EMRC

Quality Assurance Committee

Radiation Therapy Quality Assurance Program

For Hospital X-Ray Generating Equipment
TABLE OF CONTENTS

I: INTRODUCTION .......................................................... 4
   A. Quality Assurance Program Review ......................................................... 4
   B. Quality Assurance Defined ..................................................................... 5
II: QUALITY ASSURANCE COMMITTEE ........................................... 6
   A. Quality Assurance Committee Membership .............................................. 6
   B. Quality Assurance Committee Meeting Requirements ............................ 6
   C. Quality Assurance Committee Responsibilities ....................................... 6
   D. Quality Assurance Committee Communication ...................................... 7
III: INDIVIDUAL RESPONSIBLE FOR RADIATION PROTECTION .......... 8
   A. Individual Responsible for Radiation Protection (IRRP) Responsibilities ...... 8
IV: Chief Physicist ............................................................................... 9
   A. Chief Physicist Responsibilities ............................................................ 9
   B. Quarterly Audit Report ........................................................................ 10
   C. Annually Audit Report ......................................................................... 10
V: PERSONNEL RESPONSIBLE FOR QUALITY CONTROL TESTS ........ 11
   A. Personnel Performing Quality Control Testing ....................................... 11
   B. Training for Personnel Responsible for Monitoring and Performing Quality Control 11
VI: DIAGNOSTIC IMAGING EQUIPMENT QUALITY CONTROL TESTS AND PROCEDURES ..................................................................... 11
   A. Radiographic Quality Control – Interval not to Exceed 18 Months 11
      ................................................................. Error! Bookmark not defined.
   B. Fluoroscopic Quality Control – Annual .............................................. Error! Bookmark not defined.
   C. Processor QA Equipment and Procedures ............................................. Error! Bookmark not defined.
VII: RADIATION THERAPY EQUIPMENT QUALITY CONTROL TESTS AND PROCEDURES ................................................................. 11
   A. Linear Accelerator Dosimetry Quality Control – Annual ......................... 11
   B. Linear Accelerator Mechanical Quality Control – Annual ....................... 12
   C. Linear Accelerator Safety Interlocks - Annually ..................................... 12
   D. Linear Accelerator Dosimetry Quality Control – Monthly ....................... 13
   E. Linear Accelerator Mechanical Quality Control – Monthly ....................... 13
   F. Linear Accelerator Safety Interlocks - Monthly ....................................... 14
   G. Linear Accelerator Dosimetry Quality Control - Daily ........................... 14
   H. Linear Accelerator Mechanical Quality Control - Daily ......................... 14
   I. Linear Accelerator Safety Interlocks - Daily .......................................... 15
   J. Linear Accelerator Dosimetry Quality Control – As Needed ................... 15
VIII: LIST OF QUALITY CONTROL TEST EQUIPMENT ................................ 16
   A. Diagnostic Quality Control Test Equipment (or equivalent equipment): ...... Error! Bookmark not defined.
   B. Therapeutic Quality Control Test Equipment (or equivalent equipment): .. 16
IX: OPERATOR TRAINING .................................................................. 17
   A. Licensure ............................................................................................. 17
   B. KHCC Competency Training ............................................................... 17
X: RADIATION MONITORING REQUIREMENTS .................................... 18
   A. X-Ray Generating Equipment Room Surveys ....................................... Error! Bookmark not defined.
   B. Occupational Exposure Limits ............................................................. 18
C. Maintaining Occupational Exposure Limits As Low As Reasonably Achievable (ALARA). Error! Bookmark not defined.
D. Establishment of ALARA Investigational Levels ......................................................... 18
E. Establishment of Investigational Levels Above Investigational Level II .................. 19
F. Maintenance of Records ......................................................................................... 19
G. Proper Use of Area and Personnel Monitoring ..................................................... 19
H. Prenatal Exposure ................................................................................................. 20

XI: PROCEDURE FOR NOTIFYING THE DIRECTOR OF THE EMRC WHEN
INDIVIDUALS ARE OCCUPATIONALLY OVER-EXPOSED TO RADIATION .......... 21
A. Immediate Notification ......................................................................................... 21
B. Twenty-four Hour Notification .............................................................................. 21
C. 30 Day Written Notification .................................................................................. 21
D. Report Content ....................................................................................................... 21
E. Notification Mailing Address and Phone Number .................................................. 22

XII: RADIATION SAFETY POLICIES AND GENERAL RECOMMENDATIONS
Error! Bookmark not defined.
A. Shielding .................................................................................................................. Error! Bookmark not defined.
B. Mobile X-Ray Procedures .................................................................................. Error! Bookmark not defined.
C. Fluoroscopy ............................................................................................................ Error! Bookmark not defined.

