

*Training Course on Safety Assessment of Facilities and Activities
Using Radiation Sources*



**PRACTICAL EXERCISE
MEDICAL PRACTICE
(STUDENT'S BOOK)**

GENERAL INFORMATION FOR THE EXERCICES

FOREWORD

These exercises are a complement to the presentations of the training course on “Safety Assessment of Facilities and Activities using Radiation Sources”.

The objective of the exercises is to help develop the basic knowledge necessary to perform a safety assessment.

The contents of a safety assessment should include the following topics:

LIST OF CONTENTS OF A SAFETY ASSESSMENT

1.- ASSESSMENT CONTEXT

1.1.- Introduction

Regulations and Standards.

1.2.- Description of the facility or activity

Site characteristics

Engineering design

Safety measures

Operational procedures

Management Systems

1.3.- Approach and scope of the Assessment

1.4.- Assessment criteria

2.- DEVELOPMENT AND JUSTIFICATION OF SCENARIOS

2.1.- Identification of Hazards

2.2.- Selection and Hazard Screening

2.3.- Identification and description of Scenarios

3.- SAFETY ANALYSIS

3.1.- Identification of Models and Data Needs

3.2.- Dose Calculations

3.3.- Risk Calculations

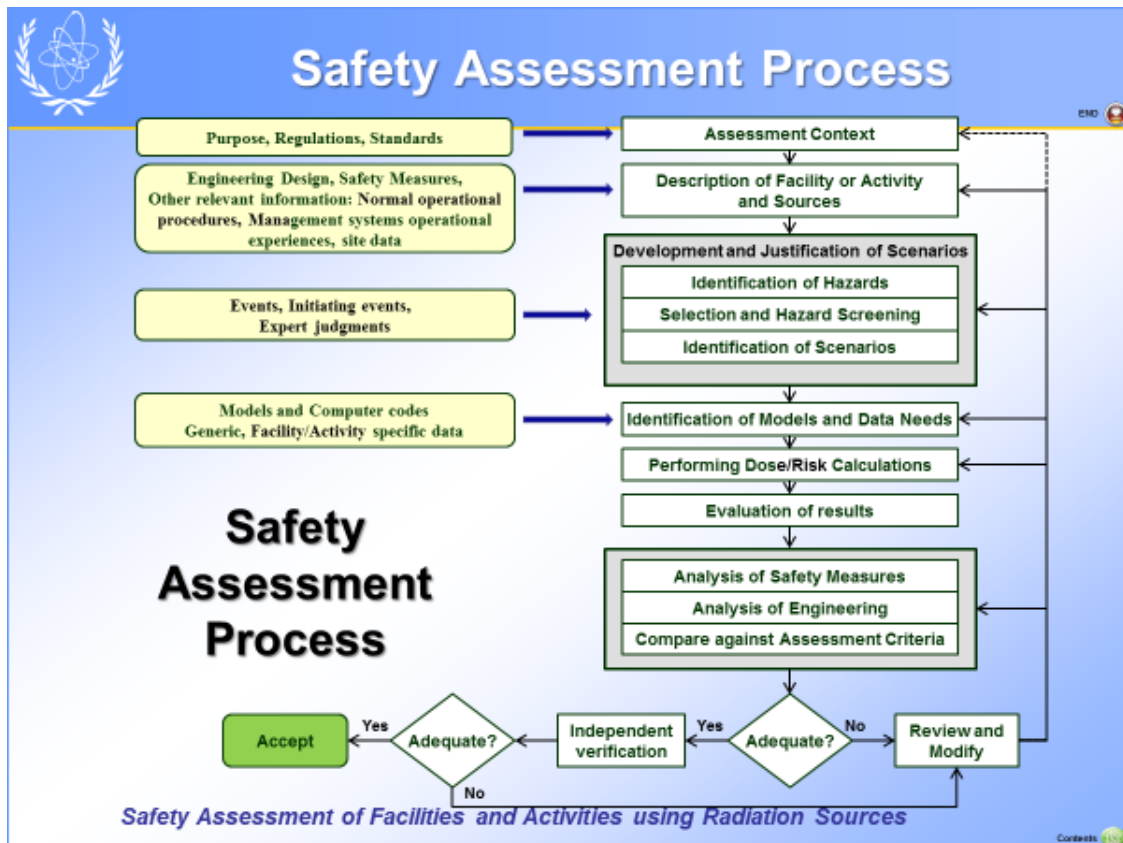
3.4.- Evaluation of results (uncertainty analysis)

4.- ANALYSIS OF ASSESSMENT RESULTS

4.1.- Comparison with assessment criteria

4.2.- Analysis and revision (if it is needed) of safety measures and engineering

Exercises are proposed for each of the sections. To facilitate understanding of the exercises, each section of the content list corresponds to a block of the safety assessment process diagram used in the course presentations:



PART 1.- ASSESSMENT CONTEXT

1.1.- Introduction

The safety assessment shall be in accordance with the requirements of the current National Regulations based on the criteria of GSR part 3 and GSR part 4.

The 24 requirements from GSR part 4 used in performing safety assessments are:

Requirement 1: Graded approach

A graded approach shall be used in determining the scope and level of detail of the safety assessment carried out in a particular State for any particular facility or activity, consistent with the magnitude of the possible radiation risks arising from the facility or activity.

Requirement 2: Scope of the safety assessment

A safety assessment shall be carried out for all applications of technology that give rise to radiation risks; that is, for all types of facilities and activities.

Requirement 3: Responsibility for the safety assessment

The responsibility for carrying out the safety assessment shall rest with the responsible legal person; that is, the person or organization responsible for the facility or activity.

