EUROPEAN COMMISSION
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Radiation Protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

POLAND

29 June to 02 July 2009

Reference: PL-09/05

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35
OF THE EURATOM TREATY

FACILITIES:	MARIA Research Reactor at Świerk Nuclear Centre, Poland.
SITE:	Świerk Nuclear Centre and surrounding area, region of Warsaw.
DATE:	29 June to 02 July 2009
REFERENCE:	PL-09/05
INSPECTORS:	Mr J-L Frichet (Head of team) Mr S Mundigl Ms C Hanot Mr P Vallet
DATE OF REPORT:	13/04/2010

SIGNATURES:

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TABLE OF CONTENTS

TECHNICAL REPORT

1. ABBREVIATIONS

ADSL	Asymmetric Digital Subscriber Line (telecommunications)
AGH	*Akademia Górniczno-Hutnicza* (University of Science and Technology, Krakow)
CA	Competent Authority
CCA	Centre of Contamination Analysis (Ministry of Defence)
CEZAR	*CEntrum do Spraw ZdArzeń Radiacyjnych* (Radiation Emergency Centre, of NAEA), Warsaw
CLOR	*Centralne Laboratorium Ochrony Radiologicznej* (Central Laboratory for Radiological Protection), Warsaw
CMS	Central Monitoring System
CoDecS	Coding DECoding Software (information exchange system for ECURIE)
cpm	counts per minute
CSI	Chief Sanitary Inspectorate, Warsaw
DG ENER	Directorate General for Energy
DG TREN	Former Directorate General for Energy and Transport
EC	European Commission
ECURIE	European Commission Urgent Radiological Information Exchange
EMERCON	EMERgency CONvention (IAEA emergency notification system)
ERL	Environmental Radioactivity Laboratory (of the IFJ, Krakow)
EU	European Union
EURDEP	European Radiological Data Exchange Platform
GIG	*Główny Instytut Górnictwa* (Central Mining Institute), Katowice
GM	Geiger Müller (radiation detector)
GPRS	General Packet Radio Service (telecommunication)
HELCOM	HELsinki COMmission (governing body of the 'Convention on the Protection of the Marine Environment of the Baltic Sea Area' – more usually known as the Helsinki Convention)
HPGe	High Purity Germanium (gamma detector)
IAE	Institute of Atomic Energy
IAEA	International Atomic Energy Agency
IFJ	*Instytut Fizyki Jądrowej* (Henryk Niewodniczański Institute of Nuclear Physics of the Polish Academy of Sciences), Krakow
IMGW	*Instytut Meteorologii i Gospodarki Wodnej* (Institute of Meteorology and Water Management)
JRC	Joint Research Centre
MCA	Multi-Channel Analyzer (electronic device for measurements)
MD	Ministry of Defence

MDA	Minimum Detectable Activity
MENV	Ministry of ENVironment
MH	Ministry of Health
MORS-PRO	Monitoring Of Radioactive Substances PROject group (of HELCOM)
MRRD	MARIA Research Reactor Department
MRRS	MARIA Research Reactor Site
MT	Ministry of Treasury
NAEA	National Atomic Energy Agency
NaI(Tl)	Sodium Iodide Thallium activated (low resolution gamma detector crystal)
NIST	National Institute of Standards and Technology (USA)
NORM	Naturally Occurring Radioactive Material
NRRW	National Repository of Radioactive Waste
PCA	Polish Centre for Accreditation
PIPS	Passivated Implanted Planar Silicon (alpha and beta detector)
PMS	Permanent Monitoring Station
PROCORAD	(Association for the) PROmotion of quality COntrol in RADiotoxicological analysis
PZH	*Państwowy Zakład Higieny* (National Institute of Hygiene)
REC	Radiation Emergency Centre (at CEZAR)
REM	Radioactivity Environmental Monitoring (European database at JRC Ispra)
RPML	Radiation Protection Measurements Laboratory (at IAE)
SCA	Single Channel Analyzer (electronic device for measurements)
SQL	Structured Query Language
SSDL	Secondary Standard Dosimetry Laboratory
WIChiR	*Wojskowy Instytut Chemii i Radiometrii* (Military Institute of Chemistry and Radiometry, Warsaw)
WIHiE	*Wojskowy Instytut Higieny i Epidemiologii* (Military Institute of Hygiene and Epidemiology, Warsaw)
WSSE	*Wojewódzka Stacja Sanitarno-Epidemiologiczna* (Voyvodship – regional – Laboratories of Sanitary Inspection)
ZUOP	*Zakład Unieszkodliwiania Odpadów Promieniotwórczych* (Radioactive Waste Management Plant)

2. INTRODUCTION

Article 35 of the Euratom Treaty requires that each Member State shall establish facilities necessary to carry out continuous monitoring of the levels of radioactivity in air, water and soil and to ensure compliance with the basic safety standards[(1)].

Article 35 also gives the European Commission the right of access to such facilities in order that it may review and verify their operation and efficiency.

For the EC, the Directorate-General for Energy (DG ENER; formerly Directorate-General for Energy and Transport - DG TREN) and in particular its Radiation Protection Unit (at the time of the visit: TREN.H.4) is responsible for undertaking these verifications.

The main purpose of verifications performed under Article 35 of the Euratom Treaty is to provide an independent assessment of the adequacy of monitoring facilities for (as far as applicable in the Member State):

- Liquid and airborne discharges of radioactivity into the environment by a site (and control thereof).
- Levels of environmental radioactivity at the site perimeter and in the marine, terrestrial and aquatic environment around the site, for all relevant pathways.
- Levels of environmental radioactivity on the territory of the Member State.

On 4 July 2006 the Commission published a Communication in the Official Journal on: 'Verification of environmental radioactivity monitoring facilities under the terms of Article 35 of the Euratom Treaty. Practical arrangements for the conduct of verification visits in Member States'

For the purpose of such a review, a verification team from DG TREN.H.4 visited the MARIA Research Reactor site located near Warsaw in Poland, as well as some laboratories which are part of the national monitoring system for environmental radioactivity. The visit included meetings with representatives of the National Atomic Energy Agency (NAEA) and the MARIA Research Reactor staff. With due consideration to the scope of the verification mission and taking into account the relatively short time available for the execution of the programme, it was agreed that emphasis would be put on the:

- Verification of the discharge monitoring (gaseous and liquid) of the MARIA Research Reactor,
- Verification of the environmental monitoring on-site and off-site of the Świerk Nuclear Centre.

The present report contains the results of the verification team's review of these relevant aspects of environmental surveillance of radioactivity on the territory of Poland.

The report is also based on information collected from documents received and from discussions with various persons met during the visit.

The verification team acknowledges the co-operation it received from all participating individuals.

3. PREPARATION AND CONDUCT OF THE VERIFICATION

3.1 PREAMBLE

The Commission's decision to require the conduct of verifications under the terms of Article 35 of the Euratom Treaty was notified to the Polish government on March 2009 (letter referenced TREN/H4/CG/cd D(2009)47791, addressed to the Permanent Representative of Poland to the

[1] Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation. (OJ L-159 of 29/06/1996, page 1).

European Union). The Polish Government designated the National Atomic Energy Agency (NAEA), which is supervised by the Ministry of Environment, to lead the technical preparations for this visit. Subsequently, practical arrangements for the implementation of the verification were made with NAEA.

3.2 PROGRAMME OF THE VISIT

A programme of verification activities under the terms of Article 35 was discussed and agreed upon with the Polish competent authorities (NAEA).

It comprised the verification of the gaseous and liquid discharges of the MARIA Research Reactor and the environmental monitoring on-site and off-site of the Świerk Nuclear Centre.

A summary overview of this programme of verification activities is provided in Appendix 1. The verification activities were carried out in accordance with this proposed programme. At the locations listed in the programmed verification activities addressed technical aspects of monitoring and sampling, analytical methods used quality assurance and control, archiving and reporting of data.

On 29 June 2009, an opening meeting was held at the MARIA Research Reactor site.

During the visit the team attended presentations on different topics relevant to the verification of:

- the MARIA Research Reactor (discharge monitoring),
- the environmental monitoring on-site the MARIA Research Reactor area,
- the environmental monitoring off-site the MARIA Research Reactor area,
- the programme for monitoring drinking waters at CLOR (Warsaw).

3.3 DOCUMENTATION

In order to facilitate the work of the verification team, a package of information was supplied in advance by the Polish authorities, in form of detailed answers to a questionnaire prepared by the Commission Services. Additional documentation was provided during and after the verification visit. A list of this documentation is compiled in Appendix 2. The verification team noted the quality and comprehensiveness of all presentations made and documentation provided. The provided information has been extensively used for drawing up the descriptive sections of this report.

3.4 REPRESENTATIVES OF THE COMPETENT AUTHORITIES AND THE ASSOCIATED LABORATORIES

1) National Atomic Energy Agency (NAEA)/Radiation Emergency Centre (CEZAR), in Warsaw

Andrzej Kowalczyk	Director of the Radiation Emergency Centre CEZAR (Department in the NAEA structure)
Rafał Dąbrowski	Head of division of monitoring and prognosis (in the structure of CEZAR)
Ernest Staroń	Chief specialist in CEZAR
Maciej Skarzewski	Chief specialist in Department of Nuclear and Radiation Safety

2) Institute of Atomic Energy POLATOM

Zbigniew Haratym, PhD	Head of RPML
Bogdan Filipiak	Deputy Head of RPML
Jakub Ośko, PhD	Head of Quality Management system
Tomasz Pliszczyński	Head of Division for Radioactivity Contamination Measurements
Katarzyna Wojdowska	Section of Internal Radioactivity Measurements

Piotr Tulik, PhD	Head of Division for Calibration of Dosimetric Instruments
Krystyna Józefowicz, PhD	Deputy Head of Division for Calibration of Dosimetric Instruments
Bożydar Snopek	Division for Radiological Control of the Świerk Centre
Grzegorz Krzysztoszek	Deputy director for research reactor
Jerzy Kozieł	Deputy director for nuclear safety and radiation protection
Andrzej Gołąb	MARIA Reactor Manager
Jan Lechniak	Head of Radiation Protection Division at the MARIA Research Reactor

3) Central Laboratory for Radiological Protection (CLOR), in Warsaw

Paweł Krajewski	Director
Krzysztof Isajenko	Deputy Director
Zofia Pietrzak-Flis	Head of Radiation Hygiene Department
Maria Suplińska	Chemist, Radiation Hygiene Department
Ludwika Kownacka	Physicist, Radiation Hygiene Department
Wojciech Muszyński	Physicist, Radiation Hygiene Department

4) The Henryk Niewodniczanski Institute of Nuclear Physics Polish Academy of Sciences (IFJ PAN)/ Environmental Radioactivity Laboratory (ERL IFJ PAN)/ Laboratory of Radiometric Expertise, ul. Radzikowskiego 152, 31-342, Krakow, Poland

Jerzy Wojciech Mietelski, PhD	Head of Environmental Radioactivity Laboratory (ERL IFJ PAN)

4. LEGAL SITUATION AS REGARDS ENVIRONMENTAL RADIOACTIVITY MONITORING

4.1 INTRODUCTION

Poland has no nuclear programme implemented so far, but the country has several environmental issues related to radioactivity. Poland has a legal framework, in line with the 'EURATOM acquis' and the IAEA standards for ionizing radiation control. It has the necessary basic administrative structure for efficient monitoring of environmental radioactivity throughout the country.

4.2 AUTHORITIES INVOLVED IN RADIOACTIVITY MONITORING

4.2.1 Scope, history and current situation

On the basis of Articles 72-74 of the Act of Parliament of 29 November 2000 – Atomic Law (Polish O.J. of 2007 No 42, Item 276), NAEA has been designated the main responsible organisation for the Polish monitoring programme of radioactivity in the environment. NAEA is supervised by the Ministry of Environment (MENV).

