**Local Rules for the use of**

|  |  |
| --- | --- |
| **Manufacturer**  **Model**  **S/N: Serial Number** | |
| **RUA No.** | **Asset Number** |

**Instructions – delete the box when you are done**

* For SEM/TEM and X-ray analysis equipment – include the text in BLUE
* For CT/Irradiator (equipment that emit x-ray with energy above 50 kV) – include the text in GREEN
* Whenever there is ### you must adapt the text to suit your need

|  |  |
| --- | --- |
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# 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. The Local Rules have been written in compliance with article (57) of the General Instructions on Protection against Ionizing Radiation in the Kingdom of Saudi Arabia (2007).

## **Purpose**

*For SEM/TEM, X-ray Analysis Equipment*

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 such as scanning electron microscopes, x-ray analysis equipment, etc.

*For CT/Irradiator, etc.*

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

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **Asset No** | **Manufacturer & Model** | **Location (e.g. B4-0250)** |
| CT/irradiator | #### | ##### | B# - #### |

**CT –** Computed Tomography. This equipment comprises an x-ray tube that provides high resolution, 3D images of samples. The beam is typically fully enclosed in a shielded enclosure. Output voltage up to 225 kV.

## **Potential Hazards & Risk Assessment**

Please remove point 3 and/or 4 if they don’t apply

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.

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

1. **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.
2. **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.
3. **Compressed gases –** In some cases compressed gases are used as part of the procedure. Please ensure that all gas bottles have the appropriate regulator and are secured to a wall or bracket. For more information see the Compressed Gas Standard (see [Compressed Gas Standard](https://hse.kaust.edu.sa/Services/PublishingImages/Pages/labsafety/Compressed%20Gas%20Standard.pdf)).

## **Area Designation**

*For SEM/TEM, X-ray Analysis Equipment*

Laboratories where x-ray equipment emitting x-rays with energy below 50 kV and which are fully enclosed (e.g. electron microscopes, x-ray analysis equipment, etc.) are designated as Non-Designated Area. There is no special restriction on access to the Non-Designated Area but x-ray equipment should be marked with a radiation hazard trefoil sign. In addition, only authorized users, who have gained permission through training, are allowed to operate the equipment.

*For CT/irradiator*

The laboratory detailed above is designated as **Supervised Area** when the x-ray emitting device is switched ON. The area is defined by the structure of the room, including doors and windows.

A warning sign should be placed at each entrance to the Supervised Area and the device shall only be used by authorized radiation users, who have gained permission through training.

# Training

*For SEM/TEM, X-ray Analysis Equipment*

It is the responsibility of supervisors and/or PI to ensure that their students, postgraduates, research scientists, etc. are adequately trained in the safe use of the radiation-producing equipment prior to the commencement of the work. The appropriate safety training courses are detailed in table 1.

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

|  |  |
| --- | --- |
| **Radiation-Producing Equipment used** | **Training required** |
| Electron microscopes | * HSE-150 SEM/TEM Training * Practical operation training for the radiation-producing equipment |
| X-ray analysis equipment (e.g. x-ray diffraction, x-ray photoelectron spectroscopy, etc.) | * HSE-151 X-ray Analysis Equipment Safety Training * Practical operation training for the radiation-producing equipment |

*For CT/irradiator*

It is the responsibility of supervisors and/or PI to ensure that their students, postgraduates, research scientists, etc. are adequately trained in the safe use of the equipment prior to the commencement of the work. The appropriate safety training courses consist of:

* HSE-151 X-ray Analysis Equipment Safety Training
* Practical operation training for (describe equipment)

Upon completion of these trainings, and acceptable score on the written examinations, users can ask their PI or LSR to add them on the authorized users list. Note that for Core Lab and few other labs, authorized users will be added to the Badger System.

Training can be taken [online](https://blackboard.kaust.edu.sa/webapps/login/) or arranged on demand with the Research Safety Team ([researchsafety@kaust.edu.sa](mailto:researchsafety@kaust.edu.sa)).

# Personnel Monitoring

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

*For SEM/TEM, X-ray Analysis Equipment*

All users of the radiation-producing equipment which have an enclosed and shielded x-ray beam are regarded as non-classified workers; i.e. the general public dose limits and accepted dose limits apply to them. The article (80) of the general regulations states the annual dose limits for members of the public. A summary of these limits is shown in Table 2.

**Table 2.** Non-classified workers radiation dose limits set by K.A.CARE and accepted dose levels set at KAUST.

|  |  |  |
| --- | --- | --- |
|  | **Non-Occupational worker and General Public** | **Non-occupational exposure accepted level set at KAUST** |
| **Whole Body** | 1 mSv/year | 1 mSv/year |
| **Lens of the eye** | 15 mSv/year | 15 mSv/year |
| **Extremities** | 50 mSv/year | 20 mSv/year |

For staff members, designated as non-classified workers, accepted dose limits are set (see Table 2). The accepted 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.

