Safety Procedures & Policy Manual

THE RADIOGRAPHY & IMAGING PROGRAMS

For

ENROLLED STUDENTS and ARRT REGISTERED FACULTY

2024 - 2025

TABLE of CONTENTS

Note: The "Individual" is referencing the student and/or the faculty person

PART 1: RADIATION SAFETY

Note: The "Individual" is referencing the student and/or the faculty person

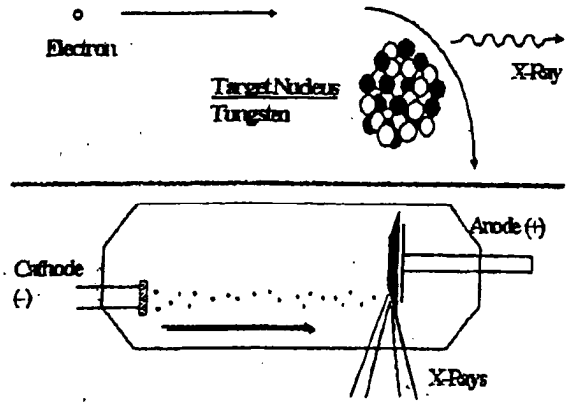
CONTENTS

Generating X-Rays

In *diagnostic radiography*, x-rays are produced when high-energy electrons collide with a metal target in an x-ray tube (see below). X-rays are only produced when the machine is activated. The patient does not become radioactive.

In the x-ray tube, electrons are generated at the filament end of the x-ray tube by thermionic emission (boiling of electrons from the filament). They are then given kinetic energy by applying a high voltage between the filament and the target. If a voltage of 100,000 volts (100 kVp) is applied to the x-ray tube, the electrons will strike the target producing x-rays with energies from 0 to 100 keV. Note: kVp is the voltage applied to the x-ray tube and keV is the energy of the x-ray. The low energy x-rays can not get out of the x-ray tube so the actual spectrum of x-rays range from about 10 keV to 100 keV. The higher the x-ray energy, the higher its ability to penetrate tissue. As the kVp increase so does the intensity of the x-ray beam, i.e. more x-rays of all energies are generated.

- The energy of the x-rays is determined by the voltage applied to the tube, kVp.
- The quantity of x-rays is determined by the milliamps (mA) of current flowing in the x-ray tube (and also by the tube voltage).



The higher the mA, the higher the radiation dose to the patient. One of the factors that affect image quality is the number of x-rays reaching the film. Image contrast is the difference in the number of photons that get through the various parts of the body being imaged. The higher the kVp, the more photons that get through, resulting in less differentiation between tissues (contrast).

The goal is to keep the mA as low as possible and the kVp as high as possible to achieve a compromise between the the number of photons reaching the film and optimum image (contrast). .

Because radiation cannot be seen or felt, the radiation symbol is used to alert you to its presence. All rooms or areas where radiation-producing equipment is used are posted with this sign.

(magenta or black with a yellow background)

Note: The "Individual" is referencing the student and/or the faculty person

Split Acting RSO Contact information:
Desiree Duncan at (252) 678-6726 or duncand@edgecombe.edu
Deanne Swartout at (252) 678-6737 or swartouts@edgecombe.edu

Radioactivity and Radiation

All matter in our environment is made of atoms. Most atoms we encounter on Earth are stable. Some atoms, however, are unstable, giving off energy in the form of radiation in order to reach a stable state. These atoms are said to be radioactive. An example is the radionuclide, Carbon-14, produced in the atmosphere when cosmic rays interact with stable nitrogen atoms. When a Carbon-14 atom undergoes radioactive decay, it gives off radiation in the form of a beta particle and then becomes a stable nitrogen atom once again. The existence of Carbon-14 in all living things enables archeologists to date ancient artifacts.

Radiation can be naturally-occurring or produced electrically, as in an x-ray tube. Radiation can only be detected by specially designed instruments. Radiation is known to cause cancer and birth defects in animals and humans. The risk of radiation damage is related to the amount of radiation absorbed by an individual. With the amounts of radiation encountered by employees and students at Edgecombe Community College, the risk is very small.

There are small amounts of naturally-occurring radioactive substances in soil, rocks, plants, animals and in our own bodies, all of which give off radiation. Large amounts of radiation are present in outer space and a small portion of this radiation penetrates the atmosphere. The low level of naturally occurring radiation is known as background radiation.

Radiation is useful in diagnostic imaging because of its ability to penetrate tissue, allowing imaging of internal structures. However, radiation may produce harmful biologic effects. Observations of exposed human populations and animal experimentation indicate that exposure to low levels of radiation over a period of years may lead to an increase in the incidence of cancer and leukemia. Exposures to high levels of radiation produce the same effects faster and many also cause hair loss, skin burns, radiation sickness or even death. Radiation may also increase risk of genetic abnormalities.

Radiation Protection in the ECC Radiography Program

To minimize the biologic effects of radiation, specials rules and regulations are set forth for individuals occupationally exposed to radiation. The amount of radiation received by persons exposed occupationally should not exceed the dosages specified in the NC Regulations for Protection against Radiation, 15A NCAC 11. These regulations and other information is available at http://drp.enr.state.nc.us/

There is, in general, minimal external radiation hazard to personnel/students from procedures involving radiation. Adherence to guidelines contained in this manual will help all x-ray equipment operators keep their exposures as low as reasonably achievable (ALARA), and reduce radiation exposures to levels allowable for individual members of the public or in some cases, to levels indistinguishable from natural background.

Radiation safety services are provided for the ECC Radiography Program by **Landauer Medical Physics** and **Radiation Detection Company, Inc.** These services include the oversight and administration of the personnel monitoring program, area surveys/shielding plan reviews, x-ray equipment inspections, and training of employees. Questions regarding safety may be directed to the acting radiation safety officer (RSO).

All ECC radiography and imaging students, as well as registered technologists employed by the college, are required to adhere to the radiation safety procedures outlined in this manual.

(updated 7/2024)

Note: The "Individual" is referencing the student and/or the faculty person

Basic Radiation Safety Procedures

The radiation protection program is guided by the concept of keeping radiation exposure As Low As Reasonably Achievable (ALARA). The ALARA concept assumes that any radiation dose, no matter how small, can have some adverse effect. Under the ALARA program, every reasonable means of lowering exposure is used. Radiation exposure can be minimized by utilizing three basic principles:

1. **Time**
2. **Distance**
3. **Shielding**

Remember that radiation cannot be seen or felt, but can be detected with radiation survey meters.

Dose Limits/Monitoring Requirements

A individual is required to be monitored if he/she is likely to receive in excess of 10% of the dose limits. Those dose limits are:

Occupational dose limits Annually	**Category**	**Dose Limit mrem**	**Dose Limit mSv**
	Total Effective Dose to Whole Body **18 ≥**	5,000mrem per/yr	50mSv per/yr
	Eye Dose Equivalent to the Lens of the Eye	15,000mrem per/yr	150mSv per/yr
	Shallow Dose Equivalent to the Skin of any extremity	50,000mrem per/yr	500mSv per/yr
	Cumulative lifetime dose	1,000mrem x age	10mSc per/yr
	Embryo Fetus Exposures Monthly	50mrem per month	0.5mSv monthly
	Embryo Fetus Exposures for Entire Pregnancy	500mrem entire pregnancy	5mSv entire pregnancy
Educational and Training Exposure Annually			
	Total Effective Dose to Whole Body **< 18 years of age**	100mrem per/yr	1mSv per/yr
Action Levels: Quarterly Dose that the acting RSO will conduct counseling at ECC			
	<18 years of age student	>10mrem	0.1mSv
	≥18 years of age:	>125mrem	1.25mSv
	Embryo Fetus Exposures Monthly	> 5mrem	0.05mSv

Personnel radiation monitoring is provided to those individuals who frequently make exposures, supervise radiography or imaging students, and perform clinical rotation within close proximity to radiation performing equipment. Radiation exposure is monitored with a an 84 OSL XG Badge dosimeter by the Radiation Detection Company, Inc. **If assigned a badge, the individual must;**

- Always wear the badge when working around radiation sources and make sure it is the badge assigned to you, the individual.

Note: The "Individual" is referencing the student and/or the faculty person

- Wear the badge on your collar facing outward (not on your name tag/badge). If a lead apron is worn, the dosimeter badge should be on the outside of the apron.
- When not in use, store badges in a low radiation area. Do not wear your dosimeter badge outside the clinical facility or educational facility. The control badge shall also be stored in a radiation-free area. The acting RSOs are responsible for the exposure records and exchanging the badges.

Action levels have been set which trigger investigations to determine if the exposures were as low as reasonably achievable. If not, recommendations are made to ensure that future exposures are ALARA.

Try to keep your, individual, personal radiation exposure as low as you can. Be aware of where you are standing and how long you stay in the radiation area. **Do not enter or remain in a radiation area unless it is necessary. Students should NEVER hold patients or image receptors during any active radiographic procedure!** During mobile fluoroscopic studies, students need to be mindful that the x-ray tube side of the c-arm is the largest area of scatter radiation for their safety in placement. For patient safety during fluoroscopy procedures, the part should be placed as close to the image receptor (image intensifier) as possible for reduced exposure. **If you suspect there has been excessive exposure or a radiation incident, immediately notify an acting RSO.**

Fetal Protection Policy

ECC has adopted a policy to protect the fetus/embryo of the pregnant female exposed to ionizing radiation in the educational and clinical environment. Regulations limit occupational dose to the pregnant technologist to 500 mrem over the course of the pregnancy. IF the female **declares voluntary pregnancy in writing to the acting RSO and clinical coordinator**, all information relative to the individual's pregnancy will be held in the strictest confidence.

If the female declares voluntary pregnancy, she should notify in writing to one of the acting RSOs. The acting RSO will arrange for to meeting to discuss acceptable protocol and precautions in order to limit radiation exposure. The acting RSO will review current clinical assignments, and the females' radiation exposure history. A second radiation monitor will be ordered and assigned, with radiation exposures to be reviewed monthly with the pregnancy individual. The fetal badge will be worn at the waist level with or without an apron. If wearing an apron, the fetal badge must be placed beneath the apron at waist level. The pregnant female must remain well behind the control barrier during radiographic exposures. During fluoroscopy, portable/mobile imaging, surgical procedures, and special procedures, the pregnant female must wear a lead apron that is a minimum of 0.5 mm Pb equivalent and maintain as much distance (minimum 6 feet) between the radiation source and self. **Under no circumstances will the pregnant student be allowed to hold patients or image receptors during x-ray exposure.** The pregnant female will be given the opportunity to read and discuss the USNRC Regulatory Guide 8.13 "Instruction concerning Prenatal Radiation Exposure", the NCRPAR Rules and Regulations, Parts15A NCAC 11 .1316 and 15A NCAC 11 .1610 and the NCRP Report no. 116. To help assure that radiation exposure to the individual and fetus are kept as low as reasonably achievable (ALARA) practices will be followed. The three cardinal rules of radiation protection include, the least amount of time spent in vicinity of generated exposure, the greatest distance from the source and the interposing of shields between the source of x-rays and self or fetus must be followed. The individual will be informed of her options to the pregnancy policy upon acceptance of employment or during pre-program orientation, again in the initial program orientation, and finally if student chooses to voluntarily disclose a pregnancy. The female will acknowledge awareness of the increased risk of embryological effects due to potential exposure of the embryo/fetus during the pregnancy. To declare voluntary pregnancy, individual will complete the Voluntary Pregnancy Declaration Form. *Please refer to the Voluntary Pregnancy Declaration Form attached for options.*

Note: The "Individual" is referencing the student and/or the faculty person

Radiation Exposure Protocol

ECC has adopted a protocol for incidental or accidental exposure of an employee or student by the radiation beam.

1. Incident must be reported to an acting RSO immediately after exposure.
2. If an **faculty member** is exposed to radiation by incidental or accidental means, the individual must report the incident to the acting RSO within 24 hours of the exposure (unless incident occurred during the weekend rotation...then the following Monday will be the dedicated meeting date). This meeting will be conducted to gather and document information related to the exposure incident.
   If a **student** is exposed to radiation by incidental or accidental means, the individual must report it to the clinical coordinator and a meeting will be conducted to gather and document information related to the exposure incident. A second meeting will be conducted with the acting RSO and the exposed student within 48 hours of the incident. The events of the meeting will be documented for a Plan of Action (POA).

Radiation Detection Company "Emergency Reading" Protocol

1. The acting RSO will collect the OSL dosimeter badge 'to be read' and will make the arrangements for it to be sent out by FED EX overnight.
2. The tracking number and expected date of arrival are to be reported to the Radiation Detection Company Customer Representative,
   Peggy Schultz
   Customer Care Representative
   ECC ACCT# 134638
   Radiation Detection Company (RDC)
   3527 Snead Drive
   Georgetown, TX 78626
   edusupport@radetco.com
   customercare@radetco.com
   phone: 512-831-7000; fax: 512-861-0248
3. At this time, the acting RSO will inform the customer representative that this is an "Emergency Reading". A fee of $75.00 will be billed to ECC along with $10.00 per badge reading fee.
4. Once the OSL badge is received by RDC, there is a 24-hour turn-around time for results to be processed and sent to the acting RSO.
5. Once results are received by the acting RSO, the clinical coordinator, and the program chair, the exposed individual will be notified and counseled. The exposure results will be documented and filed in the employee or student's master file.

Important Information

A copy of the NC Regulations for Protection against Radiation (NCRPAR) is always available for review in the office of the Program Chair and RSO.

The NCDENR "Notice to Employees" is posted in the radiographic lab on the generated radiographic room door for review.

(updated 7/2024)

Note: The "Individual" is referencing the student and/or the faculty person

Rules Governing Radiation Protection

It is the responsibility of each individual working within the Radiology and Imaging Program to protect self and others from the hazard arising from his work. Careless working habits and bad examples may unnecessarily expose employees and patients—this cannot be tolerated. Follow the list of rules for clean, careful working habits, as well as guidelines for efficient operation of the Radiology and Imaging Program.

1. Personnel monitoring devices (OSL badges) will be worn by **all** registered technologists or students in the appropriate location (level of thyroid). If a female individual is pregnant, a second OSL dosimeter badge should be worn at waist level.

2. Radiography programs use a quarterly reporting system. Imaging Programs (Mammography, CT, MRI) use a bimonthly reporting system. The OSL badges will be reviewed by the acting RSOs. Employee and student are **required** to review, initial, and date readings per program procedure to maintain confidentiality of protected information.

3. All individual dosimeter readings will be reviewed to meet the **ALARA (as low as reasonably achievable)** confirmations. All individuals must follow the ALARA concept for personnel protection.

4. Protective lead gloves, thyroid shields, and aprons, are to be provided and worn by personnel aiding or working in the radiology department. These lead accessories are inspected and x-rayed semi-annually for defects. **Always** hang lead accessories up upon completion of an exam to provide longevity of the items.

5. **Always** wear protective apparel when not behind a protective barrier. Remember, for portable exams, to wear lead apron, if possible, thyroid shield and stand **at least** 6 feet from the source of x-rays. When a portable exam is required, the registered technologist is responsible for providing lead aprons to other hospital employees that need to be present during the exposure.

6. **STUDENTS are NEVER to be in the primary beam, hold image receptors, or patients during any radiographic procedure when an immobilization method is the appropriate standard of care!**

7. **Collimation is an Obligation.** The individual has an obligation and a responsibility to collimate to the smallest field size appropriate for the exam when possible.

8. The individual will understand and apply the cardinal principles of radiation control: **Time, Distance, Shielding.**

9. Registered Technologists should **never** routinely hold patients during radiographic exams. Mechanical restraining devices, sponges, tape, etc., should be used when possible. Otherwise, a willful family member or another hospital employee can be used. However, no hospital employee should be routinely used for holding purposes during radiographic exams. **STUDENTS ARE NEVER ALLOWED TO HOLD PATIENTS or IMAGE RECEPTORS! (students please refer to #6).**

10. The individual will **never** stand in the direct (primary) x-ray beam.

11. The individual will be sure to stand behind the protective lead barrier an **all** doors are to be closed to the energized radiographic room.

12. The exposure switch is fixed on all the diagnostic units, and cannot be operated outside a shielded area.

13. Individuals will **always** ask female patients of potential pregnancy prior to procedure. Child bearing age for women is the age of 9 – 65.

(updated 7/2024)

Note: The "Individual" is referencing the student and/or the faculty person

14. **All** patients of reproductive potential to be x-rayed shall be protected with gonadal shields and thyroid shields (**if it does not interfere with the exam**) will be kept away from the radiation areas when not being x-rayed. All women under the age of 65 and all men under the age of 65 should be protected during a radiographic exam with a gonadal shield. If they have been altered reproductively, you may shield anyway for the sound security of doing so.

15. **STUDENTS will shield EVERY patient as long as it does not interfere with the exam!**

16. Do not allow familiarity to result in **false security!**

Acting RSO (Split) - Desi and Deanne

Duties/Responsibilities:

DESI

- Provide 'Occupational Dose History' Request reports from employers/students when requested within 48 hours.
- Replacement/order badges within 48 hours of requests
- Cancel badges within 48 hours of request
- **Keep and scan** all packing slips for payment of invoices.
- Invoices to be paid
- Annual Program Review Reports (documentation and upkeep)
- Placing a block on a student's account when badges are not returned upon graduation
- Revisions of Imaging Safety Manual to include Radiation safety and MRI safety, starting fall 2018.
- Keep control badge and visitor badge in your office.
- Return all unworn badges in separate packing with a note to identify these badges were not worn, to be cancelled, do not charge!
- Return ALL badges before 14 -18 days and to include all badges with control badges for return. Badges should not be returned without control badge!
    - Any badge not returned within the 20 days is subject to a late fee by the owner of the badge ($50). This is what RDC company charges ECC.