The President of the NAEA, through the Radiation Emergency Centre CEZAR, co-ordinates the monitoring of environmental radioactivity in Poland and is the Competent Authority (CA) in the field of nuclear safety and radiation protection. NAEA has the responsibility to enforce the above mentioned legislation, to ensure for environmental radioactivity monitoring and for regular reporting to the European Commission (EC-JRC/ISPRA) on the basis of Article 36 of the Euratom Treaty, to ensure for emergency preparedness and response in case of radiological accidents and to deal with all matters concerning the relations of Poland with the EU, with the IAEA and other international organisations in this field.

Other organisations involved in the national monitoring programme are:

- The Chief Sanitary Inspectorate (CSI): it supervises the basic units (see: 5.1.II) measuring radioactive contamination of the environment, agricultural products and foodstuffs. CSI reports to the Ministry of Health (MH).

- The Central Laboratory for Radiological Protection (CLOR): it supervises the basic ASS-500 aerosol stations (see: 5.1.2.1), performs the local monitoring of mixed diet, soil, water, radon, etc. by doing the measurements and – based on contracts from NAEA – organises the inter-calibration exercises for all basic units.
- The Institute of Meteorology and Water Management (IMGW): it supervises the basic stations (see: 5.1.I) under its responsibility (IMGW stations) and reports to the Ministry of Environment (MENV).
- The Centre of Contamination Analysis (CCA): it supervises auxiliary military stations and reports to the Ministry of Defence (MD).
- The Institute of Atomic Energy in Otwock-Świerk: it performs local site monitoring and reports to the Ministry of Economy (ME).
- ZUOP, the state-owned 'Radioactive Waste Management Plant': it operates the central radioactive waste repository of Poland located in Różan. ZUOP is the only Polish institution responsible for securing, handling and deposition of radioactive wastes. It reports to the Ministry of the Treasury (MT).

4.2.2 Statutory responsibilities

The statutory responsibilities of NAEA as represented by its president to be mentioned in the context of this report are:

1. Protection of radiation workers, the general public and the environment from the risks of the use of ionising radiation through implementation of, among others:
    - Licensing of medical (except Roentgen apparatus) and non-medical applications of ionising radiation in the industrial, research and educational sectors;
    - Licensing of import, export, transport, storage, use and disposal of fissile and non-fissile radioactive materials;
    - Licensing of the import and use of radiation producing equipment;
    - Monitoring environmental radioactivity by measuring air, water and soil samples;
    - Management of the personal dosimetry data of radiation workers in Poland (with the exception of workers of Roentgen apparatus used in medicine);
    - Recurrent inspections of all installations handling radioactive materials in the medical (except Roentgen apparatus), industrial, research, and educational sectors.
2. Implementation, in compliance with EC Directives, of radiation protection regulations, safety standards and codes of practice for ionising radiation installations;
3. Education and training of radiation workers on radiation protection issues;
4. Implementation of emergency preparedness and response plans.

For fulfilling some of its obligations NAEA may contract an institution which is experienced in radiation protection matters (e.g. CLOR).

The Ministry of Health has the overall responsibility of controlling and monitoring of radioactivity in foodstuffs and feeding stuffs.

4.3 LEGAL FRAMEWORK

4.3.1 Legal basis for radiation protection in Poland

Poland has comprehensive legislation in the area of radiation and nuclear safety. The main legal acts regulating the radiation protection topics are:

a) Act of Parliament of 29 November 2000 – Atomic Law (last amendment 14 April 2006); published in: Official Journal of Laws of 2007 No 42, item 276.

b) Act of Parliament of 11 April 2008 amending the Act of Parliament-Atomic Law; published in: Official Journal of 2008 No 93, item 583.

c) Regulation of the Council of Ministers of 17 December 2002 on stations for the early detection of radioactive contamination and units which measure radioactive contamination; published in: Official Journal of Laws of 2002 no 239, item 2030.

Apart from legal documents specific to radiation and nuclear safety there is a set of other legal acts dealing with:

Nuclear/radiological emergency

d) Regulation of the Council of Ministers of 27 April 2004 on intervention level values for various types of intervention measures and also the criteria for revoking such measures; published in Official Journal of Laws of 2004 no 98, item 987.

e) Regulation of the Council of Ministers of 27 April 2004 on establishing the entities authorized to exercise control the food and animal feeding stuff of compliance with the maximal permissible levels for radioactive contamination, following a radiological emergency; published in Official Journal of Laws of 2004 no 98, item 988.

Radioactive waste/Exemptions

f) Regulation of the Council of Ministers of 3 December 2002 on radioactive wastes and spent nuclear fuel; published in Official Journal of Laws of 2002 no 230, item 1925.

g) Regulation of the Council of Ministers of 6 August 2002 on the instances in which practices involving the risk of exposure to ionising radiation are not subject to the licensing or reporting requirement, and instances in which the said practices may be conducted based on a report (Amended 27 April 2004); published in Official Journal of Laws of 2002 no 137, item 1153; Official Journal of Laws of 2004 no 98, item 980.

4.3.2 Legislative acts regulating radioactivity monitoring in foodstuffs

The applied legislation is the one described in chapter 4.3.1, paragraph a), b) and e).

4.3.3 Legislative acts regulating research reactors

The applied legislation is the one described in chapter 4.3.1, paragraph a), d), e) and g).

For the Maria Research Reactor located in Świerk there are no special legislative acts regulating radioactivity releases to the environment and its monitoring. The Maria reactor is working under the license issued by the President of the National Atomic Energy Agency (NAEA) on 31 March 2009, which is valid until 31 March 2015.

4.3.4 International legislation and guidance documents

j) e.g.:

- EC Directive 96/29 EUROATOM (BSS);
- EC Publication Radiation Protection 112;
- Commission Recommendation of 8 June 2000 on the application of Article 36 of the EURATOM Treaty concerning the monitoring of the levels of radioactivity in the environment for the purpose of assessing the exposure of the populations as a whole. (2004/473/Euratom);
- Council Regulation (EC) n° 737/90 of 22 March 1990, on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station [Official Journal L 82 of 29.3.1990];
- ICRP Publication 60. Recommendations of the International Commission on Radiological Protection 1990;

- IAEA International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources. Safety Series Nº 115, 1996;
- Council Directive 96/29/Euratom of 13 May 1996 laying down basic standards for the protection of the health of workers and the general public against the damages arising from ionising radiation;
- WHO Codex Alimentarius Commission Guideline 5-1989: Guideline levels for radionuclides in foods following accidental nuclear contamination for use in international trade.

5. ENVIRONMENTAL RADIOACTIVITY MONITORING

Overview

The radiological situation of the environment in Poland is monitored by systematic measurement of ambient gamma dose rate in specific places all over the country and measurements of the radionuclide content in primary components of the environment, food and feedstuffs. The system is divided into:

- A national monitoring, providing essential data for evaluation of the radiological situation all over the country under normal conditions and in emergency situations;
- A local monitoring, providing data from areas where activities causing a potential increase in radiation exposure of the local population are (or were) conducted. This refers to the Institute of Atomic Energy in Świerk, the National Radioactive Waste Repository in Różan and the former Uranium Mining Company in the vicinity of the town Jelenia Gora (the main mining having been in the small town Kowary).

Measurements within the national and the local monitoring system are performed by (see figure 1):

- stations (= measuring devices) for early detection of radioactive contamination (early warning stations);
- units (= small laboratories) measuring radioactive contamination of environmental materials, food- and feeding stuffs;
- Specialized units (= large laboratories) of research & development organizations, universities and other institutions performing special measurements.

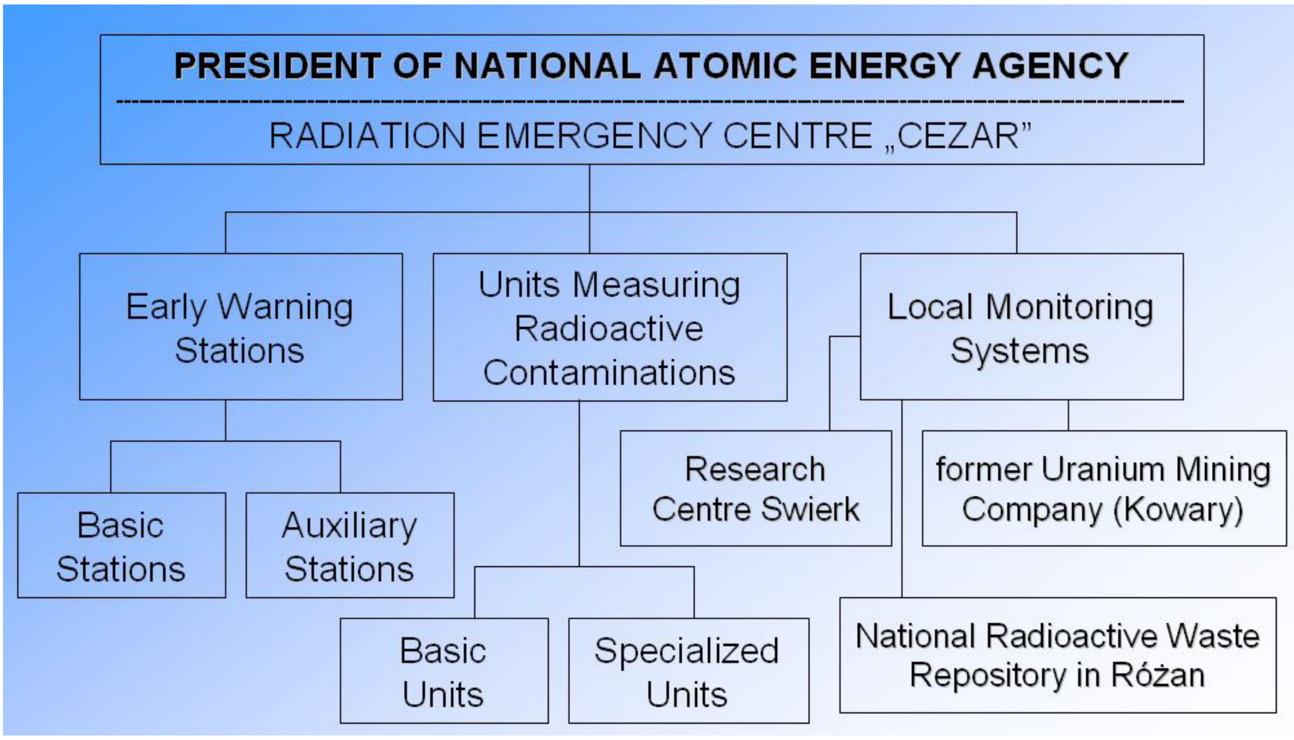

Fig. 1: Radiological monitoring system in Poland

5.1 National Monitoring Programme

According to the Regulation of the Council of Ministers of 17 December 2002, radioactivity monitoring in Poland is performed by:

I. A system for the early detection of radioactive contamination, built of (see figure 2)**:**

- **Basic stations**:
  - PMS (*Permanent Monitoring Stations*) - operating under control of the National Atomic Energy Agency (NAEA);
  - ASS-500 (*Aerosol Sampling Stations*) - operating in different organisations under control of the Central Laboratory for Radiological Protection (CLOR) ;
  - IMGW–stations, operating within the structure of the Institute of Meteorology and Water Management (IMGW) which reports to the Ministry of Environment (MENV);
- **Auxiliary 'military' stations (in Polish “stacje MON”)**, which use relatively insensitive measuring devices and are operating in military organisations reporting to the Ministry of National Defence.

