EXPERIENCE OF INVESTIGATION OF CONTAMINATED SITES IN LITHUANIA

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Accreditation of RPC laboratory

LST EN ISO/IEC 17025

"General Requirements for the Competence of Calibration and Testing Laboratories"

In 2005

Lithuanian National Accreditation Bureau

Accreditation valid until 2015

Scope of accreditation:

Gamma spectrometry,

Strontium activity,

Tritium activity,

Total alpha and beta

Personal dosimetry

LITHUANIAN NATIONAL ACCREDITATION BUREAU

Lithuanian National Accreditation Bureau is a signatory of the Multilateral Agreements of the European co-operation for Accreditation (EA) for calibration, testing, inspection, certification of products, persons, quality and environmental management systems

ACCREDITATION CERTIFICATE

Nr. **LA.01.065** Valid until 2015-02-04

The National Accreditation Bureau hereby certifies that the

Radiation Protection Centre

Kalvarijų g. 153, LT-08221 Vilnius

complies with the requirements of LST EN ISO/IEC 17025:2005

and is accredited to carry out the tests of

the activity of concentrations of gamma radionuclides, strontium (^{90}Sr), tritium (^{3}H)and gross alpha and gross beta activity, the doses accumulated in personal dosimeters and medical diagnostic X-ray devices tests

The scope of accreditation is listed in the annex

The first Accreditation Certificate was issued 2005-02-03

Director **Irena Mikelionienė**

2010-02-04, Vilnius

Gamma spectrometry at Radiation Protection Centre

- Laboratory gamma spectrometry accredited

  IEC 1452:1995 - Nuclear instrumentation – Measurement of gamma ray emission rates of radionuclides – Calibration and use of germanium spectrometers

Not accredited

- *in situ* gamma spectrometry
- Whole body counter
- Mobile laboratory

Gamma spectrometry
Technical parameters

- Four low background gamma spectrometric systems with HpGe coaxial detectors
- Relative efficiency of detectors 20.6%-27.3%
- One broad energy Ge detector (20-2000 keV) with carbon epoxy window
- Characterized detectors
- Mathematical efficiency calibration ISOCS/LabSOCS
- Digital spectrum analyzer DSA-1000
- Reference sources for calibration
- Canberra Genie-2000

Cases of *in situ* measurements of contaminated sites

1. Investigation of site contaminated due to past activities
2. Investigation of site after emergency
3. Radiological assessment of site and dose evaluation for remediation
4. Investigation plots for new NPP in the vicinity of Ignalina NPP

Methods used for investigation contaminated sites

- Gamma dose rate scanning
- Identification of gamma radionuclides with handheld dose rate meter-indentifinders with NaI detectors
- Samplers and sampling methods.
- *In situ* gamma spectrometry
- Nuclear spectroscopy in laboratory
- Measurement of radon concentrations in soil air

Assessment of exposure doses

Measurements are done with the task of assessment of doses:

- which might have been received or might be received by reference group
- conservative approach is employed
- scenarios which are used for dose calculations depend on real and possible conditions of exposure
- the final task is identification of optimized radiation protection measures to be taken

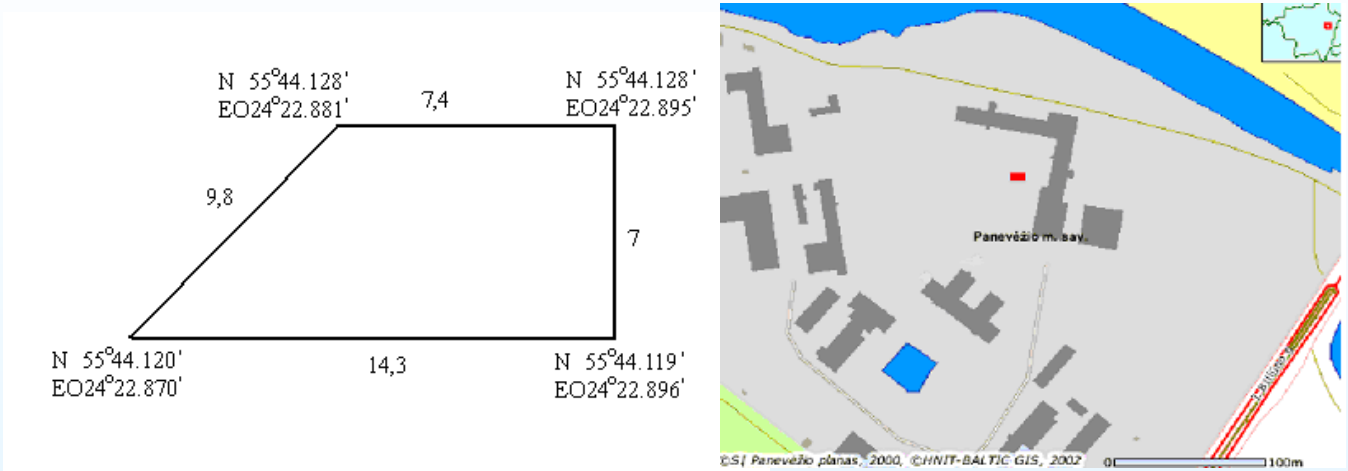
1. Investigation of site contaminated due to past activities