DEANNE

- Distribute and go over the Imaging Safety Manual with the RAD students
- Counseling (if dose is near or higher than our guideline)
- Order/Cancel - Fetal Badges and Volunteer fetal disclosure documentation
- Keeping accurate documentation and obtaining initials from RAD, CT/MRI students/employees on Occupational Radiation Exposure dose reports in a timely manner
    - These are to NEVER be destroyed and kept in a binder for recording keeping.
    - Archives of documents are to be scanned in the R drive under the Acting RSO folder. Folder location is: **R:\B\RSO\Occupational.Rad.Exp.Dose.Reports** (by year).

CT/MRI responsibilities:

- Distribute and go over the Imaging Safety Manual to CT/MRI students. *(Starting fall of 2018, this safety manual will include, "Radiation and MRI safety".*
- Timely, 2 week turn-around, for old badges when new badges are issued.
- **Email student reminders to collect all badges on final exam day.** (to increase return rate in a timely manner) – remember, every badge that is late, it cost the college a minimum of $35.

(updated 7/2024)

Note: The "Individual" is referencing the student and/or the faculty person

RADIATION MONITORING FOR FACULTY and STUDENTS
2024

ECC Dosimeter

All radiation workers must be monitored to track the amount of radiation (dose) they receive at work. There are several types of radiation monitors/dosimeters. ECC uses the 84 OSL XG Badge dosimeter which is the Optically Stimulated Luminescence (OSL) of Beryllium Oxide (BeO) blister packet. Radiography and Mammography are monitored on a quarterly period. CT/MRI are monitored on a Bi-weekly period. Fetal is monitored on a monthly period.

Description

OSL Whole Body Dosimeter

Personnel Badges are used to monitor occupational exposure to a single individual working with radioactive materials including Photons (gamma and X-ray) to ensure the dose received remains within the allowable Dose Limits.

The OSL dosimeter is a 2-element beryllium oxide (BeO) badge with a minimum reportable dose of 10 mrem (0.1 mSv), and a LLD of 1 mrem (0.01 mSv).

- Standard OSL badge or type 84 badge for photon monitoring.
- Energies Measured: Photon: 12 keV – 7 MeV.
- Reporting Periods: Monthly, Bi-Monthly, Quarterly, Semi-Annual, Annual

How the OSL work?

Optically stimulated luminescence (OSL) is a process in which a pre-irradiated (exposed to ionizing radiation) material when subjected to an appropriate optical stimulation, emits a light signal proportional to the absorbed dose. The wavelength of the emitted light **is** the characteristic of the **OSL** material.

The measure of a luminescence

Within a number of materials, the electrons and holes produced during radiation exposure can become trapped at crystal defects. These remain stored until they are excited, or stimulated, from these traps giving rise to optical emission. The intensity of the optical emission is a function of the radiation exposure and the method/intensity of the stimulation. If the trapped charges are excited by thermal stimulation (thermoluminescence) then most of them are released and any record of the radiation exposure is lost. However, if the trapped charges are optically stimulated, only a small fraction of the trapped charge is released. The process is optimized by the frequency of the stimulating light, the characteristics of the photomultiplier used to detect the emitted light, and the material used as the OSL detector.

During readout, only a small fraction of the trapped charges is released. Thus, much of the trapped charge is retained following stimulation and may be released in subsequent stimulations. This enables OSL dosimeters to be read out many times without significant loss of signal.

Note: The "Individual" is referencing the student and/or the faculty person

What they are not
They do not protect you from radiation; however, they are considered a form of radiation protection because you get quarterly reports of how much radiation you received. After viewing report, you may decide you need to change your radiation protection practices.

They are not to be mistreated. Do not wash or dry it; do not leave it out in the sun for extended periods (in car); and do not leave it lying in a radiographic room (incl. CT); do not forget to take it off the apron directly after apron use; do not wear in tanning salons, do not wear for personal medical x-ray, i.e., If you mistreat it (intentionally or unintentionally) please report it to the RSO. Any abnormal readings must be documented in our records and the monitoring company records.

They are not to be shared!

How to wear (individual dosimeter)
Must be worn at collar level clipped to clothing
(not to be clipped on the name badge because it will flip around backwards and not read properly)

Must be worn outside of lead apparel (collar level)

How will I know what my exposure is?
The acting RSO will review quarterly report with individual.

Students Remember if you forget your dosimeter on a clinical day, you will be sent home and the day is counted as a full absence.

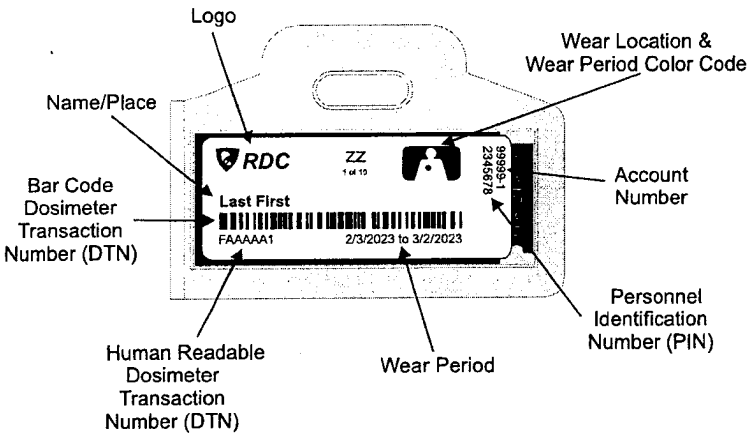
If you lose your dosimeter, you must inform the acting RSO, **IMMEDIATELY**! The monitoring company will have to overnight you a replacement OSL (which can take up to three days to arrive from Texas). The cost of overnight shipping and the replacement badge is to be paid by the student.

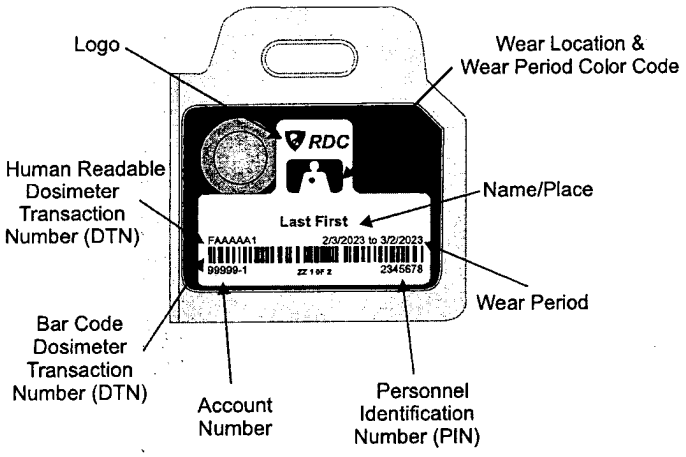
RADIATION DETECTION CO.

Invisible guardians of the people who keep us safe

TLD-XBGN & OSL Dosimeters

Badge Label Information and Wear Instructions





An accredited dose monitoring program is required to demonstrate compliance with state and/or federal regulations. RDC's dosimetry service is designed to provide valuable dose information for a facility's personnel monitoring program. To obtain accurate and meaningful data from our service, it is important to observe the following:

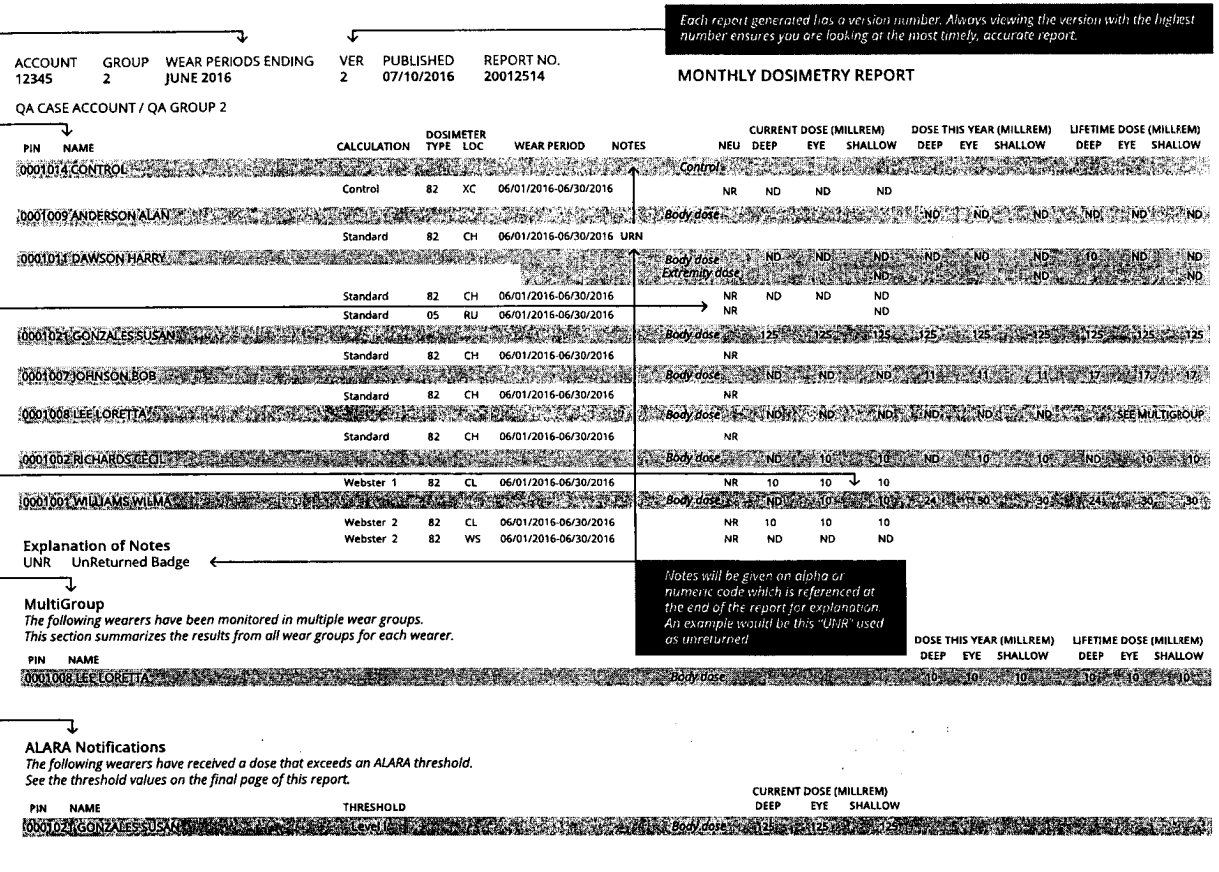
- The dosimeter should be worn at all times when there is a potential for occupational exposure to ionizing radiation.
- Dosimeters not in use should be stored in an area without radiation to prevent exposure that is not work-related.
- Remember to return the control dosimeter with the rest of the dosimeters for the same wear period. The control is used to monitor background radiation and any dose received by the dosimeters in transit. Any dose recorded by the control is subtracted from the other dosimeters, so the control should not be used for any other purpose.
- Dosimeters should be worn at the body location indicated on the dosimeter label and should never be cut, covered, blocked, or written on. When a protective garment is worn, the dosimeter should be worn at the collar, outside the protective garment or at the waist, behind the protective garment.
- Be sure to use only the dosimeter marked with the proper individual's identification. If it is necessary to reassign an unused dosimeter, please provide the necessary information on a "Badge Reassignment Form" (available online) and enclose it when you return the dosimeters.
- Replacement dosimeters for the next monitoring period will be sent before the beginning of the next monitoring period. Begin wearing the dosimeters on the date printed on the dosimeter label. Return worn dosimeters from the previous monitoring period, along with their control, in the pre-addressed mailing envelope or box provided. **PLEASE REMEMBER TO APPLY APPROPRIATE POSTAGE TO AVOID DELIVERY DELAYS AND INSUFFICIENT POSTAGE CHARGES.**
- To avoid unreturned dosimeter charges, return dosimeters promptly after each wear period.
- Please remember to detach the clip strap during dosimter change out and transfer it to your replacement dosimeter. Return only the dosimeter (less the strap) worn in the previous monitoring period for processing.

3527 Snead Drive - Georgetown, TX 78626
1-800-250-3314 | radetco.com

How to read your **Dosimetry Report**

Periodic reports are now just that. If you are looking for information on a "June dosimeter", you will find it on your June report, regardless of the dosimeter return date.

Each report generated has a version number. Always viewing the version with the highest number ensures you are looking at the most timely, accurate report.



ACCOUNT 12345 | GROUP 2 | WEAR PERIODS ENDING JUNE 2016 | VER 2 | PUBLISHED 07/10/2016 | REPORT NO. 20012514

MONTHLY DOSIMETRY REPORT

QA CASE ACCOUNT / QA GROUP 2

PIN	NAME	CALCULATION	DOSIMETER TYPE	LOC	WEAR PERIOD	NOTES	NEU	CURRENT DOSE (MILLREM) DEEP	EYE	SHALLOW	DOSE THIS YEAR (MILLREM) DEEP	EYE	SHALLOW	LIFETIME DOSE (MILLREM) DEEP	EYE	SHALLOW
0001014	CONTROL	Control	82	XC	06/01/2016-06/30/2016		NR	ND	ND	ND						
0001009	ANDERSON,ALAN	Standard	82	CH	06/01/2016-06/30/2016	URN										
		Body dose						ND	ND	ND	ND	ND	ND	ND	ND	ND
0001011	DAWSON,HARRY	Extremity dose														
		Standard	82	CH	06/01/2016-06/30/2016		NR	ND	ND	ND						
		Standard	05	RU	06/01/2016-06/30/2016		NR			ND						
0001021	GONZALES,SUSAN	Body dose						125	125	125	125	125	125	125	125	125
		Standard	82	CH	06/01/2016-06/30/2016		NR									
0001007	JOHNSON,BOB	Body dose						ND	ND	ND	11	11	11	17	17	17
		Standard	82	CH	06/01/2016-06/30/2016		NR									
0001008	LEE,LORETTA	Body dose						ND	ND	ND	ND	ND	ND	SEE MULTIGROUP		
		Standard	82	CH	06/01/2016-06/30/2016		NR									
0001002	RICHARDS,CECIL	Body dose						ND	10	10	ND	10	10	ND	10	10
		Webster 1	82	CL	06/01/2016-06/30/2016		NR	10	10	10						
0001001	WILLIAMS,WILMA	Body dose						ND	10	10	24	30	30	24	30	30
		Webster 2	82	CL	06/01/2016-06/30/2016		NR	10	10	10						
		Webster 2	82	WS	06/01/2016-06/30/2016		NR	ND	ND	ND						

Explanation of Notes
UNR UnReturned Badge

When returned with your dosimeters, the control dosimeter lists values in the calculation of your assigned dose. YTD and Lifetime are not tracked as these values in themselves are not actual dose.

ND - indicates that your dosimeter was processed, but the dose is below our minimum reportable dose of 10 millrem.

NR - indicates that the dosimeter does not monitor dose in that category.

Highlighted areas contain your assigned/effective dose for this report. It is representative of either a single dosimeter dose, the calculated dose of multiple dosimeters listed immediately underneath, or an Effective Dose Equivalent (EDE) calculation.

Notes will be given an alpha or numeric code which is referenced at the end of the report for explanation. An example would be this "UNR" used as unreturned.

MultiGroup
The following wearers have been monitored in multiple wear groups.
This section summarizes the results from all wear groups for each wearer.

Users working in multiple groups should be tracked across all groups to ensure compliance to yearly exposure limits.

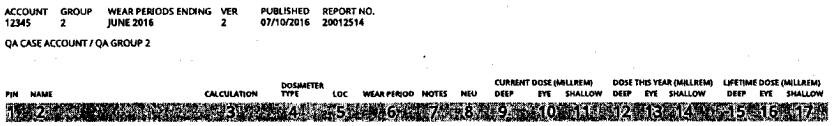
PIN	NAME		DOSE THIS YEAR (MILLREM) DEEP	EYE	SHALLOW	LIFETIME DOSE (MILLREM) DEEP	EYE	SHALLOW
0001008	LEE,LORETTA	Body dose	10	10	10	10	10	10

ALARA Notifications
The following wearers have received a dose that exceeds an ALARA threshold.
See the threshold values on the final page of this report.

ALARA Notifications can be found at the end of each report. If you have a specific ALARA limit you would like to have set for you, please contact a Customer Care representative. We will be happy to make that adjustment for you.

