Presentation Part I
RADIOTHERAPY
METHODOLOGY FOR DOSE ESTIMATES IN NORMAL OPERATION.

Internacional Atomic Energy Agency

OBJECTIVE

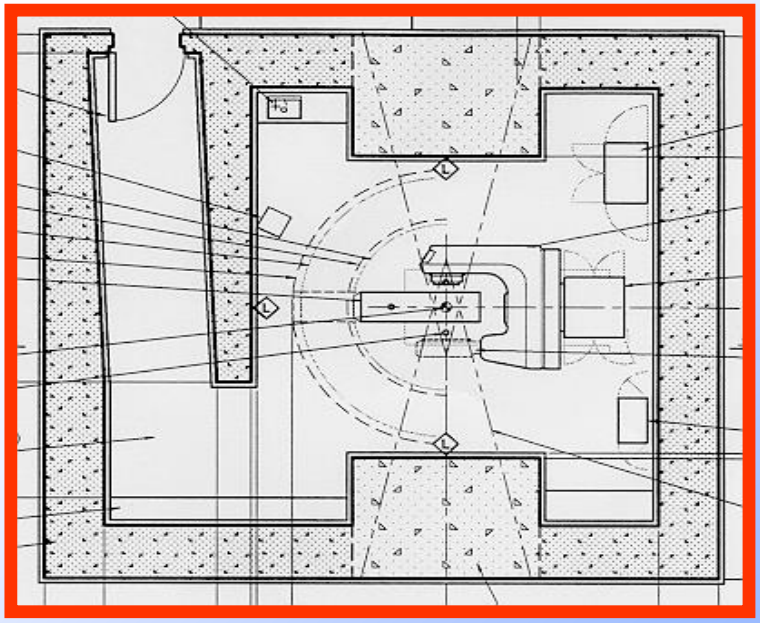
- Methodology for dose estimation in normal operating teletherapy conditions.
- Example of dose estimation in normal operating teletherapy conditions.

INTRODUCTION

To estimate doses during normal operating conditions it is necessary to identify the people potentially exposed and the exposure conditions during the daily routines.

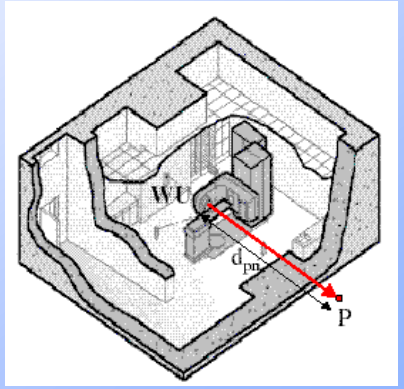
It is required to do estimations for:

1. **Exposed workers.**
2. **Members of the public.**



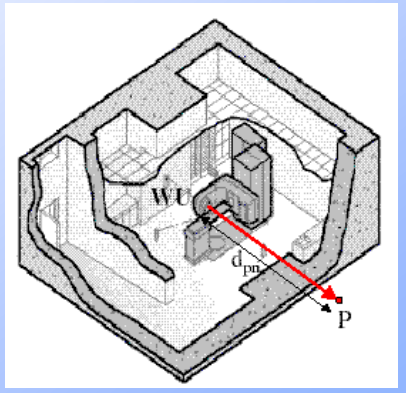
EXPOSED WORKERS IN THE PRACTICE OF TELETHERAPY

Exposed Worker	Assigned tasks	Dose
Co-60 Unit operator technician	Operating the equipment from the control panel	Y/N
	Positioning the patient at the equipment for treatment.	Y/N
LINAC unit operator technician	Operating the equipment from the control panel	Y/N
Medical Physicist	LINAC unit calibration	Y/N
	Co-60 unit calibration	Y/N
	LINAC quality control	Y/N
	Co-60 quality control	Y/N



EXPOSED WORKERS IN THE PRACTICE OF COBALT THERAPY

Exposed Worker	Assigned tasks	Dose
Co-60 Unit operator technician	Operating the equipment from the control panel	Y/N
	Positioning the patient at the equipment for treatment.	Y/N
LINAC unit operator technician	Operating the equipment from the control panel	Y/N
Medical Physicist	LINAC unit calibration	Y/N
	Co-60 unit calibration	Y/N
	LINAC quality control	Y/N
	Co-60 quality control	Y/N

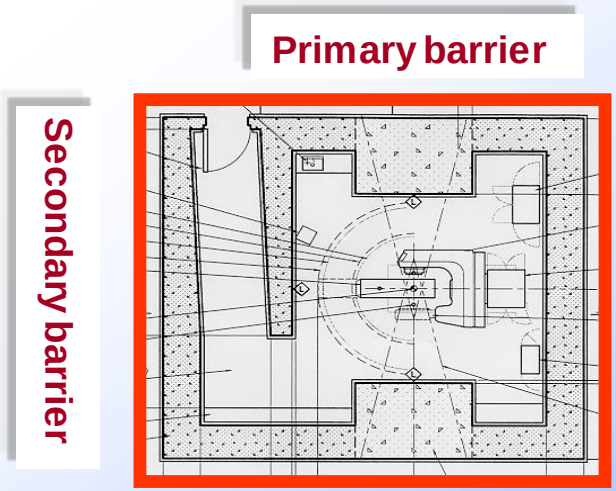


EXPOSED WORKERS IN THE PRACTICE OF COBALT THERAPY

Co-60 unit operator.

