

A NEW WASTE CHECKING LABORATORY FOR MONITORING LLW DISPOSALS IN THE UK

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ABSTRACT

The independent monitoring of solid low level radioactive waste (LLW) in the United Kingdom is undertaken by NNC Limited on behalf of The Environment Agency to ensure that disposals are within the authorised limits. Small and large waste consignments are seized by the Agency prior to disposal and are transported to the Waste Quality Checking Laboratory (WQCL) at Winfrith, where the contents are analysed and assessed by destructive and non-destructive testing. This paper outlines the regulatory framework for control of LLW disposals in the UK and describes the techniques used at WQCL for radioactive waste assessment. In addition the Laboratory provides calibrated reference drums that are used to assess the adequacy of waste producers' site-based instrumentation.

INTRODUCTION

UK Legislation and Authorizations

The disposal of radioactive waste to the environment is subject to the provisions of the Radioactive Substances Act 1993 (RSA'93) [1]. The purpose of this Act was to consolidate an earlier one, the Radioactive Substances Act 1960 (RSA'60) [2] with amendments introduced by subsequent legislation including Part V of the Environmental Protection Act 1990 [3].

Limits and conditions on the disposal of radioactive wastes are detailed in site specific Authorisation and Transfer Certificates. Over 900 premises in England and Wales are authorised. The majority of these consist of hospitals, universities and industrial research or manufacturing centres. The more significant radioactive discharges however are from a relatively small number of sites licensed under the Nuclear Installations Act 1965 [4]. These are generally referred to as "nuclear sites" and are also authorised under RSA'93 to discharge radioactive wastes. These nuclear sites include nuclear fuel fabrication and reprocessing plants, nuclear power plants, atomic research establishments and isotope production centres.

Regulatory Authorities

The Environment Agency (the Agency) is responsible for administration and enforcement of RSA'93 in England and Wales. Separate but similar arrangements exist in Scotland and Northern Ireland where the Scottish Environment Protection Agency (SEPA) and the Environment and Heritage Service are the respective regulatory authorities.

The Agency has widespread responsibilities under environment legislation for management and regulation of the water environment, and for controlling industrial pollution and wastes including those from the nuclear industry.

Independent Monitoring

Operators are required to determine and record the radioactive content of waste disposals in accordance with conditions specified in Authorisations.

In support of its regulatory function the Agency's Radiological Monitoring and Assessment Team, part of the Monitoring and Assessment Process Group, provides a range of monitoring support services that includes managing a comprehensive programme of independent radioactivity monitoring. This programme allows checks to be made on the monitoring and discharge data provided by the site operators to the Agency's Nuclear Regulators and also provides data to support independent assessment of the exposure of the public to radioactivity from non-food pathways. These results are published annually by the Agency [5]. As part of this programme consignments of solid low level radioactive waste (LLW) are sent to the Agency's Waste Quality Checking Laboratory (WQCL) for independent monitoring. This paper focuses on this process and the subsequent checking procedure and describes how the Agency uses the results to obtain added assurance that disposals and transfers are in compliance with Authorisations.

WASTE DISPOSAL

Low Level Radioactive Waste

Solid radioactive waste is classified under broad categories, according to its heat-generating capacity and activity content. Low level waste is waste containing radioactive materials other than those acceptable for disposal with ordinary refuse and with activity contents not exceeding 4 GBq/tonne of alpha emitting radionuclides or 12 GBq/tonne of beta/gamma emitting radionuclides.

The largest volumes of solid LLW originate from the following sources:

- Nuclear fuel cycle plants operated by British Nuclear Fuels plc (BNFL)
- Magnox nuclear power stations operated or being decommissioned by BNFL Magnox Generation.
- AGR and PWR power stations operated by British Energy plc
- Research establishments of the UK Atomic Energy Authority
- Ministry of Defence facilities

Several landfill sites receive solid LLW and very low level wastes (VLLW) for controlled burial. These are wastes which can be disposed of safely with special precautions. The landfill site to be used, radioactivity limits and burial arrangements are specified in Authorisations issued to the waste producer.