PIN	NAME	THRESHOLD		CURRENT DOSE (MILLREM) DEEP	EYE	SHALLOW
0001021	GONZALES,SUSAN	Level I	Body dose	125	125	125

Explanation of **Dosimetry Report**



ACCOUNT 12345 | GROUP 2 | WEAR PERIODS ENDING JUNE 2016 | VER 2 | PUBLISHED 07/10/2016 | REPORT NO. 20012514

QA CASE ACCOUNT / QA GROUP 2

PIN	NAME	CALCULATION	DOSIMETER TYPE	LOC	WEAR PERIOD	NOTES	NEU	CURRENT DOSE (MILLREM) DEEP	EYE	SHALLOW	DOSE THIS YEAR (MILLREM) DEEP	EYE	SHALLOW	LIFETIME DOSE (MILLREM) DEEP	EYE	SHALLOW
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

1. RDC assigned wearer identification number.
2. Employee name, area monitor location, or other reference designation.
3. Calculation methodology used for assigned dose computation.
4. Dosimeter Type:
   - 82 XBGN
   - 83 XBGN + Track Etch
   - 82W Wrist TLD XBGN
   - 82E Environmental TLD XBGN
   - 83E Environmental TLD XBGN + Track Etch
   - 05 Extremity ring
5. Location code - where on the body the dosimeter is worn:
   - XC *Control*
   - CH *Chest*
   - CL *Collar*
   - WS *Waist*
   - FM *Fetal Monitor*
   - EV *Environmental or Area Monitor*
   - RU *Right Hand or Upper Extremity*
   - LU *Left Hand or Upper Extremity*
6. The wear period the dosimeter monitored.
7. Notes pertaining to the specific dosimeter.
8. Neutron component of Deep Dose.
9. Deep Dose Equivalent applies to external whole body exposure and is the dose equivalent at a tissue depth of 1 centimeter (1000 mg/cm2). Dose in millirem is reported for photon energies from approximately 10 keV to MeV. Neutron dose is included if applicable.
10. Eye Dose Equivalent applies to the external exposure to the lens of the eye and is the dose equivalent at a tissue depth of 0.3 centimeters (300 mg/cm2). It includes dose in millirem for beta particles and photons. Neutron dose is included if applicable.
11. Shallow Dose Equivalent applies to the external exposure of the skin or an extremity and is the dose equivalent at a tissue depth of 0.007 centimeters (7 mg/cm2) averaged over an area of 1 square centimeter. It includes dose in millrem for beta particles and photons. Extremity doses are reported in this column based on 662 keV photons unless other energy or radiation source information is available. Neutron dose is included if applicable.
12. Year to Date Cumulative Deep Dose. Neutron dose is included if applicable.
13. Year to Date Cumulative Eye Dose. Neutron dose is included if applicable.
14. Year to Date Cumulative Shallow Dose. Neutron dose is included if applicable.
15. Lifetime Cumulative Deep Dose. Neutron dose is included if applicable.
16. Lifetime Cumulative Eye Dose. Neutron dose is included if applicable.
17. Lifetime Cumulative Shallow Dose. Neutron dose is included if applicable.

Note: The "Individual" is referencing the student and/or the faculty person

Edgecombe Community College
Radiography Program

Student Declaration of Pregnancy Form

In accordance with the NRC's regulations at 10 CFR 20.1208, "Dose to an Embryo/Fetus," I am voluntarily, declaring my pregnancy. I believe I became pregnant in _____ of 20_____. (month/year).

I understand the radiation dose to my embryo/fetus during my entire pregnancy is not allowed to exceed 5 mSv (500 mrem). The equivalent dose to the embryo-fetus in a month cannot exceed 0.5 mSv (50 mrem) (unless that dose has already been exceeded between the time of conception and submitting this declaration). As a pregnant student, I also understand the program must allow me continuance in the clinical component without modification. The program may offer clinical component options such as: (1) clinical reassignments and/or (2) leave of absence.

I have been given the opportunity to read and discuss USNRC Regulatory Guide 8.13 "Instruction concerning Prenatal Radiation Exposure", NCRPAR Rules and Regulations, Parts15A NCAC 11 .1316 and 15A NCAC 11 .1610 and the NCRP Report no. 116.

I, _____, am declaring pregnancy. I have met with the Program Chair, Clinical Coordinator and the Acting Radiation Safety Officer. I am choosing to select Option _____.

Option I:

The female has the right to make written voluntary declaration of pregnancy.

Option II:

Continue with the clinical components without modifications, until pregnancy is terminated. I understand that I am expected to fulfill all work requirements and adhere to all radiation guidelines and recommendations as follows:

a) The pregnant individual will be provided an additional dosimeter badge to monitor exposure to the fetus.
b) The pregnant individual will be required to adhere to the provisions of ALARA.
c) No more than 10% of the allowable monthly fetal dose will be tolerated without a conference with the acting RSO and a plan of action (POA) will be enforced. Ten percent of the monthly fetal dose is 5mrem.

The radiography program will not be responsible for any injuries to the embryo/fetus should the employee or student decide to remain working or in the program during the entire gestational period. All students must meet the same clinical requirements for graduation.

Note: The "Individual" is referencing the student and/or the faculty person

Option III:

The student may request a leave of absence from the program and return after pregnancy or maternity leave with a doctor's clearance note.
The student must inform the program chair of her scheduled return. All students must meet the same clinical requirements for graduation.

The student may request a leave of absence when she, the physician, or the Program Chair believes that it is no longer viable for her to function in a manner conducive to learning. All students must meet the same clinical requirements for graduation.

Option IV:

The student may request a leave of absence from the program and return within 1 year after re-admission and not lose her status in the program, contingent upon JRCERT standard of 1:1 student to tech ratio (meaning if there is clinical space). The student MUST inform the Program Chair of her intent to return 3- months prior to ensure the program remains in compliance with JRCERT student supervision requirements. All students must meet the same clinical requirements for graduation.

Option V:

Written withdrawal of declaration. I understand I have the right to withdraw this declaration.
_____ (initials)

If written withdrawal of declaration, date supported: _____ _____(initials)

Plan of scheduled return after pregnancy withdraw: _____ _____(initials)

Pregnant Individual

Signature_____ Date:_____

Program Chair_____Date:_____

Clinical Coordinator _____Date: _____

Acting RSO _____Date: _____

Acting Radiation Safety Section use only:

FETAL BADGE NUMBER: _____ DATE ISSUED: _____ DATE TERMINATED:_____

**updated: 2024,2020, 2016,2015,2014,2013,2012*

(updated 7/2024)

Note: The "Individual" is referencing the student and/or the faculty person

RAD STUDENT RULES

For

RAD LAB AND EQUIPMENT CARE

- **NO FOOD OR DRINKS IN THE GENERATED LAB AREA – ABSOLUTELY NO GUM!**
- **NO TAPE TO BE LEFT STUCK ON EQUIPMENT, GRID HOLDERS, CR/DR IMAGE RECEPTORS, TABLE OR TABLE PAD!**
- **NON-ALCOHOL WIPES TO BE USED TO CLEAN EQUIPMENT ONLY! [CAVI WIPES]**
- **CLEAN EQUIPMENT/PHANTOMS AFTER END OF EACH LAB OR USE!**
- **RETURN ALL EQUIPMENT, PHANTOMS, ACCESSORIES BACK IN THEIR PROPER HOMES AT THE END OF THE LAB (Neat and Tidy)!**
- **ALL MARKERS PLACED BACK ON MARKER BOARD!**
- **LEAD APRONS TO BE HUNG UP NEATLY AT END OF EACH USE!**
- **STRAIGHTEN AND CLEAN WORKSTATION COMPUTER AREA AFTER END OF USE!**
- **RADIATION MONITORING BADGES MUST BE ON COLLAR FOR ALL GENERATED EXPOSURES!**
- **PHANTOMS/EQUIPMENT THAT IS LOANED OFF CAMPUS MUST BE LOGGED IN X-RAY EQUIPMENT/PROPTERY LOAN LOG BOOK and INITIALED BY A FACULTY MEMBER!**

(updated 7/2024)

Note: The "Individual" is referencing the student and/or the faculty person

LAST LAB OF THE DAY OR LAST PERSON TO USE ENERGIZED EQUIPMENT

- **WIPE DOWN ALL EQUIPMENT WITH Approved CAVI-WIPES ONLY!**
- **PLACE SLIDE BOARD ON X-RAY TABLE WITH PILLOW ON TOP**
- **PLACE DR PLATE INSIDE THE BUCKY**
- **CLOSE COLLIMATOR SHUTTERS**
- **PLACE X-RAY TUBE IN 'SLEEP MODE'**
- **CENTER AND LOWER X-RAY TABLE**
- **TURN OFF X-RAY CONTROL CONSOLE**
- **TURN OFF MAIN POWER SWITCHES**
- **INSTRUCTOR TO LOCK CIRCUIT BREAKER**
- **ALL LIGHTS TURNED OFF**
- **MAKE SURE ALL LAB DOORS ARE CLOSED AND LOCKED!**

Note: The "Individual" is referencing the student and/or the faculty person

SAFETY GUIDELINES

For The

GENERATED RADIOGRAPHY LAB

1. Always wear a dosimeter badge on collar to obtain a record of radiation exposure over a given period of time.
2. **No person** is allowed in the radiography lab while exposures are being made.
3. The radiography lab will be kept locked except when being used under supervision of a registered radiographer who is readily available.
4. A radiography faculty member must be present with students if radiation exposures are being made.
5. Students must attend a lab orientation before being allowed to make exposures. The lab orientation will include instruction on equipment operation and radiation protection.
6. Radiographic exposures will only be made of the positioning dummy, phantoms, and other testing or teaching equipment.

For additional safety guidelines, please see the document North Carolina Regulations for Protection Against Radiation located in the office of the Radiography Program Chair and/or Acting Radiation Safety Officer.

(updated 7/2024)

Note: The "Individual" is referencing the student and/or the faculty person

Tube Warm Up - Procedure

- Close collimator blades fully prior to exposure
- Select 80 kVp, 100 mA or 200 mA
- Make sure no one will be exposed!!!!! Always double check prior to exposure!
- Make (3) exposures, 30 seconds apart

(updated 7/2024)

NC DEPARTMENT OF
HEALTH AND HUMAN SERVICES
Division of Health Service Regulation

NOTICE TO EMPLOYEES

Standards for Protection Against Radiation; Notices; Instructions and Reports to Workers; Inspections

NORTH CAROLINA
RADIATION PROTECTION

EMPLOYEE'S RESPONSIBILITY AS A WORKER:
Familiarize yourself with the provisions of the radiation protection regulations and operating procedures that apply to the work in which you are engaged. Observe those provisions for your own protection, the protection of your co-workers and others. If you observe conditions which may lead to violations or have a safety concern, promptly report them to your supervisor.

WHAT IS COVERED BY THESE REGULATIONS?

1. Limits on exposure to radiation and radioactive materials in restricted and unrestricted areas;
2. Measures to be taken after accident exposure;
3. Personnel monitoring, surveys, and equipment;
4. Caution signs, labels and safety interlock equipment; and
5. Exposure records and reports.

YOUR EMPLOYER'S RESPONSIBILITY:

1. Comply with the requirements of North Carolina Regulations for Protection Against Radiation 10A NCAC 15 pertaining to work involving sources of radiation; departmental orders and registration or licensing conditions;
2. Post or otherwise make available to you a copy of the North Carolina Regulations for Protection Against Radiation 10A NCAC 15, certificates, registrations or licenses and the operating procedures that apply to the work you perform, and explain those provisions to you;
3. Post Notices of Violation involving radiological working conditions and orders.
4. Provide adequate radiation safety training to you, including the use of radiation producing devices or radioactive materials you may be expected to use.
5. Keep your radiation exposure as far below the maximum allowable limits as is "reasonably achievable."
6. Provide you with information on your exposure to radiation.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY
Your employer is required to maintain records of your exposure to radiation as required by 10 CFR 20.2106. Your employer is required to provide you with written notification or a report of your exposure history under 10 CFR 19.13 if:

1. Your dose exceeds 100 millirem TEDE or 100 millirem to any organ or tissue over the monitoring year, or if you request your annual dose.
2. You receive an exposure in excess of the annual dose limits. Your employer is required by 10 CFR 20.2205 to give you this report within 30 days of the discovery of the exposure exceeding the dose limits. The exposure limits for occupational workers are found in 10 CFR 20.1201.
3. You are no longer employed by the licensee, and you request your exposure history from your former employer. 10 CFR 19.13(e) requires your former employer to provide you with this report within 30 days of your request, or 30 days after your dose is determined, whichever is later.

POSTING REQUIREMENT
Copies of this notice must be posted in a sufficient number of places in every establishment where employees perform activities regulated by NC Radiation Protection; to permit employees working in or frequenting any portion of a restricted or controlled area to observe a copy on their way to or from their place of employment.

INSPECTIONS
All licensed or registered activities are subject to inspections by representatives of the NC Department of Health and Human Services. During inspections, agency inspectors may confer privately with workers; and workers may bring to the attention of the inspectors any past or present condition which they believe contributed to or caused any violation as described above. The employer must not prevent you from talking with an inspector. If you believe your employer has not corrected violations involving radiological working conditions, you may request an inspection. The request must specify exactly what is wrong and must be signed by the worker or worker representative. The agency will make all reasonable efforts to protect your identity where appropriate and possible.

REPORTING SAFETY CONCERNS
Inquiries dealing with the matters outlined above are to be made to the Radiation Protection Section. Agency representatives may be reached during normal weekday work hours (8 a.m. - 5 p.m.) **by phone at (919) 814-2250 or by mail to: Section Chief, NC Radiation Protection, 5505 Creedmoor Road, Suite 100, 1645 Mail Service Center, Raleigh, NC 27699-1600.**

RADIOACTIVE MATERIALS BRANCH INCIDENT 24 HOUR EMERGENCY LINE:
(919) 602-7151.
After normal hours, calls may be directed to the NC Emergency Management Operation Center at
(800) 858-0368.

EMPLOYMENT DISCRIMINATION
The North Carolina Employment Discrimination Bureau (EDB) enforces the Retaliatory Employment Discrimination Act (REDA). Employees who have questions about the application of REDA or employees who believe they have been discriminated or retaliated against, should contact the EDB information officer. They will advise you of the proper procedures to file a complaint. You may contact them by sending mail to N.C. Department of Labor, Employment Discrimination Bureau, 1101 Mail Service Center, Raleigh, NC 27699-1101 or by fax at (919) 807-2824 or by phone at (800) 625-2267 or fax (919) 807-2856 That website is **http://www.nclabor.com.**

www.ncdhhs.gov • N.C. DHHS is an equal opportunity employer and provider. • 5,000 copies of this public document were printed at a cost of $320.30 or $.06406 per copy. 9/19

Health Service Regulation
HEALTH AND HUMAN SERVICES

NORTH CAROLINA DEPARTMENT OF HEALTH AND HUMAN SERVICES
DIVISION OF HEALTH SERVICE REGULATION | RADIATION PROTECTION SECTION

NOTICE TO EMPLOYEES

Standards for Protection Against Radiation (Section .1600); Notices: Instructions and Reports to Workers (Section .1000); Employee Protection

YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to:

1. Apply the North Carolina Regulations for Protection Against Radiation (10A NCAC 15) to work involving radioactive materials and/or sources of radiation;
2. Post or otherwise make available to you a copy of the Radiation Protection Commission regulations, certificates, licenses or registrations, and the operating procedures which apply to the work you perform, and explain their provisions to you; and
3. Post Notices of Violation involving radiological working conditions and orders.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The Radiation Protection Commission regulations require that your employer give you a written report if you receive an exposure in excess of any applicable limit as set forth in the regulations or in the license. The basic limits for exposure to employees are set forth in 10A NCAC 15 .1604, .1609 and .1610. These rules specify limits on exposure to radiation and to concentrations of radioactive material in air.
2. If you work where personnel monitoring is required, and if you request information on your radiation exposures,
   (a) Your employer must give you a written report of your radiation exposures upon termination of your employment, and
   (b) Your employer must advise you annually of your exposure to radiation.

POSTING REQUIREMENT

Copies of this notice must be posted in a sufficient number of places in every establishment where employees are employed in activities licensed or registered, pursuant to 10A NCAC 15 .0200 and .0300, by the N.C. Department of Health and Human Services, to permit employees working in or frequenting any portion of a restricted area to read and observe on the way to or from any particular work location to which the document applies.

WHAT IS COVERED BY THESE REGULATIONS

1. Limits on exposure to radiation and radioactive materials in restricted and unrestricted areas;
2. Measures to be taken after accident exposure;
3. Personnel monitoring, surveys, and equipment;
4. Caution signs, labels and safety interlock equipment;
5. Exposure records and reports;
6. Options for workers regarding agency inspections; and
7. Related matters.

YOUR RESPONSIBILITY AS A WORKER

For your own protection and the protection of your co-workers, you should familiarize yourself with the provisions of the Radiation Protection Commission regulations and the operating procedures which apply to the work you perform.

INSPECTIONS

All licensed or registered activities are subject to inspection by representatives of N.C. Department of Health and Human Services. In addition, any worker or representative of workers who believes that there is a violation of the N.C. Radiation Protection Act, the regulations issued thereunder, or the terms of the employer's license or registration with regard to radiological working conditions in which the worker is engaged, may request an inspection by sending a notice of the alleged violation to: *Section Chief, Radiation Protection Section, 1645 Mail Service Center, Raleigh, NC 27699-1600.* The request must set forth the specific grounds for the notice and signed by the employee or the representative of the employee. The agency will make all reasonable efforts to protect your identity where appropriate and possible. During inspections, agency inspectors may confer privately with workers; any worker may bring to the attention of the inspectors any past or present condition which he or she believes contributed to or caused any violation as described above.

