RADIATION SAFETY MANUAL

RADIATION-PRODUCING DEVICES (UKHC)

UNIVERSITY OF KENTUCKY

POLICIES AND PROCEDURES FOR AUTHORIZED USERS

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ISSUED BY

UNIVERSITY OF KENTUCKY
RADIATION SAFETY COMMITTEE

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CHAPTER 1

PREFACE

The University of Kentucky strives to provide a safe and healthful environment for all persons associated with the University, including faculty, staff, students, and visitors. Attainment of this goal requires the cooperation and commitment of all persons involved.

The University emphasizes safety education and training as the primary means of achieving this goal. While the Radiation Safety Office, the department responsible for radiation safety functions within the University, provides training and performs periodic safety inspections, department heads, faculty members, and supervisors are directly responsible for maintaining an atmosphere that promotes full compliance with University safety policies and procedures.

With regard to radiation safety matters, the Radiation Safety Committee, appointed by the President, establishes radiation policies and procedures for the University in accordance with requirements set forth by State and Federal regulatory agencies. Responsibility for carrying out these policies and procedures rests with the Radiation Safety Officer, who directs the Radiation Safety Office.

Essential elements of the University's radiation safety program are presented in this Radiation Safety Manual. The safety program has been carefully developed to assist all radiation users in utilizing the unique advantages of radiation sources while meeting their safety responsibilities in as efficient and non-intrusive manner as possible. In addition, radiation safety philosophy and regulations include an objective of maintaining all exposures at levels as far below regulatory limits as can reasonably be achieved. The University strongly supports this "As Low As Reasonably Achievable" (ALARA) safety goal. The policies and procedures found in this manual were designed to promote the achievement of this goal.

In this era of increasing concern for occupational safety and for the environment, it is essential that all members of the University community become and remain thoroughly familiar with their responsibilities for compliance with health and safety regulations, including these radiation safety policies and procedures. Please study the contents of this manual. Know and practice these and all other safety rules. Thank you for your cooperation.

CHAPTER 2

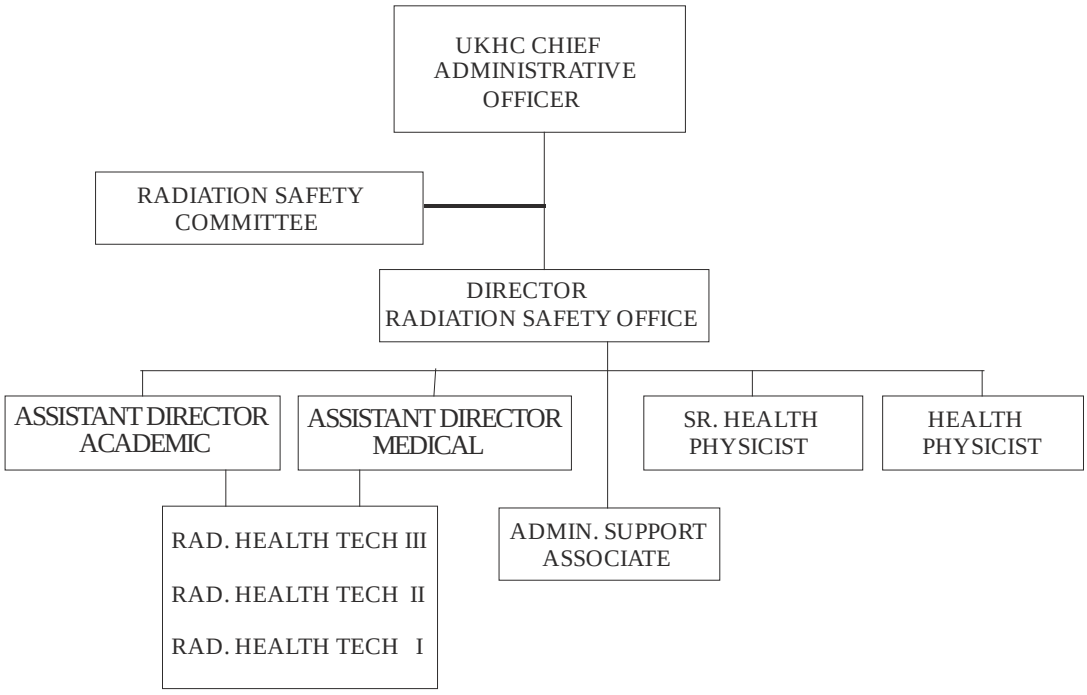
UK RADIATION SAFETY PROGRAM

INTRODUCTION

The Kentucky Cabinet for Health Services, Radiation Health and Toxic Agents Branch, authorizes the University of Kentucky to use radiation-producing devices in operations, education, research and development activities. The University's Radiation Safety Committee promulgates any policies and procedures for the safe use of these devices. It is the responsibility of clinical users, research investigators and administration to ensure that radiation-producing devices are used in accordance with established policies, procedures and regulations.

This manual summarizes the terms of the University's safety program for the safe use various radiation producing devices. A copy must be available in each use department or facility where radiation-producing devices are used. Copies of special precautions, regulations, and other operating procedures specified by the Radiation Safety Committee or Radiation Safety Officer must also be maintained. Everyone involved with the use of radiation-producing devices in any way is required to be familiar with the provisions of this manual.

MEDICAL CENTER X-RAY RADIATION SAFETY ORGANIZATIONAL CHART



Responsibilities

Radiation Safety Committee:
The Radiation Safety Committee is responsible for establishing policies governing the procurement, use, storage and disposal of radiation-producing devices. The Committee includes individuals experienced in the use of radiation sources in medicine and research at the University. The Committee consists of a Chairman, Radiation Safety Officer, representatives of management and nursing service, and four members each from the medical and main campus sectors. Committee duties include:

- Monitoring the institutional program to maintain occupational doses as low as reasonably achievable (ALARA).
- Reviewing and approving or disapproving an individual who is to be listed as the radiation safety officer submitting a registration application.
- Reviewing and approving or disapproving proposed research uses of radiation devices.
- Reviewing and approving, with the advice or consent of the Radiation Safety Officer and the management representative, or disapproving, procedures and radiation safety program changes prior to submittal to regulatory agencies.
- Reviewing quarterly, with the assistance of the Radiation Safety Officer, occupational radiation exposure records of personnel working with radiation.
- Establishing a table of occupational dose levels that, if exceeded, shall initiate investigations and considerations for action by the Radiation Safety Officer.
- Reviewing quarterly, with the assistance of the Radiation Safety Officer, radiation incidents with respect to cause and subsequent actions taken.
- Reviewing annually, with the assistance of the Radiation Safety Officer, the radiation safety program.

