PURPOSE:

To ensure that radiation producing equipment is used safely and in accordance with the national regulations of the Republic of the Philippines and the International Atomic Energy Agency (IAEA).

LEVEL:

All employees of Metro RMCI Cancer Center (MRCCC) personnel and members of the public with specific procedural protocol for Radiation Oncology and for all security personnel who have access to the areas where radiation sources, both electrically-produced and radionuclides, are used and stored.

POLICY:

MANAGEMENT COMMITMENT

The Metro RMCI Cancer Center (MRCCC) is committed to fully complying with all relevant requirements in the safe use of radiation. Hence, the hospital's Cancer Center hereby commits to the Radiation Safety Program (RSP) of the highest quality, compatible with international and local standards in radiation protection and safety.

The RSP is designed to limit the probability of occurrence of potential exposures and restrict the magnitude of exposures if such events occur during operations conducted at the Cancer Center. The RSP manual was developed to ensure the safety of the medical use of ionizing radiation for the localization and treatment of benign and malignant diseases at the Cancer Center and to minimize the probability of unwanted or accidental exposure of patients, staff, and the public.

The Cancer Center's commitment to the RSP is based on the fundamental principles on therapeutic levels of radioactivity to be used in medicine. Hence, exposures to all sources of ionizing radiation are: (1) justified; (2) optimized, i.e., to be maintained As Low As Reasonably Achievable (ALARA); and (3) within the prescribed dose limits set by the

local authorities. Hence, the Cancer Center, with its Continuing Education Program, is committed to fostering the capacity building of cancer center personnel through internal and external training customized to each specialty. Likewise, the Cancer Center's adequate manpower is observed as required by the regulations.

WORKPLACE MONITORING, AREA CLASSIFICATION AND INDIVIDUAL MONITORING

Workplace Monitoring	Frequency	Dose Rate	Action
• Door • Control Console • Hallway	Annually and as needed by RPO	Within 7.5 uSv/hr	• Dose rate reading in excess must be noted by the RPO. • RPO determines possible causes of excess dose rate reading such as loss of shielding capacity of barriers or machine malfunction.

A. Controlled and Supervised Areas

1. **Controlled Area** - the designation of an area as "Controlled" means that nobody shall be allowed to enter the area unless authorized. Radiation therapy and brachytherapy treatment rooms are classified as CONTROLLED AREAS. It is stressed that in no circumstance shall any person other than the patient be allowed in the controlled area during "BEAM ON."

2. **Supervised Area** - the restricted area beyond the patient waiting area where regular radiation work is carried out shall be classified as a SUPERVISED AREA. This includes all rooms adjacent to the treatment rooms, the waiting area, the restroom in the restricted area, and the treatment planning room. Dose constraints (effective dose rates) in supervised areas must not exceed 7.5 uSv/h.

NOTE: Areas other than the supervised areas must adhere to a dose limitation of 0.02 mSv/wk.

PERSONNEL MONITORING AND PROTECTION PROGRAM

1. A Personnel Monitoring Device, also known as a Personal Radiation Monitor, such as a Thermo-Luminescent Dosimeter (TLD) or optically-stimulated luminescence dosimeter (OSLD), shall be provided to all individuals occupationally exposed to ionizing radiation as recommended by the RPO.
2. The device must be worn by the same person for the duration of the monitoring period, i.e. 2 months, hence the word "personal".
3. All Physicians, Medical Physicists, Radiologic Technologists, Oncology Nurses, and Aides assigned to the Radiation Oncology Center shall be issued with dosimeter badges.
4. These badges shall be derived from PNRI, or any authorized service provider, on a yearly contract which includes processing and reporting.

The following shall be observed:

1. Individuals occupationally exposed to radiation shall be required to wear their personal radiation monitoring badge at all times inside the premises of the Cancer Center. This shall be part of their uniform as an employee, and proper care of the badge must be observed.
2. Personnel dosimeters shall be worn in the anterior chest area to accurately estimate the total body dose.

3. For easy reference, a permanent record of the results of each periodic dose evaluation of occupational exposure must be kept on file.The levels of investigation established for external exposure shall be used as reference values for evaluating each radiation worker's radiation protection practices.
4. A rack shall be set for proper monitoring and safekeeping of badges. The badge must be placed on the rack provided by the center and must not be taken home or elsewhere outside the center or hospital premises.
5. Workers occupationally exposed to radiation shall position patients with the least possible effort and time. He/she shall minimize unnecessary conversation with patients and immediately proceed to implement the treatment protocol.
6. A periodic quality assurance check of the therapy unit shall be done to ensure that all operational parameters of the units are within acceptable standards. The occupationally exposed worker shall be so controlled according to the recommendations of IAEA's IBSS-Safety Series 115.

SPECIAL RESTRICTIONS:

1. All female employees must inform the RPO if they are pregnant or may be pregnant.
2. A pregnant radiation worker shall be reassigned to areas with the least radiation level to protect the embryo/fetus.
3. The RPO shall promptly review all monthly exposure reports from the PNRI, or the official service provider, to evaluate unexpected high or low exposures.

LOCAL RULES AND SUPERVISION

A. Investigation Levels to Monitor Individual Occupational External Radiation Exposures

The Dr. Pablo O. Torre Memorial Hospital Cancer Center hereby establishes the Investigation Levels for individuals occupationally exposed to external radiation, such that when the values are exceeded, the RPO shall initiate the necessary investigation and recommend appropriate actions.

The investigational levels to be used must adhere to the ICRP 60 dose limits (20 mSv averaged *over 5 years, not exceeding 50 mSv per year for whole body exposure).Below is* the table, which describes the investigational levels used and is calculated as one-third of the allowable limit per year.

- ✓ **Effective dose of 20 mSv/year averaged over 5 years**
- ✓ Effective dose of 50 mSv/year in any single year
- ✓ Equivalent dose to the lens of the eye of 150 mSv/year
- ✓ Equivalent dose to the extremities or skin of 500 mSv/year.