Drigg

The primary disposal route for solid LLW however, is a near-surface repository operated by BNFL at Drigg in West Cumbria about 6km south-east of BNFL's reprocessing facility at Sellafield. The site started operations in 1959 and receives waste mainly from Sellafield but also from other nuclear and non-nuclear radioactive waste producers elsewhere in the UK. The site occupies about 120 hectares (300 acres) close to the Cumbrian coast. Suitable wastes are compacted and placed into half height ISO-containers at the Waste Monitoring and Compaction (WAMAC) facility at Sellafield. After transport to Drigg the wastes are fixed in a concrete grout prior to their orderly emplacement in a concrete lined vault.

The majority of the waste typically comprises discarded protective clothing (overalls, overshoes, gloves, paper hats etc.) and general trash from areas of low contamination. The waste is generally accumulated in 200 litre drums and the total activity of such a drum is typically 1 to 2 MBq beta/gamma but can vary between 1 kBq and 20 MBq due to the inherent inhomogeneity of this type of waste.

WASTE QUALITY CHECKING LABORATORY

History

The independent monitoring or quality checking of LLW is carried out at a laboratory established by the Agency for this purpose at the Winfrith Technology Centre in Dorset. The Laboratory was first postulated in 1983 and a contract to build the laboratory in a redundant building that once housed an experimental reactor was awarded in 1985. During this first contract the design and construction of the facility were completed and the laboratory was equipped and staffed by scientists and technicians. The work took approximately three years to complete with the laboratory being commissioned in 1988.

From 1988 to 1991, the laboratory was contracted to perform research into the analytical methods required to identify and quantify the wide variety of radioisotopes which can potentially be found in LLW. From 1991 to 1997 the laboratory was staffed and operated by Taywood Environmental Consultancy and performed routine quality checking of solid low level radioactive waste.

In 1997 the contract for managing WQCL was awarded to NNC Limited. This contract continued and expanded on this work for the Agency with the initiation of real-time X-ray inspection of waste drums and the development of neutron assay as an additional non-destructive testing (NDT) tool. The scope of testing was also expanded to include site-based testing of reference drums using operators' LLW drum gamma scanners.

The building housing the WQCL once housed an experimental reactor and this was scheduled for decommissioning and dismantling. Accordingly during 2003, this facility was decommissioned and the building subjected to a post-operational clean out prior to hand-back to its owner.

A further contract has recently been awarded to NNC to construct a new WQCL facility elsewhere on the Winfrith site and to operate it for five years. Construction of the laboratory is scheduled to be complete by February 2004 and will enter its commissioning phase in March 2004.

Description of New Laboratory

The new WQCL monitoring facility is located on the Winfrith nuclear licensed site operated by the UKAEA. This provides secure facilities for consignments of radioactive waste to be received at the laboratory and secondary waste arisings to be disposed of via site services. The laboratory also makes use of other site facilities such as emergency services, site security and the library. The facility is centered on a building once used for decontamination and degreasing which has been suitably modified and extended to provide laboratories and offices.

The new facility will have three wings each about 250 m² area:

- A self contained NDT process area next to the waste receipt and storage bay which will house the gamma, X-ray and neutron monitoring equipment (all in the existing building)
- An adjoining purpose built laboratory block where the destructive testing (DT) and waste sampling is performed will house radiochemistry and counting laboratories.
- New office accommodation in an adjoining block

Unlike the previous facility, the three wings are on one floor (ground level) to facilitate transfer of waste drums and material. The new facility has been designed to provide a logical route for waste samples to be processed through the laboratory, eliminating the risk of cross-interference between instruments and cross-contamination.

Because of the impact on the safety case of the 220keV X-ray source, the new building is a Category 2 nuclear plant [6].