The Committee meets at least once each calendar quarter. The Committee and its Chairman, is appointed by the President as a sub-committee of the Environmental Health and Safety Committee, to which it provides reports at least annually.

Radiation Safety Officer:
The Radiation Safety Officer has administrative responsibility for the University's radiation safety program. The Radiation Safety Officer provides a wide range of specific radiation protection services such as personnel monitoring, facility surveys, maintenance of records required by the State, consultation on the safe use of radiation producing devices and training.

The Radiation Safety Officer reviews all research applications for radiation-producing device use, as well as location, procedure and disposal. The Radiation Safety Officer recommends approval or disapproval to the Radiation Safety Committee. The Radiation Safety Officer may approve a change in location or operating procedures. He/she may suspend any project or use that is found to be a threat to health or property.

The Radiation Safety Officer is responsible for investigating overexposures, accidents, losses, thefts, unauthorized receipts, uses, transfers, disposals, and other deviations from approved radiation safety practice, and implementing corrective actions as necessary. The Radiation Safety Officer is also responsible for implementing written policies and procedures for the following:

- authorizing the purchase of radiation-producing devices
- keeping an inventory record of radiation producing devices
- using radiation producing devices safely
- taking emergency action if control of radiation producing devices is lost
- performance of periodic radiation surveys
- performing checks of survey instruments and other safety equipment
- ensure training of personnel who work in or frequent areas where radiation producing devices are used or stored
- keeping copies of records and reports required by state regulations
- assisting the Radiation Safety Committee in the performance of its duties

Owners, Authorized Users

An Authorized User is a faculty/staff employee who has been approved to use radiation-producing devices by the Radiation Safety Committee. In the Medical Center / Hospital, the Owner (Authorized User) is normally the department chairperson or unit director. Authorized Users are responsible for ensuring that staff and students using radiation producing devices under his/her authorization are trained in safe clinical and laboratory practices, and are complying with University policies and applicable regulations. The Radiation Safety Office offers periodic training sessions to assist the Authorized User in this regard. The Authorized User will normally be the department head or unit director in clinical areas, or the principal investigator of a research project. Although faculty members may use radiation-producing devices under another faculty member's authorization, each faculty member is encouraged to obtain his/her own authorization.

Questions regarding radiation-producing device registration, type, use and location should be directed to the Radiation Safety Officer, 323-6308.

VENDOR RADIATION SAFETY

All vendors, who sell or service radiation-producing equipment at UK, must have a radiation safety program that includes at least the following:

Education about risks and hazards
Appropriate use of PPE
Radiation monitoring (personnel) program and record keeping

The vendors must provide program documentation to the University upon request.

Vendor representatives who are in the room during radiation-producing procedures must wear monitoring devices, appropriate aprons and other shielding, and other PPE appropriate to the situation.

The company must provide the monitoring devices. The University will provide aprons, shields, and other PPE for use by the vendor representatives.

If the vendor does not need to be in the procedure room, he/she should use the observation window.

Request for Special Safety Investigations

The Kentucky Administrative Radiation Regulations, 902 KAR 100, makes provisions for employees to request an inspection or evaluation of conditions which they believe may constitute a health or safety hazard. University employees are encouraged to report such conditions to the Radiation Safety Office and to request a "Special Investigation" into the need for corrective action. Employees are encouraged to seek resolution of a hazardous condition through the Radiation Safety Office. A person requesting an inspection may request confidentiality and by law, his/her name will not appear on any record or made available to the public, to his/her immediate supervisor, or department head. After the Radiation Safety Office has concluded its investigation, the results will be communicated, in writing, to the party requesting the investigation and to other appropriate University personnel with due consideration of requests for anonymity. If it is determined that there are reasonable grounds to believe a violation or danger exists, corrective action will be initiated. If corrective action cannot be implemented within a reasonable period of time, the Radiation Safety Officer may terminate the operations until corrective action is taken.

CHAPTER 3

ACQUISITION OF A RADIATION-PRODUCING DEVICE

Prior to obtaining a radiation-producing device the facility Authorized User must:

1. Pre-register with the Radiation Safety Office by providing the following information:

    a. Name and address of the person having administrative control and responsibility for the proposed facility.
    b. Location where the device(s) is to be stored or used.
    c. A designation of the general category of proposed use (analytical, dental, medical, industrial, veterinary, or other).
    d. Plans and specifications for the proposed facility and an evaluation by a qualified expert such as required by 902 KAR 100: 160. (The Radiation Safety Office has a qualified expert on staff if needed)
    e. Have the RSO Submit an application for use to the Radiation Safety Committee.

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REGISTRATION

All machines capable of producing ionizing radiation must be registered with the UK Radiation Safety Office. The following types must be registered:

- Academic type x-ray (x-ray diffraction/fluorescence units)
- Dental x-ray units
- Diagnostic x-ray (radiographic, fluoroscopic and other diagnostic or therapeutic units)
- Particle accelerators
- Neutron generators
- Veterinary x-ray
- Any other equipment that may produce ionizing radiation

Owners or principle investigators using x-ray machines shall provide the Radiation Safety Office with documentation of the type, make, model, location, and maximum radiation output of the device before installation. A copy of the radiation survey performed at the installation and acceptance testing shall be maintained for inspection, including exposure rates in all adjacent rooms. Radiation surveys shall be repeated after major maintenance, modification or relocation of the device.