Requirement 4: Purpose of the safety assessment

The primary purposes of the safety assessment shall be to determine whether an adequate level of safety has been achieved for a facility or activity and whether the basic safety objectives and safety criteria established by the designer, the operating organization and the regulatory body, in compliance

with the requirements for protection and safety as established in the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, have been fulfilled.

Requirement 5: Preparation for the safety assessment

The first stage of carrying out the safety assessment shall be to ensure that the necessary resources, information, data, analytical tools as well as safety criteria are identified and are available.

Requirement 6: Assessment of the possible radiation risks

The possible radiation risks associated with the facility or activity shall be identified and assessed.

Requirement 7: Assessment of safety functions

All safety functions associated with a facility or activity shall be specified and assessed.

Requirement 8: Assessment of site characteristics

An assessment of the site characteristics relating to the safety of the facility or activity shall be carried out.

Requirement 9: Assessment of the provisions for radiation protection

It shall be determined in the safety assessment for a facility or activity whether adequate measures are in place to protect people and the environment from harmful effects of ionizing radiation.

Requirement 10: Assessment of engineering aspects

It shall be determined in the safety assessment whether a facility or activity uses, to the extent practicable, structures, systems and components of robust and proven design.

Requirement 11: Assessment of human factors

Human interactions with the facility or activity shall be addressed in the safety assessment, and it shall be determined whether the procedures and safety measures that are provided for all normal operational activities, in particular those that are necessary for implementation of the operational limits and conditions, and those that are required in response to anticipated operational occurrences and accidents, ensure an adequate level of safety.

Requirement 12: Assessment of safety over the lifetime of a facility or activity

The safety assessment shall cover all the stages in the lifetime of a facility or activity in which there are possible radiation risks.

Requirement 13: Assessment of defence in depth

It shall be determined in the assessment of defence in depth whether adequate provisions have been made at each of the levels of defence in depth.

Requirement 14: Scope of the safety analysis

The performance of a facility or activity in all operational states and, as necessary, in the post-operational phase shall be assessed in the safety analysis.

Requirement 15: Deterministic and probabilistic approaches

Both deterministic and probabilistic approaches shall be included in the safety analysis.

Requirement 16: Criteria for judging safety

Criteria for judging safety shall be defined for the safety analysis.

Requirement 17: Uncertainty and sensitivity analysis

Uncertainty and sensitivity analysis shall be performed and taken into account in the results of the safety analysis and the conclusions drawn from it.

Requirement 18: Use of computer codes

Any calculational methods and computer codes used in the safety analysis shall undergo verification and validation.

Requirement 19: Use of operating experience data

Data on operational safety performance shall be collected and assessed.

Requirement 20: Documentation of the safety assessment

The results and findings of the safety assessment shall be documented.

Requirement 21: Independent verification

The operating organization shall carry out an independent verification of the safety assessment before it is used by the operating organization or submitted to the regulatory body.

Requirement 22: Management of the safety assessment

The processes by which the safety assessment is produced shall be planned, organized, applied, audited and reviewed.

Requirement 23: Use of the safety assessment

The results of the safety assessment shall be used to specify the programme for maintenance, surveillance and inspection; to specify the procedures to be put in place for all operational activities significant to safety and for responding to anticipated operational occurrences and accidents; to specify the necessary competences for the staff involved in the facility or activity and to make decisions in an integrated, risk informed approach.

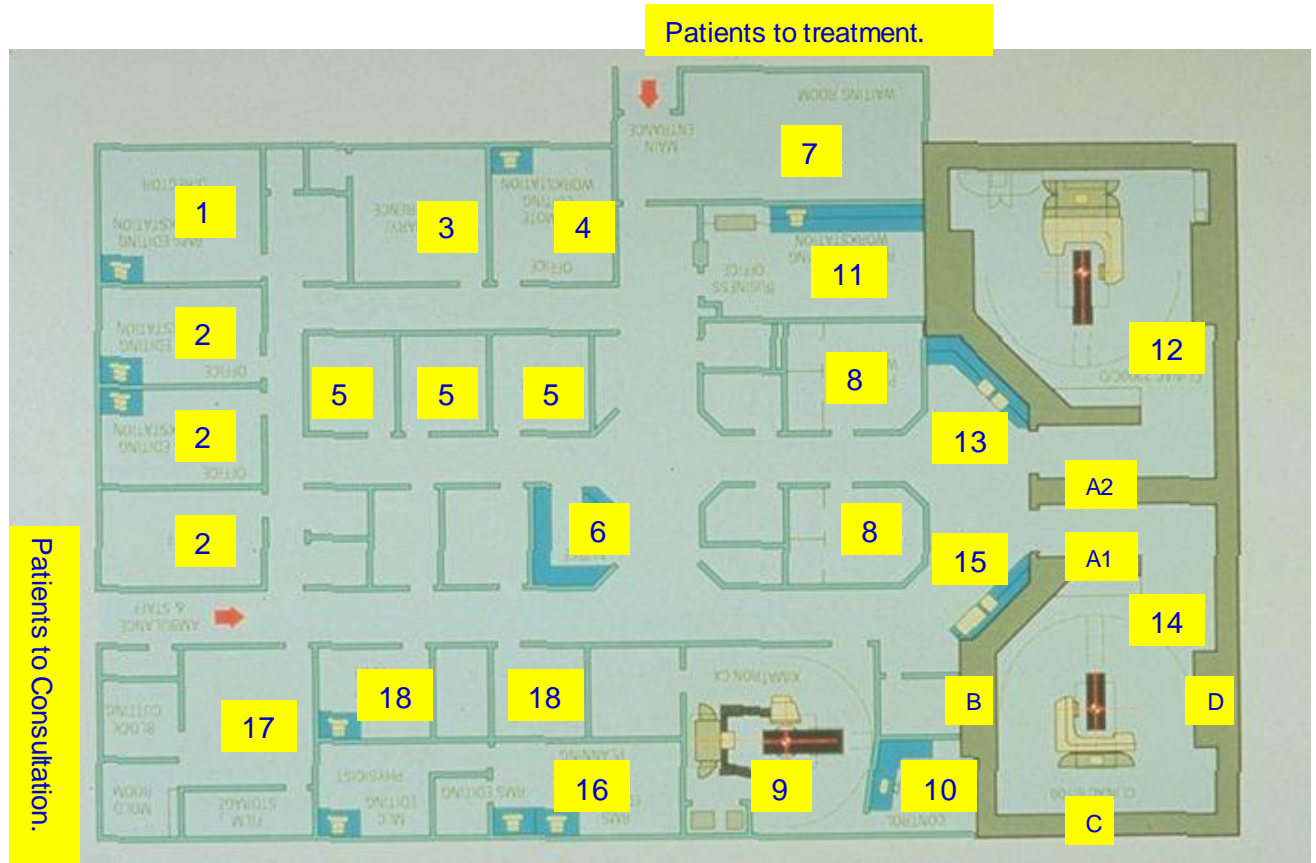
Requirement 24: Maintenance of the safety assessment

