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PROFICIENCY TEST FOR NON-DESTRUCTIVE ASSAY OF 220 LITER RADIOACTIVE WASTE DRUMS BY GAMMA ASSAY SYSTEMS

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ABSTRACT

The European Network of Testing Facilities for the Quality Checking of Radioactive Waste Packages (ENTRAP) initiated a feasibility study on how to organize in the most cost effective way an international proficiency tests for non-destructive, gamma-ray based, assay of 220 liter radioactive waste drums in the European Union.

This feasibility study addresses all aspects of proficiency testing on radioactive waste packages including the design of a commonly accepted reference 220 liter drum (matrix and radioactive source); a solution to overcome the tedious and expensive international transport costs of real or even simulated waste packages, and a general cost estimation for the organization of, and the participation in, the proficiency test. The proposed concept for the proficiency testing and the estimated costs will be presented.

INTRODUCTION

In most radioactive waste characterization laboratories of the member states of the European Union, measurement and analysis methods have been developed to characterize by non-destructive assay (NDA) the different radioactive waste packages for interim storage or final disposal. These NDA methods are based on various hardware systems and software analysis programs. Many of these laboratories are accredited by their competent national authorities according to ISO17025 or ISO9001-2000 which, amongst others, requires regular participation in proficiency tests. However proficiency tests for NDA of radioactive waste packages are seldom organized on an international level.

In the 5th EC Framework program (1995-2000) the R&D project "Round Robin test for non-destructive assay of 220 liter radioactive waste packages" has been performed. During this EC project fifteen 220 liter waste standards were transported to the ten participating laboratories located in eight different EU member countries. The organization of this international proficiency test on real size radioactive drums and simulated radioactive drums has proven to be a very time consuming and expensive process, mainly due to the organization of the international transports of the 220 liter waste packages. Since transportation of radioactive waste packages still is an expensive and tedious task today, a taskgroup of EN-TRAP (European Network of Testing Facilities for the Quality Checking of Radioactive Waste Packages*)* worked out a concept for a cost effective organization of proficiency testing in the field of NDA. An EN-TRAP project was set up for that purpose.

This project has been subdivided in the following work packages:

- The feasibility study. This study has the goal to propose commonly accepted reference waste packages (e.g. matrix, radionuclides, drum dimensions) for the test and to look in the financial aspects of the manufacture of these items, the transportation, data gathering and presentation:
- Design of the first 220 liter reference drum e.g. internal structure and matrix composition and radioactive reference sources.
- Manufacture of reference drums and reference sources.

- Organization of the proficiency tests.

This paper will discuss the results of the feasibility study and the design of drums and sources.

THE FEASIBILITY STUDY

The objective of the feasibility study is to assess all costs associated with the organization of an international proficiency test for NDA of 220 liter waste packages, introducing a concept that does not require transport of real or simulated radioactive waste packages.

Since the characterization of nuclear waste packages is commonly made by gamma-ray spectrometry methods, proficiency testing is limited to NDA gamma systems only.

An additional dimension of a European proficiency test is the fact that different member states have different approaches of waste management resulting in different waste types. Hence to be of common interest the international proficiency test needs to consider test drums that are technically interesting to a broad range of potential participants.

The EURODRUM concept

Although the transport of radioactive waste packages is expensive and time consuming, sealed radioactive sources are daily transported throughout the world without major problems and at acceptable prices. On the other hand, the transport of all type of non-radioactive goods is common practice. Hence the idea to separate the radioactive sources and the inactive 220 liter drums in order to transport them separately. To overcome long lasting tests where the test items need to travel from one laboratory to another, each laboratory will be provided with an identical set of test items.

The EURODRUM concept for the proficiency test has the following properties:

- Each participant purchases a set of two reference inactive 220 liter drums including two matrices and a set of radioactive reference sources.
- The 220 liter reference drums will be manufactured.
- The matrix components will be manufactured from homogeneous, solid and physically stable materials applying quality assurance and considering fixed tolerances so that they are guaranteed identical from a physical point of view. The matrix bulk will be machined into a set of matrix elements in such a way that different matrix configurations can be built in a reproducible manner by rearranging the building elements.
- The complete set of reference sources for the test will be prepared from one mother radioactive reference solution traceable to a standard such as NIST, and with a small and known tolerance on the radioactivity value of each source.
- Since different matrix and source configurations are easily made at each lab with this concept, different successive proficiency tests may be organized considering each time different matrix and source configurations for the tests.

In the member states of the European Union many waste management practices exist. As a result 220 liter waste packages have slightly different dimensions, and various matrix types and matrix densities occur. Hence the NDA equipment in the labs may have a different measurement range. In order to cope with these varieties and to define one common reference drum, information was gathered by sending out a questionnaire to a lot of NDA labs. With the questionnaire information was gathered on dimensions of waste packages (220 liter drum), type and density range of matrices, type of radionuclides and range of radioactivity, but also information on what costs are considered acceptable for participation in proficiency tests. This information resulted in the design of a reference drum.

