RP COP003 – Contamination Monitoring Procedures in Research Laboratories

VERSION CONTROL	
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1. Introduction

When working with radiation it is vitally important that some form of monitoring is undertaken to determine and check upon the risk from the radiation or radioactivity being used. The appropriate form of monitoring depends upon the radiation application. There are in addition many different types of radiation detectors, and it is important that the appropriate detection method is used for the form of monitoring required and the type of radiation being measured.

This Code of Practice outlines the appropriate procedures for both surface contamination monitoring and personal contamination monitoring when using relatively small activities of unsealed radioactive material in laboratories for research purposes.

It does not include measurement of airborne contamination, bulk contamination or contamination within the body.

2. Method of Measurement

2.1 Direct Measurement

The most common method of measurement of surface contamination is to use direct-reading portable contamination meters. The method is often referred to as **direct measurement**, and is the most expedient.

Readings from contamination meters are normally given in “counts per second (c.p.s.)” or “disintegrations per second (d.p.s.)”[1]. This is because the response of the instrument to surface radioactivity varies with the radionuclide being measured. However some contamination meters have standard conversion factors programmed into the instrument’s signal processing circuits, thus giving the user the option of reading in surface contamination units of becquerels per square centimetre of surface (Bq cm^{-2}), having selected the particular isotope. Some typical contamination meters are shown below:

[1] Although the time unit is normally in seconds, some manufacturers supply instruments scaled in minutes.

Mini 900 44A

2.2 Indirect Measurement

Sometimes it is not possible to take direct surface readings, the most common reason being the presence of a radiation field that cannot be distinguished from any surface contamination (e.g. high backgrounds). For very low energy beta emitters, such as tritium, most proprietary contamination meters cannot detect contamination at the levels required, and **indirect monitoring** is the only readily available technique. Indirect measurement detects contamination by means of wipe tests. Wipes can be held up against an appropriate portable contamination meter away from the surface under investigation, but quite often, especially with low energy beta emitters, liquid scintillation counting of the wipes has to be used. Remember that, by definition, this technique can only detect *removable contamination*.

3. Instrument Selection

THE RIGHT INSTRUMENT MUST BE USED FOR THE RADIONUCLIDES BEING MONITORED

If an instrument is incorrectly selected then it may not detect the radiation coming from the radionuclide it is presented to thus giving a false impression that no contamination is present. Similarly using an instrument that is too sensitive may either cause alarm or not detect appropriate levels of contamination.

The table in Appendix 1 shows the radionuclides commonly used at the University and the commonly available contamination meter that should be used. The list is not exhaustive, and advice on other meters or radionuclides can be obtained from the Radiation Protection Unit.

Although the sensitivity of a contamination probe is the most important factor in its selection, the shape and the size of the probe is also important. For example, the Berthold LB1210 contamination meter is a very sensitive instrument, but has a relatively large fixed detector. The Mini E is relatively insensitive to low energy beta emitters, but has a small mobile probe that can be used to monitor small and irregular shaped objects.

4. Measurement Procedures

4.1 Direct Monitoring

Before carrying out any monitoring, a portable contamination meter should be given a check, known as a **function check**, to see that it appears to be functioning correctly. This function check should always include:

- Checking that the instrument is within test[2];
- Checking that the battery is OK;
- Checking that the background reading appears to be normal; and
- Checking that the instrument responds to a known source of radiation.

Some instruments are equipped with a choice of slow and fast response times. Select a slow response time (if the meter is so equipped) to measure the background count rate. Take an average value for the background obtained over a reasonable period of time, viz. 10-15 seconds.

Once the function check is complete and a background reading has been established, commence surveying the surface(s) of interest[3]. Start at the leading edge with the meter or probe as close to the surface as possible (without touching it) and survey slowly over the area of interest to give the meter time to respond. A good rule of thumb regarding monitoring speed is *one probe head per second*.

When an increase in count rate is detected, move the meter or probe back and forth over the source/area of interest. If it is a point source, the count rate will decrease as the meter or probe moves away from the source. An accurate count rate can be obtained by taking the average count rate over a reasonable period of time (~ 15 seconds) and then, if significant, subtracting the background value.

Surfaces should always be kept, as far as reasonably practicable, FREE of contamination - there should be no reason for leaving loose contamination.

FREE MEANS, UNLESS SPECIFICALLY ADVISED OTHERWISE BY THE RADIATION PROTECTION UNIT, NOT MORE THAN TWICE THE NORMAL BACKGROUND OF AN APPROPRIATE CONTAMINATION METER.