The RPO shall review and record the results of personnel monitoring at least once in any calendar quarter. The values of effective doses shall be compared with the Investigational Levels and the following actions shall be taken.

The RPO shall investigate the causes of all personnel exposures in a timely manner and, if necessary, take appropriate action.

1. A report of the result of the investigation, with action taken if any, shall be presented to the Radiation Safety Committee at the first meeting following the completion of the investigation. The details of these reports shall be recorded in the minutes of the meeting.

2. Minutes of the meeting shall be made available for review or inspection to DOH-FDA-CDRRHR personnel.

B. Power- up Sequence for ELEKTA Linear Accelerator

POWER UP THE SYSTEM

Note: *Follow the local rules to power up the system. Elekta recommends that the Linear Accelerator is sufficiently warmed up before use.*

1. Switch on the main isolator for the linear accelerator.
2. Open the cover and press the **Power On (I)** button on the Console.
3. Press the power on/off switch on the Front-end computer.
4. Switch on the water chiller.

The **Start** window appears, and self-tests are done on the FEC. This takes approximately one minute.

> ***Note:*** *The system shall do a number of tests during initialization. When the tests are successfully completed, the Warming Up procedure shall start. The modulator, gun, and magnetron shall warm up. This takes approximately 15 minutes.*

When each **Checkbox** has a check symbol in it, like ☑ , the self-tests have completed successfully.

The **Log on** dialog box appears.

Log on to Clinical Mode

Log on to the system with a clinical user name to open the Clinical Mode application. Before you log on, make sure that you have:

- a user name, issued by the System Administrator
- a user password, issued by the System Administrator

To log on

1. At the **Log on** dialog box, type in the **user name**.
2. Press the keyboard **<TAB>** key or click in the password field.
3. Type in your password.
4. Click **OK**.

If the log on check fails, the user is asked to try again. If the log on is successful, Clinical window appears.

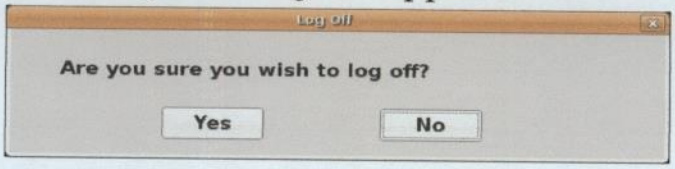
Note: Passwords are case sensitive.

Log off from Clinical Mode

1. Click the **Log Off** icon.

Log off icon

The **Log Off** dialog box appears.



Log off dialog box

2. Click **No** to return to the **Clinical** window or click **Yes** and the **Standby** dialog box appears.
3. You can either log on again or click **Shutdown**.

After you log off, the system remains powered up and available to other Authorized Users.

C. Switch off/ Shutdown Sequence for ELEKTA Linear Accelerator

Always follow the correct procedure to switch off this equipment otherwise the equipment, may be damaged.

WARNING

If the system is shut down by a procedure other than that recommended, the operation in progress may not be completed. In the case of patient treatment, look at the backup MU monitor as more MUs may have to be delivered. In the case of service calibration or configuration, do the calibration again to make sure that the correct data is saved. If you ignore this, it can cause clinical mistreatment.

1. Click **Shutdown** on the **Log on** dialog box
2. Click **Cancel** to return to the **Log on** dialog box or click **OK** to shutdown.
3. Select **Power Off** to continue shutting down.

Power down the system

1. Follow the procedures in **Shutdown**.
2. When the FEC monitor goes blank, press the **Power Off (0)** button on the Console.
3. Switch off the Water Chiller.

Note: *Follow the local procedures to remove the main power.*

Note: *When power is removed from the system, either normally or abnormally, the Back- up MU monitor shall clock up 1 MU. This shall clear when new beam parameters are entered.*

Switch off after a power failure

The TCC has an uninterruptible power supply (UPS) that supplies an auxiliary power supply to the TCC. If there is a power failure, the UPS supplies power to the TCC and Integrity™ for approximately five minutes. This shall give you sufficient time to save the treatment data and stop the operation of the system correctly.

Note: *A fully charged UPS supplies power to the TCC and Integrity™ for approximately five minutes. If the UPS is not fully charged, the time available decreases.*

When a power failure occurs, the UPS changes to battery backup immediately to supply the TCC. After 10 seconds, Integrity™ starts the sequence for power failure switch off. If the main power supply comes back in less than 10 seconds, the UPS changes to the main supply and Integrity™ does not start the sequence for power failure switch off. This gives protection against power spikes.

When it starts, the UPS gives a sound at 30s intervals to show that it is in operation. This alarm continues until power comes back or the UPS is empty. Charge the UPS immediately after usage. Do not use the UPS continuously, as this shall decrease its performance.

Total Failure of the Main Power Supply

If there is a total failure of the main power supply or if you press the Emergency Stop button, the UPS starts. After 10s, Integrity™ switches off the system. If the power failure occurs when radiation is on, the treatment terminates immediately and the **Power Supply** dialog box opens. This acknowledges the power failure and tells you that Integrity™ shall not complete the radiation delivery. The Linear Accelerator Record records data for the delivered radiation until the time of the power failure.

You have 5 minutes to manually record other displayed data, for example with the <Print Screen> key, and switch off the system correctly. If you do not stop the system in less than 5 minutes, the system shall shut down automatically.

If you were in **Receive External Prescription** when a power failure occured, save the treatment data on the R&V system. If you do not save the treatment data, refer to the documentation for the R&V system for more information.

D. Prescription for Health Surveillance

Health surveillance is done by the institution to continuously monitor the fitness of their employees with regard to their capability of performing their duties. The Employee Relations Section (ERS) of the Human Resource Division of the Dr. Pablo O. Torre Memorial Hospital Cancer Center is responsible for the health surveillance of employees. Annual physical and medical examinations are performed by the ERS to monitor occupational health of the employees. The ERS is also responsible for guiding the employees if medical attention is needed in the event that the employee may not be fit to work.