The safety assessment shall be periodically reviewed and updated.

1.2.- Description of the facility or activity

Site characteristics

The radiotherapy service is located in the basement area of the Hospital. Figure #1 shows a layout of the different areas of this radiotherapy service.



1. Head of Service office
 2. Consultation rooms.
 3. Planning.
 4. Medical physicist office.
 5. Designation of volumes.
 6. Reception counter
 7. Patients waiting room.
 8. Locker room.
 9. CT room.
 10. CT control panel.
 11. Portal imaging developing room.
 12. HDR room. (Out of order)
 13. HDR control panel. (Out of order)
 14. Co60 Unit room.
 15. Co60 control panel
 16. Mould room.
 17. Archive, Medical records.
 18. Toilets.
- A1,A2,B,C,D Layers

Engineering design

A generic radiotherapy service was envisaged, with characteristics such as might be found in the region, although the service is not necessarily representative of the region but rather of the highest level of service that may be expected. The service would include the following equipment and elements:

Type of the Equipment	Model / Year of manufacture	Serial number		Type of Radiation	Energy.	Manufacturer
		Equip.	Source/ Activity			
Cobalt-60	THERATRO N 780C	150000		Foton	1.25 MeV	THERATRON

The main features of bunker construction are shown below:

- a) Distance from the isocentre to the control panel (Point 1): 7.6 m.
- b) Distance from the isocentre of the equipment to the place of the location of the person responsible for the medicine store, adjacent to the bunker (Point 2): 3,5 m.
- c) Distance source-isocentre: 0.8 m
- d) Thickness of the wall of the primary barrier (S): 1.50 meters.
- e) Use factor $U= 0.25$. Control panel is located on the primary barrier of the bunker
- f) Occupancy factor $T= 1$. In the Control panel.

Point 1

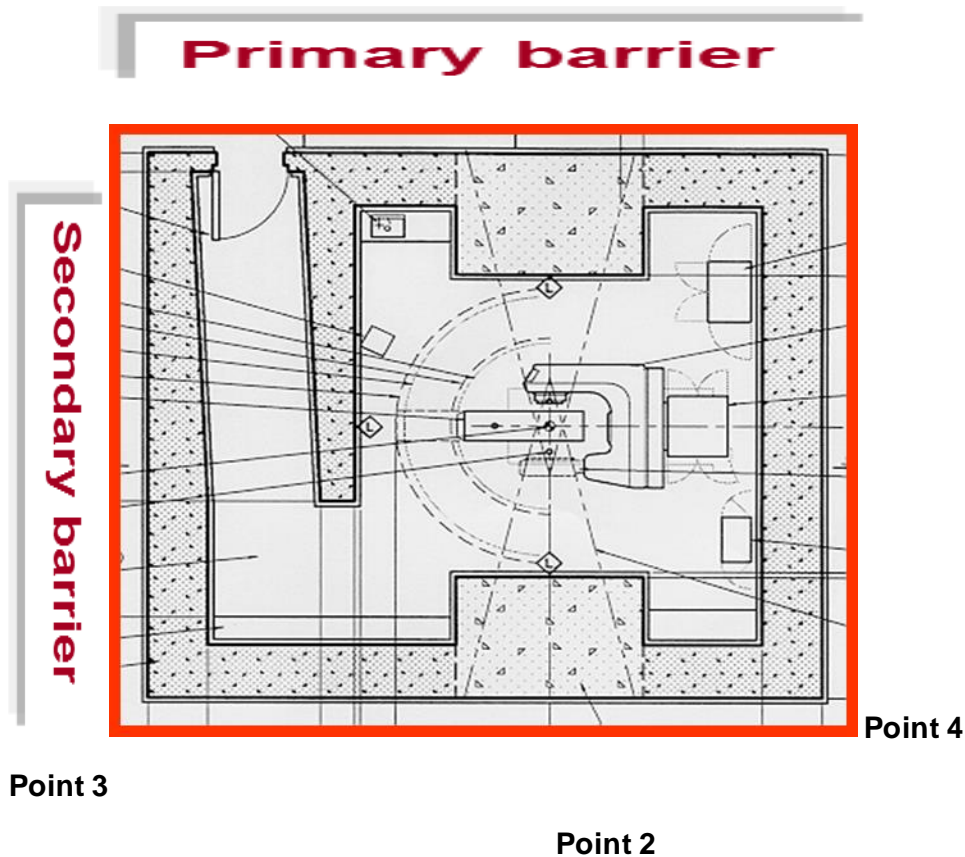


Figure 1.- Bunker plane of the cobalt-60 equipment.