If contamination is found, the area should be cleaned and re-measured. If any contamination remains, repeat cleaning and measure the cleaning wipes. If after using normal decontamination methods, there are no readings on the wipes but still contamination readings on the surface, it may need to be regarded as fixed; contact the Radiation Protection Unit for advice.

[2] This can be confirmed by checking that the 'next test due' date has not passed on the instrument label.
[3] If there was a fast/slow response time selector, set the instrument to 'fast' response when surveying areas.

If the levels of beta and gamma contamination are high enough, they may cause the meter to go off scale. This would indicate that a dose rate measurement might be required and in such situations contact the Radiation Protection Unit for further assistance.

4.2 Indirect Monitoring

Indirect contamination measurements are made by sampling with a wipe and measuring the activity on the wipe. The conventional choice of material is a glass fibre filter paper. Except for liquid scintillation counting, the size of the wipe is not important, although it should be smaller than or equal to the sensitive area of the detector of the contamination meter.

Wet the wipe with water; alcohols are not recommended unless the contamination is known to be aqueously immiscible. Hold the filter paper with your gloved thumb and forefinger or a pair of forceps, and rub it over the surface using light pressure. Wipe an area of about 100 cm2 (slightly larger than the palm of your hand) for small objects/areas. For large areas and general surfaces wipe an area up to 1000 cm2. Measure the wipe with an appropriate contamination meter away from the surface or within a scintillation counter.

A collection or pick-up factor of 10% of total activity from the surface wiped is generally assumed.

If the wipes are counted in a liquid scintillation counter, then the size of the wipe should be such as to fit within a conventional scintillation vial and not unacceptably impair the efficiency of the count; for example the liquid scintillant fluid must fully immerse the wipe to ensure all the activity on the wipe is being counted. A 42.5 mm diameter filter paper is probably an upper limit to size, and this might limit the area of surface that can be wiped, especially if it is dirty or rough. A control is essential for each monitoring exercise. The control must simulate the actual wipes as much as possible, in order to obtain a realistic background count rate.

If contamination is found, undertake the cleaning and monitoring procedure outlined in the Direct Monitoring section. **Note that you cannot detect fixed contamination by this method.**

5. When to Measure

5.1 Personal Contamination Monitoring

Contamination measurements of the body must be undertaken **every time** that a worker leaves the working area after working with radioactive material to confirm that they are not contaminated. It should also be carried out *at regular intervals* during the work, and immediately if there is any indication of a spillage occurring.

5.2 Surface Contamination Monitoring

Surface contamination measurements should always be undertaken **after** work has been carried out with unsealed radioactive material. If the laboratory facility is shared with other people, it is also a good idea to carry out monitoring *before* work is started; not only does this reduce the risk of body contamination, but also the possibility of cross-contamination of experimental material.

Due to the time it takes to undertake tritium contamination measurements, initial results might not be reasonable, but counting wipes taken before and after can indicate when any contamination arose.

6. Where to Measure

6.1 Personal Contamination Monitoring

Outer gloves should be monitored and disposed of appropriately before commencing personal contamination monitoring. As a minimum, the un-gloved hands, especially the fingertips, lab coat cuffs and the front of the lab coat must be monitored. If there has been a possible spillage, or you feel that there is a significant risk of contamination from the work, a more comprehensive check must be done. This should include at least footwear, including the soles, the face and any other part of the body that could have been contaminated.

6.2 Surface Contamination Monitoring

The locations to be monitored should be mapped by numbering them on a plan view of the laboratory. These locations should include working surfaces (benches, countertops, fume cupboards etc.), storage areas, and non-working surfaces such as the floor next to benches and equipment, instruments, door handles, light switches, sink taps and telephone receivers. Several random locations should also be monitored.

7. Monitoring Records

It is not only good practice but also a legal requirement that surface contamination monitoring and personal contamination monitoring results are recorded and kept. Monitoring records, both personal and surface, must be kept for **at least 5 years**.

7.1 Personal Contamination Monitoring

Each lab will need to have their own personal contamination monitoring form and the following information must be recorded:

- Lab/room location and details

- Make and model of the contamination meter used (e.g. instrument type)
- Background reading on instrument (e.g. 1 cps)
- Action level assigned (normally twice background[4])
- Date of check
- Name of person
- A check mark to indicate that personal contamination monitoring has been carried out
- An action (even if that is a statement to say “no action required”)

An example of a suitable personal contamination monitoring record is attached as appendix 2 to this Code of Practice together with a link for downloading a copy of the form. If this form is not used, any alternative **MUST** include the same information.