E. Access control

1. Controlled Area. Only authorized Cancer Center personnel are allowed to enter this area. This includes Oncologists and other Attending Doctors if applicable, Radiologic Technologists, Medical Physicists, Radiation Oncology Nurses and Aides. Additionally, only the patient to be treated is allowed to enter during treatment.

2. Supervised Areas and Patient Waiting Area. Only authorized Cancer Center personnel are allowed to enter this area. This includes Radiation Oncologists and other Attending Doctors if applicable, Radiologic Technologists, Medical Physicists, Radiation Oncology Nurses and Aides. Additionally, only the patient to be treated is allowed to enter during treatment. In any event that the patient needs a companion or insists on having a companion in the supervised areas, the companion shall sign a consent form which contains information on possible radiation exposures and the effects it may have on the companion. The visitors shall stay in the public areas of the center. If they must enter the supervised areas, they shall be escorted at all times by an authorized Cancer Center personnel.

V. PERSONNEL TRAINING PROGRAM

Individuals working in or frequenting restricted areas must meet the following applicable training requirements. These training requirements shall be continually reviewed and revised in order to provide function-specific and need-specific training. Therefore, these requirements may be modified. The Radiation Safety Officer shall conduct training classes, or someone of similar training and experience, in accordance with outlines reviewed and approved by the Radiation Safety Committee.

Frequency of Training. As a rule, Radiation Safety training shall be required and provided.

1. Before assuming duties or work in the vicinity of radiation sources. Annual drills shall be done for all employees.
2. Whenever there is a significant change in duties, regulations, or the terms of the license.

Description of Training

1 Training shall be sufficient to ensure that individuals who frequently work in *controlled and supervised areas adhere to the standard requirement.*

2 Individuals whose duties may require work in the immediate vicinity of radiation sources are informed about radiation hazards and appropriate precautions.

3 Content of the Training Program. The program of instruction shall include:

- 3.1 Pertinent terms and conditions of the radiation facility license, including procedures developed as a prerequisite for obtaining a license and committees incorporated into the license.
- 3.2 Appropriate response to emergencies or unsafe conditions, including participation in appropriate dry runs of emergency procedures conducted, as part of the initial and annual refresher training.
- 3.3 Areas where radiation is used.
- 3.4 Potential hazards associated with radiation.
- 3.5 Safety procedures appropriate to the duties of an employee.
- 3.6 Pertinent CDRRHR and PNRI regulation updates.

4 All personnel are obliged to report unsafe conditions to the Radiation Protection Officer.

5 The right of all personnel to be informed of radiation exposure.

- 5.1 Location where the license has to be posted or made available. Copies of regulations and copies of radiation licenses and license conditions.

D. Record of Training. Records of initial and refresher trainings shall be maintained and shall include:

1. Topics
2. Name of the individual who conducted the training
3. Names of the individuals who received the training
4. Dates and duration of the training session
5. List of the topics covered.

VI. TREATMENT PROTOCOL

1. **Clinical Evaluation and Therapeutic Decision.** The onset of radiation therapy begins with the clinical evaluation of the Radiation Oncologist on the disease based on supporting pathological, radiological, and other examinations of the patient's condition. The radiation dose prescription shall come from the Authorized User as defined in this ALARA Program, duly registered with the DOH-DFA-CDRRHR and the Philippine College of Radiology, to treat patients in the facility. The Radiation Oncologist's prescription shall be based on the Principles of Irradiation. No treatment shall be carried out unless the radiation prescription is properly initialized by the Authorized User on the patient's chart. Further, treatment shall not commence without the patient's consent. Patient shall be asked to sign a waiver form prior to irradiation.

2. **Imaging and Localization.** The region of interest that needs to be treated shall be localized with the imaging tools available to localize the target volumes. The GTV, CTV and OAR (ICRU 50 and 62) shall be determined by the Oncologist based on his clinical judgment, expertise, and experience. Other patient contours and organ segmentation may be delegated to the Medical Physicist or Radiologic Technologist for completeness. The Radiation Oncologist verifies all additional contours and segments prior to treatment planning and dosimetry.

3. **Treatment and Localization. The radiation oncologist and physicist must collaborate to design the beam aperture, field multiplicity, and collimation.** It is the responsibility of the Physicist to verify the beam data integrity and isodose distribution before a treatment plan is carried out. The best treatment plan shall be decided upon by the Radiation Oncologist before execution, keeping in mind ALARA exposures to organs at risk (OAR).

4. **Plan Verification.** Plans are verified in the initial stage through the use of the built-in CT simulation system of the Linear Accelerator machine or any other suitable simulator.

5. **Treatment.** On the first day of treatment, the Radiation Oncologist and his support staff shall establish the set-up. Localization images, chart reviews, and dosimetry checks are carried out by the Medical Physicist and Radiologic Technologist. The use of applicable immobilization devices and other accessories shall be further re-established or checked. Indelible marks may be drawn on patient skin to help aid in the reproducibility of the set-up. In the course of treatment, proper patient identification shall be observed to ensure that the right patient in the right anatomy is irradiated. As part of patient identification, the patient is called by his/her full name, and random questions may be asked of him/her regarding his/her condition, treatment, picture, etc. This procedure also serves as a check on how well the patient understands the treatment process.