XIII: PATIENT PROTECTION .................................................................................. Error! Bookmark not defined.
A. Screening for pregnancy ...................................................................................... Error! Bookmark not defined.
B. Patient Shielding ................................................................................................. Error! Bookmark not defined.
C. Patient Education .................................................................................................. Error! Bookmark not defined.
D. Patient Identity Verification ............................................................................... Error! Bookmark not defined.
E. Protection of the Public - Radiation Area Identification and Warning Signs .... Error! Bookmark not defined.
F. Holding Patients ................................................................................................. Error! Bookmark not defined.
I:  INTRODUCTION

Quality Assurance Committee has developed the procedures contained in this manual in order to ensure that deficiencies, deviations, defection equipment, or unsafe practices relating to the use of radiation sources are identified, promptly corrected and reported to the appropriate individuals.

The procedures contained herein are established in addition to existing departmental policies and procedures and may or may not be in duplication. None supersedes the other, however all procedures and policies will be adhered to by all personnel working with or having dealings with radiation sources.

A. Quality Assurance Program Review

This manual will be reviewed periodically with appropriate changes made accordingly.

SIGNATURE/DATE OF REVIEW :

Committee members
B. Quality Assurance Defined

Quality assurance is the organized and systematic activities to ensure that the radiation generating equipments are of consistently high quality with minimum exposure to the public, and workers. It consists of many factors such as quality control, preventive and corrective maintenance, continuing education and specification and acceptance of new equipment.

1. Quality control is a system of techniques used for the monitoring and maintenance of the components of the X-ray equipment. The goal of quality control is to produce diagnostic images that are clinically optimal and economic, while maintaining patient doses as low as reasonably achievable (ALARA).

2. Quality assurance is the overall management of the program, whereas quality control entails measurement of the image quality and the integrity of the equipment.

3. EMRC is committed to establishing policies and procedures in the spirit of the definitions of quality assurance and quality control.

4. The committee will conduct oversight and maintenance of the Quality Assurance Program of Jordanian hospitals on annual basis. This includes review and approval of the Quality Assurance Program on an annual basis, and the performance and submission of audits to the EMRC.

5. All employees working in radiation areas will be made aware of the scope of the Quality Assurance Program through in-services conducted upon acceptance of the Quality Assurance Program by the hospital. In addition, placards indicating the location of the program contents as well as contact information for the individual responsible for radiation protection will be posted in a conspicuous manner in each area where X-ray equipment is used.

6. Any changes to this manual will be approved by the EMRC Quality Assurance Committee and disseminated to all affected individuals both in writing and verbally during routine departmental staff meetings.

7. This manual was produced utilizing the regulatory guide, “Establishing a Hospital Quality Assurance Program For Radiation-Generating Equipment,” published by the IAEA.
II: QUALITY ASSURANCE COMMITTEE

EMRC has established a Quality Assurance Committee, which is responsible for the implementation of the Quality Assurance Program.

A. Quality Assurance Committee Membership

Mr. Elayan Elayan, Head of Physics Department, ARC
Majd Hawari, Ph.D., Deputy Head, Medical Physics Section, KHCC.
Imran Rashdan, Medical Physics Specialist
Samer Al-Heet, MS., Medical Physics Specialist
Ahmad Hamdan, Head of Radiation Inspection Department
Diya Al-Kisieh, Radiation Inspector
Bashar Al-Jaafreh, Radiation Inspector

B. Quality Assurance Committee Meeting Requirements

1. The Quality Assurance Committee will meet at least quarterly.
2. Emergency or special meetings (licensing new facilities) may be called by the EMRC.