The estimation of the dose during the unit operation, from the control panel, depends on the control panel location:

1. **Control panel located on a Primary barrier.**
2. **Control panel located on a Secondary barrier.**



EXAMPLE OF DOSE ESTIMATIONS
Co-60 UNIT OPERATOR

1. Control panel located on a Primary barrier

The instantaneous dose rate (IDR) at the primary barrier can be estimated by the equation:

$$IDR = \frac{DR_0 \cdot B}{d^2}$$

DR_0 : dose rate at the isocentre of the equipment.
B: barrier transmission factor. (*)
d: distance at the calculus point.

(*) $$B = 10^{-\left\{1+\left[\frac{S-TVL_1}{TVL_e}\right]\right\}}$$

S: thickness of the barrier.
TVL: Tenth Value Layers.

EXAMPLE OF DOSE ESTIMATIONS
Co-60 UNIT OPERATOR

1.Control panel located on a Primary barrier

The average dose rate that the operator receives in a week can be estimated from the instantaneous doses rate (IDR):

$$R_W = IDR \times \frac{W\ U\ T}{DR_0}$$

DR_0: Dose rate at the isocenter of the equipment.
W: Weekly work load,
U: Use factor
T: Occupation factor.

The annual dose received by a control panel operator is:

$$D_1 = R_w * N_w$$

N_w: Number of working weeks in a year.

EXAMPLE OF DOSE ESTIMATIONS
Co-60 UNIT OPERATOR

2. Control panel located on a Secondary barrier

The instantaneous doses rate (IDR) at the secondary barrier can be estimated by the equations:

$$IDR_p = \frac{a \cdot DR_0 \cdot B_p}{d_{sca}{}^2 \cdot d_{\sec}^2} \cdot \frac{F}{400}$$

$$IDR_f = \frac{10^{-3} DR_0 \cdot B_f}{d_f^2}$$

B_p y B_f: transmission factors of disperse and leak radiation
DR_0 -dose rate at the isocenter of the unit
d_{sca} -distance between the source of radiation and the patient, in meters
d_{sec} -distance from the patient to the interest point, in meters
d_f –distance from the head of the unit to the interest point, in meters
α -dispersion fraction defined at the distance d_{sca}. Look at the Bibliography. **(α(**30°**)**= 3,18E-03 (15MV)= 6,00E-03 (Co-60 1.25 MeV)**)**
F –Radiation field area affecting the patient, in cm^2. It is assumed a typical treatment radiation field size of 15x15 cm.

EXAMPLE OF DOSE ESTIMATIONS
Co-60 UNIT OPERATOR

2. Control panel located on a Secondary barrier

The instantaneous total dose rate is:

$$IDR_T = IDR_p + IDR_f$$

The average dose rate that the operator receives in a week can be estimated from the instantaneous total doses rate (IDR_T):

$$R_W = IDR \times \frac{W\ U\ T}{DR_0}$$

DR_0: Dose rate at the isocenter of the equipment
W: Weekly work load
U: Use factor (for the Secondary barrier, use factor =1)
T: occupation factor.

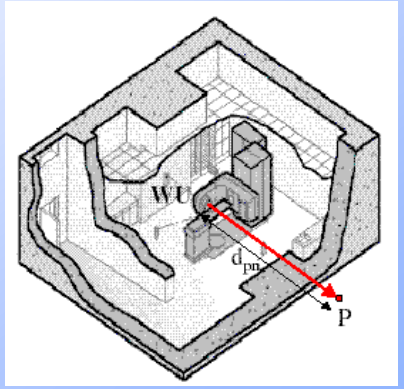
The annual dose received by a control panel operator is:

$$D_1 = R_w * N_w$$

N_w: Number of worked weeks in a year.

EXPOSED WORKERS IN THE PRACTICE OF COBALT THERAPY

Exposed Worker	Assigned tasks	Dose
Co-60 Unit operator technician	Operating the equipment from the control panel	Y/N
	Positioning the patient at the equipment for treatment.	Y/N
LINAC unit operator technician	Operating the equipment from the control panel	Y/N
Medical Physicist	LINAC unit calibration	Y/N
	Co-60 unit calibration	Y/N
	LINAC quality control	Y/N
	Co-60 quality control	Y/N