QUALITY ASSURANCE

Quality checking operations undertaken at the laboratory are carried out within a quality assurance system which was developed to ensure that all the work is performed to recognised and acceptable standards and that the results reported to the Agency are accurate and reliable. The quality system together with a number of key test methods were assessed by the National Measurement and Accreditation Service (NAMAS) in November 1993 and accreditation formally awarded to the laboratory in January 1994. Since then further test methods have been assessed and accredited as part of an ongoing programme to expand the laboratory's scope of accreditation. NAMAS became the United Kingdom Accreditation Service (UKAS) in 1997. Formal accreditation provides assurance that the measurements made on the waste are accurate and traceable to national or international standards, principally ISO EN 17025 [7]. All development work at the laboratory is carried out to ISO EN 9000 [8].

NON-DESTRUCTIVE TESTING

Waste consignments can be transported to the laboratory in a variety of containers, these include full height and half height ISO freight containers, individual drums and loose or packaged waste in skips.

However a typical consignment is an ISO freight container holding 72 45-gal (US) steel drums of unconsolidated waste. Loose or packaged waste received in skips are unpacked in a ventilated modular containment erected over the skip in the Receipt Area. Bags of waste retrieved from the skips are packed inside clean steel drums inside this enclosure in preparation for NDT.

This flexibility in the Receipt Area allows for checking of full inventories of large consignments, checking smaller targeted consignments (e.g. 1 to 5 drums) for independent assessment of a "radionuclide fingerprint" of a waste stream of interest to the Agency, special investigations in support of the Agency's regulatory role and the characterisation of orphan wastes.

Waste Receipt Checks

Upon receipt of a waste container at the laboratory, the consignment is given a unique identification number and each transport container is examined for evidence of damage or loss of integrity, any such findings are photographed and recorded. The labels attached to the transport container are photographed and all information recorded. Seals placed on the container by the Agency at the point of seizure are also examined and photographed. The container is checked for non-fixed external contamination and radiation dose rate and finally the gross weight and external dimensions of the container are measured and recorded.

Following completion of the transport container checks, the waste consignment is opened and the contents unloaded. For drummed waste received in ISO containers, the drums are unloaded directly into the Receipt Area of the laboratory and are logged into the QA system. Further checks are carried out on the waste drums at this stage. These include radiation dose rate measurements, contamination checks, drum weight measurement and a note of the visual condition and integrity of the drum. On occasion independent assessors are called in to assess the impact of corrosion and occasionally the screw-band clips on the lids of drummed waste are found to be loose.

Each drum received or packed at WQCL is given a unique identification number and a seal is placed on the lid to provide proof of sample integrity whilst at the laboratory. The non-destructive testing is carried out on the whole of the waste consignment and involves three tests, these are Real-Time X-radiography (RTX), Segmented Gamma Scanning (SGS) and Passive Neutron Coincidence Counting (PNCC).

Real Time X-Radiography

Firstly each drum is examined by X-radiography to visually determine its contents without the need to open each drum. The Real-Time X-radiography (RTX) system consists of an X-ray generator and an image intensifier unit linked via a CCD camera to video equipment. The drum is placed on a motorised turntable and scanned at each of five vertical positions. The turntable can be “jogged” to facilitate recognition of mobile liquids and gels. Video recordings are made and used to produce and store still images on a PC. Each recording is examined by trained staff to determine the contents of the drum. This is important for the identification of any prohibited items as defined in Authorisation Certificates and BNFL's Conditions for Acceptance of wastes for disposal at Drigg. These include, free liquids, aerosol canisters, materials that are likely to cause fire or explosion hazards and large amounts of putrescible or rotable materials. The identity of any drum containing prohibited items is noted for opening and more detailed examination, at which point these items would be removed from the waste. Occasionally drums are returned to the producing site for rectification.