Key Staff Function in Clinical Radiation Therapy

	KEY STAFF	SUPPORTIVE ROLES
Clinical Evaluation	Radiation Oncologist	Oncology Nurse
Therapeutic Decision	Radiation Oncologist	Medical Physicist
Target Volume Imaging and Localization	Radiation Oncologist	Medical Physicist
Imaging	Radiation Oncologist	Radiation Oncologist Medical Physicist Oncology Nurse
Tumor Volume	Radiation Oncologist	Medical Physicist
Sensitive Critical Organs	Radiation Oncologist	Medical Physicist
Patient Contour	Radiation Oncologist	Medical Physicist
Treatment Planning		
Beaming Data Computerization	Medical Physicist	
Computation of Beams	Medical Physicist	
Beams Assignments/Beam Aperture Design Beam Modifiers	Radiation Oncologist/ Medical Physicist	
Analysis of Alternate Plans	Radiation Oncologist/	

	Medical Physicist	
Selection of Treatment Plans	Radiation Oncologist/ Medical Physicist	
Dose Calculation/Authenticate Beam Data and Parameters	Medical Physicist	
Simulation and Verification of Treatment Plan	Radiation Oncologist Medical Physicist Radiologic Technologist	Oncology Nurse
Treatment		
First Day Set-up	Radiation Oncologist Medical Physicist Radiologic Technologist	Oncology Nurse
Localization Images	Radiation Oncologist Radiologic Technologist	Medical Physicist
Dosimetry Checks/Chart Review	Radiation Oncologist Radiologic Technologist	Radiologic Technologist
Repositioning/Treatment	Radiologic Technologist	Radiation Oncologist Medical Physicist

Periodic Evaluation	Radiation Oncologist	Oncology Nurse
Follow-up Evaluation	Radiation Oncologist	Oncology Nurse

The ultimate responsibility for treatment decision and the technical execution of the therapy, as well as the consequences shall always rest with the Radiation Oncologist.

VII. PRINCIPLES ON THE PRESCRIPTION OF RADIATION:

1 Evaluation of the full extent of the tumor (staging) by whatever means available, including radiographic, radioisotope, and other studies.
2 Knowledge of the pathologic characteristics of the disease, including potential areas of spread that may influence the choice of therapy (e.g. rationale for elective irradiation of the lymphatics in the neck or pelvis.)
3 Determination of the goal of therapy (curative versus palliative).
4 Selection of appropriate treatment modalities, which may include irradiation alone, or irradiation combined with surgery, chemotherapy, or both. The choice shall have a significant impact on the volume treated and the doses of irradiation delivered.
5 The determination of the optimal dose of irradiation and the volume to be treated, which are made according to the anatomic location, histologic type, stage, potential regional node involvement, and other characteristics of the tumor, and the normal structures present in the region. The Radiation Oncologist shall never hesitate to modify established policies in order to tailor the treatment plan to the needs of the patient.
6 Evaluation of the patient's general condition, periodic assessment of tolerance to treatment, tumor response, and status of the normal tissues treated.
7 Active Role of the Radiation Oncologist/s:

7.1 Examine the patient personally, review the microscopic material, perform examinations and take biopsy if necessary.

7.2 On the basis of this thorough clinical investigation Radiation Oncologist consider the plan of treatment and suggest it to the referring physician to the patient.

7.3 They reserve for themselves the right to an independent opinion regarding diagnosis and advisable therapy and if necessary the right disagreement with the referring physician.

7.4 During the course of the treatment, the Radiation Oncologist directs any additional medication that may be necessary.

7.5 Are ready to be called in an emergency at any time.

VIII. TREATMENT PLANNING CONSIDERATIONS IN PREGNANT PATIENTS

It is necessary to determine if a patient is pregnant or could possibly be pregnant. Pregnant women have lower radiation dose limits due to the sensitivity of the developing fetus to radiation. The requesting physician shall justify irradiation of the pelvic area. A written directive must state why the said intervention is needed. The patient shall sign a waiver with an explanation of the risk due to irradiation while pregnant. The following must be strictly adhered to:

1. Ensure that the dose to the fetus is kept to a minimum.
2. Complete all planning as though the patient were not pregnant.
3. Consider modifying the plan to reduce the fetal dose (changing field size and angle, for example).
4. Estimate the dose to the fetus without shielding using a phantom.
5. Design and construct special shielding if necessary.
6. Measure the dose to the fetus in a phantom during simulated treatment with shielding in place.

7. Document the treatment plan and discuss it with all personnel involved with the treatment.
8. Monitor fetal size and location throughout the course of the therapy and update estimates of fetal dose if necessary.
9. Document the completion of treatment by estimating the total dose to the fetus due to the radiation therapy.

IX. MANAGEMENT OF RADIATION THERAPY PATIENTS WITH CARDIAC PACEMAKER

1. Have the patient's coronary and pacemaker status evaluated by a cardiologist before and soon after the completion of the therapy.
2. Always keep the pacemaker outside the machine-collimated radiation beam both during treatment and when taking portal films.
3. Carefully observe the patient during the first therapy session to verify that no transient malfunctions are occurring and during subsequent treatment if magnetron misfiring (sparking) occurs.
4. Before the treatment, estimate and record the dose (from scatter) to be received by the pacemaker. The total accumulated dose should not be more than 2 Gy.
5. If treatment within this guideline is not possible, the physician shall consider having the pacemaker either temporarily or permanently removed before irradiation.

X. QUALITY ASSURANCE

Radiation Protection of Personnel and Patients

1. Personal monitoring badge is required from all personnel who work frequently in the vicinity of the Radiation Therapy Accelerator. This includes Physicians, Medical Physicians, Radiologic Technologists, Accelerator Maintenance personnel and aides.

2. Periodic radiation protection checks shall be carried out on both the machine and the facility. Checks on the facility include the door interlock.

Security

1. Only Authorized Personnel can operate all radiation emitting devices.

2. Authorized Personnel include the Medical Physicist, Radiologic Technologist and the Authorized Service Engineer.

3. The requisite security measures include requiring Radiologic Technologists to carry the console key with them if necessary at times when the console is unattended, and to lock up the console keys in a secure place after working hours.

Maintenance

1. The Medical Physicist is responsible for obtaining machine maintenance and for assuring that the accelerator is fit to use after maintenance, be it a repair or just preventive maintenance. For example, if repairs involved dosimetry components, the Medical Physicist shall check the machine output calibration and necessary beam parameters before allowing the accelerator back to clinical service.

