

كلية العلوم الطبية التطبيقية

قسم علوم الأشعة

لجنة المعامل والسلامة

Labs Safety Manual
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1- Purpose and Scope

This Labs Safety Manual builds the framework for creating a safe working environment for faculty, staff, students, and volunteers that may use the department's labs.

X-rays are a type of ionizing radiation. Radiation is considered ionizing when the energy is high enough to produce ions by breaking molecular bonds and displacing (or removing) electrons from atoms or molecules. Ionizing radiation has a number of beneficial uses that include cancer treatment, medical equipment sterilization, and scientific research. However, unsafe use of ionizing radiation is potentially harmful and can result in permanent effects on DNA, severe skin or tissue damage, and cancer (Fig 1).

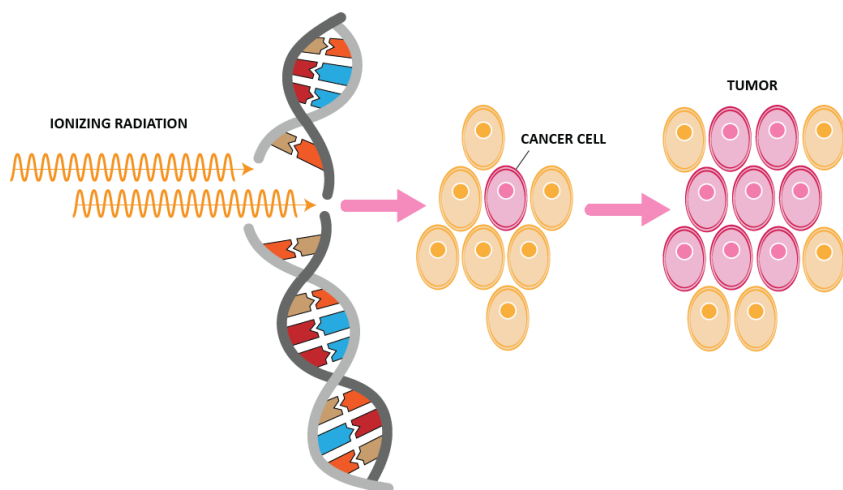


Figure 1 DNA damage by ionizing radiation

Examples of research devices that produce X-ray radiation used at the department's labs include:

X- Ray Simulators

CT Simulator

Medical X- Ray

This Labs Safety Manual contains procedural guidelines and information for prudent work practices while using any of these devices at radiology sciences department. The manual is made available to every Lab.



2- Roles and Responsibilities

Labs and Safety Committee (LSC)

The Labs and Safety Committee (LSC) ensures that radiological sciences labs are used safely and in accordance with NRRC and Taif university regulations. The LSC members are appointed by the radiological sciences department head.

The LSC has the authority to:

1. Disapprove all work that does not meet the university policies and the NRRC;
2. Terminate the use of labs by individuals who do not comply with all regulations and policies; and
3. Apply other restrictions on the use of labs to comply with all regulations and policies.

Lab User and Lab Supervisor

The Lab User and Lab Supervisor are the individuals responsible for radiation safety associated with operating x-ray machines and using the lab. The Lab Supervisor maybe the Lab User or an individual trained and experienced who is appointed as the Lab Supervisor by the LSC.

In addition to complying with all regulations, policies, and the Labs Safety Manual, it is the responsibility of the Labs Supervisors to:

- Provide:
 - Proper maintenance and documentation of the maintenance of the lab based on the manufacturer's recommendation.
 - Instructions and training on safe and proper practices to all persons working with or around the lab.
 - Emergency procedures.
 - Necessary equipment for safe work with the lab.
- Maintain adequate control of the lab to ensure that areas beyond the LSC control are not adversely affected by its use.
- Properly label the lab and the areas where it is located.