OTHER EMPLOYEE PROTECTIONS

Federal Law prohibits an employer from firing or otherwise discriminating against you for bringing safety concerns to the attention of your employer or the N.C. Radiation Protection Section. Your employer cannot fire you or discriminate against you with respect to pay, benefits, or working conditions because you help the N.C. Radiation Protection Section or raise a safety issue or otherwise engage in protected activities. If you feel that you have been discriminated against for identifying violations or safety concerns, you may file a complaint with the Employment Discrimination Bureau of the North Carolina Department of Labor (800) 625-2267 or ***http://www.nclabor.com***). They will advise you of the proper procedures to file a complaint.

HOW TO CONTACT THE RADIATION PROTECTION SECTION

The Radiation Protection Section is located at 5505 Creedmoor Road, Suite 100, Raleigh NC 27612. Agency representatives may be reached by telephone at (919) 814-2250 during normal weekday work hours (8 a.m. – 5 p.m.). After normal business hours, calls may be directed to the N.C. Emergency Management Operations Center at (800) 858-0368. You may also obtain additional information about the agency online ***http://www.ncradiation.net.***

The Radioactive Material Branch 24 hour emergency line is (919) 602-7151.

NRC FORM 3
(8-2017)

UNITED STATES NUCLEAR REGULATORY COMMISSION
Washington, DC 20555-0001

NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION (PART 20); NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS; INSPECTIONS (PART 19); EMPLOYEE PROTECTION

WHAT IS THE NUCLEAR REGULATORY COMMISSION?

The Nuclear Regulatory Commission (NRC) is an independent Federal regulatory agency responsible for licensing and inspecting nuclear power plants and other commercial uses of radioactive materials.

WHAT DOES THE NRC DO?

The NRC's primary responsibility is to ensure that workers and the public are protected from unnecessary or excessive exposure to radiation and that nuclear facilities, including power plants, are constructed to high quality standards and operated in a safe and secure manner. The NRC does this by establishing requirements in Title 10 of the Code of Federal Regulations (10 CFR) and in licenses issued to nuclear users.

WHAT RESPONSIBILITY DOES MY EMPLOYER HAVE?

Any company that conducts activities licensed by the NRC must comply with the NRC's requirements. If a company violates NRC requirements, it can be fined or have its license modified, suspended or revoked.

Your employer must tell you which NRC radiation requirements apply to your work and must post NRC Notices of Violation involving radiological working conditions.

WHAT IS MY RESPONSIBILITY?

For your own protection and the protection of your co-workers, you should know how NRC requirements relate to your work and should follow them. If you observe violations of the requirements or have a safety concern, you should report them.

WHAT IF I CAUSE A VIOLATION?

If you engaged in deliberate misconduct that may cause a violation of the NRC requirements, or would have caused a violation if it had not been detected, or deliberately provided inaccurate or incomplete information to either the NRC or to your employer, you may be subject to enforcement action. If you report such a violation, the NRC will consider the circumstances surrounding your reporting in determining the appropriate enforcement action, if any.

HOW DO I REPORT VIOLATIONS AND SAFETY CONCERNS?

If you believe that violations of NRC rules or the terms of the license have occurred, or if you have a safety concern, you should report them immediately to your supervisor. You may report violations or safety concerns directly to the NRC. However, the NRC encourages you to raise your concerns with the licensee since the licensee has the primary responsibility for, and is most able to ensure, safe operation of nuclear facilities. If you choose to report your concern directly to the NRC, you may report it to an NRC inspector or call or write to the NRC Regional Office serving your area. If you send your concern in writing, it will assist the NRC in protecting your identity if you clearly indicate that you would like your concern to be considered by the NRC Allegation Program. The NRC's toll-free SAFETY HOTLINE for reporting safety concerns is listed below. The addresses for the NRC Regional Offices and the toll-free telephone numbers are also listed below. You can also e-mail safety concerns to NRC.Allegation@nrc.gov.

WHAT IF I WORK WITH RADIOACTIVE MATERIAL OR IN THE VICINITY OF A RADIOACTIVE SOURCE?

If you work with radioactive materials or near a radiation source, the amount of radiation exposure that you are permitted to receive may be limited by NRC regulations. The limits on exposure for workers at NRC licensed facilities whose duties involve exposure to radiation are contained in sections 20.1201, 20.1207, and 20.1208 of Title 10 of the Code of Federal Regulations (10 CFR 20) depending on the part of the regulations to which your employer is subject. While these are the maximum allowable limits, your employer should also keep your radiation exposure as far below those limits as is "reasonably achievable."

MAY I GET A RECORD OF MY RADIATION EXPOSURE?

Yes. Your employer is required to make available to you the information in your dose records (as maintained under the provisions of 10 CFR 20.2106). In addition your employer is required to provide you with an annual report of the dose you received in that monitoring year if the dose exceeds 100 millirem, or if you request an annual report.

HOW ARE VIOLATIONS OF NRC REQUIREMENTS IDENTIFIED?

NRC conducts regular inspections at licensed facilities to assure compliance with NRC requirements. In addition, your employer and site contractors may conduct their own inspections to assure compliance. All inspectors are protected by Federal law. Interference with them may result in criminal prosecution for a Federal offense.

MAY I TALK WITH AN NRC INSPECTOR?

Yes. NRC inspectors want to talk to you if you are worried about radiation safety or have other safety concerns about licensed activities, such as the quality of construction or operations at your facility. Your employer may not prevent you from talking with an inspector. The NRC will make all reasonable efforts to protect your identity where appropriate and possible.

MAY I REQUEST AN INSPECTION?

Yes. If you believe that your employer has not corrected violations involving radiological working conditions, you may request an inspection. Your request should be addressed to the nearest NRC Regional Office and must describe the alleged violation in detail. It must be signed by you or your representative.

HOW DO I CONTACT THE NRC?

Talk to an NRC inspector on-site or call or write to the nearest NRC Regional Office in your geographical area (see map below). If you call the NRC's toll-free SAFETY HOTLINE during normal business hours, your call will automatically be directed to the NRC Regional Office for your geographical area. If you call after normal business hours, or if your call can't be answered during normal business hours by the regional staff, your call will be directed to the NRC's Headquarters Operations Center, which is manned 24 hours a day. Calls to the Headquarters Operations Center are recorded. You can also e-mail safety concerns to NRC.Allegation@nrc.gov.

CAN I BE FIRED FOR RAISING A SAFETY CONCERN?

Federal law prohibits an employer from firing or otherwise discriminating against you for bringing safety concerns to the attention of your employer or the NRC. You may not be fired or discriminated against because you engage in certain protected activities, including but not limited to,

- asking the NRC to enforce its rules against your employer;
- refusing to engage in activities which violate NRC requirements;
- providing information or preparing to provide information to the NRC or your employer about violations of requirements or safety concerns; or
- asking for, or testifying, helping, or taking part in an NRC, Congressional, or any Federal or State proceeding.

WHAT FORMS OF DISCRIMINATION ARE PROHIBITED?

It is unlawful for an employer to fire you or discriminate against you with respect to pay, benefits, or working conditions because you help the NRC or raise a safety issue or otherwise engage in protected activities. Violations of Section 211 of the Energy Reorganization Act (ERA) of 1974 (42 U.S.C. 5851) include actions such as harassment, blacklisting, and intimidation by employers of (i) employees who bring safety concerns directly to their employers or to the NRC; (ii) employees who have refused to engage in an unlawful practice, provided that the employee has identified the illegality to the employer; (iii) employees who have testified or are about to testify before Congress or in any Federal or State proceeding regarding any provision (or proposed provision) of the ERA or the Atomic Energy Act (AEA) of 1954; or (iv) employees who have commenced or caused to be commenced a proceeding for the administration or enforcement of any requirement imposed under the ERA or AEA or who have, or are about to, testify, assist, or participate in such a proceeding.

HOW DO I FILE A DISCRIMINATION COMPLAINT?

If you believe that you have been discriminated against for bringing violations or safety concerns to the NRC or your employer, you may file a complaint with the NRC, the U.S. Department of Labor (DOL), or appropriate state entities. If you desire a personal remedy, a complaint may be filed with the DOL pursuant to Section 211 of the ERA or with appropriate state entities. Your complaint to the DOL must describe in detail the basis for your belief that the employer discriminated against you on the basis of your protected activity, and it must be filed in writing either in person or by mail within 180 days of the date of the alleged discriminatory action or the date you received any notice, in writing or otherwise, of an adverse personnel action, whichever occured first. Additional information is available at the DOL web site at www.osha.gov. Filing an allegation, complaint, or request for action with the NRC does not extend the requirement to file a complaint with the DOL within 180 days. To do so, you may contact the Allegation Coordinator in the appropriate NRC Region, as listed below, who will provide you with the address and telephone number of the correct OSHA Regional office to receive your complaint. You may also check your local telephone directory under the U.S. Government listings for the address and telephone number of the appropriate OSHA Regional office.

WHAT CAN THE DEPARTMENT OF LABOR DO?

If your complaint involves a violation of Section 211 of the ERA by your employer, the DOL provides a process for obtaining a personal remedy. The DOL will notify your employer that a complaint has been filed and will investigate your complaint.

If the DOL finds that your employer has unlawfully discriminated against you, it may order that you be reinstated, receive back pay, or be compensated for any injury suffered as a result of the discrimination and be paid attorney's fees and costs.

Relief will not be awarded to employees who engage in deliberate violations of the Energy Reorganization Act or the Atomic Energy Act.

WHAT WILL THE NRC DO?

The NRC will evaluate each allegation of harassment, intimidation, or discrimination to determine whether sufficient information is provided to initiate NRC involvement. To assist in this evaluation, an investigator from the NRC's Office of Investigations (IO) may interview you and gather any applicable documentation in your possesion. If the NRC determines that the allegation falls within its purview, NRC's OI will initiate an investigation of your allegation of discrimination unless, prior to the initiation of such investigation, you choose to engage in mediation with your employer in an attempt to settle your allegation of discrimination. If a settlement is reached and the NRC is provided such agreement for review and fincs it acceptable, the NRC will close your allegation of discrimination and will not perform an investigation. However, any settlement agreement between you and your employer on your discrimination claim will not impact, in any way, the resolution of the underlying technical issues or any other allegation you may have filed or will file with the NRC. Alternatively, if an acceptable settlement is not reached, NRC's OI will initiate an investigation.

If the NRC or the DOL finds that unlawful discrimination has occurred, the NRC may issue a Notice of Violation to your employer, impose a fine, or suspend, modify, or revoke your employer's NRC license.

Nuclear Power Plants

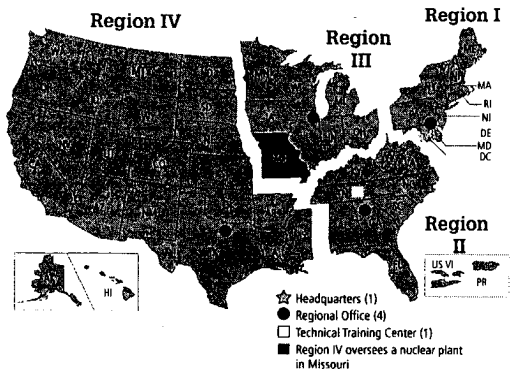
- Each regional office oversees the plants in its region—except for the Callaway plant in Missouri, which Region IV oversees.

Materials Licensees

- Region I oversees licensees and Federal facilities located geographically in Region I and Region II.
- Region III oversees licensees and Federal facilities located geographically in Region III.
- Region IV oversees licensees and Federal facilities located geographically in Region IV.

Nuclear Fuel Processing Facilities

- Region II oversees all the fuel processing facilities in all regions.
- Region II also handles all construction inspection activities for new nuclear power plants and fuel cycle facilities in all regions.



UNITED STATES NUCLEAR REGULATORY COMMISSION REGIONAL OFFICE LOCATIONS

A representative of the Nuclear Regulatory Commission can be contacted by employees who wish to register complaints or concerns about radiological working conditions or other matters associated with NRC-regulated activities at the following addresses and telephone numbers.

REGIONAL OFFICES

REGION	ADDRESS	TELEPHONE
I	U.S. Nuclear Regulatory Commission, Region I 2100 Renaissance Boulevard, Suite 100 King of Prussia, PA 19406-2713	(800) 432-1156
II	U.S. Nuclear Regulatory Commission, Region II 245 Peachtree Center Avenue ,NE., Suite 1200 Atlanta, GA 30303-1257	(800) 577-8510
III	U.S. Nuclear Regulatory Commission, Region III 2443 Warrenville Road, Suite 210 Lisle, IL 60532-4352	(800) 522-3025
IV	U.S. Nuclear Regulatory Commission Region, IV 1600 East Lamar Boulevard Arlington, Texas 76011-4511	(800) 952-9677

To report safety concerns or violations of NRC requirements by your employer,

telephone:

NRC SAFETY HOTLINE

1-800-695-7403

To report incidents involving fraud, waste, or abuse by an NRC employee or NRC contractor,

telephone:

OFFICE OF THE INSPECTOR GENERAL HOTLINE

1-800-233-3497

Note: The "Individual" is referencing the student and/or the faculty person

JRCERT Position Statement on Gonadal Shielding in the Clinical Setting

The Joint Review Committee on Education in Radiologic Technology (JRCERT) Standards for an Accredited Educational Program in Radiography are designed to promote academic excellence, patient safety, and quality healthcare.

Standard Five - Objective 5.3 of the **Standards** requires programs to assure students employ proper safety practices. Programs achieve this by instructing students in the utilization of imaging equipment, accessories, optimal exposure factors, and proper patient positioning to minimize radiation exposure to patients, selves, and others. These practices assure radiation exposures are kept as low as reasonably achievable (ALARA).

Gonadal shielding has been a longstanding practice during radiography examinations in instances where the clinical objectives of the examination are not compromised[1]. Recent research[2] in the effectiveness of gonadal shielding during abdominal and pelvic radiography has found, in most instances, that:

- Gonadal shielding does not contribute significantly to reducing patient risk from radiation exposure;
- Gonadal shielding positioned improperly may have the unintentional consequence of increasing patient exposure;
- Gonadal shielding positioned improperly may result in the loss of valuable diagnostic examination results.

Based on the recent research pertaining to the use of gonadal shielding during abdominal and pelvic radiography and the longstanding practice in radiography to only shield in instances in which diagnostic quality will not be compromised, the JRCERT has concluded that routine use of gonadal shielding for abdominopelvic radiography exams should not be standard practice for clinical radiography students when the use of such could interfere with the diagnostic quality of the exam and may result in the risk of a repeat exposure.

Educational programs should review and consider amending, if necessary, policies to assure that the use of gonadal shielding should only be utilized when it will not interfere with the purpose of the examination and when it aligns with clinical facility policy.

Consistent with **Standard Five**, programs must have policies/processes in place to assure students are educated on the importance of the proper use of shielding and optimal use of radiation to promote the health and safety of students, patients, and the public.

---

1 [NCRP] National Council on Radiation Protection and Measurements. 2021. NCRP Recommendations for Ending Routine Gonadal Shielding During Abdominal and Pelvic Radiography. Bethesda (MD): National Council on Radiation Protection and Measurements. Statement No. 13.

2 [FDA] U.S. Food and Drug Administration. 2020. Food and Drugs; radiation protection recommendations; radiological health; recommendations for the use of specific area gonadal shielding on patients during medical diagnostic x-ray procedures. Washington (DC): US Government Publishing Office. 21 CFR Part 1000.50.

Updated JRCERT Spring Pulse 2021

(updated 7/2024)

Note: The "Individual" is referencing the student and/or the faculty person

PART 2: MRI SAFETY

CONTENTS

PART 2: MRI SAFETY

Note: The "Individual" is referencing the student and/or the faculty person

RATIONALE

At ECC, an annual MRI safety training session is held for students and faculty. MRI safety training is performed by an ECC imaging faculty member certified in MRI, Rick Mastman, B.S., R.T.(MR)(CT)(ARRT) or Amie Sasser, BS, R.T.(R)(CT)(MR)(ARRT). The training session is performed the first semester (prior to clinical entrance) for new students in radiography and MRI.

Annually, a second training session includes the sophomore radiography students prior to their clinical rotation into their advanced modalities. The training session is conducted in the radiography clinical orientation sessions (first fall semester) prior to clinical entry and then again (second fall semester) prior to clinical rotation into an advanced modality.

The MR safety educates the enrolled students on effects of the static magnetic field used in MRI education and training in gradient magnetic fields, radio frequencies, cryogens, MRI personnel, facility safety zones, and MRI screening and processes. The end of the MRI safety training session, the students screen each other using a MRI screening form.

MRI SAFETY PACKET INCLUDES:

I. Agenda
II. MRI Safety Power Point by Rick Mastman, B.S., R.T.(MR)(CT)(ARRT) or Amie Sasser, B.S., R.T.(R)(CT)(MR)(ARRT)
III. Generic MRI Zone Diagram
IV. Zone 3/4 Pre-Screening Form
V. MR Procedure Screening Form for Patients (role play exercise)
VI. MRI Safety Training Review (Q/A quiz)
VII. eRadImaging Article: MRI Safety
VIII. eRadImaging Artcle: MRI Safety (Q/A quiz)
IX. MRI Safety Training Verification Form

Note: The "Individual" is referencing the student and/or the faculty person

AGENDA

I. Magnetic Resonance Imaging Safety

A. Static Magnetic Field
   1. Warning Signs
   2. Safety Labels

B. Personnel
   1. MR Medical Director
   2. Non-MR Personnel
   3. Level 1 Personnel
   4. Level 2 Personnel

C. Facility Safety Zones
   1. Zone I
   2. Zone II
   3. Zone III
   4. Zone IV

D. MRI Screening Forms
   1. MRI Patient Screening Form
   2. Environmental Screening Form for Individuals

II. Magnetic Resonance Imaging Safety Training Verification

I. Magnetic Resonance Imaging (Safety)

1

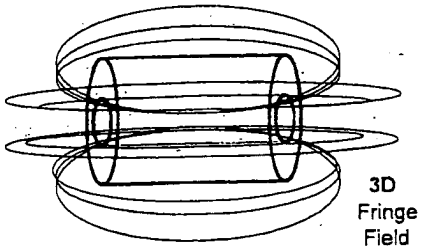
Magnetic Resonance Imaging (Safety)

Four major areas of concern:

- **Static Magnetic Field**
- Gradient Magnetic Fields
- Radio Frequencies
- Cryogens

2

A. Static Magnetic Field



3D Fringe Field

3

Static Magnetic Field (Cont.)

