

# RADIATION SAFETY

**John Bullock**

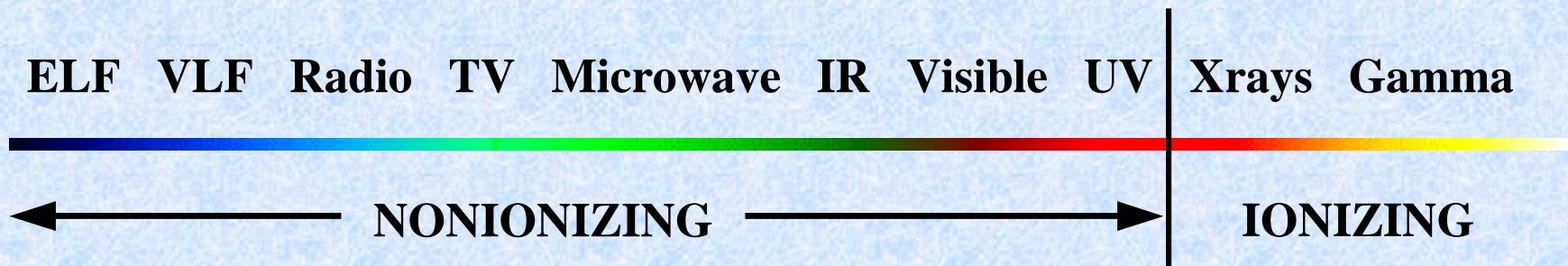
**University Radiation Safety Officer**

**Environmental Health & Safety**

# What is Radiation?

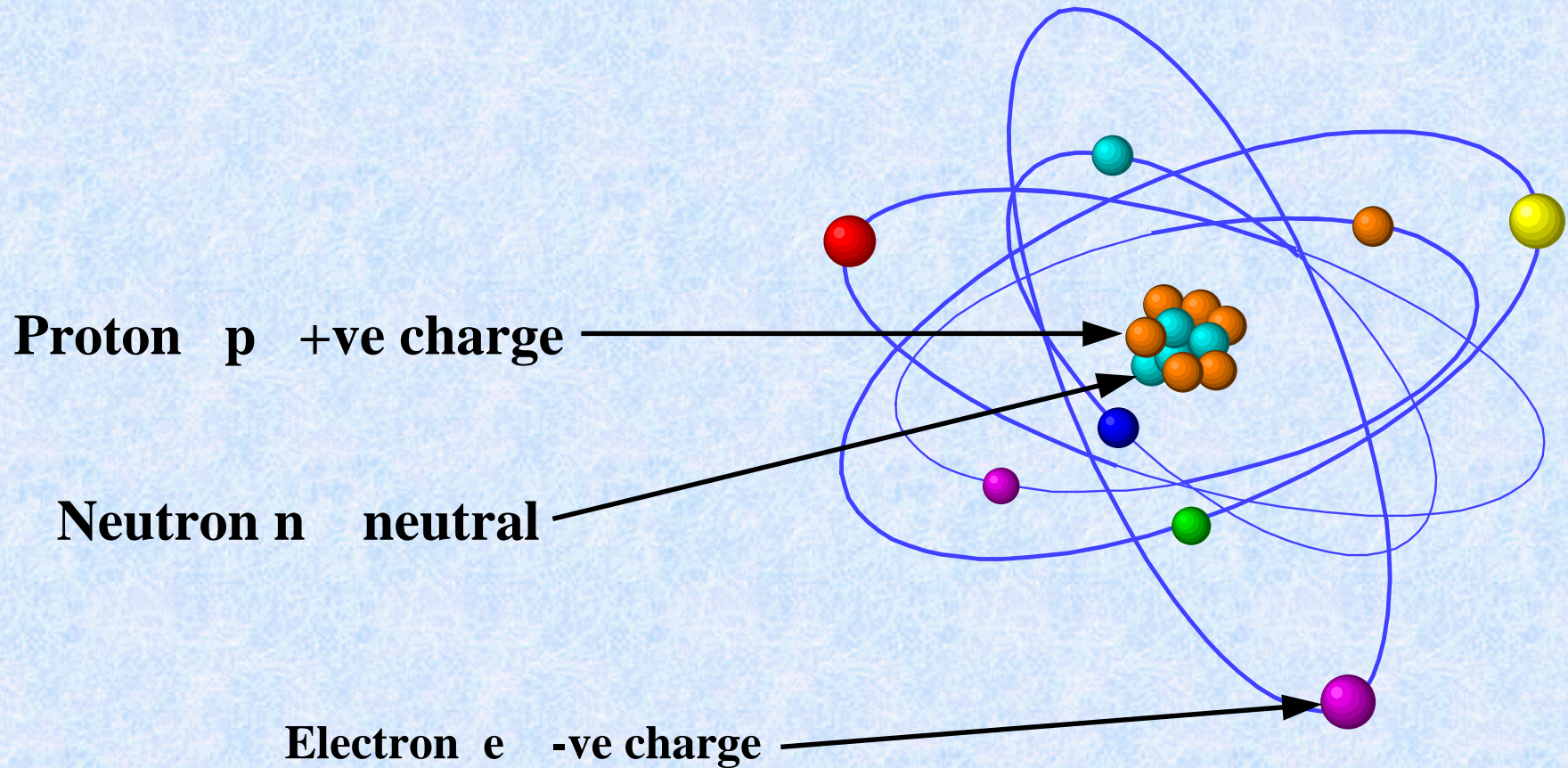
- Heat, visible light
- UV, radio, TV, microwave
- Nuclear or ionizing radiation

# Electromagnetic Spectrum



- low **FREQUENCY** high
- increasing **WAVELENGTH** decreasing
- Consider **SOURCES** **DETECTION**

# The Atom



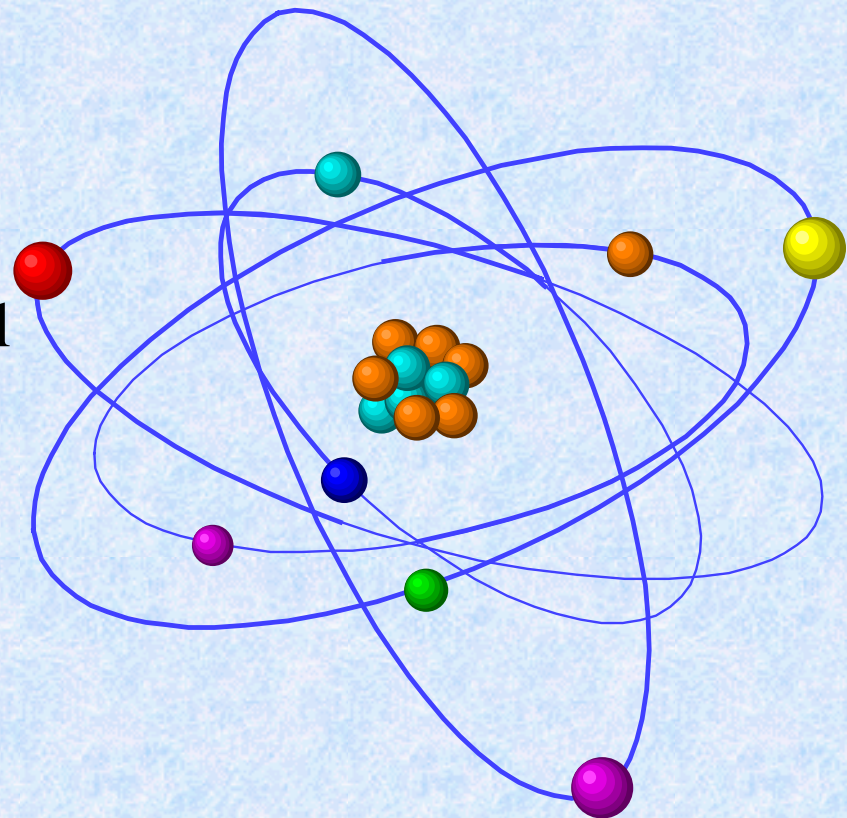
# Atoms

## Building Blocks Of Matter

Negative electrons are held in orbit around nucleus by an electric (Coulomb) force

Coulombic force between positively charged protons will split them apart (**nuclear fission**).

