



Epsilon 4

User's Guide



Epsilon 4

User's Guide

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This is the original publication of Edition 1 of this document, to be used with the Epsilon 4 instrument.

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Chapter 1. Introduction

1.1 General

This User's Guide gives a description of the hardware and instructions that are related to safety, operation, user maintenance and disposal of these systems:

- 9430 042 00400 Epsilon 4 (10 W)
- 9430 042 00400 Epsilon 4 (15 W)

Read this User's Guide together with the Epsilon 4 Quick Start Guides.

For more information, refer to the Epsilon 4 Help that is supplied with the software.

1.2 Intended use

The Epsilon 4 instrument together with the Epsilon software is designed to do routine X-ray measurements and analyses over a long period of time.

It is expected that the system will mostly be used by laboratory or factory personnel.

The system must not be used for purposes other than intended.

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

1.3 Recommended Skill Levels

The system may be operated by personnel with various skill levels. A person may only operate the system after adequate training is received for the required skill level.

The skill levels are:

Operator

- Does not need in-depth knowledge of X-ray theory or applications.
- Must have knowledge of the visible hardware, such as how to switch the instrument on/off and how to use the sample changer for loading and unloading samples.
- Must be able to follow instructions on how to measure samples using applications and how to execute pre-defined tests.

Application engineer

- Must have a thorough knowledge of the analysis process.
- Must have enough knowledge of the hardware to know the limits of what can or cannot be done when using the system.
- Must know how to set up and maintain applications.
- Must know how to develop applications for specific application areas.

System engineer

- Must have enough knowledge to set up and maintain the system, both hardware and software.
- Responsible for maintaining the password mechanism, global variables (names of filters and targets, global compound database, monitors, etc.).
- Must have an understanding of the function of the main aspects of the analysis procedure including but not limited to applications, monitors and sample lists.
- Must have enough knowledge of the hardware to start "safe" actions (not overruling security).
- Must know the actions to take when the system indicates a malfunction.

Chapter 2. Safety

2.1 Introduction to safety aspects

Please take the time to read this chapter before you start to use your instrument.

This chapter is designed to help you to maintain and operate the analytical X-ray instrument in accordance with very high safety standards. It outlines how to keep the instrument in a safe condition, and how to avoid accidents. Therefore, it is important that you read this information in order to become familiar with the safety aspects of the PANalytical instrument.

A PANalytical instrument is perfectly safe as long as it has been correctly installed and is operated according to the instructions given in this User's Guide.

If at any time there is a conflict between the safety information contained in this chapter and any relevant local (national or regional) rules, the local rules always take precedence.

2.1.1 Authorized personnel

NOTE: Authorized Personnel = Person who is trained, educated and authorized by the PANalytical organization to execute service work to a specified level and product area.

Procedures given in this User's Guide can be done by the user. The installation, maintenance and repair procedures of the instrument that are not in this User's Guide must only be done by 'Authorized Personnel'.

All repairs, adjustments and alignments to any part of the instrument must obey all applicable local regulations.

2.1.2 Safety guarantee

A PANalytical instrument is covered by the PANalytical safety guarantee when it is delivered. It remains covered throughout its life as long as the instrument is maintained and repaired by PANalytical service engineers.



WARNING GENERAL HAZARD

No UNAUTHORIZED ALTERATIONS AND/OR ADDITIONS MAY BE MADE TO THE SYSTEM.

2.1.3 Alerts and labels

Special alerts that relate to the safety of personnel and/or equipment can be found in this manual. Where it is necessary, alert labels with the applicable symbol are attached to the instrument.

Obey all instructions in the alerts in the manual and on the labels attached to the different parts of the instrument.

Alerts in this manual are shown as follows:



DANGER ELECTRICAL HAZARD

SHOWS AN IMMEDIATELY DANGEROUS CONDITION WHICH, IF NOT PREVENTED, CAN RESULT IN DEATH OR VERY SERIOUS INJURY.

(THE SYMBOL RELATES TO THE SPECIFIED HAZARD)



WARNING IONIZING RADIATION

SHOWS A DANGEROUS CONDITION WHERE THERE IS RISK OF BAD INJURY.

(THE SYMBOL RELATES TO THE SPECIFIED HAZARD)



Caution General hazard

Shows a condition that can cause damage to equipment or property, or where there is a risk of small injury.

(The symbol relates to the specified hazard)

NOTE: Gives the user more information about the procedure or system.

2.2 Safety standards

PANalytical delivers a Declaration of Conformity with every instrument. The Declaration of Conformity is a legal statement by PANalytical showing that the obligations related to the delivered instrument have been fulfilled. The customer must keep this document with the instrument for its entire life cycle.

Another important declaration for users of analytical X-ray instruments is the X-ray Safety Declaration, which is also shipped with every system.

The equipment complies with the requirements of the Machine Directive 2006/42/EC and EMC Directive 2004/108/EC and the applicable X-ray safety regulations.

Refer to the applicable standards, normative documents and directives in the Declaration of Conformity and the X-ray Safety Declaration of the instrument.

2.3 PANalytical's Approach

PANalytical manufactures and supplies analytical X-ray instruments that fulfill the appropriate international product regulations. This approach results in:

- Specification of the worldwide lowest radiation level: less than 1 $\mu\text{Sv/h}$ at 10 cm distance from the outside surface of the instrument.
- Risk calculations and assessments with respect to the use of the instrument showing that the absorbed dose stays easily within the ICRP (International Commission on Radiological Protection) level for public. This level is 1 mSv/year.
- Overall risk assessment with respect to the safety of the instrument.
- Instrument design, production and documentation certified by notified bodies PTB and/or CSA. See the Declaration of Conformity and the X-ray Safety Declaration for detailed information.
- PANalytical's environmental policy deployed across the whole organization. The following measures are taken:
 - a. Information about environmental aspects of third party products is collected from the suppliers.
 - b. Design rules are implemented to reduce energy consumption, packaging materials, and weight.
 - c. Environmental information is supplied together with the instrument in order to inform service employees and users (people using the system).
- Emission of sound, produced by the instrument during normal operation, in compliance with the requirements of the Machine Directive.
- Instrument design measures to ensure safety with respect to moving parts, such as preventive precautions and warning labels on the instrument and in the manuals.

Assurance of these processes is achieved by organizational requirements such as ISO 9001, ISO 14001, radiation safety board inspections and audits.

2.4 User responsibilities

In this section, the responsibilities of the user are listed, which are required to keep the instrument at the classified safety level.

1. The user must ensure that the instrument is correctly installed. The user's site facilities must meet the specifications in the pre-installation and installation

information. Additionally, the facilities must meet the applicable safety requirements. Remember that:

- a. a suitable ground (earth) must be available.
 - b. the table must be adequate for the instrument.
2. Installation and maintenance must be carried out by personnel authorized by PANalytical.
 3. Safety devices must NEVER be made inoperative.
 4. The user must ensure that people using the system are fully instructed in the safety procedures.
 5. The user must ensure that the system is operated according to the locally applicable safety regulations.
 6. All X-ray analysis systems must be monitored regularly (based on a local risk assessment) using a suitable radiation monitor.
 7. If the instrument is left unattended in an unsafe condition, remove the HT (high-tension) key, disconnect the mains power supply and attach a "DO NOT OPERATE" warning notice to the front panel.
 8. When generating X-rays, the fail-safe warning lamp X-RAYS ON must be on. This lamp must be clearly visible to everyone in the area.
 9. In some countries, a warning lamp must be mounted outside the room, and the international warning sign must be displayed.
 10. After installation or any maintenance/repair procedure, the user and the service engineer must verify that the safety interlocks function correctly.
 11. For troubleshooting, checking the system after repair, or application support, a PANalytical service engineer or application specialist can perform remote support on the instrument.

