



Health-Physics Measurements

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THE ACCURATE DETERMINATION of radioactivity by direct or indirect measurement of people and surfaces or by the measurement of samples is an essential part of radiological protection. Being able to provide expertise in this domain for government and industry belongs to the mission of SCK•CEN.

Objectives

- to offer complete services in health-physics measurements according to international quality standards;
- to improve continuously these measurement techniques and to follow up international recommendations and legislation concerning the surveillance of workers;
- to support and advise nuclear and non-nuclear industry on problems of radioactive contamination.

Programme In the framework of health-physics measurements, SCK•CEN provides several services, such as gamma spectrometry on samples and humans, beta and alpha spectrometry, dosimetry, and radon measurements. We also offer complementary services, valorizing existing infrastructure and competence: instrumentation, calibration, standard source preparation, and neutron activation analysis.

Gamma spectrometry SCK•CEN's gamma-spectrometry service performs measurements on low-radioactivity samples (environmental and reactor samples, foodstuffs, etc.), for internal and external clients. Since 1995, the service is accredited by Beltest as conforming to the EN 45001 standard for the quantification of gamma emitters by high-resolution gamma spectrometry.

In 1997, the number of gamma-spectrometry analyses on samples stabilized as compared to 1996: we performed a larger number of analyses for the BR2 and for external clients, but fewer for other research projects at SCK•CEN.

At the end of 1997, we initiated the renewal of the gamma-spectrometry section, by purchasing modern electronics equipment and software. We aim at a thorough update and recal-

ibration of the apparatus by 1999. We revised the Si(Li) measurement chain for X-ray analysis and prepared a variety of calibration sources of ^{55}Fe for an extensive calibration programme.

We summarized our systematic measurements on radiocaesium contamination in air, rain, grass, milk, and humans in Belgium from the late 1950s to present day. The average impact of atmospheric nuclear weapon tests on the human body burden in our region was shown to

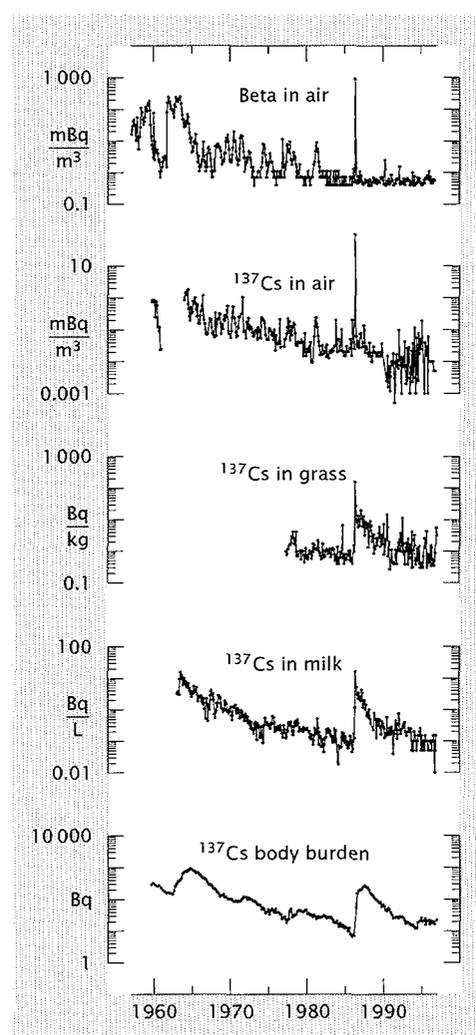


Figure 1 Monthly average of (from top to bottom) beta activity in airborne dust measured at SCK•CEN, Mol, Belgium; ^{137}Cs activity in airborne dust at SCK•CEN; ^{137}Cs activity in grass samples from a farm in the vicinity of Mol (Dessel, Belgium); ^{137}Cs activity in milk samples from the same farm; ^{137}Cs body burden for a standard man of 70 kg.