Neutrons attract other neutrons and protons by a force known as the “**Strong Force**”



# Mass Number

Mass Number = Protons *plus* Neutrons

$$A = Z + N$$

Z = Atomic Number

N = Number of Neutrons

Mass No. 'A' → 12

Atomic No. 'Z' → 6

C

# Isotopes

An Isotope has the same Atomic Number (Z)

But has a different number of Neutron (N)

Therefore a different Mass Number (A)

Mass No. 'A' → <sup>14</sup>

Atomic No. 'Z' → <sub>6</sub>C

# Radioactive Isotopes

- **Some isotopes are unstable (imbalance in neutron/proton ratio)**
- **Nucleus spontaneously disintegrates or decays**
- **Emit mass (particles) and energy**
- **Probability of decay characteristic of the nuclide**

# Activity

- is a measure of the rate of decay
- **Becquerels** (old unit Curie)
- $1 \text{ dps} = 1 \text{ Bq} = 27 \text{ pCi}$
- $1 \text{ uCi} = 37,000 \text{ dps} (2,222,222\text{dpm})$

# Half Life

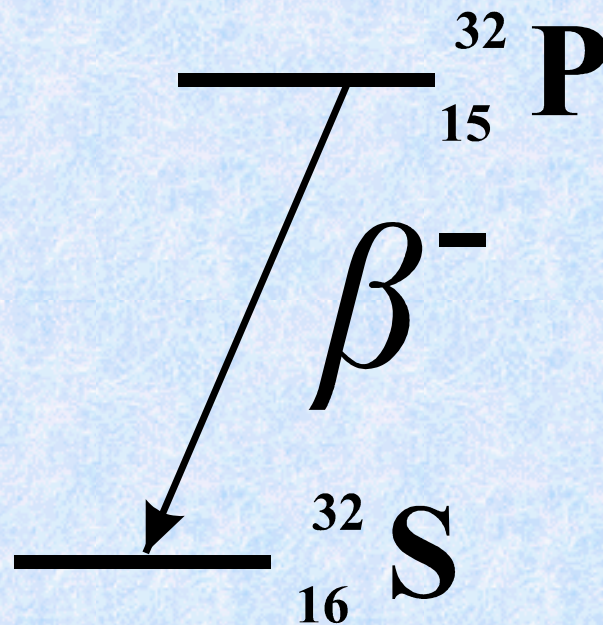
- Amount of time required for the activity to be reduced by 50%
- To calculate remaining activity  
 $0.5^n$   
n= # half lives

# Types of Radiation

- **Alpha**
- **Beta**
- **Xray and Gamma**
- **Neutrons**
- **Positrons**

# Neutron Excess: Beta Decay

- **Excess neutron is transformed into a proton and an electron**
- **Electron (plus a neutrino) are emitted from nucleus**

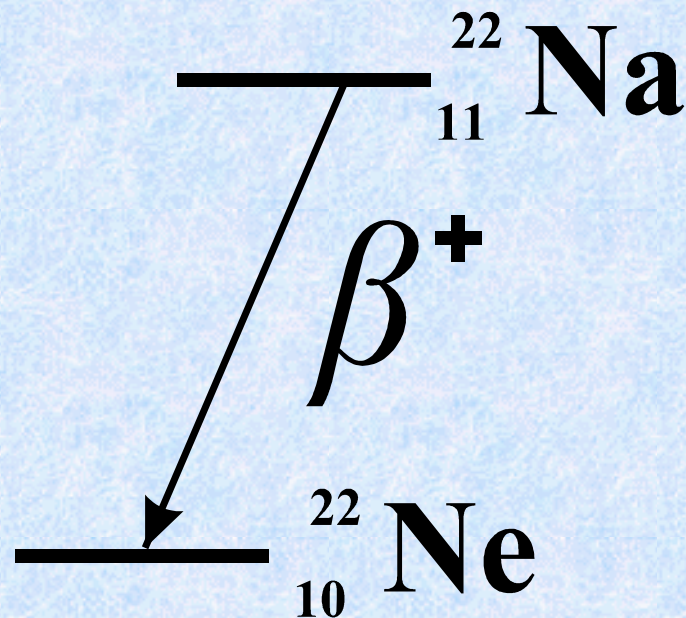


# Beta Particles

- **Charge = -1**
- **Same size as electron, so faster than alpha for same energy**
- **Slightly penetrating**
- **Produces secondary Bremsstrahlung Radiation in dense materials**
- **Shielding material with a low Z number needed to avoid Bremsstrahlung production**

# Proton Excess: Positron Emission

- Excess proton is transformed into a neutron plus a positron
- Positron is a positive electron
- Positron (plus a neutrino) are emitted from nucleus

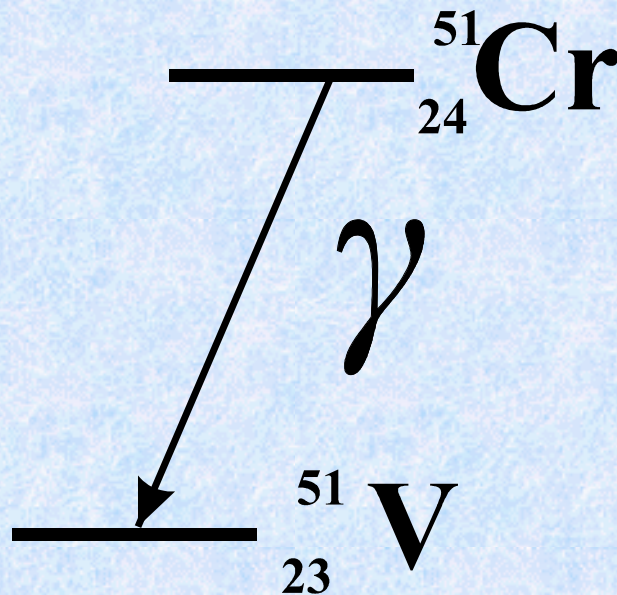


# Positrons

- **Charge = +1**
- **Same size as electron**
- **slightly penetrating**
- **Lead shielding required to shield against gamma pairs**

# Proton Excess: Electron Capture (EC)

- Excess proton is transformed into a neutron by capturing one of its own orbiting electrons
- Mass difference is converted to energy
- Gamma ray and neutrino are emitted

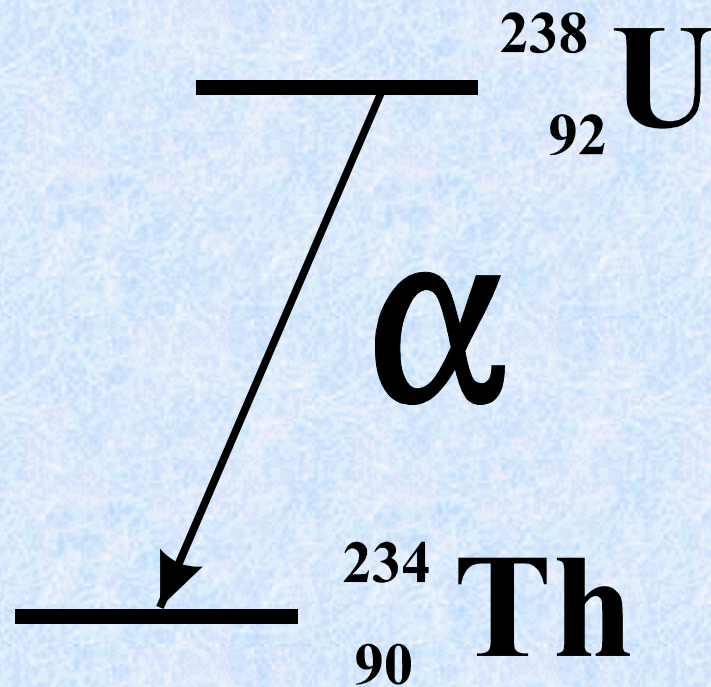


# Xray and Gamma Rays

- **No Charge**
- **No mass, waves are pure energy**
- **Very penetrating**
- **High Z, high density material needed for shielding (lead)**