Lab Users

- Notify the LSC of any accident or abnormal incident involving or suspected of involving radiation.
- Inform the LSC of:
 - Any changes in personnel and any significant changes in the lab or procedure.
 - Plans to relocate, dispose or loan the equipment/machines/items.
- Ensure initial training of:
 - Radiation and related safety procedures to the lab.
 - Device-specific safety procedures through training by the manufacturer or an experienced and qualified user.
- Prepare Standard Operating Procedures(SOPs), including Safe Work Practices for all routine processes involving the lab.
- provide lab safety checklist regularly.
 - Determine and document the personalprotective equipment (PPE) needed for each lab. The Lab Users must follow the direction of the Lab Supervisor. Additionally, it is the responsibility of the lab Users to:
 - Comply with the requirements outlined in this manual and all university safety policies.
 - Know the emergency procedures.
 - Work in labs only after receiving initial radiation safety training and device-specific training and passing the radiation protection course 374212-2.
 - Report any unsafe practices to the Lab Supervisor and the LSC.
 - Notify the LSC of any accident or incident involving or suspected of involving radiation



3- Authorization

Training

All individuals who work in the labs (with the exception of Ultrasound machines), or work in the vicinity of the labs must be educated about the potential health hazards of ionizing radiation as well as methods and procedures to minimize radiation exposure.

All individuals (including the Lab Supervisor, and Lab Users) must complete a radiation safety training course/module and a device-specific training prior to working in labs. Successful completion of the courses is a prerequisite for working in labs at the department.

Lab Supervisors may be exempted from Radiation Safety Training course provided that they:

- Have documentation of equivalent training at another institution.
- Are able to pass Radiation Safety Quiz successfully.
- Have practical experience with the equipment in the labs.

All Labs Users must attend the Radiation Safety Training or pass radiation protection module 374212-2. The Lab Supervisor is responsible for ensuring all Lab Users are trained in safety practices.

Human Use

Lab users who wish to use the lab for medical purposes or to conduct human use research must comply with the acceptable training and experience guidelines by the university of Taif and provide ethical approval.

Only certified Radiologic Technologists are to be supervised by physicians with valid operator Permits for any use of X-rays on humans (whether clinical or research).

Documentation

All training or education that employees receive must be documented and maintained on file for review by the Radiation Safety Program.

Radiation Use Authorization (RUA)

Radiation Use in Animals

All protocols involving the use of a Lab on a live animal require valid ethical approval.

Radiation Use in Humans

All protocols involving the use of a Lab on humans require valid ethical approval.



4- Required Safety Measures

Hazard Communication in Labs

All labs must be labelled as follows:

- A label or sign that reads “Caution Radiation Hazard” must be placed at the entrance of any lab containing a radiation/X-ray machine at eye level.
- A label or sign that reads “Warning; Pregnant women should not enter” must be placed at the entrance of any lab containing a radiation/X-ray machine at eye level.
- A label or sign that reads “No eating or drinking in this laboratory” must be placed at the entrance of any lab containing a radiation/X-ray machine at eye level.
- A label or sign that reads “Electrical Hazard” must be placed at power generators, power supplies or where an electrical hazard is presented.



Figure 2 Radiation hazard sign.

Safe Operation

For safe operation of a lab, ensure that:

- All unused X-ray ports are closed.
- Both the warning lights and the meters on the console are checked prior to opening a shutter or beginning X-ray production.
- An energized X-ray machine is never left unattended unless the room is locked for warming up procedure.
- Proper PPE is worn in the laboratory, especially around electrical equipment.
- No part of the body is exposed to the primary beam.

Repairs and Preventative Maintenance (PM)

Do not attempt to repair faulty X-ray equipment. Always consult the vendor. Trainees are not allowed to press the X-ray exposure switch without consulting an experienced person.

All labs equipment must be continually maintained to ensure safe operation based on the manufacturer's recommendations. Maintenance records demonstrating compliance shall be maintained for three years and available for inspection.

Shielding

The utilization of shielding (see Figure 3) and access control is dependent on the procedure type. All X-ray units have integral shielding and usually require no additional shielding. However, some procedures require a shielding apron. Other protective items are presented in labs.