Before starting and performing remote support, the user must take proper precautions to ensure that the instrument can be operated safely without local intervention.

12. Although the instrument is designed and tested to be safe, maintenance is of vital importance. Information about user level maintenance is provided in this guide. Any further maintenance must be performed by the authorized service engineer.

2.4.1 What to do in case of an emergency

If an emergency, or a suspected exposure to radiation from an analytical X-ray instrument occurs, the following must be done:

1. Switch off the instrument and ensure that it cannot be switched on again.

2. Take any medical/remedial first aid steps required.
3. Do not take any remedial action to cure the fault that caused the accident and/or exposure.

NOTE: In the case of an X-ray exposure incident, assessment of the absorbed dose is more difficult if the fault is corrected.

4. Put a sign on the instrument to indicate that the instrument must not be used or altered in any way.
5. You must notify the following about the occurrence:
 - The user
 - The (Radiation) Safety officer
 - The local PANalytical representative

NOTE: If it is an X-ray exposure accident and it exceeded the level set in local regulations, refer the exposed person for medical examination.

2.5 General hazards

2.5.1 Ionizing radiation

Generally, worldwide legislation forbids the use of ionizing radiation. Its use is allowed only when it is justified. This means that it can only be used after special permission has been given by the relevant authority.

Protection against ionizing radiation is a safety aspect that is covered in the applicable standards. The basic principle is to reduce the radiation outside the instrument to a level that is as low as reasonably achievable (ALARA principle).

When properly operated within the specifications, the radiation level at a distance of 10 cm from the outside surface of the instrument is less than 1 $\mu\text{Sv/h}$.



WARNING IONIZING RADIATION

X-RAYS ARE HARMFUL. THE INSTRUMENT PRODUCES X-RAYS WHICH CAN BE DANGEROUS TO HEALTH IF THE PROPER PRECAUTIONS ARE NOT TAKEN.

IT IS IMPORTANT FOR THE HEALTH AND SAFETY OF THE USER THAT THE RECOMMENDATIONS GIVEN IN THE INSTRUMENT MANUALS ARE CAREFULLY OBSERVED.

LOCAL SAFETY REGULATIONS MUST BE STRICTLY COMPLIED WITH.

2.5.2 Toxic material

The instrument may contain materials that can be hazardous to health. A hazardous substances label is attached to the rear of the instrument.

Unknown samples may contain toxic material. Take proper precautions when handling unknown samples.

For detailed information, refer to the Material Safety Data Sheets delivered with the instrument.



Figure 2.1 Hazardous substances label

2.5.2.1 Beryllium

X-ray tube windows and most detector windows contain beryllium.



WARNING TOXIC MATERIAL

BERYLLIUM AND COMPOUNDS OF BERYLLIUM (FOR EXAMPLE BERYLLIUM OXIDE) ARE POISONOUS.

- **DO NOT TOUCH, SWALLOW OR BREATHE IN BERYLLIUM.**
- **DO NOT GET BERYLLIUM ON YOUR BARE SKIN. ALWAYS WEAR GLOVES WHEN YOU TOUCH ITEMS THAT CONTAIN BERYLLIUM.**
- **IF THERE ARE DUST OR FUMES OF BERYLLIUM, USE A DUST MASK AND PROTECTIVE CLOTHING.**

DISPOSAL OF BERYLLIUM MUST OBEY ALL APPLICABLE LOCAL REGULATIONS.

REFER TO THE SAFETY INFORMATION IN THIS DOCUMENT AND THE RELATED MATERIAL SAFETY DATA SHEET FOR MORE DETAILS.

2.5.2.2 Lead

Lead is used as a shielding material for X-rays.



WARNING TOXIC MATERIAL

LEAD AND COMPOUNDS OF LEAD (FOR EXAMPLE LEAD OXIDE) ARE POISONOUS.

- **DO NOT TOUCH, SWALLOW OR BREATHE IN LEAD.**
- **DO NOT GET LEAD ON YOUR BARE SKIN. ALWAYS WEAR GLOVES WHEN YOU TOUCH ITEMS THAT CONTAIN LEAD.**
- **IF THERE ARE DUST OR FUMES OF LEAD, USE A DUST MASK AND PROTECTIVE CLOTHING.**

DISPOSAL OF LEAD MUST OBEY ALL APPLICABLE LOCAL REGULATIONS.

REFER TO THE SAFETY INFORMATION IN THIS DOCUMENT AND THE RELATED MATERIAL SAFETY DATA SHEET FOR MORE DETAILS.

2.5.3 Flammable material



WARNING FLAMMABLE MATERIAL

THE END-USER IS AT ALL TIMES RESPONSIBLE FOR TREATING (THE SUBSTANCES OR MATERIALS USED FOR FABRICATING) ITS SAMPLES WITH ALL DUE CARE AND DILIGENCE. PANALYTICAL CANNOT BE HELD LIABLE FOR ANY DAMAGE RESULTING FROM THE USE OF FLAMMABLE, COMBUSTIBLE OR OTHER HAZARDOUS SUBSTANCES OR MATERIALS IN (THE PREPARATION OF) ANY SAMPLES.

2.5.4 Earth leakage current

The leakage current of instruments permanently connected to the mains supply voltage may, under some circumstances, exceed 10 mA. Therefore, depending on the local regulations (based on the risk of a broken earth connection), a second earth (ground) connection to the instrument may be required.

2.6 Safety measures

The following sections explain several safety measures and their incorporation into the instrument.

2.6.1 HT keyswitch

All systems are equipped with an HT keyswitch on the control panel. The removable HT key helps the local radiation safety officer to control who uses the system.

The HT key must be removed to prevent unauthorized use of the system. However, normal mains power remains available for other functions.

2.6.2 X-RAYS lamps

When the X-RAYS lamps are on, the instrument is generating X-rays. The X-RAYS lamps are part of the safety circuit. If one of the lamps is defective, no high voltage can be generated meaning that no X-rays can be produced.

Only when the system senses that all conditions are safe will the X-RAYS lamp go on and high tension be applied to the X-ray tube. If an X-RAYS lamp fails, the HT generator is switched off and cannot be switched on.

2.6.3 Double independent safety loops

Double independent safety loops are required to ensure fail-safe operation of the instrument. It is important to check these loops (vital for X-ray safety) regularly and adequately, and to document the results of the checks.

2.6.4 Xsafe

The user is protected from unexpected exposure to X-rays by the Xsafe safety system. This system consists of an electronic board which permanently monitors various switches throughout the instrument to ensure that it is safe for X-rays to be generated.

The X-ray tube in an instrument is powered by a high voltage power supply. The safety circuits automatically ensure that the high voltage and X-rays are immediately switched off if the instrument becomes unsafe.

To ensure the correct functioning of the Xsafe system, the operation of the safety switches must be checked at least once a year. Some safety switches are automatically tested while the instrument is in use. However, other safety features may not be used as often as once a year.

NOTE: The Epsilon 4 has no visual indication of the Xsafe status.

2.6.5 Safe use of the instrument

During normal operation of the instrument with all panels in position, there are no safety risks for the operator.

The next sections show possible safety risks from the instrument during sample handling.

