# CLINICAL RADIATION SAFETY CONCERNS

## OBJECTIVES:

1. Describe the effect of time on radiation exposure.
2. Calculate the exposure one would receive over a given period of time.
3. Calculate the effect on exposure when the distance from a radiation source changes.
4. Calculate the after shielding exposure using the shielding formula and half-value layers.
5. Describe the equipment used to perform ambient exposure rate surveys.
6. Describe when and how area radiation surveys are done.
7. Describe the procedure for performing wipe test to determine the presence of removable radioactive contamination.
8. List the annual occupational dose limits.
9. List the four types of personnel monitoring devices.
10. Describe the process of receiving a radioactive shipment.
11. Describe the radiation signs which are posted in a nuclear medicine department.
12. Explain the procedure used following a radioactive spill.

# TIME

- THE LESS TIME SPENT AROUND A RADIATION SOURCE, THE LOWER THE EXPOSURE
- DIRECTLY PROPORTIONAL
- IF YOU WOULD RECEIVE 12 mR IN ONE HOUR, YOU WOULD RECEIVE ONLY 6 mR IN 30 MINUTES

$$\frac{\text{mR}}{\text{hr}} = \frac{\text{mR}}{\text{hr}}$$

- IF YOU WOULD RECEIVE 20,000 mR/hr HOLDING A SYRINGE CONTAINING 99m-TcO4, HOW MUCH EXPOSURE WOULD YOU RECEIVE IN ONE MINUTE?

$$\frac{20{,}000 \text{ mR}}{60 \text{ MIN}} = \frac{? \text{ mR}}{1 \text{ MIN}}$$

$$20{,}000 = 60x$$

$$333 \text{ mR} = x$$

# DISTANCE

- A CHANGE IN DISTANCE INVERSELY EFFECT THE INTENSITY
- IF YOU DOUBLE THE DISTANCE FROM A RADIATION SOURCE, YOU DECREASE THE EXPOSURE TO 1/4
- THE RADIATION FIELD BECOMES DILUTED AS THE PHOTONS SPREAD OUT
- HELPFUL HINTS
- MOVE A COMFORTABLE DISTANCE FROM PATIENT
- USE TONGS TO MOVE VIALS

$$\frac{I_1}{i_2} = \frac{d^2}{D^2}$$

IF THE EXPOSURE AT 1 FT. FROM A RADIATION SOURCE WERE 36 mR/hr, WHAT WOULD IT BE AT 2 FT?

$$\frac{36 \text{ mR/hr}}{X} = \frac{2^2}{1^2}$$

$$4X = 36$$

$$X = 9 \text{ mR/hr}$$

# SHIELDING

- THE EFFECTIVENESS OF A SHIELDING MATERIAL IS DETERMINED BY THE THICKNESS AND DENSITY AND ENERGY OF THE SOURCE
- LEAD BRICKS ARE MOST COMMONLY USED
- VIAL SHIELDS AND SYRINGE SHIELDS SHOULD ALSO BE USED TO REDUCE EXPOSURE
- THE TYPE OF RADIATION MUST ALSO BE CONSIDERED
- ALPHA PARTICLE > A SHEET OF PAPER
- BETA PARTICLE > 1/4 INCH OF PLASTIC
- GAMMA RAY > CANNOT STOP COMPLETELY
- SHIELDING FORMULA

$$I = I_O \times E^{-UX}$$

$I_O$ = ORIGINAL INTENSITY

E = NATURAL LOG

U = LINEAR ATTENUATION COEFFICIENT

X = THICKNESS(IN SAME UNIT AS U)

- IF 35 mR/hr SOURCE IS SHIELDED WITH 1/4 INCH (0.635 CM) OF LEAD WITH A U OF 27.1, WHAT IS THE AFTER SHIELDING EXPOSURE?

$I = 35\ mR/hr \times E^{-27.1 \times 0.635}$

$I = 35 \times E^{-17.2}$

$I = 35 \times 0.000000034$

$I = 0.00000118\ mR/hr$

# HALF VALUE LAYERS

- THE THICKNESS OF A GIVEN MATERIAL WHICH WILL REDUCE THE INTENSITY OF A RADIATION FIELD TO ONE-HALF OF IT'S ORIGINAL INTENSITY
- 1 HVL = 50%

  2 HVL = 25%

  3 HVL = 12.5%
- SIMILAR TO HALF-LIVES, IF YOU TAKE O.5 TO THE POWER OF THE NUMBER OF HVLs, YOU HAVE THE PERCENTAGE REMAINING. IF THE HVL IS 0.23 CM AND YOU HAVE 2 CM, THE FRACTION REMAINING IS?

