hazard alerts and read all safety data sheets.





WARNING! Hazardous process gases.

Components of CRIUS II may contain hazardous gases which can be detrimental for your health. Extensive purge and oxidation procedures are mandatory prior to disassembly of any pipework or wetted components. Even after extensive purging and oxidation, exposure to toxic content may still arise.

Always wear appropriate personal protective equipment (gas mask, hand protection, eye protection) during these operations.

7.2.3 Statutory basis

Responsibilities

The end user is responsible for proper disposal of the CRIUS II in keeping with the relevant regulations. The end user must hand over the system to either a licensed private or public disposal company or he/she must recycle the unit himself or dispose of it in accordance with the pertinent regulations.



NOTE:

If the end user hands over the CRIUS II to a disposal company then he/she must also forward a copy of the System Manual to the company in question. The System Manual contains important information which is required for system disposal.

Obligation to register

Companies that dispose of and recycle their own waste material must be officially licensed to do so and are subject to official supervision. They can, under certain circumstances, be exempted from the obligatory license, provided that they are in a position to meet the demands for protection of the environment. These companies are obliged to register. For further information contact the departmental office competent for environmental protection.

Environmental statutes

Waste material must be recycled or disposed of in a manner which does not present a health hazard. Use only procedures and methods which do not cause damage to the environment. In particular, make sure that:

- Air, water and ground are not contaminated
- Flora and fauna are not endangered
- Irritation from noise and obnoxious odors does not occur
- Environment and landscape are not damaged

Sorting

Subsequent to dismantling the system, you must sort the individual system parts into their respective waste categories. Do this in accordance with the classifications contained in the current European Waste Catalog (EWC) or other similar statutes. The EWC catalog is valid for all waste material. It makes no difference if the waste material is destined for disposal or recycling.

Administration of waste material

Adhere to the official administration and handling plans which outline the procedure for dealing with waste material. These plans comprise the following:

- Type, amount and origin of waste material
- General technical regulations
- Special arrangements for specific waste products
- Suitable regions for dumping grounds and other disposal installations

The plans also include the following information:

- Natural persons and legal entities who have authorization to deal with waste material
- The estimated costs for recycling and disposal
- Measures which can be implemented to rationalize collection, sorting and handling of waste material
- Identification labels for hazardous waste

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7.2.4 Disposal: Other assemblies and components

The components of the CRIUS II comprise the following materials:

Material	Examples
Metals and alloys	• Aluminum (housing, cover plates, etc.) • Copper (electric lines) • Steel (profiles, fixation equipment such as screws, etc.) • Stainless steel (process chamber)
Glass	• Glass (sight glasses, panes used in display instruments)
Synthetic material and rubber	• Synthetic material (operating elements, tubing, casing, wheels, etc.) • Rubber seals, silicon tubing
Composite material	• Electrical material (cables, motors, components) • Electronic material (printed circuit boards, PC, monitor, printer)
Packaging	• Wood (packing cases) • Styrofoam (padding material) • Plastic (foil) • Iron (nails, wire)

Tab. 7-2 *Materials used in the CRIUS II*

7.2.5 Recycling of materials

Materials which are not contaminated with chemicals should be recycled.

CAUTION! Contaminated materials.



Contaminated materials are harmful for the environment.

Materials which are contaminated with chemicals must not be recycled. Dispose of these components as hazardous waste according to the regulations.

The following components are contaminated and **must not** be recycled:

- Tubing and valves of the process gas system
- Reactor
- Components in the process chamber

These components must be classified as hazardous waste and brought to a specialized hazardous waste disposal company.

NOTE:



The above assessment is based on the baseline process. If the system is used for other processes, then the user must adapt the recycling and decommissioning process to ensure safe disposal.

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8 Appendix

8.1 Glossary

Anode — Positive pole of a unit that is operated with direct current.

bar — Pressure unit. This unit is obsolete and has been replaced by Pa.
1 bar = 10^5 Pa = 0.1 MPa

Baratron — Vacuum gauge (capacitance manometer) for gas-type independent measurements.

Cathode — Negative pole of a unit that is operated with direct current.

CVD — Chemical vapor deposition. A common method for deposition of thin films. In a CVD process, volatile compounds are transported into the reactor chamber via the gas phase. Here they are decomposed on a hot substrate by thermal energy.