2.6.5.1 Alerts and hazards



Figure 2.2 Front



1

2

1

1.  Ionizing radiation:
X-RAYS lamp

2.  Toxic material: system contains
hazardous substances

Figure 2.3 Rear

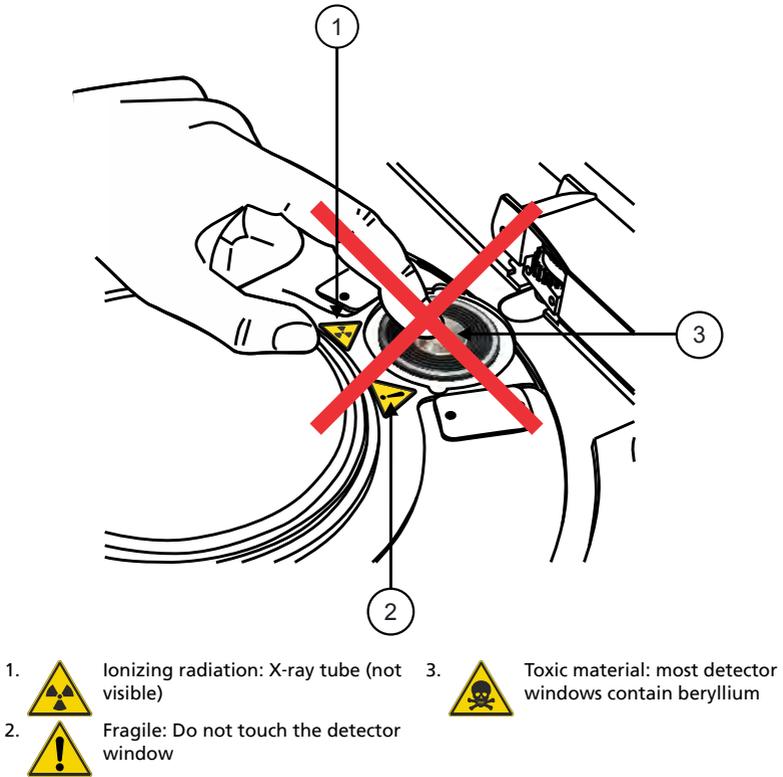


Figure 2.4 *Detector window*

Chapter 3. System description

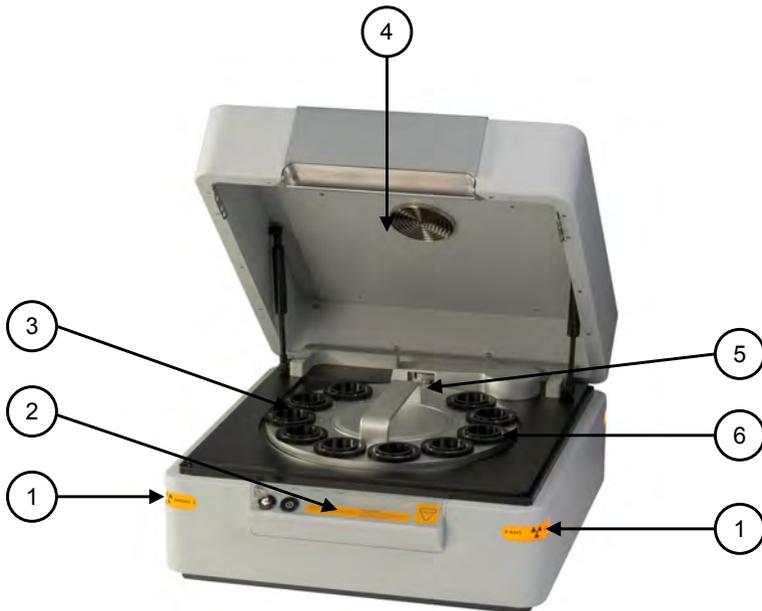
3.1 Introduction

The Epsilon 4 is a compact energy-dispersive X-ray spectrometer to do elemental analysis of a wide range of samples. You can control the system with an analytical software package installed on an external computer.

These configurations of the Epsilon 4 are available:

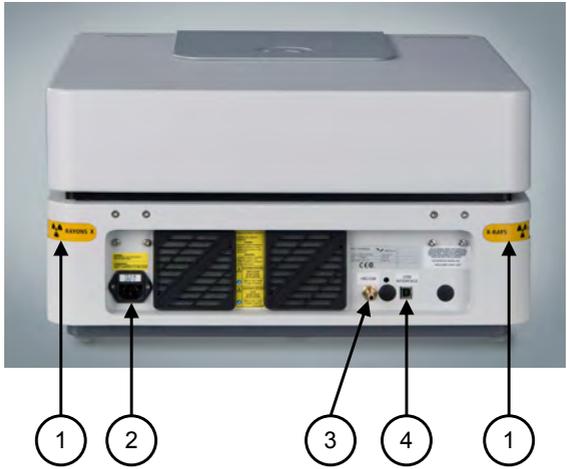
- Epsilon 4, 10 W
- Epsilon 4, 15 W

3.2 Location of components



- | | | | |
|----|---------------|----|------------------------|
| 1. | X-RAYS lamps | 4. | Handle to open the lid |
| 2. | Control panel | 5. | Measuring position |
| 3. | Sample tray | 6. | Sample holder |

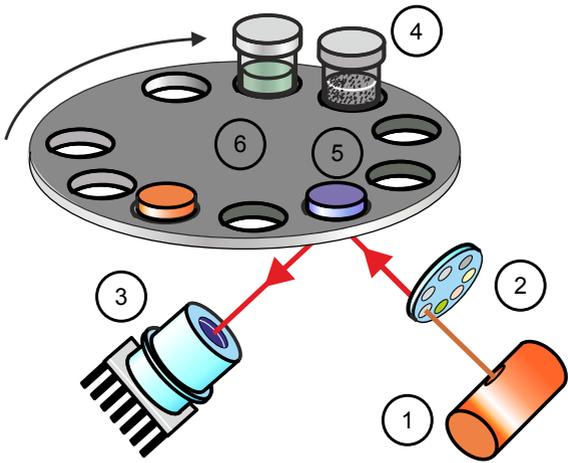
Figure 3.1 Front



- 1. X-RAYS lamps
- 2. Mains power supply connection
- 3. Gas connection
- 4. USB connection

Figure 3.2 Rear

3.3 Optical path



- 1. X-ray tube
- 2. Tube filter changer (7)
- 3. Samples
- 4. Measuring position
Sample tray
- 6. Detector

Figure 3.3 Optical path

Chapter 4. Installation

4.1 Introduction

Before you install the system, make sure that the supplies are installed and agree with the requirements in the Epsilon 4 Pre-installation manual.

If it is necessary to move the instrument, refer to the Epsilon 4 Pre-installation Manual for the requirements about storage, transport and installation.

If you are not sure, always contact your local PANalytical representative.

When the instrument is installed for the first time, a PANalytical service engineer must do the X-ray leakage test. If the instrument is moved, the X-ray leakage test is the responsibility of the customer. We recommend that the X-ray leakage test is done by a person trained in X-ray safety.



WARNING IONIZING RADIATION

X-RAYS ARE HARMFUL. THE INSTRUMENT PRODUCES X-RAYS WHICH CAN BE DANGEROUS TO HEALTH IF THE PROPER PRECAUTIONS ARE NOT TAKEN.

IT IS IMPORTANT FOR THE HEALTH AND SAFETY OF THE USER THAT THE RECOMMENDATIONS GIVEN IN THE INSTRUMENT MANUALS ARE CAREFULLY OBSERVED.

LOCAL SAFETY REGULATIONS MUST BE STRICTLY COMPLIED WITH.

4.2 Unpack the instrument

NOTE: Keep the original packaging for future transportation.