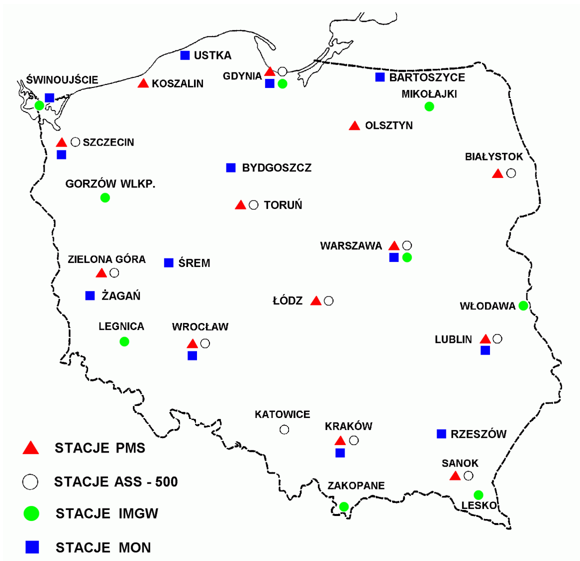

Fig. 2: Location of the stations for early detection of radioactive contamination

II. A network of units using laboratory methods to measure the content of radionuclides in samples of environmental materials, foodstuffs and feeding stuffs

There are two kinds of units:

- **Basic units** – laboratories of the sanitary and epidemiological control system operating in the structure of the Chief Sanitary Inspectorate (CSI) (figure 3);
- **Specialised units** – operating in different governmental institutions, research, universities, etc.

The 48 basic units (of which 34 perform measurements according to the plan agreed with NAEA and send results to the REC CEZAR, NAEA) measure Cs-137 (some also Sr-90) activity in milk (monthly) and foodstuff samples (quarterly).

Within the network, 9 specialized units (laboratories) carry out complex analyses of environmental sample radioactivity (e.g. determination of tritium in water). They are the:

- Central Laboratory for Radiological Protection (CLOR) in Warsaw
- National Institute of Hygiene (PZH) in Warsaw
- Institute of Atomic Energy (IEA) in Otwock-Świerk
- H. Niewodniczański Institute of Nuclear Physics of the Polish Academy of Sciences (IFJ) in Krakow
- Central Mining Institute (GIG) in Katowice

- University of Science and Technology (AGH) in Krakow
- Institute of Meteorology and Water Management (IMGW) in Warsaw
- Military Institute of Hygiene and Epidemiology (WIHiE) in Warsaw
- Military Institute of Chemistry and Radiometry (WIChiR) in Warsaw

Fig. 3: Geographical distribution of the basic units.

Every year, the basic and the specialized units take part in inter-calibration exercises organised by the NAEA President.

5.1.1 Ambient gamma dose rate; the Telemetric Radioactivity Monitoring Network of Poland

Poland has established an ambient gamma radiation monitoring network, with local monitoring stations of different types and two control centres to monitor continuously gamma radiation in the air. One centre is located at CEZAR and the other at CCA (military centre). This network serves also as an Early Warning System (EWS) for the country by sending alarms in case of a radiological emergency when preset dose rate levels are exceeded.

5.1.1.1 Permanent Monitoring Stations (PMS-system)

Thirteen automatic PMS stations (Permanent Monitoring Station), which belong to NAEA, carry out a continuous measurement of:

- Total ambient gamma dose rate (using a "TDLG" tube - based on a *VacuTec* GM counter, produced by *TD-Electronics*);
- Low energy resolution gamma spectrum (using a 3"x3" NaI(Tl) detector type *Canberra 802-* 3x3), to give an indication of the radionuclides leading to elevated dose rate levels;
- Precipitation;
- Temperature.

Normally, all data are transmitted every hour to the Radiation Emergency Centre (CEZAR) at NAEA via GPRS connections. In emergency situations the transmission interval can be lowered to 10 minutes. All data are stored at CEZAR-NAEA in a *Microsoft*® SQL database. They are also stored and displayed on the station's dedicated computer.

Quarterly and yearly reports on the radiation situation in Poland are issued by the NAEA and a daily map of the distribution of gamma dose rate in Poland is published on the NAEA web site (see Appendix 2).

Gamma dose rate data are also transferred to the EURDEP system of the European Commission and to the Council of the Baltic Sea States.

5.1.1.2 IMGW automatic stations

Nine automatic stations are set up by the Institute of Meteorology and Water Management (IMGW) at different locations.

For continuous measurement of total ambient gamma dose rate they are equipped with a proportional counter (*ESM Eberline FHZ 621 G-L*). All stations have an old device (*SSU-70-2* connected to a *Sapos 90-M* Environmental Radiation Monitor) as backup.

Within the meteorological system data are transmitted daily to IMGW headquarters in Warsaw. There a daily report is produced containing the average, minimum, and maximum values from each station. This report is transferred to CEZAR at NAEA, where the data are stored in the *Microsoft*® SQL database. NAEA includes them in its quarterly and yearly reports concerning the radiation situation in Poland.

The IMGW data are transferred together with PMS data to the EURDEP system.

5.1.1.3 Military stations

The Ministry of National Defence operates 13 automatic stations that measure continuously total ambient gamma dose rate using GM tubes. The values are registered automatically in the Centre of Contamination Analysis (CCA). The data are transmitted daily to the National Centre for Co-ordination of Rescue and Protection of Population (at Fire Brigades headquarters) and weekly to CEZAR-NAEA.

5.1.2 Airborne radioactivity: gases and particulates

5.1.2.1 ASS-500 system

The Central Laboratory for Radiological Protection (CLOR) has developed and produces high volume air sampling devices – *ASS-500*. The devices are equipped with *WPMA-12F* blowers having a nominal flow of 500 to 800 m^3/h, infrared heaters (to avoid filter clogging during adverse weather conditions) and a *Vortex* flow rate meter. The average air flow rate is 500 m^3/h.

Currently, thirteen stations of this type collect continuously airborne aerosols on a filter (*Petrianov FPP 15-1.5*) which is changed once a week.

The radionuclide content in the samples is measured in the laboratory routinely using high resolution gamma spectrometry. A first measurement of 3000 s is performed immediately after collection. After two days (to allow decay of radon progenies) the filter is pressed into a disc and measured again for 80 000 s thus offering high detection sensitivity.

Most of these measurements are performed by the institutions (laboratories) where the stations are located (usually, academic centres). Only the filters from a few stations are sent to CLOR in Warsaw for measurement.

Furthermore, twelve of these stations (except the one located at Świder) also measure directly gamma activity of airborne aerosols using a 2"x2" NaI(Tl) detector mounted directly above the filter plates. This detector is connected to an *AS-01* controller. Routinely, seven regions of interest are set in the low resolution gamma spectrum to give an indication for the presence of high values of Cs-137 and of

I-131, and for natural isotopes. Data of these 'on line' stations are transferred once a day via public telephone lines and using modems (from all 12 to CLOR, from 11 to CEZAR).

Twelve of the *ASS-500* stations are the property of the Central Laboratory for Radiological Protection (CLOR) in Warsaw. One station belongs directly to NAEA.

5.1.2.2 IMGW automatic stations

Seven of the nine hydrological-meteorological stations (all except Gdynia and Warsaw) that belong to the Institute of Meteorology and Water Management (IMGW) in Warsaw also operate automatic aerosol monitors (*Eberline FHT 59Si*). These devices have an average air flow rate of 8 m^3/h. They use a glass fibre step-filter band system with steps of 1/10 of the impact zone diameter every half hour and determine:

- Total alpha and total beta activity of aerosols during collection by a PIPS detector;
- Calculated natural alpha and natural beta activity (using an inbuilt algorithm).

Data are processed in the device using *FHT 8000* measuring electronics (which is a component of *FHT59Si*) and transmitted to the local data management PC. All data are daily sent to IMGW headquarters in Warsaw which daily reports to CEZAR-NAEA (via internet).

Calibration (using Sr-90 and Am-241 sources) is done every one to three months by the station's staff.

Total artificial alpha and beta activities measured by the IMGW stations are transferred to the EURDEP system.

5.1.3 Precipitation /Rainwater samplers

All hydrological-meteorological stations (IMGW) operate precipitation samplers (dry and wet deposition, 'fallout') consisting of four trays (1500 cm^2 each) per station. Three of these are for the collection of monthly samples, one is for daily samples. The bottom is covered by a thin layer of water (summer) or ethanol (winter).

Total beta measurement is performed at the station using a plastic scintillation detector (*SSU-70-2* probe) and PC data processing with beta analysis software 'Genie2K'**.** A similar system using *Sapos-90* electronics is available as backup.

The monthly collected samples from all the stations combined are analysed in Warsaw for their Cs-137 content by gamma spectrometry (HPGe detector and gamma analysis software 'Genie2k') and for their Sr-90 content using radiochemistry.

A 2 m^2 precipitation sampler is located at IFJ in Krakow.

5.1.4 Samples of milk produced in Poland

Cow's milk is sampled quarterly by the basic units under the responsibility of the Sanitary Inspection (sampling unit locations see fig. 3 in chapter 5.1.II).

Generally, the samples are analysed for Cs-137 activity. In some units also Sr-90 activity is determined.

The values are transmitted to the headquarters which send reports containing all data to CEZAR-NAEA.

5.1.5 Water monitoring

5.1.5.1 Water from rivers and lakes

Samples of water are collected twice a year (in spring and autumn) from the River Vistula and its two tributaries (the Bug and the Narew rivers), from the River Odra and its tributary the River Warta and from six lakes located in various regions of Poland. Water samples of 20 l are taken from main streams of the rivers or from platforms on the lakes. The location of the sampling points is given in figure 4. Sample analysis is performed by CLOR.

Cs-137 and Sr-90 in water is determined with radiochemical methods. Determination of Cs-137 involves selective absorption of caesium on a thin ammonium molybdophosphate layer and the measurement of beta activity. The determination of Sr-90 is carried out with the method developed by Volchok (via its progeny Y-90). Activities of Cs-137 and of Y-90 are measured with the low-level beta GM multicounter system Model *Risø GM-25-5* having a background of about 0.2 counts per minute and an efficiency of about 40%.

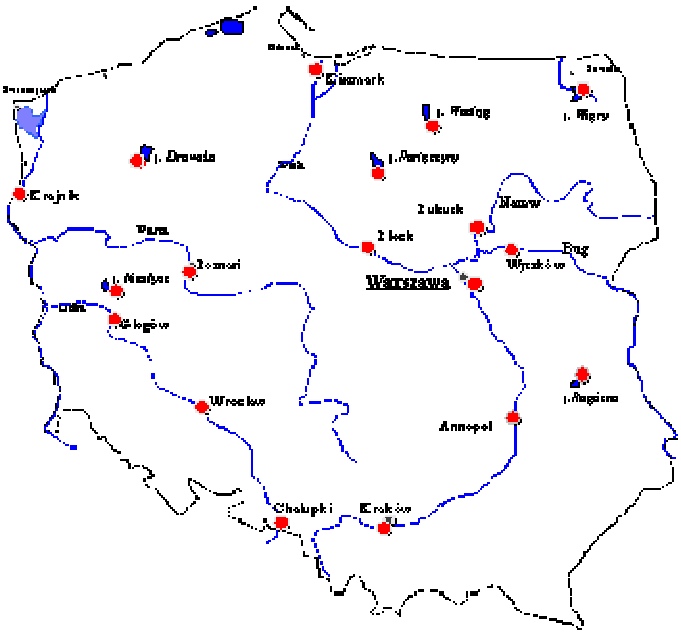

Fig.4: Sampling locations for surface water and sediment

5.1.5.2 Drinking water

For drinking water, no sampling programme was defined up to 2007. During the previous Art. 35 mission held from 13 to 17 November 2006, the lack of such monitoring was pointed out by the verification team. Since then, a drinking water programme has been implemented in CLOR (see chapter 7), which is financed and supervised by the National Atomic Energy Agency (NAEA projects 23/OR/2007, 23/OR/2008, 23/OR/2009).