Warning Signs

4

Static Magnetic Field (Cont.)

Safety Labels

Green

Yellow

Red

5

B. Personnel

MR Medical Director

Non-MR Personnel

Level 1 MR Personnel

Level 2 MR Personnel

6

C. Facility Safety Zones

Zone I

Zone II

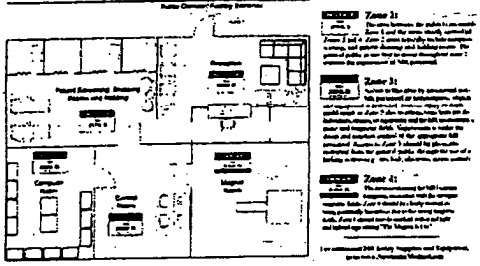
Zone III

Zone IV

7

Facility Safety Zones (cont.)

Generic MRI Zone Diagram



See Handout

8

D. MRI Screening Forms

MRI Patient Screening Form

Environment Screening Form for Individuals

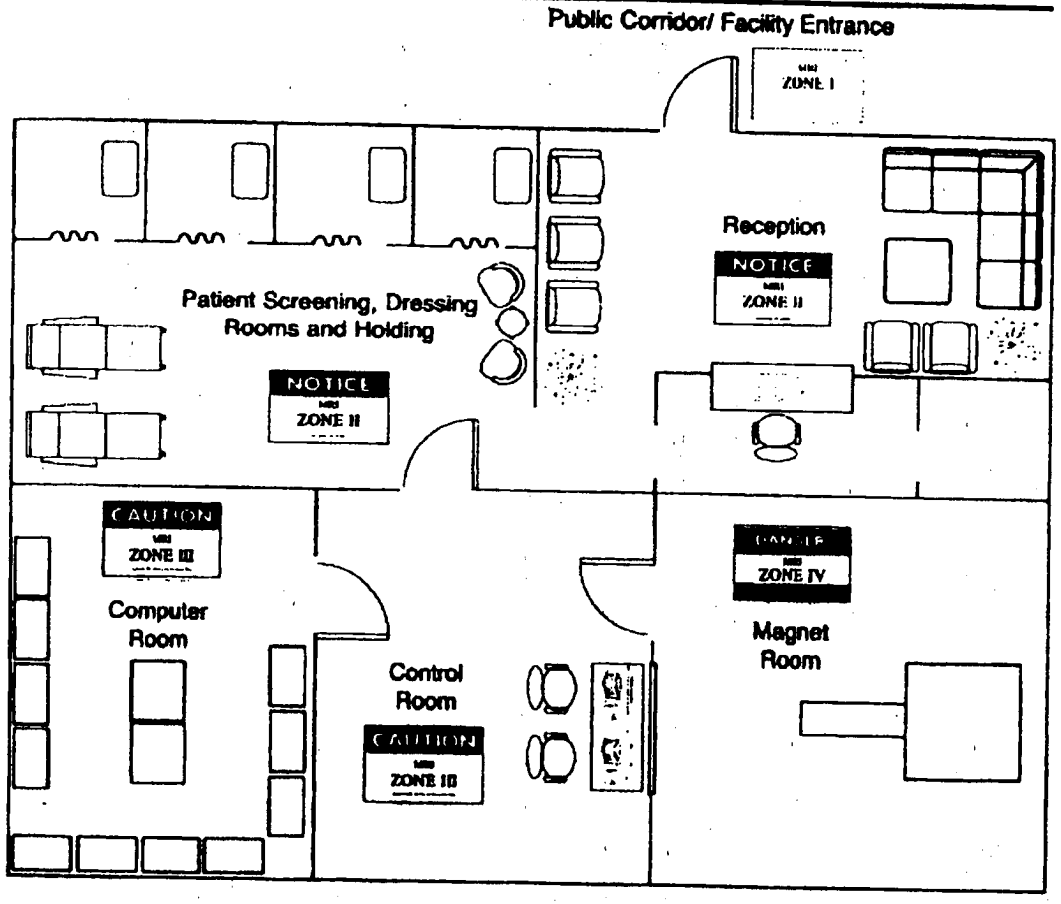
9

II. Magnetic Resonance Imaging (Safety Training Verification)

10.

Generic MRI Zone Diagram

These guidelines insure this facility's signage and safety protocol are appropriately implemented.



ZONE I

Zone 1:

All of the areas, outside of the MR environment, that are freely accessible to the general public (e.g., corridors and entrances just outside the MR environment).

NOTICE
ZONE II

Zone 2:

The area between the publicly accessible Zone 1 and the more strictly controlled Zones 3 and 4. Zone 2 areas typically include reception, waiting, and patient dressing and holding rooms. The general public is not free to move throughout zone 2 without the supervision of MR personnel.

CAUTION
ZONE III

Zone 3:

Access to this area by unscreened non-MR personnel or ferromagnetic objects and equipment is restricted. Serious injury or death could result in Zone 3 due to interactions between the individuals, objects, or equipment and the MR environment's static and magnetic fields. Supervision is under the direct and constant control of the appropriate MR personnel. Access to Zone 3 should be physically restricted from the general public through the use of a locking system (e.g., key lock, electronic access control).

DANGER
ZONE IV

Zone 4:

The room containing the MRI scanner (magnet), associated with the strongest magnetic fields. Zone 4 should be clearly marked as being potentially hazardous due to the strong magnetic fields. Zone 4 should also be marked with a red light and lighted sign stating "The Magnet Is On."

For additional MR Safety Supplies and Equipment, go to www.NewmaticMedical.com

Magnetic Resonance Screening Form for Students

Magnetic resonance (MR) is a medical imaging system in the radiology department that uses a magnetic field and radio waves. This magnetic field could potentially be hazardous to students entering the environment if they have specific metallic, electronic, magnetic, and/or mechanical devices. Because of this, students must be screened to identify any potential hazards of entering the magnetic resonance environment before beginning clinical rotations.

Pregnancy Notice: The declared pregnant student who continues to work in and around the MR environment should not remain within the MR scanner room or Zone IV during actual data acquisition or scanning.

Name: _____ **Date:** _____

	Circle Yes or No	
1. Have you had prior surgery or an operation of any kind?	Yes	No
If yes to question 1, please indicate the date and type of surgery: Date: _____ Surgery Type: _____		
2. Have you had an injury to the eye involving a metallic object (e.g. metallic slivers, foreign body)?	Yes	No
If yes to question 2, please describe: _____		
3. Have you ever been injured by a metallic object or foreign body (e.g., BB, bullet, shrapnel, etc.)?	Yes	No
If yes to question 3, please describe: _____		
Please indicate if you have any of the following:		
Aneurysm clip(s)	Yes	No
Cardiac pacemaker	Yes	No
Implanted cardioverter defibrillator (ICD)	Yes	No
Electronic implant or device	Yes	No
Magnetically-activated implant or device	Yes	No
Neurostimulator system	Yes	No
Spinal cord stimulator	Yes	No
Cochlear implant or implanted hearing aid	Yes	No
Insulin or infusion pump	Yes	No
Implanted drug infusion device	Yes	No
Any type of prosthesis or implant	Yes	No
Artificial or prosthetic limb	Yes	No
Any metallic fragment or foreign body	Yes	No
Any external or internal metallic object	Yes	No
Hearing aid	Yes	No
Other device: _____	Yes	No

I attest that the above information is correct to the best of my knowledge. I have read and understand the entire contents of this form and have had the opportunity to ask questions regarding the information on this form. Should any of this information change, I will inform my program director.

Signature of Person Completing Form: _____ Date ____/____/____

☐ The student has not identified any contraindications to entering MR Zone III or IV.

☐ The student has identified contraindications to entering MR Zones III and IV. The student has been advised not to progress past MR Zone II unless screened by an MR Level II Technologist onsite at each clinical setting.

Form Information Reviewed By: _____ (Print name) _____ (Signature) _____ (Title)

Be advised, the MRI system magnet is ALWAYS ON.

_____ (initial)	I understand that if there is a change in my medical status which would alter my answer to any of the above questions, I should notify the Program Director immediately

MAGNETIC RESONANCE (MR) PROCEDURE SCREENING FORM FOR PATIENTS

Date ____/____/____ Patient Number _____

Name _____ Age _____ Height _____ Weight _____
Last name First name Middle Initial

Date of Birth ____/____/____ Male ☐ Female ☐ Body Part to be Examined _____
month day year

Address _____ Telephone (home) (____) ____-____

City _____ Telephone (work) (____) ____-____

State _____ Zip Code _____

Reason for MRI and/or Symptoms _____

Referring Physician _____ Telephone (____) ____-____

1. Have you had prior surgery or an operation (e.g., arthroscopy, endoscopy, etc.) of any kind? ☐ No ☐ Yes
   If yes, please indicate the date and type of surgery:
   Date ____/____/____ Type of surgery _____
   Date ____/____/____ Type of surgery _____
2. Have you had a prior diagnostic imaging study or examination (MRI, CT, Ultrasound, X-ray, etc.)? ☐No ☐ Yes

If yes, please list:	Body part	Date	Facility
MRI	_____	____/____/____	_____
CT/CAT Scan	_____	____/____/____	_____
X-Ray	_____	____/____/____	_____
Ultrasound	_____	____/____/____	_____
Nuclear Medicine	_____	____/____/____	_____
Other_____	_____	____/____/____	_____

3. Have you experienced any problem related to a previous MRI examination or MR procedure? ☐ No ☐ Yes
   If yes, please describe: _____
4. Have you had an injury to the eye involving a metallic object or fragment (e.g., metallic slivers, shavings, foreign body, etc.)? ☐ No ☐ Yes
   If yes, please describe: _____
5. Have you ever been injured by a metallic object or foreign body (e.g., BB, bullet, shrapnel, etc.)? ☐ No ☐ Yes
   If yes, please describe: _____
6. Are you currently taking or have you recently taken any medication or drug? ☐ No ☐ Yes
   If yes, please list: _____
7. Are you allergic to any medication? ☐ No ☐ Yes
   If yes, please list: _____
8. Do you have a history of asthma, allergic reaction, respiratory disease, or reaction to a contrast medium or dye used for an MRI, CT, or X-ray examination? ☐ No ☐ Yes
9. Do you have anemia or any disease(s) that affects your blood, a history of renal (kidney) disease, renal (kidney) failure, renal (kidney) transplant, high blood pressure (hypertension), liver (hepatic) disease, a history of diabetes, or seizures? ☐ No ☐ Yes
   If yes, please describe: _____

For female patients:

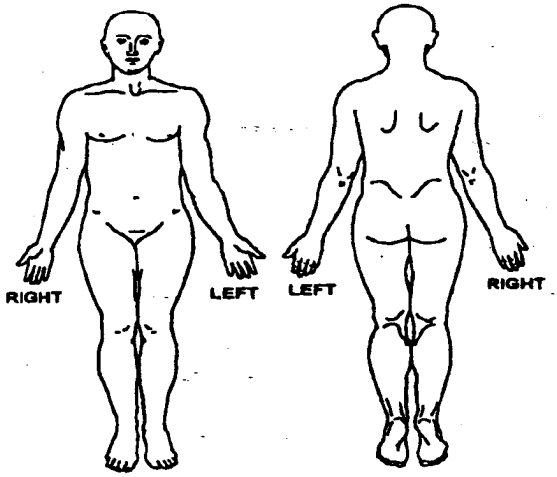
10. Date of last menstrual period: ____/____/____ Post menopausal? ☐ No ☐ Yes
11. Are you pregnant or experiencing a late menstrual period? ☐ No ☐ Yes
12. Are you taking oral contraceptives or receiving hormonal treatment? ☐ No ☐ Yes
13. Are you taking any type of fertility medication or having fertility treatments? ☐ No ☐ Yes
    If yes, please describe: _____
14. Are you currently breastfeeding? ☐ No ☐ Yes

WARNING: Certain implants, devices, or objects may be hazardous to you and/or may interfere with the MR procedure (i.e., MRI, MR angiography, functional MRI, MR spectroscopy). Do not enter the MR system room or MR environment if you have any question or concern regarding an implant, device, or object. Consult the MRI Technologist or Radiologist BEFORE entering the MR system room. The MR system magnet is ALWAYS on.

Please indicate if you have any of the following:

- ☐ Yes ☐ No Aneurysm clip(s)
- ☐ Yes ☐ No Cardiac pacemaker
- ☐ Yes ☐ No Implanted cardioverter defibrillator (ICD)
- ☐ Yes ☐ No Electronic implant or device
- ☐ Yes ☐ No Magnetically-activated implant or device
- ☐ Yes ☐ No Neurostimulation system
- ☐ Yes ☐ No Spinal cord stimulator
- ☐ Yes ☐ No Internal electrodes or wires
- ☐ Yes ☐ No Bone growth/bone fusion stimulator
- ☐ Yes ☐ No Cochlear, otologic, or other ear implant
- ☐ Yes ☐ No Insulin or other infusion pump
- ☐ Yes ☐ No Implanted drug infusion device
- ☐ Yes ☐ No Any type of prosthesis (eye, penile, etc.)
- ☐ Yes ☐ No Heart valve prosthesis
- ☐ Yes ☐ No Eyelid spring or wire
- ☐ Yes ☐ No Artificial or prosthetic limb
- ☐ Yes ☐ No Metallic stent, filter, or coil
- ☐ Yes ☐ No Shunt (spinal or intraventricular)
- ☐ Yes ☐ No Vascular access port and/or catheter
- ☐ Yes ☐ No Radiation seeds or implants
- ☐ Yes ☐ No Swan-Ganz or thermodilution catheter
- ☐ Yes ☐ No Medication patch (Nicotine, Nitroglycerine)
- ☐ Yes ☐ No Any metallic fragment or foreign body
- ☐ Yes ☐ No Wire mesh implant
- ☐ Yes ☐ No Tissue expander (e.g., breast)
- ☐ Yes ☐ No Surgical staples, clips, or metallic sutures
- ☐ Yes ☐ No Joint replacement (hip, knee, etc.)
- ☐ Yes ☐ No Bone/joint pin, screw, nail, wire, plate, etc.
- ☐ Yes ☐ No IUD, diaphragm, or pessary
- ☐ Yes ☐ No Dentures or partial plates
- ☐ Yes ☐ No Tattoo or permanent makeup
- ☐ Yes ☐ No Body piercing jewelry
- ☐ Yes ☐ No Hearing aid
  (Remove before entering MR system room)
- ☐ Yes ☐ No Other implant _____
- ☐ Yes ☐ No Breathing problem or motion disorder
- ☐ Yes ☐ No Claustrophobia

Please mark on the figure(s) below the location of any implant or metal inside of or on your body.



IMPORTANT INSTRUCTIONS

Before entering the MR environment or MR system room, you must remove all metallic objects including hearing aids, dentures, partial plates, keys, beeper, cell phone, eyeglasses, hair pins, barrettes, jewelry, body piercing jewelry, watch, safety pins, paperclips, money clip, credit cards, bank cards, magnetic strip cards, coins, pens, pocket knife, nail clipper, tools, clothing with metal fasteners, & clothing with metallic threads.

Please consult the MRI Technologist or Radiologist if you have any question or concern BEFORE you enter the MR system room.

NOTE: You may be advised or required to wear earplugs or other hearing protection during the MR procedure to prevent possible problems or hazards related to acoustic noise.

I attest that the above information is correct to the best of my knowledge. I read and understand the contents of this form and had the opportunity to ask questions regarding the information on this form and regarding the MR procedure that I am about to undergo.

Signature of Person Completing Form: _____ Date ____/____/____
Signature

Form Completed By: ☐ Patient ☐ Relative ☐ Nurse _____ _____
Print name Relationship to patient

Form Information Reviewed By: _____ _____
Print name Signature

☐ MRI Technologist ☐ Nurse ☐ Radiologist ☐ Other_____

MRI Safety: Applying the Latest Guidelines From The Joint Commission

Mark P. Bowes, PhD

*Medical Writer, Portland, Oregon.

Address correspondence to:
Mark P. Bowes, PhD, Medical Writer
7135 SE 18th Avenue, Portland, OR, 97202.
Email: mpbowes@gmail.com

Disclosure Statement: Dr Bowes reports having no financial or advisory relationships with corporate organizations related to this activity.