2. Service log report shall be kept for this purpose.

D. Quality Control

1. **External Auditing.** The external audit is performed by CDRRHR-FDA-DOH annually for QA/QC program of the machine and by QUATRO Philippines for facility operations. These audits are performed to ensure that the radiation facility complies with the policies and regulations issued by DOH.

2. **Internal Auditing.** Radiation dosimetry shall be performed to maintain quality control over the radiation beam being produced by the machine. Below are the parameters to be checked and their corresponding tolerances. The **Dr. Pablo O. Torre Memorial Hospital Cancer Center** will follow the quality assurance program for LINAC published in AAPM Report No. 46 as shown on table below.

   Quality Assurance for the Cancer Center Linear Accelerator:

FREQUENCY	PROCEDURE	TOLERANCE
Daily	Dosimetry • X-ray output constancy • Electron output constancy Mechanical • Localizing lasers • Distance indicator (ODI) Safety • Door interlock • Audiovisual monitor	 3% 3% 2mm 2mm Functional Functional
Monthly	Dosimetry • X-ray output constancy • Electron output constancy • Back-up monitor constancy • X-ray central axis dosimetry parameter constancy (PDD, TAR, TPR) • Electron central axis dosimetry parameter	 2% 2% 2% 2% 2mm@ therapeutic depth

	constancy (PDD) • X-ray and electron beam flatness constancy • X-ray and electron beam symmetry Safety • Emergency off switches • Wedge-electron interlocks Mechanical • Light/radiation field coincidence • Gantry/collimator angle indicators • Wedge position • Tray position • Applicator position • Field size indicators • Cross-hair centering • Latching of wedges, blocking tray • Jaw symmetry • Field light intensity	2% 3% Functional 2mm or 1% on a side 1 degree 2mm 2mm 2mm 2mm 2mm diameter Functional 2mm Functional
Annually	Dosimetry • X-ray/electron output calibration constancy • Field size dependence of x-ray output constancy • Output factor constancy for electron applicators • Central axis parameter constancy (PDD, TAR, TPR) • Off axis factor constancy	2% 2% 2% 2% 2% 2%

	• Transmission factor constancy for all treatment accessories	2%
	• Wedge transmission factor constancy	1%
	• Monitor chamber linearity	2%
	• X-ray output constancy vs gantry angle	2%
	• Electron output constancy vs gantry angle	2%
	• Off axis factor constancy vs gantry angle	2%
	Mechanical	
	• Collimator rotation isocenter	2mm diameter
	• Gantry rotation isocenter	2mm diameter
	• Couch rotation isocenter	2mm diameter
	• Coincidence of collimator, gantry, couch axes with isocenter	2mm diameter
	• Coincidence of radiation and mechanical isocenter	2mm
	• Table top sag	2mm
	• Vertical travel of table	Functional
	Safety	
	• Manufacture tests procedures	

E. Structural Shielding

1 When the design of the radiation shielding was considered, the workload of the equipment and the way it is to be used, as well as the intended use of the areas adjacent to the treatment room and the occupancy of the areas in question for the new facility, were taken into account.

2 The wall is further provided with a maze-type wall barrier of appropriate thickness in order to provide additional protection between the source of radiation and the main entrance door of the treatment room.

3 The shielding calculations were based on NCRP Publication no. 51. The required thickness of concrete was used for the walls and ceiling, and the appropriate thickness of steel for the door.

4 Warning Signs, Alarm and Interlock System

4.1 The BEAM-ON and BEAM-OFF light signals are installed at the main entrance door to the treatment room to warn the public that radiation exposure is going on inside the treatment room. These warning signals are electrically coupled to an interlock relay switch that is mounted at the entrance door, which deactivates the BEAM-ON light signal when the door is open.

4.2 The door interlock system automatically switches the x-ray source to the off position whenever the door to the treatment room is accidentally opened during the course of radiation treatment.

4.3 A radiation warning sign according to international standards is conspicuously posted at the entrance door of the treatment room to keep unauthorized persons from entering the irradiation area.

F. Monitoring Instruments

1 Areas where work involving ionizing radiation is undertaken must have suitable monitoring instruments within immediate reach.

2 An Ionization Chamber survey meter shall routinely be used to measure radiation at the level of the door and at the console room.

- 2.1 The instrument must undergo individual calibration by a competent authority prior to its initial use.
- 2.2 A copy of the calibration certificate shall be kept with the instrument.
- 2.3 If such instruments are battery operated, then a weekly check shall be made on the condition of the batteries.

Calibration Program of Survey Meter

1. Survey instruments shall be calibrated before their use, following their repairs, and annually. Any local (CDRRHR or PNRI) or international Secondary Standard Dosimetry Laboratory can perform the calibration.
2. If there is a check source, the constancy of the survey meter shall be checked at regular intervals.
3. Records of Calibration shall be retained for at least five years.
4. Batteries shall be checked on a daily basis. Spare batteries shall always be available.
5. The survey instrument shall be stored in the control room at all times for easy access during treatment and in case of emergency.

XI. SYSTEM OF RECORDS

A. Personnel Exposure. Personnel exposure is monitored by personal dosimeters, which are measured every two months. Results from the PNRI or any other authorized service provider on personnel exposure, shall be kept for reference for at least ten years before disposal.

1. Accumulated doses per year are recorded with a hard copy filed in a folder.
2. The results of previous personnel exposures are summed up together with the current results to monitor lifetime dosage as a radiation worker.

Unusual doses received by the individual shall be investigated and recommendations shall be made according to the investigational levels set by the Cancer Center.

B. Area Survey. The Equivalent dose rate shall be measured monthly and the Area Survey Form shall be completed accordingly. Measurements shall be taken in the following areas:

1. In front of the treatment room door
2. Control room
3. Immobilization device storage room
4. Supplies storage
5. UPS room
6. The hallway adjacent to the treatment room during BEAM ON.