5.1.5.3 Sea water

Sea water is sampled and analysed within the HELCOM obligations.

5.1.6 Bottom sediments of rivers and lakes taken within the national monitoring programme

In bottom sediments of rivers and lakes Cs-137 and Pu-239,240 are determined by CLOR. Samples are collected twice a year from the same rivers and lakes where Cs-137 and Sr-90 is measured in water; the sampling locations are given in figure 4.

Bottom sediments are taken using a *Van Veen* type device or, if the bottom is stony, with a shovel at a distance of two to five meters from the river bank. The sediment sample mass is about 1 kg.

Cs-137 concentrations are determined by gamma spectrometry. The samples are dried at room temperature and then at 105^{o}C for 16 hours, sieved through a 2-mm mesh to remove plants and stones and placed into a 500 ml Marinelli beaker. Sample volume for measurement is 450 cm^{3}.

Determination of Pu-238 and Pu-239,240 is performed using a radiochemical method with Pu-242 added as tracer. The procedure includes the separation of plutonium from a 50-g sample of sediment, its electrodeposition on a stainless steel plate and the activity measurement by alpha spectrometry. The detection limit of Pu-238 and Pu-239,240 for a counting time of 164000 seconds is 4 mBq/kg.

5.1.7 Bottom sediments from the Southern Baltic Sea

In bottom sediments from the Southern Baltic Sea Cs-137, Pu-238 and Pu-239,240, Sr-90 and Ra-226 are determined. Bottom sediment core samples are collected (using a *Niemisto* corer) from various regions of the southern part of the Baltic Sea, during sampling cruises into the Baltic Sea, organised once a year. The locations of the sampling points are presented in figure 5. Analysis is done by CLOR.

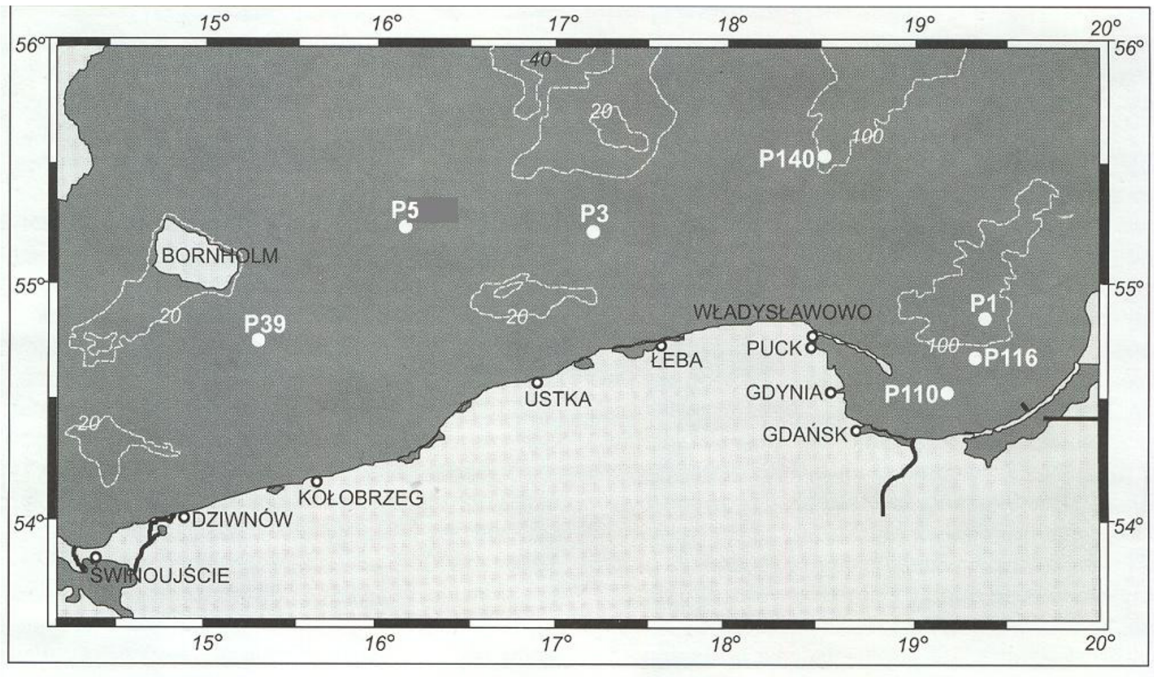

Fig.5: Sea sediment sampling locations

The Cs-137 activity concentration is determined by gamma spectrometry. Plutonium is separated by ion exchange chromatography, followed by electro deposition onto stainless steel disks and measurement by alpha spectrometry; Pu-242 is used as an internal tracer.

The concentration of Ra-226 is determined radiochemically, using an emanation method (measurement of Rn-222 in Lucas-type scintillation chambers) preceded by separation of radium.

The activity concentration of Sr-90 is determined by means of radiochemical separation and measurement of its short-lived progeny Y-90 with a low-level beta counter. The reliability of the applied methods is checked by participation in inter-comparison exercises organised by IAEA and Risø National Laboratory, Denmark.

5.1.8 Foodstuffs (incl. mixed diet)

Individual foodstuffs:

Foodstuffs are collected at hypermarkets and local shops.

- milk products and poultry – twice per year,
- fish, eggs, cereals – once per year,
- fruit, vegetables – once per year during harvest,
- meat (different kinds) – once per quarter.

Vegetables, fruit, freshwater and sea water fish as well as feeding stuffs are measured by selected basic units of the Sanitary Inspection (WSSE).

Mixed diet:

Mixed diet samples originate from canteens preparing breakfast, dinner and supper. Meals from one day are gathered into one sample. Whole day samples are collected through eight days, twice per year (during spring and autumn seasons).

Sampling is performed by CLOR.

In all of the above mentioned samples Cs-137 and Sr-90 activity concentration is determined at CLOR.

5.1.9 Meteorological parameters

Meteorological data that may be used in radiological emergency management such as wind speed, wind direction, atmospheric pressure, relative humidity and ambient temperature are obtained from the Meteorological Service of Poland.

Some meteorological parameters (rain intensity, outdoor temperature) are measured by PMS stations as well (see 5.1.1.1; locations see figure 2).

5.2 LABORATORIES INVOLVED IN NATIONAL MONITORING

Accreditation is not required for environmental radioactivity monitoring in Poland. The acceptance is granted by the President of NAEA if standard methods authorised by NAEA are used and the laboratory successfully participates in NAEA's inter-comparison exercises.

5.2.1 Central Laboratory for Radiological Protection (CLOR)

5.2.1.1 General information

The Central Laboratory for Radiological Protection (CLOR), established in 1957, was until 2001 under the authority of the National Atomic Energy Agency. From August 2001 onwards, CLOR has been supervised by the Ministry of Economy. Presently CLOR works on contract basis, mostly annual contracts with NAEA. Approximately 30% of its funds come from contracts with the Ministry of Education and are based on scientific studies and educational training in the field of radiation protection. The total budget of CLOR is around 1 M Euro.

This institute was covered by the verification mission in 2006. It was not included in the current visit as a whole (with regard to drinking water issues see Chapter 7).

The statutory responsibility of CLOR is the protection of the general population, occupationally exposed persons, and of the environment against the hazards of ionizing radiation. CLOR fulfils this task by routine practical activities, preventive and operational tasks, mainly provided by its 12 stations (*ASS-500*) and by providing sound advice to private and governmental organisations. As in former years, the efforts of CLOR were concentrated on operational and preventive actions, aimed to ensure the radiation safety of the country.

CLOR is responsible for the sampling of environmental samples from 500 sampling places in Poland. The main duties of CLOR within the statutory obligations of NAEA are:

- monitoring of radioactive contamination in foodstuffs and environmental components;
- monitoring of personal radiation doses;
- calibration and attestation of radiation measurement instruments;
- research on matters dealing with radiation, radiation protection, radiobiology and radioecology;
- professional training in radiation protection.

CLOR currently employs 60 persons, among them 29 scientists and 16 technicians.

Its statutory duties are fulfilled by several sub-laboratories, some of them having accreditation i.e.: Laboratory of Personal and Environmental Doses and Secondary Standard Dosimetry Laboratory – SSDL (both accredited to ISO 17025 in 2003), Radon Dosimetry Laboratory (accredited to ISO 17025 for radon and radon progenies standard concentrations). The building materials laboratory is foreseen to obtain the accreditation certificate in November 2009, the Laboratory of Radiochemical Analysis and Spectrometry (food monitoring) in February 2010. An organisation chart of CLOR is shown in figure 6.

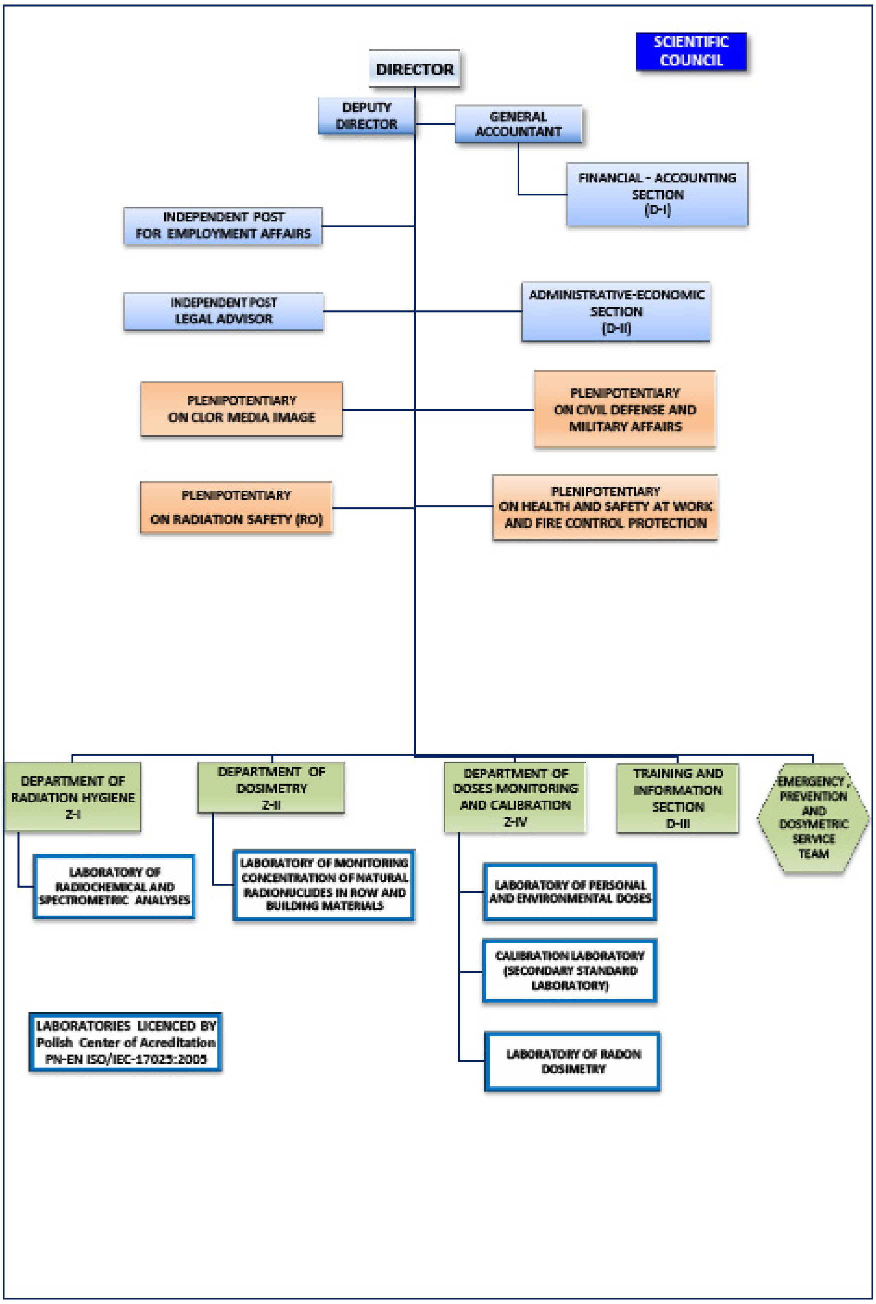

Fig.6: Organisational structure of CLOR

5.2.2 Environmental radioactivity laboratory (ERL) of the Henryk Niewodniczanski Institute (IFJ)

The Henryk Niewodniczanski Institute of Nuclear Physics of the Polish Academy of Sciences is a research institute employing 500 persons. It is divided into 5 divisions with 17 departments. The environmental laboratory consists of several sub-laboratories, one of which is the Environmental Radioactivity Laboratory (ERL).

