SCK•CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE

Low-level Radioactivity Measurements

Context

The expert group Low-level Radioactivity Measurements (LRM) monitors the radioactivity of the environment affected by various nuclear facilities and the workers handling radioactive materials inside those facilities. The possible radioactive contamination of man and environment are controlled routinely.

Objectives

To assess possible internal contamination, we analyse yearly thousands of biological samples (urine, faecal and nose blow) from employees working in nuclear facilities who, because of their professional activities, might be exposed to radioactive material. In addition, we also collect and analyse a great variety of environmental samples for their radioactivity content (airborne dust, rainwater, surface water, sediments, soils, vegetation and foodstuffs).

The expert group LRM has several laboratories and offers services to both internal (SCK•CEN) and external clients (Belgonucleaire, Belgoprocess, the nuclear power plants of Doel and Tihange, the Institute for Reference Materials and Measurements IRMM, the Antwerpse Waterwerken, Coca Cola, the Federal Agency for Nuclear Control (AFCN/FANC), the Federal Agency for the Safety of the Food Chain (FASFC), ...).

We are accredited for all of our routine environmental and biological analysis techniques since 1998. The accreditation was granted by the Belgian Accreditation organisation BELAC in compliance with the international norm ISO-17025.

BELAC Nr. 015-TEST

Finally, we also measure samples for research and development purposes.

Liquid extraction of iodine (Monitoring of ^{131}i in milk).

Main activities

The activities of de expert group Low-level Radioactivity Measurements are carried out by nine groups, each of them having their specific tasks.

Sampling, Sample Preparation and Sample Management

This group is responsible for the collection of the samples, sample pre-treatment (if necessary), the registration of data and requests for analysis in the central database, the distribution of samples to the different laboratories and the correct storage and disposal of samples before, during and after the analyses are carried out.

Left: Dust filter for environmental air sampling.
Right: Evaporation of water samples for gross alpha/beta counting.

Laboratory for Gross Alpha and Beta counting

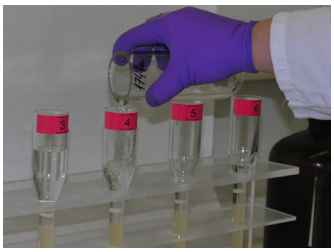
This analytical laboratory is responsible for the measurement of gross alpha or beta activity of environmental samples. This method allows a fast indication of a possible radioactive contamination, because only minimal pre-treatment is necessary. A separation of the different radio-elements is not necessary. The equipment consists of a dedicated counting room holding an array of zinc sulphide counters (gross alpha counting) and proportional counters (gross alpha and gross beta counting).

Laboratory for Strontium and Iodine measurements

This laboratory is responsible for the quantitative determination of strontium-90 (by measuring the activity of the daughter product yttrium-90) and iodine-131. These two radionuclides are with caesium-134 and caeseum-137 the main fission products which are formed during the uranium-235 fission. For this reason, these radionuclides are very good indicators in case of a possible contamination of the environment following an incident. This method requires extensive chemical pre-treatment and separation of the radio-elements prior to measurement (i.e. ion chromatographic separation and liquid extraction). Sample preparation and measurements are carried out in a dedicated laboratory using proportional counters.

Laboratory for Actinide Measurements

This laboratory performs quantitative analyses by alpha spectrometry of radioelements from the actinide group (thorium, neptunium, plutonium, americium, curium) and of polonium. This method is more accurate and sensitive than those used for gross alpha counting, but requires extensive chemical pre-treatment and separation of the radioelements prior to measurement.
This pre-treatment calls for techniques such as column chromatography, electro-deposition, and addition of radioactive tracers for the determination of the chemical yield. Thanks to this, a determination of these different radionuclides can be performed with a very low limit of detection.
This laboratory also operates a Time Resolved Kinetic Phosphorescence Analyzer (TR-KPA) for the determination of uranium concentration by weight in aqueous samples.



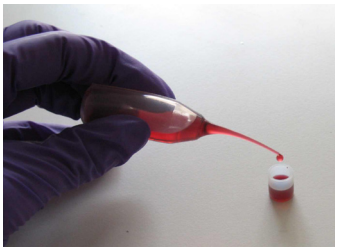
Left: Chromatographic separation of actinides.
Right: TR-KPA instrument for the determination of uranium.

Laboratory for Gamma-Ray Spectrometry

The laboratory uses high-resolution gamma-ray spectroscopy to measure radioactivity in samples. Gamma-ray spectrometry is a relatively simple, but very interesting technique that allows to identify numerous radionuclides and to determine their radioactivity. Moreover sample preparation is generally simple and consists of pouring the sample in the standard measurement vial. For this reason gamma-ray spectrometry is often used as a fast characterisation technique for unknown samples.

Laboratory for Source Preparation

The laboratory for source preparation supports the other laboratories of LRM by providing the sources required for the calibration of the measurement chains. Different measurement techniques are used to prepare sources: gamma-ray spectrometry, 2π-α-counting, 4π-β-γ counting.



Left: Cross-section of a Marinelli™ beaker on a Ge-detector.
Right: Source preparation using pycnometer vials.

Laboratory for Liquid Scintillation Counting

The liquid scintillation counting laboratory is responsible for the measurement of the radioactivity due to low-energetic beta emitters (such as tritium, radiocarbon, phosphorus-32, nickel-63, technetium-99, etc) in both environmental and biological samples (water samples, fish, urine samples, wipes, etc). A liquid scintillation counter is used where the detector (a liquid scintillation cocktail) is mixed with the sample to be measured. Measurement of liquid samples requires little preparation, reason why this technique is adapted for rapid determination of radioactivity.
A dedicated laboratory for sample preparation holds the various distillation setups, microwave destruction, the combustion installation.

Laboratory for Radium and Radon measurements

This laboratory is responsible for the quantitative determination of radium-226 through the measurement of its daughter product radon-222 which is measured in a cell whose internal wall is covered with zinc sulphide (also called Lucas cell). The radon after a determined growing period is concentrated and transferred into the Lucas cell for measurement.

Left: Pre-treatment of water samples for radium-226 measurement.
Right: Liquid scintillation counting vials.

Laboratory for Neutron Activation Analysis

Neutron Activation Analysis (NAA) is a sensitive nuclear analytical technique for multi-elemental analysis of major and trace elements in samples from almost every field of interest or for any matrix. In NAA the sample is bombarded with neutrons in a nuclear reactor, causing the elements to form radioactive isotopes and afterwards counted via gammaspectrometry allowing fingerprinting the composition of the sample. NAA allows discrete sampling of elements as it disregards the chemical form an element in the sample, and focuses solely on its nucleus and is therefore complementary to most chemical techniques. NAA has the advantage of being matrix independent, multi-element (more than 60 elements can be determined within one run), very sensitive and most important, very accurate. Recently, this lead to the recognition of NAA as a primary technique in elemental analysis.

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