The article (51) also sets an exposure limits for the fetus of pregnant women to 1 mSv from the declaration of the pregnancy.

*For CT/irradiator*

All users of the CT scanner mentioned above are considered classified workers; i.e. the occupational dose limits set in article (80) of the regulations apply to them. In addition, KAUST has set accepted dose levels; these are not an absolute limits but are intended to provide guidelines to ensure doses are kept as low as reasonably achievable. If the accepted dose levels are exceeded, an investigation by the RSO will be carried out. In addition, it is important to note that this radiation-producing equipment is equipped with sufficient engineering control measures which means that radiation doses to individuals are not expected to exceed the general public dose limits set in the regulations. A summary of these limits is shown in Table 2.

Table 2: Classified workers radiation dose limits set by K.A.CARE and accepted dose levels set at KAUST.

|  |  |  |
| --- | --- | --- |
|  | **Occupational dose limits set by K.A.CARE** | **Occupational accepted dose levels set at KAUST** |
| **Whole Body** | 20 mSv/year | 1 mSv/year |
| **Lens of the eye** | 20 mSv/year | 15 mSv/year |
| **Extremities** | 500 mSv/year | 50 mSv/year |

The article (51) also sets an external exposure limits for the pregnant women to 2 mSv from the declaration of the pregnancy.

## **Personnel Monitoring**

*For SEM/TEM and X-ray Analysis equipment*

Workers using fully enclosed x-ray systems in Non-Designated Area are not expected to receive a radiation dose above background level because of the engineering controls in place. As a result, they do not require personal dosimeters. However, the radiation-producing equipment is subject to area dosimetry monitoring to confirm that non-classified workers are unlikely to exceed the accepted dose levels set at KAUST. All area monitoring will be kept on file.

*For CT/irradiator*

Workers using fully enclosed x-ray systems in Supervised Area are required to wear whole body personal dosimeter issued by Research Safety Team. The whole body personal dosimeter should be worn attached to the lab coat top pocket or trousers’ belt, and returned on the specified dates to the LSR.

## **Pregnant staff**

Whilst pregnant workers are not generally banned from working with devices producing ionizing radiation, it is extremely important that female members of staff and students are informed of the importance of declaring any pregnancy. Only after such declaration can steps be taken to restrict any exposure of the fetus to ionizing radiation.

For the majority of mothers-to-be, there will likely be no requirement to alter their work activities / research practices involving ionizing radiation.

# Maintenance Plan

*For SEM/TEM and X-ray Analysis equipment*

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

* General maintenance of the equipment shall be carried out only by manufacturer’s engineer or authorized users who have been trained to perform these maintenances on the equipment (e.g. beam alignment, filament replacement, vacuum pumps checks, etc.). However, authorized users are not allowed to work with open x-ray beam;
* A service engineer from the manufacturer’s equipment or sub-contractor may be contracted if work on open x-ray beam are required.

*For CT/irradiator*

Provide actual details of the maintenance plan for the equipment: for example general maintenance will be done by LEM, maintenance of the x-ray tube will be done when required by the manufacturer only, etc.

# Safety Measures

## **Safety Features**

*For SEM/TEM or X-ray Analysis Equipment – For CT/Irradiator (you must select the one that apply and add the one in green)*

The radiation-producing equipment should be fitted with many radiation protection features. Understanding these features is the most important step to ensure radiation safety. Note that the list below includes most safety features and that some equipment may not be fitted with all of these.

* X-ray tube housing - The x-ray tube is enclosed in a tube housing that cannot be fractured or deformed by normal use, accidental impact or misuse.
* X-ray energized warning indicator (light) - indicates when the x-ray tube is in operation and x-rays are generated and emitted in the chamber/enclosure.
* Key operated system – the system can be disable by removing the key.
* Enclosure - It houses the animals or samples and prevents accessing the primary x-ray beam. The enclosure is constructed of appropriate materials (e.g. steel, lead, lead glass, etc.) to attenuate x-ray radiation during operation.
* Interlocks - Safety interlocks microswitches are fitted on the irradiator to ensure that users cannot be exposed to a primary or diffracted beam of x-ray radiation. Any attempt to open the chamber/enclosure, when the x-ray tube generates x-rays, will lead to the system being de-energized immediately. Users shall not operate the irradiator when the safety interlocks have been disabled unless they have been trained to do so.
* Push-off button (Red Push Button) – the radiation-producing equipment may be equipped with push-off buttons to shut down the electric power. This button is typically Red and should be labeled with “Emergency Stop”. Users should know its location and must only be used it in case of emergency.
* Service/disruption Notice – When a user finds a problem of operation or safety, he/she must shut down the unit, put a notice in front of the unit and then inform the LSR or PI. When users find a warning notice has been placed on the irradiator, DO NOT use that unit until you are told it is safe to use by the LSR, PI and/or RSO.
* Shielding integrity and inspection of the equipment is carried out on a yearly basis or whenever required (e.g. after maintenance, etc.). Records of the results are kept on file.
* Maintenance – Regular maintenance of the system by KAUST staff and/or manufacturer’s service engineers ensure that the radiation-producing equipment operates safely.
* Warning signs – Warning signs should be clearly displayed at the entrance of the laboratory.

