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Description automatically generated with medium confidenceLocal Safety Rules**

|  |
| --- |
| **Manufacturer**  **Type & Model**  **S/N: *Equipment or X-ray source Serial Number***  **RUA No. *Asset Number*** |

|  |  |
| --- | --- |
| Radiation Safety Officer:  **Mohammad Bahmaid**  Al-Jazri Building (Bldg.4), Room 0250, WS10  Phone: 966 (012) 808 7843  Mobile: 966 (054) 470 0427  Email: [mohammad.bahmaid@kaust.edu.sa](mailto:mohammad.bahmaid@kaust.edu.sa) |  |
| Responsible Person  **Name**  Phone: 966 (012) 808 ####  Mobile: 966 (054) ### ####  Email: | Principal Investigator  **Name**  Phone: 966 (012) 808 ####  Mobile: 966 (054) ### ####  Email: |

# Introduction

The purpose of these Local Rules is to set out the key arrangements for restricting exposure to ionizing radiation from work with radiation-producing equipment.

## **Purpose**

The purpose of the SOP is to describe the operation for safe use of all radiation producing equipment which have an enclosed and shielded X-ray beam.

The purpose of the SOP is to describe the operation for safe use of:

|  |  |  |  |
| --- | --- | --- | --- |
| **Type**  **(XRF,CT, XRD,SEM,..etc)** | **Asset No** | **Manufacturer & Model** | **Location (e.g. B4-0250)** |
| Add | Add | Add | Add |

## **Potential Hazards & Risk Assessment**

Failure to follow these Local Rules may results in exposure to:

1. **X-ray -** X-rays are produced within the equipment by the X-ray tube. The design of the device ensures that all X-rays produced are contained within a shielded enclosure. Safety interlocks are installed to prevent the device from producing the X-ray beam if the device is not fully sealed. This greatly minimizes the likelihood of getting an X-ray exposure. Users should not be exposed to radiation above background level when using this equipment according to the manufacturer specifications.
2. **Electrical hazard –** In order to produce an X-ray beam the device requires a high voltage. The device should be grounded appropriately, and the high voltage power supply should be lifted from the ground by approximately 5 cm to avoid being in contact with water in case of flood.
3. **Chemical hazard –** In some cases, chemicals are used as part of the procedure and all safety recommendations must be followed, including the use of all required personal protective equipment. See [Lab Safety Manual](https://hse.kaust.edu.sa/Services/Pages/LabSafetyManual/Introduction.aspx) for more detailed information.

**No staff is authorized to work with unshielded X-ray beams, i.e., when safety interlocks are disabled.**

## **Area Designation**

Laboratories with X-ray equipment emitting X-rays above 5 kVp and fully enclosed are classified as Supervised Areas. Such X-ray equipment must display a radiation hazard trefoil sign, and a warning sign should be posted at each entrance to the Supervised Area. Only authorized radiation users, who have completed the required training, are permitted to operate the equipment.

# Training

The PI/RUA holder is responsible for ensuring that their students, postgraduates, research scientists, and other personnel are properly trained in the safe use of radiation-producing equipment before beginning work. Relevant online safety training courses are listed in Table 1. After completing these courses and achieving an acceptable score on the exams, users may request their PI or LSR to add them to the authorized users list.

**Table 1.** Safety training course for use of radiation-producing equipment

|  |  |
| --- | --- |
| **Radiation-Producing Equipment used** | **Training required** |
| Scanning Electron Microscopes | * [**HSE\_151 X-Ray Analysis Equipment Safety Training**](https://urldefense.com/v3/__https:/lms.salutesafety.com/course/view.php?id=27__;!!Nmw4Hv0!yrM6a02eP951XSilO1of2s0_WvVePC6SPVdrR9hOOP-uQ2IGyuhfxwHsDlVBpUphsYmPOwmF0J0oYyr_z5ffVFYm_kG_sFR_mEL_874$) * Practical operation training for the radiation-producing equipment |
| Analytical X-ray System | * [**HSE-151 X-ray Analysis Equipment Safety Training**](https://lms.salutesafety.com/course/view.php?id=48) * Practical operation training for the radiation-producing equipment |

All radiation safety trainings are accessible via the SALUTE LMS Portal or can be arranged on demand with the Radiation Safety team at [hse@kaust.edu.sa](mailto:hse@kaust.edu.sa).

