UNIVERSITY OF CAMBRIDGE
Safety Office

Guidance Notes

Leak Testing of Radioactive Sealed Sources

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University of Cambridge
Safety Office

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Section Nine, of HSD066R Working Safely with Sealed Radioactive Sources, sets out the general requirements for leak testing of sealed radioactive sources. A sealed source is defined in the Environmental Permitting Regulations 2016 (EPR16) and the Ionising Radiations Regulations 2017 (IRR17), as "*a source containing any radioactive substance, whose structure is such as to prevent, under normal circumstances, any dispersion of radioactive substances into the environment*".

Further guidance in respect of 'how to do leak tests' is set out below.

1) The Legal Requirement

Under EPR (sealed source Permit and exemption conditions) and Regulation 28(3) IRR17 requires that leak tests are performed (where appropriate) on sealed sources. These tests must (wherever practicable) be carried out at least once every two years and records of the test kept for at least two years, or until a further record is made of a subsequent test. Guidance on 'where appropriate' and on advised intervals for testing can be found in section 9.5 of Working Safely with Sealed Radioactive Sources.

2) Methodology

The IRR guidance indicates that tests should be carried out in accordance with the source manufacturers guidance, or in the absence of such guidance, in accordance with test methods set out in ISO (International Organisation for Standardisation) publication 9978 (1992) 'Radiation Protection – Sealed Radioactive Sources – leakage test methods'.

The simplest and most widely used test from ISO 9978 is Wipe Test 1 (A) –

'The source is wiped with a swab or tissue moistened with ethanol or water; the activity removed is measured. Removed activity should not exceed 200Bq.'

Depending on the radionuclide in question, measurement can be by presenting the swab directly to an appropriate monitor probe, or if necessary, by the use of a liquid scintillation counter or other indirect system.

Refer to the risk assessment and contact the RPA for advice if needed. Always leak test large sources (>1GBq) indirectly, by wipe testing the immediate storage container or the access tube that the source is moved through. Do not handle or test these sources directly, or attempt to move them with remote handling tools. For smaller sources, the source should be handled with a remote handling tool and presented to a swab, or vice-versa, to avoid high doses to the fingers. Suitable gloves should always be worn when carrying out direct or indirect tests in order to avoid the possibility of contamination of the skin from a leaky source. Low energy sources such as Ni-63 will require the swab to be counted by a liquid scintillation counter, other sources can be assessed by presenting the swab directly to an appropriate contamination monitor (see 5, below).

Before proceeding with a leak test, determine the likely radiation exposure to the hands and body that could result from the procedure. Data on dose rates should be available from the risk assessment relating to the source, or otherwise contact the

Safety Office/RPAs for further advice. Apply the techniques of minimising TIME, maximising DISTANCE and employing SHIELDING as appropriate, when testing a source, and take precautions against contamination in case the source is leaking.

The Approved Code of Practice (ACOP) to IRR17 indicates that the record of the test should include the following information:-

- ID of source
- Date of test
- Reason for test
- Method of test including:
    - whether the test was direct or indirect
    - a statement of what part of the device was tested;
    - a statement about whether this is likely to detect any leaking material
- Numerical result of test and whether pass or fail
- Any action to be taken name, signature and position of person undertaking test.

A suitable monitor calibrated for the type of source undergoing test must be used.

3) Is there a minimum activity of source that legally requires a leak test?

For quality control reasons you may wish to leak test all sources no matter how low the activity, but the legal minimum can be linked to Parts 1 or 2 of Schedule 7, columns 2 and 3, of IRR17. These are the levels at which notification applies and are also the minimum accounting levels for discrete sources (IRR17, ACOP paragraph 605c). Examples of these levels are shown below.

Minimum Activity from Schedule 7	**Examples of Radionuclides**
1 kBq	U-Nar, Pu-240
10 kBq	Kr-85, Sr-90, Cs-137, Tl-204, Pb-210, Po-210, Ra-226, U-235, dep-U, Pu-239, Am-241, Cm-244, Cf-252
100 kBq	Co-60, Ru-106, I-129
1 MBq	Na-22, Si-32, Cl-36, Fe-55, Co-57, Ba-133
10 MBq	C-14, Sn-119^{m}
100 MBq	Ni-63

4) What can be advised as best practice for Departments?