All measurements shall be limited to 0.05 mSv/h, measured dose rate readings in excess of 0.05 mSv/h shall be reported to the RPO and possible causes of the incident shall be determined.

All accomplished Area Survey Forms shall be kept in a specified file folder for at least 5 years.

C. Instruments Tests and Calibration

1 Survey Meter

1.1 The Survey Meter shall be calibrated annually at the PNRI or CDRRHR-DOH Secondary Standard Dosimetry Laboratory.

1.2 Results of instrument calibration and the wear and tear of the instrument shall be kept for five years for monitoring and assessment of the instrument's performance.

2 Dosimetry Assembly (Electrometer, Ion Chamber and Extension Cable)

2.1 The Dosimetry Assembly shall be subjected to calibration every two years *by a laboratory designated by the manufacturer.*

2.2 The results of instrument calibration and wear and tear must be kept for at least 10 years for monitoring and performance evaluation.

3 Environment Monitoring Instruments

3.1 Instruments such as barometers and thermometers shall be calibrated in a laboratory of PAGASA or recommended by PAGASA.

3.2 Results of instrument calibration and the wear and tear of the instrument shall be kept for five years for monitoring and assessment.

D. Audits and Reviews of Radiation Safety Programs. This Radiation Safety Program shall be reviewed annually or as needed. Audit and review results must be documented.

All recommendations from the Auditing Team shall be noted and implemented in adherence to the ALARA principle.

E. Incident and Accident Investigation Reports. An investigation shall be initiated by the Radiation Protection and Safety Officer of the facility, and a report on the accident and incident involving ionizing radiation shall be prepared.

Aside from the patient's demographics, the report shall include all machine parameters, irradiation time, accessories, and treatment aides used.

The cause of the incident shall be thoroughly investigated with the dose received by the involved parties accounted for or approximated. Corrective or mitigating actions, instructions, and recommendations shall be taken to avoid recurrences and shall be retained on the premises for 10 years.

F. Maintenance and repair work. All maintenance and repair work done by Service and Software Engineers shall be noted in the service report provided by the servicing party, and such shall be confirmed by both the Technician or the Engineer and the Medical Physicist.

The documentation shall be kept on file and shall be used in the event that repairs and/or maintenance work needs to be carried out. All actions and reasons for service must be documented.

G. Facility Modifications. The Medical Physicist/Radiation Protection Officer must log any changes to the facility that affect radiation protection and safety for workers, patients, and the general public. The Regulatory Agency shall be properly notified if any modifications are carried out.

H. Training Provided

I. Evidence of Health Surveillance of Workers. The Employee Relations Section under the Human Resources Department of Dr. Pablo O. Torre Memorial Hospital keeps a record of the health status of all members of the staff. Close monitoring of employee health is done and records of each employee are kept on file.

J. Radioactive Material License. The radioactive material license shall be issued by the Philippine Nuclear Research Institute (PNRI). A copy of the license shall be posted prominently within the radiation facility.

K. Patient Discharge Surveys. Patient discharge surveys shall be issued and recorded by the Receptionist/s of the Cancer Center. The Center collects the survey information on a daily basis.

L. Clinical Dosimetry Records. Documentation on dosimetry shall be filed together with associated tests/studies as requested by the Oncologist for clinical evaluation. The parameters and factors assumed, such as gantry, collimator, and couch orientations; field sizes; weighting factors; inhomogeneity factors; attenuation; transmission and scatter factors; and treatment time, must be reflected in the dosimetric calculation.

It shall also include dose point data on the maximum dose or ICRU points if necessary (refer to ICRU Reports 50 and 62).

XII. RADIATION ACCIDENT / INCIDENT REPORT

The Cancer Center defines a reportable radiation accident as:

A. The actual or potential exposure of a worker to more than 5 mSv.
B. The actual or potential exposure of a member of the public to more than 1 mSv.
C. The administration of External Beam Therapy where the dose received differs by more than 15% from the prescribed dose.

The following are the steps to be observed:

1. The RPO/RSO with the help of the Attending Physician shall furnish a report immediately after investigation to the CDRRHR concerning patients who are accidentally exposed.

2. Information on the individual's name, age, sex, occupation, and classification shall be furnished with the report, as well as a detailed description of the accident/ incident.

3. For the therapeutic treatment delivered to the wrong patient, wrong tissue (site) or with dose fractionation substantially higher than the values prescribed by the Radiation Oncologist, the report shall come with details of calculated or estimated dose received by the irritated region.

   The distance between the patient and the source, the patient's orientation to the source and the part of the body that was exposed, the duration of the exposure, and the presence of any shielding material between the source and the patient must all be taken into account.

4. Only patients are allowed to stay inside the treatment room during "BEAM ON." Individuals other than the patient who are accidentally exposed to ionizing radiation inside the treatment room during therapy shall be likewise investigated. The RPO must calculate and estimate the dose they received.

5. If the individual is a radiation worker, a temporary suspension from work that shall expose him further to radiation hazards may be recommended as deemed necessary. No worker undergoing intervention shall be exposed in excess of the maximum single year dose limit for occupational exposure except:

a. In order to save a life or prevent serious injury;
b. If actions are being taken in order to avoid a large collective dose;
c. If undertaking actions to prevent the development of catastrophic conditions (IBSS Safety Report Series 115).

6. After an accident, comprehensive records of assessments and their updates and of monitoring results for patients, workers, the general public, and the environment shall be maintained. The Radiation Accident/Incident Report contains:
    a. Name and Address of the Facility;
    b. Name of Radiation Protection and Safety Officer;
    c. Equipment brand/model/serial number/beam energy equipment;
    d. Vital information about the people who were inadvertently exposed, such as their name, age, gender, occupation, and classification, whether they were patients, workers, or members of the general public;
    e. Accident or incident identification and detailed description;
    f. Cause of the incident/accident;
    g. Dose calculation or estimation;
    h. Corrective measures required to prevent recurrence of such accident/incident;
    i. Corrective measures implemented;
    j. Interventions taken by the institution on the accidentally exposed persons.