ABSTRACT

Magnetic resonance imaging (MRI) is associated with the potential for accidents, injuries, failure of implanted medical devices, and other adverse outcomes as a result of the powerful magnet and radiofrequency fields in the MRI environment. The Joint Commission (TJC), a nonprofit organization that accredits more than 21,000 healthcare organizations and programs in the United States, recently published revised accreditation requirements for MRI and other types of medical imaging services in US hospitals and ambulatory healthcare centers. The guidelines establish specific standards that must be met related to several aspects of medical imaging, including the environment of care, human resources, provision of care, and performance improvement. Additional MRI safety standards and guidelines have been developed by other organizations, including the American College of Radiology (ACR). Magnetic resonance (MR) technologists and other MR professionals share a critical responsibility to ensure adherence to TJC and ACR guidelines and standards, including controlling access to the MRI facility, screening for ferromagnetic objects and medical devices, the risks associated with MRI contrast agents, patient positioning to prevent burns, special considerations for patients in the MRI facility who require urgent or emergent care, emergency shutdown procedures, patient claustrophobia or anxiety, and acoustic noise injury and protection. Controlling access to the MR environment, combined with staff education and training, are the foundations of good MRI safety practices.

Introduction

Magnetic resonance imaging (MRI) is a noninvasive technique that is used to obtain high-resolution medical images of the entire human body, and that is

especially useful for anatomical areas such as the central nervous system, musculoskeletal system, head and neck, abdomen, and pelvis.[1] The use of MRI in medical imaging has markedly increased over the last several decades, including both in the number of installed scanners and the number of scans performed annually.[2] In a 2012 study published in the *Journal of the American Medical Society* that looked at imaging utilization data from 6 large, integrated healthcare systems, researchers reported the use of MRI had quadrupled between 1996 and 2010.[3] In 2014, MRI exams were performed at a rate of 109 per 1000 population in the United States, which is higher than in nearly any other industrialized nation.[4]

MRI scanners use very strong static magnetic fields, time-varying magnetic fields, and radiofrequency (RF) fields to form images of the body.[5] In contrast with imaging modalities such as radiography or computed tomography (CT), MRI does not expose patients or staff to ionizing radiation. However, MRI does require a special environment to isolate the surrounding area from high-energy radio waves and magnetic fields.[1] In addition, the strong magnetic fields generated by MRI scanners necessitate important safety precautions for patients and healthcare professionals, as well as for others who might enter the MRI facility (eg, maintenance and custodial workers, police officers, firefighters, family members or caregivers, and others). Although MRI generally offers a high degree of patient safety, several types of injury have occurred at MRI facilities[6]:

- "Missile effect" or "projectile" injury in which ferromagnetic objects (those having magnetic properties) such as intravenous (IV) poles, wheelchairs, and ferrous oxygen canisters are pulled into the MRI scanner at rapid velocity
- Injury related to dislodged ferromagnetic implants such as aneurysm clips, external fixation devices, and drug infusion devices
- Burns from objects that may heat up during the MRI process (such as wires, electrocardiogram (EKG) leads, electrodes, or surgical staples), or from the patient's body touching the inside walls of the MRI scanner
- Malfunction of medical equipment or devices caused by the magnetic field (eg, battery-powered laryngoscopes or microinfusion pumps, programmable infusion pumps)
- Injury or complication due to failure to attend to patient support systems during the MRI (eg, ferrous oxygen canisters or infusion pumps run out and staff must either leave the MRI area to retrieve a replacement or move the patient to an area where a replacement can be found)
- Acoustic injury from the loud knocking noise made by the MRI scanner
- Adverse events related to the administration of MRI contrast agents
- Adverse events related to cryogen handling, storage, or inadvertent release in superconducting MR system sites

A 2005 analysis of data from the US Food and Drug Administration (FDA) identified 389 reports of MRI-related accidents and injuries, including 9 deaths. MRI-related events included failures of pacemakers, insulin pumps, or other implanted devices; projectile injuries; and burns, among others.[6] The most common patient injuries are burns, which often occur in association with wires or leads, pulse oximeter sensors and cables, cardiorespiratory monitor cables, safety pins, metal clamps, drug delivery patches (which sometimes contain metal foil backings), and tattoos (which may use pigments that contain iron oxide).[6] The risk of accidents and injury is even greater with ultra high-field MRI scanning equipment (3 Tesla [T] and above), which provides greater spatial and temporal resolution than older MRI scanning equipment (0.5T-1.5T), but also generates magnetic fields that are much more powerful.[1] In addition to missile effect, objects can themselves become magnetized when placed in a strong magnetic field.[1] Although MRI safety guidelines call for screening for ferromagnetic objects at least twice before MRI, a recent survey of MR staff at 8 imaging facilities found that only about 25% of respondents said their patients were always screened twice.[7]

The Joint Commission (TJC) recently published revised standards for diagnostic imaging that include new requirements for MRI safety.[8] TJC is a US-based, nonprofit, tax-exempt organization that accredits more than 21,000 healthcare organizations and programs in the United States. TJC accreditation is a condition of licensure and receipt of Medicaid reimbursement. Revised TJC requirements for diagnostic imaging service providers in US hospitals and ambulatory care centers went into effect July 15, 2015. These standards specify requirements that organizations must meet to maintain accreditation in advanced diagnostic imaging modalities; CT, positron emission tomography (PET), nuclear medicine, and MRI. The 2015 TJC diagnostic imaging requirements make specific recommendations for several aspects of MRI, including the environment of care; human resources; provision of care, treatment, and services; and performance improvement.[8] Within each of these areas, the guidelines establish one or more standards that must be met, and define the specific elements of performance by which healthcare professionals can meet each standard. Supporting guidelines and documents have also been developed by the American College of Radiology (ACR), which provides accreditation to facilities for specific imaging modalities (eg, MRI, CT, mammography, nuclear medicine, and PET).[9] The ACR published an initial set of MRI safety guidelines in 2002, which have been revised and updated several times, most recently in 2013.[10] These guidelines represent the unanimous consensus of a blue-ribbon panel of experts convened by the ACR.

The revised TJC requirements and ACR MRI guidelines compel healthcare providers to actively manage several areas of MRI safety. This article will focus on the new TJC Standards as they pertain to MRI, including key recommendations and standards that are most relevant for MR technologists. Important TJC recommendations are summarized and presented with additional guidelines and other supporting recommendations from TJC, ACR, and other organizations. The complete TJC diagnostic imaging requirements can be found online at: http://www.jointcommission.org /diagnostic_imaging_standards/.

An Environment of Care

TJC Standard: The Organization Manages Safety and Security Risks

Elements of performance:

The organization manages MRI safety risks associated with the following:

- Patients who may experience claustrophobia/anxiety
- Patients who may require urgent or emergent care
- Patients with implants, medical devices, or retained foreign bodies
- Ferromagnetic objects
- Acoustic noise/injury protection

The organization manages these MRI safety risks by doing the following:

- Restricting access of everyone not trained in MRI safety or screened by trained staff from the scanner room and the area that immediately precedes the entrance to the scanner room
- Ensuring restricted areas are controlled by and under the direct supervision of staff trained in MRI safety
- Posting signs that make it clear that potentially dangerous magnetic fields are present in the room. Signage should make it clear that the magnet is always on, except in cases where the MRI system is designed to be routinely turned on and off

Controlling Access to the MRI Room

TJC Standards identify several risk categories associated with MRI, including patient claustrophobia/anxiety; patients who require urgent or emergent care; risk associated with implants, medical devices, or other ferromagnetic objects; and acoustic noise.[8] As noted in the Standards, the starting point for managing these risks is to ensure access to the area surrounding the MRI magnet is accessible only to specifically trained personnel or to individuals (including patients) who have been carefully screened by trained personnel. Only individuals who have completed MRI safety instruction within the previous 12 months are considered "MRI personnel" - all others are considered "non-MRI personnel." ACR guidelines require that each site identifies an MRI medical director, who is responsible for ensuring that MRI safe practice guidelines are established and followed, and who establishes the training requirements that must be met by MRI personnel at that facility. In addition, ACR guidelines identify 2 levels of MRI personnel[10]:

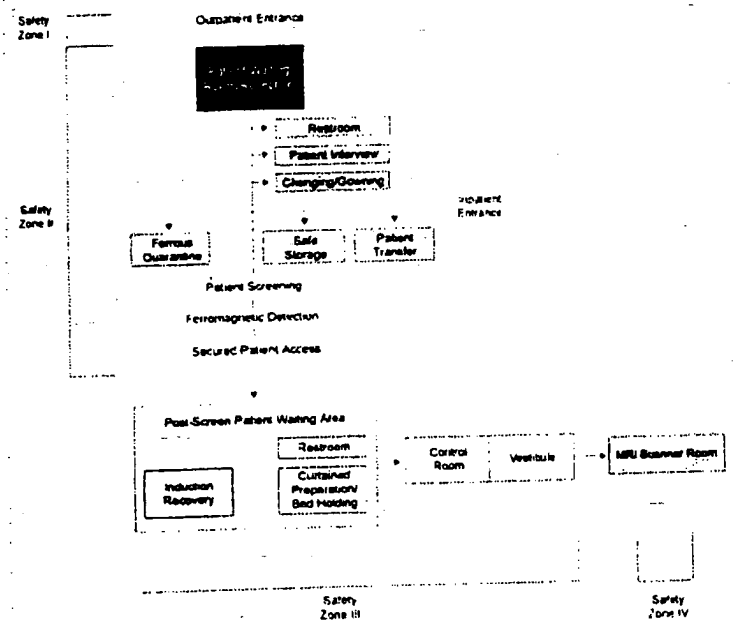
- **Level 1:** Individuals who have passed minimal safety education efforts
- **Level 2:** Individuals who have been more extensively trained and educated in MRI safety issues. The MRI Medical Director identifies necessary training and individuals who quality as Level 2 personnel

A central principle of controlling access to the MRI environment is the use of the "4-Zone" concept of MRI facility design, as defined by TJC.[6] According to this concept, the MRI site is conceptually divided into 4 zones, which control access throughout the MRI facility by employing progressive restrictions as patients move from public access areas to rooms that house the MRI equipment[6,10]:

- **Zone I - Access to the general public:** This zone includes all areas that are freely accessible to the general public. This area is usually outside the MRI environment and may be used by patients, healthcare personnel, and other employees to access the MRI facility.
- **Zone II - Unscreened MRI patients:** This zone provides the interface between the publically accessible, uncontrolled Zone I, and the more strictly controlled Zones III and IV. Patients presenting for an MRI session are usually greeted in Zone II. Individuals in Zone II are not typically free to move around at will, but are usually under the supervision of MRI facility staff. This zone is used for tasks such as patient screening, taking histories, medical insurance questions, and so on.
- **Zone III - Screened MRI patients and personnel:** Access to Zone III is highly restricted. In this zone, the entry of unscreened non-MRI personnel or of ferromagnetic objects or equipment may result in serious injuries or death due to interactions with the scanner's environment, including the scanner's static and time-varying magnetic fields. MR technologists and other authorized personnel are responsible for controlling and monitoring patient access to this zone, and ensuring that safety guidelines are followed. These functions are directly under the authority and responsibility of the MRI medical director or other Level 2 designated physician of the day for the MRI site. Zone III regions should be physically restricted from access by the general public using key locks, passkey locking systems, or similar security features. Combination locks are not recommended because combinations may become more widely distributed than intended. ACR guidelines note that only MRI personnel should have free access to Zone III, that there should be no exceptions to this procedure, and that this guidance specifically includes people such as hospital administrators, physicians, security officers, and other non-MRI personnel. The guidelines also note that Zone III (or, at a minimum, areas where the static magnetic field strength exceeds 5 Gauss) should be clearly marked as potentially hazardous. It is also important to recognize that the magnetic fields produced by MRI scanners are 3-dimensional shapes that may extend to floors above or below the MRI scanner. Areas of magnetic field hazard should be clearly indicated even if they extend to places that are not normally occupied (eg, a rooftop above the MRI magnet).
- **Zone IV - Screened MRI patients under constant direct supervision of trained MR personnel:** This area is synonymous with the MRI scanner magnet room itself; that is, the room where the MRI scanner is located. Zone IV should be clearly marked as potentially hazardous due to the presence of very strong magnetic fields. The access pathway entering Zone IV should be under direct visual observation by Level 2 MRI personnel. ACR guidelines note that Zone IV should be marked with a red light and a lighted sign indicating that the magnet is on. It should be noted that even some healthcare workers may be unaware that the MRI magnet is always on.[6] Signage should also notify the public that the magnetic field is active even when power to the facility is deactivated. The light and signage should be illuminated with a backup battery power source to provide illumination in the event of a power loss.

An idealized example of the 4-zone configuration is shown in Figure 1.[10] All individuals who work within Zone III or Zone IV should be documented as having successfully completed MRI safety programs approved the MRI medical director. Attendance should be repeated at least annually.[10] Any patients, visitors, or other staff who are not knowledgeable about the MRI environment should be accompanied by trained personnel at all times. Educational materials such as guidelines, brochures, or posters should be available to convey the unique risks associated with the MRI suite.[4] Personnel who are expected to accompany patients or other individuals to the MRI suite should undergo annual education updates. All non-MRI personnel must undergo a safety screening process before entering Zone III. This screening may be performed only by MRI personnel. Level 1 MRI personnel are permitted access to Zones III and IV, and are also permitted to accompany non-MRI personnel in Level 3. However, Level 1 personnel are not permitted to be responsible for non-MRI personnel in Zone IV.[10] In addition, to prevent missile-effect accidents, maintenance and housekeeping staff should only be permitted to enter the MRI suite after completing a safety education program, only when no patient is present in the suite, and they must be screened each time and supervised by Level 2 personnel.[8] Finally, although there should be compliance with Health Insurance Portability and Accountability (HIPAA) patient privacy regulations in all 4 zones, ACR guidelines note that there should be an additional privacy barrier in Zone III so unauthorized persons cannot view the MRI control panels.[10]

Figure 1. Four-zone approach to controlling access to MRI scanner room.[10]



MRI = magnetic resonance imaging

Quality Control Measures

TJC Standard: The Organization Manages Medical Equipment Risks

Elements of performance:

The organization identifies quality control and maintenance activities to maintain the quality of the MRI images produced.

TJC Standard: The Organization Inspects, Tests, and Maintains Medical Equipment

Elements of performance:

The organization maintains the quality of the MRI images produced. For MRI, TJC Standards establish that at least annually, a diagnostic medical physicist or MRI scientist conduct a performance evaluation of all MRI equipment, including assessment of the following metrics:

- Image uniformity for all RF coils used clinically
- Signal-to-noise ratio (SNR) for all coils used clinically
- Slice thickness accuracy
- Slice position accuracy
- Alignment light accuracy
- High-contrast resolution
- Low-contrast resolution (or contrast-to-noise ratio)
- Geometric or distance accuracy
- Magnetic field homogeneity
- Artifact evaluation

These standards identify specific guidelines for regular quality control, which is performed under the supervision of a medical physicist or MRI scientist. ACR guidelines recommend that whenever any significant changes occur in the MRI environment (eg, adding faster or stronger gradient capabilities or higher RF duty cycle studies), safety policies and procedures should be reviewed and updated.[10]

Human Resources

TJC Standard: Staff Participate in Ongoing Education and Training

Elements of performance:

The organization verifies and documents that technologists who perform MRI examinations participate in ongoing education that includes annual training on safe MRI practices in the MRI environment, including the following:

- Screening of ferromagnetic objects/implants
- Screening for nephrogenic systemic fibrosis (NSF) risks
- Patient positioning to prevent burns
- Ensuring equipment and supplies are appropriate for MRI environment
- Procedures for patients who require emergency care
- Emergency shut-down procedures, such as MRI system quench and cryogen safety
- MRI patient hearing protection
- Management of anxious or distressed patients

This standard defines education and training that should be documented for technologists who perform MRI evaluations.

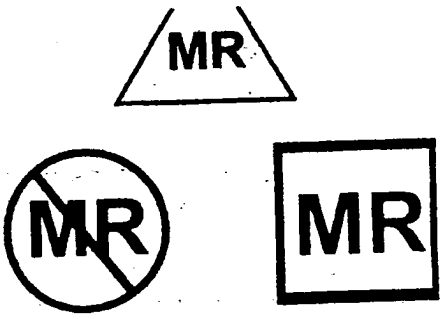
Ferromagnetic Objects and Medical Devices

As described previously, the 4-zone MRI facility layout, combined with training of MRI personnel, is essential to managing risks associated with the unique MRI environment. A key consideration is the risk associated with high magnetic fields on medical devices and other ferromagnetic items. The introduction of undetected metal objects into MRI facilities has been associated with a large number of injuries, including fatalities.[11] These accidents have involved large objects such as IV drug poles, toolboxes, sandbags containing metal filings, cleaning equipment (eg, vacuum cleaners, mop buckets), wheelchairs, oxygen and nitrous oxide tanks, and others.[11] Only equipment (eg, fire extinguishers, physiologic monitors, aneurysm clips) that has been tested and approved for use with MRI scanners should be introduced into the MRI environment.[6] Restrictions on medical devices and other metallic objects near the MRI device may also require special considerations for patients who require emergency services.

Specifically, TJC and ACR guidelines note that all ferrous objects should be excluded from Zone III when possible, including those brought by patients, visitors, contractors, or others.[10] MRI sites should have access to a strong handheld magnet (≥1000 Gauss) and/or a ferromagnetic detection device. Portable metallic or partially metallic devices that are on or external to the patient (eg, oxygen cylinders) must be positively identified in writing as MR Unsafe, MR Safe, or MR Conditional in the MR environment before being

Figure 2. US Food and Drug Administration labeling criteria* for portable objects taken into Zone IV.[10]

permitted into Zone III.[10] MR Safe items are those that pose no known hazard in all MRI environments; MR Conditional items have been demonstrated to pose no known hazards in a specified MRI environment with specified conditions of use. Portable metallic or partially metallic objects that are to be brought into Zone IV must be properly labeled as indicated in Figure 2. Wholly nonmetallic items are indicated using the green square "MR Safe" label, while ferromagnetic items should be identified using a red "MR Unsafe" label. MR Conditional items are identified using a triangular yellow label containing the letters "MR."