C. Quality Assurance Committee Responsibilities

1. Reviewing the shielding and design report before issuing the site and facility license.
2. Ensuring the safe use of radiation-generating equipment in accordance with EMRC’s radiation protection rules.
3. Reviewing the training and experience of all individuals who operate radiation-generating equipment and determine that their qualifications are sufficient to enable them to perform their duties safely and in accordance with EMRC’s radiation protection rules.
4. Monitoring the hospital’s dosimetry program to maintain individual and collective doses as low as practical.
5. Establishing investigational levels (ALARA levels) for occupational radiation exposure.
6. Granting permission for an occupational worker to receive a dose to the whole body in excess of mandated quarterly dose limits.
7. Deciding who should be supplied with individual monitoring devices.
8. Ensuring that all activities conducted under the registration are consistent with ALARA policies.
9. Review quarterly report and instituting corrective actions as necessary.
10. Monitoring the radiation safety training program to ensure the adequate instruction of all individuals who work in the vicinity of radiation-generating equipment.
11. Review and approve of all requests for the purchase of radiation-generating equipment within the hospital.
12. Review of the annual audit performed by the chief physicist and recommending remedial actions to correct any deficiencies identified by the audit.
13. Maintaining written records of all committee meeting, actions, recommendations, and decisions for a minimum of three years.
14. Reviewing incident reports involving radiation-generating equipment and recommending actions,
15. Reviewing results of acceptance testing and radiation protection surveys on new equipment and approving or denying the new equipment for clinical use,
16. Assuring that individuals responsible for quality control are properly instructed,
17. Reviewing and approving all radiation safety policy revisions, reviewing equipment and structural modifications for safety, and organizing the hospital to provide adequate radiation safety.

D. Quality Assurance Committee Communication

1. Conclusions of the Quality Assurance Committee meeting will be presented to staff members at the next regularly scheduled staff meeting. If immediate notification is required, a memorandum will be distributed appropriately to affected staff members.
2. Committee will review all Quality Assurance Incident Reports for appropriateness and include in the annual Report to the EMRC.
III: INDIVIDUAL RESPONSIBLE FOR RADIATION PROTECTION

Every center needs to designate an individual responsible for radiation protection.

A. Individual Responsible for Radiation Protection (IRRP) Responsibilities

The individual designated responsible for radiation protection has been given sufficient authority, organizational freedom and management prerogative by EMRC to:

1. Identify and document radiation safety issues.
2. Initiate, recommend or provide corrective actions.
3. Verify implementation of corrective actions.
4. Oversee and be responsible for the monitoring of the dosimetry program for radiation-generating equipment to maintain individual and collective doses as low as reasonably achievable (ALARA). Ensuring that all of radiation-generating equipment is conducted in a safe manner and in accordance with all EMRC radiation protection rules.
5. Assigning the responsibility of collection, distribution, and Shipment of individual monitoring devices and reviewing the reports generated from those devices.
6. Notify the EMRC QA Committee when individuals are occupationally overexposed to radiation, pursuant to EMRC administrative code. The individual overexposed will be notified in writing and an investigation will be conducted to determine the cause.
7. Implementing the quality assurance program developed by the EMRC QA Committee.
8. Ensuring that all individuals whose duties may require them to work in the vicinity of radiation-generating equipment are properly instructed.
9. Ensuring that the quality assurance program is audited at least annually by the internal QA committee.
10. Ensuring that the annual audit is submitted to the within 90 days of completion.
IV: Chief Physicist

Every center needs to designate a chief physicist, chief physicist is given sufficient authority, organizational freedom, and management prerogative to the chief physicist such that he may:

- Identify and document radiation safety issues
- Initiate, recommend, or provide corrective actions
- Verify implementation of corrective actions

A. Chief Physicist Responsibilities

This delegation of authority will be conspicuously posted in areas of radiation-generating equipment including the name, title, and telephone number of the chief physicist.

1. The chief physicist will review the corrective actions recommended by the EMRC QA Committee as a result of the audit if applicable, and ensure that the corrective action is well documented and appropriate.

2. Review and assist in the maintenance of the radiation-generating equipment inventory and in the registration of this equipment to the EMRC.

3. Ensure that individuals working in the vicinity of radiation-generating equipment are properly instructed in radiation safety practices as well as the location, boundaries, and purposes of restricted areas.

4. The chief physicist for radiation oncology will perform Medical Physics quality control testing or review testing done by the Medical Physics personnel on all radiation therapy X-ray equipment as described in the attached pages at least annually in order to ensure compliance with all applicable regulations. The quality control testing will be performed with equipment described in the attached pages.

5. Implement a competency review on personnel who perform the quality control testing.

6. Perform radiation area surveys on all newly installed equipment. The chief physicist will ensure that there is a record of radiation surveys for all equipment.

7. Submit a written report of the findings of the quality control testing for each X-ray unit. These reports will be in the form of a narrative describing the testing parameters and results in comparison with acceptable values. Data sheets may also be submitted with the narrative report.