To register the radiation-producing device or accelerator, the owner must provide the Radiation Safety Office with a completed Registered form (Appendix A).

Before installation of an x-ray device, a radiation shielding plan and specifications must be produced and filed with the Radiation Safety Office.

An initial radiation safety survey of the equipment and all adjacent rooms, shall be conducted and a copy maintained by the Owner or principle investigator and the Radiation Safety Office. Similar radiation surveys shall be repeated after major maintenance, modification (such that could affect radiation safety parameters) or relocation. A copy of

the survey will be maintained by the Radiation Safety Office as long as the equipment is owned.

The Radiation Safety Office must be notified prior to any device installation, maintenance, modification (such that may affect radiation safety parameters) or relocation, discontinuation or transfer of a radiation-producing device. Reports of transfer (surplus, sale, gift, etc.) must include the name and address of the transferee.

CHAPTER 4

RADIATION WORKER REGISTRATION AND TRAINING

All radiation workers must complete a **Radiation Worker Registration Form.** This form provides essential information for issuing a radiation monitoring badge, and provides information on training and experience. The Radiation Safety Officer (or his/her designee) will review registration forms and schedule necessary training sessions. The Radiation Safety Office is to be informed of all changes in personnel working with radiation sources. Radiation worker updates should be provided when a worker is added, deleted or transfers to another Authorized User.

Training

All individuals using radiation-producing devices will receive initial radiation safety training offered by the Radiation Safety Office. This training must be completed prior to the issuing of a radiation monitoring badge.

In addition individuals will be trained on the operation of the particular radiation producing device he/she will be using and actions to take in the event of an emergency by the Authorized User or their designated trainer. Training shall be repeated annually.

In some cases, such as with analytical and cabinet x-ray devices, the Authorized User will give the safety training, with the course content approved by the Radiation Safety Office.

Medical x-ray operators are certified by the State and no further training is required when certification is verified.

CHAPTER 5

RADIATION PROTECTION POLICIES AND PROCEDURES

Radiation producing devices do not make anything radioactive and do not produce radiation contamination (certain particle accelerators may be an exception). External radiation exposure is from x-rays only (with the possible exception of clinic or research accelerators). Applying basic radiation control measures can control the external dose.

Radiation Control Measures

Time/Distance/Shielding: The principal objective of radiation protection is to ensure that the dose received by any individual is as low as reasonably achievable (ALARA), while not exceeding the maximum permissible limit. Any one, or a combination, of the following methods may achieve this objective:

Time. Limit the time of exposure. For illustrative purposes, a person entering a relatively high radiation field of 1000 millirem/hr, but for only 30 seconds, would receive a relatively low dose of 8 millirem. The maximum permissible whole body dose is 5000 millirem per calendar year for occupational workers.

Distance. The inverse square law states that radiation intensity from a point source varies inversely as the square of the distance from the source. The formula is:

$$\frac{I_1}{I_2} = \frac{(D_2)^2}{(D_1)^2}$$

where I_1, I_2 = intensities and D_1, D_2 = distances

By increasing the distance between the source of exposure and an individual, the dose received can be significantly reduced. When an individual doubles his/her distance from a source, the dose will usually be reduced by approximately three-fourths.

Shielding. Absorbing material, or shields, can be incorporated to reduce exposure levels. The specific shielding material and thickness is dependent on the amount and type of radiation involved. Lead shielding is generally used for diagnostic and other low-energy x-rays, while concrete and steel are often used with higher energy sources such as accelerators. The Radiation Safety Office will assist in designing and specifying appropriate shielding.

Exposure. The **"strength"** (killivoltage, milliamphreage, etc.) of the radiation source. By reducing the intensity of the radiation used (lowering the current settings on a radiation producing machine), dose can be reduced.

The fundamental objectives of radiation protection measures are to limit exposure to external radiation to levels that are always within the established dose limits, and as low as reasonably achievable.

Exposure Limits

External radiation levels should be kept to less than 0.1 millirem/hr at 5 centimeters from the source surface or source housing and to levels as low as reasonably achievable.

For x-ray sources, the units of roentgens, rads, and rems may be considered equivalent.

Posting and Labeling Requirements

The Radiation Safety Office is responsible for the posting of all lab or room radiation warning signs. It is the responsibility of the Authorized User to ensure the required postings are maintained. The user also must post the **Notice to Employees** Form KR441, and **Emergency Procedures**. A copy of the UK Radiation Producing Devices Safety Manual must be readily available.

Signs that must be posted on entry doors to rooms containing x-ray machines:

OR


Label that must be posted near the controls of x-ray machines:

"WARNING: THIS X_RAY UNIT MAY BE DANGEROUS TO PATIENT OR OPERATOR UNLESS SAFE EXPOSURE FACTORS AND OPERATING INSTRUCTIONS ARE OBSERVED."

Signs that must be posted on mobile or near dental x-ray machines:

OR


Label that must be posted on fluoroscopic x-ray machines:

UK RADIATION SAFETY OFFICE
Fluorscopic Exposure Output Data

Measured By: _____ **Date:** _____

Maximum Exposure Rates

Dose Mode	Roentgen/min	kVp	mA
Normal	_____	_____	_____
Boost	_____	_____	_____

Maximum exposure rate measured with 1/8" lead blocking the image intensifier.

Ion chanber placed: Q **Table Top** Q **30cm above Table or image intensifier**

Inspections

The KY Cabinet for Health Services, the Radiation Safety Office and other safety services inspect x-ray machines periodically for safety practices and regulatory compliance.

CHAPTER 6

PERSONNEL RADIATION EXPOSURE MONITORING

Personnel monitoring devices (film badges, TLD, pocket dosimeters, etc.) are provided by the Radiation Safety Office to measure an individual's radiation exposure from X-ray sources. The standard monitoring device is a clip-on badge or ring badge bearing the individuals name, date of the monitoring period and a unique identification number. The badges are provided, processed and reported through a commercial service company, which meets current requirements of the National Institute of Standards and Technology National Voluntary Laboratory Accreditation Program (NVLAP).