1. Examine the external impact indicators. Refer to Section 4.2.1.
2. Use a forklift or trolley to move the crate on the pallet as close as possible to the installation location.
3. Remove the lid of the crate.
4. Remove all sides of the crate.
5. Remove the cardboard box with parts from the pallet.
6. Make sure that all the parts are supplied. Refer to the Packing List in the envelope. If some parts are missing, contact your local PANalytical organization immediately.
7. Open the cardboard box with the instrument.

8. Remove the 4 corner buffers.
9. Open the foil.
10. Lift the instrument from the cardboard box. The weight of the Epsilon 4 is ~ 47 kg.



WARNING LIFTING HAZARD

THE EPSILON 4 IS HEAVY. IT MUST BE LIFTED BY AT LEAST 2 PERSONS.



Figure 4.1 Lift the instrument with 2 persons

11. Move the instrument to the final installation location with 2 persons. The installation location must have a strong surface, for example, a table.

NOTE: Keep 20 cm space behind the instrument for the airflow and to connect or disconnect the mains power supply.



Figure 4.2 Installation position

12. Open the lid.
13. Remove the protective foam.



WARNING GENERAL HAZARD

Do NOT TOUCH THE DETECTOR WINDOW. THE DETECTOR WINDOW IS FRAGILE.

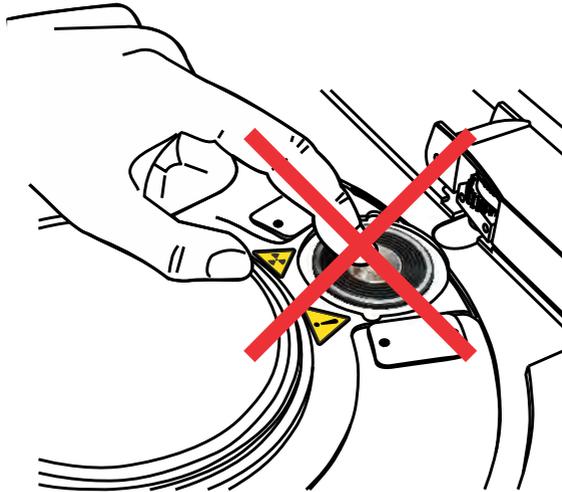


Figure 4.3 Detector window

The windows of the X-ray tube and most detectors contain beryllium.



WARNING TOXIC MATERIAL

BERYLLIUM IS POISONOUS. DO NOT TOUCH OR BREATHE IN BERYLLIUM.

FOR MORE INFORMATION, REFER TO THE TOXIC MATERIAL SECTION IN THE SAFETY CHAPTER.

14. Remove these items from the cardboard box with the parts:
 - Sample tray
 - Box with sample holders
 - Other items (if ordered)

4.2.1 Examine the external impact indicators

1. When the instrument is delivered to your site, examine the crates and/or cartons, and any impact indicators that are attached to them.

NOTE: If an impact indicator was attached to a crate or carton before shipping, this is shown on the shipping documents.

2. If an impact indicator is activated or missing, or a crate/carton has visible damage, do as follows.
 - a. You can accept the shipment, but record the activated or missing indicator and any visible crate or carton damage on the delivery document.

NOTE: The recorded results of the impact indicator can help with any damage claims procedure.

- b. Contact PANalytical's local organization or agent/representative about the damaged crate and activated or missing indicator the same day.
3. Store the delivery document for future reference.
 4. If you have accepted the shipment, make sure that a customer support engineer of PANalytical unpacks the instrument and examines it for internal damage as soon as possible.

4.3 Install the instrument

1. Put the sample holders in the sample tray.



Figure 4.4 Put the sample holders in the sample tray

2. Put the sample tray onto the sample changer.



WARNING PINCH HAZARD

DO NOT PUT YOUR HAND BETWEEN THE SAMPLE CHANGER AND THE SPINNER WHEEL.



Figure 4.5 Put the sample tray onto the sample changer

3. Close the lid.
4. When the instrument is moved to the installation location, let the instrument stay closed for one night to adjust to the new temperature and humidity.
5. Connect the instrument to the mains power supply. The Epsilon 4 is supplied with a cable for the mains power supply. Only use this cable if it agrees with local regulations.

Connect the Epsilon 4 to a single phase mains power supply. If you do not obey the mains power specifications, you can damage the instrument and the warranty of the instrument or parts of the instrument can be canceled.
6. Install the helium supply as follows:
 - a. Install the pressure regulator. Refer to Section 7.5.1.
 - b. Connect the hose between the pressure regulator and the rear of the instrument.
7. Do NOT connect the USB cable to the computer at this time.

4.4 Let the instrument become stable

It is important that the Epsilon 4 is at a stable operating temperature before you do the gain initialization. The gain initakes a 'snapshot' of the instrument and this must be done on a stable instrument.

1. Close the lid.
2. Press the **POWER** button to switch on the instrument.
3. Turn the HT keyswitch clockwise to switch on the HT generator.
4. If the instrument is installed for the first time, a PANalytical service engineer must do the X-ray leakage test.
5. Do the X-ray leakage test. Refer to Section 4.4.1.

NOTE: We recommend that the X-ray leakage test is done by a person trained in X-ray safety.

6. Wait 2 hours until the Epsilon 4 is stable.

4.4.1 Do an X-ray leakage test

In the section PANalytical's Approach, PANalytical tells that their instruments agree with the most strict regulations for ionizing radiation: $< 1 \mu\text{Sv/h}$ at a distance of 10 cm from the outside surface of the instrument. Refer to Section 2.3.

An X-ray leakage test is done for each instrument and the X-ray radiation level is measured before shipment. Our instruments are intrinsically safe when they are operated and maintained correctly.

But also if it is not necessary in local regulations, PANalytical recommends that you do an X-ray leakage test of the instrument regularly. This is specially important during the installation, when the instrument is moved or when the instrument does not get maintenance regularly.

Always use a calibrated X-ray radiation survey meter.

4.5 Install the software

If the computer is supplied with the instrument, the software is already installed. If the computer is not supplied with the instrument, you must install the software as follows:

1. Put the Epsilon software DVD in the computer. The installation menu starts automatically.
2. If the installation menu does not show, start **SETUP.EXE** in the root of the DVD.
3. In the installation menu, click **Install Epsilon Controller Software**.

NOTE: The Epsilon Controller Software is necessary if the instrument will be directly connected to the computer.

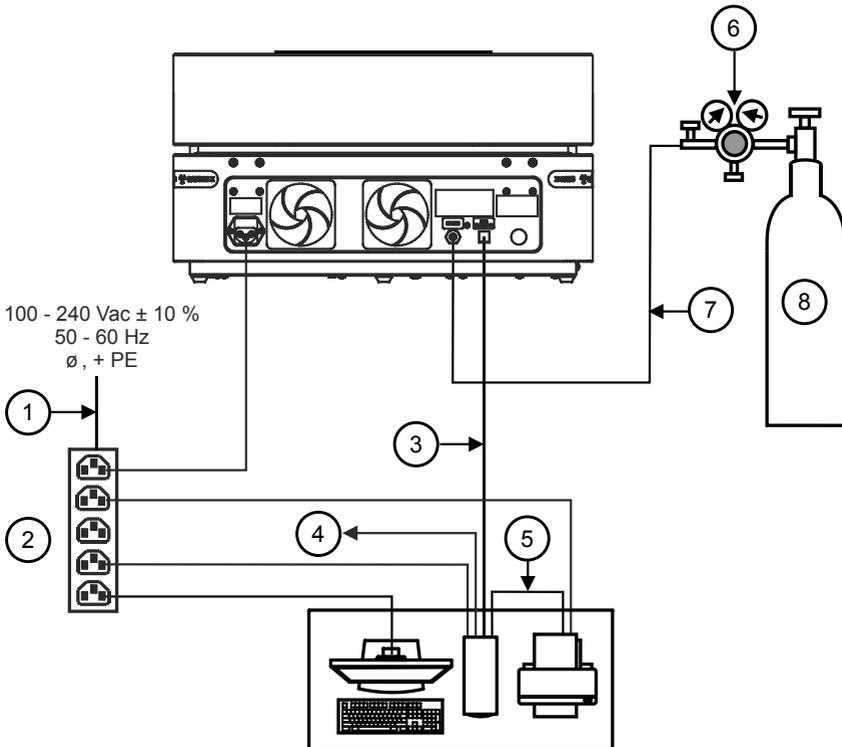
4. Do the instructions of the wizard.
5. In the installation menu, click **Install Epsilon Software**.