# Alpha Decay

- Sometimes energetically more favourable for nucleus to emit 2 protons and 2 neutrons (Helium nucleus)
- Especially true of very large nuclei



# Alpha Particles

- **Two n, two p (same as He nucleus)**
- **Charge = +2**
- **Large in size so slower for same energy**
- **Not very penetrating**
- **High density ionizations**
- **Shielded with outer layer of skin or a few centimetres of air**

# Neutron Radiation

- **Produced in nuclear reactor**
- **Less bulky sources are available by mixing an alpha emitting nuclide with Beryllium**
- **e.g.  $^{241}\text{Am} + \text{Be}$**

# Neutrons

- **No Charge**
- **Heavy**
- **Very penetrating**
- **Low Z with large concentration of Hydrogen nuclei need for shielding (paraffin wax, water)**

# Ionization

- **Incoming particles interact mainly with electrons in the target material**
- **Target electron is 'excited' and it 'pops' out of the orbit  
Leaving a -ve and +ve charged ion**
- **Each charged particle (ion) creates a strong electric field in immediate area**
- **Ionization of target material causes biological damage**

# Model for Biological Effects

**Physical Stage ( $10^{-18}$  to  $10^{-13}$  seconds)**

**Ions and excited molecules produced in irradiated material.  
Ionized and excited molecules dissociate giving free radicals and  
molecular products**

**Chemical Stage ( $10^{-13}$  to 1 second)**

**Free radicals react to give new chemical products**

# Model for Biological Effects

**Biochemical Stage (1 second to 11 days)**

**Possible impairment of biochemical functions; damage to membranes, enzymes**

**Biological Stage (11 days to 32 years)**

**loss of viability, sterility, cancer, genetic damage**

# Units of Radiation Dose

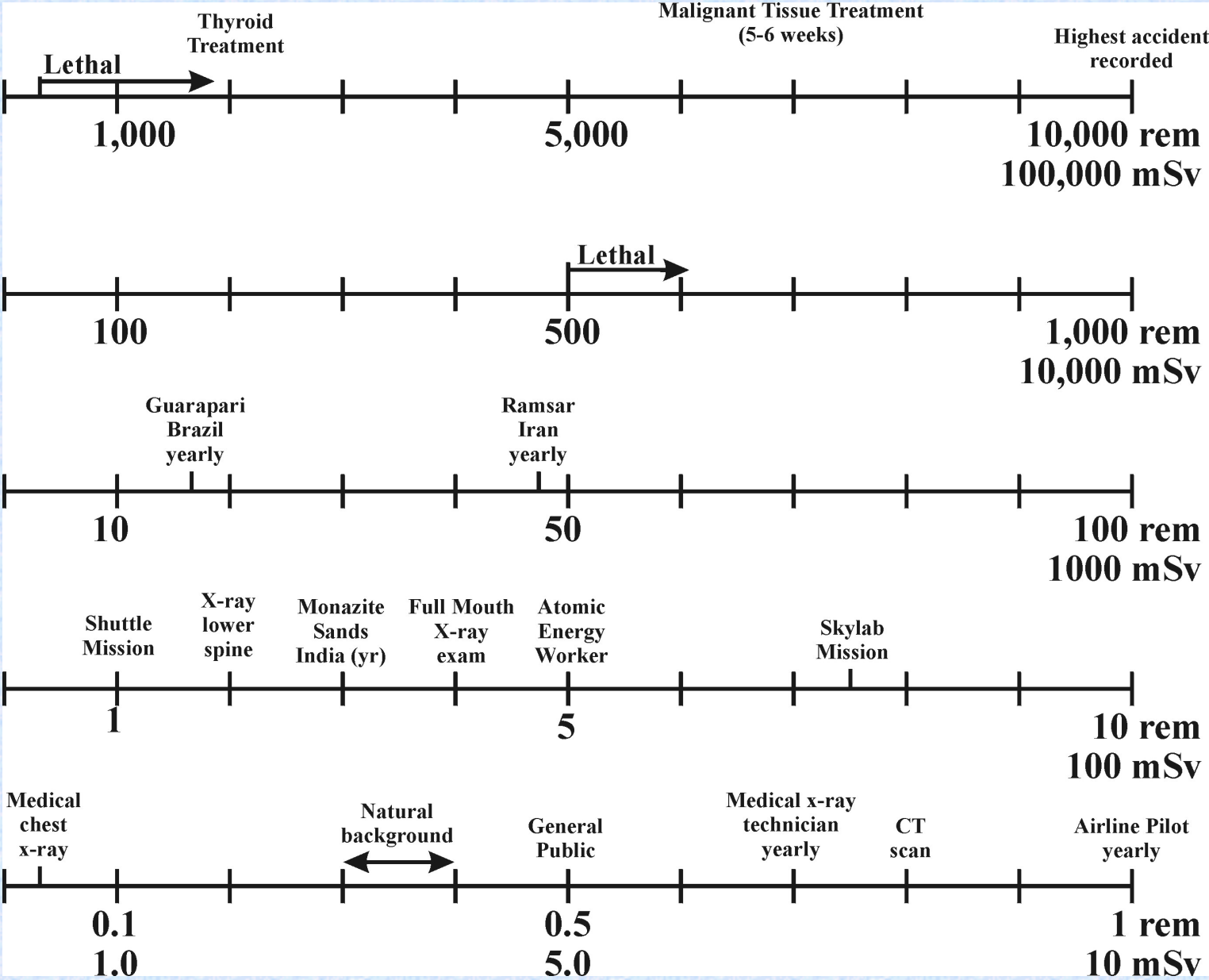
- **Roentgen (R)**
  - Adopted in 1928
  - Ability of photons to produce ionizations in air
  
- **Gray (Gy)**
  - Adopted in 1953 to overcome shortfalls of the roentgen
  - Amount of energy absorbed in mass

# Units of Radiation Dose

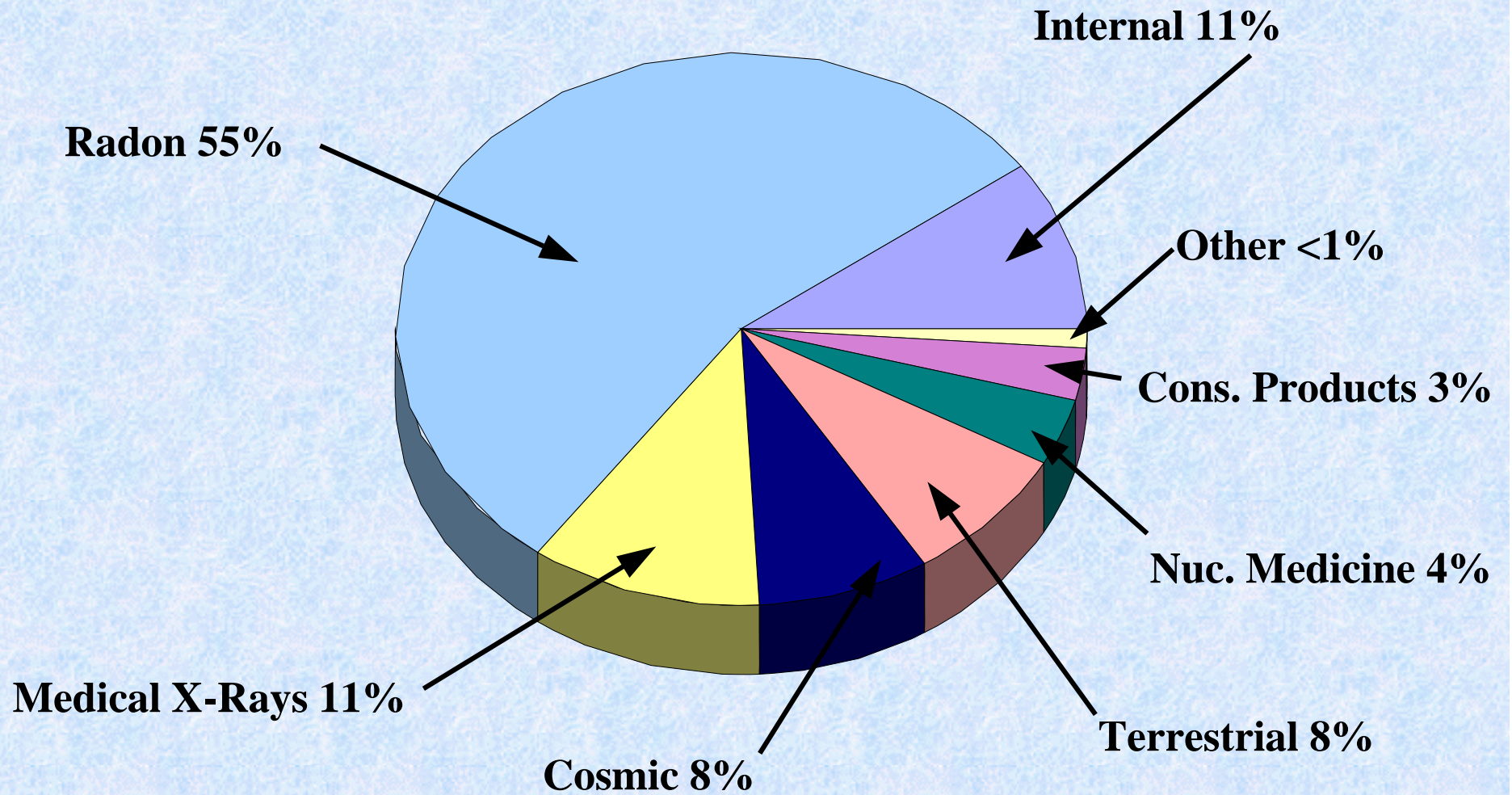
- **Sievert (Sv) (Old Unit rem)**
- Reflects biological effects of radiation
- Amount of energy absorbed in a given mass multiplied by a Quality Factor (Q)
- 1 Sv= 100 rem