Monitoring Requirements: Radiation protection regulations and UK policy require that appropriate personnel monitoring equipment be provided to individuals who:

- are likely to receive an annual radiation dose in excess of 10 percent of any of the following annual dose limits:
  - Total effective dose equivalent of 5 rems
  - Sum of the deep dose equivalent and the committed dose equivalent to an individual organ or tissue (other than the lens of the eye) being equal to 50 rems
  - Eye dose equivalent of 15 rem
  - Shallow dose equivalent of 50 rems to the skin or to an extremity

- are less than 18 years of age and are likely to receive a radiation dose in any calendar quarter in excess of 1 percent of the doses listed in (1) above.

- are radiation workers and have declared a pregnancy or planned pregnancy.

- enter a High Radiation Area (exposure to greater than 100 millirem in any one hour at 30 cm from the radiation source or from a surface that the radiation penetrates).

- operate analytical X-ray devices (ring and whole body badges).

- meet special criteria as assessed by the Radiation Safety Officer or his/her delegated representative.

Procedures for Monitoring Devices: Authorized Users must file a Radiation Worker Registration Form for each individual who may work with radiation sources or radiation producing devices. This form provides for the basic information regarding training and experience and personnel monitoring needs. Initial personnel monitoring decisions will be based on this information. Further evaluations, and re-evaluations, will be made through radiation employee registration updates, application reviews, personnel monitoring reports, ALARA investigations, surveys and individual interviews by responsible Radiation Safety staff members.

Badges may be exchanged on a monthly or quarterly basis. Badges must be returned to the Radiation Safety Office by the tenth of the month so that they may be properly processed.

The Radiation Safety Officer may require the use of pocket dosimeters, ring badges, or other monitoring devices when particular procedures are in operation.

The Radiation Safety Office will request prior radiation dose histories from all past employers and will maintain all personnel occupational radiation dose records.

It will be the responsibility of each individual badge recipient to wear and use the badge(s) properly. Authorized Users are responsible for assuring their radiation workers are wearing badges appropriately and that badges are returned on time for processing. Authorized Users/radiation workers may be penalized for late or lost badges.

Use of Personnel Monitoring Devices: The whole body badge (or other device), is to be worn on the body where it will most likely approximate the radiation exposure to the head and torso of the wearer. A badge assigned for whole body monitoring is not to be used to monitor the extremities (hands, forearms, feet, ankles). Separate badges must be assigned for extremity monitoring. Only the individual assigned the badge shall wear it and only at University of Kentucky or other approved facilities.

Generally, whole body badges are to be worn between the waist and the neck. When a protective apron is worn, the badge is to be worn at the collar, outside the apron. The Radiation Safety Officer should be consulted for advice in these circumstances.

Extremity monitoring badges (rings) are available in large or small sizes for the right or left hand or both. Ring badges should be worn whenever working with applicable sources.

Exposure of a personnel monitoring device to deceptively indicate a dose delivered to an individual is prohibited by state regulations.

Personnel Monitoring Reports: Exposure reports are currently monthly and quarterly. Each report includes the name, monitoring period date, dose (millirem) for the immediate past period, current calendar quarter and calendar year.

The personnel monitoring reports are on file in the Radiation Safety Office. They are available for all monitored employees to review. The reports are considered medical records and may not be released without written consent.

UK Pregnant Employee - Fetal Dose Policy: The UK fetal dose policy incorporates safety information and radiation dose guidelines for ensuring safe radiation limits for the embryo/fetus of occupationally exposed employees. Pregnant radiation workers should notify the Radiation Safety Office in writing as soon as possible after learning of their pregnancy.

Exposure to a pregnant worker to ionizing radiation from either external or internal sources would also involve exposure of the embryo or fetus. A number of studies have indicated that the embryo or fetus is more sensitive than an adult, particularly during the first three months after conception, when a woman may not be aware that she is pregnant.

Federal and state regulations require that special precautions be taken to limit exposure to radiation sources when an occupationally exposed woman could be pregnant.

The current maximum permissible radiation exposure is 500 millirem for the duration of the gestation period, and the monthly exposure should be limited to 50 millirem. Fetal monitoring (double badging) is available at the Radiation Safety Office.

In order to be recognized as pregnant, for the purpose of exposure limits, a person must declare in writing to the University RSO that she is pregnant.

It is recommended that the pregnant person avoid higher radiation exposure procedures such as x-ray fluoroscopy.

ALARA Levels and Notifications: There are two notification levels for the ALARA program, Level I and Level II. Level I notifications normally involve a radiation worker receiving greater than 2.5 percent of the maximum allowable dose in a calendar month exposure period. The recipient is notified in writing when their exposure meets these criteria. The notification requests that the worker review their work procedures in order to reduce exposure, if feasible.

Level II notifications normally involve a radiation worker receiving greater than 7.5 percent of the maximum allowable dose in a calendar month exposure period. The recipient is notified when their exposure meets these criteria. In addition to reviewing procedures as with Level I, Level II requires the worker to respond in writing to the Radiation Safety Office. The response must include the cause of the exposure and a consideration of actions that may be taken to reduce the probability of a recurrence.

The Radiation Safety Committee may adopt different, higher ALARA levels for some specific job functions.

Part of Body	Notification Level I (millirem per calendar month)	Notification Level II (millirem per calendar month)
Whole body (head, trunk), gonads, upper arms or legs	**125**	**375**
Lens of the eye	**375**	**1125**
Skin of whole body- extremities (hand, elbow, lower arms or legs, foot, knee)	**1250**	**3750**
Embryo-Fetus	**20**	**30**

Overexposure: If an exposure exceeds the maximum allowable dose, the employee and supervisor will be notified and the required reports will be filed with the State of Kentucky Cabinet for Health Services.