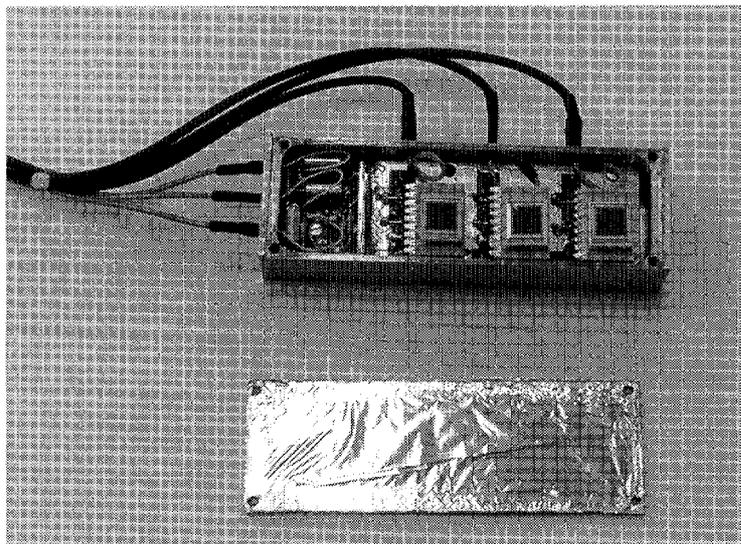


Figure 3 This array of three silicon diodes with their preamplifier, installed in a copper casing, is used for the determination of internal contamination in humans. The left part of the casing hosts the noise filter circuit.

Dosimetry The dosimetry service is in charge of the personal dosimetry of more than 4 500 workers in different companies and hospitals, among which 800 are SCK•CEN workers. Moreover, we supply extremity and environmental dosimeters, all of which operate on the thermoluminescence principle.

A test programme investigated the need for the introduction of a special beta dosimeter as routine personal dosimeter. This beta dosimeter has a special thin filter in front of a thin TLD detector. Laboratory tests showed that it indeed detects low-energy beta rays better than the normal routine dosimeter. During a nine-month test period, these dosimeters were used by people working with low-energy X-rays and beta rays in a hospital, showing minimal doses coming from beta rays to the workers. Nevertheless, the beta dosimeters are now used in practice for a small number of people liable to receive some beta dose.

Radon measurements SCK•CEN's radon group offers customized solutions in the area of radium and radon contamination. It can perform long-term and short-term radon measurements in indoor and outdoor environments on behalf of industry, authorities, and the general population.

Calibration The calibration service calibrates all radiation detectors at SCK•CEN. It also calibrates neutron monitors, gamma monitors, and electronic personal dosimeters for customers outside SCK•CEN. The Beltest accreditation of some calibration services is foreseen for 1998.

Instrumentation The instrumentation service is responsible for the maintenance of all the electronic measuring devices used in radiation protection at SCK•CEN. To install, for a client, a system to take representative and reliable samples in a new ventilation outlet, the instrumentation service studied the monitoring of the outlet, measured the air velocity, and constructed an isokinetic sampling tool.

Standard source calibration The standard source calibration service of SCK•CEN can deliver standards in almost any shape and activity for most commonly available isotopes. The radioactivity is traceable to international reference laboratories. The absolute calibration is based on a 4π proportional counter with gamma coincidence as primary technique and a calibrated NaI well detector for integral gamma counting as secondary technique. A 2π windowless alpha detector is used for calibration of solid alpha sources.

Neutron activation analysis SCK•CEN performs elemental analyses for the industry and for research projects by neutron activation analysis. The combination of the facilities of our gamma-spectrometry laboratory and the reference neutron fields of our BR1 reactor constitute an excellent framework for exploiting this technique. The main achievement in 1997 was the implementation of the k_0 methodology; besides two HPGe detection setups for the analysis of long-lived isotopes, we also assembled a new setup for short-lived isotopes at the fast-rabbit system in channel S84 of the BR1 reactor. A typical commercial application was the analysis of fluor ($T_{1/2} = 11$ s) in liquids.