6. Do the instructions of the wizard.
7. When all necessary services are installed, click **Exit**.
8. Connect the USB cable to the computer. Use the USB cable supplied with the system, because it has a ferrite bead layer to prevent EMC interference.
9. Install the USB driver. Refer to Section 4.5.1.

4.5.1 Install the USB driver

1. Examine if MS Windows on the computer is 64-bit or 32-bit as follows:
 - a. Press the **Win** + **Pause/Break** key to open the **System** window.
 - b. Examine the **System type** field in the **System** section to find if you have a 64-bit or a 32-bit operating system.
2. Make sure that you have administrator rights.
3. Open the Device Manager:
 - a. Press the **Win** + **R** key to open the **Run** window.
 - b. In the **Open** field, enter "devmgmt.msc".
 - c. Click **OK**.
4. Double-click **Epsilon**.
5. Select the **Driver** tab.
6. Click **Update Driver**.
7. Select **Browse my computer for driver software**.
8. Go to the Epsilon software disk.
9. Double-click the **USB** folder (located in Epsilon\Disk1).
10. Double-click the correct folder:
 - a. If MS Windows on the computer is 64-bit, double-click **x64 (64bit)**.
 - b. If MS Windows on the computer is 32-bit, double-click **x86 (32bit)**.
11. Click **OK**.
12. Click **Next**.
13. Acknowledge the **Security warning** and the install the driver.
14. Click **Close**.

4.6 Supply connections



1. Mains power supply, with earth (plug type is related to country)
2. Power strip 5-way (Euro)
3. USB cable type A (computer) to type B (instrument), with ferrite bead
4. Internet connection
5. USB cable
6. Pressure regulator for helium
7. 10 m rubber hose for helium
8. Helium cylinder

Figure 4.6 Epsilon 4 supply connections

Chapter 5. Operate the instrument

5.1 Introduction

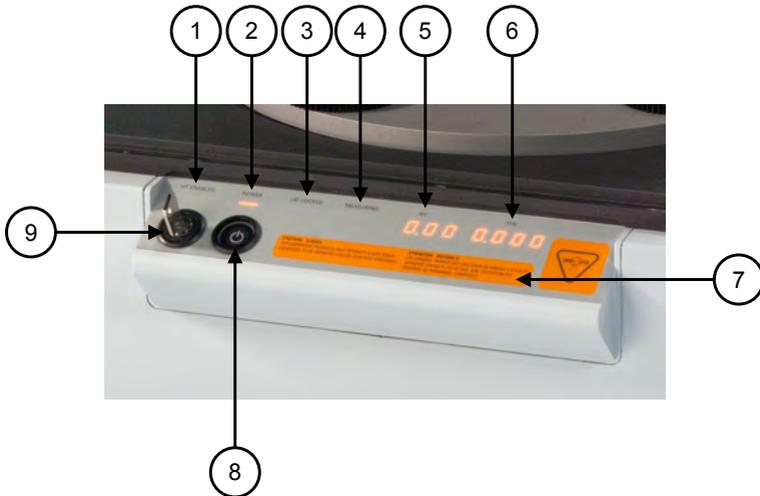


Caution General hazard

Before you operate the instrument, obey these instructions:

- **The instrument must be safely in position.**
- **To prevent accidents, the floor around the instrument must be dry and there must be no dirt or grease.**

5.2 Control panel



- | | |
|-------------------------|-------------------|
| 1. HT ENABLED indicator | 6. mA indicator |
| 2. POWER indicator | 7. X-rays warning |
| 3. LID LOCKED indicator | 8. POWER button |
| 4. MEASURING indicator | 9. HT keyswitch |
| 5. kV indicator | |

Figure 5.1 Control panel

5.2.1 POWER button and indicator

When you press the **POWER** button, the instrument switches to the ON condition. In this condition, all instrument systems except the HT supply are in operation.

The instrument is in the ON condition when the **POWER** indicator is on.

When you press the **POWER** button again, the instrument switches to the OFF condition. In this condition, the HT supply is off but the peripherals are in operation.

The instrument is in the OFF condition when the **POWER** indicator is off.

5.2.2 HT keyswitch and HT ENABLED indicator

When you turn the HT keyswitch clockwise, the HT generator goes on. If the safety loops are closed, the HT generator is automatically set to standby settings.

When the HT generator is in the ON condition, the indicators are as follows:

- The **HT ENABLED** indicator is on.
- The **kV** and **mA** indicators on the control panel show the settings.
- The X-RAYS lamps on the sides of the instrument are on.

When you turn the HT keyswitch counter-clockwise, the HT generator goes off.

The HT keyswitch is also used to reset the Xsafe system. Refer to Section 8.3.1.

If the HT key is removed from the instrument and an unsafe condition is sensed, you cannot switch the high tension on again.

NOTE: The HT key can be removed and kept in a safe place.

5.2.3 LID LOCKED indicator

When the **LID LOCKED** indicator is off, it is safe to open the lid.

When the sample changer moves or samples are measured, the lid is locked and the **LID LOCKED** indicator is on.

5.2.4 MEASURING indicator

During a measurement, the **MEASURING** indicator is on.

5.3 Switch on the instrument

1. Connect the instrument to the mains power supply.

2. If a helium gas cylinder is installed, do as follows:
 - a. Open the main valve of the gas cylinder. The gas cylinder pressure gauge must show a pressure of approximately 20 MPa.
 - b. Slowly open the reduction valve until the output pressure gauge shows a pressure of 0.08 MPa.
3. Connect the USB cable between the computer and the instrument.
4. Press the **POWER** button to switch on the instrument.
5. Turn the HT keyswitch clockwise to switch on the HT generator.
6. If the instrument was moved, do the X-ray leakage test. Refer to Section 4.4.1.

NOTE: We recommend that the X-ray leakage test is done by a person trained in X-ray safety.
7. Wait until the temperature is stable.

When you use the instrument for the first time or when the instrument has been switched off for a long period of time, we recommend a warm-up time of 2 hours.

8. Start the Epsilon software.

5.4 Switch off the instrument

1. Close the Epsilon software.
2. Turn the HT keyswitch counter-clockwise to switch off the HT generator.
3. Press the **POWER** button to switch off the instrument.
4. If a cylinder with helium gas is installed, close the main valve on the cylinder.
5. If it is necessary for the instrument to be switched off for a long period of time, you can also switch off the mains power supply to the instrument.

5.5 Backup the userdata

You should make regular backups of your userdata to prevent accidental loss or hardware and media failure. Always keep a minimum of one backup off-site in a safe location.

1. Start the Epsilon software.
2. Go to **System > Backup userdata** to show the **Backup userdata** window.
3. In the **Source** field, select the folder "...\\panalytical\\epsilon\\userdata".

4. In the **Destination** field, select a destination folder, for example "...\epsilon-userdata-backup".

NOTE: You only have to specify the source folder and the destination folder the first time. After that, these are automatically used as default.