Triangular yellow label is for objects with "MR Conditional" rating. round red label is for "MR Unsafe" objects, and square green "MR Safe" label is for wholly nonmetallic objects.[10]
*Developed by American Society for Testing and Materials International.

Pacemakers and other medical devices are a common challenge in the MRI facility. It has been estimated that as many as 75% of patients with pacemakers or implantable cardioverter-defibrillator (ICD) devices will eventually require MRI imaging for additional cardiovascular disease or other medical conditions.[12] With increased use of newer cardiac MRI procedures such as MR angiography, it is anticipated that the number of individuals with pacemakers or other devices who require MRI will continue to increase.[12] Implanted devices are potentially susceptible to RF heating at the tip of the pacemaker leads. This may result in loss of cardiac pacing, and is also associated with the potential for severe and permanent injuries, including myocardial perforation.[12,13] Other potential problems include[12,14]:

- Damage to batteries or other electronic component
- Movement of the device or dislodgement of the leads from the heart tissue due to presence of ferromagnetic materials present in device components and the strong magnetic field
- Change in device function and programming
- Detection by the device of electric signals generated during the scan, and false interpretation of these as being caused by electric activity of the heart

Due to potential hazards such as these, the presence of an ICD was long considered a contraindication to MRI, and FDA labeling generally recommends that most pacemakers not be permitted to enter the MRI field. Recent research has led to the development of a growing number of cardiac devices that contain specific hardware and software features that have been tested and approved for the MRI environment under specifically defined conditions.[13] It was only in 2011 that the FDA approved the first MR Conditional pacemaker. Since then, more pacemakers and ICD devices have been introduced that are approved for use in 1.5T and 3T MRI devices.[13] In general, no device should be brought into the MRI environment unless it is proven to be either MR Safe or MR Conditional.[6] The safety of MR Conditional items must be verified with the specific MRI scanner and environment in which they will be used.[6] Most ICDs are considered MR Unsafe, although a growing number of pacemakers and ICDs are now considered MR Conditional. Fully MRI Safe devices have not yet been devloped.[12] Concerns about medical devices have become even more significant with increased use of 3T and more powerful magnets. As a result, users should not assume that a device is MR compatible unless this is clearly documented in writing.[10] Decisions that are based on published MR safety and compatibility information should recognize that these claims only apply to the specific conditions under which the device was tested, such as static magnetic field strength and spatial distribution, and the strengths and rates of change of gradient and RF magnetic fields.

Although there are important concerns about exposing pacemakers to the MRI magnetic field, it is often possible to appropriately program devices to ensure patient safety. For example, a study conducted in 2011 examined outcomes for patients with older pacemakers who underwent MRI evaluation.[15] This study found that when pacemakers were appropriately programmed, no adverse events related to the MRI field occurred using a 1.5T magnetic field strength. In addition, several other steps should be followed to ensure safe imaging of patients with implanted cardiac devices[6,14]:

- MRI should be performed only when deemed absolutely necessary. Some implanted devices may require placement >6 weeks before imaging
- The device settings should be adjusted before the MRI scan, with the exact setting chosen depending on both patient and device characteristics
- The patient must be continuously monitored during the scan, and both personnel and equipment for cardiac resuscitation should be readily available
- After the scan, the device should be examined to verify its proper function and reprogrammed to its original prescan setting; device function should be examined again at least 1 month later
- Imaging personnel should plan in advance for critically ill patients who may require monitoring or continuous drug infusions while in the scanner

A safety protocol used at Johns Hopkins University for MRI in patients with implantable cardiac devices was recently published, and is shown in Table 1.[16]

Table 1. The Johns Hopkins Hospital MRI Safety Protocol for Patients With Implanted Cardiac Devices[16]

Before MRI procedure	• Exclude patients with:

Trained personnel should screen nonemergent patients twice for metal objects such as implanted devices, drug delivery patches, tattoos, and any devices that are activated electrically, magnetically, or mechanically.[6] If the patient is unconscious, family members or surrogate decision-makers should be questioned. If the patient is unsure, other means may be used to identify potential implants or devices. For example, the patient may be examined for scars or deformities; the patient's history should be reviewed; a plain-film radiograph may be obtained; or the patient may be screened with ferromagnetic detectors. The technologist should have access to the patient's complete medical history to ensure that he or she can be safely scanned. All implants should be identified, and the safety of each implant should be confirmed using product labeling, manufacturer information, or peer-reviewed published data. Patient statements regarding the safety of implanted devices with MRI are not sufficient to establish the suitability of a device for MRI.[10] Metal detectors are often used to identify metal objects in or on patients, but they are not completely accurate and do not identify all possible objects that may experience heating or malfunction during an MRI scan.[6] ACR guidelines recommend that only metal detectors that differentiate between ferrous and nonferromagnetic materials be used. Conventional metal detectors are not recommended for several reasons[10]:

1. Pacemaker implanted before 1998
2. ICD implanted before 2000
3. Recently implanted (<6 weeks), abandoned, or nontransvenous leads
4. Pace-dependent ICD

	• Record device parameters (lead impedance and threshold, P/R wave amplitude, battery voltage)
	• Reprogram pace-dependent pacemaker to VOO/DOO (asynchronous) mode
	• Reprogram pacemaker/ICD to VVI/DDI (inhibited) mode in stable underlying rhythm
	• Deactivate tachyarrhythmia therapies (ATP/defibrillation)
	• Deactivate other functions (magnet rate, PVC noise, ventricular sense conducted AF response)
During MRI procedure	• Monitor blood pressure, ECG, oxygen saturation, and symptoms
After MRI procedure	• Recheck device parameters (lead impedance and threshold, P/R wave amplitude, battery voltage)
	• Restore original programming
	• Follow-up interrogation in 3-6 months

AF = atrial fibrillation, ATP = antitachycardia pacing, DDI = dual-chamber inhibited pacing without atrial pacing, DOO = dual-chamber asynchronous pacing, ECG = electrocardiography, ICD = implantable cardioverter-defibrillator, MRI = magnetic resonance imaging, PVC = premature ventricular contraction, VOO = ventricular asynchronous pacing, VVI = ventricular inhibited pacing

Adapted with permission from Ilgen EG, Naranan S. Safety of implanted cardiac devices in an MRI environment. Curr Cardiol Rep. 2015;17(7):605-604.

- Variable device sensitivity and operator skill
- Inability to detect potentially dangerous ferromagnetic metal fragments (eg, 2x3 mm metal fragment in the orbit or near the spinal cord/heart)
- Do not differentiate between ferromagnetic and nonferromagnetic metallic objects, including implants and foreign bodies

In contrast, ferromagnetic detection systems are recommended as an adjunct to a thorough and conscientious screening. These detectors add to, but do not replace, a thorough screening.[10]

Patients and non-MRI personnel with a history of potential ferromagnetic foreign object penetration must undergo additional evaluation before entering Zone III. This evaluation might include plain x-ray or a review of previous CT or MRI studies of the area.[10] ACR guidelines also provide an example of a standard MRI screening form, which must be filled out completely by any non-MRI personnel entering Zone III (eg, patients, guardians, research subjects). In some cases, an unidentified ferromagnetic implant or foreign body is discovered within a patient while the examination is in progress. This is usually indicated by the presence of a large field-distorting artifact. The medical director, safety officer, or physician in charge should immediately be notified of the suspected findings. This individual will review the imaging information and decide on a course of action.[10] To improve the detection of metallic objects and reduce patient risk, some experts have recommended the use of a pre-MRI "time out" period that is similar to the time-out period used with surgical patients. This time out period gives technologists and other practitioners the opportunity to verify and document important safety information before proceeding to image acquisition.[7]

Although the hazards associated with many ferromagnetic objects are easily recognized, others may be less obvious. For example, over the last few decades, a growing number of individuals have used acupressure or other complementary and alternative medicine practices that incorporate small magnets that adhere to the skin.[17,18] These small magnets have the potential to cause image artifacts and even patient injury, yet they may escape detection with metal detectors.[17]

Finally, there has been a trend toward the use of more powerful MRI magnets (eg, 7T, in contrast with more widely used 1.5 or 3T magnets) which improve the resolution of MRI imaging. Although research on the safety of these devices is limited, the available evidence suggests they do not pose a markedly higher risk to patients with implanted devices or tattoos, and that these patients do not need to be routinely restricted from 7T devices.[19]

A list of ferromagnetic objects is shown in Table 2.[6]

Table 2. Ferromagnetic Objects[6]

- Buffing machines
- Chest tube stands
- Clipboards (patient charts)
- Gurneys
- Hairpins
- Hearing aids
- Identification badges
- Insulin pumps
- Keys
- Medical gas cylinders
- Mops
- Nail clippers and nail files
- Oxygen cylinders
- Pulse oximeters
- Pacemakers
- Pagers
- Paper clips
- Pens and pencils
- IV poles
- Prosthetic limbs
- Shrapnel
- Sandbags (with metal filings)
- Steel shoes
- Stethoscopes
- Scissors
- Staplers
- Tools
- Vacuum cleaners
- Watches
- Wheelchairs

IV = intravenous

Nephrogenic Systemic Fibrosis

Injected contrast agents are often used to improve the visibility of certain tissues on MRI scans. IV contrast media that contains gadolinium is associated with several potential adverse effects, including allergy, asthma, cardiovascular responses, anxiety, and others. Of particular concern for many patients is the risk of contrast-associated kidney disease, including nephrogenic systemic fibrosis (NSF).[20] NSF is a disease that typically involves fibrosis and thickening of the skin and subcutaneous tissues, but may also involve other organs such as the lungs, heart, skeletal muscles, and joints.[10] Although the precise mechanism is not well understood, NSF has been associated with the use of gadolinium contrast agents in patients with severe kidney disease, which significantly increases the time required for contrast agents to be eliminated from the body.[21] It is thought that in these patients, gadolinium ions dissociate from the contrast media and bind to phosphate or other ions within the patient's tissues, forming an insoluble precipitate. This precipitate then triggers infiltration and fibrosis by circulating cells known as fibrocytes.[20]

According to contrast media safety guidelines developed by the ACR, decreased renal function may be suggested by a large number of potential risk factors, including[20]:

- Renal disease (including solitary kidney, renal transplant or other renal surgery, or renal tumor)
- Age >60 years
- History of hypertension requiring medical therapy
- History of diabetes
- History of severe hepatic disease/liver transplant, pending liver transplant
- History of certain cardiovascular diseases
- Prolonged use of nonsteroidal anti-inflammatory drugs (NSAIDs)
- Multiple myeloma, lupus erythematosus, urinary tract infection

Patients receiving gadolinium-based contrast should be considered to be at risk for NSF if any of the following apply[20]:

- On dialysis (of any form)
- Severe or end-stage chronic kidney disease (CKD), including CKD stage 4 or 5, or estimated glomerular filtration rate (eGFR) <30 mL/min/1.73 m^2 without dialysis
- eGFR 30 to 40 mL/min/1.73 m^2 without dialysis
- Acute kidney injury (AKI)

The guidelines note that the methods used to identify at-risk patients may vary between inpatients and outpatients. For inpatients, eGFR level should be obtained within 2 days before contrast administration, and the ordering healthcare professional should assess the patient for the possibility of AKI. Outpatients should be screened for conditions or other factors that may be associated with renal impairment. ACR guidelines recommend the use of a screening checklist to identify outpatients who should undergo a pre-contrast assessment of eGFR. These screening items include the following[20]:

- Age >60 years
- History of renal disease, including:
  - Dialysis
  - Kidney transplant
  - Single kidney
  - Kidney surgery
- History of known cancer involving the kidney(s)
- History of hypertension requiring medical therapy
- History of diabetes

Although there are many other conditions that can affect renal function, ACR guidelines do not recommend routine screening for these conditions, as the benefits of routine screening have not been established.

Patient Positioning to Prevent Burns

Procedures should be in place to reduce the risk of patient burns during scanning. The technologist should ensure items such as leads are not formed into a loop, since magnetic induction in looped wires or cables may result in significant heating. If the patient's body touches the bore of the MRI scanner,

nonconducting foam padding should be used to insulate the patient. A cold compress or ice pack should be placed on ECG leads, surgical staples, or tattoos that will be exposed to RF energy.[6]

Urgent/Emergent Care

It is essential that medical staff responding to a call for assistance in the MRI facility are aware of and comply with MRI safety protocols.[10] This includes physicians, nurses, respiratory technicians, paramedics, security, and others. Interference from the magnet within Zone IV may make it difficult to interpret ECG data. Imaging staff should never attempt to perform a cardiopulmonary arrest code or resuscitation within the MRI magnet room.[6] Facilities must have procedures in place to safely perform emergent resuscitation or other medical intervention. In the case of cardiac or respiratory events or other medical emergencies that require urgent management, ACR guidelines note that appropriately trained and certified MRI personnel should initiate basic life support or CPR while the patient is being emergently removed from Zone IV to a magnetically safe location that has been identified and designated in advance.[10] All priorities should be focused on stabilizing and then evacuating the patient as rapidly and safely as possible from Zone IV and the MRI environment to a predefined area where resuscitation efforts are continued. ACR guidelines strongly recommend that all facilities perform regular drills to rehearse and refine emergency response protocols.

Emergency Shutdown Procedures

For superconducting systems, the MRI magnet is not routinely quenched for medical emergencies.[10] Quenching the magnet may require a minute or longer for the magnetic field to dissipate. In the event of a medical emergency requiring resuscitation, ACR guidelines recommend that the time required for magnet quench would be better spent initiating life support and transporting the patient from the magnet room. In addition, because the quenching process itself is potentially hazardous, the magnet room should be evacuated if possible before an intentional quench. Quenching involves the release of cryogenic gasses (eg, liquid helium), which is typically expelled through an exterior vent. Inadvertent release of cryogenic gasses into a confined area such as the MRI room can potentially cause suffocation.[6] A quench subjects a magnet to a temperature change of approximately 500°F within the space of a few dozen seconds. The resulting thermal shock can cause major physical damage to the device. Although unlikely, the venting system can rupture and release cryogenic gasses into the magnet room. If quench of a superconducting magnet is conducted in response to a fire, helium (and, in older magnets, nitrogen) itself is not flammable. However, supercooling of the air near released cryogenic gasses can cause formation of liquid oxygen, which may increase the fire hazard. Venting of cryogenic gasses into the MRI room may be evidenced by the appearance of white "clouds" or "fog" above or around the MRI scanner.[10]

Claustrophobia/Anxiety

Some patients experience significant anxiety when positioned within the confines of the MRI scanner, which may include a measurable physiologic stress response.[22] Anxiety is usually greatest at the beginning of the procedure, when the MRI table moves into the scanner.[23] Patients who have a difficult or unpleasant scanning experience are more likely to experience significant anxiety during future MRI episodes.[24] Patients are often prescribed a sedative before an MRI appointment to help alleviate anxiety. Blindfolds , aroma therapy and playing music for the patient during their exam can also be helpful. In addition, MRI anxiety may be prevented by providing patients with information about the scanning procedure or maintaining regular communication during the acquisition session (eg, contact with the patient via intercom at 2-minute intervals).[22]

Acoustic Noise/Injury Protection

MRI devices produce a high level of acoustic noise, which may affect both patients and healthcare workers. This noise occurs as the result of rapid switching of gradient coils during image acquisition, which produces loud tapping or knocking sounds.[5] The effects of acoustic noise may include annoyance, difficulties in verbal communication, increased patient anxiety, temporary hearing loss, and possibly even permanent hearing impairment.[25] MRI sequences are not FDA approved without hearing protection, which should be provided to all patients.[6,10]

Provision of Care, Treatment, and Services

TJC Standard: The Organization Provides for Diagnostic Testing

Elements of performance:

Prior to conducting a diagnostic imaging study, the organization verifies the following:

- Correct patient
- Correct imaging site
- Correct patient positioning

In addition, to preventing unnecessary duplication of examinations, the patient's age and recent imaging exams should be considered when deciding on the most appropriate type of imaging exam.[8]

Performance Improvement

TJC Standard: The Organization Collects Data to Monitor Its Performance

Elements of performance:

Organizations are required to collect data on patient thermal injuries that occur during MRI exams, incidents involving ferromagnetic objects unintentionally left on the MRI scanner room, and injuries resulting from these objects.

MRI facilities should have procedures in place to ensure that all adverse events, MRI safety incidents, or "near incidents" that occur in the MRI suite are reported to the medical director in a timely manner (eg, within 24 hours, or 1 business day).[8,10] Adverse events should be examined as part of continuous quality improvement efforts. In addition, these events must also be reported to the FDA Medwatch system.[10] Facilities should appoint a safety officer who is responsible for implementing and enforcing safety procedures in the MRI suite. The facility should also use written protocols, checklists, and other systems to ensure safe practices, while periodically assessing compliance with the organization's MRI policies, procedures, and protocols.

Summary and Conclusions

The unique MRI environment poses important risks for patients and healthcare professionals, which may include missile-effect injuries, adverse events associated with medical devices, hearing loss, and potential safety concerns surrounding an unplanned magnet quench. Recent guidelines from the TJC and ACR identify a number of specific actions MR professionals may undertake to reduce these risks. Controlling access to the MR environment, combined with staff education and training, are the foundations of good MRI safety practices.