## **Systems of Work**

*For SEM/TEM or X-ray Analysis Equipment*

**Access to the area**

* Access to the laboratory may be restricted via card reader access or pin-coded door;
* Some equipment may have their access restricted via log-in code.

**Protection of staff and visitors**

* Only authorized users may operate the radiation-producing equipment;
* The person operating the radiation producing equipment is responsible for the safety of others who work in the area;
* When entering the room follow the lab safety plans policy toward PPE use;
* Users MUST NOT defeat the safety interlock and expose themselves or any other person to radiation;
* If you are pregnant, then you are encouraged to notify the RSO, in confidence.
* Notify the LSR, PI and RSO immediately if there is any reason to believe that any person may have been exposed to radiation accidentally.

*For CT/Irradiator – use the one that applies and add points that are not included.*

**Access to the area**

* All persons must observe notices at the entrance to the Supervised Area;
* Access to the laboratory is restricted via the use of pin-coded doors;
* Service engineers external to KAUST should be asked to sign the handover form before they start work, and again before they leave. They are then operating the CT scanner under the Local Rules prepared by their company.

**Protection of staff and visitors**

* Only authorized users may operate the #######;
* The person operating the ### is responsible for the safety of others who work in the area;
* Take note of all warning signs before entering the room;
* When entering the room follow the lab safety plans policy toward PPE use;
* Users MUST NOT defeat the safety interlock and expose themselves or any other person to radiation;
* All authorized users must wear all personal dosimeters issued to them at all times when operating the #####;
* If you are pregnant you are encouraged to notify the RSO, in confidence;
* Notify the LSR, PI and RSO immediately if there is any reason to believe that any person may have been exposed to radiation accidentally.

## Standard Operating procedures

These can be found in a separate document that is kept in the lab.

# **Emergency Procedures**

Use as it is for *SEM/TEM or X-ray Analysis Equipment - For* CT/Irradiator just keep the points that apply to the device.

## **Radiation Incident**

Where a radiation accident is accompanied by serious personal injury, treatment of the injury takes precedence over equipment fault. However, it is necessary to turn off the system by pressing the red emergency button (if there is one). Immediate medical assistance can be obtained by dialing 911 from a landline or 012 808 0911 from a mobile phone.

Please follow the steps below:

1. In an emergency interrupt the x-ray emission by hitting the Red emergency stop button, or turning the key switch off.
2. Deal with life threatening conditions first. Summon someone trained in First Aid if necessary.
3. Stabilize the Situation: If possible, return to the radiation-producing equipment, ensure it is switched off and that the x-ray source is electrically isolated.
4. Prevent Access: Ensure that no one is able to restart the x-ray generator. Post appropriate warning messages on the machine and remove the keys.
5. Contact your LSR, PI and RSO and let them know what has happened. If the equipment has been damaged in any way seek advice before using the equipment again.
6. After the incident has been satisfactorily dealt with you will need to report the incident using the university’s accident reporting system ([Report it](https://apps.kaust.edu.sa/sites/reportit/Pages/InitialForm.aspx)).

## **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 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 affecting the laboratory, local area fire drill procedures should be followed.

Please follow the steps below:

1. In an emergency interrupt the x-ray emission by hitting the Red emergency stop button, or turning the key switch off.
2. Call the Fire Department and inform the Lab Manager and Research Safety Team.
3. Prevent Access: Ensure that no one is able to restart the x-ray generator (e.g. by removing the key).
4. Evacuate the laboratory according to the local area fire drills.
5. Report: After the incident has been dealt with in a satisfying manner you will need to report the incident using the University’s accident reporting system.

It is considered radiologically safe for emergency services to enter Non-Designated and 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.

**Document History**

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| --- | --- | --- |
| **Revision #** | **Details of Significant Changes** | **Date (dd/mm/yyy)** |
| 0 | First version | 28-Aug-2018 |
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