5. Click **Backup**.

Every backup creates a new subfolder in the **Destination** folder with this format:

YYYYMMDDHHMMSS

where YYYY = year, MM = month, DD = day, HH = hour, MM = minutes, SS = seconds

Chapter 6. Measure samples

6.1 Measurement overview

These steps are necessary to do a measurement:

1. Open the lid.
2. Load one or more samples.
3. If you want to measure “large samples”, first put protection foil on top of the measuring position. Refer to Section 6.6.
4. Close the lid.
5. To measure a sample with a measurement program, do as follows:
 - a. Start the Epsilon software.
 - b. Create an application.
 - c. Go to **Measure > Measure application**.
 - d. Select the application.
 - e. Click **Measure** to start the measurement.
 - f. Select the position on the sample changer. The sample automatically moves to the measuring position and the measurement is done as given in the analytical software.
6. To measure a sample manually, do as follows:
 - a. Start the Epsilon software.
 - b. Go to **Measure > Manual control**.
 - c. In the **Sample changer** field, enter the position of the sample.
 - d. Click **Move**.
 - e. The sample automatically moves to the measuring position and the measurement is done as given in the analytical software.

The **On-line status** window opens during a measurement. It shows the status of the measurement and the temporary results.

6.2 Sample types

You can measure these sample types with the Epsilon 4:

- Solid samples.

These samples must be between 27 and 51.5 mm diameter with a maximum height of 10 cm.

- Liquid samples.

These samples are usually 10 ml. They must be put in the special 'P1 liquid cell'. The liquid cells must be put in steel sample holders.

6.3 Sample loading

You must load samples manually or with a robot arm when you have an instrument with automation kit.



WARNING TOXIC MATERIAL

IF YOU MEASURE UNKNOWN OR TOXIC SAMPLES, REFER TO THE MATERIAL SAFETY DATA SHEET ABOUT HANDLING INSTRUCTIONS.



WARNING FLAMMABLE MATERIAL

THE USER IS ALWAYS RESPONSIBLE TO USE ITS SAMPLES, AND ITS MATERIALS TO PREPARE THESE SAMPLES, VERY CAREFULLY AND CORRECTLY.

PANALYTICAL IS NOT LEGALLY RESPONSIBLE FOR DAMAGE THAT IS CAUSED BY FLAMMABLE SAMPLES, OR BY OTHER HAZARDOUS MATERIALS IN THE SAMPLES OR THAT ARE USED WHEN THE SAMPLES ARE PREPARED.



Caution General hazard

To prevent contamination of the measurement chamber and optical path, obey these instructions:

- **Only use sample cups that are approved for use in PANalytical instruments.**
- **For liquid cups, make sure that the cup lid is safely in position.**
- **Do not keep temperature sensitive samples in the instrument for a long period.**

If a pressed powder sample breaks or a liquid sample leaks in the measurement chamber or the optical path, immediately switch off the instrument. Do not clean the contaminated parts. A PANalytical service engineer must clean the measurement chamber and the optical path.

6.4 Sample tray



Figure 6.1 Sample tray layout

NOTE: The sample positions are on the sample tray.

6.5 Load samples

1. Open the lid.
2. Put the sample holders on the sample tray.

- Put the sample tray with sample holders onto the sample changer.



WARNING PINCH HAZARD

DO NOT PUT YOUR HAND BETWEEN THE SAMPLE CHANGER AND THE SPINNER WHEEL.



Figure 6.2 *Put the sample tray onto the sample changer*

- Put the sample in a sample cup of the correct size.
- Put the sample cup in a sample holder on the sample tray.
- Do steps 4 and 5 again for all samples that you want to measure.



Figure 6.3 *Put sample cups in the sample holders*

- Close the lid.

6.6 Measure large samples

When you want to measure large samples, you must protect the measuring position with a protection foil.

NOTE: Only use the protection foil on top of the measuring position when you measure in Large Sample mode.

1. Start the Epsilon software.
2. Go to **System > Enter "Large Sample" mode**. The beam stop automatically moves away from the measuring position.
3. Do the instructions on the screen.



WARNING GENERAL HAZARD

Do NOT TOUCH THE DETECTOR WINDOW. THE DETECTOR WINDOW IS FRAGILE.

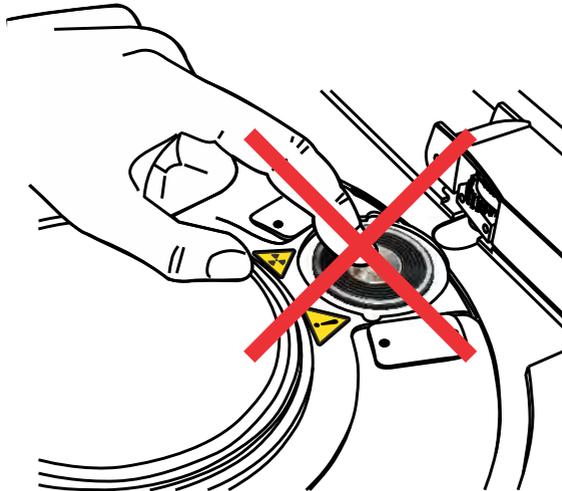


Figure 6.4 *Detector window*

The windows of the X-ray tubes and most detectors are made of beryllium.



WARNING TOXIC MATERIAL

BERYLLIUM IS POISONOUS. DO NOT TOUCH OR BREATHE IN BERYLLIUM.

FOR MORE INFORMATION, REFER TO THE TOXIC MATERIAL SECTION IN THE SAFETY CHAPTER.

4. Use laboratory tweezers to remove the clamping ring from the measuring position.



Figure 6.5 Remove the clamping ring

5. Put the protection foil on top the measuring position. The protection foil is very sensitive for electrostatic charges.



Figure 6.6 Put the protection foil on top of the measuring position

6. Put the clamping ring around the measuring position.
7. Carefully push the clamping ring down.
8. Remove the paper frame.



Figure 6.7 Remove the paper frame

9. Use the laboratory tweezers to put small holes in the protection foil, on top of the four holes of the measuring position.

NOTE: The holes are necessary to release helium gas and air during measurements.



Figure 6.8 Put small holes in the protection foil

10. Put the sample on top of the protection foil.
11. Close the lid.

12. Turn the HT keyswitch clockwise to switch on the HT generator.
13. Start the measurement.
14. Wait until the measurement is completed.
15. Make sure that the HT is in the standby settings.
16. Turn the HT keyswitch counter-clockwise to switch off the HT generator.
17. Open the lid.
18. Use laboratory tweezers to remove the clamping ring from the measuring position.
19. Use laboratory tweezers to remove the protection foil.



Figure 6.9 *Remove the protection foil*

20. Put the clamping ring around the measuring position.
21. Carefully push the clamping ring down.
22. Go to **System > Exit "Large Sample" mode**. The beam stop automatically moves over the measuring position.
23. Do the instructions on the screen.

Chapter 7. User maintenance

7.1 Introduction

Follow the safety precautions of this User's Guide when you do any of these procedures. Refer to Chapter 2.



WARNING GENERAL HAZARD

IF THE SYSTEM IS IN AN UNSAFE CONDITION AND YOU GO TO A DIFFERENT ROOM, DO AS FOLLOWS:

- **DISCONNECT THE SYSTEM FROM THE MAINS POWER SUPPLY.**
- **PUT A WARNING NOTICE ON THE INSTRUMENT.**
- **REMOVE THE HT KEY.**

To do these procedures, it can be necessary to move the instrument from its normal operating position.