7.2 Surface Contamination Monitoring

If radiation work is carried out *infrequently*, then the results of each monitoring must be recorded and kept. If work is *frequent*, **and** a regular monitoring schedule/rota is in place, then the results from the monitoring schedule/rota can be recorded and kept as definitive monitoring records (rather than the before/after work check).

Each laboratory must have its own survey sheet, and the following results must be included:-

- Date and time of measurement;
- Make and model of the contamination meter used;
- A basic description of each location monitored, including the corresponding number from the laboratory plan;
- The monitoring results in c.p.s. for each location (for liquid scintillation counting in c.p.m.); if contaminated give the results before and after final decontamination;
- The background measurements for portable instruments and the control measurement for liquid scintillant counters;
- The investigation level in c.p.s. for portable monitors (or c.p.m. for scintillation counting), i.e. unless specifically advised otherwise by the Radiation Protection Unit, not more than twice the normal background of an appropriate contamination meter.

An example of a suitable surface contamination monitoring record is attached as appendix 3 to this Code of Practice together with a link for downloading a copy of the form. If this form is not used, any alternative **MUST** include the same information.

[4] It is not sufficient to simply write “twice background”. If the background is 1 cps then, if the chosen action level is twice background, then “2 cps” must be written down as the assigned action level.

8. Instrument Testing Arrangements

Like all radiation meters, contamination meters must be tested before use, at regular intervals, and after any repair that might have affected its accuracy.

The before-use test is carried out by the manufacturers and after-repair may be carried out by the agent who carries out the repair or the RPU. If a department wishes the RPU to carry out the test after repair then the instrument must be sent to the RPU lab for testing.

The Radiation Protection Unit undertakes an annual test of all radiation meters, and issues a test certificate for each instrument. The RPS or assistant RPS for each area normally coordinates the testing arrangements which includes contacting the RPU around the due date to organise a suitable date for testing.

9. Further Information

Further advice on the University's arrangements for contamination monitoring can be obtained from the Radiation Protection Unit of the Health and Safety Department.

Appendix 1 – INSTRUMENT SELECTOR GUIDE

RADIONUCLIDE	EXAMPLE OF APPROPRIATE CONTAMINATION METER									
	Mini Instruments						Southern Scientific			Berthold large area meters
	E	EP15	42A	42B	44A	44B	SS315	SS404AI	SS404Be	LB1210B / LB122 / LB124 LB124Scint / LB124*Scint-300*
Tritium (Hydrogen-3)	** USE LIQUID SCINTILLATION COUNTER ONLY **									
Calcium-45 (Ca-45)		✓					✓			✓
Carbon-11 (C-11)					✓	✓		✓	✓	✓
Carbon-14 (C-14)		✓					✓			✓
Chlorine-36 (Cl-36)	✓	✓					✓			✓
Chromium-51 (Cr-51)						✓			✓	
Cobalt-57 (Co-57)					✓	✓		✓	✓	✓
Fluorine-18 (F-18)					✓	✓		✓	✓	✓
Indium-111 (In-111)					✓	✓		✓	✓	✓
Iodine-125 (I-125)			✓	✓	✓	✓		✓	✓	✓
Iodine-131 (I-131)	✓	✓					✓			✓
Iron-55 (Fe-55)						✓			✓	
Oxygen-15 (O-15)					✓	✓		✓	✓	✓
Phosphorus-32 (P-32)	✓	✓					✓			✓
Phosphorus-33 (P-33)		✓					✓			✓
Rubidium-86 (Rb-86)	✓	✓					✓			✓
Selenium-75 (Se-75)					✓	✓		✓	✓	✓
Sulphur-35 (S-35)		✓					✓			✓
Technetium-99m (Tc-99m)					✓	✓		✓	✓	✓
Uranium (in sec. eq.)	✓	✓					✓			✓
Yttrium-90 (Y-90)	✓	✓					✓			✓
Alpha emitters	** If Alpha + Beta use Mini Instruments EP15. If pure Alpha emitter use Mini Instruments AP2 or Southern Scientific SS700A **									

Appendix 2 – PERSONAL CONTAMINATION MONITORING RECORD

For a downloadable version of this pro forma, please visit: https://www.ed.ac.uk/health-safety/radiation-protection/tools-forms/forms-and-checklists

PERSONAL CONTAMINATION MONITORING RECORD

******* Guidance Notes on completing this monitoring record are found overleaf and must be read *******

Laboratory location & details[1]: ________________________________

		1	2
	Instrument ID:	1	2
	Instrument type [2]:		
	Background:	(c.p.s./c.p.m.*)	(c.p.s./c.p.m.*)
Action Levels →	**Twice background:**	(c.p.s./c.p.m.*)	(c.p.s./c.p.m.*)
			** delete as appropriate*

Date	Full Name [PRINT]	Instrument ID[3]	Check[4]	Action[5]
20/06/16	*Mark Green*	1	✓	*No cps > twice background. No action required.*

Mark a ✓ in the check column to indicate personal contamination monitoring has been done.