Safety measures

The installation has the following safety systems:

- a) Stationary radiation detector inside the bunker with light and sound indication of the presence of high levels of radiation in case the source is exposed.
- b) CCTV to visualize the patient and the head of the equipment during the treatment.
- c) Interlock at the bunker entrance door, allowing the source to be stored in its shielded head when inadvertent entry of a person into the bunker occurs while the source is exposed.
- d) Equipment is available for the daily control of the radiation beam (flatness and beam symmetry).
- e) Emergency stop interlocks on the control panel and inside the team bunker

Operational procedures

The radiotherapy service has procedures for performing the different stages of the treatment process as shown below:

- i.- Prescription of the treatment.
- ii.- Data acquisition for treatment planning.
- iii.- Treatment planning.
- iv.- Preparation of customized accessories.
- v.- Initial treatment session.
- vi.- Daily treatment.
- vii.- Weekly medical follow-up of the patient.

Management Systems

The hypothetical service has enough radiation oncologists, medical physicists, and radiotherapy and mould technicians, and a safety and quality assurance programme, with written procedures and a committee to monitor compliance;

Equipment manuals are in the local language, in accordance with applicable IEC and ISO standards on accompanying documentation, the performance specifications and instructions for handling and maintenance, including translated instructions on protection and safety;

The calibration of beams and radiation sources used in radiotherapy are traceable to a standards dosimetry laboratory;

The quality assurance programme includes measuring physical parameters at commissioning and periodically thereafter, along with verifying relevant physical and clinical factors used in the diagnosis or treatment of patients, recording significant procedures and the results thereof in writing, and verifying that the calibration and operational state of dosimetry equipment are correct;

There are guidelines for training radiation oncologists, medical physicists, and radiotherapy and mould technicians and technologists. In addition to education in the professional specialty, clinical practice and experience are covered, along with specific training on the apparatus being used, including the treatment planning system (TPS), the correct interpretation of dosimetry equipment calibration certificates and lessons learned from accidental exposure;

There are procedures for the purchase and acceptance of equipment and accessories, and it is compulsory to validate changes to procedures that may have repercussions for dosage or dose distribution.

1.3.- Approach and scope of the Assessment

The safety assessment is focused on ensuring the radiological safety of patients, workers, and the public during oncological treatments using Co-60 source-based teletherapy equipment. It includes all stages and substages of the treatment process as well as the acceptance, commissioning, maintenance and quality controls that are performed on this equipment.

1.4.- Assessment criteria

The criteria are based on what is established in the current national regulation according to IAEA recommendations, and are as follows.

- a) Dose limits. According to GSR Part 3
 - i. For workers: 20 mSv / year on average in 5 years and no more than 50 mSv in a year.
 - ii. For public: 1mSv / year.
- b) Dose Restrictions. According to applicable National Regulation .
 - i. For workers: 10 mSv/year.
 - ii. For public: 0.5 mSv/year.
 - iii. For people who provide assistance to patients: 5 mSv for whole treatment
- c) Acceptability of Risk. According IAEA-TECDOC 1685.
 - a. Accidental Sequences of "Very High Risk" (VHR). They are unacceptable, it is necessary to stop the treatments since they are an imminent risk.
 - b. Accidental Sequences of "High Risk" (HR). They are unacceptable, it is necessary to implement a plan of measures to reduce the risk within a reasonable time since they are not an imminent risk.
 - c. Accidental sequences of "Medium Risk" (MR). Are Tolerable, a plan of measures to reduce the risk according to criteria of Cost-Benefit must be implemented.
 - d. Accidental Sequences of "Low Risk" (LR). They are widely accepted, no risk reduction required.

PART 2.- DEVELOPMENT AND JUSTIFICATION OF SCENARIOS

2.1.- Identification of Hazards

The following are the hazards that have been identified for this safety assessment:

- Fire in the work area where the equipment is used.
- Physical damage due to blows to the patient during their placement in the equipment.
- Overdose caused to persons due to the operation of the equipment, including:
 - Damages to the Worker.
 - Damages to the patient
 - Damages to the public.
- Uncontrolled use of sources.
- Lack of training and/or experience of workers
- Obsolete or faulty software
- Floods.
- Earthquakes.

2.2.- Selection and Hazard Screening

To be developed during the exercise.

2.3.- Identification and description of Scenarios

2.3.1 Scenario for normal operation. Stages.

During normal operation, the radiotherapy service operates a LINAC unit. The treatment process includes the following stages:

Prescription of the treatment.

Data acquisition for treatment planning.

Treatment planning.

Preparation of customized accessories.

Initial treatment session.

Daily treatment.

Weekly medical follow-up of the patient.

2.3.2.- Scenario for normal operation. Assumptions.