XIII. EMERGENCY PREPAREDNESS AND RESPONSE PLAN

The following are the general steps taken in the event of an emergency:

1. Any person discovering an abnormal event or condition shall immediately inform the RSO/RPO and the proper local authorities.

2. When responding to an emergency situation, the emergency procedures will be the basis of any response by any personnel. In the case of security issues, the management of the response may be handled through a unified command involving appropriate staff from local organizations such as the police or the necessary authority to address the situation.

3. The personnel involved shall give information sufficient to determine the category/classification of the situation in order for local organizations to implement initial protective actions and provide additional recommendations appropriate to the situation.

4. In the event of an emergency, the RSO/RPO shall assume the role of an emergency response coordinator and shall initiate appropriate notifications to manage the emergency until relieved by local authorities.

Responsibilities

All Cancer Center personnel shall abide by the following responsibilities:

1. Understand the emergency procedures and phone numbers.
2. They should know the designated area or assembly point for their work area and the best route to get there (or an alternate route in the event the best route is blocked).
3. They know the assembly areas in other parts of the institution that they frequently visit. Maps shall be posted near the exits of all buildings.

4. Assist patients and members of the public in their work areas to the nearest assembly point.
5. Review and check their work area periodically for situations that could present a hazard or have a negative environmental impact during an emergency.
6. Assume responsibility when using bookcases, shelves, and cabinets for storage. Loose items (e.g. glassware and liquid containers) may need shelf restraints.
7. Keep aisles clear to allow for quick exit from buildings, if necessary.
8. Be familiar with any equipment they work on and how to turn it OFF fast and safely.

During commissioning, testing, internal audit, or external audit

When the x-ray beam fails to terminate when the accumulated dose displayed on the upper primary dose monitor exceeds the preset dose, the following shall be done:

1. Press the INTERRUPT push button on the console.
2. But if the beam remains ON, press the EMERGENCY OFF button in the console room, near the door, or in the treatment room behind the gantry.
3. But if the beam remains ON, switch off the breaker in the power distribution box.
4. Report the incident immediately to the RSO/Physicist/Service Engineer.
5. Do not attempt to operate the linear accelerator until service personnel have verified proper operation, including emergency off circuits.

In the event of a power failure, press the EMERGENCY OFF button either in the console room, near the door, or in the treatment room behind the gantry. When the power is restored, do not attempt to operate the Linear Accelerator machine until **completing the daily start-up procedures.**

During patient treatment, the following emergency procedures A-E will be followed:

A. Safety Control System Failure

1 **Accidental Medical Exposure of a Patient.** The X-ray beam fails to terminate when the accumulated dose displayed on the upper primary dose monitor exceeds the preset dose. When this happens:

- **1.1** Press the INTERRUPT push button on the console.
- **1.2** But if the beam remains ON, press the EMERGENCY OFF button in the console room, near the door, or in the treatment room behind the gantry.
- **1.3** But if the beam remains ON, switch off the breaker in the power distribution box.
- **1.4** Remove the patient from the treatment room.
- **1.5** Report the incident immediately to the RSO/Physicist.
- **1.6** Do not attempt to operate the linear accelerator until service personnel have verified proper operation, including emergency off circuits.

2 **Power Failure**

- **2.1** If a patient was receiving therapy at the time of the power failure, record the cumulative number of monitor units received up to the interruption. This value is shown on the LCD back-up dosimetry display of the Treatment Control Cabinet.
- **2.2** When the power is restored, do not attempt to operate the Linear Accelerator machine until **completing the daily start-up procedures.**

B. Emergency Off Circuit Fails to Terminate

The EMERGENCY OFF circuit has failed to terminate if an EMERGENCY OFF button is pressed and the sound of the running motors within the treatment room continues or the power indicator on the console remains on. If this case happens, follow the steps below:

1. Immediately turn off the main circuit breakers.
2. If a patient was receiving therapy at the time of the EMERGENCY OFF failure, record the cumulative number of monitor units received up to the time of the interruption. This value is shown on the LCD back-up dosimetry display of the Treatment Control Cabinet.
3. Do not attempt to operate the Linear Accelerator machine until service personnel have verified proper operation, including emergency circuits.

C. Accelerator Beam is stuck 'ON' in a Treatment Room

The accelerator beam shall be considered stuck "ON" if the beam does not stop when the preset dose has been reached, when requested, and when paused. Follow the steps below for guidance:

1. Press the emergency stop button. If the beam stays on, it trips the main breaker of the accelerator.
2. Remove the patient from the treatment room.
3. Notify the RSO immediately once the beam has been shut off or the room is cleared.

D. Accidental Exposure of a Worker

Individuals Detected in Vaults or Treatment Rooms. When someone other than the patient is discovered inside the treatment room:

1. Stop the Linear Accelerator machine immediately to eliminate the radiation.
2. Take the person out of the treatment room.
3. Inform the RSO.
4. The RSO must investigate, document, and give recommendations.

Staff in a Treatment Room When the Beam is Turned On. If you are inside the vault or room when the Linear Accelerator is turned on:

1. Push the nearest emergency stop button at once.
2. Exit the room and contact RSO immediately.

3. The RSO shall take your dosimeter to expedite processing and shall issue a spare to you for the remainder of the monitoring period.

E. Accidental Exposure of a Member of the Public

In the case of accidental radiation exposure:

1. Press the INTERRUPT push button on the console.
2. But if the beam remains ON, press the EMERGENCY OFF button in the console room, near the door, or in the treatment room behind the gantry.
3. But if the beam remains ON, switch off the breaker in the power distribution box.
4. Remove the person from the treatment room.
5. Refer the radioactive person to the RSO.

In the case of an earthquake, fire, smoke or gas fumes:

1. Interrupt the treatment and transport the patient to a safe distance outside the center.
2. Turn off the machine and lock the Treatment Room.
3. After the incident, cordon off the area to prevent access by the public.
4. Notify the RSO, Medical Physicist, CDRRHR, and/or the Service Engineer immediately about the incident. Do not attempt to operate the Linear Accelerator until completing the daily start-up procedures.