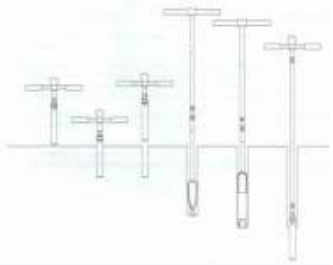
- Investigated area is located Skaistakalnis park, in Panevėžys city
- Former Soviet military base
- Repair shop of military air force unit.
- Some information from archives was got:

Soil (approximately 4 m^3) wooden floor, vessel with 400 litres of radioactive liquid used for washing of engines was taken by air to Russia in 1985.

1. Investigation of site contaminated due to past activities

Contaminated area was approximately 76 m^2

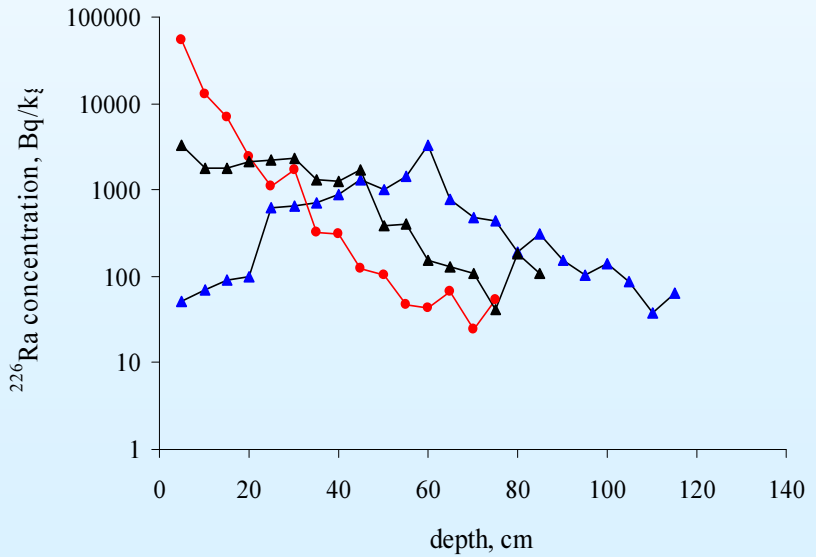




- Gamma dose rate scanning of site
- Identified locations of contaminated spots
- Vertical distribution sampling of soil was performed
- Gamma spectrometry . Identified ^{226}Ra and activity concentrations were measured
- Radon concentrations in soil air

1. Investigation of site contaminated due to past activities

- The samples of soil were taken in points where gamma dose rate was the highest.
- ^{226}Ra concentration was 0.1-54 Bq/g even 198 Bq/g.
- Contamination was not uniform in depth and in area, it was like small spots.
- Radon in water was measured.
- It was not high concentrations.