In normal operation, we will assume:

- a) The workload (W) is 450 Gy per week (30 patients/day, in 8 hours of work per day, 5 days per week and an average dose of 3 Gy in the isocentre per patient).
- b) Working 5 days a week, 50 weeks a year.
- c) 2 technologists (Unit Operator) in each shift of work, each one of them assuming the positioning of 15 patients.
- d) During the positioning of the patient, the technologist remains 2 minutes at a distance of 1.5 meter from the head of the unit.
- e) The rate of leakage from the head of the unit, according to the manufacturer, is 0.02 mGy/h.
- f) The maximum dose rate in the isocentre D_0 is 2.35 Gy/min = 141 Gy/h.
- g) Distance source-isocentre: 0.8 m.
- h) Thickness of the tenth value layer for concrete of density 2.35 g / cm³ is TVL₁ = 0.21 meters.
- i) Thickness of the equilibrium tenth value layer for concrete of 2.35 g/cm³ density is TVL_e = 0.21 meters. (due to the Co-60 energy)

2.3.3 Scenario for an accident situation.

Several possible scenarios in accident situations:

- a) Clogging the source upon completion of a patient's treatment and preventing the source to return to the shielding position.
- b) Inadvertent entry of a member of the public into the treatment room.
- c) Human errors during prescription of treatment.
- d) Human errors during acquisition of anatomical patient data
- e) Human errors that cause the wrong treatment of a patient's treatment plan.
- f) Positioning errors of a patient in a treatment session.
- g) Human errors during the commissioning of the equipment.
- h) Maintenance errors that affect the physical parameters of the equipment.
- i) Human errors during the commissioning of the treatment planning system.
- j) Failures of the treatment team.
- k) Failure of the treatment planning (TPS).

2.3.4.- Scenario for an accident situation. Assumptions.

- a) 2 technologists (Unit Operator) in each shift of work.
- b) The maximum dose rate in the isocentre D_0 is 2.35 Gy/min = 141 Gy/h.
- c) Distance source-isocentre: 0.8 m.
- d) Patient stay time in the treatment bed after the source clogging occurs: 15 s = 0.25 min.

PART 3.- SAFETY ANALYSIS

3.1.- Identification of Models and Data Needs

For dose estimation under normal operating conditions, the following methodologies have been considered:

- a) Estimation of doses in areas adjacent to the bunker. Methodology of the NCRP 151.
- b) Dose estimates within the bunker. Law of the Inverse of the square of the distance. Point source considerations.

For risk estimates, the "Risk Matrix" methodology has been considered. Publication IAEA-TECDOC 1685. The SEVRRRA 3.0 software has been used. (Available on WWW.foroiberam.org)

3.2.- Dose Calculations

3.2.1 Dose estimates in Normal operation.

3.2.1.1 Occupationally exposed personnel.

Some of the service workers are exposed to radiation under normal operating conditions during radiotherapy treatments using the cobalt unit. The following table describes the job positions that are more exposed to ionizing radiation during the execution of their duties.

No.	Job position	Duties	Dose
1.	Radiotherapist	Prescription of treatments	Y/N
		Obtaining CT images for planning	Y/N
		Starting treatment	Y/N
		Follow-up of the patient under treatment	Y/N
2.	Medical Physicist	Cobalt Unit calibration	Y/N
		Quality control	Y/N
		Treatment Planning	Y/N
		Starting treatment	Y/N
3.	Unit Operator	Starting treatment	Y/N
		Positioning of patients	Y/N
		Delivering the daily treatment from the Control Panel of the Cobalt unit	Y/N

3.2.1.2 Dose estimates in Normal operation. (For the public).

During the implementation of the Radiotherapy treatments using the Cobalt Unit, some members of the public and workers of the Hospital outside the Radiotherapy Service receive low doses due to the use of Telecobaltotherapy equipment. The following table describes the areas and members of the public exposed.

No.	Job position	Work Area Location	Dose
1.	Responsible for the Hospital's Drug Store	Office located at a distance of 0.3 meters from the bunker wall (Point 2).	Y/N
2.	Hospital personnel traveling at a distance of 0.5 meters from the wall, Through the corridor (Point 3)	External corridor close to the radiotherapy service (Point 3)	Y/N
3.	Members of the public walking through the parking area, 3.5 meters from the outer wall of the radiotherapy service (Point 4)	Parking outside the Hospital (Point 4)	Y/N

When analysing the exposure conditions in which the members of the public, mentioned in the above table, we consider that the Head of the hospital's Drug Store who works 8 hours a day at 30 centimetres of the wall, considered the Bunker's primary barrier .

Parameters for the calculation of the dose:

- a) Distance from the isocentre of the equipment to the place of the location of the person responsible for the medicine store, adjacent to the bunker (Point 2): 3,5 m.
- b) Distance source-isocentre: 0.8 m.
- c) Thickness of the wall of the primary barrier (S): 1.50 meters.
- d) Use factor U= 0.25.
- e) Occupancy factor T= 1. In hospital's Drug Store.
- f) The Head of the hospital's Drug Store works at 30 centimetres of the wall.
- g) Thickness of the tenth value layer for concrete of density 2.35 g / cm³ is TVL₁ = 0.21 meters.
- h) Thickness of the equilibrium tenth value layer for concrete of 2.35 g/cm³ density is TVL_e = 0.21 meters. (due to the Co-60 energy)

3.3.- Risk Calculations

3.3.1. The selection of the accident initiating events list has to be made by adapting the Event List Recommended initiators for the practice of Telecobalt therapy in IAEA's TECDOC 1685 by using the SEVRA3.0 software (See Annex 1). The list of events analyzed included 132 events distributed along the different stages of the treatment process.

3.3.2. All selected events must be evaluated to estimate the applicable frequency level considering the following levels:

High: The initiating event occurs frequently, more than 50 events /year.

Medium: The initiating event occurs occasionally, greater or equal than 1 and equal or less than 50 events/year.

Low: Unusual or rare occurrence of the initiating event, less than 1 event/year and greater or equal than 5 events per 100 years.

Very Low: It is very rare that the initiating event occurs, less than 5 events per 100 years. There is no information the event ever occurred

3.3.3. Each event analyzed must be evaluated to accept the level of consequences proposed in SEVRA 3.0. Consequences have been classified with the following levels:

Very high: Death or disability damage to various patients (systematic exposure). It is assumed that the magnitude of error in the dose is higher than 25%, regardless the prescribed dose.