8. The chief physicist shall conduct oversight and maintenance of quality assurance programs for the facility, including review and approval of the quality assurance program on an annual basis, the performance of audits and the submission of audit reports in accordance with the following:
B. Quarterly Audit Report

Perform a quarterly review of the Quality Assurance Program and present a report of this review to each member of the internal Quality Assurance Committee. The review will contain, as applicable:

1. Proposed radiation safety policy revisions.
2. Occupational exposure record reviews.
3. Radiation safety incidents.
4. Compliance testing results.
5. Radiation worker continuing education performed.
7. Any recommended corrective actions necessary to comply with requirements of the EMRC Revised Code.

C. Annually Audit Report

Perform an annual audit of the Quality Assurance Program reported on forms developed by the EMRC QA committee. The audit results will be submitted to the EMRC within 90 days of the performance of the audit. The audit report will also be presented at the next Quality Assurance Committee meeting following the date of the audit. The annual audit will include at least the following items:

1. Assessment of radiation safety policies and procedures.
2. Review of the appropriateness of any corrective actions taken.
3. Review of equipment maintenance and calibration logs.
4. Review of all incident reporting involving the use of radiation-generating equipment.
5. Review of all patient and occupational overexposure, and
6. Results of equipment testing.
7. Annual report of personnel exposure
V: PERSONNEL RESPONSIBLE FOR QUALITY CONTROL TESTS

A. Every center needs to define an Personnel Performing Quality Control Testing

B. Training for Personnel Responsible for Monitoring and Performing Quality Control
   1. Personnel responsible for quality control testing shall be in-serviced annually in proper procedures by EMRC QA committee. Their competency in the performance of each step of this manual will be evaluated. This training will be documented on a competency form.

VI: RADIATION THERAPY EQUIPMENT QUALITY CONTROL TESTS AND PROCEDURES

A. Linear Accelerator Dosimetry Quality Control – Annual

   It is the policy of the Department of Radiation Therapy to ensure the accuracy and consistency of the radiation dose delivered to the patient by the linear accelerator. All quality control indicators listed below shall be evaluated by the internal QA committee.

   **Indicators and Action Levels:**
   1. Photon output calibration constancy - within +/-2% of 1.000cGy/MU
   2. Electron output calibration constancy - within +/-2% of 1.000cGy/MU
   3. Independent output calibration constancy - within +/-3% of 1.000cGy/MU
   4. Photon output field size dependence constancy - within +/-2% of those values currently in use at the institution.
   5. Photon central axis percent depth dose (PDD) constancy - within +/-2% of those values currently in use at the institution.
   6. Electron central axis percent depth dose (PDD) constancy - within +/-2% of those values currently in use at the institution.
   7. Photon beam flatness constancy – within 2%(from acceptance value)
   8. Electron beam flatness constancy – within 3%(from acceptance value)
   9. Photon beam symmetry constancy – within 3%(from acceptance value)
   10. Electron beam symmetry constancy – within 3%(from acceptance value)
   11. Off-axis factor constancy - within +/-2% of those values currently in use at the institution.
   12. Transmission factor constancy - within +/-2% of those values currently in use at the institution.
   13. Wedge transmission factor constancy - within +/-2% of those values currently in use at the institution.
   14. Short term stability - [(max - min)/min x 100 < +/-2%]
   15. Long term stability - [(Av2 - Av1)/Av2 x 100 < +/-2%]
   16. Monitor chamber linearity - The ratio of 50/100 should be between 0.49 and 0.51. The ratio of 300/100 should be between 2.97 and 3.03.
   17. Dose rate independence - the average dose for the minimum and maximum dose rate should be within +/-2% of the dose at the clinical dose rate.
18. Photon output constancy vs. gantry angle - the average value for each gantry angle should be within +/-2% of the calibration value.
19. Electron output constancy vs. gantry angle - the average value for each gantry angle should be within +/-2% of the calibration value.
20. Off-axis factor constancy vs. gantry angle - within +/-2% of those values currently in use at the institution.

Action Level Response:
Any deviation from the action levels defined above shall be corrected by the Medical Physicist or by a qualified Engineer under the supervision of the Medical Physicist.

B. Linear Accelerator Mechanical Quality Control – Annual

It is the policy of the Department of Radiation Therapy to ensure the accuracy and consistency of the mechanical systems of the linear accelerator. All quality control indicators listed below shall be evaluated by internal QA Committee.

