SUBJECT: Safety Precautions for Equipment Producing Ionizing Radiation

OBJECTIVE

To provide for the safety of affected patients and personnel in a manner consistent with accepted professional standards for radiological equipment that produces ionizing radiation.

DEFINITIONS

For the purpose of this policy, the following definitions apply:

**IEMA** – Illinois Emergency Management Agency

**Radiological modalities that use ionizing radiation**: Conventional radiographs (X-ray), Computed Tomography (CT), Fluoroscopy, Bone Densitometry (DEXA), Radiation Therapy, Electron beam therapy (EBT), Brachytherapy

**Operator** – A practitioner licensed to practice a treatment of human ailments by virtue of the Medical Practice Act of 1987 [225 ILCS 60], the Illinois Dental Practice Act [225 ILCS 25], or the Podiatric Medical Practice Act of 1987 [225 ILCS 100], or by a medical radiographer or radiation therapist accredited in accordance with the provisions of 32 Ill. Adm. Code 401.100 or an individual exempt from the provisions of 32 Ill. Adm. Code 401, by Section 401.30 of that Part (attending physicians, fellows, residents, medical radiographers, radiation therapists, nuclear medicine technologists, etc).

**Radiation Area** – An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.05 mSv (0.005 rem) in 1 hour at 30 centimeters from the source of radiation or from any surface that the radiation penetrates.

**High Radiation Area** – An area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving a dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour at 30 centimeters from the radiation source or 30 centimeters from any surface that the radiation penetrates.

**Very High Radiation Area** – An area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in 1 hour at 1 meter from the radiation source or 1 meter from any surface that the radiation penetrates.

Radiation Monitoring Devices- Devices worn on the body to measure radiation exposure. The most commonly used monitoring devices are clip on plastic badges to monitor whole body exposure and plastic thermoluminescent dosimeter(TLD) rings to monitor exposure to the hands. Providers, staff, or vendors required to be monitored are identified in section E of this policy.

POLICY

The Radiation Safety Office shall be responsible for the safety of the equipment producing ionizing radiation. Precautions shall be taken to maintain ionizing radiation doses as low as reasonable achievable (ALARA) to patients and personnel and maintain the safety of radiologic
services. The UIC Radiation Safety Manual shall be followed. All procedures must be performed under the direction of a physician. Directors of areas performing procedures involving ionizing radiation are responsible for assuring that staff and providers are following appropriate safety precautions as defined in this policy and that hospital staff receive education on the hospital’s expectations and their role in tracking their cumulative radiation exposure.

UNIVERSITY OF ILLINOIS HOSPITAL AND CLINICS
MANAGEMENT POLICY AND PROCEDURE

PROCEDURE

A. General Precautions

1. Minimizing number of people to exposure:
   a) Except for the patient and single family member if the patient is a minor, only the operator and ancillary personnel required for performance of a procedure may remain in the room during the ionizing radiation exposure.
   b) Anyone who must remain in the room to assist during ionizing radiation procedures must be protected from scatter radiation by protective aprons or a whole-body radiation protective barrier of not less than 0.5-millimeter lead equivalence.
   c) Anyone required for assistance with ionizing radiation procedures shall be positioned so that no part of the body can be struck by the useful beam unless protected by 0.5-millimeter lead-equivalent shielding material.
   d) In lieu of personnel supporting or restraining a patient during ionizing radiation procedures, mechanical support or restraining devices should be utilized for holding either the patient or image receptor whenever possible.
   e) During any ionizing radiation procedures, any door designed to be part of a protective barrier must be closed.

2. Precautions for personnel remaining in testing area
   a) Prior to putting on a radiation protection garment, personnel will verify that the most recent safety check is within 18 months. A visual cue (e.g., sticker or color-coded tag) should be apparent to let staff know the check is current.
   b) Personnel who have to stand with their backs to the ionizing radiation source or patient should wear wraparound aprons.
   c) Personnel who do not need to be close to the patient or ionizing radiation source should stand as far away as is practical without compromising patient care.
   d) Personnel whose hands must be very close to the ionizing radiation beam should wear lead containing gloves. Do not place hands in the direct beam, even with lead gloves, as the lead will only cause a higher level of radiation to be produced.
   e) During angled C-arm or O-arm fluoroscopy, personnel should stand on the image intensifier side of the patient rather than the side of the ionizing radiation source, provided it is practical and does not compromise patient care.
   f) Personnel radiation monitoring devices (badges/rings) must be worn appropriately by all individuals as required by section E of this policy.
   g) Additional consideration for protection of the fetus requires the pregnant employee to declare her pregnancy to the Radiation Safety department in writing.
if she opts to accept this added level of protection.

h) During use of mobile equipment, the fluoroscope operator or assisting technologist will notify personnel when ionizing radiation is being used.