Segmented Gamma Scanning

The most important non-destructive technique used in waste quality checking is Segmented Gamma Scanning (SGS) (Fig. 1). Using this technique the gamma emitting radioisotopes within each drum can be identified and quantified. Each drum is placed on a turntable within the instrument which allows the radioactivity within defined segments or slices of the drum to be determined. Up to 40 segments can be defined within a single drum, although, more typically, eight segments are used. The drum is assayed by a single high purity germanium detector which is aligned with each segment in turn. Because of the relatively low throughput of the laboratory scan times can be as long as 8 hours.

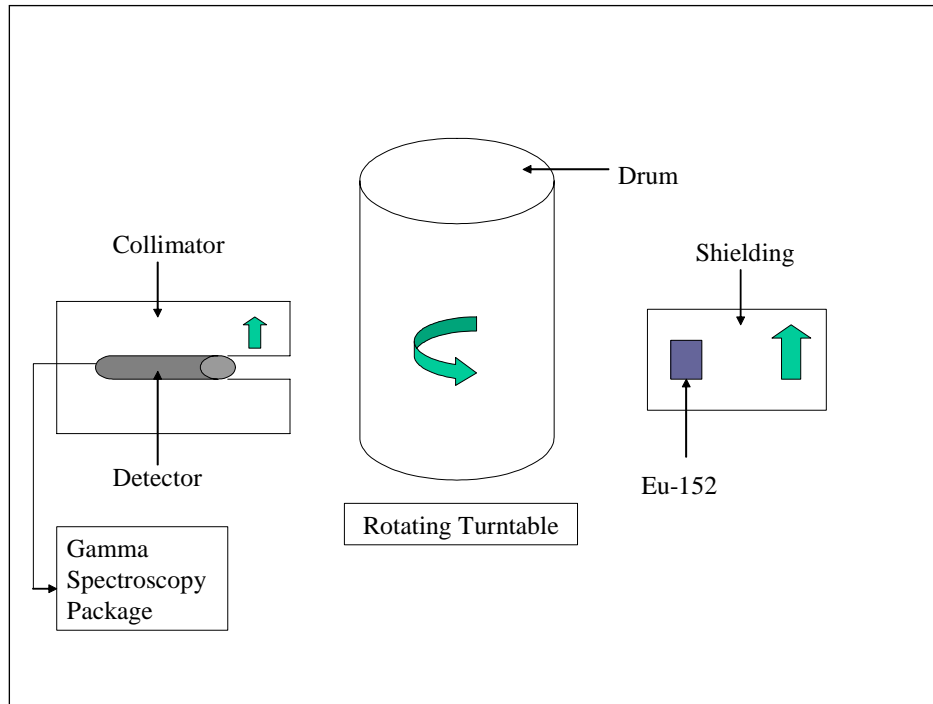


Fig. 1 The Segmented Gamma Scanner (Schematic)

Individual isotopes are listed and quantified and the total radioactivity within the drum is then calculated by adding the results from each segment. A correction for the attenuating effect of the drum's waste content is made by use of an external Eu-152 gamma emitting transmission source. The instrument is routinely calibrated and checked using reference radioactive sources traceable to national standards.

The wide range of waste material densities together with the large number of gamma emitting radioisotopes found in LLW can give rise to significant uncertainties in the radioactivities determined by the SGS. In an effort to reduce these uncertainties and achieve UKAS accreditation for SGS measurements, an extensive research programme was undertaken. This work, together with projects undertaken in collaboration with European partners (see below) has led to significant improvements in the use of SGS and interpretation of the results for waste monitoring purposes. On completion of the NDT campaign the gamma emitting radioisotopes identified are listed and the total gamma emitting radioactivity for the waste consignment is calculated for comparison with the waste producer's declaration.

Passive Neutron Coincidence Counting



Fig. 2 The Hexagon 2000 Passive Neutron Coincidence Counter.