CHAPTER 7

ALARA PROGRAM

The University is committed to minimizing radiation exposure to all persons associated with the University. Therefore, the **As Low As Reasonably Achievable (ALARA)** philosophy is adopted as policy for the University. The Radiation Safety Committee, with the Radiation Safety Officer as its delegated representative, will develop and implement policies and procedures to ensure radiation exposures are ALARA.

The following policies and procedures are utilized to keep radiation exposures ALARA:

- The Radiation Safety Committee will review quarterly and annually radiation worker doses, investigating ALARA notifications to determine whether exposures are being kept to a minimum.

- The Radiation Safety Officer will brief management once per year regarding occupational exposure levels.

- The Radiation Safety Committee will carefully review applications for radiation producing devices to ensure that the applicant is qualified and that the proposal incorporates the ALARA philosophy.

- The Radiation Safety Committee will adopt investigation levels for occupational radiation exposures. When these levels are exceeded, the Radiation Safety Officer will notify the recipient and review work practices, etc., in order to attempt to lower the exposure if possible.

- The Radiation Safety Officer will provide training classes to radiation workers and ancillary personnel regarding the ALARA philosophy and methods to keep exposures ALARA.

CHAPTER 8

DENTAL X-RAY UNITS

In performing intra-oral dental radiography the following rules shall apply:

1. Each installation shall comply with the current KY radiation regulations. Contact the Radiation Safety Office in advance for consultation and guidance on new installations, reinstallations, and modifications, as well as other matters.

2. Film holding devices shall be used if, technique permits;

3. Neither the tube housing assembly nor the position-indicating device shall be hand-held during an exposure;

4. The x-ray system shall be arranged and operated in a manner that the useful beam at the patient's skin does not exceed the dimensions specified in 902 KAR 100:130, Section 3 of the KY administrative regulations.

5. Each patient undergoing dental radiography shall be draped with a protective apron of not less than 0.25 mm lead equivalent to cover the gonadal area;

6. Film of a USASI (USA) speed group rating of **"D"** or faster shall be used,

7. All dental radiographic x-ray systems registered after March 2, 1977, shall be provided with electronic timers; and

8. If patients are immobilized during an x-ray exposure, mechanical restraints shall be used, if technique permits.

Dental x-ray facilities should be inspected once every three years unless certification or other reasons require a different schedule.

CHAPTER 9

DIAGNOSTIC X-RAY UNITS

Technique Chart. In the vicinity of each x-ray system's control panel a chart shall be provided which specifies pertinent examination information. The chart shall include but not be limited to the following:

1. The patient's anatomical size versus technique factors to be utilized;

2. The type and size of the film or film-screen combination to be used;

3. The type and focal distance of the grid to be used, if used;

4. The source to image receptor distance to be used, and

5. The type and location of gonadal shielding to be used, if used.

Personnel in X-ray Room. Except for patients who cannot be moved out of the room, only staff and ancillary personnel required for the medical procedure or training shall be in the room during the radiographic exposure. The patients and personnel shall be protected as follows:

1. Other than the patient being examined, individuals in the x-ray room shall be positioned so that no part of the body not protected by five-tenths (0.5) mm lead equivalent, is struck by the useful beam.

2. Staff and ancillary personnel shall be protected from direct scatter radiation by protective aprons or whole body protective barriers of not less than 0.25 mm lead equivalent; (All protective lead aprons shall be inspected at least yearly in accordance to UKHC policy)

3. Patients who cannot be removed from the room shall be protected from the direct scatter radiation by whole body protective barriers of not less than 0.25 mm lead equivalent or shall be so positioned that the nearest portion of the body is at least two (2) meters from both the tube head and the nearest edge of the image receptor; and

4. If a portion of the body of staff or ancillary personnel is potentially subjected to stray radiation which results in that individual receiving one-quarter (1/4) of the maximum permissible dose as defined in these administrative regulations, additional protective measures may be required as appropriate (improved shielding, rearrangement of setup, etc.).

5. Patients shall be held in accordance with UK Healthcare Clinical Enterprise (UKHC) and Radiation Safety Committee policy:

   When an x-ray examination is performed in the patient's room, or for difficult patients in the trauma setting, the radiologic technologist sometimes needs assistance in positioning the patient. Since the need for assistance is highly variable and unpredictable, Radiology is not staffed to provide the extra hands necessary to complete these exams successfully. Nationwide, the standard practice is for the patient's care team or a family member to

provide this extra assistance with positioning. UK policy requires that persons who are not routinely exposed to radiation or a family member provide this assistance, to the maximum extent practicable, since it would unacceptably increase the risk of adverse health effects already borne by workers who are routinely exposed to radiation as part of their job duties. The amount of radiation received by a person providing positioning assistance is very low and is considered by the radiation safety community to be safe, especially when the precautions mentioned below are observed.

Radiologic technologists who request positioning assistance will make every effort to keep the radiation exposure of those providing assistance to levels that are as low as reasonably achievable. The assisters (staff or family members) will be shown how to position themselves in the safest and most effective way. A lead apron and lead gloves will be given to the assister, and the assister will stand so that they are outside of the primary radiation beam to the greatest extent practicable. Pregnant staff or family members will not be used to provide positioning assistance. No one person will be asked to routinely hold patients. An assister who is already wearing a film badge will position the badge at the collar outside the apron during the procedure.

Fluoroscope Procedures

Operating Procedures and Auxiliary Equipment. The following operating procedures and auxiliary equipment shall be utilized, if applicable, in the operation of a fluoroscopic x-ray system:

1. Fluoroscopy performed by technologists shall be under the direction of a radiologist and be exclusively for localization purposes;

2. Spot film images shall be obtained only under the direction of a licensed practitioner of the healing arts;

3. Protective gloves of at least 0.25 mm lead equivalent shall be readily available to the fluoroscopist during every examination;

4. Protective aprons of at least 0.25-mm lead equivalence shall be worn by the fluoroscopist and by persons in the fluoroscopic room except the patient during each examination;

5. Fluoroscopic x-ray systems designed strictly for fluoroscopy shall not be used for spot filming or radiography; and

6. Dental fluoroscopic x-ray systems without image intensification shall not be used.

Medical diagnostic facilities, to satisfy JCAHO standards, should be inspected annually.