3. Patient Precautions
   a) Question female patients of childbearing age regarding the possibility of pregnancy. Perform a pregnancy test if the procedure may involve risk of
exposure to the uterus of a patient who may be pregnant. If a woman is determined to be pregnant or concerned that she may be pregnant despite a negative pregnancy test, consultation with the physician to discuss the risks versus benefits of ionizing radiation should occur before the procedure and the informed consent of the patient should be obtained to proceed with the ionizing radiation procedure.

b) Use gonadal shielding (not less than 0.5 millimeters of lead) for all patients of procreative potential when the gonads are in or within two inches of the primary radiation field, except in cases where it would interfere with obtaining the desired information.

c) Demonstrate collimation on all images and limit to the area of interest.

d) Select the imaging technique factors to achieve adequate image quality at a minimum patient radiation dose. Use automatic exposure systems (e.g., automatic exposure control (AEC), automatic brightness systems (ABS), auto mA) where feasible.

e) Document fluoroscopic exposure times in the patient record.

B. Precautionary Labeling and Identification of Radiation Producing Equipment

1. All radiation producing equipment will be labeled in a manner that cautions individuals that radiation is produced when it is energized.

2. Radiation Areas will be posted with a conspicuous sign or signs bearing the radiation symbol and the words “CAUTION, RADIATION AREA.”

3. High Radiation Areas will be posted with a conspicuous sign or signs bearing the radiation symbol and the words “CAUTION, HIGH RADIATION AREA” or “DANGER, HIGH RADIATION AREA.”

4. Very High Radiation Areas will be posted with a conspicuous sign or signs bearing the radiation symbol and words “GRAVE DANGER, VERY HIGH RADIATION AREA.”

5. The following are exempt from posting requirements:
   a) A room or area containing radiation machines used solely for diagnosis.
   b) A room or area containing radiation machines for periods less than 8 hours if the machines are constantly attended during those periods by an individual who takes the precautions necessary to prevent the exposure of individuals to radiation in excess of public exposure limits (Appendix 2.)

C. Access Control to High and Very High Radiation Areas

1. Each entrance or access point to a high or very high radiation area shall have one or more of the following features:
   a) A control device that, upon entry into the area, causes the level of radiation to be reduced below the level at which an individual might receive a deep dose equivalent of 1mSv (0.1 rem) in 1 hour at 30 centimeters from the source of radiation or from any surface that the radiation penetrates.
b) A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry.
c) Entryways that are locked, except during periods when access to the areas is required, with positive control over each individual entry.

2. For High Radiation Areas, the controls of subsection (a) may be substituted for continuous direct or electronic surveillance to enable action to be taken to prevent unauthorized entry.

D. Periodic Equipment Inspection
   Refer to Hospital policy:
   EC 4.02 Medical Equipment Management Program

E. Personnel Radiation Monitoring
   1. Hospital and Clinic Providers & Staff
      a) Personnel likely to receive a dose in excess of 10% of the annual permissible dose or those working in high radiation areas or very high radiation areas will be supplied with personal monitors (radiation badges and/or rings) (see Addendum 2 for dose limits)
      b) Additional monitors will be supplied to pregnant individuals who declare pregnancy to the Radiation Safety department in writing (see Radiation Safety form 8.2.197).
      c) Ring monitors will be provided for individuals who are likely to receive a dose to the hands in excess of 10% of the permissible extremity dose (12,500 mrem per calendar quarter).
      d) Radiation monitors can be requested from Radiation Safety using form 8.2.122.A
      e) Radiation monitor reports are reviewed monthly by the Radiation Safety Officer.
         i. Unusual deviations in monthly exposures are investigated by the Radiation Safety Officer and discussed with affected staff.
         ii. Discrepancies and non-compliance are reported to the Radiation Safety Committee quarterly as a part of the Radiation Safety ALARA report.
         iii. The Radiation Safety committee recommends corrective action based on severity and frequency. Corrective actions include additional staff training, official notification, and escalation to administration.