A third NDT technique, neutron monitoring, was introduced at WQCL in 2002 and this will be re-installed in the new WQCL. The Hexagon 2000 passive neutron coincidence counter was designed and built by SCK•CEN in Belgium (Fig. 2). The instrument has a detection efficiency of 24% and uses computed neutron coincidence counting (via a time interval analyzer), rossi-alpha counting statistics and improved filtering of high multiplicity cosmic induced events to detect sub-milligram levels of plutonium in waste drums [9].

The coincident neutron flux from sub-milligram levels of plutonium is very low and needs careful discrimination from natural background, e.g. cosmic-ray induced spallation of neutrons from the wastes and from the materials of construction of the instrument. Thus the instrument has been used to measure background coincident neutrons in simulated waste drums of varying weight and material content [10]. It has also been used to monitor for the presence of plutonium in a consignment of real waste. Further development work is planned for the neutron counter during the new contract. This includes the derivation “add-a-source” correction algorithms using small plutonium and californium sealed sources to further deconvolute the effect of the waste matrix on the monitored neutron flux.

DESTRUCTIVE TESTING (DT)

Drum Selection

In order to determine the alpha and beta emitting radioisotopes within a consignment of LLW, destructive testing must be performed on a representative portion of the waste. In general, approximately 5% of the packages or drums within a consignment are selected and sampled for radiochemical analysis. The criteria used for the selection of drums are dependent on the Agency’s requirements and the nature of the waste being assessed. Examination of the RTX images, for example, may reveal prohibited items such as aerosol canisters or free liquids which must be removed. The presence of dense objects seen during X-

radiography may conceal sources of radioactivity which may not have been revealed by SGS monitoring. Drums may also be selected from examination of the gamma emitting radioisotope content as found by the SGS and by specific request from the Agency e.g. based on the origin of the waste within the producer's site.

Sampling

Once a drum has been selected for destructive testing it is transferred to the radiochemistry laboratory and attached to the waste receipt glove box. The lid of the drum is then removed from inside the glove box and the contents of the drum are examined. The waste receipt glove box is fitted with a fixed video camera and all drum opening operations are recorded on video tape. Any prohibited items found in the drum are photographed to provide evidence of the finding and segregated from the remainder of the waste which is then transferred to a second glove box. Here the waste is packaged, if necessary and the contact radiation dose rate and weight of the package are measured and recorded. Representative sub-samples are then taken and transferred by bag-less transfer to a fumehood for radiochemical analysis.

Destructive testing begins with the preparation of an aqueous solution of the solid sample taken from the waste. This can be accomplished in a variety of ways depending on the type of waste material found. Methods such as acid dissolution, leaching or fusion are commonly used, the principal objective being the extraction of all the radioactive species into solution. Once the primary solution has been prepared, aliquots are first taken for the determination of total alpha, total beta, total and individual gamma emitting radioisotopes.

Analysis

The total alpha measurements are made by preparing a counting disc from the primary sample solution by evaporation onto a planchette. This is then analysed in one of twelve alpha spectrometer cells, counting times being calculated from count rate measurements. The results are used to identify the component alpha emitters and quantify the total alpha radioactivity of the sample.

Total beta determinations are made using Liquid Scintillation Counting (LSC). An aliquot of the sample solution is added to a vial containing a scintillation medium and is then analysed using a liquid scintillation counter. As for the alpha measurements the results are used to identify component beta emitters wherever possible and calculate the total beta radioactivity of the sample.

Component gamma emitting radioisotopes within the sample are determined by analysing a 50 ml aliquot of the primary solution in a fixed geometry on a gamma spectrometer. A separate low energy gamma spectrometer is used to determine low energy gamma and X-ray emitting radioisotopes such as Fe-55, I-125 and I-129.

For all three of these techniques the chemical and radiochemical concentration of the solution must be controlled to optimise the counting characteristics and reduce interferences. All the analysis instruments used are regularly calibrated and checked using reference sources traceable to national or international standards. To ensure that the methods used and the results obtained from destructive testing are acceptable, the laboratory participates in regular inter-laboratory comparison exercises.