Indicators and Action Levels:
1. Radiation isocenter
   a. Gantry rotation – within 2mm diameter
   b. Collimator rotation – within 2mm diameter
   c. Couch rotation – within 2mm diameter
2. Jaws
   a. Symmetry – 2mm difference in distance of each jaw from isocenter
   b. Orthogonality – within +/- 1° on corners
3. Couch
   a. Vertical travel – within +/- 2mm
   b. Sag flexure – within 2mm
4. Mechanical pointers – within +/- 2mm

Action Level Response:
Exceptions to the above action levels shall immediately be corrected by the Medical Physicist and/or the Biomedical Engineer.

C. Linear Accelerator Safety Interlocks & Ventilation - Annually

It is the policy of the Department of Radiation Therapy to ensure the proper operation of all linear accelerator safety and ventilation systems. All safety interlocks are checked on a daily or monthly basis.

Indicators and Action Levels:
1. Emergency off switch - Functional
2. Door interlock – Functional
3. Wedge interlock – Functional
4. Electron Cone interlock - Functional
5. Beam on light – Functional
D. Linear Accelerator Dosimetry Quality Control – Monthly

It is the policy of the Department of Radiation Therapy to ensure the accuracy and consistency of the radiation dose delivered to the patient by the linear accelerator.

Indicators and Action Levels:
1. Photon output constancy – within +/-2% of 1.000cGy/MU
2. Electron output constancy – within +/-2% of 1.000cGy/MU
3. Backup monitor constancy – within 2%
4. Photon central axis %DD constancy – within +/-2% of those values currently in use at the institution.
5. Electron central axis %DD constancy – within +/-2% of those values currently in use at the institution.
6. Photon beam flatness constancy – within 2%
7. Electron beam flatness constancy – within 3%
8. Photon beam symmetry constancy – within 3%
9. Electron beam symmetry constancy – within 3%

Action Level Response:
- If the output constancy action level is exceeded the setup shall be double-checked. If necessary, the output shall be calibrated by the medical physicist to bring the linear accelerator dose rate into compliance.
- If the flatness or symmetry action level is exceeded the setup shall be double-checked. If necessary, the medical physicist in perform a machine calibration in water with Biomedical Engineering to bring the linear accelerator flatness or symmetry into compliance.

E. Linear Accelerator Mechanical Quality Control – Monthly

It is the policy of the Department of Radiation Therapy to ensure the accuracy and consistency of the mechanical systems of the linear accelerator. All quality control indicators listed below shall be evaluated by the therapy CRE or his designee and reviewed by the CRE.

Indicators and Action Levels:
1. Light/radiation field coincidence – within +/-2mm or 1% on a side
2. Gantry/collimator angle indicators – within +/-1°
3. Wedge position – within +/-2mm
4. Tray position – within +/-2mm
5. Applicator position – within +/-2mm
6. Field size indicators – within +/-2mm
7. Cross-hair centering – within 1mm diameter
8. Treatment couch position indicators – within +/-2mm and 1°
9. Latching of wedges and blocking trays – functional
10. Jaw symmetry – within +/- 2%
11. Field light intensity – functional
12. Optical distance indicator - within +/-2mm

Action Level Response:
Any deviation from the action levels defined above shall be corrected by the Medical Physicist or by a qualified Biomedical Engineer under the supervision of the Medical Physicist.

F. Linear Accelerator Safety Interlocks - Monthly

It is the policy of the Department of Radiation Therapy to ensure the proper operation of all linear accelerator safety systems. All quality control indicators listed below shall be evaluated by the therapy CRE or his designee and reviewed by the CRE at intervals indicated below.

Indicators and Action Levels:
1. Emergency off switch - Functional
2. Door interlock – Functional
3. Wedge interlock – Functional
4. Electron Cone interlock - Functional
5. Beam on light – Functional
6. Intercom cameras and monitor

Action Level Response:
If any action levels are exceeded notify the Medical Physicist and/or the Biomedical Engineer.

G. Linear Accelerator Dosimetry Quality Control - Daily

It is the policy of the Department of Radiation Therapy to ensure the accuracy and consistency of the radiation dose delivered by the linear accelerator to the patient. All quality control indicators listed below shall be evaluated by a therapy technologist and reviewed by the internal QA committee.

Indicators and Action Levels:
1. Photon output constancy – within +/- 3% of the benchmark values set by the Medical Physicist.
2. Electron output constancy – within +/- 3% of the benchmark values set by the Medical Physicist.

