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LOW-LEVEL RADIOACTIVITY MEASUREMENTS

Background

The low-level radioactivity measurements service performs measurements of alpha or beta emitters on various types of low-radioactivity samples (biological and environmental) from internal and external clients.

Objectives

- to maintain and develop techniques concerning the measurements of low-level radioactivity of alpha and beta emitting radionuclides in environmental and biological samples;
- to measure these samples by means of low-background counters (liquid scintillators, proportional counters, ZnS counters and alpha-spectrometers);
- to support and advise the nuclear and non-nuclear industry on problems of radioactive contamination and low-level radioactivity measurements;
- to maintain and improve the quality assurance (QA) system according to the ISO 17025 standard for which we obtained the Beltest accreditation in 1998 and to expand this QA system to all our routine measurements;
- to assess the internal dose from occupational intakes of radionuclides for workers in the nuclear industry.

Programme

Our laboratories offer low-level radioactivity measurements of:

- total alpha and beta activity with proportional and ZnS counters;
- ^{3}H, ^{14}C and other low energy beta emitters by liquid scintillation;
- $^{90/89}Sr$ and ^{131}I activity measurements with proportional counters;
- ^{226}Ra and ^{222}Rn by the emanation method;
- natural uranium by fluorimetry;
- polonium, thorium, uranium, plutonium, neptunium, americium and curium by alpha spectrometry;

These measurements are performed on biological and environmental samples.

Achievements

In 2001, the Low-level Radioactivity laboratories have measured more than 9800 samples, yielding more than 13000 results. These services were provided for half to SCK•CEN and half to external clients.

Our laboratories analysed 3891 biologic samples (3559 urine, 322 nose-blow and 10 faeces). These analyses were requested for 85% by Health Physics departments of external clients for the control of workers handling radioactive materials. The main elements measured in these samples are plutonium, uranium, americium and tritium. In 2001, 1979 urine sample analysis were measured for uranium in urine from the Belgian military contingent on their return from Kosovo. During this screening program (from 1999 to 2001), in the 6034 urine samples analysed, we have not found any positive results showing that no significant contamination has occurred for the Belgian military contingent during their sojourn in Kosovo.

Within the framework of radiological survey of nuclear installations, our laboratories have measured numerous environmental samples. Daily airborne dust samples collected on SCK•CEN's site at Mol, were measured for total alpha and beta activities. For 2001, the average total alpha and beta activity in airborne dust was 0.03 mBq/m³ and 0.49 mBq/m³ respectively. Weekly rainwater samples collected at SCK•CEN were also measured for alpha and beta activities. The average total alpha and beta activity of rainwater was 15 and 131 mBq/l respectively. The results obtained in 2001 were not significantly different from those measured previously. Our laboratories measured environmental samples collected at or around SCK•CEN or nuclear facilities such as Doel, for alpha and beta global activity and for tritium, ^{90}Sr, ^{131}I, ^{226}Ra, uranium, plutonium and americium. These samples consisted of surface water, river water, soil, sediment, fish and milk.

Our measurement capabilities have also been made available to research groups of our institution. In particular for the division Radioactive Waste & Clean-up, measurements have been performed for the research on Waste package, Migration studies and the technical liability.

At the request of the Health Physics Department, we performed numerous measurements for the control of SCK•CEN installations such as the reactors BR1 and BR2 and the chemistry building and for the control of the environment in and around our institution.

Our laboratory has set-up a new analytical procedure for the analysis of uranium using a KPA (Kinetic

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Phosphorescence Analyser). In the near future, this procedure will be applied to the routine uranium determination in urine samples.

As part of the QA system to control the quality of our analyses, our laboratories participate successfully in the yearly intercomparison exercises organised by PROCORAD. These exercises involved bioassay measurements of tritium, Sr, Cs, U, Np, Pu, Am and Cm and this year, for the first time ^{14}C.

In the scope of the 5th Framework Programme our laboratory takes part in the project OMINEX (**O**ptimisation of **M**onitoring for **I**nternal **Ex**posure). We are in charge of one of the Work Packages of OMINEX, namely WP3, *"Uncertainties in measurements"*. This work package is focussing on the uncertainties associated with indirect measurements such as bioassay of urine and faeces, and direct (*in vivo*) measurements such as whole-body, lung or thyroid monitoring.

The aim of this work package is to compile descriptions of the measurement procedures used by EU laboratories for monitoring of workers from the nuclear industries, quantify the associated measurement uncertainties, and investigate how the available methods and techniques can be exploited in such a way as to reduce these uncertainties.