In research work the radiation shielding plan should be revised by the LSC and measurements should be conducted by the LSC to ensure safe exposure levels.



Figure 3 Lead aprons

Personal Protective Equipment (PPE) and Laboratory Hygiene

In place when working with hazardous materials and equipment. All university personnel (including all students and employees) who enter or work in laboratories and other areas that contain hazardous materials, including chemicals, biological agents and radiological materials or dangerous equipment must at a minimum, wear full-length pants (or clothing that otherwise fully covers the legs and ankles) and closed toe/heel shoes.

1. Wear personal whole-body dosimeters TLD as required and issued by the LSC.
2. When working around unshielded radiation-producing devices, it is recommended that you wear lead aprons and thyroid collars. It is also recommended that all protective aprons or gloves be inspected frequently. Look for visible damage and feel for sagging and deformities on the PPE. Remove any PPE from service if damage, sagging, or deformities are apparent.



5-Limits of Exposure

Annual Occupational Dose Limits

The occupational radiation dose limits are specified in IAEA safety standard No.RS-G-1.1, ICRP Publication 103 and are summarized in Table 5.1. Radiation workers that are expected to receive 10% of the defined limits will be monitored through external and internal dosimetry.

Table 5.1. Annual Dose Limits

Dose Term	Dose Limit
Whole Body	5 rem/yr
Lens of Eye	15 rem/yr
Skin, organ, or extremities	50 rem/yr
Minors	10% of the above specified limits for adult workers
Embryo/fetus of a Declared Pregnant Woman	0.5 rem/entire pregnancy*

*Avoid substantial variation above a uniform monthly exposure rate of 0.05 rem/month during the entire pregnancy

Declared Pregnant Radiation Workers

A Declared Pregnant Radiation Worker (DPRW) is a woman who has voluntarily informed her immediate supervisor in writing of her pregnancy. The DPRW has the option to:

- Refer to Regulatory Guide 8.13 "[Instruction Concerning Prenatal Radiation Exposure](#)", published by the Nuclear Regulatory Commission (NRC), for a detailed discussion to inform her decision.
- Discuss her pregnancy confidentially with the LSC if she has further questions following her review of the Regulatory Guide.
- Declare her pregnancy by using the "[Form Letter for Declaring Pregnancy](#)".
- Rescind her declaration at any time.

Once the radiation worker declares her pregnancy:

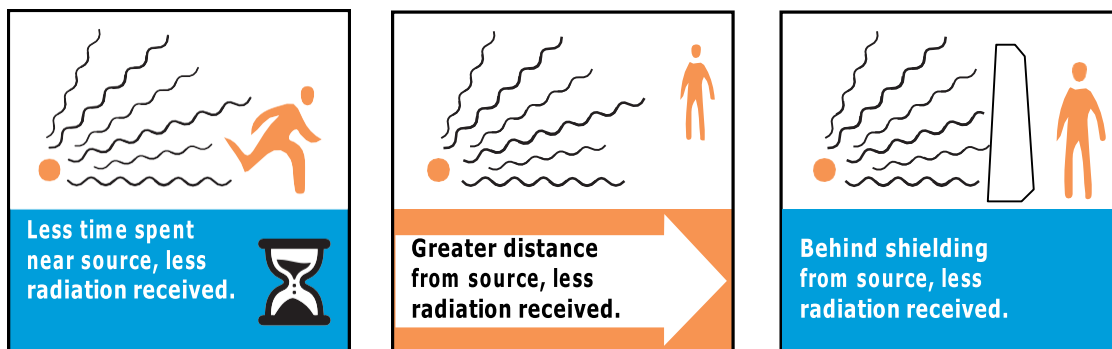
- The lower occupational dose limit of 500 mrem during the entire gestation period is enforced with no substantial variations above a uniform monthly exposure rate.