This institute was covered in the verification mission in 2006; it was not included in the current visit.

5.2.3 WSSE basic units

Generally, WSSE basic units are supplied with:

- Dose rate monitors;
- NaI(Tl) detectors for gamma spectrometry;
- *Inter-Polon Tristan 1024* MCAs with manual peak setting;
- Polon electronic devices;
- *Inter-Polon Sapos-90* high voltage supply / amplifier / SCA / counter devices (generally used with 3 channels for NaI(Tl) gamma measurements and for dose rate).

Some units also operate:

- PMS stations;
- *ASS-500* stations;
- Liquid scintillation counters;
- HPGe gamma spectrometry systems.

5.2.4 IMGW stations

Generally, IMGW stations are supplied with:

- *ESM FHZ 621 G-L* with proportional counters (gamma dose probe);
- *SSU-70-2* detectors as backup;
- *Sapos-90M* and *Sapos-90* Environmental Radiation Monitors;
- Beta scintillation detectors;
- NaI(Tl) detectors for the measurement of samples from the pump *RAS-1* to detect artificial radionuclides in air;
- PCs for signal processing and data analysis (gamma and beta analysis);
- Precipitation samplers (description see 5.1.3).

Some units also operate:

- Automatic *ESM FHT 59SI* aerosol monitors (description see 5.1.2.2);
- Air pumps *RAS-1* with iodine filters.

5.2.5 The CEZAR-NAEA data centre

<u>General</u>

Poland has signed bilateral agreements on early notification of a nuclear accident and on co-operation in nuclear safety and radiological protection with Denmark, Norway, Austria, Ukraine, Belarus, the Russian Federation, Lithuania, Czech Republic, Germany and the Slovak Republic.

NAEA's role in emergency arrangements is through the Radiation Emergency Centre 'CEZAR'.

CEZAR was covered in the verification mission in 2006; it was not included in the current visit.

CEZAR was established in 1997; at first it was part of the Nuclear and Radiation Safety Department, in 2002 it became a separate department of NAEA. Since 2005 CEZAR is fully operable performing all the tasks written in the proper Articles of chapters X and XI of Atomic Law. CEZAR is a body of NAEA designed to observe the radiation situation in the country and as international contact point (warning point and contact point for domestic and abroad as well as Competent Authority contact point) for EC (ECURIE) and IAEA (EMERCON) working on a 24 hours a day basis. It also serves as channel for exchanging information on radiation emergencies with neighbouring countries according to bilateral agreements.

The organisational setup of NAEA is shown in figure 7.

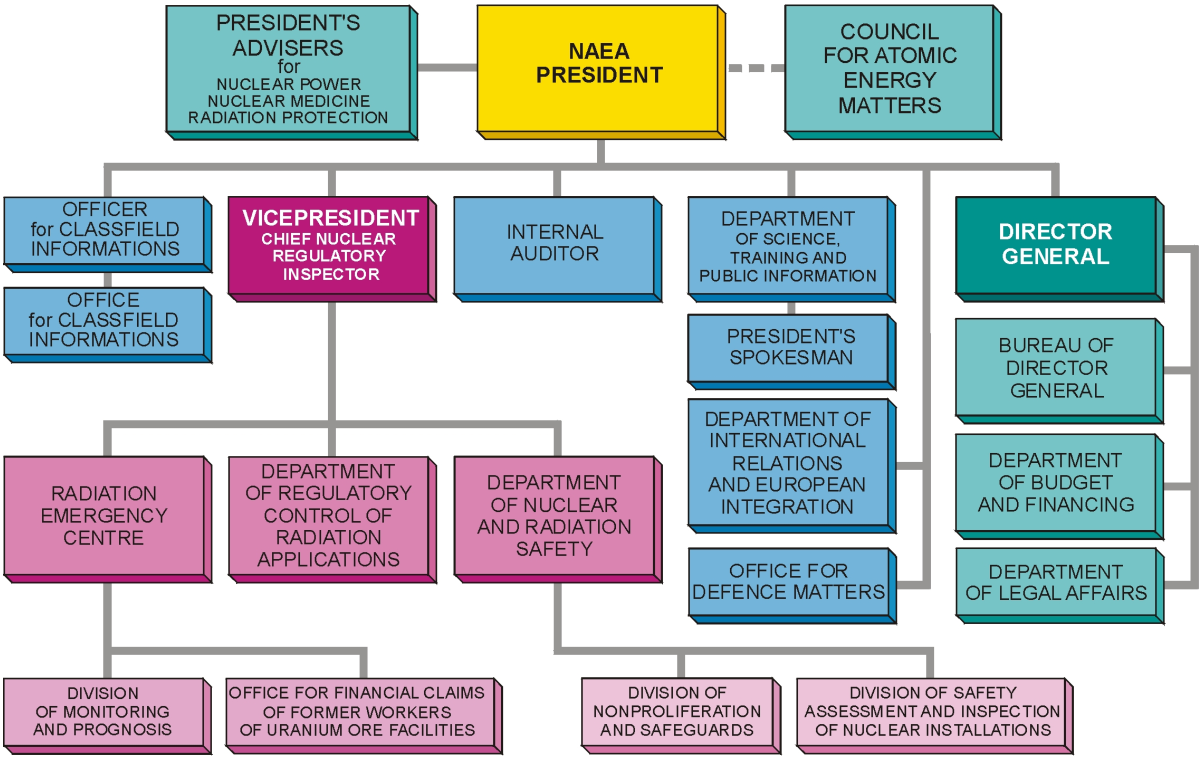

Fig.7: Organisational structure of NAEA

<u>*Data centre*</u>

Among other tasks CEZAR fulfils a role of a data centre. 10 persons are employed in CEZAR in the Warsaw headquarter of the NAEA (additional 4 persons are employed in the Office for financial claims of former workers of Uranium Ore Facilities in Jelenia Gora (south part of Poland)). The tasks are related to managing radiological data from automatic and laboratory based networks for normal situations as well as in emergencies. In particular, CEZAR manages data from the automatic monitoring systems, PMS and *ASS-500* (on line NaI(Tl) detector). All the 13 PMS stations transmit data online (gamma dose rate, temperature, spectra, background). Data from 11 of the ASS-500 stations are transferred by public telephone line twice a day to CEZAR and are displayed on a computer screen. Results of laboratory spectrometric measurements (of filters) are prepared by CLOR each month and send to CEZAR-NAEA as a paper report. CEZAR also receives – by fax - the data collected under the responsibility of the Ministry of Defence, once per week in paper form.

The following data systems are available at CEZAR:

- ECURIE system/CoDecS station (European emergency notification and information system)
- EURDEP (FTP server, where data from the early warning stations are published for the EC and the Council of the Baltic Sea States)
- REM Data Submission Tool (European laboratory data transmission system for the REM data base at JRC/Ispra)
- METEO (Polish meteorological data communication system; data are sent to CEZAR/NAEA as text files once a day via a dedicated internet line using point to point connection).

- *MS* SQL server (data from the early warning stations, data for the *ARGOS* decision support system)

Presentations and reports can be generated using dedicated software tools. Using these tools reports may be generated at any time if needed.

<u>*Reporting*</u>

- daily reports – data from stations
    - map (published on the Internet) – data from PMS
    - chart report – data from PMS and IMGW
- official quarterly announcements on some specific items (published in the Polish law bulletin “Monitor Polski”)
- Annual Report for the Prime Minister – data presentation and description

<u>*Mobile measurement system*</u>

CEZAR-NAEA operates a radiation survey vehicle that can be used for:

- continuous measurement of ambient gamma dose rate and gamma spectra along the vehicle’s route,
- searching and identification of orphan radioactive sources,
- collecting environmental samples for laboratory measurements,
- other purposes.

6. VERIFICATION ACTIVITIES AT THE MARIA RESEARCH REACTOR

6.1 MARIA RESEARCH REACTOR– OVERVIEW

The Maria Research Reactor is situated inside the Świerk Nuclear Research Centre, near Otwock, at around 30 kilometres south-east of Warsaw. The reactor is a pool type reactor with a nominal power of 30 MW_{th} (usually operated at 16 MW, 4000 h/year, weekly cycles). It was built between 1970 and 1974, the first criticality was in December 1974. The reactor is water and beryllium moderated and has a graphite reflector. The fuel elements consist of U-Al alloy and contain fuel with 36% enrichment of U-235. For experiments with neutrons, six horizontal tubes are available. It is the only reactor of this type in the world.

The research reactor was constantly modernised since 1985 as follows:
1985 to 1991
- primary cooling system modernisation
- ventilation system modernisation
- reactor core enlargement
- neutron measurement lines modernisation (*SAKOR A* instrumentation replaced by *SAKOR B*)

2000-2001
- implementation of new instrumentation for controlling thermo-hydraulic reactor parameters
- implementation of a new neutron measurement line based on *Hartmann & Braun* instrumentation

2006-2007
- modernisation of radiation monitoring systems; old system replaced by "intelligent" *Eberline* detectors

2007-2008
- modernisation of a fuel integrity detection system

2008
- implementation of a new visualisation recording system (*SAREMA*).

56 employees are working in the research reactor, 7 of which are focusing on maintenance.

The reactor at the MARIA Research Reactor Site (MRRS) is operated by the Institute of Atomic Energy (IAE). IAE is responsible for the organization of the environmental radioactivity monitoring system connected with this site. This system consists of two parts:

- Radiological monitoring system "on site" in the reactor buildings. It deals with all radiation problems and is defined in radiological terminology as a controlled area. This monitoring is organized by the MARIA Research Reactor Department (MRRD).
- Environment radioactivity monitoring "off site". The area is determined as a territory of the whole Świerk Centre and its vicinity. This territory in radiological terminology is named the surveillance area. System of the control is run by the Radiation Protection Measurement Laboratory (RPML).

The Maria reactor is working under a license issued by the National Atomic Energy Agency (NAEA) on 31 March 2009, which is valid until 31 March 2015. This license states that releases to the atmosphere through the reactor stack are restricted to 1.0 10^{15} Bq/a for noble gases and 5.0 10^{9} Bq/a for all isotopes of iodine (including aerosols). All limits are listed in the Operational Safety report (an updated edition was issued in 2009). Special equipment is located in the stack for on-line measurements and the results are presented in the reactor's control room. The operator of the reactor reports the releases through the reactor stack quarterly to the NAEA.

The MARIA Research Reactor does not have an individual authorisation for liquid discharges. After collection in a tank system and analysis of the content, liquid discharges from the MARIA Research Reactor are transferred to the Department of Waste Management of the Świerk Nuclear Research Site.