Action Level Response:
If any action levels are exceeded record the measurement and notify the Medical Physicist. The Medical Physicist will record the action taken to correct the problem.

H. Linear Accelerator Mechanical Quality Control - Daily

It is the policy of the Cancer Center to ensure the accuracy and consistency of the mechanics of the linear accelerator. All quality control indicators listed below shall be evaluated by a therapy technologist and reviewed by the internal QA Committee.

Indicators and Action Levels:
1. Gantry angle - within +/-1.0°
2. Laser alignment with isocenter - within 1mm
3. Light field size - within 1% of that indicated
4. Optical distance indicator - within +/-2mm

Action Level Response:
If any action levels are exceeded notify the Medical Physicist and/or the Biomedical Engineer.
I. Linear Accelerator Safety Interlocks - Daily

It is the policy of the Department of Radiation Therapy to ensure the proper operation of all linear accelerator safety systems. All quality control indicators listed below shall be evaluated by a therapy technologist and reviewed by the CRE or his designee.

Indicators and Action Levels:
1. Door interlock – Functional
2. Audiovisual monitor - Functional
3. Beam on light - Functional
   a. Visually check that the BEAM ON lights at console and above door.
4. Intercom cameras and monitor

Action Level Response:
If any action levels are exceeded notify the Medical Physicist and/or the Biomedical Engineer.

J. Linear Accelerator Dosimetry Quality Control – As Needed

It is the policy of the Department of Radiation Therapy to ensure the accuracy and consistency of the radiation dose delivered by the linear accelerator to the patient. All quality control indicators listed below shall be evaluated by internal QA Committee.

Indicators and Action Levels:
1. Output constancy for electron applicators.
2. Arc Mode – within +/- 3% or 1MU, which ever is greater. This will be tested before each patient is treated with this mode.
3. Scatter radiation measurements (newly installed or relocated only)

Action Level Response:
If any action levels are exceeded notify the Medical Physicist and/or the Biomedical Engineer.
VII: LIST OF QUALITY CONTROL TEST EQUIPMENT

A. Therapeutic Quality Control Test Equipment (or equivalent equipment):

1. 3D Scanning Water Phantom
2. Survey Meter (ion chamber)
3. Multi polarity electrometer
4. Associated external ion chambers
   a. Parallel plate Ion Chamber
   b. Two 0.6cc Farmer Ion Chamber
5. Well type detector
6. Barometer
7. Thermometer
8. Water level
9. 30x30x30 cm³ Water Phantom
10. Solid Water Phantom
11. Densitometer
12. Laser Alignment Tool
VIII: OPERATOR TRAINING

A. Licensure

1. All individuals operating radiation generating equipment will be licensed by the EMRC for the area of radiology that he or she works (i.e., Nuclear Medicine, Radiography or Radiation Therapy).
2. Part of the license requirement is for the individual to maintain current continuing education training in radiation safety.

B. Competency Training

EMRC will ensure that individuals are competent in the established safe operating procedures for each type of radiation-generating equipment he or she uses. In order to ensure technologist’s competency, proof of technologist’s competency will be documented in the employee’s personnel record. Competency training will involve the following:

1. New employees will be required to complete the competency evaluation within 30 days of employment.
2. All operators of radiation-generating equipment will read and become familiar with the established Quality Assurance Program as described in this manual.
3. A student may train under the direct supervision of a licensed technologist that is current in the completion of his or her competency evaluation provided that the student has obtained a license from the EMRC to operate in that capacity.
4. The training to be provided to operators of radiation-generating equipment upon employment and annually thereafter will include at least the following: (if applicable)
   a. Time, distance and shielding concepts
   b. Dose limits and proper use of monitoring devices
   c. Prenatal exposure policy
   d. Mobile X-ray safety policies
   e. C-arm fluoroscopy policies
   f. Patient shielding policies
   g. Patient holding policies
   h. Pregnant patient screening
   i. Pregnant employee policies
   j. Facility regulations and their location
   k. Biological effects of radiation exposure
5. Records of this training will be maintained including the name of individual presenting, names and signatures of attendees, dates and duration of in-service, list of topics covered, and results of testing if applicable.
IX: RADIATION MONITORING REQUIREMENTS

A. Occupational Exposure Limits

1. Personal monitoring equipment and supplied to:
   a. Each individual who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar year in excess of 25% of the applicable occupational exposure limit value specified in The EMRC rules.
   b. Each individual under 18 years of age who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar year in excess of 5% of the applicable value in the below table.