As Low As Reasonably Achievable (ALARA)

Prevention (or mitigation) of radiation exposure to individuals well below the annual limits is espoused by the ALARA principle i.e., *As Low As Reasonably Achievable*.

ALARA is the effective use of Time, Distance, and Shielding to mitigate or eliminate exposure (see illustration below).

- **TIME:** Plan experiments to minimize time spent around radiation.
- **DISTANCE:** Maximize the distance from the primary X-ray beam and the device when using an XPD.
- **SHIELDING:** Use shielding to effectively reduce radiation exposure when working in close proximity to a radiation source.



Source: NRC



6- Personnel Monitoring & Dosimetry

Personnel likely to receive a dose in excess of ten percent (10%) of the annual limit for occupational workers must wear a personal monitoring device TLD. The LSC mandates that personal monitoring devices will be worn at labs by anyone who frequently works in the vicinity of a lab, with the exception of working with ultrasound machines.

The LSC will make the final determination whether personal monitoring is required. The LSC may remove the requirement if dosimetry records indicate only minimal exposure over a period of at least one year.

Dosimetry Monitoring Devices

The sole purpose of dosimetry monitoring devices TLD (Fig 4) is to record radiation exposure. They do not shield the wearer from the hazardous effects of radiation. Dosimeters are exchanged every quarter as assigned.

All dosimeters are commercially processed, and the exposure reports are sent to the LSC for review. Any exposure that exceeds Investigation Level I (see Table 6.1) will be reviewed by the LSC and will report the results to the radiology sciences department.



Figure 4 TLDs

Any exposures above Level II (see Table 8.1) will be investigated by the LSC who will take appropriate action if warranted. Appropriate actions taken will include steps to prevent a recurrence. Any individual may receive a copy of his/her exposure history by requesting it in writing from the Radiation Safety Program.

Tampering with TLD badge will be investigated and reported by the LSC to the radiology sciences department to take action. Also, losing/unintentionally damaging the TLD will be fined 450 Saudi riyals.

Table 6.1. Investigation Levels

Body Part	Level I	Level II
Whole Body, Head and Trunk, Active Blood-Forming Organs, Lens of the Eye, or Gonads	125 mrem/quarter	375 mrem/quarter
Hands and Forearms, Feet and Ankles	1,875 mrem/quarter	5625 mrem/quarter
Skin of Whole Body	750 mrem/quarter	2,250 mrem/quarter

Note that investigation levels are not new dose limits but serve as checkpoints above which the results are considered sufficiently important to justify investigations.

Proper Use and Care of Dosimeters

- Dosimeters are worn between the waist and the collar underneath the lead apron with the name showing and must be worn at all times while on duty (Fig 5 and 6). If a lead apron is worn, the badge will be worn at the collar outside the apron. NOTE: Individuals who wear an apron, thyroid shield, and eye shield of at least 0.25 mm lead equivalent (0.5 mm for individuals working around fluoroscopic machines lacking lead drapes) may submit a written request for a variance to wear their badge under their apron.
- Leave the dosimeter in a safe place when not on duty. Make sure it is away from all sources of radiation. **DO NOT** take personal dosimeters off campus unless the LSC is notified.
- Never wear a dosimeter issued to another person or share your dosimeter with anyone else.
- Remove dosimeters from lab coats/aprons before sending them to a professional laundry service.
- Return the dosimeter at the proper time to exchange it for a new one.
- Do not tamper with the dosimeter.
- A replacement must be obtained from the LSC immediately if the dosimeter is lost or damaged. Obtain and complete a "[Violation form](#)" from the Clinical Training Committee. Exposure is assessed for the time period lost and added to the wearer's personal exposure history.
- **Report any accidental exposure incident to the Radiation Safety Program immediately.**
- Do not wear the dosimeter if one is undergoing any medical procedure that involves radiation or radioactive material.