Partners, sponsors, and customers

Scientific partners Universiteit Gent (UG) — Vrije Universiteit Brussel (VUB) — Université de Liège (ULg) — Belgoprocess (BP)

Customers Belgonucléaire (BN) — Franco-belge de fabrication de combustibles International (FBFC Int.) — Belgoprocess (BP) — Kerncentrale Doel (KCD) — Centrale nucléaire de Tihange (CNT) — Institute for Reference Materials and Measurements (IRMM) — Contrôle de sécurité de l'Euratom (CCE)

Scientific output

Book published in 1997

F. VERREZEN, C. HURTGEN, "Radioassay of Low-Level, Low Energy Beta Activity in Multilabeled Samples Containing High-Energy Impurities Using Liquid Scintillation Spectrometry," in: G. T. Cook *et al.*, eds., *Liquid Scintillation Spectrometry*, 381-389 (Radiocarbon 1996).

Publications in 1997

J.-L. GENICOT, "Room Temperature Semiconductor Detectors for In-Vivo Monitoring of Internal Contamination in Environmental Health Perspectives," Proc. of the int. conf. on Radiation and Health, Beer Sheva, Israël, November 3-7, 1996. *Environmental Health Perspectives* 105:6, 1423-1426 (1997).

J.-L. GENICOT, J.-P. ALZETTA, "New Technique Using Room Temperature Diodes for the Direct Assessment of Internal Contamination by Low Energy Gamma-Ray Emitters," *Appl. Rad. Isot.* 48:3, 349-358 (March 1997).

S. A. MIHAI, C. HURTGEN, "Plutonium and Americium in Sediment Samples along the Romanian Sector of the Danube River and the Black Sea Coast," *Journal of Radioanalytical and Nuclear Chemistry* 222:1-2, 275-278 (1997).

S. A. MIHAI, G. SHAW, I. I. GEORGESCU, C. HURTGEN, "Correlated Concentration Distributions of Natural Alpha Radionuclides in Sediment Samples along the Romanian Sector of the Danube River and the Black Sea Coast," *Journal of Radioanalytical and Nuclear Chemistry* 221:1-2, 203-205 (1997).

J. UYTENHOVE, S. POMMÉ, B. VAN WAEYENBERGE, F. HARDEMAN, J. BUYSSE, J.-P. CULOT, "Survey of the ¹³⁷Cs Contamination in Belgium by In-Situ Gamma Spectrometry, A Decade after the Chernobyl Accident," *Health Physics* 73, 644-646 (1997).

Presentations delivered in 1997

J.-P. CULOT, W. BLOMMAERT, C. HURTGEN, J.-P. MINON, "Follow-Up of an Old Contamination Case," Workshop on Intakes of Radionuclides Occupational and Public Exposure: Avignon, France, September 15-18, 1997.

J.-L. GENICOT, "Room Temperature Semiconductor Detectors in Whole Body Counting," DOE Lung Intercalibration Committee: Savannah River Site, South Carolina, USA, May 5-8, 1997.

J.-L. GENICOT, "Room Temperature Semiconductor Detectors: New Techniques for the Monitoring of Internal Contamination's and Applications in Nuclear Medicine," First scientific meeting of the Brazilian Society of Nuclear Biosciences and second scientific meeting of Biophysics and Biometry: Rio de Janeiro, Brazil, November 17-20, 1997.

S. POMMÉ, J. UYTENHOVE, B. VAN WAEYENBERGE, J.-L. GENICOT, J.-P. CULOT, F. HARDEMAN, "Radiocesium Contamination in Belgium," Fourth int. conf. on Methods and Applications of Radioanalytical Chemistry (MARC-IV): Kailua-Kona, Hawaii, USA, April 6-11, 1997.

Report published in 1997

M. LOOS, M. LAMPROYE, "Studie van de schouwmonitoring voor gebouw 5 FBFC," contract study for FBFC (1997). AH/0054/2326/TD.