In addition to the total alpha, beta and gamma techniques described, the laboratory has a number of other specific radioisotopic methods which can be used for destructive testing. The determination of specific radioisotopes by destructive testing first requires radiochemical separation from the other species found in the primary sample solution. The method adopted will depend on the chemistry of the element being

isolated and may involve solvent extraction, distillation or ion-exchange chromatography. The laboratory has accredited analysis methods for most of the radioisotopes commonly found in low level radioactive waste in the UK. These include alpha emitters e.g the radioisotopes of U, Pu, Th and Cm and specific beta emitters; H-3, C-14, Sr-90, Ca-45, S-35, Cl-36 and Tc-99.

REPORTING AND APPLICATION OF RESULTS

All the results produced by the laboratory from quality checking operations on waste consignments are reported to the Agency. Written reports are produced on the findings of the non-destructive and destructive testing campaigns and these are forwarded to the Agency for review.

Some typical results obtained from the quality checking of a waste consignment are shown in Table I. The tables compare the results obtained by NDT and DT for four different drums taken from three separate waste streams within a single waste consignment. It can be seen that in general there is very good agreement between the two techniques.

From the regulatory point of view the results of the checking process may be considered as being in two distinct categories. Firstly, there are qualitative issues such as whether there was free liquid in the waste or whether the waste contained prohibited materials or items. Secondly, quantitative results can be compared with the activity as declared by the waste producer.

Table I Comparison of activity determinations by different methods

Waste Stream 1, Drum "1"

Radioisotope	NDT Results (kBq/Drum)	NDT % of Total	DT Results (kBq/Drum)	DT % of Total
Mn-54	12.4 ± 5.1	1.2	2.4 ± 0.4	0.2
Co-60	954 ± 90	93.6	1005 ± 13	92.6
Zn-65	52.3 ± 22.5	5.1	12.8 ± 1.5	1.2
Cs-137	N/D	0	65 ± 10	6

Waste Stream 1, Drum "2"

Radioisotope	NDT Results (kBq/Drum)	NDT % of Total	DT Results (kBq/Drum)	DT % of Total
Mn-54	1033 ± 322	4.8	1600 ± 100	5.4
Co-60	18910 ± 2470	87.4	26000 ± 300	87.7
Zn-65	1543 ± 498	7.1	1900 ± 400	6.4
Cs-134	150 ± 68	0.7	128 ± 29	0.4
Cs-137	N/D	0	1.9 ± 0.2	0

Waste Stream 2, Drum "3"

Radioisotope	NDT Results (kBq/Drum)	NDT % of Total	DT Results (kBq/Drum)	DT % of Total
Mn-54	53.5 ± 19.2	2.1	69.8 ± 9.7	2.3
Co-60	2278 ± 226	90	2691 ± 24	88.3
Zn-65	197 ± 63	7.8	275 ± 37	9
Cs-137	3.04 ± 1.07	0.1	0.011 ± 0.008	0
Eu-155	N/D	0	12.6 ± 2.4	0.4

Waste Stream 3, Drum "4"

Radioisotope	NDT Results (kBq/Drum)	NDT % of Total	DT Results (kBq/Drum)	DT % of Total
Co-60	2840 ± 348	98	1772 ± 42	95.6
Cs-137	56.9 ± 12.6	2	82 ± 7	4.4

Results reports are always issued to the relevant Agency site Nuclear Regulator who makes the judgement as to what action, if any, should be taken against the waste producer. Qualitative issues are usually an indication that either the operator's procedures are deficient in some way, or that the procedures have not been complied with. These are concrete issues which the Inspector would take up formally with the operator and would ensure by subsequent site inspections that adequate corrective actions had been taken. Quantitative issues can be much more complex, particularly where the results are from destructive testing and analysis. Results from SGS analyses are not dependent on sampling as all drums in the consignment are analysed whereas for chemical analyses a proportion (typically 5%) of the drums are selected and a further selection of material within a drum is sampled. Nevertheless, the correlation of total activities calculated by the two methods is generally much better than might be expected. This increases confidence in the results. If the check analyses indicated that authorised or declared activities had been exceeded further samples or analyses would be carried out to confirm the results. In all cases the follow up action is taken by the Agency Nuclear Regulator for the appropriate site and in severe cases an operator would be liable to prosecution.