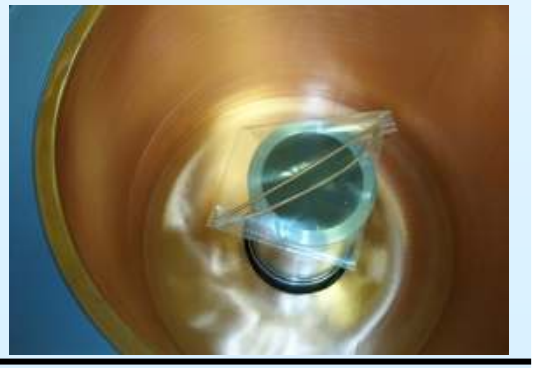


1. Investigation of site contaminated due to past activities

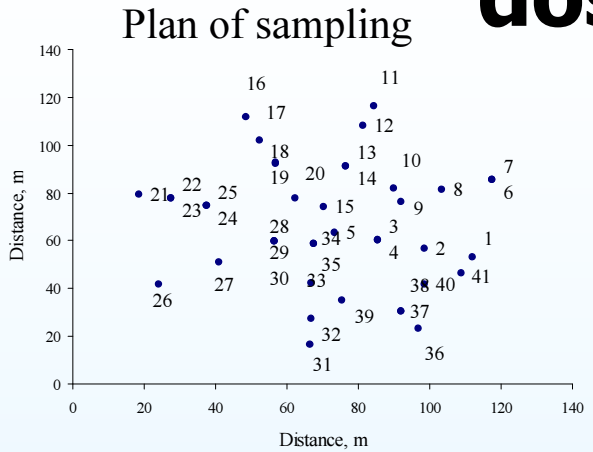
- Radon concentration in soil air was 13-79 kBq/m^3, similar to concentrations in Lithuanian soil.
- Since radon is a decay product of ^{226}Ra it was clear that comparatively small amount of soil was contaminated.
- Having analyzed results potential exposure doses were assessed
- Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment, IAEA Safety Reports Series No. 19
- Three possible measures for remediation had been identified:
  - to transfer 30 cm top layer (23 m^3) of contaminated soil to repository of radioactive waste,
  - not to take any measures,
  - to cover the contaminated soil with the clean one.
- The last option has been suggested as the most optimized.
- A few years after water was monitored.

2. Investigation of site where Russian fighter crash and analysis of found metal

- Measurements and analysis had to be done very quickly and no initial information what might be found was available
- Dose rate scanning of accident place. Identifinder Target FieldSpec was used. ^{238}U was identified in metal sticks.
- Gamma spectrometry and MGAU (Multiple Group Analysis for Uranium) code were used
- It has been found that metal sticks contains:
  ^{235}U – (0.325±0.004) %,
  ^{238}U – (99.674±0.004) %. It was depleted uranium from broken bombs.
- Dose rate scanning of site was repeated many times.
- Wrecks were checked with do

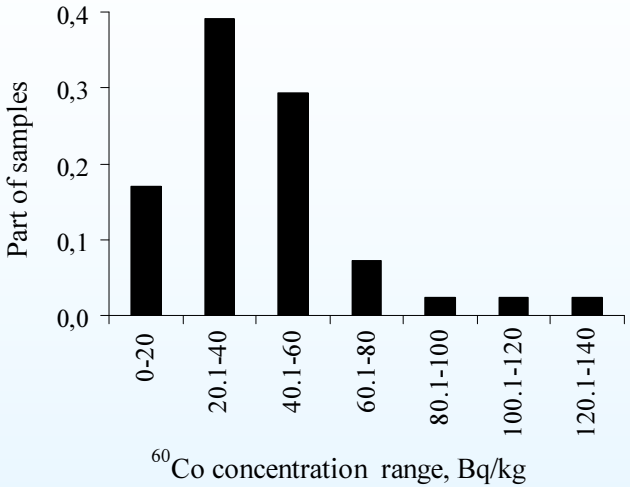


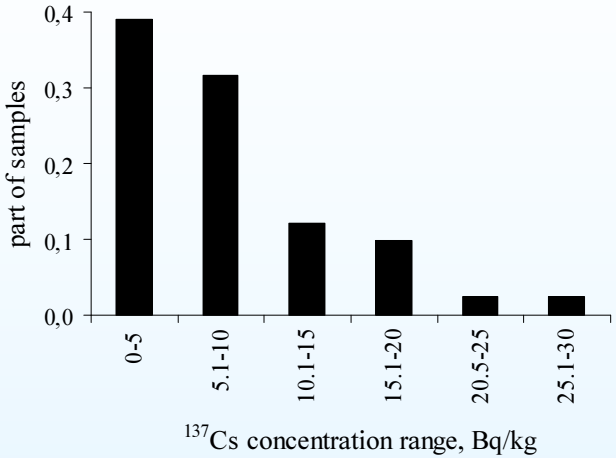
3. Radiological assessment of site and dose evaluation



