**Radiation Hazards,   
Evaluation , Control & Safety for Human Body.**

**DR HARDEV**

**IES UNIVERSITY BHOPAL**

***Email:*** [***hardev.singh555@gmail.com***](mailto:hardev.singh555@gmail.com)

***DATE :- 31/07/2023***

**OVERVIEW**

* Radiation Quantities & Units
* External radiation hazard
* Source output
* Safety for Human Body.
* Principles of protection

**RADIOACTIVITY**

It is a phenomenon in which the unstable nucleus attains stability by emission of energy in the form of radiation. ( Henry Becquerel, 1896) Spontaneous nuclear transformation that produces new element Radiation can be in the form of particles or e.m. radiation or both

Radiation is such a powerful and dangerous divine rays that humans cannot see by themselves, coming in contact with it can cause serious illness or death to a person. Dr. HARDEV

If X-ray is less, then gamma is more, if it is beneficial, then if it is used incorrectly, it is more harmful. DR. HARDEV

**ACTIVITY**

Measure the quantity of radioactivity

Rate of decay or no. of disintegrations per second (Bq) is known as activity

Modern unit (SI) - Bequerel : 1 Bq = 1 dps

Traditional unit- Curie (Activity of 1 g of Ra-226)

**EXPOSURE**

Measure of Photon flux & Amount of energy transferred from X-Ray field to a unit mass of air

1 X unit = 1 C/kg air ( SI Unit)

Roentgen ; 1 R = 1 sC/cm3 air

at 0 0C & 760 mm Hg 1 R = 2.58 x 10-4 C/kg

OR

1 X unit = 3881 R

**Absorbed Dose**

Unit Expressed in terms of Energy Absorbed per unit mass; Measure of Energy Deposited by radiation in the irradiated material

1 Gy = 1 J/kg

Earlier Unit : Rad 1 rad = 100 erg/g

1 Gy = 100 rad

**Equivalent Dose**

Measure of Biological Damage Radiation Weighting Factor (WR)

Ratio of Amount of Energy from 200 keV X- Rays required to produce given biological effect to amount of energy from any other radiation to produce same effect (RBE)

**Unit Sievert (Sv)**

Equivalent Dose Sv = Dose in Gy x WR

Earlier Unit is Rem & 1 Sv = 100 rem

WR for X-Rays = 1 For X-Rays & γ-rays

1 Sv = 1 Gy & 1 rem = 1 rad

Radiation Weighting Factors

Effective Dose

Effective Dose (Whole Bode Dose)

: WT x HT

WT :Contribution of tissue T to the total risk due to stochastic effects.

Useful in converting equivalent dose received by one or more tissues to effective dose.

Tissue Weighting Factor

**Old and New Units**

**Natural Background Radiation Exposure** - Effective dose is a general term that refers to the amount of energy absorbed by tissue from ionizing radiation. The effective dose is measured in sieverts (Sv) and is more commonly expressed in units of either millisieverts (mSv) – which represents a thousandth of a sievert – or microsieverts (μSv) – one millionth of a sievert. The total worldwide average effective dose from natural radiation is approximately 2.4 mSv per year; in Canada, it is 1.8 mSv. In some parts of the world, it is naturally much higher – for instance on the Kerala Coast in India, the annual effective dose is 12.5 mSv. The dose varies with the source of the radiation.

**For example**, in northern Iran, geological characteristics result in a dose that can reach 260 mSv a year.

**Source-** Background radiation is a constant source of ionizing radiation present in the environment and emitted from a variety of sources. According to the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), there are four major sources of natural radiation: cosmic radiation, terrestrial radiation and intakes of naturally occurring radionuclide’s through inhalation and ingestion

**External-** I have a final project where I should measure maximum solar radiation heat flux during a day on re-radiating surface (i.e mirror) towards a window. My object finally is to to find an optimum angle(which will be controlled by a control system) for the mirror that should re-radiate the maximum heat flux toward the chosen surface(in my case- window). I've searched manuals and tutorials over the web to find how I can simulate the given problem in Comsol 4.3 but it seems I cannot do it. As far as I succeeded is to simulate a heat flux on given geometry during specific time of a day, where my goal is to simulate heat flux re radiated from the mirror given a mirror angle over the whole daytime range.  
Any clues and directions would be much appreciated!

**Cosmic Rays-** Regions at higher altitudes receive more cosmic radiation. According to a study by Health Canada, the annual effective dose of radiation from cosmic rays in Vancouver, British Columbia, which is at sea level, is about 0.30 mSv. This compares to the top of Mount Lorne, Yukon, where at 2,000 m, a person would receive a dose of about 0.84 mSv annually. Flying in an airplane increases exposure to cosmic radiation, resulting in a further average dose of 0.01 mSv per Canadian per year

**Terrestrial Sources-** There are also natural sources of radiation in the ground, and some regions receive more terrestrial radiation from soils that contain greater quantities of uranium. The average effective dose from the radiation emitted from the soil (and the construction materials that come from the ground) is approximately 0.5 mSv per year. However, this dose varies depending on location and geology, with doses reaching as high as 260 mSv in Northern Iran and 90 mSv in Nigeria. In Canada, the estimated highest annual dose for terrestrial radiation is approximately 1.4 mSv, as measured in the Northwest Territories

Internal

Potassium- 40

Radon-220,222

And daughters

Uranium, Thorium

Radiation Hazards Evaluation

External Hazard

Internal Hazard

Radiation Hazard Depends

Energy of Gamma Radiation

Radiation Output (Activity )

Half-life

Handling Facilities & Awareness

External Radiation Hazard

Exposure pathways: Internal

Characteristics of Radiation Sources

Properties of radioactive Neutron sources

Source Output – Gamma ray Ir-192 & CO 60.