   Occupational exposure limit values specified by EMRC:

<table>
<thead>
<tr>
<th>Body Area</th>
<th>mSv per calendar year</th>
</tr>
</thead>
<tbody>
<tr>
<td>The total effective dose equivalent</td>
<td>20</td>
</tr>
<tr>
<td>The sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye.</td>
<td>500</td>
</tr>
<tr>
<td>Lens dose equivalent</td>
<td>20</td>
</tr>
<tr>
<td>Shallow dose equivalent to skin or extremity</td>
<td>500</td>
</tr>
</tbody>
</table>

B. Establishment of ALARA Investigational Levels

EMRC hereby establishes investigational levels for occupational exposure which, when exceeded, will initiate review or investigation by the EMRC QA committee.

1. Personnel dose less than Investigational Level I
   a. Except when deemed appropriate by the EMRC, no further action will be taken in cases where an individual’s dose is less than values for Investigational Level I

2. Personnel dose equal to or greater than Investigational Level I but less than Investigational Level II
   a. The EMRC will review the dose of each individual whose quarterly dose equal to or greater than Investigational Level I and report the results of the reviews at the first QA meeting following the quarter when the dose was recorded.
   b. If the dose does not equal or exceed equal to or greater than Investigational Level II, no action related specifically to the exposure is required unless deemed appropriate by the QA committee.

3. Personnel dose equal to or greater than Investigational Level II
   a. The EMRC will investigate in a timely manner the causes of all personnel doses equaling or exceeding Investigational Level II and, if warranted, will take action.
   b. A report of the investigation, any actions taken, and a copy of the individual’s form NRC-5 or its equivalent will be presented to the QA
committee at its first meeting following completion of the investigation. The details of these reports will be included in the QA committee minutes.

C. Establishment of Investigational Levels Above Investigational Level II

1. In cases where a worker’s or a group of workers’ doses need to exceed an investigational level, a new, higher investigational level may be established for that individual or group on the basis that it is consistent with good ALARA practices. Justification for new investigational levels will be documented.
2. The QA committee will review the justification for and must approve or disapprove all revisions of investigational levels.

D. Maintenance of Records

1. We shall maintain records showing the radiation exposures of all individuals for whom personnel monitoring is required under the EMRC rules. Such records shall be clear and legible, shall be for periods of time not to exceed one calendar quarter, and shall contain the following information:
   a. Participant’s name
   b. Monitoring period
   c. Type of dosimeter
   d. Deep, eye, and shallow dose equivalent (mSv)
   e. Accumulated dose equivalent for the year
   f. Inception date
   g. ID number
   h. Birth date
2. Records of individual radiation exposure shall be preserved until a date 5 years after termination of the individual's employment or association with this facility.
3. The Chief Physicist shall review records of personnel exposure quarterly and annually, and shall report the results to the QA Committee per EMRC. Copies of the dosimetry reports without the employee social security number will be forwarded to individual departments for posting.
4. The EMRC, at the request of any individual employed or associated with this facility, shall advise such individual annually of the individual’s exposure to radiation.
5. All new radiation workers should make their prior occupational exposure history available to the employer. Cumulative exposures should be maintained for moonlighting workers.
6. Employees will be notified of their annual dose in a printed report. A copy of this report will be kept in the Radiation Safety Office.

E. Proper Use of Area and Personnel Monitoring

1. Specific dosimeters should be worn as follows:
   a. Dosimeters labeled as “Whole Body” are to be worn on the trunk, between the shoulders and knees, at a level of highest expected exposure. The “Whole Body” badge is to be worn on the body under any protective lead shielding so as to accurately monitor the exposure to the body.
b. The “Collar” badge is to be worn on the outside of the thyroid shield. Any individual issued a “Collar” badge is required to wear a thyroid shield during fluoroscopic studies.
c. A “Wrist” badge is required to be worn at the wrist under any protective lead shielding.
d. A “Ring” badge is to be worn on the dominant hand.
e. Control badges are to be stored in non-radiation areas.
f. Visitors who will be viewing procedures may be issued pocket dosimeters if available. Documentation regarding those exposures must be kept by the EMRC.

2. At the request of the EMRC, individuals may be required to wear additional protective shielding during procedures (lead aprons, gloves, thyroid shields and leaded glasses). All such protection is recommended where practicable.

3. When not in use, monitoring devices should be kept in an area away from radiation. They should never be taken home or used while working for other employers. Control monitoring devices are used to determine the background radiation and radiation received during shipment. They should be kept away from radiation areas. Ideally, monitoring devices should be stored with the controls when not in use.