Independent monitoring has so far given confidence that operators have taken a responsible and thorough approach to complying with disposal Authorisations. Non-compliances found have been in the nature of qualitative breaches as described above and appropriate corrective actions have been undertaken by operators.

REFERENCE DRUM TESTS

A review of the potential for on-site checking of site operators' drum monitoring equipment was carried out in 1998 under the Environment Agency's LLW monitoring contract. As a result of this review two drums of simulated waste have been prepared at WQCL.

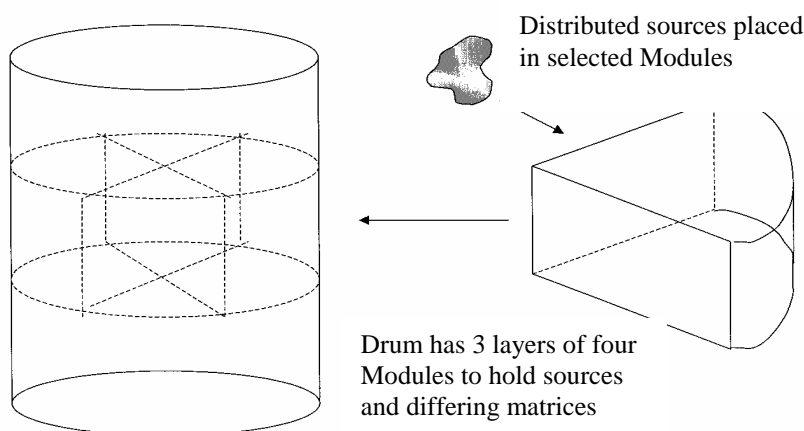


Fig. 3 Reference Drum RD 16 (Schematic)

The first drum, designated RD15, was the reference drum used in the EN-TRAP Round Robin Test of gamma scanning systems [11] thereby adding to the database of existing measurements on this drum and providing a broader base from which to draw comparisons. The drum contains six radioactive reference sources distributed within simulated mixed density waste material. The total gamma emitting radioactivity of this drum is close to the average (4.6 MBq) as calculated from measurements made at WQCL on thirteen consignments of real LLW (814 drums) over seven years of routine operation. These consignments originated from a number of different sites and represent a variety of UK waste streams. The radionuclides chosen; Mn-54, Co-60, Sb-125, Ba-133, Cs-137 and Am-241 represent both activation and fission products and are fairly typical of those found in real waste.

The second drum, RD16, was designed and built by NNC specifically for this intercomparison testing programme. The philosophy behind the design of the drum was to produce a modular waste package, which can be assembled in a variety of configurations and can be adapted to meet specific testing requirements. The drum (Fig. 3) contains twelve discrete modules or 'cheeses' which fit closely together and may be filled with materials of different density. Three different materials were chosen to fill the modules these are vermiculite (density $0.1\text{g}\cdot\text{cm}^{-3}$) 'spilkene' (a proprietary absorbent material with density $0.73\text{g}\cdot\text{cm}^{-3}$) and fine gravel (density $1.48\text{g}\cdot\text{cm}^{-3}$)

The modules may also contain reference sources and are arranged in three layers, top middle and bottom, containing four modules in each layer. Sources have been prepared at the Laboratory to simulate real waste in that they are dispersed in sealed packages rather than point sources. The sources can be added to selected modules and the configuration of the drum can thereby be tailored to simulate a variety of UK waste streams. The number of radionuclides used in this drum so far has varied between three and eleven in three separate configurations.

