



Module 5

Exposure Control and Personal Monitoring



TOPICS

- ALARA,
- Survey Techniques,
- Personnel Monitoring,
- Monitoring Badges,
- Radiation Exposure Report.



ALARA

ALARA Principle

- ALARA – As Low As Reasonably Achievable.
- To minimize the radiation doses, you can use 3 things:
 - Time – minimize the time spent in the radiation field,
 - Distance – maximize the distance between you and the radiation sources,
 - Shielding – place proper shielding between you and the radiation sources.

Time

- Exposure rate or dose rate is given in the function of time such as R/hr, mR/hr, Sv/hr or mSv/hr,
- Reducing the time in the radiation field reduces radiation exposure.

Distance

- Inverse Square Law:

- $\frac{I_1}{I_2} = \frac{D_2^2}{D_1^2}$

- Where I_1 = Intensity at Distance D_1 , I_2 = Intensity at Distance D_2 .
- Radiation intensity reduces to a quarter when the distance increases by two.

Shielding

Radiation Shielding is a physical barrier designed to provide protection from the effects of ionizing radiation. Different types of radiation require different types of shielding materials.

- Alpha radiation could be stopped by a piece of paper or dead layer of skin.
- Beta radiation could be stopped by aluminum foil.
- Gamma and x-ray radiation require the use of dense materials such as concrete or lead.



Survey Techniques

Typical Survey Instruments

- Laboratories typically have Ludlum survey meters such as a Model 3 or Model 14C with a Pancake Probe (Model 44-9 or equivalent).
 - Can be used to measure exposure rates for beta and gamma radiation.



Laboratory Survey

- Laboratory surveys are conducted to identify radiation contamination and exposure.
- All radiation workers and personnel who frequent the laboratory should know about these exposures.
- If contamination is found, it should be cleaned up right away.
- All records of in-laboratory surveys should be kept in the laboratories copy of the RSM.
- The “handling” of radioactive materials involves the removal from stock vials, waste handling, or disposal into sink.

Laboratory Surveys by Approved Users

- A laboratory survey shall be conducted by the approved users on any day that more than 0.5 millicuries of radioactive material has been used or handled.
- C-14 and H-3 surveys should use Styrofoam or paper swipes counted with an appropriate liquid scintillation counter.
- All other isotopes can be counted with survey meters.
- All survey results should be documented and retained for in the RSM for inspection by the RSO.

Procedures for H-3 and C-14 Users

- Locations to swipe:
 - Work areas, office spaces, and on all surfaces accessible to human touch.
- Types of swipes to use:
 - 1 in X 1 in Styrofoam, cotton, or paper swipes.
- Counting:
 - Use a liquid scintillation counter to count the swipes.
- Documentation:
 - All survey results should be kept in the RSM for inspection.
- If a hot spot is located, tape it off and begin clean up procedures. You can also call the RSO.
 - Contact the RSO for action limits concerning your liquid scintillation counter.

Operational Checks for Survey Meters

1. Verify that the survey meter is within calibration,
2. Turn the knob or switch to see if the battery is good,
3. Make sure the survey meter is responding to a known radiation source,
4. Take a measurement of background radiation levels and record it.

How to survey

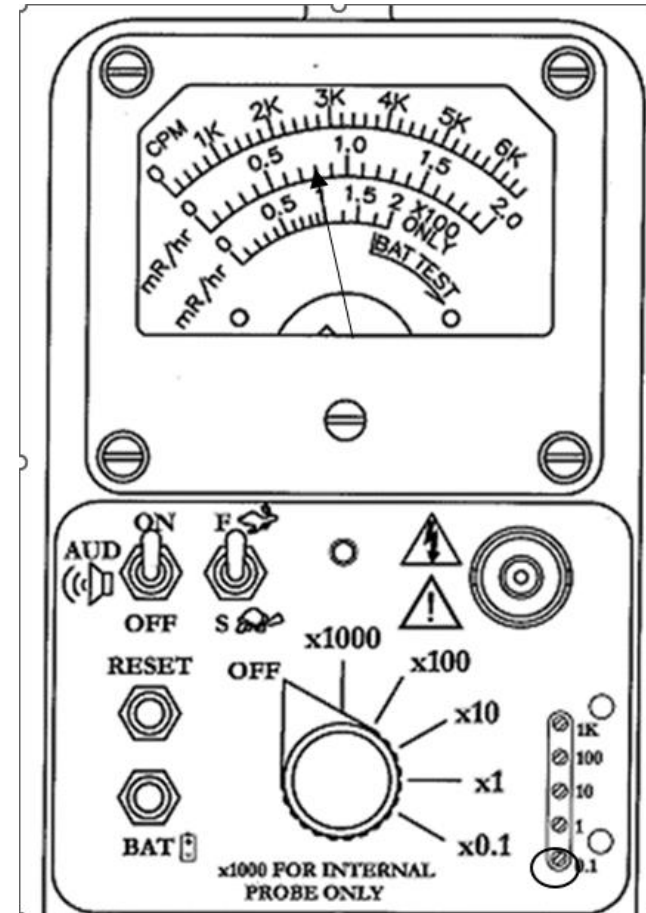
- Move the probe left and right to cover the entire surface you are trying to survey.
- The probe should be around a quarter of an inch above the surface.
- The probe should be moved less than one inch per second.
- If a hot spot is detected, then switch the fast/slow response to slow to get a better reading.
- Once the hot spot is detected, tape it off and begin clean up procedures. You can also call the RSO.