- Temporary storage of sewage sludge of Visaginas city was in a quarry, in Karlu village, Ignalina district.
- Workers of Ignalina NPP (RBMK reactor) live in Visaginas. Waste from Ignalina NPP could get into storage.
- Plan of sampling
- software Environ-Calc by American Chemical Society the number of samples needed to be sampled was optimized
- The area of site was 1 hectare. Layer of sludge was 1-1.5 m. 38 sludge samples from different depth (5-90 cm) were collected. Round area was divided to 8 equal parts. Samples were taken on radiuses every 10-15 meters

3. Radiological assessment of site and dose evaluation





- Gamma spectrometry.
- Two artificial radionuclides ^{60}Co and ^{137}Cs were found. Average activity concentration of ^{60}Co for the fresh weight in the samples was (42±8) Bq/kg (range 1.4-135 Bq/kg) ^{137}Cs – (10±4) Bq/kg, (range 1.2-25 Bq/kg). Correlation was calculated
- Activity of tritium in water was measured

3. Radiological assessment of site and dose evaluation

- General dose model was used for conservative evaluation
- Possible ways of exposure,
- External and internal exposure
- Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment, IAEA Safety Reports Series No. 19
- Two potential exposure pathways from radionuclides in sewage sludge were considered and two scenarios descriptions were made.
- The first scenario was when the sludge is using for fertilization and the second one – the sludge is covered with soil.
- The lower doses would be when the sewage storage is covered using soil

4. Investigation plots for new NPP in the vicinity of Ignalina NPP

- Gamma dose rate scanning with hand held instruments
- *In situ* gamma spectrometry
- Sampling
- Laboratory gamma spectrometry

In situ gamma spectrometry

- High purity germanium crystal (diameter – 63.5 mm, length – 64.4 mm)
- Relative efficiency 51.1%
- Calibration is done in the energy range from 59 keV (^{241}Am) to 1836 keV (^{88}Y). Calibration standard is a mixture of 10 radionuclides in the Marinelli beaker
- Resolution (0.91 keV FWHM at 122 keV and 1.86 keV FWHM at 1332keV)
- Canberra Genie 2k for analysis of spectra
- Detector without collimator
- Spectrometer fixed on a tripod holder.
- Geometry of measurements is a circle of 20 m in diameter and 20 cm in thickness; detector is situated 1 m above the ground, directed downwards
- The efficiency mathematical calibration with ISOCS software
  - geometry of source (volume of soil, from which gamma photons are recorded by detector)
  - geometry is characterized by thickness of layer of soil and area of soil
  - presumption is made that surface of soil is flat, this area has the shape of a circle
- Density of contamination of soil with radionuclides is recorded in Bq/m^2, though these radionuclides are distributed in the layer of some thickness

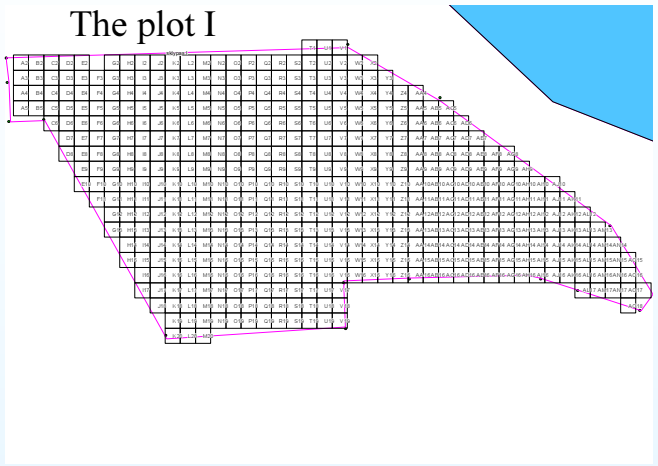
Equipment for measurements and sampling used during investigations

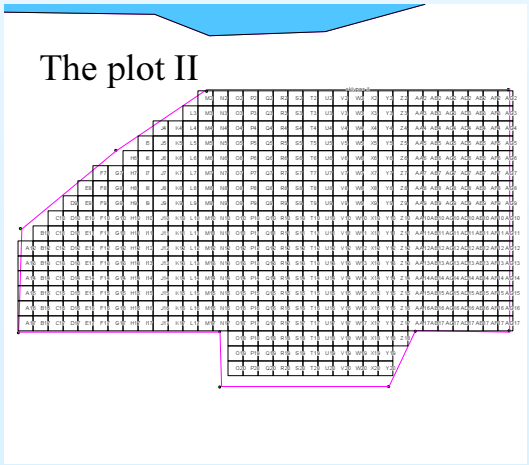
1. *Instruments for location of points of sampling and measurements:*
   - GPS (*Global Positioning System*);
   - Small flags;
   - Metal rods, ribbon for marking;
   - Laser length gauge (up to 100 m);
   - Maps of plots
2. *Devices for measurements of dose rate*:
   - Dose rate survey meter FH 40, extra batteries;
   - Means for registration of results of measurements.
3. *Instruments for soil sampling:*
   - **Soil sample ring (square - 0.015 m^2, depth – 5 cm);**
   - Hermetic plastic bags, labels.