| Radiation Type   | Quality Factor |
|------------------|----------------|
| X, Gamma, Beta   | 1              |
| Thermal Neutrons | 2 –3           |
| Fast Neutrons    | 10             |
| Alpha            | 20             |

# Human Experience: Ionizing Radiation



# Exposure Sources



# Radiation Interacts with Cells

- **Nothing**
- **cell death**
- **change and repair**
- **limited permanent change**
- **changes leading to cancer**

# Exposure and Risk

- **risk of cancer**
- **normal rate of death from cancer 25%**
- **1 rem (10 mSv) of exposure increases rate to 25.05%**

# **REDUCING THE RISK**

## **ALARA**

**(As Low As Reasonably Achievable)**

- **To ensure individual dose is as low as reasonably achievable**
- **To ensure collective dose is as low as reasonably achievable**
- **To ensure radioactive waste is as low as reasonably achievable**
- **To ensure that radioactive emissions are as low as reasonably achievable**

# **REVIEW DESIGN, AND PROCEDURAL CHANGES**

- **Review shielding requirements to minimize dose rate to workers in accessible areas**
- **Calculate dose to member of public in accessible areas.**
- **Distance 'hot' items from locations requiring regular access by non-trained personnel.**

# Reduce Exposure Time

**TIME**

$$D = d * t$$

Where

D = Radiation Dose Received

d = Dose Rate

t = Time Exposed

# Reduce Exposure Time

**TIME**

- Training
- Mock-ups
- Work-Planning

# Increase Distance

## **DISTANCE**

If time and dose are constant, the radiation dose decreases in proportion to the square from the radiation source.

# Increase Distance

## **DISTANCE**

This means that doubling your distance from the source will reduce your dose received by  $\frac{1}{4}$  of the original dose.

This is known as the  
“Inverse Square Law”

# Increase Distance

$$D_2 = D_1 * \frac{S_1^2}{S_2^2}$$

$D_2$  = Dose Rate Received

$D_1$  = Dose Rate at Original Distance

$S_1$  = Original Distance

$S_2$  = New Distance

# Increase Distance

## **DISTANCE**

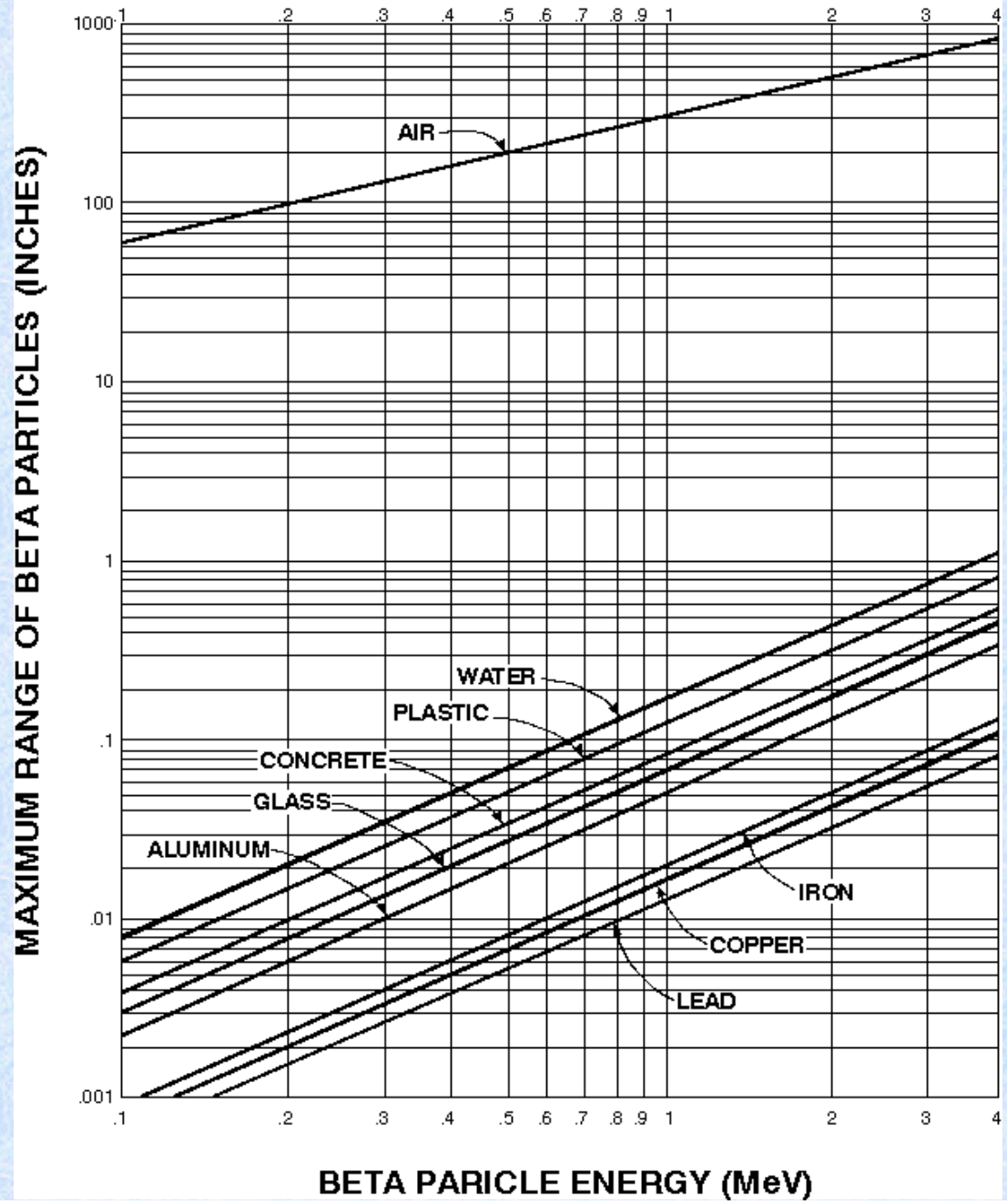
- **Eliminate the source**
- **Reduce source strength**
- **Optimize positioning of workers**
- **Decontaminate surfaces**
- **Reduce airborne contamination**