The Świerk Nuclear Research Centre has a license to release liquid discharges with a total activity of up to 2.6 GBq/week provided that activity concentrations of discharges stay below 3.7 kBq/dm^3. The total activity A is calculated according to the following formula:

$$A = A_\beta + A_\gamma + 5 \cdot A_\alpha + 15 \cdot A_{Sr-90}$$

With
A_β = beta activity
A_γ = gamma activity
A_α = alpha activity
A_{Sr-90}= Sr-90 activity

6.2 GASEOUS EFFLUENTS CONTROL

Gaseous and volatile radioactive releases through the reactor stack are continuously monitored in a bypass using four measurement systems, using *ESM Eberline* measuring devices:

1SG: Activity of radioactive noble gases; measuring device *FHT 671 S4* with detector *51B51/2M* (NaI(T1) detector);

2SG: Gamma dose rate; measuring device *FHT 191 N*; measuring range 10 nSv/h-10 Sv/h; ionization chamber; energy range 35 keV-7 MeV;

1SA1: Activity of iodine isotopes; measuring device *FHT 671 S4*; detector *51 B51/2M* (NaI(T1) detector)

1SA2: Activity of aerosols; measuring device *FHT 671 S4*; detector *SBB 31* (beta detector).

Additionally, some of the filters of these systems are analysed in the laboratory in order to allow nuclide specific accounting of aerial discharges.

The verification team could check the continuous measurement of the systems 1SG and 2SG and the continuous measurement of the air flow rate in the bypass. A thermal-resistance probe installed in the reactor stack allows correcting the air flow values.

The measuring systems 1SG and 2SG are calibrated once a year and each time when changes in the ventilation system are installed. Calibration is based on releasing specific concentrations of isotopes through the stack.

Since for iodine releases weekly discharge limits are in place, weekly filters (filter change each Monday regardless of reactor operation) are analysed in the laboratory. The determination of discharges of iodine isotopes (I-131, I-132, I-134, I-135) from the MARIA reactor into the environment is based on the gamma spectrometric measurement of I-131 collected on the carbon filters (*Machery-Nagel and Co*, type *MN 728*, diameter 90 mm) that are used in the monitoring system 1SA1, and on calculations by means of the computer code "Iodine Releases". The adsorption efficiency for I-131 for an air flow through the filter of 2 m^3/h is around 85%.

Activity releases of Rb-88 and Cs-138 are determined based on gamma spectrometric measurements of the filters that are used in the monitoring system 1SA2 (fabric filters *FPP-15-1.5*).

The verification does not give rise to recommendations.

6.3 LIQUID DISCHARGE CONTROL

Contaminated liquids are collected in a three chamber tank situated outside the MARIA Research Reactor building. One chamber has a volume of 110 m^3, the two others of 52 m^3. The team verified the presence of the tank. After sampling and analysis by gamma spectrometry, the measurement results are sent to the Department of Waste Management located in the area; this body (independently financed by the government budget) is responsible for all liquid discharges from the whole Świerk research site.

The verification team visited the sewage system of the Świerk Nuclear Research Centre and assisted at the weekly sampling of a water probe at the discharge tank and the subsequent analysis of the sample (see also the visit of the Radiation Protection Measurements Laboratory – RPML – that is responsible for the radiation protection programme; chapter 6.7).

The verification does not give rise to recommendations.

6.4 MAIN RADIATION CONTROL ROOM

Values from the continuous stack monitoring system (see chapter 6.2) and other measuring devices located in the reactor building are transmitted to the dosimetry system in 60 second cycles. Data acquisition and presentation uses the *NetView* system developed by *Thermo Electron Corporation Company* (installed ca. two years ago). When a probe exceeds the preset threshold value an acoustic and visual warning signal is generated in the main radiation control room. The team received an explanation and a presentation of the dosimetry system in this room. Presentation of the measured quantities is in tabular form or graphically (linear diagrams) integrated over time intervals from 1 hour to 30 days. All measurement results received from this system are automatically recorded in the Central Dosimetry Office as monthly files.

Altogether, the dosimetry system includes:

- 15 measuring lines for gamma dose rate,
- 3 measuring lines for neutron dose rate,
- 11 measuring lines detecting air contamination caused by beta radioactive aerosols (probes with plastic scintillators),
- 1 measuring line for iodine releases through the reactor stack (spectrometry with NaI(T1)).

Four types of intelligent probes are used in the system:
- *FHT 191 N* (with ionization chamber),
- *FHZ 621 G-L4* (with proportional counter),
- *FHT 751 BIOREM* (with BF_3 counter),
- *FHT 671* (with scintillation counter).

The verification of the main radiation control room does not give rise to recommendations.

6.5 THE OPERATOR'S LABORATORIES FOR DISCHARGE SAMPLES

The primary purpose of the laboratory analysis programme performed by the operator of the MARIA Research Reactor is to estimate the total radiation dose due to aerial discharges received by a member of the public in the surroundings of the Research Reactor. Thus, the measurements mainly concern the emissions of radioiodine isotopes (radioactive noble gas emissions are calculated based on the on-line monitoring). The laboratory also analyses the 'discharge' tank samples.

The laboratory's gamma spectrometry system consists of a coaxial HPGe detector (*Ortec* "HP GEM-10185-P", ca. 10% relative efficiency, 1.85 keV resolution), NIM electronics from *Canberra*, a multichannel analyzer "TUKAN-8K" and analysis software "TUKAN 2.0" (developed by a team of engineers employed in the Department of Nuclear Radiation Detectors and Electronics of the Institute for Nuclear Studies at the Świerk site).

Cylindrical geometries are calibrated for filter and discharge samples. Once a year an energy calibration is done, using Eu-152 and Am-241 sources. Energy checks are performed before each measurement.

After measurement the filters are stored in a special room for two years.

The verification team noted that a computerised database has been available for the last twelve years; before, an old type of spectrometer was used which could not be linked up with computers ("Tri Star", replaced by "Tukan").

The verification does not give rise to recommendations.

6.6 CONTROL BY REGULATOR

The National Atomic Energy Agency (NAEA; the regulator) does not have its own monitoring programme of the discharges of the Świerk reactor. It supervises the measurements conducted by IAE – the operator.

NAEA quarterly receives data concerning aerial discharges[2]. In case of an excess of the limits imposed by NAEA the operator is obliged to immediately inform the regulator.

The verification team supports all necessary steps to implement an efficient control system by the regulator.

[2] The verification team was informed that the situation as of November 2010 is as such: "Measurements of aerial discharges via the stack are made automatically by the dosimetric system. The NAEA inspectors have full access to the dosimetric system records during inspections or at any time as needed".

6.7 ON-SITE INSTALLATIONS FOR RADIATION PROTECTION (RADIATION PROTECTION MEASUREMENTS LABORATORY – RPML)

6.7.1 Description

The Radiation Protection Measurements Laboratory (RPML) is responsible for the radiation protection programme at the Institute of Atomic Energy, in the vicinity of the Świerk Nuclear Centre and at the National Repository of Radioactive Waste (NRRW) at Różan.

The main tasks are:

- Radiation monitoring of the Świerk and Różan sites,
- Surveillance of radiation safety,
- Radioactive waste control,
- Improvement of radiation protection measurements and methods,
- Calibration of radiation protection monitoring instruments,
- Personal dosimetry,
- Sewage and drainage water activity measurements,
- Environmental radiation monitoring.

The following laboratories and facilities are available at RPML:

(a) Mixed radiation fields laboratory
(b) Contamination Measurements Department
    i) Section of in-vivo measurements (Whole body counter, counter of thyroid activity)
    ii) Section of in-vitro measurements (Radiochemical laboratory)
    iii) Section of Environmental measurements
(c) Calibration Department with standard radiation fields and sources
(d) Radiological Control Laboratory of the Nuclear Centre territory

The verification team was invited to visit the Central Monitoring System (CMS) which is in place to monitor the Świerk Nuclear Centre consisting of 13 intelligent gamma probes for background measurements, two intelligent gamma probes for personal gate measurements, five intelligent gamma probes for water measurement, two air monitoring station, and a meteorological station, all connected to a control panel. All monitoring equipment is from Canberra Packard.

The verification team visited the certified calibration laboratory where all equipment for radiation measurements (air kerma rate for gamma radiation, ambient dose equivalent rate for gamma radiation, neutron flux density, neutron dose equivalent rate, surface emission rate for alpha and beta particles) is being calibrated. This laboratory contains the following sources

- Set of gamma sources with collimated beam:
    - Cs-137 – 160 GBq (1968)
    - Cs-137 – 370 GBq (2004)
    - Co-60 – 11 GBq (2004)
    - Am-241 – 11.1 GBq (2004)
- Set of neutron sources:
    - Cf-252 – 2 GBq (2.3E8 n/s) (2005)
    - Pu-239 – Be (2.12E7 n/s) (1972)
    - Am-241 – Be (1.14E7 n/s) (1984)

The standard ambient dose rate equivalent of the radiation field in the calibration hall has been determined by the Central Office of Measures in Poland.

The verification team visited also the facilities for in-vivo measurements of incorporated radionuclides consisting of a whole body counter and a thyroid counter. The Radiochemistry Laboratory of RPML performs the following in-vitro measurements:

- Activity (concentration) of gamma radionuclides in urine,

- Tritium activity in urine,
- Activity of sulphur (S-35) in urine,
- Activity of phosphorus (P-32) in urine,
- Activity of strontium (Sr-90) in urine

The laboratory is accredited by the Polish Centre for Accreditation (PCA) as follows:
- The determination of internal body contamination (whole body, thyroid and urine) – PCA accreditation No. AB 567.
- Calibration of dosimetric instruments (gamma, neutron and surface contamination monitors) – PCA accreditation No. AP 070.

The Radiation Protection Measurements Laboratory participates in national and international inter-laboratory comparisons, confirming in this way the proficiency of the applied methods.

The comparisons organised by the National Atomic Energy Agency make possible to check the proficiency of procedures of marking the isotopes in environmental samples. Analysed isotopes are: Sr-90, Cs-137, Pu-239, Am-241, Ra-226 and tritium, in samples of drinking and surface water, milk powder, liquid milk, wheat flour, soil and carrot.

RPML participates in international laboratory comparisons coordinated by PROCORAD (Association for the Promotion of Quality Control in Radiotoxicological Analysis). The objects of comparisons are samples of urine; the gamma activity of the isotopes Cs-137, K-40, Co-60, Ba-133, Na-22, I-129 and others and the beta activity of Sr-90 and H-3 is analysed. These experiments enable to estimate the proficiency of accredited procedures.

The team was informed that RPML in cooperation with the Central Laboratory of Radiological Protection (CLOR) organised an inter-laboratory comparison relating to the measurements of iodine I-131 in the thyroid phantom. The comparison gives the possibility of validation of accredited methods concerning the iodine in thyroid determination.

Verification activities with respect to sample preparation, measurements, record keeping and quality control at the Contamination Measurements Department do not give rise to particular remarks.

The verification team focused on the environmental radioactivity monitoring programme in the area and in the vicinity of the Świerk Nuclear Centre. The programme performed by the laboratories of RPML covers the analysis of the following types of samples: air (for aerosols), drainage water, well water, river water, process water, precipitation, mud, milk, soil, cereals and grass.

6.7.2 Sample reception

Samples from the Świerk Nuclear Centre are registered in a log book. An internal database is used for storing and retrieving all samples and measurement related data. General rules are described in a Quality Manual of procedures (in Polish).

The verification team visited the sewage water sampling facility and participated in the taking of a sample from one of the water tanks of 1 m^3.

6.7.3 Sample preparation

Samples are prepared according to the Operational Procedures manual (in Polish).

6.7.4 Sample measurement

Samples of drainage water, well water, river water, process water, precipitation, mud, milk, soil, cereals and grass are analysed for gamma emitters using low background HPGe and NaI(Tl) spectrometers.

The pure beta emitters HTO, Sr-90, S-35 and P-32 are determined by Liquid Scintillation Counters (LSC) and Proportional Counters (PC).

Total alpha and beta activities are measured by LSC and PC measurement devices.

