Clearance of materials, some experience from the UK

Pete Burgess, Nuvia Ltd

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Introduction

This project was primarily designed to clear waste which was expected to be clean, i.e. there was no reasonable possibility that it could have been contaminated, because it came from an area on the outside of a cell line which was modern, well designed and where there had been no incidents.
The fingerprint, based on a detailed analysis of sample of the sludge which had been processed through the cell line, had a strong medium energy beta component, mostly Cs-137.
The aim was to identify any sample where the count rate generated was 2 sigma or more higher than the appropriate reference background. This clearly happened about 1 time in 40. In such a case, the sample was remeasured.

An edited version of the work instruction is given below. Note that items in italics have been added to aid understanding for the reader and were not present in the original instruction.

Note that this is not scientifically rigorous, but tends to be conservative and is easy to use on a day to day basis by monitoring, rather than professional, staff.

The work instruction was accompanied by a computer based form which calculated the point of suspicion based on the background derived from one of the selected background, known clean, samples which covered, fairly broadly, the real materials to be processed.

The process allowed the release for recycling of the building contents, with the exception of some areas of the cell line and the actual process pipework etc. giving a large overall reduction in the cost of demolition, despite the relatively intensive monitoring effort.

WORK INSTRUCTION PURPOSE

This instruction is concerned with the monitoring of items in order to demonstrate that they are Exempt material. It describes:

The monitoring equipment to be used;
How to assign a unique reference number to items being monitored;
How to measure record the dimensions of the items;
How to measure the background activity levels;
How to perform the fixed contamination monitoring.

SCOPE

This instruction applies to items that may be released from the building as Exempt material. *(Exempt in this case meant that the item clearly met the then relevant UK legislation, which demanded that artificial activity was less than 0.4 Bq/g. This has been replaced with nuclide specific limits based on RP122. Calculation of average activity, in Bq/g, had any been found, would have been based on the total surface activity, of both sides of a plate for example, in Bq/cm^2 divided by the mass cross section in g/cm^2, assuming a solid object. Alternatively, the total activity could also have been calculated and then divided by the total mass. This is the approach that would have been used for objects of more complicated shape)*

This instruction applies to all persons monitoring such items.

PRE-REQUISITES

Personnel performing the monitoring must be trained in the use of the equipment.

Personnel performing the monitoring, weighing and measuring must be trained against this instruction to ensure that they understand the requirements. *Note the emphasis on understanding. The monitoring staff were taken through the basic physics of the process to ensure that they appreciated the Point of Suspicion approach and that they would get occasional results in excess of the Point of Suspicion. They were also trained on why integrated readings made sense, rather than simple ratemeter measurements traditionally used in radiation protection.*

MONITORING EQUIPMENT

Loose contamination monitoring will normally be performed using a DP6 probe + Electra ratemeter. *The DP6 is a 100 cm^2 dual phosphor alpha and beta contamination probe, manufactured by Thermo and a common UK detector with which the workforce were familiar. The Thermo Electra is a popular dual channel ratemeter which also has an averaging function based on user selected averaging times*

Fixed contamination will be normally be performed with a DP6 probe + Electra ratemeter for items with surfaces whose dimensions are as big as, or larger than, the DP6 probe.

For items that have surfaces which are smaller than the DP6 probe, fixed contamination will normally be performed with a HP210 probe + Electra ratemeter or BP4A or D probe + Electra ratemeter. In some cases, with the approval of the Waste Policy & Compliance Team, it will be acceptable to use the DP6 probe and record how much of the probe is actively monitoring the item. *The HP210 is a standard pancake GM "frisker" probe.*

A record of the instrumentation must be made.

A member of the WPC Team may agree, in writing, to the use of different instrumentation. A comment must be made in the Notes box on the form referencing this approval.

A member of the WPC Team may agree, in writing, to the use of a combination of instrumentation e.g. if an item has a mix of large and small surfaces. A comment must be made in the Notes box on the form referencing this approval. Note that if this occurs Area, Swab and Item background readings must be recorded for both probes as described in sections 7, 8 and 9.

The DP6 probe will monitor both alpha and beta activity and both sets of data must be recorded.

The HP210 probe detects both beta and alpha emissions, but does not display them in separate channels. The BP4 probe detects beta emissions only. These instruments are considered acceptable for the fixed contamination monitoring because the fingerprint is dominated by beta emitters (> 99.9%). In both cases the monitoring results must be recorded as beta activity only.

UNIQUE REFERENCE NUMBERS

Each item must be given a unique reference number.

After monitoring, the number must be recorded on the item using a marker that cannot be accidently or easily erased.

If it is not appropriate to apply a reference number to each item, the reasons must be recorded in writing and approved by the WPC Team. A comment must be made in the "Notes" box on form referencing this approval.

RECORDING DETAILS & MEASURING THE WEIGHT & DIMENSIONS OF THE ITEMS

In the descriptions section, provide a description of the item e.g. metal pipe, plastic pipe, solid metal block.

Measure the mass of the item using a calibrated set of measuring scales with an appropriate range to measure the mass accurately. Record the mass on the form

Record the type and reference number of the scales. Check that these are in calibration and then sign, print name and date to confirm this.

Measure the dimensions of the item using a ruler or tape measure with an appropriate range and/or sensitivity to measure the value accurately. Record measurements as appropriate.

For irregularly shaped items, a Waste Conformance Document (WCD) Exceptions Form will be raised to describe how the surface area will be calculated and why this method is acceptable.

MEASURING THE BACKGROUND LEVELS IN THE AREA

Contamination monitoring must be performed in a low background area. This is checked simply by placing the instrument in the operating area and performing a 100 second count.