These standard waste packages form the basis of an ongoing programme, started in 1999, of on-site intercomparison tests on site operators' waste drum gamma assay instrumentation. The use of reference drums containing defined radionuclides of known radioactivity allows the Agency to assess the adequacy of operators' arrangements for assaying drummed LLW destined for disposal at the BNFL Drigg repository.

The results have been used to compare and contrast the two main types of gamma assay instrumentation currently in use in the UK. Most of the sites visited as part of this programme relate measurements of key radionuclides in the waste to a wastestream fingerprint which is then used to infer the activity of the full range of alpha, beta and gamma emitting radionuclides in the waste drums. Site operators may have a number of these fingerprints relating to different areas on the site having LLW arisings.

In recent years there has been a trend for site operators to move away from high resolution gamma spectroscopy (HRGS) systems and towards low resolution gamma spectroscopy (LRGS) systems for the assay of LLW. This offers a number of advantages i.e. the systems are robust and reliable and do not require cryogenic cooling, drums can be scanned in five minutes instead of one hour and they take up less room than the HRGS systems. The precision of the high efficiency detectors in determining e.g. Co-60 is good but relies on the accuracy of the operators' wastestream fingerprint in characterising the waste consignment from this measurement. HRGS systems as operated by WQCL and most of the EN-TRAP partners that took part in the Round Robin Test have the disadvantage of being larger, more complex to operate and requiring longer count times due to the low efficiency of the Ge detectors. Their advantage, however is that they are able to detect a larger number of gamma emitting radionuclides in the waste and are therefore able to monitor for any unexpected components or variance in the wastestream at the operators' site.

Where wastestreams are inhomogeneous errors can arise from differences in the attenuation of the emitted gamma rays compared with that calculated from a simple mass over volume density correction.

The programme to date has demonstrated the value of this type of intercomparison testing in the quality control of radioactive waste disposal. It is the Environment Agency's intention to utilise the results obtained to date in order to refine the protocols for future tests. The Agency also intends to extend this programme to other areas of non-destructive testing in the future (i.e. neutron counting).

EUROPEAN NETWORK ACTIVITIES

Since October 1992 the laboratory has participated in the European Network of Testing Facilities for the Quality Checking of Radioactive Waste Packages (EN-TRAP). This Network was formed to promote co-operation between laboratories within the European Union who are involved in quality checking activities. The countries represented in this Network are: Belgium, Germany, France, Spain, Italy, The Netherlands, Austria, Finland and The United Kingdom. Each country has laboratory and regulatory participants represented on the Steering Committee of the Network and a number of Working Groups have been established to focus on important aspects of quality checking. There are currently three Working Groups whose remits are: (a) gamma and neutron measurements, (b) chemical and radiochemical testing and (c) quality assurance/quality control.

The Steering Committee and Working Groups meet twice a year to discuss technical issues and matters of mutual interest. The Network is currently involved in completing a number of jointly funded research projects as part of the European Commission's fifth framework programme on nuclear fission safety. These research projects included a European inter-laboratory comparison test for radiochemical determinations on waste samples and the development of assay techniques for large waste packages such as half height ISO containers of non-compactable waste and large reactor components which fall outside current waste checking regimes.

CONCLUSIONS

The Environment Agency exercises regulatory control over the discharge and disposal of radioactive waste under the Radioactive Substances Act 1993. Independent monitoring is a key element of this control and, in the context of solid LLW, the Waste Quality Checking Laboratory (WQCL) fulfills an important role. The quality and reliability of the laboratory's work is underpinned by formal accreditation of its test methods by UKAS and its participation in EN-TRAP. The results from this work confirm that, in general, waste consignors have appropriate systems in place to ensure compliance with Authorisations. Identification of non-conformances continues to be a useful feedback to Agency Nuclear Regulators who use such information for identifying where operator's procedures and application of procedures can be further improved.

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