It is advised that where practicable, all the sealed sources in a department are tested, but note in the record whether a test is legally required or not. It is sensible to carry out the leak tests in conjunction with one of the regular monthly checks of all sealed sources and the related departmental records. In addition to the information that the ACOP recommends is recorded (see above) also include: the location of the source, its initial activity and its current activity. This should not cause any extra work as all the data relating to sealed sources must already be in the department source record.

A very simple pass/fail criteria could be used i.e. 'fail' if you found anything leaking (above the monitor background) using an appropriate contamination monitor for the source being tested. This is valid for nearly all radionuclides that you are likely to find in a sealed source as, given a counting efficiency of just 10%, 20cps above background will result in a 'fail' as advised by the ISO document (>200Bq). If you believe that a source has 'failed', then contact the Safety Office/RPAs for further advice. Ensure that the 'leaky' source or equipment is contained in a plastic bag or sheeting, to minimise any spread of contamination.

A rather more scientific approach to pass/fail based on typical monitor responses is set out in the table below.

In practice, of course, monitor response will vary according to the particular energy being monitored and the individual characteristics of the monitor used. This straight forward approach has been adopted in other UK Universities through advice from members of the Association of University Radiation Protection Officers (AURPO).

5) Summary of detection limits, action levels and selection of monitors

It is recommended that the Mini900 EP15 monitor is used for beta and beta+gamma emitters, although other GM detectors could be used. A BP4 scintillation detector could also be used, or a DP2 on the beta setting for all beta+gamma radionuclides, except low energy beta emitters. If using other monitors an exercise would need to be carried out using the calibration data for the monitor, in order to establish suitable action levels. For greater accuracy, individual monitors could be calibrated against, or correction figures given, for specific radionuclides. It *may* be possible to do this at the time of the annual examination and test of monitors, subject to prior discussion with the testing laboratory.

For gammas, use a Mini 900 44A monitor, although a Mini 900 44B should be used for electron capture isotopes because of its improved detection capabilities at low energies. The 44A is not suitable for Fe-55, and has a poorer response for some other radionuclides as well. Check the energy response of the 44 probes compared to energies of the specific radionuclide under test[+].

Any alpha monitor or dual phosphor probe with a fine mesh grille will be suitable for alpha detection at a satisfactory level.
To avoid having too many action levels AURPO have published the following table:-

Radionuclides	**Monitor**	**Pass/fail criteria**
Alphas	DP2/AP2	20cps
Betas<0.3 MeV*****	EP15 (or EL or BP4)	10cps
Betas>0.3 MeV *****	EP15 (or EL or BP4 or DP2)	20cps
Gammas <10keV	44B	10cps
Gammas >10keV[+]	44B or 44A	20cps

***** includes all beta/gamma emitters
[+] response to some hard gammas with 44 probes may be poor – check calibration first.

NB If you have only carried out an indirect wipe (i.e. not directly accessing the source) and find some counts, then more than 200Bq could have leaked from the source, but you may not picked all of it up.

6) What do you do with a leaky source?

As stated above, if you suspect that a source is leaking; always contact SO/RPAs after taking basic precautions to prevent further spread of contamination, including monitoring yourself.

Finding a leaky source is, fortunately, an extremely rare occurrence. In the past some small alpha sources, or foil/electrodeposited sources have been found to leak, and this may have been caused by suspected surface damage by people cleaning them. Even if the leakage is less than the past/fail threshold you may wish to consider that if the source is leaking a little bit now it will probably be leaking a lot more in the future! – and therefore consider disposal of the source. Contact SO/RPAs for advice. Always ask for advice before leak testing alpha sources.

If you do detect a few counts above background, but well below the pass/fail criteria, an alternative to disposing of the source, may be, following further RPA advice, to instigate a more frequent leak testing regime for the source, e.g. test again in 3 months time – if nothing is found, test again in 6 months time. If, in these instances, you had carried out an indirect test, you should see if there is a safe way of getting somewhat closer access to the source to establish the seriousness of any leak (but do not risk increasing your own exposure from the source). If the leakage is deemed to be not too serious at the present time, a decision on retention of the source can, (subject to RPA advice), be influenced by how important the source is to the people using it, and if they need time to budget for a replacement. Always contact the RPA for advice when considering disposal of sources, as there are legislative requirements that must be observed.

7) References

Ionising Radiations Regulations 2017.

Policy and Guidance document: Working Safely with Sealed Radioactive Sources, HSD066R.

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