For bioassay measurements, investigations are concentrating on analytical procedures set up for monitoring actinides (Th, U, Pu and Am). Detailed information is being requested from laboratories concerning chemical procedures, chemical tracers, measurement procedures, calculation of uncertainties, determination of detection limits and measurement equipment used.

For *in vivo* measurements, information is being requested on detector systems, measurement geometries, calibration phantoms, calculation of uncertainties and systematic errors, calculation of detection limits, and confidence intervals/detection levels for various radionuclides. Investigations are concentrating on measurements of Pu, Am, U and Th in the lungs, fission products in lungs and whole body, and iodine in thyroid.

We have set-up several questionnaires to gather all these information. These questionnaires have been sent to 55 European laboratories and also to 16 laboratories in the rest of the world.

Perspectives

As an ongoing process, we will continue documenting our routine analysis methods according to ISO 17025 standard and the overall SCK•CEN's QA procedures in view to expand our accreditation to all our analytical procedures. In 1998 our laboratory obtained the accreditation for the global alpha and beta measurement procedure and for the liquid scintillation measurement procedure. In 1999 and 2001, our accreditation was confirmed and extended to the ^{90}Sr analytical procedure. In 2001, this accreditation was extended to the ^{131}I and nose-blow analytical procedure. The next step is an extension of this accreditation to the a spectrometric measurements of the bioassay samples, the analyses of ^{226}Ra and ^{222}Rn by the emanation method and the measurement of natural uranium by the Kinetic Phosphorescence Analyser.

In the scope of the 5th Framework Programme our laboratory will take part in the project IDEAS *General guidelines for the estimation of committed dose from incorporation monitoring data*. All the intercomparison exercises have shown that there are a wide variety of evaluation procedures, depending on the experience and the skill of the dosimetrist as well as on the hardware and software tools. However, for a given set of internal monitoring data in terms of body/organ activity and/or urine/faecal activity there can be only one best estimate for the intake and the committed dose equivalent. This best estimate is well defined by the monitoring data, the biokinetic models for the description of the metabolism, and – if available – some additional information, such as time of intake, route of intake, aerosol size, absorption type, f_1-factor and eventually previous internal exposures. The aim of the project is to provide general guidelines, which enable everybody to derive this well-defined standard estimate for any given set of data. This is of great importance for the harmonisation of internal dose assessment in Europe and elsewhere. Our laboratory is in charge of Work Package 1 which is *Collection of incorporation cases* and it is devoted to the collection of data both by means of a bibliographic research (survey on the open literature) and contacting and collecting data from specific organisations. All the participants in the project will act to get data from these or other owners of incorporation cases. Two databases (the bibliographic database and the incorporation cases database) will be prepared and some reference cases for the performance of Work Package 3 will be selected. The incorporation cases database will be further updated during the whole period of the project.

PROCORAD	Association pour la Promotion du Contrôle de qualité des analyses de biologie médicale en Radiotoxicologie
ULg	Université de Liège

-	Belgoprocess (Dessel, Belgium)
-	BELGONUCLEAIRE (Dessel, Belgium)
-	Electrabel Doel (Doel, Belgium)
-	Electrabel Tihange (Tihange, Belgium)
-	Prayon Rupel-Engis (Engis, Belgium)
-	Umicore (Olen, Belgium)
-	FBFC International (Dessel, Belgium)
AWW	Antwerpse Waterwerken (Antwerp, Belgium)
DSM	DSM Research BV (Geleen, The Netherlands)
IDEWE	Interdisciplinaire Dienst voor het Welzijn (Heverlee, Belgium)
IRMM	Institute for Reference Materials and Measurements (Geel, Belgium)
MHKA	Militair Hospitaal Koningin Astrid (Brussels, Belgium)
PIDPA	Provinciale en Intercommunale Drinkwatermaatschappij der Provincie Antwerpen (Antwerp, Belgium)
ULg	Université de Liège (Liège, Belgium)
Vito	Vlaamse instelling voor technologisch onderzoek (Mol, Belgium)

Publications

Hurtgen, C. "Natural radioactivity in bioassay by alpha-spectrometry measurements." J. Radioanal. Nucl. Chem. 248(2): pp. 477-482, 2001.

Conferences

Hurtgen, C. "Suivi de la contamination de l'uranium par son dosage dans les urines, l'expérience belge." Société française de Radioprotection. "Luranium sous forme appauvrie." Paris, November 27, 2001.