4. *Devices and instruments for measurements by in situ gamma spectrometer*:
   - In situ gamma spectrometer with HpGe detector;
   - Tripod holder for spectrometer.

Dose rate scanning

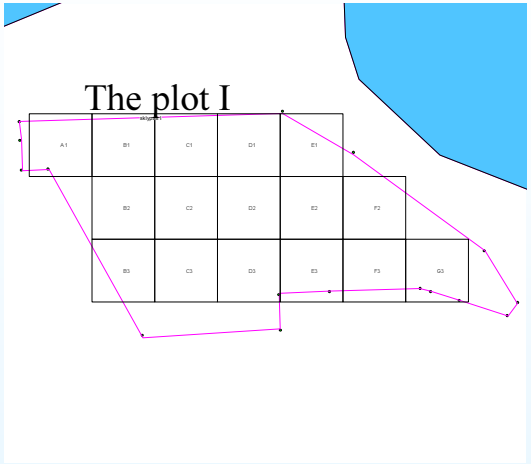
- Dose rate scan at 1 m above ground
- 500 measurements were done for every plot.
- Dose rate higher than background was not found

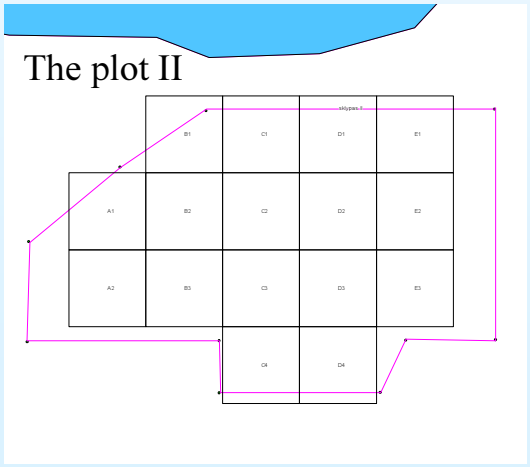




In situ gamma spectrometry, sampling, gamma spectrometry of soil samples

- Plots were divided to 16 quadrates
- In situ gamma spectrometry and sampling was done in the middle of every quadrate
- GPS used
- Regular sampling
- The same time soil samples for measurements was taken from the same places
- “Envelope” method was used for sample collection
- 5 volumes at a depth of 0-5 cm





In situ gamma spectrometry measurement

Location of measurement was as flat as possible and similar to geometry of calibration.

Before *in situ* measurements an actual distribution of artificial radionuclides was unknown

Plot I

- ^{137}Cs<MDA (0.3-0.6 kBq/m^2)
- ^{60}Co<MDA (0.1-0.5 kBq/m^2)

Plot II

- ^{137}Cs – MDA-(3.1±0.4) kBq/m^2
- ^{60}Co<MDA (0.1-0.5 kBq/m^2)

Gamma spectrometry of soil samples

- Lower concentrations were measured compare with *in situ* gamma spectrometer.

shielding, dried samples, longer measurement time

Plot I

- ^{137}Cs – MDA-(0.6±0.1) Bq/kg
- ^{60}Co<MDA (0.3 Bq/kg)

Plot II

- ^{137}Cs – MDA-(21±2) Bq/kg
- ^{60}Co<MDA (0.3 Bq/kg)

People who worked on these projects under leadership of G. Morkunas: R. Ladygiene, L. Pilkyte, A. Abromaityte, J. Ziliukas, A. Skripkiene, A. Orentine, V. Zukauskaite, A. Juraityte, R. Kievinas. They are or were workers at Radiation Protection Centre

Conclusions

- Radiation Protection Centre makes efforts in optimized use of available resources in order to characterize contaminated sites and identify radiation protection measures