References

1. Yilmaz S. The safety of high-field MRI? Int J Occup Environ Med. 2014;5(2):63-64.

2. Chung M, Dahabreh IJ, Hadar N, et al. Emerging MRI technologies for imaging musculoskeletal disorders under loading stress. Rockville (MD): Agency for Healthcare Research and Quality (US); 2011.

3. Smith-Bindman R, Miglioretti DL, Johnson E, et al. Use of diagnostic imaging studies and associated radiation exposure for patients enrolled in large integrated health care systems, 1996-2010. JAMA. 2012;307(22):2400-2409.

4. Organisation for Economic Co-operation and Development. OECD health statistics 2015. https://www.oecd.org/els/health-systems/OECD-Health-Statistics-2015-Frequently-Requested-Data.xls. Accessed May 10, 2016.

5. Ng K-H, Ahmad AC, Nizam MS, et al. Magnetic resonance imaging: health effects and safety. Proceedings of the International Conference on Non-Ionizing Radiation at UNITEN. Electromagnetic Fields and Our Health; October 20-22, 2003.

6. The Joint Commission. Sentinel Event Alert. Preventing accidents and injuries in the MRI suite. Issue 38, February 14, 2008. https://www.jointcommission.org/assets/1/18/SEA_38.PDF. Accessed June 16, 2016.

7. Berry ZJ, Barr ZB. Addressing magnetic resonance safety using a modified preoperative time-out approach. Radiol Technol. 2015;86(5):574-579.

8. The Joint Commission. Diagnostic imaging requirements. August 10, 2015. https://www.jointcommission.org/assets/1/18/AHC_DiagImagingRpt_MK_20150806.pdf. Accessed July 15, 2016.

9. Gilk T, Kanal E. Interrelating sentinel event alert #38 with the ACR guidance document on MR safe practices: 2013. An MRI accreditation safety review tool. J Magn Reson Imaging. 2013;37(3):531-543.

10. Kanal E, Barkovich AJ, Bell C, Borgstede JP, et al; Expert Panel on MR Safety. ACR guidance document on MR safe practices: 2013. J Magn Reson Imaging. 2013;37(3):501-530.

11. Landrigan C. Preventable deaths and injuries during magnetic resonance imaging. N Engl J Med. 2001;345(13):1000-1001.

12. Jung W, Jäckle S, Zvereva V. MRI and implantable cardiac electronic devices. Curr Opin Cardiol. 2015;30(1):65-73.

13. Nordbeck P, Ertl G, Ritter O. Magnetic resonance imaging safety in pacemaker and implantable cardioverter defibrillator patients: how far have we come? Eur Heart J. 2015;36(24):1505-1511.

14. Eyal A, Roguin A. Cardiology patient page. Magnetic resonance imaging in patients with cardiac implantable electronic devices. Circulation. 2015;132(14):e176-e178.

15. Nazarian S, Hansford R, Roguin A, et al. A prospective evaluation of a protocol for magnetic resonance imaging of patients with implanted cardiac

devices. Ann Intern Med. 2011;155(7):415-424.

16. Ipek EG, Nazarian S. Safety of implanted cardiac devices in an MRI environment. Curr Cardiol Rep. 2015;17(7):605-609.

17. Otjen JP, Mallon K, Brown JC. Acupressure magnets: a possible MRI hazard. J Magn Reson Imaging. 2015;41(3):858-860.

18. Lee CH, Lin MF, Chan WP. Management of a sandbag accident in an MRI unit. Magn Reson Imaging. 2015;33(9):1187-1189.

19. Noureddine Y, Bitz AK, Ladd ME, et al. Experience with magnetic resonance imaging of human subjects with passive implants and tattoos at 7 T: a retrospective study. MAGMA. 2015;28(6):577-590.

20. American College of Radiology. ACR Manual on Contrast Media. 2015. http://www.acr.org/~/media/37D84428BF1D4E1B9A3A291BDA9E27A3.pdf. Accessed June 3, 2016.

21. Cheong BY, Muthupillai R. Nephrogenic systemic fibrosis: a concise review for cardiologists. Tex Heart Inst J. 2010;37(5):508-515.

22. Tazegul G, Etcioglu E, Yildiz F, Yildiz R, Tuney D. Can MRI related patient anxiety be prevented? Magn Reson Imaging. 2015;33(1):180-183.

23. van Minde D, Klaming L, Weda H. Pinpointing moments of high anxiety during an MRI examination. Int J Behav Med. 2014;21(3):487-495.

24. Shortman RI, Neriman D, Hoath J, et al. A comparison of the psychological burden of PET/MRI and PET/CT scans and association to initial state anxiety and previous imaging experiences. Br J Radiol. 2015;88(1052):20150121.

25. McJury M, Shellock FG. Auditory noise associated with MR procedures: a review. J Magn Reson Imaging. 2000;12(1):37-45.

TAKE CE TEST!

Comments/Questions

What did you think of this article?
MRI Safety: Applying the Latest Guidelines From The Joint Commission

- **Comment From: rt_mmontoya** — *Posted on: 10/21/2016 22:44 PM*
This information was great to read since I am new to MRI.

- **Comment From:** — *Posted on: 10/29/2016 17:58 PM*
excellent!

- **Comment From:** — *Posted on: 11/11/2016 8:19 AM*
You may want to check the answers for these questions. I'm fairly sure I got them all right, but my test was graded with 2 wrong. (My answers were word for word out of the text.)

There are 4 total comments: View All Comments

Post A Comment

Post Comment Below:

PART 3: DOCUMENTS (Q/A Quizzes, Signature forms, i.e.,)

3.1. eRADImaging Article: MRI Safety Q/A Quiz

3.2. MRI Safety Training Verification Form

3.3. OSL Dosimeter Badge Order Form

3.4. OSL Dosimeter Quiz

3.5. Safety Procedures Manual Quiz

3.6. Annual Radiation Safety Program Review Form (completed annually)

3.7. Safety Procedures Manual & Voluntary Pregnancy Declaration Initial Acknowledgement Form

3.8. Safety Procedures Manual & Voluntary Pregnancy Declaration Annual Acknowledgement Form

3.9 Review of the Safety Procedures Manual Student Acknowledgement Form

eRADIMAGING Article: MRI Safety: Applying the Latest Guidelines from The Joint Commission (TJC)

Article QUIZ.

January 5, 2017

Student Name: _____ Date: _____

Student Signature: _____

Instructor Name: _____

Article Quiz: 1 point each. **Total: 10 points.**

1. FDA analysis of MRI data found that the most common patient injuries are:
   A. Hearing related
   B. Burns
   C. Failure of clips or staples
   D. Pacemaker failures

2. A central principle of controlling access to the MRI environment is the use of the _____ concept of MRI facility design.
   A. Level 1
   B. Level 2
   C. 4-zone
   D. 6-zone

3. Who is **NOT** permitted to be responsible for non-MRI personnel in Zone IV?
   A. Any MRI facility employee
   B. Level 1 personnel
   C. Level 2 personnel
   D. Level 3 personnel

4. _____ items are identified using a triangular yellow label containing the letters "MR".
   A. Ferromagnetic
   B. Nonferromagnetic
   C. MR Safe
   D. MR Conditional

5. Most implanted cardiac devices are considered:
   A. MR Safe
   B. MR Conditional
   C. MR Unsafe
   D. MR Unrated

Article QUIZ. **January 5, 2017**

6. Trained personnel should screen nonemergent patients for metal objects:
   A. Before entering Zone I
   B. Before entering Zone II
   C. At each transition from one zone to another
   D. Twice

7. When screening for metallic objects, American College of Radiology (ACR) guidelines recommend:
   A. Against the use of metal detectors due to the poor accuracy of these devices for identifying metallic implants
   B. The use of a conventional metal detector to identify metallic objects or implants
   C. That only metal detectors that differentiate between ferrous and nonferromagnetic materials be used
   D. That patient statement about device safety are usually adequate to determine whether the patient may be undergo MRI

8. Patients with implanted devices or tattoos must be routinely restricted from T7 devices.
   A. True
   B. False

9. Of particular concern for many patients is the risk of contrast-associated:
   A. Kidney disease
   B. Vision loss
   C. Headache
   D. Liver disease

10. The appearance of white 'clouds' or 'fog' above or around the MRI scanner may suggest:
   A. Venting of cryogenic gasses into the MRI room
   B. Magnet overheating
   C. Rapid switching of RF coils
   D. Excess humidity in the MRI environment

Eastern NC Consortium
of
Computed Tomography & Magnetic Resonance Imaging
and
Edgecombe Community College
Radiography Program

MRI SAFETY TRAINING VERIFICATION FORM

On _____(date), I, _____(print student name), participated in an MRI safety training session through Edgecombe Community College. The training included four components:

First: Covered the effects of the static magnetic field
Second: Covered MRI personnel
Third: Covered MRI facility safety zones
Fourth: Covered MRI safety screening forms

I understand that if my status changes I am mandated to notify the program.

Student Signature: _____

Instructor Signature: _____

Instructor Credentials: _____

Updated: 8/17/2022

ECC Radiography
OSL Dosimeter Order Form
Cohort 2024-2026

PRINT LEGIBILY

Last Name: _____

First Name: _____

Gender: **N/A** **Male** **Female** *(circle one)*

DOB: _____ **Format: (03/20/2014)**

College ID #: _____

5 points total

rvsd. 2024, 2020

Radiation Safety Manual

OSL Dosimeter Quiz

(1 point each).

1. **ECC's dosimeter is a personal dosimeter by Radiation Detection Company. What type of dosimeter is it?**
   - **A. Thermoluminescent (TLD) type**
   - **B. Film badge type**
   - **C. Optically Stimulated Luminescence (OSL)**
   - **D. Leaded type**

2. **How low is the sensitivity of reading (minimum reportable dose) for this type of badge?**
   - **A. 1 mrem; 0.01 mSv**
   - **B. 10 mrem; 0.1 mSv**

3. **What are you to do if you misplace, lose, or damage your dosimeter?**

4. **Your dosimeter is a process in which a pre-irradiated (exposed to ionizing radiation) material when subjected to an appropriate optical stimulation, emits _____ signal proportional to the absorbed dose.**
   - **A. Heat**
   - **B. Light**
   - **C. Rays**
   - **D. Fog**

5. **Where is the correct placement of your personal dosimeter on person (at what level)?**

Edgecombe Community College
Radiography Program
Annual Radiation Safety Program Review
2024

Printed Name: _____ **Date:** _____

This review is required annually by the State of NC Radiation Protection Division and **MUST** be completed and signed annually by **ALL** faculty members and **ALL** students.

1. **Who are the ECC Radiography/Imaging program's acting RSOs?**

2. **What is the "Notice to Employees" and where is it located in the ECC program?**

3. **What type of badge is worn by the ECC faculty and students that measure occupational dose?**

4. **How often are the ECC radiography dosimeters exchanged?**

5. **How often are the ECC CT dosimeters exchanged?**

6. **Define ALARA.**

7. **What three things are performed to satisfy the ALARA concept?**

8. **What is the Embryo Fetus Exposure amount (dose) for the entire pregnancy in mrem?**

9. **What are the three Action Levels (Quarterly Doses) that will result in consultation with the Acting RSO?**

Signature: _____

(Student or **Faculty)** circle one

Acting RSO Signature: _____

25 points

Rvsd. 2024, 2020; 2016

SAFETY PROCEDURES & POLICY MANUAL QUIZ

(to be taken after reading the manual)

Printed name of tester: _____

Date: _____ Grade: _____

Each question is worth 1 point, unless stated otherwise

1. T or F Declaration of pregnancy is voluntary.

2. If a student is exposed to radiation by incidental or accidental means the student must first report this incident to the _____ _____. A second meeting will be held with the _____ _____ _____ and a plan of action (POA) will be developed. (2 pts total)

3. ECC uses what type of personnel dosimeter? _____

4. T or F If I forgot my personal dosimeter at home, it is okay to borrow someone else's while at clinical.

5. What does the acronym ALARA stand for?

_____

6. What specifically should be kept ALARA? _____

7. T or F My radiation risk as an x-ray student is minimal, as long as I practice ALARA concepts.

8. The government sets exposure limits based on minimal risks. As a student or registered technologist my **annual Total Effective Dose limit** for whole body exposure is _____mrem.

9. As an x-ray student, although **highly** unlikely, if my quarterly dose should exceed _____ mrem (reference dose), I will be counselled by the acting RSO.

10. At ECC radiology student dosimeters are sent to the company by the acting RSO on a _____ basis (**monthly, bimonthly, quarterly** or **annually**) to be read. CT student dosimeters are sent to the company by the acting RSO on a _____ basis. Who is responsible for turning the personal dosimeter badge to the CI, CC, or acting RSO at the appropriate time? _____(3 pts)

11. List the 3 basic principles (three cardinal rules) of minimizing radiation exposure. (3 pts)

25 points

12. Always wear a _____ _____ when not behind a protective barrier.

13. T or F As a student, I am expected to hold patients.

14. I should always stand **at least** _____ feet away from the source of x-rays.

15. T or F As a student and/or a radiographer, I must shield ***all*** patients as long as it does not compromise the image.

16. T or F As a student and/or a registered technologist, it is unethical of me to question females about the possibility of pregnancy.

17. What naturally occurring radionuclide is used by archeologists to date ancient artifacts?

18. T or F Time is of the essence and sometimes it is "OK" to fold or flop the lead apron over a chair after use.

19. If a radiation worker becomes pregnant, she is monitored on a monthly basis. What is her embryo/fetus **monthly** exposure limit? _____

20. Explain what the following statement regarding rules governing radiation protection is referring to. ***"Do not let familiarity result in false security."*** (2 pts)

You must score an 80% or higher to pass this quiz!

EDGECOMBE COMMUNITY COLLEGE
RADIOGRAPHY PROGRAM

SAFETY PROCEDURES MANUAL and VOLUNTARY PREGNANCY DECLARATION
Initial Acknowledgement Form

I have received, reviewed, and understand the **Safety Procedures Manual, the Radiation Safety Plan and the Voluntary Pregnancy Declaration** on _____, _____, 20_____. The information was presented to me during the initial clinical orientation with the acting Radiation Safety Officer (RSO). All questions were thoroughly answered by the acting RSO and I acknowledge my copy of the Safety Procedures Manual is to be kept in my clinical notebook for reference.

Student Name (printed) _____

Student Signature _____

Acting RSO Signature _____

revised 8/18 DD

EDGECOMBE COMMUNITY COLLEGE
RADIOGRAPHY PROGRAM

SAFETY PROCEDURES MANUAL and VOLUNTARY PREGNANCY DECLARATION
Annual Acknowledgement Form

I have received, reviewed, and understand the **Safety Procedures Manual, the Radiation Safety Plan and the Voluntary Pregnancy Declaration** on _____, _____, 20_____. The information was presented to me during the first week of the 4th semester (prior to clinical education) with the acting Radiation Safety Officer (RSO). All questions were thoroughly answered by the acting RSO and I acknowledge my copy of the Safety Procedures Manual is to be kept in my clinical notebook for reference.

Student Name (printed) _____

Student Signature _____

Acting RSO Signature _____

revised 8/18 DD

Edgecombe Community College (ECC)
Radiography and Imaging Program
Student Acknowledgement Form

Review of the Safety Procedures Manual

I have received, reviewed, and understand the importance of the ongoing radiation safety plan in the updated Safety Procedures Manual. I understand and acknowledge the strict safety standards to be followed as a student at ECC. _____/_____ (initial/date).

In addition;

On campus, I understand as a student, I am **NOT** allowed to be in the generated x-ray room during x-ray exposures, or make exposures without a qualified faculty member's supervision.

In the clinical education centers, I understand as a student, I am **NEVER** to hold patients or the image receptor during any radiographic procedures when an immobilization method is the appropriate standard of care.

By signing below, I agree to follow with full fidelity the Safety Procedures Manual and the contents within the Radiation Safety and MRI Safety procedures.

Student Name (printed) _____

Student Signature _____

Acting RSO Signature _____

Rvsd. 2/17; 6/18

⚠ DANGER

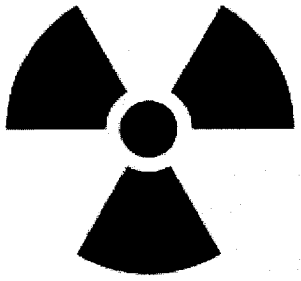
THE MAGNET IS ALWAYS ON

SmartSign.com • 800-952-1457 • LB-0958

⚠ CAUTION

X-RAY IN USE

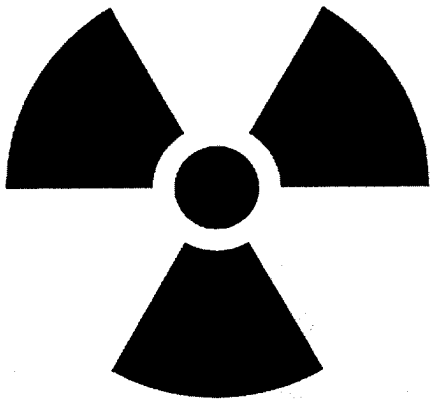
If you are pregnant or unsure, notify staff immediately.



⚠ CAUTION

X-Ray Radiation

When Light is On



SmartSign.com • 800-952-1457 • S-8176