  $2 / 0.23 = 8.7 >> 0.5^{8.7} = 0.002$

SO IF THE ORIGINAL INTENSITY WERE 67 mR/hr,

67 X -.002 = 0.134 mR/hr REMAINING

SHIELDING SHOULD BE ARRANGED TO REDUCE EXPOSURE TO LESS THAN 2 mR/hr

- USUALLY LESS THAN 1 mR/hr

# MONITORING

## MONITORING SHOULD BE DONE WITH SURVEY METER SENSITIVE TO 0.1 mR/hr

- G.M. USUALLY PREFERRED
- "ACTION" LEVEL USUALLY TWICE BACKGROUND
- DAILY ON HOT LAB & INJECTION TABLE
- WEEKLY EVERYWHERE ELSE

## WIPE TEST FOR REMOVABLE CONTAMINATION DONE WEEKLY

- CONTAMINATION > 2,000 DPM/ 100 $CM^2$ for all radionuclides except I-131
- CONTAMINATION for I-131, 200 DPM/ 100 $CM^2$
- PURPOSE IS TO FIND CONTAMINATION NOT TO FIND 100 SQUARE CM.

# PERSONNEL MONITORING

## REQUIRED IF DOSES MAY EXCEED 10% OF LIMITS [10 CFR 20.1201]

- 5 REM TOTAL EFFECTIVE DOSE EQUIVALENT (TEDE)
  - TEDE = DDE + CEDE
  - DEEP DOSE EQUIVALENT (DDE)
  - DETERMINED FROM WHOLE BODY FILM BADGE
  - COMMITTED EFFECTIVE DOSE EQUIVALENT (CEDE) (INTERNAL DOSE X WEIGHING FACTOR )
- 50 REM TOTAL ORGAN DOSE EQUIVALENT (INTERNAL DOSE TO MAX. EXPOSED ORGAN)
- 50 REM SHALLOW DOSE EQUIVALENT (SDE)
  - DETERMINED FROM SHALLOW DOSE ON FILM BADGE AND EXTREMITY BADGE
- 15 REM EYE DOSE EQUIVALENT OR LENS DE

**PERSONNEL MONITORING DEVICES**

- FILM BADGES ARE SENSITIVE TO 10 mrem
- LUXEL BADGES ARE SENSITIVE TO 1 mrem
- TLD RINGS ARE SENSITIVE TO 10 mrem
- PIC - USED IN SPECIAL SITUATIONS

# OCCUPATIONAL INTAKE OF RADIOACTIVE MATERIALS

- MONITORING REQUIRED IF PERSONNEL LIKELY TO EXCEED 10% OF THE ALI LIMIT

- ALI = ANNUAL LIMIT ON INTAKE

  INGESTION AND INHALATION

- THE RADIONUCLIDE OF CONCERN HERE IS

  **I-131**

- 10% ALI-I-131 Bioassay @ 24 hr. + 0.665 uCi.

  BIOASSAYS AND MONITORS USUALLY CONFIRM THAT CALCULATION OF INTERNAL DOSE IS NOT NECESSARY

# RECEIPT OF RADIOACTIVE SHIPMENTS

## DEPARTMENT OF TRANSPORTATION (DOT) RULES

- TRANSPORTATION LABELS

| | SURFACE (EXPOSURE IN mR/hr) | 1 METER |
|---|---|---|
| - WHITE I | < 0.5 | N/A |
| - YELLOW II | </= 50 | < 1.0 |
| - YELLOW III | </= 200 | </= 10 |

- TRANSPORTATION INDEX (T. I.) = EXPOSURE 1 METER FROM THE PACKAGE

- WHITE I DOES NOT HAVE A T. I.

# RADIATION PROTECTION PROGRAM

## OBJECTIVES:

1 IDENTIFY THE PART OF 10 CFR 20 WHICH PERTAINS TO A RADIATION SAFETY PROGRAM.

2 STATE THE REASON FOR A RSP.

3 LIST THE COMPONENTS OF A RSP.

4 REVIEW A FICTITIOUS RSP.

**10 CFR 20.1101**

EACH LICENSEE SHALL DEVELOP, DOCUMENT, AND IMPLEMENT A RADIATION PROTECTION PROGRAM COMMENSURATE WITH THE SCOPE AND EXTENT OF LICENSED ACTIVITIES AND SUFFICIENT TO ENSURE COMPLIANCE WITH THE PROVISIONS OF THIS PART (PART 20)

- ENSURE COMPLIANCE WITH ALARA
- ENSURE MINIMAL DOSE TO THE PUBLIC

# COMPONENTS OF A RSP

- **PURPOSE** - COMPLIANCE
- **AUTHORITY** - RADIATION SAFETY COMMITTEE
- **IMPLEMENTATION** - RADIATION SAFETY OFFICER
- **PROCEDURES**
  - -CONTAMINATION CONTROL
  - -RADIOACTIVE WASTE MANAGEMENT
  - -PERSONNEL DOSIMETRY
  - -FACILITY DESIGN
  - -TRAINING
- **AUDITS AND CORRECTIVE ACTION**
  - - AT LEAST YEARLY
  - - RSO MAY AUDIT QUARTERLY AND REVIEW WITH RSC ANNUALLY

- **CONCLUSIONS**