Table 7.1 Maintenance schedule

Maintenance procedure	Maintenance interval	Reference
Test of the safety integrity	Every year	Refer to Section 7.2.
Clean the instrument	When necessary	Refer to Section 7.3.
Clean the dust filters of the air inlet	When necessary	Refer to Section 7.4.
Replace the gas cylinder	When necessary	Refer to Section 7.5.1.

7.2 Test of the safety integrity

This test is necessary to make sure that the HT keyswitch, Xsafe and safety loops work correctly and to move the related switches.

1. Press the **POWER** button to switch on the instrument.
2. Wait until the initialization is finished.
3. Turn the HT keyswitch clockwise to switch on the HT generator.
4. Make sure that the X-RAYS lamps go on.
5. Turn the HT keyswitch counter-clockwise to switch off the HT generator.
6. Make sure that the X-RAYS lamps go off.
7. After 5 seconds, turn the HT keyswitch clockwise.
8. Start the Epsilon software.

9. Go to **Measure > Manual control**.
10. In the **Sample changer** field, enter position "5".
11. Click **Move**.
12. Examine that the **LID LOCKED** indicator comes on and that you cannot open the lid.
13. In the **Sample changer** field, enter position "0".
14. Click **Move**.
15. After the movement is finished, examine that the **LID LOCKED** indicator goes off and that you can open the lid.

7.3 Clean the instrument



Warning General hazard

If a pressed powder sample breaks or a liquid sample leaks in the measurement chamber or the optical path, immediately switch off the instrument. Do not clean the contaminated parts. A PANalytical service engineer must clean the measurement chamber and the optical path.

1. Make sure that the HT is in the standby settings.
2. Turn the HT keyswitch counter-clockwise to switch off the HT generator.
3. Make sure that the sample changer is in the reference position.
4. Press the **POWER** button to switch off the instrument.
5. Open the lid.
6. Remove the sample tray.
7. Clean the sample cups and sample inserts and sample tray with industrial alcohol. If the sample cups or sample inserts cannot be cleaned, replace them.



Caution General hazard

Be careful with the sample holders. The bottom of the sample holders is very thin so you can easily make dents. This changes the distance between the sample and detector, which has a negative effect on the analysis results.

8. Wait until the alcohol is completely dry before you do a measurement.

9. Disconnect all cables at the rear of the instrument.
10. Make sure that there is no damage or leakage at the rear of the instrument.
11. Clean the outer side of the instrument with a moist cloth.
12. Clean the inner side of the instrument with a lint-free cloth. Do not clean the optical path.



Figure 7.1 *Clean the inner side*

13. Put the sample tray onto the sample changer.
14. Close the lid.
15. Connect all cables at the rear of the instrument.
16. Press the **POWER** button to switch on the instrument.
17. If helium is installed, make sure that it operates correctly.
18. Turn the HT keyswitch clockwise to switch on the HT generator.

7.4 Clean the dust filters of the air inlet



CAUTION **GENERAL HAZARD**

Replace the dust filters of the air inlets regularly. If there is dust on the air inlets, the fans cannot decrease the temperature of the components and the electrical circuits can become damaged.

1. Remove the two black covers with dust filters from the rear of the instrument.

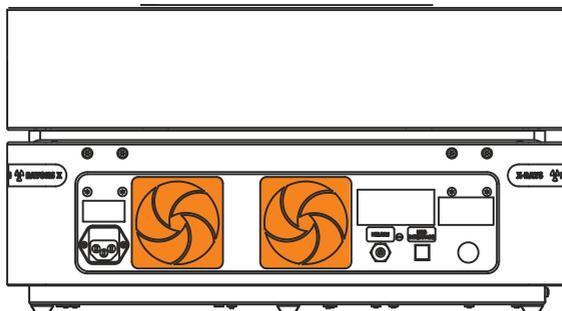


Figure 7.2 Dust filters of the air inlet

2. Blow the dust filters clean with compressed air.
3. Install the black covers with dust filters at the rear of the instrument.

7.5 Maintain the gas systems

As standard, the Epsilon 4 instrument has a helium flow gas system. The pressure in the helium gas system must be 0.8 bar to operate correctly.

If the pressure in the gas cylinder is below 4 bar, replace the gas cylinder. If you do not replace the gas cylinder in time, this will have unwanted effect on the analysis results. When the gas cylinder is empty, the Epsilon software shows a warning.

7.5.1 Replace the cylinder of the helium gas

NOTE: Do this procedure when the gas cylinder is empty.



WARNING GENERAL HAZARD

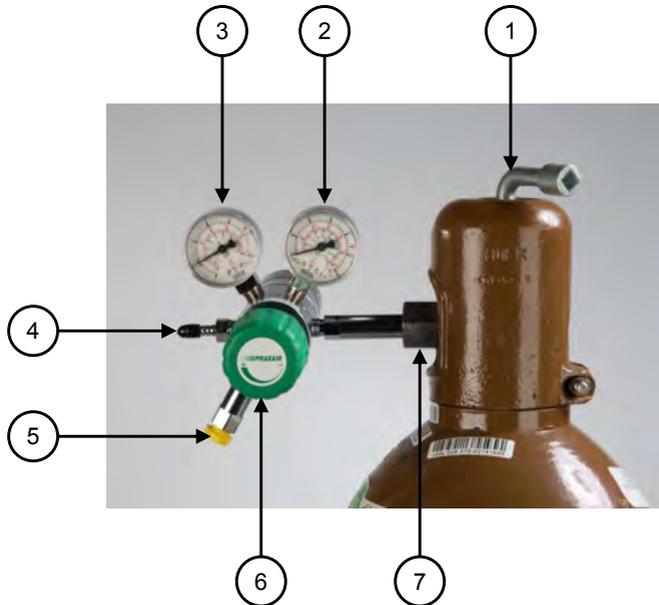
THE GAS CYLINDER MUST BE ATTACHED TO THE WALL OR IN A SUITABLE HOLDER. A FULL CYLINDER CAN HAVE A PRESSURE OF UP TO 18 MPA AND CAN EXPLODE IF THE CYLINDER FALLS.



WARNING GENERAL HAZARD

IF GAS LINES FROM THE CYLINDER TO THE INSTRUMENT ARE ON THE FLOOR, PUT PROTECTION OVER THE GAS LINES TO PREVENT DAMAGE.

NOTE: If you put the gas cylinder inside a room, make sure that the gas cylinder is at room temperature before you connect it to the instrument.



- | | |
|-----------------------------------|------------------------------|
| 1. Main valve of the gas cylinder | 5. Overpressure relief valve |
| 2. Gas cylinder pressure gauge | 6. Reduction valve |
| 3. Output pressure gauge | 7. Connection nut |
| 4. Output pressure outlet | |

Figure 7.3 Pressure regulator

1. Start the analytical software.
2. Set the medium to air.
3. Turn the reduction valve (6) counter-clockwise to close it.
4. Turn the main valve of the gas cylinder (1) clockwise to close it.
5. Turn the connection nut (7) a small turn clockwise to remove the remaining pressure, then loosen it completely.
6. Remove the pressure regulator from the gas cylinder.
7. Put the protective nut on the output connection of the gas cylinder.
8. Put the domed cover on the gas cylinder.
9. Remove the domed cover of the new gas cylinder.
10. Remove the protective nut from the output connection of the new gas cylinder.
11. Make sure that the outlet of the new gas cylinder points in a safe direction.

12. Quickly open and close the main valve of the new gas cylinder a small turn. This blows out dust particles in the gas cylinder connection.
13. Connect the pressure regulator to the new gas cylinder as follows:
 - a. Put a new washer inside the connection nut.