EXAMPLE OF DOSE ESTIMATIONS
Co-60 UNIT OPERATOR

3. Positioning of the patient at the unit for treatment .

Considerations for dose estimation

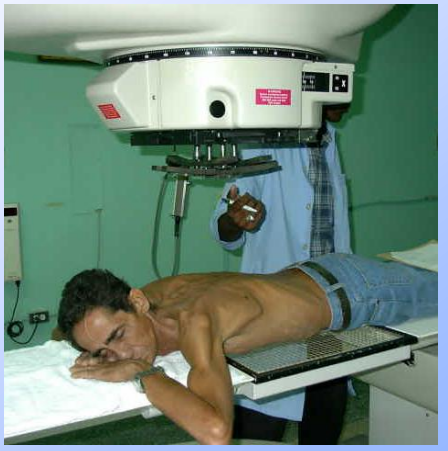
1. According to the standard IEC 60601-2-1 it is assumed that the dose rate at 1 m from the head of the unit is 0.02 mGy/h
2. N_0 patients a day are treated, assuming that each work shift has 2 technicians and each technician positions half of the patients.
3. Each patient receives an average of 3 radiation fields in each treatment sessions.
4. In each positioning field the technician spends 2 minutes.
5. Technicians works 5 days a week, 50 weeks a year.

EXAMPLE OF DOSE ESTIMATIONS
Co-60 UNIT OPERATOR

3.Positioning of the patient at the unit for treatment.

D_2: Annual dose due to the positioning of the patients

$D_2 = N_o/2$ pat/days * 3 pos/pat * 0.0333 h/pos * 0.02 mSv/h * 50 weeks/year * 5 days/week (mSv/year)



EXAMPLE OF DOSE ESTIMATIONS
Co-60 UNIT OPERATOR

Annual total dose (D_{ta}) that the operator receives in normal operating conditions.

D_1 D_2

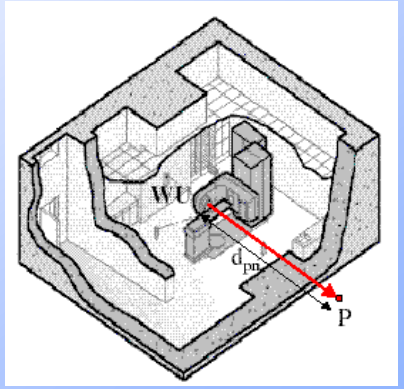
+

$$D_{ta} = D_1 + D_2$$

Conclusion: *D_{ta} must be less than the dose constrain (P)*

EXPOSED WORKERS IN THE PRACTICE OF LINAC THERAPY

Exposed Worker	Assigned tasks	Dose
Co-60 Unit operator technician	Operating the equipment from the control panel	Y/N
	Positioning the patient at the equipment for treatment.	Y/N
LINAC unit operator technician	Operating the equipment from the control panel	Y/N
Medical Physicist	LINAC unit calibration	Y/N
	Co-60 unit calibration	Y/N
	LINAC quality control	Y/N
	Co-60 quality control	Y/N



EXAMPLE OF DOSE ESTIMATIONS LINAC UNIT OPERATOR

Annual total dose (D_{ta}) that the operator receives in normal operating conditions.

D_1 $D_2 = 0$

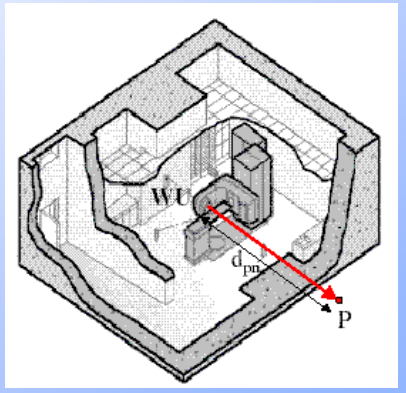
+

$$D_{ta} = D_1$$

Conclusion: *D_{ta} must be less than the dose constrain (P)*

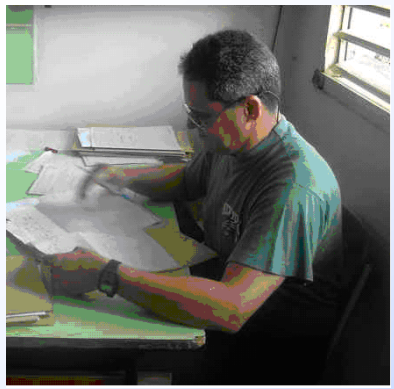
MEMBERS OF THE PUBLIC EXPOSED IN THE PRACTICE OF CO-60 THERAPY

Members of the Public	Activity	Dose
Patient´s escort	Waiting during treatment	Y/N
	Assistance of the elderly people and children.	Y/N
Hospital workers and other patients	Offices , bathrooms ,halls where the hospital workers are present.	Y/N



EXAMPLE OF DOSE ESTIMATIONS
Co-60 UNIT MEMBERS OF THE PUBLIC

To estimate the doses received by the members of the public we use the same equations that are used to estimate the control panel operator doses. Distances, use and occupation factors should be realistic.



Primary barrier:

$$IDR = \frac{DR_0 \cdot B}{d^2}$$

Secondary barrier:

$$IDR_p = \frac{a \cdot DR_0 \cdot B_p}{d_{sca}{}^2 \cdot d_{\text{sec}}^2} \cdot \frac{F}{400}$$

$$IDR_f = \frac{10^{-3} DR_0 \cdot B_f}{d_f^2}$$