High: Death or disability damage to one patient affected by the whole or a great part of the treatment (programmatic exposure) (the magnitude of error in the dose is higher than the prescribed dose). It also includes those expositions that affect multiple patients with dose errors between 10% and 25%, regardless the prescribed dose.

Medium: There is no health risk for the patient. Only one of the patients treated is exposed during the session.

Low: No effects whatsoever are produced on the patients. The level of defenses has decreased.

3.3.4. Each initiating event considered must be analyzed to identify the applicable defenses according to the principle of defense in depth. In each event, the Barriers and Reducers (Frequency and Consequences) will be identified. Based

on the quantity and quality of the existing defenses, SEVRRRA evaluates the variables of the risk equation and assigns the Risk Level corresponding to each accidental sequence.

PART 4.- ANALYSIS OF ASSESSMENT RESULTS

4.1.- Comparison with assessment criteria.

To be developed during the exercise.

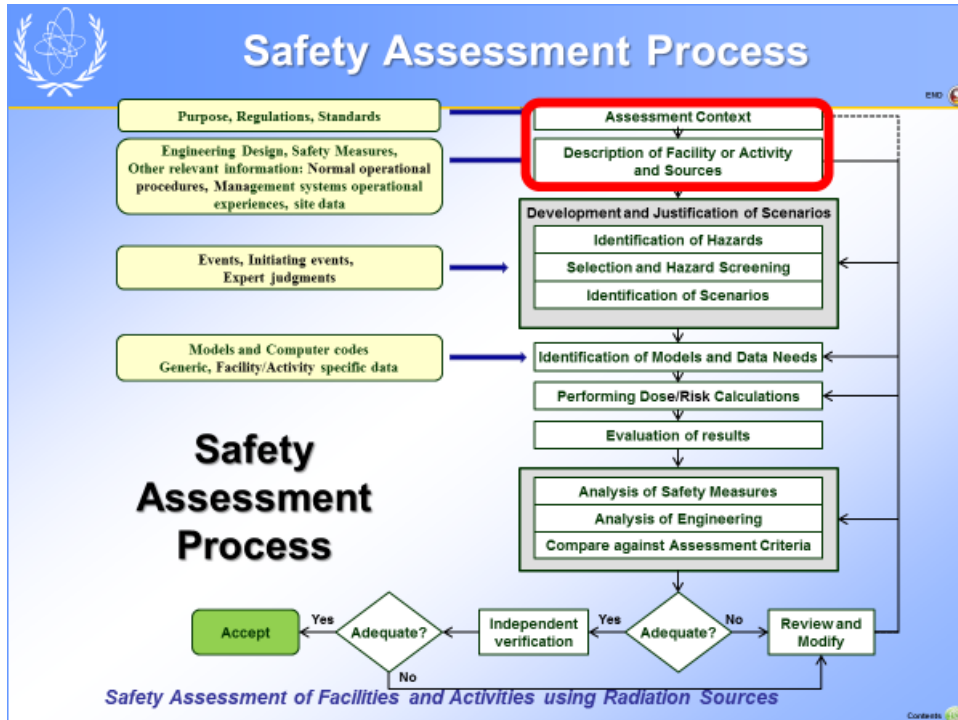
4.2.- Analysis and revision (if it is needed) of safety measures and engineering.

To be developed during the exercise.

EXERCISES

EXERCISES PART 1.- ASSESSMENT CONTEXT

These exercises cover first block of presentations.



EXERCISE PART 1 #1

GSR Part 3 Requirement 13: Safety assessment states: *“The regulatory body shall establish and enforce requirements for safety assessment, and the person or organization responsible for a facility or activity that gives rise to radiation risks shall conduct an appropriate safety assessment of this facility or activity.*

3.29. *The regulatory body shall establish requirements for persons or organizations responsible for facilities and activities that give rise to radiation risks to conduct an appropriate safety assessment. Prior to the granting of an authorization, the responsible person or organization shall be required to submit a safety assessment, which shall be reviewed and assessed by the regulatory body.*

3.30. *The person or organization, as required under para. 3.9(d), or registrants and licensees, as appropriate, shall conduct a safety assessment that is either generic or specific to the practice or source for which they are responsible.*

3.31. *Safety assessments shall be conducted at different stages, including the stages of siting, design, manufacture, construction, assembly, commissioning, operation, maintenance and decommissioning (or closure) of facilities or parts thereof, as appropriate, so as:*

(a) To identify the ways in which exposures could be incurred, account being taken of the effects of external events as well as of events directly involving the sources and associated equipment;

(b) To determine the expected likelihood and magnitudes of exposures in normal operation and, to the extent reasonable and practicable, to make an assessment of potential exposures;

(c) To assess the adequacy of the provisions for protection and safety.

3.32. The safety assessment shall include, as appropriate, a systematic critical review of:

(a) The operational limits and conditions for the operation of the facility;

(b) The ways in which structures, systems and components, including software, and procedures relating to protection and safety might fail, singly or in combination, or might otherwise give rise to exposures, and the consequences of such events;

(c) The ways in which external factors could affect protection and safety;

(d) The ways in which operating procedures relating to protection and safety might be erroneous, and the consequences of such errors;

(e) The implications for protection and safety of any modifications;

(f) The implications for protection and safety of security measures or of any modifications to security measures;

(g) Any uncertainties or assumptions and their implications for protection and safety.