# Reduce and Minimize Radiation Field

## **SHIELDING**

- **Optimize positioning of workers**
- **Shield the source**

# MAXIMUM RANGE OF BETA PARTICLES as a Function of Energy in Various Materials



**Phosphorous 32**

**Maximum Beta Energy**

**- 1.71 MeV**

**Max. Penetration of Beta in Plastic**

**- .25 inches**

# Half Value Layer

- HVL - The thickness of a material required to reduce the intensity of gamma and x-rays by a factor of 2

# Half Value Layers (in cm)

| Energy<br>MeV | Lead | Energy<br>MeV | Lead  |
|---------------|------|---------------|-------|
| 0.3           | .160 | 1.5           | 1.174 |
| 0.5           | .396 | 2.0           | 1.358 |
| 1.0           | .816 | 2.5           | 1.443 |

# Calculate Number of HVL

**The number of Half Value Layers (#HVL) is calculated:**

$$\#HVL = T / HVL$$

**T = Thickness of Shielding in cm**

**NOTE: Determine the HVL thickness for the highest photon energy of the radioisotope and shielding material, from the HVL Chart**

# Calculate Number of HVL

**EXAMPLE Chromium-51 emits photons with an energy of .320 MeV and is stored behind .8 cm of lead.**

**The HVL for Lead for Cr-51 is 0.16 cm**

$$\begin{aligned}\#HVL &= T / HVL \\ &= .8 / .16 \\ &= 5\end{aligned}$$

# Attenuation Factor

**The attenuation factor (AF) is the fraction of exposure rate remaining when the shield is in place.**

**This is calculated by:**

$$AF = 0.5^n$$

**n = #HVL**

**FROM EXAMPLE**

$$\begin{aligned} AF &= 0.5^n \\ &= 0.5^5 \\ &= 0.03135 \end{aligned}$$

# Thickness of Shielding Required

The Thickness of shielding needed to give a required attenuation factor is calculated:

$$\text{\#HVL Required} = \text{Log}(1/\text{AF}) / \text{Log}(2)$$

**EXAMPLE** A user wishes to reduce exposure to 15%. How many HVL of shielding material will be required?

$$\begin{aligned}\text{\#HVL} &= \text{Log}(1/\text{AF}) / \text{Log}(2) \\ &= \text{Log}(1/.15)/\text{Log}(2) \\ &= \text{Log}(6.67)/\text{Log}(2) \\ &= .82412/.30103 \\ &= 2.73\end{aligned}$$

# Reducing the Risk

- **Time**
- **Distance**
- **Shielding**
- **Eliminate the source**
- **Reduce source strength**
- **Decontaminate surfaces**
- **Reduce airborne contamination**

# Canadian Nuclear Safety Commission

- **Through consultative process, establishes regulations to meet public's needs and expectations.**
- **Communicates regulations and other requirements to licencees.**
- **Act is 'enabling' legislation.**
- **Inspects licencees for compliance to regulations, requirements, licence conditions and the licencee's program.**
- **Responsible to "interfere" with management of facility if it believes licencee is ineffective at implementing good programs.**

# Canadian Nuclear Safety Commission

- The CNSC has also required Queen's to:
- Establish a University Radiation Safety Committee
- Hire a University Radiation Safety Officer

# Radiation Control at Queen's University

- **One consolidated licence is issued for all radioisotopes**
- **Conditions are imposed on usage as part of the licence**
- **Some of the conditions impose specific limits or require specific procedures for specialized use of radioisotopes**
- **Many 'administrative' conditions are imposed**

# Radiation Safety Committee

- Acts as a resource body for the University.
- Develops University policy and procedures with respect to the safe use of radioactive materials and techniques capable of producing hazardous emissions.
- Advises the University, its faculties, departments, cross-appointees and researchers of the Committee's policy and of the special requirements relating to research and transport of the above materials and devices.

# Radiation Safety Committee

- Makes recommendations to the University, concerning the actions to be taken on specific aspects of radiation matters.
- Provides reports at appropriate intervals to the University and to external agencies.

# Radiation Safety Committee

- The suspension, when necessary, of the use of any radioisotope or radiation producing devices at the University.

# Radiation Safety Officer

- Works under the advice of and reports to the Chairman of the Committee and the Director of Environmental Health and Safety on all matters pertaining to radiation safety.
- Administers the policy of the University and its Radiation Safety Program and act as liaison with the CNSC and other regulatory agencies .

# Radiation Safety Officer

- Advise the Committee on new and proposed legislation.
- Serve as the Committee representative when plans are being formulated for new radiation laboratory facilities or alterations to existing laboratories.
- Assume control in any emergency involving radiation hazards.

# Radiation Safety Officer

- Review all applications for Radioisotope Permits.
- Maintain files on all activities involving radioactive materials and sources of hazardous radiation including dosimetry records.

# Radiation Safety Officer

- Review orders for the purchase of radioactive materials.
- Inspect laboratories and other workplaces where radioisotopes are used
- Supervise a radioactive waste collection and disposal service.

# Radiation Safety Officer

- Administer personnel dosimeter service.
- Provide and supervise educational programmes on radiation safety for University personnel.

# Permit Holder Responsibilities

- Ensure that the conditions stated in the radioisotope permit are fulfilled.
- Arrange for adequate facilities, equipment, instruments, supervision and instruction in compliance with the University's radiation protection policies.
- Report all radiation incidents to the URSO
- Maintain an inventory of radioactive materials used, and ensuring that the possession limits are not exceeded.

# Permit Holder Responsibilities

- Establish a laboratory procedure to ensure that when working with an open source:
  - 1. survey measurements have established that external radiation and contamination levels are within permissible limits.
  - 2. radiation sources are properly labeled and stored.
  - 3. experiments that will be in progress after normal working hours will be properly attended.
  - 4. each laboratory is secured against unauthorized access.

# Permit Holder Responsibilities

- Instruct all workers, prior to employment in radiation laboratories, to make them aware of the potential hazards of radiation, including genetic effects and ensure that all workers have completed the University Radiation Safety Course.
- Keep records of the disposal of radioactive material.
- Ensure that all persons wear appropriate protective equipment, radiation monitoring badges and/or pocket dosimeters as required.

# Permit Holder Responsibilities

- Allowing only authorized persons to enter rooms that are specified as restricted areas.
- Ensure that the URSO has an up-to-date listing of all radioisotope users authorized by the permit.
- Post of warning signs and labels as required by the Atomic Energy Control Regulations and the Radiation Committee Policy and Procedures.

# Worker Responsibilities

- Each individual who uses radioactive material is responsible for complying with the Radiation Committee Policy and Procedures, and with those established for the permit holder's radioisotope permit.

# Application For A Radioisotope User's Permit

- Form available through EH&S

# Permit

- Issued for a 1 year period
- Renewed annually
- Department Head also signs annual renewal

# Laboratory Set Up

- Post Permit, Laboratory Rules and Radiation Warning Signs
- Order Dosimetry Badges if Required
- Ensure that proper instrumentation is in place
- Ensure that all lab personnel are registered for Radiation Safety Course

# Laboratory Set Up

- Instruct lab personnel in lab procedures
- Set up Inventory, Waste and Contamination Monitoring records
- Write out protocol and 'flow chart'
- Designate areas where isotope work will be carried out.

# Laboratory Classification

| <b>Level of Radioisotope Laboratory</b> | <b>Permissible Qty of Radioactivity (Annual Limit Intake (ALI))</b> |
|---|---|
| <b>Storage</b>                          | <b>Isotopes not manipulated</b>                                     |
| <b>Basic</b>                            | <b>Does not exceed 5 ALI</b>  |
| <b>Intermediate</b>                     | <b>Does not exceed 50 ALI</b>                                       |
| <b>High</b>                             | <b>Does not exceed 500 ALI</b>                                      |
| <b>Contaminant</b>                      | <b>Exceeds 500 ALI</b>  |

# Ordering

- Only EH&S can order radioisotopes
- All suppliers get copy of licence and letter stating that they may only accept orders from EH&S
- Only those authorized by Permit Holder may place order electronically through Financial Services On-Line System

# Ordering On-Line

- **Permit Number:** Fill in under Additional Information
- **Phone:** Laboratory Phone Number
- **Supplier:** Perkin Elmer, Amersham etc
- **Commodity Numbers:** Ensure that 06 Radioisotopes is selected
- **Ship To:** Include PI's name and lab number
- **Quantity:** 1 x 250uCi, 1 vial etc
- **Catalogue Number:** BLU512H etc
- **Isotope and Description:** 32P dATP, etc
- **Price & Quote:** Indicate if there is special quote

# How To Handle Radioisotope Shipments

- Note Activity and isotope on package label.
- Wipe test outside package for removable contamination.
- Open outer package and remove packing slip.
- Open inner package and verify that contents match packing slip.

