

Leak testing - myth versus actuality

“I’m never going to use electricity in my department because there’s a legal requirement that portable appliances need to be tested.” If you had a pound for every time you heard somebody say that, you would not have any extra money at all. Nobody thinks that way, at least where electricity is concerned.



Figure 1 - ZP1481 (foreground) and Frederiksen GM tubes.

However, we know that a number of people are put off from working with radioactive materials because some sources need an annual leak test to ensure that radioactive material is not escaping into the environment. A strange mythology has grown around the leak test. *It is complex. It is onerous. A lot of paperwork is involved.* We hope to show you that none of this is true.

What has to be tested?

- All sealed sources except radium;
- Protactinium generators;
- Eluting half-life sources.

No leak tests are required for gas mantles, mineral sets or thoriated TIG welding rods. Radium sources, very rare in Scottish schools, require a different test. Contact rpa@sserc.scot if you have one.

How often do I leak test?

The law says every two years. However, the sealed sources used in schools tend to be kept for much longer than

their recommended working lives. Extensive experience has shown us that this is not at all unsafe. However, if your sealed source is more than 10 years old, or 5 if it is cobalt, switch to annual testing. Note that a protactinium generator will require specialist disposal at the end of its 8 year recommended working life. If any source is dropped on the ground, leak test it as soon as possible.

What do I need?

- Geiger-Müller tube and counter.
- Timer (if the counter cannot be set to count for a fixed time of 100 seconds).
- Ethanol (few ml).
- Dropper.
- Clamp stand.
- Filter paper.
- Cotton buds (certain sources only).
- Paper and pen.
- Computer with a copy of SSERC leak test analysis spreadsheet. >>



Figure 2 - Wiping the grill on a "standard" source.

The widely-used Centronics/Mullard ZP1481 tube is suitable, as is the Frederiksen model (Figure 1), which is often rebadged by datalogger manufacturers such as Alba and Pasco. You can download the leak test analysis spreadsheet from www.tinyurl.com/radproSSERC.

Getting started

Remove the end cap, if fitted, from the GM tube. Clamp the tube vertically, a few mm above a piece of filter paper. With any sources at least 4 metres away, take and record two readings of background count, each over 100 seconds. Expect a count of between 20 and 40 per 100 seconds, though it may be a little more or a little less depending on your location.

Wiping

For old-style "standard sources", the eluting source and the protactinium generator, cut a piece of filter paper about 1 cm x 2 cm. As it is important to know which side of the paper was used for wiping the source, you might wish to put a dot on one surface. Moisten it with ethanol. When wiping sources, work over a tray placed on a bench so that if the source drops it will not roll on to the floor. Hold the wipe with tweezers.

For sealed sources: Holding the source with a handling tool, wipe the protective grill. Put the source back in its pot (Figure 2).

For the eluting source, wearing gloves, hold the source. Remove the cap from the end where the liquid emerges. Wipe this end (Figure 3).

For the protactinium generator, place it in a tray with the sealed cap uppermost. Wipe around the cap (Figure 4).



Figure 3 - Wiping an eluting source.

More modern Hi-Tech type sources do not have a protective grill. Using an ethanol-moistened cotton bud, you can either wipe the inner end of the source, being very careful not to touch the foil, or you can wipe the storage pot. We recommend the latter (Figure 5).

Place the wipe or bud on the filter paper. Make sure the side you used to wipe the source is facing upwards. Place all sources are at least 4 metres away. Do not let the wipe or bud touch the end of the GM tube.

Further readings

Take four readings, each over 100 seconds, with the wipe in place. Remove the wipe from under the GM tube but do not discard it. Take a further two background readings, again each over 100 seconds. >>



Figure 4 - Arrow shows where to wipe the protactinium generator.

Processing results

The easiest way to process results is to enter them into the downloadable SSERC spreadsheet (Figure 6). This processes the data and displays whether or not the wipe has passed or failed. Enter the background counts in the green column, overwriting any existing values. Wipe counts go in the yellow column. Be careful not to enter data in other cells as you may overwrite a formula.

If you prefer to process results manually, do the following:

- Take the mean of the four background readings. Call this N_b .
- Take the mean of the four wipe readings. Call this N_w .
- Find the difference $N_w - N_b$.
- The spreadsheet checks to see whether the difference in the means is greater than two standard deviations in the difference. It can be shown that this is approximately equal to $\sqrt{(N_w + N_b)}$.
- Statistics theory tells us that if two means differ by more than two standard deviations, the difference has a 95% chance of being significant.
- In other words, if $N_w - N_b > \sqrt{(N_w + N_b)}$, there is a 95% chance that the wipe is contaminated.

We use this statistics-based test because of the random nature of radioactive decay. A more detailed explanation can be found in our document *Working with Radioactive Materials in Schools*.

If the source passes

If the source passes, put the wipe in the bin. File your results, making sure the test date and the source are clearly identified. One way of doing this is to save and print the spreadsheet, having entered the source and date in an empty cell.



Figure 5 - Wipe the pot, not the source.

If the source fails

Using the same wipe, repeat the readings, i.e. two background, four wipe and another two background readings, each over 100 seconds. Put the wipe in a sealed plastic bag. Put the source in storage. Send your results to rpa@sserc.scot. There is a “Set of 8” tab on the spreadsheet into which you can enter all 16 values. Do not use the source again until we have discussed your results with you.

Tips

If you have more than one source, use the last two background counts for source A as the first two for source B and so on.

Beware sudden air changes which can affect radon gas levels in the testing room. It is best to keep the door shut and to place a ‘Do Not Enter’ sign on the door.

Watch out for sudden very high readings. Occasionally, a cosmic ray burst will cause this to happen.

Safe working summary

- Wear a lab coat.
- Point sources away from the body.
- Work over a lined tray.
- Handle standard sources using tongs or bespoke handling tools or holders.
- Wear disposable gloves when handling the eluting source.
- Wear eye protection and disposable gloves when handling the protactinium generator.
- Place a wipe that is suspected to be contaminated in a sealed bag, before disposal.



	A	B	C	D	E
	Background count	Wipe count	Difference in mean values	Twice SD of difference	Leak test result
1					
2	$(100 \text{ s})^{-1}$	$(100 \text{ s})^{-1}$			
3	29	25			
4	28	31			
5	25	23			
6	23	27			
7	105	106			
8	26.25	26.5	0.25	7.26	Pass

Figure 6 - Downloadable spreadsheet.