Depends on radionuclide and activity

Example

Radiation Output at 1 m from given source is = ERC x activity

1. Radiation Level from 7 Ci Ir-192 source
2. Radiation Level from 200 GBq Co-60 source
3. If Radiation Level is 1.5 R/h from Ir-192

What is activity?

Example- Calculate the dose rate at 1m from a

1 PBq Cobalt - 60 source.

Answers : Dose rate at –

* Safety for Human Body.

Aim-Safety procedure for open field radiography –

Equips:- Radiography camera , survey meter, warning symbols, fencing roper ,radiography accessories ,collimator, civitong, lead pot ,siren red light)

Theory – all type radiation safety procedures should be followed during setting up of radiography unit.

Procedure- wear personnel monitoring (TLD) badge &pocket dosimeter.

Take survey meter which is in proper condition.

Before opening the storage pit monitor radiation levels.

Check the locks & radiation level on the camera.

Carry radiography camera on a trolley to the site.

Cordon off required area with fencing rope & put the red light with fencing rope.

Connect smallest guide tube possible the source assembly (pigtail) should in lock position.

Set up radiography joint with film & pentameter.

Position the collimator in such a way that the radiation bean should be towards unoccupied area .

Spread out maximum length of drive cable &couple it with the source assembly properly.

Put the camera in operate position.

Ensure that no one is in the cordoned pone & switch on siren red light button.

Drive the source in minimum time.

Monitor radiation level at the gear box.

Components of radiation protection

Time - calculation of radiation time and safety.

Distance- radiation time very long distance.

Shielding- radiation time used very heavy lead ,steel, concrete shielding .

TIME

“The amount of radiation dose an individual will receive while being exposed to radiation is directly proportional to the time he/she spends around the radioactive materials. Therefore, the less time spent being exposed to radiation the smaller the dose.”

Time

Example - What dose would be received standing 1 m away from a 1 PBq Co-60 source for 1minute ?

Answer : Dose rate at -

Application of distance

For x and gamma radiation, an Inverse Square Law applies :-

DISTANCE

Like A Shotgun Spread Affect

Dose-rate verses Distance

Example

What dose-rate would be measured 5 m

away from a 1 PBq Co-60 source ?

Answer :

Dise rate at =

RADIATION SHIELDING

Important principle for

Protection of personnel

Radiation control

Shielding requirement will vary depending on

Type of radiation- x-ray, gamma ray and natural radiation

Intensity - Radiation intensity is defined as the power per unit solid angle that is the power incident on that portion of the surface of a sphere which subtends an angle of one radian at the centre of the sphere in both the horizontal and the vertical planes.

Energy of radiation source – Ir-192, Co -60 act.

Shielding

The effectiveness of shielding depends on:

the type of radiation

the ENERGY of the radiation

the nature of the absorber

the thickness of the absorber

**ATTENUATION**

When photons interact with matter three things can occur. The photon may be:

Transmitted through the material unaffected

Scattered in a different direction from that traveled by the incident photon

Absorbed by the material such that no photon emerges

SHIELDING

Exponential Attenuation

Attenuation Coefficients

There are two types of attenuation coefficients:

Linear Attenuation Coefficient (LAC) provides a measure of the fractional attenuation per unit length of material traversed

Mass Attenuation Coefficient (MAC) provides a measure of the fractional attenuation per unit mass of material encountered

Half Value Thickness (HVT) &  
Tenth Value Thickness (TVT)

HVT : Thickness of a specified material required to reduce the dose-rate to one half of its original value.

TVT: Thickness of a specified material required to reduce the dose-rate to one tenth of its original value.

Shielding

Shielding

HVT & TVT Values (cm)

HVT & TVT Values (cm)

Example

Dose rate at 4 m distance from a 1 PBq cobalt-60 radiation

source is 22 Sv h-1.. If a 1 metre thick concrete shield is built

there what would be the dose rate after the shield ?

From the above Table, 1 metre of concrete represents 4 x TVT

for Co-60.

Dose rate after shield will therefore be:

= 22 x 1 x 1 x 1 x 1 Sv h-1 10 10 10 10

= 2.2 mSv h-1

Radiation protection of staff and public

Occupational Dose

Personnel Monitoring Equipment

Public Dose

Surveillance Program

Radiation Safety Program Audit

Occupation dose limits

Workers3

Effective dose

20 mSv/a over 5 years

50 mSv in any single year

Equivalent dose

to the lens of the eye 150 mSv/a

extremities (hands and feet) or the skin   
500 mSv/a

Apprentices and students of 16 - 18 years of age

Effective dose

6 mSv/a in a year

Equivalent dose

to the lens of the eye 50 mSv/a

extremities (hands and feet) or the skin 150 mSv/a

Public Dose Limits

Members of the public

Effective dose

1 mSv/a

in special circumstances 5 mSv in a single year provided that 1 mSv/a over 5 years is not exceeded

Equivalent dose

to the lens of the eye 15 mSv/a

extremities (hands and feet) or the skin 50 mSv/a

Radiation Protection Programmed

Objective

Assignment of responsibilities

Accountability of radiation sources

Classification of areas

Trained persons

Personnel Monitoring

Area monitoring /Workplace monitoring- RSM

Radiation Surveillance& records

Periodic training /Appraisal Programmed

Review and updating of Emergency Plans

**THANK YOU.   
 YOU   
 FOR   
 ATTENTION! !**