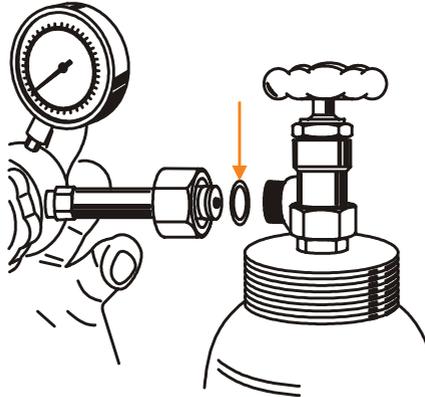


Figure 7.4 Washer

- b. Connect the pressure regulator to the gas cylinder and turn the connection nut counter-clockwise.
 - c. Use 2 wrenches to tighten the connection nut and to make sure that the pressure regulator does not turn.

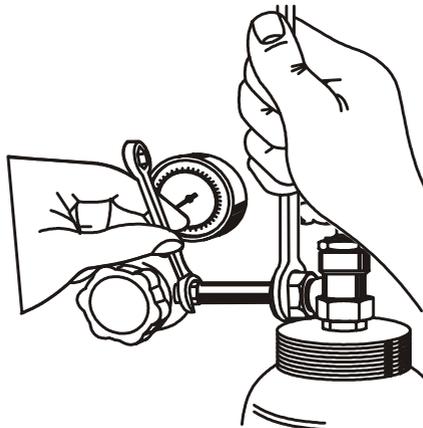


Figure 7.5 Tighten the connection nut

14. Open the main valve of the detector flow gas cylinder. The gas cylinder pressure gauge must show a pressure of approximately 20 MPa.

15. Do a leakage test of the gas system. Refer to Section 7.5.2.
If there is no leak, continue with the next step.
16. Slowly open the reduction valve of the detector flow gas cylinder until the output pressure gauge (4) shows a pressure of 0.08 MPa.
17. Set the medium to helium.

7.5.2 Leakage test of the gas system

Do a leakage test of the gas system each time a gas cylinder is connected to the instrument.

1. Close the main valve of the gas cylinder.
2. Close the reduction valve.
3. Slowly open the main valve of the gas cylinder.
4. Write down the pressure value.
5. Close the main valve of the gas cylinder.
6. Keep the main valve of the gas cylinder closed for approximately 30 minutes.
7. After approximately 30 minutes, compare the pressure value with the pressure value of step 4.

If the pressure value is the same, there is no leak.

If the pressure has decreased, there is a leak in the connection between the gas cylinder and the pressure regulator. Repair the leak.

7.5.2.1 Repair a leak in the gas system

1. Turn the reduction valve (6) counter-clockwise to close it.
2. Turn the main valve of the gas cylinder (1) clockwise to close it.
3. Turn the connection nut (7) a small turn clockwise to remove the remaining pressure, then loosen it completely.
4. Remove the pressure regulator from the gas cylinder.
5. Use petroleum ether to carefully clean the coupling.
6. Connect the pressure regulator to the gas cylinder and turn the connection nut counter-clockwise.
7. Open the main valve of the gas cylinder.
8. Do a leakage test of the gas system again.

7.6 Consumable materials

Table 7.2 Consumable materials for maintenance

Item	Ordering code
Protection foil for optical path	9430 500 07101
Dust filter (1)	5322 784 02871
Dust filters (set of 25)	5322 784 04251
Sample tray bearing ring	5332 000 03291

Chapter 8. Troubleshooting

8.1 Introduction

This chapter gives the most common problems with the system and their solutions.

If a problem is not in this chapter, or if the solution did not remove it, collect all relevant information about the problem and contact your local PANalytical service organization.

If possible, a PANalytical service engineer uses remote support to find a solution for the problem. During a remote support session, your aid can be necessary. If a remote support session did not remove the problem, a service visit can be necessary.

8.2 Instrument does not switch on

Table 8.1 Possible causes for instrument does not switch on

Cause	Solution	Reference
The instrument is not switched on.	Switch on the instrument.	Refer to Section 5.3.
A fuse has blown in the mains power supply.	Replace the fuse.	Refer to Section 8.2.1.

8.2.1 Replace the mains power fuses

There are two 5 A, 250 V slow-blow mains fuses above the mains power supply socket of the instrument. These fuses must only be replaced by Authorized Personnel.

1. Disconnect the instrument from the mains power supply.
2. Use a flat screwdriver to pull the fuse holder out off the socket.
3. Remove the fuses from the fuse holder.
4. Put the new fuses in the fuse holder.
5. Push the fuse holder back into the socket.
6. Connect the instrument to the mains power supply.
7. If the fuses blow again, do as follows:
 - a. Disconnect the instrument from the mains power supply.
 - b. Contact your local PANalytical service organization.

8.3 HT generator does not switch on

If the HT generator does not switch on, there is usually a problem in the HT safety circuit.

Table 8.2 Possible causes for HT generator does not switch on

Cause	Solution	Reference
HT keyswitch is in the OFF position.	Turn the HT keyswitch clockwise.	Refer to Section 5.2.2.
1 or more of the X-RAYS lamps on the corners of the instrument is defective.	Contact your local PANalytical service organization.	
Xsafe is activated.	Reset Xsafe.	Refer to Section 8.3.1.

8.3.1 Reset Xsafe

NOTE: The Epsilon 4 has no visual indication of the Xsafe status.

When you think that the Xsafe system is activated, do as follows:

1. Turn the HT keyswitch counter-clockwise to switch off the HT generator.
2. Turn the HT keyswitch clockwise to switch on the HT generator.
3. Switch on the instrument. Refer to Section 5.3.

Chapter 9. Disposal instructions

9.1 WEEE directive

The instrument complies with the WEEE Directive (Waste of Electrical and Electronic Equipment), identified by this alert symbol on the instrument:



Figure 9.1 WEEE directive alert symbol

The function of the European WEEE Directive is to decrease the quantity of waste from electrical and electronic equipment, and to decrease the hazardous substances of this waste to protect human health and the environment.

9.2 Hazardous substances

When you dispose of hazardous materials, obey all applicable and local regulations to prevent damage to the environment. You can also send the hazardous materials back to PANalytical for disposal. Use a recorded shipping method.

On the instrument, the hazardous materials are identified with a label.

If you are not sure about the correct disposal procedure, contact your local PANalytical representative.

9.2.1 Beryllium

The windows of X-ray tubes and most detectors contain **beryllium (Be)**.



WARNING TOXIC MATERIAL

BERYLLIUM IS POISONOUS. DO NOT TOUCH OR BREATHE IN BERYLLIUM.

FOR MORE INFORMATION, REFER TO THE TOXIC MATERIAL SECTION IN THE SAFETY CHAPTER.

9.2.2 Lead

The base plate and the beam stop contain **lead (Pb)**.



WARNING TOXIC MATERIAL

LEAD IS POISONOUS. DO NOT TOUCH OR BREATHE IN L.

FOR MORE INFORMATION, REFER TO THE TOXIC MATERIAL SECTION IN THE SAFETY CHAPTER.

9.2.3 X-ray tube

The window of the C-Tech X-ray tube contains **beryllium (Be)**.

For disposal instructions, refer to the Tube Instruction Manual supplied with the X-ray tube.

9.2.4 Detector

The window of the silicon drift detector contains **beryllium (Be)**.

9.2.5 Beam stop

The beam stop contains **lead (Pb)**.



Figure 9.2 Beam stop

9.2.6 Base plate

The base plate contains **lead (Pb)**.



Figure 9.3 *Base plate*

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