Figure 5 correct position TLD below apron



Figure 6 incorrect position TLD below apron

Return of Dosimeters

Return personal dosimeters to the LSC by the fifth working day of the new wear period. Users that do not return dosimeters will receive a "[Violation form](#)" and will be instructed to return either the completed form or the dosimeter by the fourteenth working day of the month/quarter.

If either the dosimeter or the form is not returned by the fourteenth working day, the LSC will notify the user's

Department Chair that the user is not permitted to operate or involve in any clinical training/research work until the dosimeter or form is returned. Exemptions will be granted on an individual basis for individuals on vacation, sick leave, etc.



7- Tests and Inspection Program

Leakage Surveys

After the initial set up and after each major change in experimental set up, the Radiation Safety Office will visually inspect each X-ray port and survey the lab for scattered or leakage radiation. The LSC is responsible for notifying the radiology sciences department of any events which may require any additional leakage survey or suspending the lab work.

Routine equipment surveys are recommended to ensure the equipment is functioning properly. The lab supervisors will perform leakage surveys annually as a part of each inspection.



8- Emergency/Injury & Incident Reporting

Lab Emergency

If an injury results from exposure in the labs contact LSC immediately (Mr Alghorabi tel: 0544436658)

If labs equipment or related safety system (including safety alarms and interlocks) malfunctions, take the following actions:

1. Exit the room immediately. Evacuate the room if others are present.
2. Contact the LSC.
3. Lock doors, post a warning sign, and have the area guarded at a known safe distance to ensure against accidental exposure.

Injury/Incident Reporting

It is essential for trainees, Lab supervisors or other laboratories/department personnel to notify the radiology sciences department as soon as possible in the event of the following:

- Exposure to harmful material (chemical, biological, or radiological) or radiation
- Eye injury or exposure, regardless of how minor it may appear
- Needlestick injury
- Chemical or thermal burn
- Cuts or lacerations, if there is significant bleeding, stitches are required, or there are complications such as hazardous materials contamination or embedded broken glass.
- Concussion (actual or suspected)
- Fracture
- Dismemberment
- Death
- Any event requiring transport to a hospital, e.g. sudden illness

Non-Serious Injury or Illness Reporting

Even if an injury or illness does not meet the requirements for emergency reporting, it is important that the affected employee receives proper care. Contact the LSC for any assistance.

Near Misses

A near miss is an unanticipated event that did not result in harm/injury but had the potential to do so.

Examples would be:

- Failure of a safety interlock
- Unauthorized use of a lab and radiation equipment.
- Known or suspected excess radiation exposure to the general public or lab personnel
- Loss or damage to personnel dosimeters

Notify the LSC (Mr. Alghorabi tel: 0544436658) immediately when any of these events occur. The LSC will maintain a database of accidents and near misses for educational purposes to increase user awareness of potentially hazardous situations.

Incident Investigation

Upon being notified of a laser safety incident, the LSC (or designee) will conduct an accident investigation which includes the following:

- Interviews with injured trainees/workers and witnesses
- Examination of the workplace for factors associated with the accident/exposure
- Determination of possible cause(s) of the accident/exposure
- Corrective action(s) to prevent the accident/exposure from recurring
- Documentation of the findings and corrective actions taken

If an incident results in significant injury, is a “near miss” (i.e., could easily have been much more severe), or reveals systemic problems in safety management and culture within a research group, then the report maybe circulated more widely, with appropriate recipients potentially including:

- Department/college/University
 - Safety Officer/Coordinator (when position exists)
 - Senior management (Head of Department, Dean, Vice Deans)
 - Safety committee chairperson

The purpose of the LSC is to clarify what happened and to identify contributing factors, in order to learn lessons and thereby improve future safety. Incident reports will normally contain specific recommendations for addressing any safety deficiencies or contributing factors identified during the investigation. Students/workers and laboratory personnel needs to understand that LSC incident investigations are not intended to be punitive or to apportion blame. Personnel are expected to cooperate fully with LSC in any incident investigations by providing full and accurate information.