Cautions during the Surveys

- Do not touch the surface of the work bench or tray that you are surveying with the probe.
- Always survey on top of the work bench and not beneath it.
- If the survey meter has different scales, always start with the lowest scale (i.e., typically X0.1).
- If the survey meter is equipped with a fast/slow response mode, survey should start with the fast response mode.
- Any readings above 3 times the background level should be reported to the RSO and recorded in the RSM.

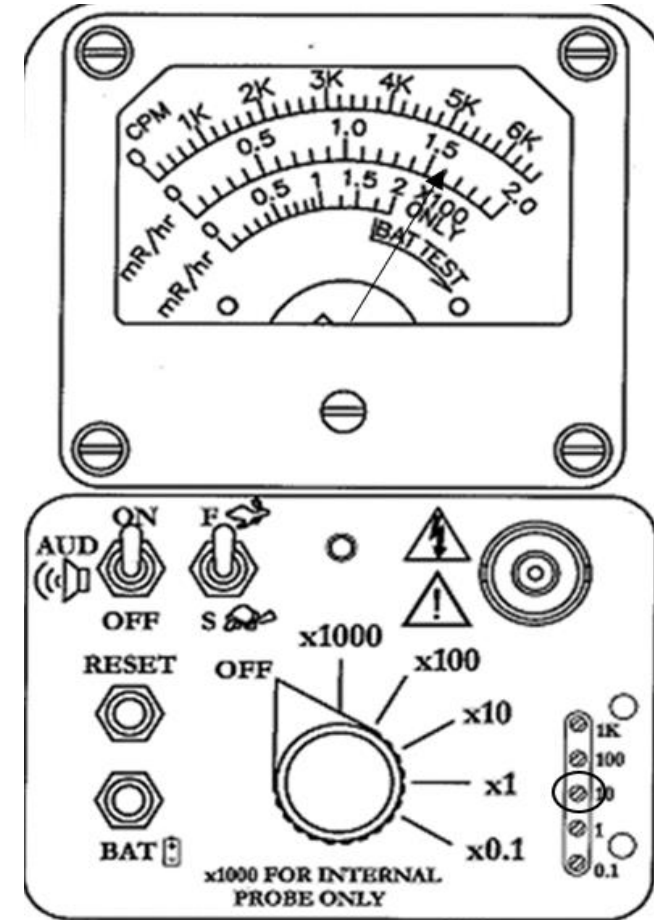
Reading Survey Meter Example 1

- Wherever the needle is pointing the reading should be multiplied by the multiplier indicated by the knob. Example shown here has needle pointing at 0.8 mR/hr at X 0.1 scale.
- The reading is $0.8 \times 0.1 = 0.08$ mR/hr.



Reading Survey Meter Example 2

- Wherever the needle is pointing the reading should be multiplied by the multiplier indicated by the knob. Example shown here has needle pointing at 1.6 mR/hr at X 10 scale.
- The reading is $1.6 \times 10 = 16 \text{ mR/hr}$.





Personnel Monitoring

What is a Personnel Monitoring Program?

- A systematic process for monitoring, recording, evaluating, and reporting the radiation doses received by occupationally exposed individuals.

Purpose of Personnel Monitoring

- To ensure compliance with established dose limits
- To keep radiation doses as low as reasonably achievable (ALARA)

Monitoring Criteria

- Any occupationally exposed individual who is likely to receive a dose in excess of 10% of any applicable limit.
- Any occupationally exposed individual who is likely to receive an intake of radioactive material in excess of 10% of the annual limit on intake (ALI).
- Any person entering a high radiation area or very high radiation area.

Dose Limits

- Occupational Dose Limits;
 - Adult – 5 rem a year,
 - Minor – 0.5 rem a year,
 - Embryo/Fetus – 0.5 rem a year,
 - Eye – 15 rem a year,
 - Extremities – 50 rem.
- Public Dose Limits:
 - General Public – 0.1 rem a year.

Declared Pregnancy

- All female radiation workers should be informed of their right to declare a pregnancy in writing and receive a lower dose limit and receive instruction concerning the risks to the embryo/fetus from radiation exposure.
- Declaration of a pregnancy is completely voluntary.
- The 0.5 rem limit on the dose to the embryo/fetus is in force only if the pregnancy is declared, in writing, to the Radiation Safety Office.
- The exchange frequency for fetal badges is on a monthly basis.



Monitoring Badges

Wearing Radiation Badges

- Collar Badges – should be worn between the hips and shoulders outside of any clothing with the window facing outward on the portion of the body nearest the radiation source.



Wearing Radiation Badges

- Ring or extremity badges should be on the workers' dominant hand.



Why are some radiation workers not badged?

- The radiation emitted by some isotopes is not measured with radiation badges.
- For example, H-3 and C-14 are weak beta emitters and cannot be detected by whole body or ring badges.



Radiation Exposure Report

Radiation Exposure Reports

- Everyone that is provided radiation badges are provided with an annual report of one's radiation exposure at the RSO.
- If you want a copy of your radiation exposure, call or email the Radiation Safety Office and make your request.

Moonlighting

- Individuals who incur additional radiation exposure from off-duty employment must provide records of any doses received to the Radiation Safety Office.