Personal Contamination Monitoring Record Page 1 of 2 September 2016

PERSONAL CONTAMINATION MONITORING RECORD_WITH EPD DOSE RECORD

Guidance Notes - General:

- **REMEMBER! After working with open sources of radioactive material or waste, all persons will want to check that they are not contaminated and therefore when leaving the working area:**
  - **Appropriately monitor yourself for contamination using a suitable instrument; AND,**
  - **Wash your (bare) hands thoroughly using soap and water at the hand-basin provided.**
- A written record of this monitoring is required to be kept **for at least 5 years** to ensure that the conditions and limits in the University's Radioactive Permits are being met.
- Note that this form refers to monitoring of the body and clothing for contamination, e.g. *personal contamination monitoring*; it DOES NOT replace the area monitoring that takes place to ensure that working areas are free from contamination before and after work with open sources of radioactive material.
- When working with Tritium it is assumed that personal contamination monitoring is impractical and cannot reliably be carried out, see RP CoP003 for further discussion. No personal contamination monitoring record is therefore required for Tritium work.
- More information on area monitoring AND personal contamination monitoring can be found in the Health and Safety Department's Code of Practice RP CoP003 – Surface Contamination Monitoring Procedures in Research Laboratories.

Notes to tables on Page 1:

(1) – Record the building and room number of the lab; 1 active sheet per lab.

(2) – Note down the make & model type of instrument used e.g. Mini900 EP15 or Mini900 E.

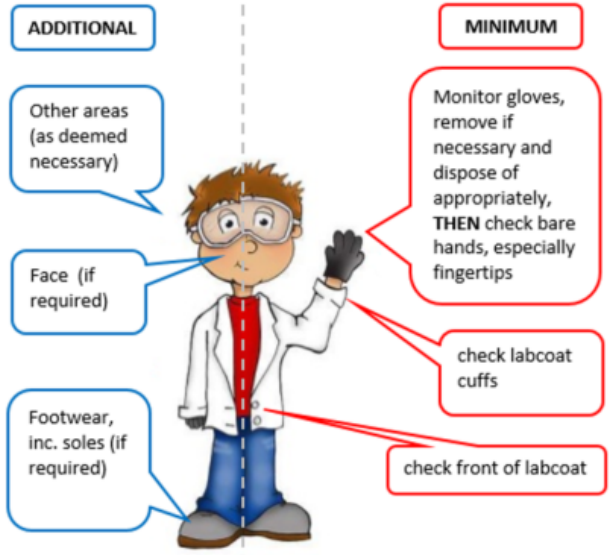
(3) – Record the relevant instrument ID e.g. enter "1" or "2" here depending on instrument used from the Instrument ID table.

(4) – The extent of the personal contamination monitoring carried out should be commensurate to work undertaken. There is no specific protocol, but as a minimum, gloves, hands, especially the fingertips, lab coat cuffs and front of lab coat must be monitored. Where it is considered that there could be a significant risk of contamination of other parts of the body, a more comprehensive check, including in particular the soles of the footwear, must be done.

(5) – Note down the reading from the EPD, to the nearest microsievert (μSv).

(6) – Record a YES or NO if you also wore a TLD badge when in the room.

(7) – ***An action must be recorded***. If there are no counts detected above twice background then indicate this on the form and that no action was therefore required. This column must not be left blank.



Appendix 3 – SURFACE CONTAMINATION MONITORING RECORD

For a downloadable version of this pro forma, please visit: https://www.ed.ac.uk/health-safety/radiation-protection/tools-forms/forms-and-checklists

SURFACE CONTAMINATION MONITORING RECORD

Laboratory Details: .....

Instrument & serial number:				
	Background:	(c.p.s./c.p.m.*)	(c.p.s./c.p.m.*)	(c.p.s./c.p.m.*)
Action Levels →	Twice background:	(c.p.s./c.p.m.*)	(c.p.s./c.p.m.*)	(c.p.s./c.p.m.*)

** delete as appropriate*

Measurement results (c.p.s./c.p.m.)*

Date	Time	Monitor	Isotope	Location (see plan)										Action	Initials
				A	B	C	D	E	F	G	H	I	J		

Note: Not all locations A to J need to be filled if the lab doesn't require 10 different monitoring areas

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