# How To Handle Radioisotope Shipments

- Check for possible breakage of seals or containers, loss of liquid or change in colour of absorbing material.
- Wipe test inner container.
- Place container behind shielding if required.
- Record isotope in inventory control records.

# Inventory

- Form available in Manual
- one form per vial
- Name, Permit #, Department
- Purchase Order
- Lot Number or other Identifying mark

# Inventory

1. Must be completed immediately upon receipt of radioisotope
2. Copy of Purchase Order should be attached
3. Transportation of Dangerous goods forms must be attached
4. Packing slips must be attached

# Transfer of Isotopes

- Ensure that other permit is allowed to have particular isotope.
- Both labs must inform RSO that there has been a transfer, and give all particulars of the transfer.

# Waste

- maintain 'garbage log'
- Segregate long lived and short lived isotopes
- Segregate high activity waste from low activity waste
- Solid Waste in clear 3 mil bags
- Scintillation Vials in 6 mil bags
- Solvents in Disposal cans

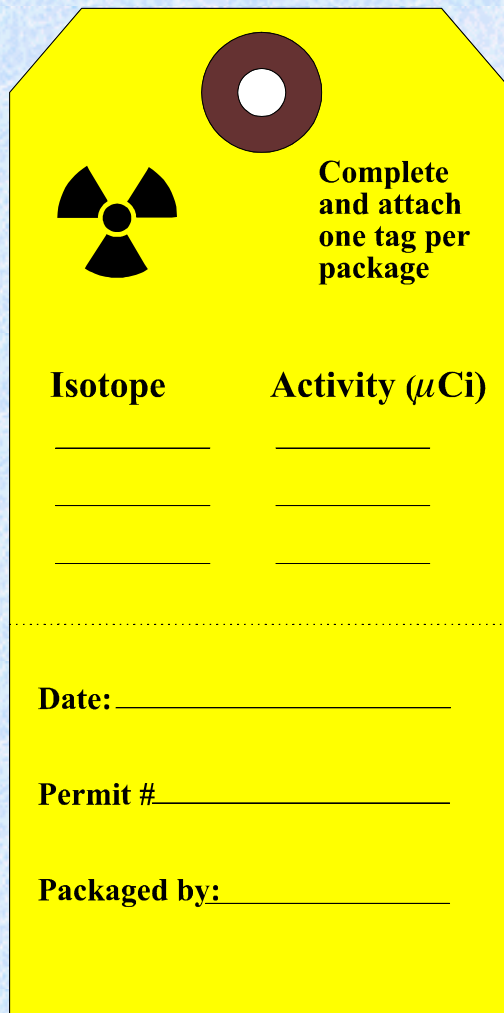
# Waste

- Ensure that there are no radioactive markings are defaced (vials, tape) inside bags.
- Do not tape bag shut with radioactive tape.
- Ensure that no other waste is included in bags of scintillation vials.
- Ensure that Isotope, activity (uCi, mCi), Permit Number, and name of Packer are on waste tag.

# Waste

- Lead pigs must be swiped and the scintillation counter print-out attached to disposal box
- Waste must not be put in designated waste pickup areas until Thursday morning (prior to 9:00 am)

# Waste Tag



**Complete and attach one tag per package**

| Isotope | Activity ( $\mu\text{Ci}$ ) |
|---------|-----------------------------|
| _____   | _____                       |
| _____   | _____                       |
| _____   | _____                       |

---

**Date:** \_\_\_\_\_

**Permit #** \_\_\_\_\_

**Packaged by:** \_\_\_\_\_

# Contamination Measurement Criteria

The licensee shall ensure that:

- (a) non-fixed contamination in all areas, rooms, or enclosures where unsealed nuclear substances are used or stored does not exceed 3 Bq/cm<sup>2</sup> all Class A, 30 Bq/cm<sup>2</sup> all Class B, and 300 Bq/cm<sup>2</sup> all Class C radionuclides averaged over an area not exceeding 100 square centimetres

# Contamination Measurement Queen's Permit Criteria

If the removable contamination is greater than either 3 times background or 3 Bq/cm<sup>2</sup> averaged over an area not exceeding 100 cm<sup>2</sup> then the surfaces must be decontaminated.

# Elements of a Contamination Monitoring Program

## Method of Measurement

- **Radioactive contamination may be measured directly or indirectly**
- **Direct measurement: use of portable radiation detection instruments to detect both fixed and removable contamination. May be used when background radiation levels are negligible compared to licence criteria.**
- **Indirect measurement only detects removable contamination by means of wipe tests.**

# Elements of a Contamination Monitoring Program

## Instrument Selection

- The ability of various radiation detection instruments to detect radioisotopes of interest will vary with the instrument and manufacturer.
- Guidance on the selection of instruments may be obtained from Environmental Health and Safety.

# Elements of a Contamination Monitoring Program

## Locations of Measurements

- Locations that are to be monitored are numbered on a plan of the radioisotope work area.
- Work areas (benches, countertops, fumehoods)
- Storage areas
- Non work areas (floors, door handles etc)
- Pick other random sites

# Elements of a Contamination Monitoring Program

## Frequency of Monitoring

- At least WEEKLY when isotopes are in use.

## Decontamination

- Non-fixed contamination more than licence criteria OR
- More than 3x background

# Elements of a Contamination Monitoring Program

## Monitoring Records

- Kept 3 years or until next CNSC Inspection
- date of measurement
- make an model of the instrument
- monitoring locations
- contamination monitoring results in Bq/cm<sup>2</sup>  
(before and after decontamination)

# Elements of a Contamination Monitoring Program

- results of operational checks and background measurements for portable instruments.
- blank and standard measurement results for non-portable instruments.