DI water — Deionized water. Water that has been purified from minerals by an ion exchange process. DI water may still contain uncharged impurities such as organic compounds.

DOR — Double O-ring system. Used to create an intermediate vacuum.

EMO — Emergency-off. If triggered, the EMO circuit shuts down potentially hazardous components. EMO buttons are red with a yellow collar.

EMS — Emergency-stop. If triggered, the EMS circuit stops the movement of a particular component. EMS buttons are red. The collar (if present) is not yellow.

End user — Legal term for the system owner. The end user is responsible for the installed system, especially for the safety and training of the personnel.

GMS — Gas mixing system. Mixing system for the process gases and the precursors.

GUI — Graphic user interface. The interface used for communication between the user and the system controller. Consists of a screen, a keyboard and a pointing device (mouse or trackball).

Inert gas Chemically non-reactive process gas, e.g. the noble gas argon.

IPA Isopropyl alcohol. Also known as isopropanol or 2-propanol. A colorless, volatile, and flammable solvent. IPA is an excellent cleaning agent for many applications.

LOTO Lockout/tagout. Safety procedure which ensures that a component is isolated from energy. The LOTO procedure must be performed in order to protect employees servicing the equipment.

mbar Pressure unit. This unit is obsolete and has been replaced by Pa.
1 mbar = 10^2 Pa = 1 hPa

MFC Mass flow controller. Used to control the flow of process gases.

MPa Megapascal. Pressure unit.
1 MPa = 10^6 Pa = 10 bar = 145 psi

MPV Multi-position valve. Each of the multi-position valves has three inlets and one outlet. The valve has three positions: One of the inlets can be connected to the outlet at a time. The valve position is set by means of two binary digits.

MSDS Material safety data sheets. Suppliers of chemicals generally include safety data sheets with delivered chemicals. The safety data sheets contain all safety related information on the delivered materials. MSDS can also be found on the Internet.

OEM Original equipment manufacturer. Original manufacturer of a component which is delivered together with the CRIUS II.

Pa Pascal. Pressure unit.
1 Pa = 1 N/m^2 = 10^{-2} mbar = 10^{-5} bar = 7.50 mTorr

PLC Programmable logic controller. System controller for the CRIUS II.

PMC Process module controller. Controller for the process module.

psi Pressure unit. This unit is obsolete and has been replaced by MPa.
14.5 psi = 1 bar = 0.1 MPa

RCD Residual current device. If current leaking out of the monitored circuit exceeds the safety limits, the main switch disconnects. It jumps to the «tripped» position.

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sccm Standard cubic centimeters per minute. Gas flow in cm^3/min at standard conditions (20 °C, 1013 hPa).

SCS Safety control system. The SCS prevents any unsafe state of the system.

slm Standard liters per minute. Gas flow in l/min at standard conditions (20 °C, 1013 hPa).

Substrate Part which is coated during a process run.

TMC Transfer module controller. Controller for the transfer module.

Torr Pressure unit. This unit is obsolete and has been replaced by Pa.
1 Torr = 1.333 mbar = 133.3 Pa

UPS Uninterruptible power supply. Used to supply components with power during a power failure. The UPS can supply power for a short time only.

Vacuum (in mbar) A region in which gas is present at a low pressure. Usually, we distinguish between rough vacuum (10^3…1 mbar), fine vacuum (1…10^{-3} mbar), high vacuum (10^{-3}…10^{-7} mbar), and ultrahigh vacuum ($p < 10^{-7}$ mbar).

Vacuum (in Pa) A region in which gas is present at a low pressure. Usually, we distinguish between rough vacuum (10^5…10^2 Pa), fine vacuum (10^2…10^{-1} Pa), high vacuum (10^{-1}…10^{-5} Pa), and ultrahigh vacuum ($p < 10^{-5}$ Pa).

Valve A component which controls the flow or pressure of a gas. Typical examples: Shut-off valve, metering valve, non-return valve, pressure relief valve.

Voltage sag A drop in the mains voltage for durations from half-cycle to a few seconds. Also known as voltage dip.

Wafer A thin slice of semiconductor material which is used as a substrate in the fabrication of integrated circuits. In most cases, wafers consist of highly pure and nearly defect free single crystalline silicon. Silicon wafers are available with diameters of 25…300 mm and a thickness of 0.3…0.8 mm.

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