The measurements are carried out with the following equipment:
- Four low background gamma spectrometers with HPGe detectors (*Canberra* – type *GX 3520* and *GX 4018*; *Silena Varro* – type *IGC 30* and *PRGC 4019*);
- Two low background gamma spectrometers 6” x 4” NaI(Tl) and 3” x 3” NaI(Tl) (*Silen*a – *Tukan*);
- Three Liquid Scintillation Counters for alpha and beta measurements (Beckman – LS 6000 IC and *Perkin Elmer – Tri-Carb 2900TR* and *Tri-Carb 3180 TR/SL*);
- Three proportional counters for alpha and beta measurements (*Berthold LB 5310*, *Berthold LB 6305* and *Polon – ZR 16*);

Geometries used and calibration standards: Marinelli, plate sources, point sources and radioactive liquid sources – Czech Metrological Institute; *Polatom*; Amersham; NIST and AEA Technology.

Analysis software used: *Silena*, *Canberra*, *Tukan*, *Beckman* and *Perkin-Elmer*.

The stability of the gamma spectrometers and of the beta and alpha meters is tested using the standard sources before each measurement series.

6.7.5 Measurements results

Recording and archiving procedures are fixed in the Quality Manual of RPML (in Polish).

The registration of results below detection limits should be expressed as "less than MDA (Bq)". Such a result indicates that the radioactivity of the sample is less than the capability of the instrument for detecting radioactivity.

6.7.6 Reporting obligations

The laboratory information system is described in the Quality Manual of RPML and in the General Procedures (in Polish).

According to the agreement between NAEA and *IAE–Polatom*, all environmental sample measurement results should be reported quarterly, except aerosol measurements in air which are reported monthly.

Once a year a report of *IAE–Polatom* is prepared showing an overall estimation of radiological conditions on the territory of the Świerk Nuclear Centre and its vicinity. The last report is IAE Report B, No. B-5/2009 (in Polish).

6.7.7 Sample storage and archiving

Samples are stored for at least two years after the date of measurements.

6.7.8 Verifications

The verification team verified the environmental monitoring programme in place at Świerk, in particular

- Structure and completeness of the programme
- Measurement equipment of the environmental laboratory
- Calibration and quality assurance procedures
- Sample preparation, measurement, reporting and archiving procedures at the laboratory

Verification activities with respect to the on-site environmental monitoring programme do not give rise to particular remarks.

6.8 OFF-SITE ENVIRONMENTAL MONITORING

6.8.1 Description

Environmental radioactivity monitoring off-site concerns an area comprising the whole site of the Świerk research centre and its vicinity (in a perimeter of 200 km). In radiological terminology this territory is named the 'surveillance area'. The monitoring is carried out by the Radiation Protection Measurements Laboratory (RPML) (see chapter 6.6).

In addition, part of the national monitoring system for environmental radioactivity is located in this area. Its stations and units of different types that are situated in a distance of up to 200 km around the research reactor are shown in figure 8. A description of the various types is given in chapter 5.1.

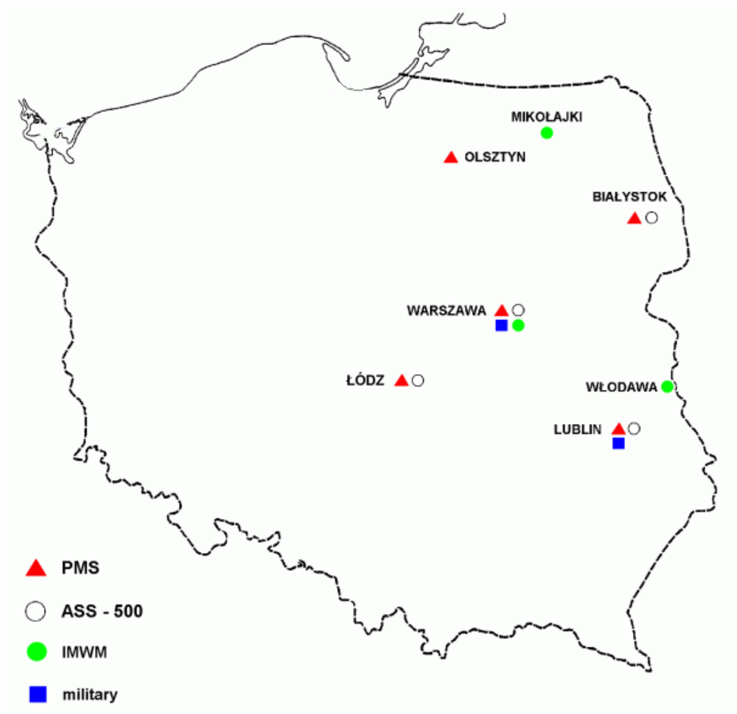

Figure 8: Stations for early detection of radioactive contamination situated in a distance of up to 200 km around the Świerk research reactor (the map does not contain the local ASS-500 *station in Świder near the research reactor).*

6.8.2 Sampling and monitoring sites in Łódź and Warsaw

6.8.2.1 Institute of Applied Radiation Chemistry, Faculty of Chemistry, Technical University of Łódź

The verification team visited the Institute of Applied Radiation Chemistry, Faculty of Chemistry of the Technical University of Łódź, where a PMS station and an ASS500 air sampler are located.

The PMS station is located on the premises of the technical university. Measurements are transmitted to CEZAR, Warsaw, on an hourly basis or on demand every ten minutes via GPRS. This equipment uses a *TDLG* probe (based on a GM counter) for measuring total ambient gamma dose rate and a NaI(Tl) detector (*Canberra 802*-3x3 (3x3" NaI(Tl)) for gamma spectroscopy, both situated outside the building in a closed area. Data are stored in a database at CEZAR and can be accessed locally at the station. The verification team verified the operability of the PMS station, its on-line connection, and the presence of an independent battery supply for power cuts.

The high volume air sampler, an *ASS-500* station, is located outside in a locked area; the key is kept at the gate. For a description of this device type see chapter 5.1.2.1. The filters sampled (weekly change) are prepared and analysed at the university laboratory. Two days after sampling (to allow for the decay of short-lived natural radionuclides), the filter is pressed into a disc form to obtain a standard geometry used for analysis by an HPGe detector. The press used to obtain the disc geometry is located in a different building.

The sample is analysed with a *Canberra* HPGe detector (measurement time 80000 seconds), which is mainly used for measurements of water and soil samples within a research programme at the Institute of Radiology. The filters are analysed for artificial radionuclides, mainly for caesium. The detector is calibrated once a year with standard sources sent by CLOR; in addition, there is an automatic computer calibration. The background spectrum of the detector system is determined once a year with a 5-day measurement.

The results of these weekly analyses are sent to CLOR by email.

There are no cumulative analyses combining filters from several weeks to obtain monthly, quarterly or yearly results. The filters of the current year are kept at the Institute of Radiology but there is no real archiving system. The analyses are performed by a single individual of the scientific staff of the Institute of Radiology. Standardised measurement procedures or protocols were not available.

> *The verification activities with respect to the measurement and sampling station do not give rise to particular remarks.*
>
> *The verification team recommends CLOR to consider establishing standardised measurement procedures and to organise staff back-up*[3].

6.8.2.2 Sanitary Inspection (WSSE) – local laboratory in Łódź

The Sanitary Inspection Stations (WSSE) belong to the Health Ministry and are responsible for the safety of the environment and of the population.

The verification team visited the WSSE laboratory in Łódź, one of 16 provincial sanitary inspection stations in Poland, and verified the presence and operability of the laboratory instruments, as well as the adequacy of the analytical systems in place, including sample registration and preparation and various aspects of quality assurance and control (working instructions, methodologies, calibration, maintenance, bookkeeping of results, reporting etc.). The team noted that all the instructions and procedures were present and readily available at all workstations.

[3] After the verification, CLOR informed the Commission that standard measurement procedures do exist, however, at the time of the visit these were apparently not available at the visited location.

Sampling is performed at district level by local staff. Every three months food, grass, water (surface and underground), and animal feeding stuff samples are collected according to a sampling procedure with predefined sampling sites. Upon arrival, sample information is entered in a log book using a unique sample code. Each sample is accompanied by a sample protocol with all sampling data, the name of the sampling person, his/her signature and the registration number of the station. The sample preparation is done in the laboratory. Samples are not archived after measurement. The samples are routinely analysed for Cs-134, Cs-137, and K-40.

Verification activities with respect to sample reception, encoding and preparation do not give rise to particular remarks.

The verification team noted: The laboratory has two NaI(Tl) detectors (*Canberra 802-3* 2"x2" and *Canberra 802-4* 3"x3") for gamma spectrometry connected to *AccuSpec+* card transducers with *GENIE PC* and *GENIE 2000 Canberra Packard* software. Reference sources with the corresponding certificates were available.

The verification team emphasises that NaI(Tl) based gamma spectrometry is a low resolution application. It is reasonably suited for the measurement of single nuclides showing few peaks.

6.8.2.3 Institute of Meteorology and Water Management in Warsaw

The verification team visited the Institute of Meteorology and Water Management (IMGW) in Warsaw, which offers products in the field of meteorology, hydrology and water management to a variety of customers including the public, the government (central and regional administrations), economy and others. The verification team visited the laboratory and verified the presence and operability of the laboratory instruments, as well as the adequacy of the analytical systems in place, including sample registration and preparation and various aspects of quality assurance and control (working instructions, methodologies, calibration, maintenance, bookkeeping of results, reporting etc.).

Nine IMGW stations are located in Poland, near the boarders, according to the legislation. They measure gamma dose rate and α and β activity in air. For gamma dose rate measurement *FHZ 621-G-L* probes are used; they help distinguishing between dose rate from natural and artificial sources ('NBR method', Natural Background Reduction). To allow separate measurement of natural and artificial α and β activity, an *FHT 59 SI* system is used in seven of the stations. Their data are reported to CEZAR on a daily basis.

The Institute at Warsaw has various rain water collectors (three monthly containers and one daily container) for fall out measurements, using *Eberline* probes for monitoring. Samples are collected and measured by gamma spectrometry (HPGe detector), mostly for Cs-137 traces. Such measurements are carried out since 1961.

Most of the analyses for radiochemistry are done at the IMGW in Gdynia, but some are done on site, in the institute's radiochemistry laboratory. Fall out and some specific waters are being analysed; firstly the water is evaporated under infrared light on a tissue, then this tissue is burnt in an oven at 450°C and the ashes are measured.

Following the measurements, annually a report is drafted and sent to the Ministry of Environment. The correlation between gamma dose rate and rain or snow is calculated annually.

The verification team was informed that the Warsaw laboratory participated in intercomparison exercises with very good results.

The verification activities with respect to the measurements and the sampling procedures do not give rise to particular remarks.

7. CLOR - DRINKING WATER MONITORING - VERIFICATION

As a result of the previous Article 35 mission to Poland (13 to 17 November 2006) the verification team that visited CLOR (*Centralne Laboratorium Ochrony Radiologicznej* - Central Laboratory for Radiological Protection, Warsaw) pointed out that for drinking water, no routine monitoring programme was in place. Since then, a drinking water programme has been implemented by CLOR, financed by the National Atomic Energy Agency (NAEA projects 23/OR/2007, 23/OR/2008, 23/OR/2009). Thus, the EC team visited CLOR to verify what has been done in the frame of monitoring of drinking water.

The current monitoring programme includes the determination of the activity concentration of tritium, gross alpha, gross beta, Cs-137 and Sr-90 in water intended for human consumption in larger urban agglomerations.

If gross alpha radioactivity exceeds 0.1 Bq/l and gross beta radioactivity exceeds 1 Bq/l, the following radionuclides have to be determined:

- natural Ra-226, U-238, U-234, Po-210, Ra-228, K-40;
- artificial Cs-134, I-131.