3.33. The registrant or licensee shall take into account in the safety assessment:

(a) Factors that could give rise to a substantial release of radioactive material, the measures available to prevent or to control such a release, and the maximum activity of radioactive material that, in the event of a major failure of the containment, could be released to the environment;

(b) Factors that could give rise to a smaller but continuing release of radioactive material, and the measures available to detect and to prevent or to control such a release;

(c) Factors that could give rise to unintended operation of any radiation generator or a loss of shielding, and the measures available to detect and to prevent or to control such occurrences;

(d) The extent to which the use of redundant and diverse safety features that are independent of each other, so that failure of one does not result in failure of any other, is appropriate to restrict the likelihood and magnitude of potential exposures.

3.34. Registrants and licensees shall ensure that the safety assessment is documented and, where appropriate, that it is independently reviewed under the relevant management system.

3.35. Registrants and licensees shall perform additional reviews of the safety assessment as necessary to ensure that the technical specifications or conditions of use continue to be met when:

(a) Significant modifications to the facility or to its operating procedures or maintenance procedures are envisaged;

(b) Significant changes occur on the site that could affect the safety of the facility or of activities on the site;

(c) Information on operating experience, or information about accidents and other incidents that could result in exposures, indicates that the current assessment might be invalid;

(d) Any significant changes in activities are envisaged;

(e) Any relevant changes in guidelines or standards have been made or are envisaged.

3.36. If as a result of a safety assessment, or for any other reason, opportunities to improve protection and safety appear to be available and improvement seems desirable, any consequential modifications shall be made cautiously and only after favorable assessment of all the implications for protection and safety.

The implementation of all improvements shall be prioritized so as to optimize protection and safety.”

Question: Can you highlight the main recommendations of this requirement that would apply to the installation described in this exercise?

EXERCISE PART 1 #2

Split the students in 4 groups. Each group should identify the requirements (from GSR part 4) that apply to the Safety Assessment parts:

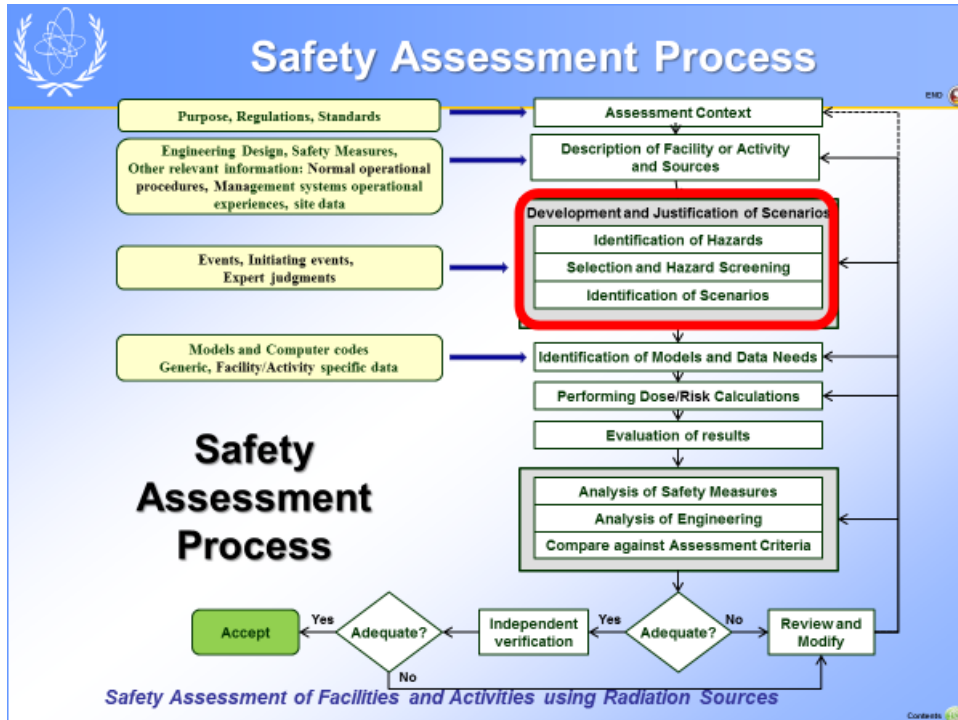
- 1.- ASSESSMENT CONTEXT
- 2.- DEVELOPMENT AND JUSTIFICATION OF SCENARIOS
- 3.- SAFETY ANALYSIS
- 4.- ANALYSIS OF ASSESSMENT RESULTS

EXERCISE PART 1 #3

Split the students in small groups. Each group should review the information given in #1.2. (**Description of the facility or activity**) and identify if it contains enough information to fulfil the safety assessment requirements.

EXERCISES PART 2.- DEVELOPMENT AND JUSTIFICATION OF SCENARIOS

These exercises cover second block of presentations.



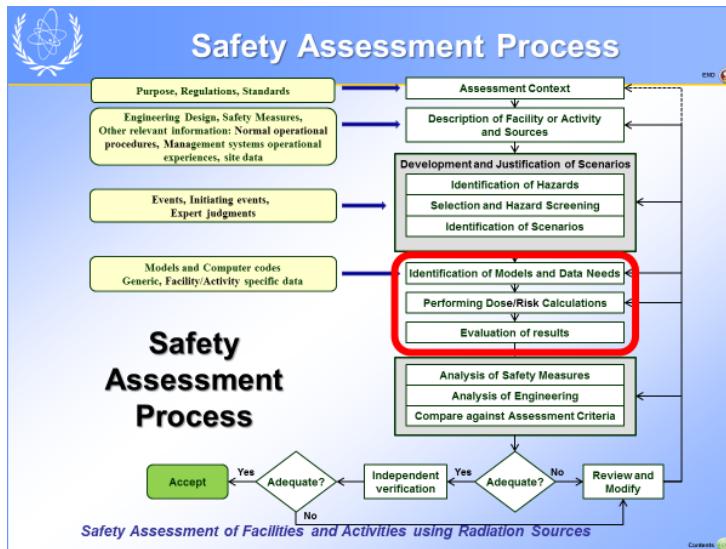
EXERCISE PART 2 #1. Analyze the list of hazards shown in #2.1 (**Identification of Hazards**) and select those that are present in a radiotherapy service using a Teletherapy equipment with Co-60 source.