CHAPTER 10

PARTICLE ACCELERATORS

A label bearing essentially the words **"CAUTION - RADIATION - THIS MACHINE PRODUCES RADIATION WHEN ENERGIZED"** shall be placed near switches that energize portions of the machine. Labels shall use the conventional colors (magenta or purple on yellow background) and bear the conventional radiation symbol.

Written operating procedures pertaining to radiation safety shall be established for each accelerator facility.

Written emergency procedures pertaining to radiation safety shall be established and posted in a conspicuous location. These shall list the telephone number(s) of the radiation safety officer and shall include the following actions to be taken if a known, or suspected, accident involving radiation exposure occurs:

1. Notifying radiation safety officer; and

2. Arrange for medical examination.

3. The registrant shall assure that operators and other appropriate personnel are familiar with and have been given a copy of the written operating and emergency procedures pertaining to radiation safety. Each operator shall demonstrate an understanding of these procedures and the applicable requirements of 902 KAR 100:020 and 902 KAR 100: 165. These procedures shall be maintained at the accelerator control panel.

4. Particle accelerators shall be secured when not in operation to prevent unauthorized use.

5. The operator(s) shall ensure that personnel do not expose a part of their body to the radiation beam.

6. If it is necessary to intentionally alter safety devices, e.g., bypassing interlocks or removing shielding, such action shall be:

    a. Specified in writing and posted on the control console and at each entrance requiring a safety interlock as required by this administrative regulation so that other persons are aware of the existing status of the machine;

    b. Terminated as soon as possible; and

    c. Authorized by the radiation safety committee or radiation safety officer.

Particle accelerators should be inspected annually.

CHAPTER 11

MISCELLANEOUS DEVICES

No person is required to register the following:

Electronic equipment that produces radiation incidental to its operation for other purposes provided the dose equivalent rate averaged over an area of ten (10) square centimeters does not exceed five-tenths (0.5) mrem per hour at five (5) centimeters from an accessible surface of the equipment.

Domestic television receivers are exempt from the regulations.

Any electronic circuit with voltage above approximately 1000 volts may produce x-rays. Usually, such devices are designed and constructed such that there is no significant exposure on the exterior surface of the device. The U.S. FDA regulates electronic devices such that this limit is equal or less than 0.5 millirem per hour at 5 centimeters from the surface.

Electron microscopes may need to be inspected due to CAP or other certification bodies. Such inspections will be conducted upon request to the Radiation Safety Office. These devices do not require registration or safety inspections.

If a radiation safety survey is wanted by anyone, call the Radiation Safety Office, 323-6777, and make a request.

APPENDIX A

UNIVERSITY OF KENTUCKY

X-ray Registration Form

Instructions: Complete all information and forward two copies to the Radiation Safety Office, 102 Animal Pathology. New machines must be registered and inspected for safety prior to use.

☐ **Existing** ☐ **New**

1. Identify person(s) who will (a) supervise use of the machine and (b) all personnel who will use the machine (attach sheet if necessary).

Name	**Dept.**	**UK Title**	**Bldg/Rm #**	**Phone#**

2. Location (Bldg. & Rm. #) of machine _____

3. Type of use (check all that apply):

☐ **Medical:** ☐ **Diagnostic** ☐ **Therapeutic**
☐ **Dental:** ☐ **Intraoral** ☐ **Cephalometric** ☐ **Panoramic**
☐ **Veterinary**
☐ **Academic:** ☐ **Analytical** ☐ **Cabinet**
☐ **Other** _____

4. Machine Type:

☐ **Stationary**
☐ **Mobile**
☐ **Portable**

5. Manufacturer/Model _____

Serial # _____

Note: All X-ray machine operators must wear a personnel monitoring device (badge), which is provided by the Radiation Safety Office. Other requirements may also apply, depending on the type of machine and applications. Please contact the Radiation Safety Office if you need a badge or have any questions.

Responsible Person _____ _____ _____
Printed Name **Signature** **Date**

For use by Radiation Safety Office only:

Comments
_____

_____

Office Use Only

Wear Date _____

Spare Badge # _____

Binary # _____

PARTICIPANT NUMBER

APPENDIX B

UNIVERSITY OF KENTUCKY

RADIATION WORKER REGISTRATION FORM

LAST NAME	**FIRST NAME**	**MI**	**SOC. SEC. NO.**	**BIRTH DATE**

UK ID	**LINK BLUE**	**DEPARTMENT**	**ROOM #**	**BUILDING**

WORK PHONE	**START DATE**	**PREVIOUS AUTHORIZED USER (S) AT UK**

RADIATION SOURCES

TYPE OF TRAINING	WHERE TRAINED Date	DURATION OF TRAINING	ON THE JOB (circle one)		FORMAL COURSE (circle one)	
Principles and practices of radiation protection			YES	NO	YES	NO
Radioactivity measurement standardization and monitoring techniques and instruments			YES	NO	YES	NO
Mathematics and calculations basic to the use and measurement of radioactivity			YES	NO	YES	NO
Biological effects of radiation			YES	NO	YES	NO

PREVIOUS EXPERIENCE WITH RADIATION

RADIOACTIVE MATERIALS	MAXIMUM AMOUNT	WHERE EXPERIENCE WAS GAINED	DATES OF USE	TYPE OF USE

☐ I HAVE HAD ***NO*** PREVIOUS OCCUPATIONAL EXPOSURE

☐ I HAVE HAD PREVIOUS OCCUPATIONAL EXPOSURE (COMPLETE EXPOSURE HISTORY BELOW)

NAME & ADDRESS OF EMPLOYER(S	DATES EMPLOYED

To (last employer): _____ You are hereby authorized to furnish the University of Kentucky all available information concerning my radiation exposure history. I was associated with your organization from: _____ to _____

Radiation Worker Signature _____ Date _____

PI / AUTHORIZED USER (PRINT)	**PI / AUTHORIZED USER (SIGNATURE)**	**DATE**

APPENDIX C

GLOSSARY

Absorbed Dose
the amount of energy imparted to matter by ionizing radiation per unit mass of irradiated material. The unit of absorbed dose is the **Rad**, which is 100 ergs/gram.

