Section 8
Monitoring of radiation

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Introduction

A regular, systematic and inquisitive system of monitoring is the only practical way to ensure that levels of radioactivity or radiation are kept as low as reasonably practicable, ideally at negligible or zero, and in any case well below statutory limits.

In most cases, with the exception of Tritiated compounds, the simplest technique for simple, plain surfaces will be to monitor the area with a probe directly. The results can then be dealt with immediately. Wipe tests should then be used for more awkward objects for which a direct probe reading will lead to inaccuracies.

All groups who work with ionising radiation must have appropriate monitoring instruments available in the laboratory where the work takes place. Note that contamination meters record only the level of radioactivity NOT the dose rate which must be determined by specific dose rate instruments.

All instruments must be presented to the UIRPO annually, to enable the statutory calibration checks to take place.

The responsibility and cost for the repair and replacement of instruments rests with the group or department.

Reference instruments and dose rate instruments are held by the UIRPO and DIRPS.

8.1 Instruments

For *alpha (α)* radiation, an efficient zinc sulphide scintillation counter should be used.

For *beta (β)* radiation of maximum energy greater than 0.3 MeV, almost any type of thin walled (e.g. glass) Geiger probe may be used.

For β-radiation of lower energy, it is essential to use a thin (mica) end window type of counter. It should be noted that even this type of Geiger counter probe is completely insensitive to the extremely low energy, β-particles emitted by tritium, which can only be monitored using a liquid scintillation counter.

For gamma (γ) radiation and X-rays, usually a Geiger probe similar to that recommended for strong β-emitters can be used. However the sensitivity of such instruments is limited and for monitoring contamination an appropriate scintillation probe must be used, this is especially true if one is trying to monitor radioisotopes such as ^{125}I.

It is important to note that most monitors are very insensitive to short pulses of ionising radiation. If it is considered that apparatus does emit this type of ionising radiation then the University's RPA must be consulted as to the optimum monitoring method.

8.2 Monitoring Procedures

The department must devise a routine monitoring procedure which must be followed precisely.

Closed sources must be wipe tested on a two yearly basis. A copy of the monitoring results should be made available to the DIRPS and UIRPO.

All areas where open sources of radiation are used must be checked for radiation using appropriate monitoring methods at least fortnightly and a copy provided to the DIRPS.

A permanent record must be kept of all results obtained from such monitoring.

If significant levels of radiation are found in any area, the DIRPS, in conjunction with the UIRPO and RPA, shall determine the source of the radiation as well as checking the experimental procedures that led to the presence of the radiation.

Advice on appropriate wipe test procedures to establish levels of contamination is given below.

8.3 Wipe testing procedure for open sources

The radioisotopes which are the most difficult to detect are low energy β emitters, say of E(max) less than 0.2 MeV, for example:

^{3}H, ^{14}C, ^{35}S, ^{45}Ca and ^{63}Ni

For these radioisotopes an alternative method of monitoring is the *indirect* method of *wipe testing*.

Wipe testing involves:

1. A glass-fibre disc (Whatman GFA 25mm glass fibre recommended) is moistened with water or a solvent (e.g. 70% ethanol) in which the labelled compound is soluble.

   Glass-fibre is preferable to filter paper because it is wetted more effectively; this allows the liquid scintillator to penetrate the fibres of the disc and produces a higher counting efficiency, which is especially important for ^{3}H.

   Some commercial wipes are made of materials such as polystyrene which dissolves in scintillator solvents and for these homogeneous samples the efficiency can be measured by the usual methods.

   This is not the case for other wipes where radioactivity is counted on a solid in the scintillator and the efficiency usually has to be assumed.

2. A known area, say 100 to 1000cm², of the surface is wiped once.

3. The activity on the disc is counted using a liquid scintillation counter.

4. It is assumed that 10% of the activity in the wiped surface has been transferred to the disc.

   For example, if an area of 1000 cm² produced a disc giving 9000 counts per second in a counter of efficiency 30%, the contamination level would be:

$$\frac{9000 \text{ x } 10}{0.3 \text{ x } 1000} = \text{Bqcm}^{-2}$$

   This method gives an estimate of removable contamination but not fixed contamination.

Differentiation between radioisotopes

If detected contamination could be one of several radioisotopes used in a laboratory, it is often simple to find out which one is responsible. Three methods are available:

1. Find the effect of absorbers on the count rate. The data below will be useful.

2. Use different types of monitor to measure the contamination.

3. Count a wipe-test sample in different channels of a liquid scintillation counter.

   For example, if ^{3}H, ^{35}S, ^{32}P and ^{125}I are all in use:

Only the latter three are detectable by direct monitoring. All the βs from ^{35}S will be absorbed by a piece of thin card. Half of those from ^{32}P will be absorbed by about five index cards (100 $mgcm^{-2}$) and 6 mm of Perspex will absorb them all. In contrast the radiation from ^{125}I is only stopped by lead, Perspex has very little shielding effect for γ and X-rays

A type of EP15 GM probe will detect both ^{35}S and ^{32}P but a type 44A scintillation probe will detect primarily the ^{32}P and ^{125}I.

Counting of a wipe in a three channel scintillation counter can in principal give an estimate of the contributions of ^{3}H, ^{35}S and ^{32}P to the contamination.

8.4 Wipe testing of closed sources

Wipe testing of closed sources will be carried you every 2 years by the DIRPS. The following procedure is recommended:

1. Label scintillation vials (lid and tube) with the number of each source. One wipe per source plus a background sample.
2. Moisten a glass-fibre disc (Whatman GFA 25mm glass fibre recommended) with 70% ethanol.
3. For sources in sealed containers, do a wipe as close to the source as possible. Place wipe into vial. Also put a wipe into the vial to cover background readings. Record where wipe was taken. (e.g. edge of tube).
4. For sources within machinery, try to get as near to the closed sources as possible. Wipe near grills or at point where the join of pipe work.
5. Add 4mls of scintillation fluid (e.g. Optima Gold) to each vial and run on a wide window (low to high energy) for 2 minutes, to determine the counts/minute.
6. If measurements are also taken using a contamination meter, note its type, serial number and date of last calibration. Always take a background reading as well.

The test is passed if the activity detected on the wipe using suitable contamination monitoring instrument, liquid scintillation or gamma spectrometry techniques as appropriate is less than 200 Bq. (Ref ISO 9978:1992(E), *Sealed radioactive sources: Leakage test methods*, paragraph 5.3.1.).

A certificate confirming results of closed source wipe testing must be provided to the UIRPO within a month of testing.