4. All badges should be turned in promptly at the end of the monitoring period and shipped out to be read in a timely fashion.

5. Lost monitoring devices should be reported immediately and a replacement issued to the employee. For the period corresponding to the lost device, an average dose based on past exposure history can be added to the employee’s lifetime dose.

F. Prenatal Exposure

1. The technologist may declare her pregnancy in writing, providing an estimated date of conception.

2. The declared pregnant worker shall be supplied with a fetal radiation monitor to be worn at waist level.

3. If needed, work should be restricted so that the radiation dose will be limited to 5 mSv during the gestational period.

4. Management should be notified of any change in pregnancy status, such as termination or delivery.

5. Upon declaration of pregnancy, the individual in charge of radiation safety (RPO) should review the potential risks to the embryo/fetus from exposure to radiation. Documentation of such review should be maintained for EMRC inspection.
X: PROCEDURE FOR NOTIFYING THE DIRECTOR OF THE EMRC WHEN INDIVIDUALS ARE OCCUPATIONALLY OVER-EXPOSED TO RADIATION

G. Immediate Notification

The individual responsible for radiation protection shall immediately notify the EMRC director by telephone and Fax/Email of any incident involving any radiation generating device possessed by EMRC which may have caused or threatens to cause:

1. Exposure to the whole body of any individual to 250 mSv or more; or,
2. Exposure of the skin of the whole body of any individual to 1500 mSv or more; or,
3. Exposure of the feet, ankles, hands, or forearms of any individual to 3750 mSv; or,
4. A loss of one working week or more of the operation of any facilities affected;

H. Twenty-four Hour Notification

The individual responsible for radiation protection shall within 24 hours notify the director of the EMRC by telephone and Fax/Email of any incident involving any radiation generating device possessed by EMRC which may have caused or threatens to cause:

1. Exposure of the whole body of any individual to 50 mSv or more; or,
2. Exposure of the skin of the whole body of any individual to 300 mSv or more; or,
3. Exposure of the feet, ankles, hands, or forearms to 750 mSv or more; or,
4. A loss of one day or more of the operation of any facilities affected.

I. 30 Day Written Notification

The individual responsible for radiation protection shall report in writing to the director of the EMRC within 30 days of each exposure of a personnel radiation dosimeter, or a person’s body, to radiation in excess of any applicable limits or any incidents for which notification is required either immediately or within 24 hours (see above), or in the event of levels of radiation in an unrestricted area in excess of the following:

1. Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of 0.2 mSv in any one hour; or,
2. Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of 10 mSv in any seven consecutive days.

J. Report Content

1. Any report filed with the director of the EMRC shall be prepared in such a manner that names of individuals who have received exposure to radiation will be stated in a separate part of the report.
2. Each report shall describe the extent of the exposure of individuals to radiation, levels of radiation involved, the cause of the exposure, and corrective steps taken or planned to assure against a recurrence.
3. In any case where a report to the EMRC director is required, we shall, not later than making the report to the EMRC director, also notify individuals involved of the nature and extent of the exposure. Such notice shall contain
the following statement: "This report is furnished to you under the provisions of the EMRC's rules entitled. You should preserve this report for future reference."

K. Notification Mailing Address and Phone Number

1. All immediate notification will use the following phone number notify the director of the Energy & Minerals Regulatory Commission

2. All other notifications will be mailed to the following address notify the director of the Energy & Minerals Regulatory Commission
XIV: Simulator Quality Control – Annual:

It is the policy of the Department of Radiation Therapy to ensure the accuracy and consistency of the radiation dose delivered to the patient by the simulator. The internal QA committee shall evaluate all quality control indicators listed below.

**Indicators and Action Levels:**

- Collimator rotation isocenter – within 2 mm diameter
- Gantry rotation isocentre – within 2 mm diameter
- Table rotation isocentre – within 2 mm diameter
- Exposure rate – within Baseline
- kVp and mAs calibration – within Baseline
- High and low contrast resolution – within Baseline

XV: Simulator Quality Control – Monthly:

- Field size indicator – within 2 mm
- Gantry/collimator angle indicators – within 1°
- Focal spot axis indicator – within 2 mm
- Distance between known points in the image – within 2 mm

XVI: Simulator Quality Control – Daily:

- Safety switches – Functional
- Lasers – within 2 mm
- Distance indicator – within 2 mm