Absorption
the phenomenon by which radiation imparts some or all of its energy to any material through which it passes.

Acute Exposure
the absorption of a relatively large amount of radiation (or intake of radioactive material) over a short period of time.

Acute Health Effects
prompt radiation effects (those that would be observable within a short period of time) for which the severity of the effect varies with the dose, and for which a practical threshold exists.

Adult
an individual 18 or more years of age.

ALARA
(acronym for **As Low As Reasonably Achievable**) making every reasonable effort to maintain exposures to radiation as far below the dose limits as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.

Atom
smallest particle of an element that is capable of entering into a chemical reaction.

Attenuation
the process by which a beam of radiation is reduced in intensity when passing through some material. It is the combination of absorption and scattering processes and leads to a decrease in flux density of the beam when projected through matter.

Background Radiation
ionizing radiation arising from radioactive material other than the one directly under consideration. Background radiation due to cosmic rays and natural radioactivity is always present. There may also be background radiation due to the presence of radioactive substances in other parts of the building, in the building material itself, etc.
charged particle emitted from the nucleus of an atom during radioactive decay. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron.

Bremsstrahlung
electromagnetic (x-ray) radiation produced by the deposition of charged particles in matter. Secondary photon radiation (x-ray) produced by the deceleration of charged particles through matter.

Calibration
determination of variation from standard, or accuracy, of a measuring instrument to ascertain necessary correction factors. The check or correction of the accuracy of a measuring instrument to assure proper operational characteristics.

Chronic Exposure
the absorption of radiation (or intake of radioactive materials over a long period of time), i.e., over a lifetime.

Committed Effective Dose Equivalent
the sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues.

Controlled Area
an area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason.

Declared Pregnant Worker
a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

Decontamination
the reduction or removal of contaminating radioactive material from a structure, area, object, or person. Decontamination may be accomplished by (1) treating the surface to remove or decrease the contamination, (2) letting the material stand so that the radioactivity is decreased as a result of natural decay, and (3) covering the contamination to shield or attenuate the radiation emitted.

Deep Dose Equivalent
applies to external whole-body exposure and is the dose equivalent at a tissue depth of one centimeter (1000 mg/cm^2).

Delayed Health Effects
radiation health effects which are manifested long after the relevant exposure. The vast majority are stochastic, that is, the severity is independent of dose and the probability is assumed to be proportional to the dose, without threshold.

Dose or Radiation Dose
a generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined in other paragraphs of this section.

Dose Equivalent (HT)
the product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and the sievert (Sv). The ICRP defines this as the equivalent dose, which is sometimes used in other countries.

Dose Rate
the radiation dose delivered per unit of time. Measured, for example, in rem per hour.

Dosimeter
a portable instrument for measuring and registering the total accumulated exposure to ionizing radiation. (see dosimetry.)

Dosimetry
the theory and application of the principles and techniques involved in the measurement and recording of radiation doses. Its practical aspect is concerned with the use of various types of radiation instruments with which measurements are made (see film badge; thermoluminescent dosimeter; Geiger-Mueller counter).

Effective Dose Equivalent
the sum of the products of the dose equivalent to the organ or tissue and the weighting factors applicable to each of the body organs or tissues that are irradiated.

Electromagnetic Radiation
a traveling wave motion resulting from changing electric or magnetic fields. Familiar electromagnetic radiations range from x-rays (and gamma rays) of short wavelength, through the ultraviolet, visible, and infrared regions, to radar and radio waves of relatively long wavelength. All electromagnetic radiations travel in a vacuum with the velocity of light (see photon).

Electron Volt
a unit of energy equivalent to the amount of energy gained by an electron in passing through a potential difference of 1 volt. Abbreviated eV. X-ray energy is typically measured in keV. (thousand electron volts).

Exposure
(1) Being exposed to ionizing radiation or radioactive material. (2) a measure of the ionization produced in air by x or gamma radiation. It is the sum of the electrical charges on all ions of one sign produced in air when all electrons liberated by photons in a volume element of air are completely stopped in air, divided by the mass of air in the volume element. The special unit of exposure is the Roentgen.

External Dose
that portion of the dose equivalent received from radiation sources outside the body.

Extremity
hand, elbow, arm below the elbow, foot, knee, or leg below the knee.

Eye Dose Equivalent
applies to the external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 centimeter (300 mg/cm^2).

Geiger-Mueller (G-M) Counter
a radiation detection and measuring instrument. It consists of a gas-filled tube containing electrodes, between which there is an electrical voltage but no current flowing. When ionizing radiation passes through the tube, a short, intense pulse of current passes from the negative electrode to the positive electrode and is measured or counted. The number of pulses per second measures the intensity of radiation.

Gray
The international (SI) unit of absorbed dose in which the energy deposited is equal to one Joule per kilogram (1 J/kg).

Half Value Layer
the thickness of any specified material necessary to reduce the intensity of an x-ray or gamma ray beam to one-half its original value.

Health Physics
a term in common use for that branch of radiological science dealing with the protection of personnel from harmful effects of ionizing radiation. The science concerned with the recognition, evaluation and control of health hazards from ionizing and non ionizing radiation.

High Radiation Area
an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 mSv) in one hour at thirty centimeters from the radiation source or from any surface that the radiation penetrates.

Hot Spot
the region in a radiation/contamination area in which the level of radiation/contamination is noticeably greater than in neighboring regions in the area.

Inverse Square Law
the intensity of radiation at any distance from a point source varies inversely as the square of that distance. For example: if the radiation exposure is 100 Rem/hr at 1 inch from a source, the exposure will be 0.01 Rem/hr at 100 inches.