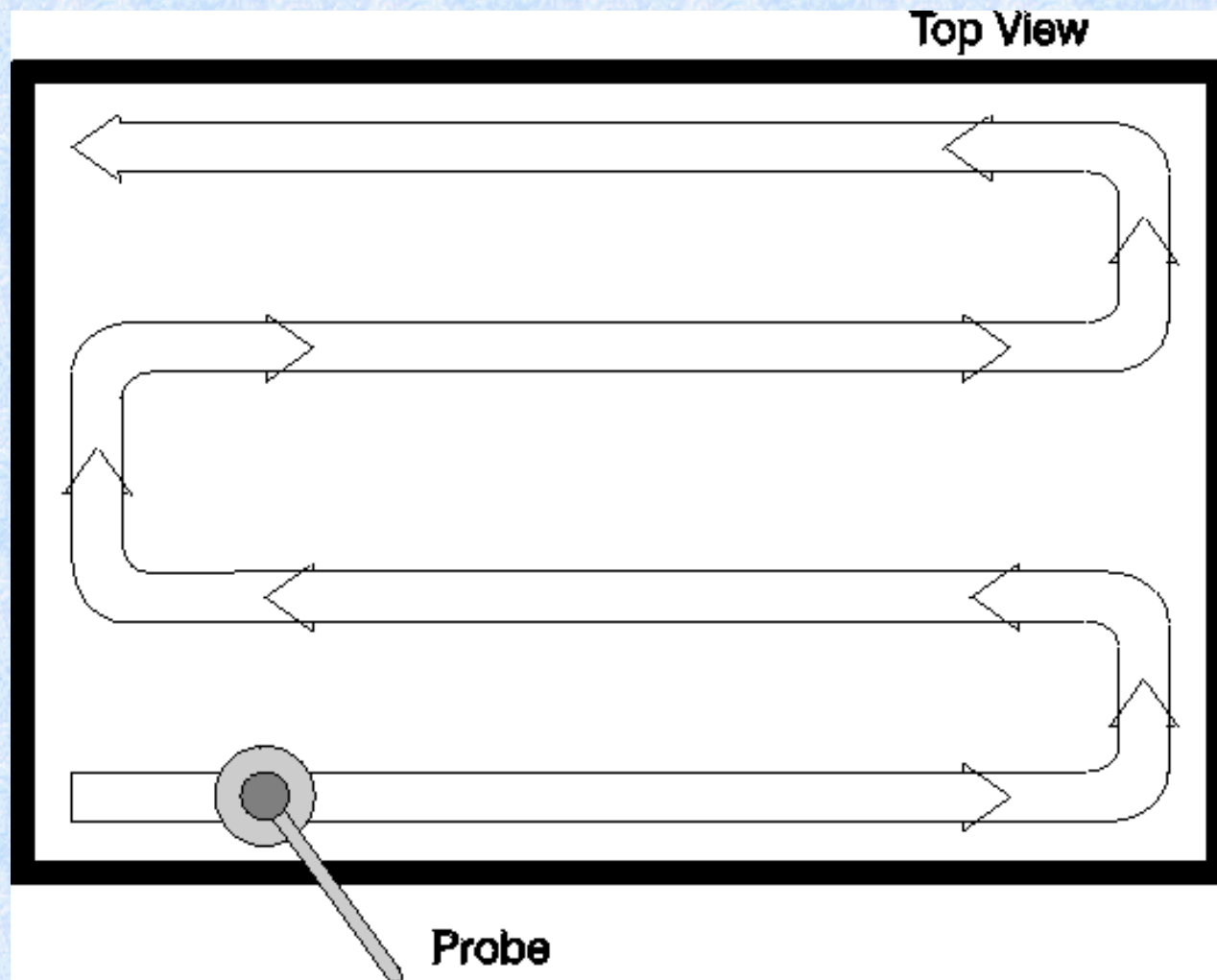
# Direct Monitoring Technique

- Perform operational checks on the instrument. Record results of checks.
- Select a slow response time (if the metre is so equipped) and measure and record the background count rate.
- Select the response time to a fast response time and commence to survey the surfaces marked on the plan of the working area.

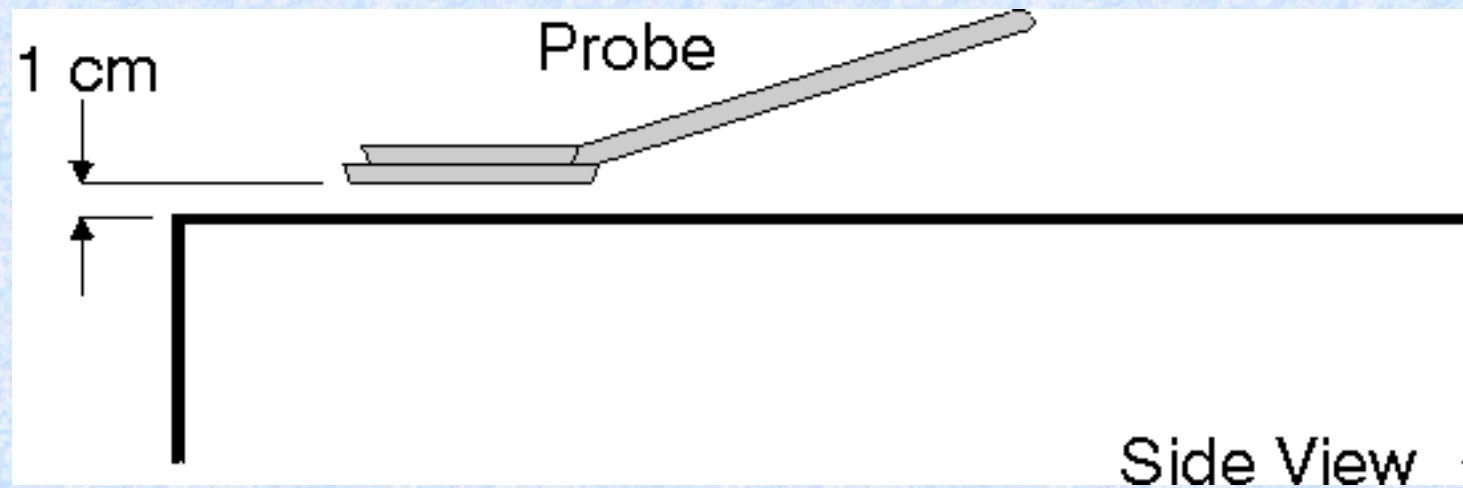
# Direct Monitoring Technique

- Start at the leading edge with the metre or probe 1 cm from the surface.
- Meter is not a 'magic wand', therefore you must survey slowly to give the metre time to respond.

# Direct Monitoring Technique



# Direct Monitoring Technique



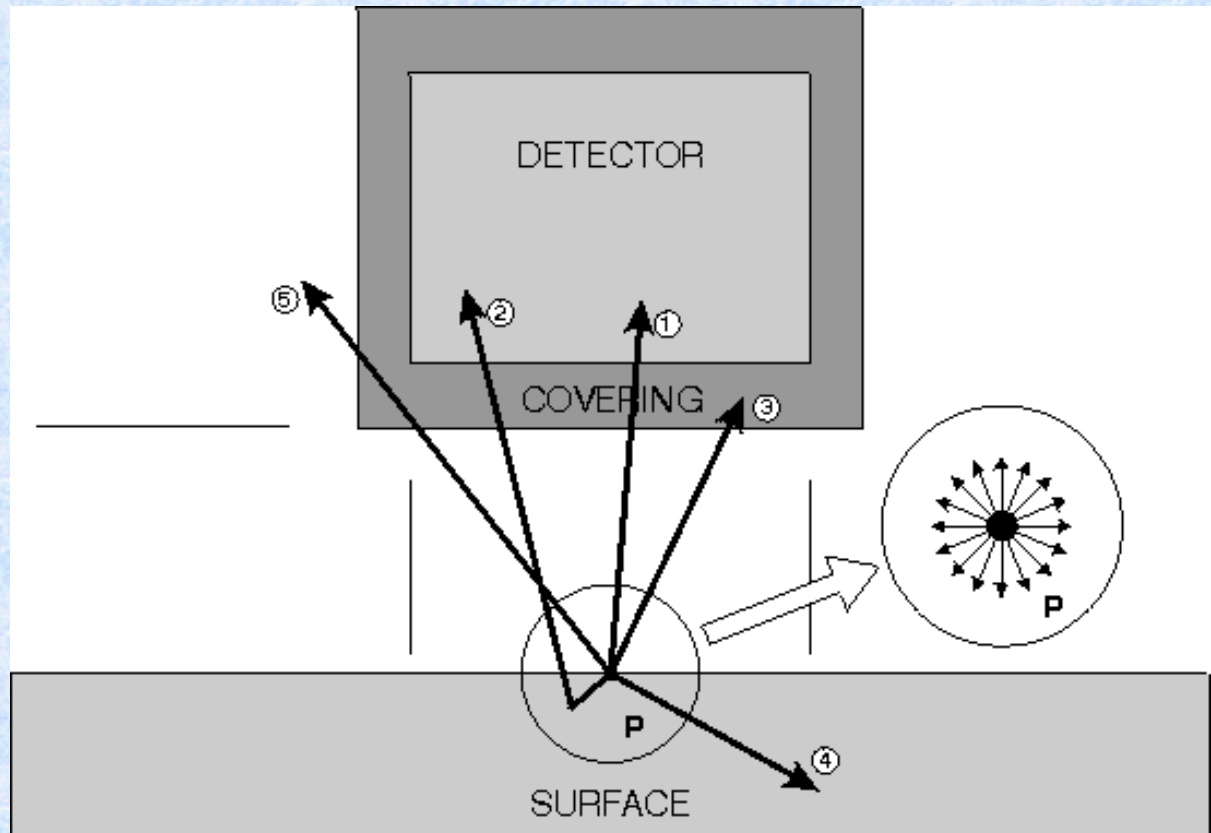
# Detector Efficiency

The detector efficiency depends upon:

- Type of detector (GM, NaI Scintillation, Proportional)
- Detector size and shape
- Radioisotope and type of radiation measured (alpha, beta, gamma radiations and their energies)

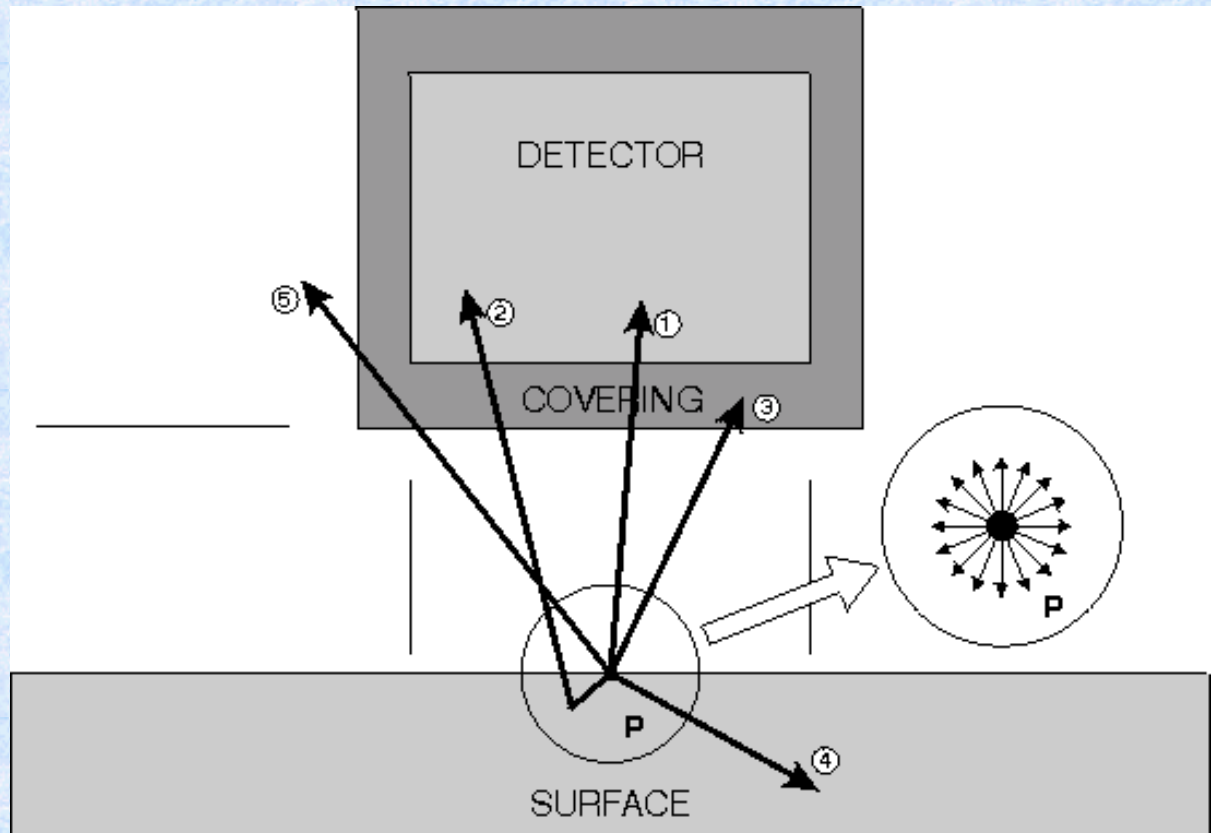
# Detector Efficiency

1. Goes directly from the source P, into the detector.
2. backscatter off the surface, into the detector.



# Detector Efficiency

3. Absorbed by the detector covering.
4. Most radiation doesn't even get detected.
5. If the detector was closer, would be detected.



# Detector Efficiency

The detector efficiency can be found by:

1. Counting a standard source of known activity with your detector.

$$\textit{efficiency} = \frac{\text{Detector Count} - \text{background}}{\text{known activity}}$$

2. Asking the manufacturer about the efficiency of the detector for specific radioisotope(s).

# Indirect Monitoring Technique

- Indirect removable contamination measurements are made by sampling with a wipe and measuring the activity on the wipe.
- Wipe each of the locations shown on the plan of the working area with a filter paper.
- Hold the filter paper with your thumb and forefinger and rub the smear over the surface using light pressure.

# Indirect Monitoring Technique

- Wipe an area of 100 cm<sup>2</sup> (slightly larger than the palm of your hand).
- Use only one wipe per location.
- If the wipes are counted with a contamination meter, the wipe should be smaller than or equal to the sensitive area of the detector.

# Indirect Monitoring Technique

- If the wipes are counted in a liquid scintillation counter, the printouts from the counter must be kept with the contamination monitoring records.
- Clean any contaminated area and remonitor.
- Blank and a standard should be counted and recorded with each set of wipes

# Relating Measurement Readings To Regulatory Criteria

$$C = \frac{N - B}{Ex60xAxF}$$

- **C=Contamination Level (Bq/cm<sup>2</sup>)**
- **N=Total Counts (cpm)**
- **B=Background (cpm)**
- **E=Instrument Efficiency**
- **60=sec/min**
- **A=Area wiped (not to exceed 100 cm<sup>2</sup>) or area of detector in cm<sup>2</sup> (for indirect)**
- **F=collection factor of wipes**

# Spills

## General Precautions

1. Inform persons in the area that a spill has occurred. Keep them away from the contaminated area.
2. Cover the spill with absorbent material to prevent the spread of contamination.

# Minor Spills

## Definition:

- a spill that is typically less than 100 scheduled quantities of radioisotope

# Minor Spills

- Wearing appropriate disposable gloves and a lab coat, or disposable coveralls, clean up the spill using absorbent paper and place it in a plastic bag for transfer to a radioactive waste container.
- Avoid spreading contamination. Work from the outside of the spill towards the centre.
- Wipe test or survey for residual contamination as appropriate. Repeat decontamination, if necessary, until contamination monitoring results meet the radioisotope licence criteria.

# Minor Spills

- Check hands, clothing and shoes for contamination.
- Record spill details and contamination monitoring results.
- Report the spill and cleanup to the Supervisor.
- Submit a full report along with a copy of the contamination monitoring results to the University Radiation Safety Officer.
- Adjust inventory and waste records appropriately.

# Major Spills

## Definition:

- a spill that involves more than 100 scheduled quantities, or contamination of personnel, or release of volatile material.

# Major Spills

- Clear the area. Persons not involved in the spill should leave the immediate area. Limit the movement of all personnel who may be contaminated until they are monitored.
- If the spill occurs in a laboratory, leave the fumehood running to minimize the release of volatile radioactive materials to adjacent rooms and hallways.
- Close off and secure the spill area to prevent entry. Post warning sign(s).

# Major Spills

- Notify the University Radiation Safety Officer (URSO) immediately.
- The URSO will direct personnel decontamination and will decide about decay or cleanup operations.
- Follow the cleanup procedure for minor spills.
- Record the names of all personnel involved in the spill. Note the details of any personal contamination.

# Major Spills

- The URSO will arrange for any necessary bioassay measurements.
- Submit a full report along with a copy of the contamination monitoring results to the URSO
- The URSO will submit a report to the CNSC.
- Major spill procedures should be implemented whenever minor spill procedures would be inadequate.

# Decontamination of Personnel

- Contact URSO at 32951
- If skin is intact
  - wet hands and apply mild soap
  - work up good lather and keep lather wet
  - rub gently for 2-3 minutes
  - rinse, remonitor and repeat if necessary

# Decontamination of Personnel

- If cuts, abrasions or open wounds observed
  - use wet swabs in direction away from area.
  - If wound is contaminated, wash with copious amounts of warm water
  - for facial wounds, ensure that contamination does not spread to eyes, nasal passages or mouth
- If there is ingestion, contact URSO

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**University Radiation Safety Officer**  
**Environmental Health & Safety**  
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**Environmental Health & Safety Home Page**  
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(links to MSDS's are also available on the Home Page)