DESIGN OF THE 220 LITER REFERENCE DRUM

From the data obtained by the questionnaire the following characteristics for the 220 liter EURODRUM were defined:

- The Belgian standard 220 liter drum was selected as the one that best matches the average European waste drum.
- Two different solid polymers will be considered as matrix material with respectively one density in the range 700 – 1000 kg/m^3 and the other about 1500 kg/m^3. Matrices will be machined in modular elements allowing homogeneous and heterogeneous matrices to be simulated in a reproducible way by stacking the elements in the appropriate order in the drum. The matrix elements will be designed with holes in order to position the reference sources correctly in the matrices.
- For the radioactive reference source sets, multi-energy and commonly used gamma-ray emitting radionuclides will be used e.g.:
  - ^{152}Eu (line source, 650 kBq/source); ^{60}Co (point source 3 MBq);
  - Line and point sources are used in order to simulate uniform and different non-uniform source distributions.

The source sets will be made starting from a single mother solution with known and very small variability between individual sources.

A schematic drawing of the homogeneous matrix configuration is presented in Figure 1. Figure 2 illustrates how different matrix configurations can be achieved by reshuffling the basic matrix elements. The basic matrix element is crescent shaped. Put side be side, two elements form a disc, filling the section of the drum. Stacking the discs will fill the drum. Guides are used to guarantee a perfect vertical stacking and alignment of the holes for the sources.

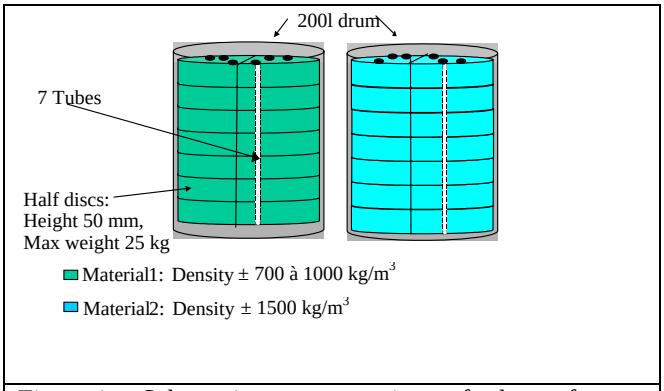

Figure 1. Schematic representation of the reference drum filled with the matrix elements.

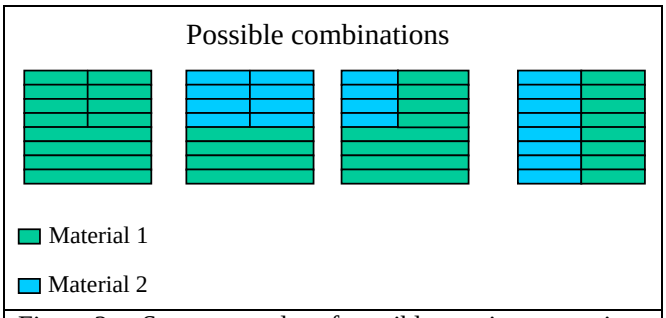

Figure 2. Some examples of possible matrix geometries.

Due to the fact that only calibrated radioactive sources will be used few problems are expected with the transport of these sources to participants. It is evident that a participant has to be licensed by its government to be able to receive these radioactive sources.

OVERALL COST ESTIMATION

Table 1 gives cost estimations for the different items and actions necessary to organize the proficiency tests. In this stage, costs are only approximate.

The cost is divided in two parts:

a. The investment costs, covering drums, matrices, sources and transport. This cost has to be made once for several series of proficiency tests and can be shared by several participants. In this case they are responsible for transport of the test materials between their organizations.

b. The test participation cost that will give each institute or company access to the project. This cost covers the organization of the test, data handling and the reporting of results.

Each partner can deliver two data sets per NDA system: one using his system as a basic system (allowing a broad intercomparison over several institutes) and a second one using more sophisticated options that are not available on all systems (transmission, tomography, ...)

Table 1 *Summary of the best costs estimates (July 2007) .*

Cost type	Includes	Amount in €
Investment cost (per group of participants)	Drums, matrices and their transport Sources and their transport	14860 per set
Participation cost (per participant)	Data handling and reporting	2500 per test campaign

DISCUSSIONS AND CONCLUSIONS

The EURODRUM concept, defined a reference drum and source set and an organization that avoids expensive nuclear transport of radioactive waste packages and guarantees that test results are available in a relatively short time.

The cost to organize proficiency tests with the EURODRUM concept have been investigated and worked out in such a detail that good overall cost estimations could be established.

The study shows that for the reference radioactive sources and participation fee, costs can be kept within those accepted by potential participants. The costs for the manufacture of the reference drum including two matrixes and the transport of the radioactive reference sources turned out to be more expensive, mainly to the relatively high costs for the polymers and the machining of these. However one of the advantages of the concept is that several successive proficiency tests can be easily organized without requiring further investments.

All future communication concerning this proficiency test will be made available at WWW.EURODRUM.EU

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