Ionization
the process by which a neutral atom or molecule acquires either a positive or a negative charge.
Ionization Chamber
an instrument designed to measure the quantity of ionizing radiation in terms of the charge of electricity associated with ions produced within a defined volume.
Ionizing Radiation
alpha particles, beta particles, gamma rays, x-rays, neutrons, high speed electrons, high speed protons, and other particles or electromagnetic radiation capable of producing ions.
Limits
the permissible upper bounds of radiation exposures, contamination or releases.
Member of the Public
an individual in a controlled or unrestricted area (who is not a radiation worker). However, an individual is not a member of the public during any period in which the individual receives an occupational dose.
Millirem (mrem)
a sub multiple of the Rem equal to one-thousandth (1/1000th) of a Rem. (see Rem)
Minor
an individual less than 18 years of age, as pertains to radiation exposure limits, works with radioactive materials (not a member of the general public).
Monitoring
the measurement of radiation levels, and the use of the results of these measurements to evaluate potential exposures and doses.
Natural Radiation
ionizing radiation, not from manmade sources, arising from radioactive material other than the one directly under consideration. Natural radiation due to cosmic rays, soil, natural radiation in the human body and other sources of natural radioactivity are always present. The levels of the natural radiation vary with location, weather patterns and time to some degree.
Occupational Dose
the dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation and to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include dose received from background radiation, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the general public.
Particle Accelerator
any machine capable of accelerating electrons, protons, deuterons, or other charged particles in a vacuum and of discharging the resultant particulate or other radiation into a medium at energies usually in excess of 1 MeV.
Personnel Monitoring Badge
a packet of photographic film, thermolumenisent material or other passive systems used for the approximate measurement of radiation exposure for personnel monitoring purposes. The badge may contain two or more detection elements of differing sensitivity, and it may contain filters to aid in determining the types of radiation and the energy.
Photon
a quantum (or packet) of energy emitted in the form of electromagnetic radiation. Gamma rays and x-rays are examples of photons.
Pocket Dosimeter
a small ionization detection instrument that indicates radiation exposure directly. An auxiliary charging device is usually necessary.

Principal Investigator (PI)
a faculty member, assistant professor or higher (no visiting faculty), appointed by the licensee, who has been approved through the Radiation Safety Committee for the purchase and use of radioactive materials.

Protective Barriers
barriers of radiation absorbing material, such as lead, concrete, plaster and plastic, that are used to reduce radiation exposure.

Public Dose
the dose received by a member of the public from exposure to radiation and to radioactive material released by a licensee, or to another source of radiation. It does not include occupational dose or doses received from background radiation, as a patient from medical practices, or from voluntary participation in medical research programs.

Quality Factor (Q)
a modifying factor that is used to derive dose equivalent from absorbed dose. It corrects for varying risk potential due to the type of radiation.

Rad
the special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/gram or 62.4×10^6 MeV per gram.

Radiation Area
an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in one hour at thirty centimeters from the radiation source or from any surface that the radiation penetrates.

Radiation Worker
an individual who uses radioactive materials under the licensee's control. Individuals must be trained and have passed a radiation safety examination prior to beginning work with radioactive materials.

Radiography
the making of shadow images on photographic film by the action of ionizing radiation.

Radiology
that branch of medicine dealing with the diagnostic and therapeutic applications of radiant energy, including x-rays and radioisotopes.

Radiosensitivity
the relative susceptibility of cells, tissues, organs, organisms, or other substances to the injurious action of radiation.

Reference Man
a hypothetical aggregation of human physical and physiological characteristics arrived at by international consensus. These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult to a common base.

Relative Biological Effectiveness
for a particular living organism or part of an organism, the ratio of the absorbed dose of a reference radiation that produces a specified biological effect to the absorbed dose of the radiation of interest that produces the same biological effect.

Rem
the special unit of dose equivalent. The dose equivalent in rem is numerically equal to the absorbed dose in rads multiplied by the quality factor, distribution factor, and any other necessary modifying factors.

Restricted Area
an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

Roentgen (R)
the quantity of x or gamma radiation such that the associated corpuscular emission per 0.001293 gram of dry air produces, in air, ions carrying one electrostatic unit of quantity of electricity of either sign. Amount of energy is equal to 2.58 x 10^{-4} coulombs/kg air. The Roentgen is a special unit of exposure.

Shallow Dose Equivalent
applies to the external exposure of the skin or an extremity and is taken as the dose equivalent at a tissue depth of 0.007 centimeter (7 mg/cm^2) averaged over an area of one square centimeter.

Shielding Material
any material which is used to absorb radiation and thus effectively reduce the intensity of radiation, and in some cases eliminate it. Lead, concrete, aluminum, water and plastic are examples of commonly used shielding material.

Sievert
The international unit (SI) of dose equivalent (DE, human exposure unit), which is equal to 100 rem. It is obtained by multiplying the number of grays by the quality factor, distribution factor, and any other necessary modifying factors.

Somatic Effects of Radiation
effects of radiation limited to the exposed individual, as distinguished from genetic effects, which may also affect subsequent unexposed generations.

Stochastic Effects
health effects that occur randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects.

Survey
an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

Terrestrial Radiation
the portion of the natural radiation (background) that is emitted by naturally occurring radioactive materials in the earth.

Thermoluminescent Dosimeter (TLD)
crystalline materials that emit light if heated after being exposed to radiation.

Unrestricted Area
an area, access to which is neither limited nor controlled by the licensee.

Very High Radiation Area
an area accessible to individuals, in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in one hour at one meter from a radiation source or from any surface that the radiation penetrates.

Whole Body
for purposes of external exposure, head, trunk (including male gonads), arms above the elbow, or legs above the knee.

X-rays
penetrating electromagnetic radiations having wavelengths shorter than those of visible light. They are usually produced by bombarding a metallic target with fast electrons in a high vacuum. In nuclear reactions it is customary to refer to photons originating in the nucleus as gamma rays, and those originating in the extra-nuclear part of the atom as x-rays. These rays are sometimes called Roentgen rays after their discoverer, W.C. Roentgen.