# Personnel Monitoring

## **Staff Designation and Dose** **Limits**

All users of radiation-producing equipment with an enclosed and shielded X-ray beam are considered non-classified workers and are subject to the maximum permissible dose limits set by KAUST. A summary of these limits is provided in Table 2.

**Table 2.** Annual Public and Occupational dose limits (NRRC) and Dose Constraints levels for individuals working at KAUST

|  |  |  |  |
| --- | --- | --- | --- |
|  | **General Public** | **NRRC Occupational**  **Annual Dose Limit** | **Maximum Permissible Occupational Doses set at KAUST** |
| **Whole Body** | 1 mSv/year | 20 | 2 mSv/year |
| **Lens of the eye** | 15 mSv/year | 20 | 15 mSv/year |
| **Skin or Extremities** | 50 mSv/year | 500 | 50 mSv/year |

The maximum permissible dose limit is a specified level of radiation dose received by a worker above which a formal investigation will be undertaken by the RSO in order to ensure that exposure to ionizing radiation is being restricted as low as is reasonably achievable.

## **Personnel Monitoring**

Personnel using fully enclosed X-ray systems in Supervised Areas are not expected to receive radiation doses above background levels due to effective engineering controls. Consequently, personal dosimeters are not required for these workers. However, area dosimetry monitoring is conducted on the radiation-producing equipment to ensure non-classified workers remain within the dose limits set by KAUST. All area monitoring records will be maintained on file.

## **Pregnant staff**

Pregnant workers are generally not prohibited from using ionizing radiation-producing devices. However, it is essential that female staff and students are informed of the importance of declaring any pregnancy. Only upon declaration can measures be implemented to limit fetal exposure to ionizing radiation. In most cases, no changes to the work activities or research practices involving ionizing radiation will be necessary for pregnant individuals. For more information, please contact the RSO.

## **Radiation Survey and Area Monitoring**

The Radiation Safety Office will conduct annual inspections of analytical X-ray equipment to ensure compliance with regulatory requirements. These routine inspections will be scheduled with the responsible person/LSR, and the X-ray equipment will need to be operated at maximum operating energy during the inspection.

Additional radiation surveys are required under certain conditions. If any of the following occur, it is the responsibility of the responsible user/LSR contact the Radiation Safety Office to arrange a radiation survey:

* Upon installation of new equipment.
* Following any changes to the initial setup, quantity, or type of local system components.
* After any maintenance that involves disassembly or removal of a local component in the system.

# Maintenance Plan

A Maintenance Plan must be submitted to the RSO and should include the following:

* Basic regular maintenance of the equipment should only be performed by the manufacturer’s engineer, an LEM maintenance specialist, or trained users (e.g., tasks like beam alignment, filament replacement, and vacuum pump checks). However, users are strictly prohibited from working with an open X-ray beam.
* If maintenance work requires access to an open X-ray beam, a certified service engineer from the equipment manufacturer or an LEM-certified maintenance specialist must be contracted to perform the work

# Safety Measures

## **Safety Features**

Radiation-producing equipment should be equipped with various radiation protection features. Understanding these features is essential for ensuring radiation safety. Below is a list of common safety features, though some equipment may not include all of them:

* **X-ray Tube Housing**: The X-ray tube is enclosed in a housing designed to withstand normal use, accidental impact, or misuse without fracturing or deforming.
* **X-ray Energized Warning Indicator (Light)**: This light indicates when the X-ray tube is active, generating and emitting X-rays within the chamber/enclosure.
* **Key-Operated System**: The system can be disabled by removing the key, preventing unauthorized use.
* **Enclosure**: The enclosure contains animals or samples and prevents access to the primary X-ray beam. It is constructed with suitable materials (e.g., steel, lead, lead glass) to block X-ray radiation during operation.
* **Interlocks**: Safety interlock switches are installed to prevent user exposure to the primary or diffracted X-ray beam. Attempting to open the chamber/enclosure while the X-ray tube is active will immediately de-energize the system. Users should not operate the equipment if the interlocks are disabled unless trained to do so.
* **Emergency Stop Button (Red Push Button)**: A red, clearly labeled "Emergency Stop" button may be installed to shut down power to the equipment. Users should be aware of its location and use it only in emergencies.
* **Service/Disruption Notice**: If a user encounters an operational or safety issue, they should shut down the unit, place a notice on it, and inform the LSR or PI. If a warning notice is posted on the equipment, users should not operate it until cleared by the LSR, PI, or RSO.
* **Shielding Integrity and Inspection**: Shielding and equipment integrity are inspected annually or as needed (e.g., after maintenance). Inspection records are maintained on file.
* **Maintenance**: Regular maintenance by KAUST staff and/or manufacturer service engineers ensures safe operation of the equipment.
* **Warning Signs**: Clearly visible warning signs should be displayed at the laboratory entrance.