EXERCISE PART 2 #2 Taking into account its radiological consequences, select the most important hazards that will be considered within the Safety Assessment.

EXERCISE PART 2 #3 Describe the most likely extreme scenarios that can trigger the hazards selected in question #2.

EXERCISES PART 3.- SAFETY ANALYSIS

These exercises cover the third block of presentations



DOSE CALCULATIONS

Using the information provided in part 3 and with the support of the presentations about dose calculations, solve the following exercises:

EXERCISE PART 3 #1 Fill the following table taking into account the job positions that are more exposed to ionizing radiation during the execution of their duties:

No.	Job position	Duties	Dose
1.	Radiotherapist	Prescription of treatments	NO
		Obtaining CT images for planning	
		Starting treatment	
		Follow-up of the patient under treatment	
2.	Medical Physicist	Cobalt Unit calibration	
		Quality control	
		Treatment Planning	
		Starting treatment	
3.	Unit Operator	Starting treatment	
		Positioning of patients	
		Delivering the daily treatment from the Control Panel of the Cobalt unit	

EXERCISE PART 3 #2 Estimate the dose received, in normal operating conditions, for the position of the Cobalt Unit Operator in order to demonstrate that this worker does not exceed the restrictions and dose limits established:

- a) in the Control Panel
- b) during the positioning of the patient
- c) total dose

EXERCISE PART 3 #3 Fill the following table for the members of the public potentially exposed.

No.	Job position	Work Area Location	Dose
1.	Responsible for the Hospital's Drug Store	Office located at a distance of 0.3 meters from the bunker wall (Point 2).	
2.	Hospital personnel traveling at a distance of 0.5 meters from the wall, Through the corridor (Point 3)	External corridor close to the radiotherapy service (Point 3)	
3.	Members of the public walking through the parking area, 3.5 meters from the outer wall of the radiotherapy service (Point 4)	Parking outside the Hospital (Point 4)	

EXERCISE PART 3 #4 Estimate the dose received by the Head of the hospital's Drug Store in normal operating conditions.

RISK CALCULATIONS

Using the information provided in part 3 and with the support of the presentations about risk analysis and SEVRRRA software, practice with the following exercises:

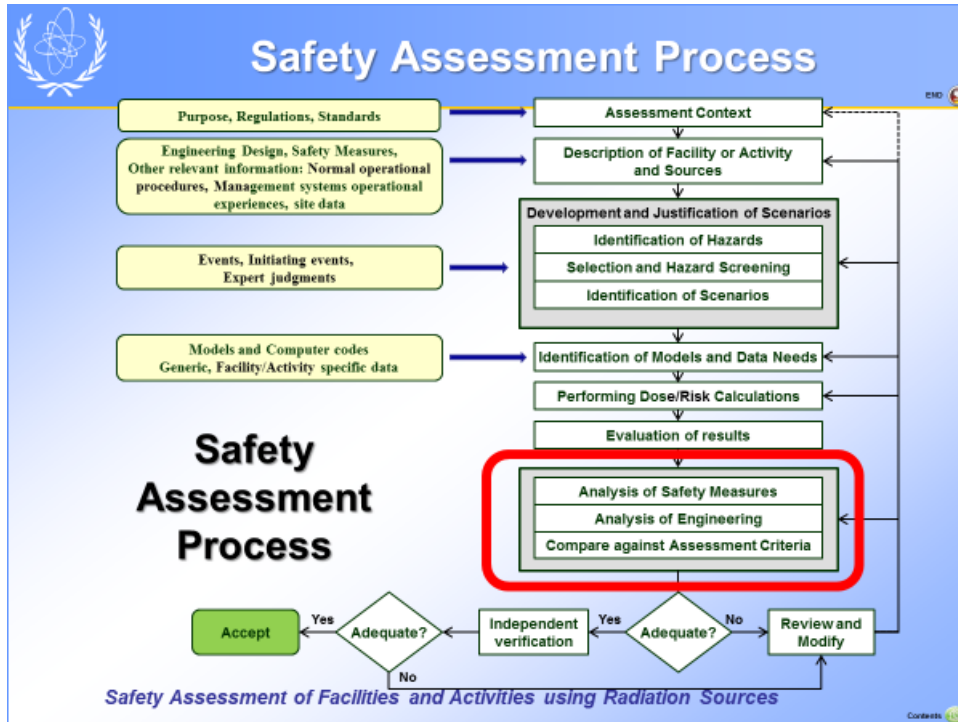
EXERCISE PART 3 #5: Using SEVRRRA software, analyze the events on the following stages:

- a) Commissioning of the Co-60 Unit
- b) Treatment planning

EXERCISE PART 3 #6: Analyze the results generated by SEVRRRA after the assessment of the reference installation (Annex 1)

EXERCISES PART 4.- ANALYSIS OF ASSESSMENT RESULTS

These exercises cover last block of presentations



EXERCISE PART 4 #1: Use the result of dose calculations in exercises “part3 #1 and #2” and compare these results with the assessment criteria defined in paragraph 1.4 “Assessment criteria”.

EXERCISE PART 4 #2: Use the results of risk calculations with SEVRA software (Annex1), assess these results and propose measures to reduce the risk of accidental "High Risk" sequences.