F. Procedures for Lost Source Emergency Response

1. Notify RSO;
2. Call Security;
3. Notify the Director of the Cancer Center;
4. Give a description of the missing source or unauthorized personnel suspected of stealing or breaking in;
5. Security will implement a lockdown until the source or person is found.
6. Verify the source or person upon location;
7. Make an inventory of all sources.

8. Notify PNRI by phone immediately;
9. Make an incident report.
10. Take corrective measures.

G. Accidental Exposure. In the event of accidental exposure to radiation, whether gamma or x-ray, immediately contact the RPO/RSO/Medical Physicist.

H. Medical Exposure. Our facility is committed to adhering to the DOH Department Circular No. 323 s. 2004, Principles of Radiation Protection and International Basic Safety Standards (IBSS) Reports Series 115, which includes among others.

1 Justify Exposure. In line with this principle, our facility shall not allow any patient exposure either for diagnostic or therapeutic purposes unless such exposures are warranted by a qualified physician and found to be medically beneficial. No patient shall be administered a diagnostic or therapeutic medical exposure unless the exposure is prescribed by an Authorized User defined by the document. The calibration dosimetry and quality assurance requirements shall be conducted by or under the supervision of the Medical Physicist. We strongly discourage any practice requiring patient exposure for the sole purpose of conducting research with no medical benefit to the exposed individual/s arising from such radiological practice.

2 Optimization. Device for medical exposures:

2.1 Radiation producing devices shall conform to the applicable standards of the Center for Device Regulation, Radiation Health and Research-Department of Health, the International Electrotechnical Commission (IEC), and the International Organization for Standardization or to equivalent standards as appropriate.

2.2 Performance specifications, operations and maintenance instructions, including protection and safety, shall be provided to the users of radiation producing equipment.

2.3 When practicable, the operating terminology (or its abbreviations) and operating values shall be displayed on operating consoles. The facility shall prepare, adopt, and implement simple and easy-to-follow protocols which must be well understood by personnel concerned with the above-mentioned treatment process so that the incidence of human error in the delivery of unplanned medical exposure is minimized. "All exposures shall be kept as low as reasonably achievable, taking into account social and economic factors".

3 Calibration

3.1 Radiotherapy equipment calibration shall be determined and recorded in terms of radiation quality or energy, and either at an absorbed dose or at a predefined distance under specified conditions. Factors shall be based on IAEA Technical Reports Series 398 and/or AAPM TG 148 Recommendations and Literature supported by the Scientific Community on Dosimetry and Metrology.

3.2 Calibration shall be carried out at the commissioning of a unit after its maintenance and at periodic intervals specified by National Regulation or by the Radiation Safety Committee.

I. Investigation of Accidental Medical Exposure

The Radiation Safety Officer shall be notified of and shall promptly investigate any of the following incidents:

1. Any therapeutic treatment delivered to either the wrong patient or the wrong tissue or with a dose fractionation differing substantially from the values prescribed by the may lead to undue acute secondary effects.
2. Any equipment failure, accident, error, mishap, or other unusual occurrence that has the potential to result in a patient exposure that differs significantly from that intended.

J. Responsibility of the First Responder. Notify RSO and security personnel immediately upon discovery of theft, destruction, or unauthorized access to restricted areas.

K. Accidental Medical Exposure Report. The following information must be included in the accident medical exposure report:

1. Calculated or estimated doses received and their distribution within the patient.
2. The corrective measures are required to prevent the occurrence of such incidents or accidents.
3. The implementation of all corrective measures, as well as the person or persons in charge of these corrective measures.
4. Submission of a written report to the CDRRHR stating the cause(s) of the incident, as well as all other pertinent information.
5. Information given to the patient and the doctor about the incident.
6. Information concerning the medical aspects (if needed) of handling the externally irradiated person in the radiological accident.

XIV. POSTING AND LABELLING

Entrances to the treatment rooms must be properly posted with "Radiation Area" or "High Radiation Area" signs as applicable, and must be continuously controlled while radiation is present.

Warning lights outside the Linear Accelerator Room must warn if the equipment is on. Separate permanent radiation monitors must give a visual indication that radiation is present and must be visible before a person enters a high radiation area.

XV. REFERENCES

1. International Basic Safety Standards (IBSS) Reports Series 115
2. CPR Part 3, Standards for Protection Against Radiation, PNRI
3. Joint Commission International Accreditation 5th Edition, April 2014
4. Code of Philippine Nuclear Research Center (PNRI) Regulations CPR Part 14 International Atomic Energy Agency Standards
5. ICRP publication no. 60
6. NCRP publication no. 51
7. Department of Health – Administrative Order No. 2013-0031
8. DOH Department Circular 323 s. 2004 & AO 149 s. 2004

APPROVAL:

	Name/Title	Signature	Date
Prepared by:	**SAMUEL A. DE LA PAZ JR., RRT** Chief Radiation Therapist		9/1/22
Verified:	**MARK ERNEST F. DIZON** Radiation Protection Officer (RPO)		9/13/22
	NEIL M. GANCHERO, MN, FPCHA MRCCC Manager		9/13/22
Reviewed:	**DENNIS C. ESCALONA, MN, FPCHA, FPSQua** Quality Assurance Supervisor		9/18/2022
Recommending Approval:	**PAOLO G. SOGONO, MD, DPBRO** Medical Director- MRCCC		09/26/2022
	MA. ANTONIA S. GENSOLI, MD, FPPS, FPCHA Vice President- Chief Medical Officer		9.27.22
	SOCORRO VICTORIA L. DE LEON,CPA,MBA,PhD,FPCHA Vice President- Chief Operating Officer		09/27/2022
Approved:	**GENESIS GOLDI D. GOLINGAN** President and CEO		9/29/22