For the DP6 probe + Electra ratemeter, HP210 probe + Electra ratemeter and BP4A or D probe + Electra ratemeter, low background is defined as follows.

	DP6 + Electra	HP210 or BP4A or D + Electra
Alpha (cps)	≤ 0.2	1
Beta (cps)	≤ 6	

The measured value(s) are recorded.

If the background reading(s) are in excess of these values, monitoring **must not** commence until approval has been obtained in writing e.g. e:mail, from a member of the WPC Team.

Any monitoring that has been performed with background levels in excess of these stated figures **will be rejected** unless WPC approval has been obtained as described in point 7.4.

MEASURING THE ITEM BACKGROUND LEVELS

Obtain a clean item of similar material, thickness and size to the items to be monitored. Record what has been used in the "Notes" box on the form. Consult the WPC Team for advice if required.

Place the item over the probe to be used for the fixed contamination monitoring.

Perform a 100 second count. Record the alpha and beta count rates in the top table on the form. The alpha reading should be very close to zero.

If the form is being completed on the computer, the uncertainty in the 100 second count rates will be automatically calculated using Uncertainty = √B/G count ÷ 10. *This is based on the standard deviation of the total count being the square root of the total counts, i.e. indicated average count rate multiplied by the time. This is then divided by 100 to get the corresponding value in cps.*

The long count is used to produce a good measure of the average background. Shorter periods will be used for materials measurement. *Essentially, the uncertainty in the background was ignored as the overall uncertainty was dominated by the sample counting time. This clearly leads to an overall low value in the total uncertainty but based on the fact that most of the items were small and only a few kg, when averaged over 100 kg or more then the overall uncertainty would be less.*

The background readings must be repeated at the start of each new monitoring session or after 2 hours maximum. It must also be repeated if there is any large movements of waste around the monitoring position.

FIXED CONTAMINATION MONITORING

Set the Electra ratemeter to perform a 30 second integrated count.

Start the count and move the probe over the accessible surface of the object in question, trying to give reasonably even coverage using the DP6 probe + Electra ratemeter, HP210 + Electra ratemeter, BP4A or D + Electra ratemeter (or other approved instrument). Record the final result(s).

If the total surface area of the item is in excess of 2500 cm^2, it must be monitored in sections not exceeding this value. Record all monitoring and make notes on page 2 to clarify how many readings have been taken on a particular item.

During the monitoring process, listen carefully to the ratemeter output to note if there are any elevated count rates. If so, monitor these areas again in normal ratemeter mode. *This is in response to the possibility that there could be a localised spot of contamination that, averaged over the area monitored, did not result in an average count rate over the Point of Suspicion*

If there are areas where the gross readings exceed the Point of Suspicion then repeat the monitoring process and use the average of the two values. If this average exceeds the limit, inform the AWO.

If the surface area of the item (as presented to the probe) is smaller than the probe, record how much of the probe surface is covered by the item at any one time. Record this value on the form.

The count rate from a clean item will have a bigger random fluctuation than the 100 second background count, simply because the counting period is shorter. The item should be treated as potentially contaminated if the recorded count exceeds Background + 0.37√ Background. *This is based on the total counts recorded at background will be 30 times the average displayed. The standard deviation in this is the square root of the total, i.e. √ Background x √30. Converting to cps, this changes to √ Background / √30 = √ Background x 0.1826. As we worked at the point of suspicion being at 2 sigma, this is doubled to give a rounded 0.37.*

Typical limits for the DP6 probe + Electra and the HP210 + Electra or BP4A or D probe + Electra ratemeter are given in the following table.

	DP6 probe + Electra		HP210 probe or BP4A or D + Electra
	Alpha (cps)	Beta (cps)	Alpha + Beta or Beta only (cps)
Typical background (B/G)	0.2	6	1
0.37 x √B/G	0.17	0.9	0.37
Limit = B/G + 0.37 x √B/G	0.37	6.9	1.37

When the item background data is entered onto the computer version of the form, the box headed “Item B/G (cps)” will be automatically populated with the sum of Alpha B/G (cps) + 0.37√(Alpha B/G) and Beta B/G (cps) + 0.37√ (Beta B/G) as appropriate.

RECORDS

At the end of each monitoring session, place a line through all unused boxes.

For hand written data, if any results or details are recorded incorrectly, place a line through the reading so that it remains legible, write the correct information and initial the changes. Do not use snopake.

Sign, print name and date the monitoring sheet.

Present all completed sheets to WPC.

MAXIMUM MISSABLE ACTIVITIES

The maximum missable mean count rate corresponds to approximately 4σ when using the criterion that anything producing B/G + 2σ, the Point of Suspicion, is treated as potentially contaminated.

For a 30 second count using direct probe monitoring, 4σ corresponds to 0.73 √BG. The following table shows the maximum missable values for a DP6 probe + Electra or a HP210 or BP4 A or D probe + Electra.

	DP6 probe + Electra		**HP210 or BP4 A or D probe + Electra**
	Alpha	**Beta**	**Alpha + Beta**
Typical Background (B/G) in cps	0.2	6	1
Maximum Missable = 0.73 x √B/G in cps	0.33	1.79	0.73
cps to Bq/cm^2 Conversion	NA	12	2.6
Maximum Missable Activity in Bq/cm^2	NA	0.15	0.28
Maximum Missable Activity Assuming 300 cm^2 Item in Bq	NA	45	84
Maximum Missable Activity Assuming 1000 cm^2 Item in Bq	NA	149	281