The verification team was informed that on the basis of the determined concentrations of particular radionuclides and the quantity of consumed water, the annual intake of radionuclides with water is evaluated and the according dose is calculated.

For the dose calculation from water consumption, the following age groups are considered:

- - children below 1 year of age (annual water consumption 250 L);
- - children 1-10 years (annual water consumption 350 L);
- - adolescents 11-17 years (annual water consumption 540 L);
- - adults (annual water consumption 730 L).

7.1 SAMPLING

Figure 9 shows the sampling sites for tap water collection in 2007, 2008 and 2009 in Poland.

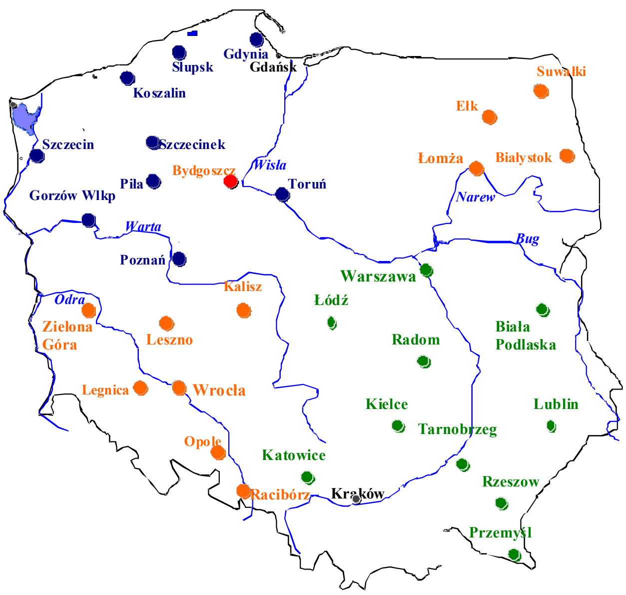

Figure 9: Tap water collection sites (green - 2007, yellow - 2008, dark blue - 2009)

At each site a 20-litre sample of water is taken. 15 litres are used for the determination of Cs-137 and Sr-90; in the remaining 5 litres tritium, gross alpha and gross beta activity are determined.

7.2 METHODS

7.2.1 Cs-137 and Sr-90

These isotopes are determined radiochemically. After evaporation of water, the dry residue is dissolved in nitric acid.

Cs-137 is selectively sorbed on an ammonium molybdophosphate (AMP) mat placed in a radiochemical funnel.

Sr-90 is determined in the remaining solution via the short-lived decay product Y-90. The yield of the chemical separation of Sr-90 is controlled with a tracer (Sr-85).

The beta activity of Cs-137 and Y90 is measured with a low-level beta GM multicounter system, Model *Risø GM-25-5*, of Danish production. The background count rate of this system is about 0.2 cpm. The system was calibrated using standard solutions of Cs-137 and Sr-90. The calibration standards were prepared in the same way as the samples.

7.2.2 Gross beta activity determination

A water sample of 4 litre volume is evaporated to 50 ml. It is transferred to a porcelain dish; some drops of H_2SO_4 are added and the sample is evaporated to dryness. The evaporating dish is placed in a furnace and left for 30 minutes at 350 C°. After cooling, the dry residue is ground in the evaporating dish and weighted. 250 mg of the dry residue are put into a measuring cup of 2 cm diameter. For the measurement of the beta activity the same equipment is used as for the measurement of Cs-137 and Y-90.

The measurement time is twice 180 minutes. The measurement system was calibrated using potassium chloride, in the same geometry as the dry residue after water evaporation.

The detection limit for gross beta activity with the applied method is 0.014 Bq/l.

7.2.3 Gross alpha activity determination

The measurement of gross alpha activity is performed in the dry residue after evaporation of 4 litres of water, as explained above for the gross beta activity method. The dry residue is placed in an aluminium cup of 5 cm diameter and 2 ml of ethanol are added in order to evenly distribute the dry residue on the cup surface; then the sample is dried.

The alpha activity is measured using a low background system with a scintillation detector (background count rate ca. 0.1 cpm). The counting time for the samples is 1000 minutes.

For calibration an Am-241 standard solution was used.

The detection limit for this method is 0.015 Bq/l.

For the calculation of the uncertainty of gross alpha and beta activity the following components are considered: uncertainty due to sample gross count, background count, detector efficiency, weighting and volume measurement.

7.2.4 Tritium determination

When the concentration of tritium is too low for the direct measurement, a method of electrolytic tritium enrichment is applied. The enrichment consists of electrolysis of the water sample with the addition of 20% NaOH solution; the water decomposes to oxygen and hydrogen, whereas the quantity of NaOH remains unchanged. Due to the different ionic mobility of tritium and hydrogen, the decomposition of H_2O is faster than the one of T_2O. Therefore, in the process of electrolysis, the percentage of HTO in the residue becomes higher.

In praxis, three parallel samples of distilled water from each sampling point, 300 ml each, are put in electrolysers and 8 ml of 20% NaOH are added. Electrolysis of the analysed water samples, 3 samples of 'dead' water (background water) and 3 samples of tritium standard samples of known activity has to be carried out simultaneously.

The electrolysis is conducted at a stabilized current of 5 A for 8 to 10 days in electrolysers cooled to a temperature of +1 C°. Electrolysis should be conducted until the liquid reaches the volume of about 14 ml. Afterwards, the volume of the liquid is measured in each of the electrolysers and the liquid is distilled in steel flasks.

10 ml of the distillate are mixed with 10 ml of liquid scintillator (*Ultima Gold*) in glass vials of 20 ml volume. The activity of the samples is measured in the liquid scintillation spectrometer. In order to provide good statistics, for the used device, the measurement time should be at least 25000 s.

The results of the measurement obtained for the standard solutions are used for the calculation of the efficiency of the enrichment (tritium recovery coefficient K). The detection limit of the method is 0.5 Bq/l; the combined standard uncertainty does not exceed 10%.

The verification activities with regard to the drinking water programme do not give rise to recommendations.

8. CONCLUSIONS

All verifications that had been planned by the verification team were completed successfully. In this regard, the information supplied in advance of the visit, as well as the additional documentation received before the start and during the verification, was useful. The information provided and the outcome of the verification activities led to the following observations:

(1) The verification activities that were performed demonstrated that the facilities necessary to carry out continuous monitoring of levels of radioactivity in the air, water and soil in Poland were in place. The Commission could verify the operation and efficiency of these facilities.

(2) With regard to regulatory surveillance of the MARIA Research Reactor at Świerk the verification team recommends preparing and implementing all necessary steps to set up an efficient control system. A few further topical recommendations are formulated that aim at improving some aspects of environmental surveillance in Poland. The recommendations do not discredit the fact that environmental monitoring in Poland is in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

(3) The verification findings and ensuing recommendations are compiled in the 'Main Findings' document that is addressed to the competent authority in Poland through the Permanent Representative of Poland to the European Union.

(4) The present Technical Report is to be enclosed with the Main Findings.

(5) The Commission Services ask the Polish competent authority to inform them of any achievements with regard to the situation at the time of the verification.

(6) The verification team acknowledges the excellent co-operation it received from all persons involved in the activities it performed.

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APPENDIX 1

VERIFICATION PROGRAMME

Monday 29 June 2009

10:30 – 12:30 Opening meeting on the Swierk Research Reactor site with the NAEA and Swierk staff.

- Introductions
- Presentations
- Fixing details of the verification visit

13:30 – 17:00 Team 1: Verification of the Swierk Research Reactor

- Discharge monitoring (gaseous and liquid)

Team 2: Verification of the environmental monitoring on-site the Swierk Research Reactor area

- Dose rate monitoring
- Sampling

Tuesday 30 June - Verifications at the Swierk Research Reactor and surrounding area

09:30 – 17:00 Team 1: Discharge monitoring

- Discharge monitoring (continued)

Team 2: Environmental monitoring off-site the Swierk Research Reactor area

- Monitoring by the operator (6 points…to be clarified at the opening meeting)
- Institute of Meteorology and Water Management (Warsaw): IMGW early warning station

Wednesday 01 July - Verifications at the Swierk Research Reactor and surrounding area

09:30 – 17:00 Team 1: Discharge monitoring

- Discharge monitoring (continued)
- CLOR (Warsaw) : programme for monitoring drinking waters, monitoring by the regulator – past years (till 2009)

Team 2: Environmental monitoring

- Technical University of Lodz: Sanitary Epidemiological Station (WSSE) and PMS, ASS-500 stations.

APPENDIX 2

DOCUMENTATION

National (Polish) Atomic Agency (NAEA)

(http://www.paa.gov.pl/?frame=0.1)

Legislation

Radiation protection

- Act of Parliament of 29 November 2000 – Atomic Law, published in the Official Journal of 2004 No.161, Item 1689 and No. 173 Item 1808.
- Regulation of the Council of Ministers of 17 December 2002 on stations for the early detection of radioactive contamination and units which measure radioactive contamination, published in the Journal of Laws, No. 239, item 2030.

NORM industry

- Regulation of the Council of Ministers of 03 December 2002 on the requirements imposed on the content of natural radioisotopes in raw materials and components applied in buildings for the accommodation of people and livestock, and in industrial waste applied in construction, and the control of radioisotope content, published in the Journal of Laws, No. 220, item 1850.

Mining environment

- *Regulation* of the Ministry of Economy of 06 June 2006 amending the regulation on work safety and hygiene, operations and specialist safeguards in underground mining facilities, published by the Official Journal 2006, No 124.
- Annex 9, 'Radiation hazard from natural radioactive substances' of the Regulation of the Ministry of Economy of 06 June 2006 amending the regulation on work safety and hygiene, operations and specialist safeguards in underground mining facilities, published in the Official Journal 2006, No 124.

Radiological emergency

- Regulation of the Council of Ministers of 17 January 2005 on the emergency planning for radiological emergency, on the basis of Article 87, paragraphs 1 and 2 of the Act of Parliament of 29 November 2000 – Atomic Law (Polish O.J. of 2004 No. 161, Item 1689 and No. 173 Item 1808).

Institute of Nuclear Physics

(www.ifj.edu.pl**)**

Modernisation of the ASS-500 high volume aerosol sampler

Institute of Meteorology and Water Management (IMGW)

(http://www.imgw.pl/wl/internet/zz/english/index.html)

- Technique of gamma dose rate measurement in air for basic stations (document in Polish)
- Technique of artificial alpha and beta activity of airborne aerosols measurement (document in Polish)
- Technique for gamma spectrometry measurement of radionuclides' content in samples of total fallout (document in Polish)
- Technique of total alpha and beta activity measurements in daily and monthly samples ofentire precipitation (document in Polish)
- Programme of gamma dose rate measurement in air for basic stations of IMGW in normal situations (document in Polish)

- Programme of alpha and beta activity of airborne aerosols measurement for basic stations of IMGW in normal situation. (document in Polish)
- Programme of measurements for specialized stations of IMGW in normal situation (document in Polish)

Central Laboratory for Radiological Protection (CLOR)

(http://www.clor.waw.pl)

- Measurement techniques for radiological contamination of the atmospheric air using the ASS-500 stations, issued by the Department of Dosimetry, 2003. (document in Polish)
- Radiation Atlas of Poland, 2005
- Radiation monitoring network in Poland – Structure and activities, Radioactive Contamination Department
- Methodology for radiochemical Cs-137 assay in foodstuff samples and in water, Department of Radioactive Contamination
- Methodology for radiochemical SR-90 assay in foodstuff samples and in water, Department of Radioactive Contamination
- Annual report, 2005
- Paper and electronic report of CLOR on the Research and the Operational Activities, 2002-2003

Other documents:

- Questionnaire on the implementation of Art. 35 of the EURATOM Treaty in the Republic of Poland, 2009