   2. Vendor Representatives
      a) Vendor representatives who must be in a radiation area during radiation producing procedures must wear appropriate aprons and other shielding, and other PPE appropriate to the situation.
      b) Vendor representatives who must be in a high radiation area during radiation producing procedures must also wear monitoring devices.
      c) The vendor must provide the monitoring devices.
      d) The Hospital/Clinic will provide aprons, shields, and other PPE for use by the vendor representative.
      e) If the vendor representative does not need to be in the procedure room, he/she should use the observation window.

F. Operator Training and Competency
   1. Each individual who applies ionizing radiation (Operator) shall be provided with written operating and safety procedures. These procedures shall include restrictions
required for the safe operation of each radiation machine and shall include the following topics as applicable:
   a) Operating and emergency procedures
   b) Use of personnel and patient protective devices
   c) Procedures to minimize patient and occupational doses, including procedures for selecting personnel to support patients or film
   d) Use of individual monitoring devices
   e) Film/image processing procedures
   f) Prohibited uses of machines producing ionizing radiation
      (Addendum 1)

2. Individuals, excluding licensed practitioners (i.e., physicians), who apply ionizing radiation, shall be provided with initial and annual in-service training to ensure their awareness of radiation safety practices and policies. The in-service training shall include the topics listed in 6.a.

3. Radiation equipment operator form (EHSO Form 8.2.088F) should be filled out by the licensed practitioners (i.e., physicians) who will be operating radiation producing equipment. The form should be signed by the director of the area where radiation equipment is used and approved by the Radiation safety officer.
4. The Radiation Safety Competency Evaluation Form shall be used by department directors to document compliance with radiation safety training and competency requirements for non-physician operators (i.e., licensed technologists)

Keywords Radiation, ionizing radiation, equipment, ALARA

References
Hospital Management Policy and Procedure
EC 4.02 Medical Equipment Management Program

American College of Radiology Practice Parameters and Technical Standards

IEMA Title 32, Chapter II, Subchapter b, Part 360
IEMA Title 32, Chapter II, Subchapter b, Part 401
IEMA Title 32, Chapter II, Subchapter b, Part 340
IEMA Title 32, Chapter II, Subchapter b, Part 310

ACR-AAPM Radiation Safety Officer Resources

UIC Radiation Safety

Radiation Safety Manual - Chapter 9

Radiation Safety Competency Evaluation Form

Radiation Safety form 8.2.197

Addenda
Addendum 1: Prohibited Uses of Machines Producing Ionizing Radiation
Addendum 2: Dose Limits

Rescission Date none

Policy Owner – Associate Hospital Director, Imaging & Diagnostics
Addendum 1: Prohibited Uses of Machines Producing Ionizing Radiation

Prohibited Uses of Machines Producing Ionizing Radiation

1) Unauthorized Exposure. Individuals shall not be exposed to the useful beam except for healing arts purposes and only when the exposure has been authorized by a licensed independent practitioner with credentialing and privileging to include ionizing radiation.
   A) Exposure of individuals for training, demonstration or other non-healing arts purposes.
   B) Exposure of individuals for the purpose of "healing arts screening"

2) Fluoroscopy shall not be used as a substitute for radiography or in lieu of proper anatomical positioning/centering procedures prior to radiographic studies.

3) Fluoroscopic equipment using phosphorescent screens shall not be used. Image intensification shall be utilized on all fluoroscopic equipment.

4) The use of direct exposure x-ray film (without intensifying screens) for routine diagnostic radiological imaging procedures, other than intraoral dental radiography and therapeutic portal imaging, is prohibited.

5) The use of photofluorographic systems is prohibited.

6) The use of an individual accredited as a limited diagnostic radiographer by IEMA pursuant to 32 Ill. Adm. Code 401 by a portable x-ray service provider is prohibited.
Addendum 2: Dose Limits

### Annual Occupational Limits

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<tr>
<td>Extremities (SDE, ME)</td>
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### Other Applicable Limits

- Dose to Embryo/Fetus (declared pregnancies) - 500 mrem
- Members of the Public - 100 mrem
- Unrestricted Areas - 2 mrem in any one hour.