## **Systems of Work**

**Area Access Controls**

* **Entry Requirements** 
  + Follow all posted notices at Supervised Area entrance
  + Access restricted through card reader or pin-code system
  + Specific equipment may require additional login credentials

**Safety and Operating Requirements**

* **Authorization and Responsibility** 
  + Only trained, authorized personnel may operate radiation equipment
  + Operators are responsible for area safety during equipment use
  + Follow laboratory PPE requirements
* **Safety Protocols** 
  + Never bypass or disable safety interlocks
  + Wear assigned dosimeters during equipment operation
  + Follow all laboratory safety plans
* **Reporting Requirements** 
  + Report suspected radiation exposure immediately to LSR, PI, and RSO
  + Pregnant workers encouraged to confidentially inform RSO
  + Report any safety concerns or incidents promptly

## Standard Operating procedures (SOP)

This is a required separate document that should detail the proper use and operation of the equipment.

Each analytical X-ray device must have written, step-by-step instructions available to all authorized users, as applicable. These instructions should cover procedures for sample insertion and handling, equipment alignment, routine maintenance, and any data recording steps related to radiation safety.

The RUA holder is responsible for ensuring that no one operates the analytical X-ray equipment outside of the standard operating procedures.

Any procedure, maintenance, or alignment that requires access to the primary X-ray beam with any local system component disassembled or removed must receive prior approval from the Radiation Safety Officer.

# **Emergency Procedures**

## **Radiation Incident**

In the event of a radiation accident involving serious personal injury, attending to the injury takes priority over addressing equipment issues. However, if possible, turn off the system by pressing the red emergency button. Immediate medical assistance can be obtained by dialing 911 from a landline or 012 808 0911 from a mobile phone. Please follow these steps:

1. **Stop X-ray Emission**: Press the red emergency stop button or turn off the key switch to interrupt the X-ray emission.
2. **Address Life-Threatening Conditions First**: Call for someone trained in First Aid if necessary.
3. **Stabilize the Situation**: If possible, return to the equipment, ensure it is switched off, and verify that the X-ray source is electrically isolated.
4. **Prevent Access**: Make sure no one can restart the X-ray generator. Place warning signs on the machine and remove the keys.
5. **Notify Key Personnel**: Contact your LSR, PI, and RSO to report the incident. If the equipment has sustained any damage, seek guidance before resuming use.
6. **Report the Incident**: Once the situation is resolved, report the incident through the university's accident reporting system ("Report it").

## **Damage or malfunction of the X-ray emitting device**

If the radiation-producing equipment is damaged or malfunctioning, please follow the steps below:

1. Stop the radiation-producing equipment using the normal procedure and if necessary, press the Red emergency stop button, or any other method to interrupt the X-ray emission.
2. If the equipment is equipped with a key, remove the key.
3. Place a warning notice on the equipment “DO NOT USE – EQUIPMENT FAULT”.
4. Contact your LSR, PI and the RSO and let them know about the issue so the radiation-producing equipment can be fixed.

## **Laboratory Fires and Explosions**

In the event of a fire or explosion in the laboratory, follow the local fire drill procedures.

Steps to take:

1. **Interrupt X-ray Emission**: Press the red emergency stop button or turn off the key switch to halt X-ray emissions.
2. **Notify Authorities**: Call the Fire Department and inform the Lab Manager and the Research Safety Team.
3. **Restrict Access**: Ensure no one can restart the X-ray generator by removing the key or taking other measures.
4. **Evacuate**: Leave the laboratory in accordance with the local fire drill evacuation procedures.
5. **Report the Incident**: Once the situation is under control, report the incident using the University’s accident reporting system.

It is considered radiologically safe for emergency services to enter Supervised Areas where radiation-producing equipment are used. However, due to the other hazards present in the lab, chemical suits and breathing apparatus may need to be worn when entering these areas.